Syllabus for
BA/B.Sc.(Honours) Geography
Choice Based Credit System (CBCS)

Course effective from the academic year 2019-20

This is approved in the Academic Council held on 8/11/2019

Department of Geography

GAUHATI UNIVERSITY

Guwahati-781014

September 2019

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CBCS-UG Geography Syllabus, 2019

Credit and Marks distribution scheme for CBCS Curriculum: Honours Course

Semester	Course Type	Paper Code	Paper Name	Credits	Full Marks
Semester I Credit: 22 Marks: 400	Ability enhancement Course	ENG-AE-1014/ ASM-AE-1014	English Communication Paper, Assamese/ MIL Communication paper	4	100
	Honours Core	GGY - HC – 1016	Geomorphology	4+2=6	100
		GGY - HC – 1026	Cartographic Techniques	4+2=6	100
	Generic Elective paper (Anyone)*	GGY- HG- 1036	Physical Geography	4+2=6	100
		GGY - HG – 1046	Geography of Tourism	4+2=6	100
Semester II Credit: 22 Marks: 400	Ability enhancement Course	ENV-AE-2014	Environmental Science	4	100
	Honours Core	GGY - HC - 2016:	Human Geography	4+2	100
		GGY - HC - 2026:	Climatology and Biogeography	4+2	100
	Generic Elective paper (Any one)*	GGY-HG-2036	Human Geography	4+2=6	100
		GGY - HG - 2046:	Disaster Management	4+2=6	100
		GGY - HG - 2056:	Resources and Sustainable Development	4=2=6	100

Semester III Credit: 28 Marks: 500	Honours Core	GGY - HC - 3016:	Economic Geography	4+2	100
		GGY - HC - 3026:	Geography of India with Special Reference to North-East India	4+2	100
		GGY - HC - 3036:	Quantitative Methods in Geography	4+2	100
	Skill Enhancement Course (Any one)	GGY - SE - 3044:	River Basin Studies	2+2	100
		GGY - SE - 3054:	Thematic Cartography	2+2	100
	Generic Elective paper (Any one)*	GGY - HG - 3066:	Economic Geography	4+2=6	100
		GGY - HG - 3076:	Cartographic Methods	4+2=6	100
Semester IV Credit 28 Marks 500	Honours Core	GGY - HC - 4016:	Environmental Geography and Disaster Management	4+2	100
		GGY - HC - 4026:	Population and Settlement Geography	4+2	100
		GGY - HC - 4036:	Remote Sensing , GIS and GPS	4+2	100
	Skill Enhancement Course (Any one)	GGY - SE - 4044:	Advanced Statistical Techniques for Spatial Analysis	2+2	100
		GGY - SE - 4054:	Surveying Techniques	2+2	100
	Generic Elective Paper (Any one)*	GGY - HG - 4066:	Geography of India with Reference N.E. India	4+2=6	100
		GGY - HG - 4076:	Population and Settlement Geography	4+2=6	100

Semester V Credit 24 Marks 400	Honours Core	GGY - HC - 5016	Social and Political Geography	4+2	100
		GGY - HC - 5026	Field Techniques in Geography	4+2	100
	Discipline Specific Elective (Any two)	GGY - HE - 5036:	Geography of Transportation	4+2=6	100
		GGY - HE - 5046:	Regional Development and Planning	4+2=6	100
		GGY - HE - 5056:	Urban Geography	4=2=6	100
		GGY - HE - 5066:	Agricultural Geography	4+2=6	100
Semester VI Credit 24 Marks 400	Honours Core	GGY - HC - 6016	Geographical Thought	4+2	100
		GGY - HC - 6026	Research Methods in Geography and Project Work	4+2	100
	Discipline Specific Elective (Any two)	GGY - HE - 6036:	Geography of Health	4+2=6	100
		GGY - HE - 6046:	Hydrology	4+2=6	100
		GGY - HE - 6056:	Geography of Tourism	4=2=6	100
		GGY - HE - 6066:	Geography of Resources and Development	4+2=6	100

Syllabus for
BA/B.Sc.(Honours) Geography
Choice Based Credit System (CBCS)

Course effective from the academic year 2019-20

1st Semester

This is approved in the Academic Council held on 8/11/2019

Department of Geography

GAUHATI UNIVERSITY

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Class 1 Hour 1	Duration	Credit
1 Theory Class	1 Hour	1
1 Tutorial Class	1 Hour	1
1 Practical Class	2 Hours	1

Credit and Marks distribution scheme for CBCS Curriculum: Honours Course (1stSemester)

Semester	Course Type	Paper Code	Paper Name	Credits	Full Marks
Semester I Credit: 22 Marks: 400	Ability enhancement Course	ENG-AE-1014/ ASM-AE-1014	English Communication Paper, Assamese/ MIL Communication paper	4	100
	Honours Core	GGY - HC – 1016	Geomorphology	4+2=6	100
		GGY - HC – 1026	Cartographic Techniques	4+2=6	100
	Generic Elective paper (Anyone)*	GGY- HG- 1036	Physical Geography	4+2	100
		GGY - HG – 1046	Geography of Tourism	4+2	100

Subject	Semester	Paper type	Paper Code	Paper name	Total Marks	Marks Distribution					Paper Credit
						External		Internal			
						Theory	Practical	Sessional	Practical /Assignments	Attendance	
Geography	1st	HonoursCore	GGY-HC-1016	Geomorphology (Theory + Practical)	100	60	20	10	6	4	4+2=6
Geography	1st	HonoursCore	GGY-HC-1026	Cartographic Techniques (Theory+Practical)	100	60	20	10	6	4	4+2=6
Geography	1st	Generic Elective	GGY-HG - 1036	Physical Geography (Theory + Practical)	100	60	20	10	6	4	6
Geography	1st	Generic Elective	GGY-HG - 1046	Geography of Tourism (Theory + Practical)	100	60	20	10	6	4	6

*Honours Geography students have to take generic subjects from other disciplines

NB: The examinations for the practicals for couse GGY-HC 1016 and GGY-HC-1026 will be held on same day. There will be two questions of 8 marks along with2marksforvivaand2marksforpracticalnotebookforeachpaper.Studentswillprepareonepracticalbookforevaluationhavingtwopartsforpaper GGY-HC-1016andGGY-HC-1026.Examinerswillsubmitmarksintwoseparatemarksfolios.

CBCS-based U.G. Course in Geography, 2019

Course Name: Geomorphology (Core Course)

Paper Code: GGY - HC – 1016

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives

- To provide a general idea about the topographic and surficial characteristics of the earth's surface to thestudents.
- To make the students aware of the dynamic geomorphic processes responsible for the development of landforms of varied types andnature.
- To apply scientific knowledge on landform development based on geomorphic concepts, principles andtheories.

Course outcomes

- The students will learn that the earth is unstable and it is undergoing constant changes due to dynamic earth'sprocesses.
- The students will come to know about the meaning and scope of geomorphology as a major branch of PhysicalGeography.
- After gaining knowledge based on the contents embodied in this paper, the students will be able to realize the importance of geomorphological knowledge as applied in various developmental activities executed in differentareas.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

Sl. No.	Topic	No of Classes
1	Geomorphology: Nature, ScopeandSignificance	4classes
2	Structure and characteristics of the earth's crustandinterior	4classes
3	Forces of landform development: Endogenetic forces (folding, faulting earthquakes and volcanoes) and exogenetic forces (weathering, erosion and masswasting).	10classes
4	Earth Movements: Continental Drift Theory, Isostasy, Mountain building: views of Holmes and Kober,Platetectonics.	10classes
5	Concept of Cycleof Erosion: Davis and Penck, Landform development under Fluvial, Aeolian and Glacialconditions	12classes

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

Sl. No.	Topic	No of Assignments
1	Study of Topographical Maps: Topographical map content and numbering system, the generalinterpretationoftoposheetsinrespectofphysicalcharacteristics.	3Assignments

Sl. No.	Topic	No of Assignments
2	Profile Drawing (serial, superimposed,projected andcomposite	3Assignments
3	Preparation of Slope Map / Relative Relief Map: Wentworth's method and Smith's method.	3Assignments
4	Delineation of drainage basin and drainage network, construction of cross and long profiles, stream ordering by Horton andStrahler'smethod	6Assignments
5	Interpretation of Geological map and Construction of cross –section (Two geological maps including one with interruptions) showing different sedimentarybeds.	2Assignments
Unit II: Practical Note-Book and Viva-voce (4 Marks)		
6	Evaluation of Practical Note-Book	(2 Marks)
7	Viva-voce	(2 Marks)

Reading List:

1 Bloom A. L., 2003: Geomorphology: A Systematic Analysis of Late Cenozoic Landforms, Prentice-Hall of India, New Delhi.
2 Bridges E. M., 1990: World Geomorphology, Cambridge University Press, Cambridge.
3 Christopherson, Robert W., (2011), Geosystems: An Introduction to Physical Geography, 8 Ed., Macmillan Publishing Company
4 Kale V. S. and Gupta A., 2001: Introduction to Geomorphology, Orient Longman, Hyderabad.
5 Knighton A. D., 1984: Fluvial Forms and Processes, Edward Arnold Publishers, London.
6 Richards K. S., 1982: Rivers: Form and Processes in Alluvial Channels, Methuen, London.
7 Selby, M.J., (2005), Earth's Changing Surface, Indian Edition, OUP
8 Skinner, Brian J. and Stephen C. Porter (2000), The Dynamic Earth: An Introduction to Physical Geology, 4th Edition, John Wiley and Sons.
9 Strahler, A. N. and Strahler, A. H., 2008: Modern Physical Geography, John Wiley & Sons, New York.
10 Thornbury W. D., 1968: Principles of Geomorphology, Wiley.
11 Steers, J.A., 1988: The Unstable Earth, Kalyani Publishers, New Delhi.
12 Monkhouse, F.J. and Wilkinson, H.R., 1989: Maps and Diagrams, B.I. Publications Ltd., Mumbai.
13 Singh R. L. and Singh R. P. B., 1999: Elements of Practical Geography, Kalyani Publishers.
14 Singh, L.R., 2013: Fundamentals of Practical Geography, ShardaPustakBhawan, Allahabad
15 Sarkar, A., 2015: Practical Geography: A Systematic Approach. Orient Black Swan Private Ltd., New Delhi
16 Misra, R. P. and Ramesh, A., 1989: Fundamentals of Cartography, Concept Publishing Company, New Delhi

CBCS-based U.G. Course in Geography, 2019
Course Name: Cartographic Techniques (Core Course)
Paper Code: GGY-HC-1026
Total Credit: 6 (4+2)
Total Marks: 100
(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives

This course on Cartographic Techniques provides a general understanding of the field of cartography including its modern developments and importance in geographic study. It more particularly focuses on various types of map scale and their construction; principles of map projection and construction of selected few; and preparation of thematic maps through the representation of various geographical data using different cartographic techniques.

Course outcomes

- Understandingtheimportanceofvariouscartographictechniquesingeographicalstudy
- General understanding of map type, map scale and mapcontent.
- An acquaintance of different cartographic techniques for representation of various facets of physical and human geographic data of anyarea.

Part I: Theory
Credit: 4 (60 Marks)
(40 classes of 1 hour duration each)

Sl. No.	Topic	No of Classes
1	Cartography – Meaning, Development (Traditional and Modern Cartography) and Importance of CartographyinGeography.	8 classes
2	Shapeandsizeoftheearth,coordinatesystem(latitudeandlongitude)	8 classes
3	Maps: Types, scale and content, representation of point, line and area in maps	8 classes
4	Map Projections: Concept of Map Projection, Classification of Map Projections; Choice ofmapprojection.	10 classes
5	Thematic mapping: Conceptandtypes	6 classes

Part II: Practical
Credit: 2 (20 Marks)
(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)
(Two questions of 8 marks each)

Sl. No.	Topic	No of Assignments
1	Construction of graphical scale (linear, diagonal and comparative); conversion of map scale	6Assignments
2	Construction of graticules of Zenithal Polar Gnomonic and Stereographic, Simple Conical with one standard parallel, Bonne's conical, Gall's Stereographic Cylindrical along with their properties, usesandlimitations.	5Assignments

Sl. No.	Topic	No of Assignments
3	Preparation of thematic maps (choropleth,isopleth and pie diagram) for representing various physicalgeographicdata.	4Assignments

Unit II: Practical Note-Book and Viva-voce (4 Marks)

6	Evaluation of Practical Note-Book	(2 Marks)
7	Viva-voce	(2 Marks)

Reading List:

1 Anson R. and Ormelling F. J., 1994: *International Cartographic Association: Basic Cartographic Vol.,* PergamanPress.

2 GuptaK.K.andTyagi,V.C.,1992:*WorkingwithMap*,SurveyofIndia,DST,NewDelhi

3 MisraR.P.andRamesh,A.,1989:*FundamentalsofCartography*,Concept,NewDelhi.

4 MonkhouseF.J.andWilkinsonH.R.,1973:*MapsandDiagrams*,Methuen,London.

5 RhindD. W. and Taylor D. R. F., (eds.), 1989: *Cartography: Past, Present and Future*, Elsevier, International CartographicAssociation.

6 RobinsonA.H.,2009:*ElementsofCartography*,JohnWileyandSons,NewYork.

7 Singh R. L. and Singh R. P. B., 1999: *Elements of Practical Geography*, Kalyani Publishers.

8 Sarkar, A. (2015) *Practical Geography: A Systematic Approach*. Orient Black Swan Private Ltd., NewDelhi

9 Singh, L.R., 2013: *Fundamentals of Practical Geography*, ShardaPustakBhawan, Allahabad.

10 Talukder,S.,2008:*IntroductiontoMapProjections*,EBHPublishers(India),Guwahati.

CBCS-based U.G. Course in Geography, 2019
Syllabus of Generic Elective Papers
Course Name: Physical Geography
Paper Code: GGY-HG-1036
Total Credit: 6 (4+2)
Total Marks: 100
(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives

- To provide a general idea about the topographic and surficial characteristics of the earth's surface to thestudents.
- To make the students aware of the dynamic geomorphic processes responsible for the development of landforms of varied types andnature.
- To impact applied scientific knowledge on landform development based on geomorphic concepts, principles andtheories.

Course outcomes

- The students will learn that the earth is unstable and it is undergoing constant changes due to dynamic earth'sprocesses.
- The students will come to know about the meaning and scope of geomorphology, which a major branch of PhysicalGeography.
- After gaining knowledge based on the contents embodied in this paper, the students will be able to realize the importance of geomorphological knowledge as applied in various developmental activities executed on the land and over the earth'ssurface.

Part I: Theory
Credit: 4 (60 Marks)
(40 classes of 1 hour duration each)

Sl. No.	Topic	No of Classes
1	Physical Geography – Definition and Scope, Components of EarthSystem	4 Classes
2	Atmosphere – Composition and the vertical structure, Heat Balance, Global Circulation Pattern, Monsoon, Koppen'sClimaticClassification.	10 Classes
3	Lithosphere–InternalStructureofEarthbasedonSeismicEvidence	8 Classes
4	Endogenetic and Exogenetic processes, Works of River, Fluvial Cycle of Erosion – Davis	8 Classes
5	Hydrosphere: hydrological cycle, ocean bottom relief features, oceanic deposits, tides andcurrents.	10 Classes

Part II: Practical
Credit: 2 (20 Marks)
(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)
(Two questions of 8 marks each)

Sl. No.	Topic	No of Assignments
1	Relief representation from the topographical sheet (v-shaped valley, u-shaped valley, conical hill, cliff,uniformslope).	6 Assignments

Sl. No.	Topic	No of Assignments
2	Profile Drawing (Serialandsuperimposed).	4Assignments
3	Rainfall-Temperature Graph, ClimographandHythergraph.	3Assignments
4	Hypsometric andbathymetriccurve.	2Assignments

Unit II: Practical Note-Book and Viva-voce (4 Marks)

6	Evaluation of Practical Note-Book	(2 Marks)
7	Viva-voce	(2 Marks)

Reading List:

1 Conserva H. T., 2004: Illustrated Dictionary of Physical Geography, Author House, USA.

2 Gabler R. E., Petersen J. F. and Trapasso, L. M., 2007: Essentials of Physical Geography (8th Edition), Thompson, Brooks/Cole, USA.

3 Garrett N., 2000: Advanced Geography, Oxford University Press.

4 Goudie, A., 1984: The Nature of the Environment: An Advanced Physical Geography, Basil Blackwell Publishers, Oxford.

5 Hamblin, W. K., 1995: Earth's Dynamic System, Prentice-Hall, N.J.

6 Husain M., 2002: Fundamentals of Physical Geography, Rawat Publications, Jaipur.

7 Monkhouse, F. J. 2009: Principles of Physical Geography, Platinum Publishers, Kolkata.

8 Strahler A. N. and Strahler A. H., 2008: Modern Physical Geography, John Wiley & Sons, New York.

CBCS-based U.G. Course in Geography, 2019

Syllabus of Generic ElectivePaper

Course Name: Geography of Tourism

Paper Code: GGY - HG -1046

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

- Thispaperintroducesthestudentswiththefieldoftourismfromthelensofgeography.
- It seeks to develop new insights among students on how tourism and allied activities are shaped by geography of an area and also how such activities are responsible in shaping economic, social and environmental context from global to locallevels.

Course Outcomes

- The paper will be useful for students in developing ideas on how geographical factors determine tourism activities and how geographers seek to address issues of development and carrying capacities of varied environments. It will also build skills among students to engage them to work with tourism/eco-tourism planningexercises.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Nature and Scope: Concept of tourism; Issues relating to recreation and leisure inter-relations; Geographical parameters oftourism as postulated byRobinson. **(4classes)**
2. Types of Tourism: Nature Tourism, Cultural Tourism, Medical Tourism,Pilgrimage. **(6 classes)**
3. Recent Trends of Tourism: International and Domestic (India); Eco-Tourism, Sustainable Tourism, Meetings Incentives Conventions andExhibitions(MICE). **(12classes)**
4. Impact of Tourism on Economy, EnvironmentandSociety. **(6classes)**
5. Tourism development in India: Tourism Infrastructure; Case Studies of tourism development in different geographical contexts: Himalayas, Desert, North-East India and Coastal Areas; NationalTourismPolicy. **(12classes)**

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Trend of growth of tourist arrivals (International and domestic) in the India/ Assam since

1960 using movingaveragemethod. **(2Assignments)**

2. Trend of tourist arrivals in the north-eastern states of India since 1980 in comparison to a top ranking tourist arriving state of India using Band-graph. **(2Assignments)**

3. Representation of relationship among the rainfall, temperature and tourist arrival for any year or a specific period for Assam and Meghalaya by using appropriate carto-statistical technique. **(2Assignments)**

4. Preparation of a map of Assam to show important tourist destinations along with their road, railway andairconnectivity. **(2Assignments)**

5. Preparation of a tourist map of N.E. India showing inflow of tourists (domestic and international) to major national parks and wildlife sanctuaries. **(2Assignments)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 Marks)
2. Viva-voce (2 Marks)

Reading List:

1. Bhattacharya, P. (2011): Tourism in Assam: Trend and Potentialities, Banimandia, Guwahati
2. Dhar, P.N. (2006) International Tourism: Emerging Challenges and Future Prospects. Kanishka, NewDelhi.
3. Hall, M. and Stephen, P. (2006) Geography of Tourism and Recreation – Environment, Place and Space, Routledge,London.
4. Kamra, K. K. and Chand, M. (2007) Basics of Tourism: Theory, Operation and Practise, Kanishka Publishers,Pune.
5. Page, S. J. (2011) Tourism Management: An Introduction, Butterworth-Heinemann- USA. Chapter2.
6. Raj, R. and Nigel, D. (2007) Morpeth Religious Tourism and Pilgrimage Festivals Management: An International perspective by, CABI, Cambridge,USA,www.cabi.org.
7. Tourism Recreation and Research Journal, Center for Tourism Research and Development, Lucknow
8. Singh Jagbir (2014) "Eco-Tourism" Published by - I.K. International Pvt. Ltd. S-25, Green Park Extension, Uphaar Cinema Market, New Delhi, India (www.ikbooks.com).
9. Market Research Division, Dept. of Tourism, Govt. of India, India Tourist Statistics (available in PDF form), NewDelhi
10. UNWTO: Tourism Barometer (available in their web portal to have a fresh glimpse of global tourism statistics/ other relevant sites may also beconsulted).

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BA/B.Sc.(Honours) Geography
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Course effective from the academic year 2019-20

IInd Semester

This is approved in the Academic Council held on 8/11/2019

GAUHATI UNIVERSITY
Guwahati-781014
September 2019

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Class 1 Hour 1	Duration	Credit
1 Theory Class	1 Hour	1
1 Tutorial Class	1 Hour	1
1 Practical Class	2 Hours	1

Credit and Marks distribution scheme for CBCS Curriculum: HonoursCourse (IIndSemester)

Semester	Course Type	Paper Code	Paper Name	Credits	Full Marks
Semester II Credit: 22 Marks: 400	Ability enhancement Course	ENV-AE-2014	Environmental Studies	4	100
	Honours Core	GGY - HC – 2016	Human Geography	4+2=6	100
		GGY - HC – 2026	Climatology and Biogeography	4+2=6	100
	Generic Elective paper (any one)	GGY- HG- 2036	Human Geography	4+2=6	100
		GGY - HG - 2046:	Disaster Management	4+2=6	100

Subject	Semester	Paper type	Paper Code	Paper name	Total Marks	Marks Distribution					Paper Credit
						External		Internal			
						Theory	Practical	Sessional	GD/Assignments	Attendance	
Geography	IInd	HonoursCore	GGY-HC-2016	Human Geography (Theory+ Practical)	100	60	20	10	6	4	4+2=6
Geography	IInd	HonoursCore	GGY-HC-2026	Climatology and Biogeography (Theory+ Practical)	100	60	20	10	6	4	4+2=6
Geography	IInd	Generic Elective (Any one)	GGY-HG-2036	Human Geography (Theory+ Practical)	100	60	20	10	6	4	4+2=6
			GGY-HG-2046	Dusastermanagement (Theory+ Practical)	100	60	20	10	6	4	4+2=6

*Honours Geography students have to take generic subjects from other disciplines

NB:TheexaminationsforthepracticalsforcouseGGY-HC2016andGGY-HC-2026andGGY-HC-2036willbeheldontwoseparatedays.Therewillbetwo questions of 8 marks along with 2 marks for viva and 2 marks for practical note book for each paper. Students will prepare one practical book for evaluationhavingthreepartsforpaperGGY-HC-2016andGGY-HC-2026GGY-HC-2036.Examinerswillsubmitmarksinthreeseparatemarksfolio.

Core Course

CBCS-based U.G. Course in Geography, 2019

Syllabus of Honours Core Course

Course Name: Human Geography

Paper Code: GGY-HC–2016

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives

- This paper is a core paper that intends to introduce students to human geography and how humankind transforms and gets transformed by geographicspace.
- It seeks to develop new insights among students on the relevance of human-environmentalrelationshipsandhowaspatialperspectiveshapestheserelationships.

Courseoutcomes

- The paper will be useful for students in developing ideas on human-environment issues that geographers usually address in theanthropocene
- The paper will be useful for students preparing for UGC NET/SLET exams and other competitive exams including the civilservices.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Defining the field of human geography: Meaning and Scope; Nature of human geography and its relation with other socialsciences. **(5classes)**
2. Schoolsofhumangeography:HumanEcology,LandscapeandLocational.**(5classes)**
3. Paradigms of man-environment relationship study: Determinism, Possibilism, Neodeterminism, andCulturalDeterminism. **(8classes)**
4. Man and environment relationship: Impact of environment on man in different geographical conditions; Impact of man and its activities on environment in different parts of the world; Impact of Population growth on development and environmental degradations; House types in differentenvironmentalconditions. **(8classes)**
5. Man and culture: Ethnicity and Race; Global patterns of racial composition of population and associated characteristics of major racial groups; Global patterns of religious and linguistic composition of population; Tribal people of India and their socio-economic characteristics. **(7classes)**
6. Human Settlements: Rural and urban settlements - Origin, growth and morphological characteristics; Types/Patterns of rural settlements; Burgess and Hoyt theories of internal structureoftown;patternsofurbanization:GlobalandIndianscenario. **(7classes)**

Part II: Practical
Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each

1. TraditionalhousetypesofselectedethnicgroupsofN.E.IndiaandIndia.**(2Assignments)**
2. Trend of population growth in the world in relation to five most populous countries of the world usinglinegraph. **(2Assignments)**
3. Religious and Linguistic composition of population in the world and five most populous countries of the world usingpie-graph. **(2Assignments)**
4. Spatial patterns of scheduled tribes population and urban population in India at state level throughchoroplethmap(basedonpercentageandLQ). **(2Assignments)**
5. Drawing of major rural settlement types/patterns; Morphological diagram of a village and a town (preferably based on student's own village and town); Drawing of internal model structure of towns according to Burgess andHoyt. **(4Assignments)**
6. Mappingofdistributionofmajorracialandlinguisticgroupsofpopulationintheworld.

(2Assignments)

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 marks)
2. Viva-voce (2marks)

Reading List:

1. Chandna, R.C. (2010) Population Geography, KalyaniPublisher.
2. Hassan, M.I. (2005) Population Geography, Rawat Publications,Jaipur
3. Daniel, P.A. and Hopkinson, M.F. (1989) The Geography of Settlement, Oliver & Boyd, London.
4. JohnstonR;GregoryD,PrattG.etal.(2008)TheDictionaryofHumanGeography, BlackwellPublication.
5. Jordan-Bychkov et al. (2006) The Human Mosaic: A Thematic Introduction to Cultural Geography. W. H. Freeman and Company, NewYork.
6. Kaushik, S.D. (2010) ManavBhugol, Rastogi Publication,Meerut.
7. Maurya,S.D.(2012)ManavBhugol,ShardaPustakBhawan.Allahabad.
8. Hussain, Majid (2012) ManavBhugol. Rawat Publications,Jaipur.

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CBCS-based U.G. Course in Geography, 2019

Syllabus of Core Course

Course Name: Climatology and Biogeography

Paper Code: GGY-HC-2026

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives:

- This paper is a core paper that intends to introduce students to the rationale underlying climatological studies ingeography
- It seeks to develop new insights among students on the relevance of climatic variable stangenting on climatechange.
- This paper intend to develop an understanding in the physical and human factors responsible for the distribution, conservation, and restriction of living organisms on the earthsurface.

Course outcomes:

- The paper will be useful for students in developing ideas on climate related aspects of geographicalanalyses.
- The paper will help provide theoretical insights and perspectives to students if they wish to pursue a research programme infuture.
- Students will develop a basic understanding of the introductory concepts in biogeography.
- The paper be very useful for students preparing for UGC NET-JRF / SLET exam and other competitive exams including civilservices.

Part 1: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

Group A: Climatology (35 Marks) (24 Classes)

1. Meaning of climatology and its significance in geographical studies. **(2 classes)**
2. Atmospheric Composition and Structure; and their variation with altitude, latitude and season. **(3 classes)**
3. Insolation and Temperature; Factors and Distribution and Heat Budget. **(3 Classes)**
4. Atmospheric Pressure and Wind system; Planetary Winds, Forces affecting Winds, General Circulation, Jet Streams **(5 Classes)**
5. Atmospheric Moisture – Evaporation, Humidity, Condensation, Fog, Precipitation Types, Stability and Instability. **(5 Classes)**

6. Climatic classification of Koppen and Trewartha; Monsoon - Origin and Mechanism. **(4 Classes)**
7. Cyclones and anticyclones; Tropical Cyclones, Extra-Tropical Cyclone.**(2 Classes)**

Group B: Biogeography (25 marks) (16 classes)

1. Meaning, Scope and Significance of biogeography **(2 Classes)**
2. Ecology and Ecosystem, Structure and functioning of ecosystem **(4 Classes)**
3. Global distribution of major plants and animals. **(4 Classes)**
4. Biomes and Biodiversity hotspots of the world. **(2 Classes)**
5. Soil as a component of environment , soil formation process and factors , soil composition and horizon, Soil types and their distribution in India **(4 Classes)**

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each, taking one from Climatology and one from Biogeography)

Climatology

1. Interpretation of Indian Weather map for Monsoon and non–monsoon seasons/months basedonvariousweathersymbolsdepictedonmaps. **(2Assignments)**
2. Preparation of weather reports of Indian subcontinent by analyzing the weather satellite images of at least three consecutive days (e.g. INSAT 3D, NOAAsatellite).

   https://mausam.imd.gov.in/imd_latest/contents/satellite.php#. **(3 Assignments)**
3. Preparation of rainfall-temperature graphs; hythergraph, climograph and ergograph taking data fromIndia/N.E.India/Assam **(3Assignments)**
4. Calculation of average annual rainfall and variability of annual rainfall and preparation ofrainfalldistributionandvariabilitymaps(usingisopleths).**(2Assignments)**

Biogeography

5. Mapping of protected areas (National park, biosphere reserve and wildlife sanctuary) of Assam/ N.E.India/India. **(3Assignments)**
6. Mapping of phyto-geographic and zoogeographic regions of theworld.**(2Assignments)**
7. Mapping of Biodiversity hotspots of theworld. **(1Assignment)**
8. Mapping of Soil types of Assam/N.E. India andSoilhorizons.**(2 Assignments)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 marks)
2. Viva-voce (2marks)

Reading List:

1. Barry R. G. and Carleton A. M., 2001: *Synoptic and Dynamic Climatology*, Routledge, UK.
2. Barry R. G. and Corley R. J., 1998: *Atmosphere, Weather and Climate*, Routledge, New York.
3. Critchfield H. J., 1987: *General Climatology*, Prentice-Hall of India,New Delhi
4. Lutgens F. K., Tarbuck E. J. and Tasa D., 2009: *The Atmosphere: An Introduction to Meteorology*, Prentice-Hall, Englewood Cliffs, NewJersey.
5. Oliver J. E. and Hidore J. J., 2002: *Climatology: An Atmospheric Science*, Pearson Education, NewDelhi.
6. TrewarthaG.T.andHorneL.H.,1980:*AnIntroductiontoClimate*,McGraw-Hill.
7. Gupta L S(2000): JalvayuVigyan, Hindi MadhyamKaryanvayNidishalya, Delhi VishwaVidhyalaya,Delhi
8. Lal, D S (2006): JalvayuVigyan, PrayagPustakBhavan,Allahabad
9. Vatal, M (1986): BhautikBhugol, Central Book Depot,Allahabad
10. Singh, S (2009): JalvayuVigyan, PrayagPustakBhawan,Allahabad
11. Soil and Biogeography, Kalyani Publishers., ManideepRaj
12. Cox, C.B., Moore, P.D. and Ladle, R., 2016. *Biogeography: an ecological and evolutionary approach*. John Wiley &Sons.

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Generic Elective Course for Honours
CBCS-based U.G. Course in Geography, 2019
Syllabus of Generic Elective Course
Course Name: Human Geography
Paper Code: GGY-HG-2036
Total Credit: 6 (4+2)
Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives:

- This paper is a core paper that intends to introduce students to human geography and how humankind transforms and gets transformed by geographicspace.
- It seeks to develop new insights among students on the relevance of human-environmental relationships and how a spatial perspective shapes theserelationships.

Course outcomes:

- The paper will be useful for students in developing ideas on human-environment issuesthat geographers usually address in theanthropocene.
- The paper will be useful for students preparing for various competitive examinations including the civilservices.

Part 1: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Fieldofhumangeography:meaning,scopeandimportance. **(8classes)**
2. Concepts of man-environmentrelationship: Determinism andPossibilism. **(8classes)**
3. Impact of environment on man; impact of man on environment; population growth and environmental changes; house types in different environmentalconditions. **(10classes)**
4. Globalpatternsofracial,religiousandlinguisticcompositionofpopulation. **(7classes)**
5. Origin, growth and characteristics of rural and urban settlements; Patterns of rural settlements;PatternsofurbanizationinIndiaandN.E.India. **(7classes)**

Part II: Practical
Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each

1. TraditionalhousetypesofselectedethnicgroupsofNorth-EastIndia.**(1assignment)**

2. Trend of population growth in the world in relation to five most populous countries of the world using linegraph.. **(1assignment)**
3. Religious composition of population in the world and three most populous countries of the worldusingpie-graph. **(2assignments)**
4. Spatial patterns of urban population in Assam and N.E. India at state level through choroplethmap. **(2assignments)**
5. Drawing of major rural settlement types/patterns; Morphological diagram of a village andatown(preferablybasedonstudent'sownvillageandtown).**(3 assignments)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 marks)

2. Viva-voce (2 marks)

Reading List:

1. Chandna, R.C. (2010) Population Geography, KalyaniPublisher.
2. Hassan, M.I. (2005) Population Geography, Rawat Publications,Jaipur
3. Daniel,P.A.andHopkinson,M.F.(1989)TheGeographyofSettlement,Oliver&Boyd, London.
4. JohnstonR;GregoryD,PrattG.etal.(2008)TheDictionaryofHumanGeography,
5. Blackwell Publication.
6. Jordan-Bychkov et al. (2006) The Human Mosaic: A Thematic Introduction to Cultural Geography. W. H. Freeman and Company, NewYork.
7. Kaushik, S.D. (2010) ManavBhugol, Rastogi Publication,Meerut.
8. Maurya,S.D.(2012)ManavBhugol,ShardaPustakBhawan.Allahabad.
9. Hussain, Majid (2012) ManavBhugol. Rawat Publications,Jaipur.

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CBCS-based U.G. Course in Geography, 2019

Syllabus of Generic Elective Course

Course Name: Disaster Management

Paper Code: GGY-HG-2046

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives:

- To provide students an exposure to disasters, their significance and types on Spatio-temporaldimensions.
- To develop basic ability to respond to their surroundings with potential disaster response in areas where they live, with duesensitivity
- To provideinformation and knowledge about how disasters can be checked andmanaged.

Course outcomes:

- The students will be able to analyse the causes and management issues related to disasters taking place in students' ownlocalities.
- The students will be able to differentiate the types of disasters, causes and their impact on environment and society along with various disaster management strategies and their applicability in differentsituations.

Part 1: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Meaning and Definition: Hazard, Disaster and Vulnerability; Types of Disasters- Flood, Land Slide and Mass Movement, Cyclone, Drought, Earthquake and Tsunami, Volcanic eruptions,Avalanche,Famines. (10 Classes)
2. Classification of Disaster: Manmade and Natural disasters; Their Causes, Processes and impact on landandPeople. (8 Classes)
3. Disasters in India: Types and Geographical Dimensions with special referenceto Assam.

   (8 Classes)
4. Approaches to Disaster Risk Reduction: Mitigation and Preparedness, Role of UNDP, NDMA, NIDM and ADMA; Do's and Don'ts Pre During and Post Disasters Indigenous Knowledge and Community-BasedDisasterManagement. (8 Classes)
5. Reciprocal Relationship of Development and Disaster; Sustainable Disaster Management. (6Classes)

Part II: Practical
Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Mapping of world and India showingDistributionofDisasters. (2 Assignments)
2. CartographicrepresentationofmajordisastersIndiaandAssamatleast30years. (2 Assignments)
3. Preparation of flood hazard zonation mapofIndia/Assam. (2Assignments)
4. Representationoffault,thrustsandearthquakezonationmapofNorthEastIndia. (1 Assignment)
5. Preparation of Potential Tsunami-genic mapofWorld/India. (2Assignments)
6. Mapping of world Major and MinorPlates. (1Assignment)

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 marks)
2. Viva-voce (2 marks)

Reading List:

1. Government of India. (1997) Vulnerability Atlas of India. New Delhi, Building Materials & Technology Promotion Council, Ministry of Urban Development, Government of India.
2. Kapur, A. (2010) Vulnerable India: A Geographical Study of Disasters, Sage Publication, NewDelhi.
3. Modh, S. (2010) Managing Natural Disaster: Hydrological, Marine and GeologicalDisasters, Macmillan,Delhi.
4. Singh, R.B. (2005) Risk Assessment and Vulnerability Analysis, IGNOU, New Delhi. Chapter 1, 2 and3
5. Singh, R. B. (ed.), (2006) Natural Hazards and Disaster Management: Vulnerability and Mitigation, Rawat Publications, NewDelhi.
6. Sinha, A. (2001). Disaster Management: Lessons Drawn and Strategies for Future, New United Press, NewDelhi.
7. Stoltman, J.P. et al. (2004) International Perspectives on Natural Disasters, Kluwer Academic Publications.Dordrecht.
8. Singh Jagbir (2007) “Disaster Management Future Challenges and Opportunities”, 2007. Publisher- I.K. International Pvt. Ltd. S-25, Green Park Extension, Uphaar Cinema Market, New Delhi, India(www.ikbooks.com).

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Syllabus for
BA/B.Sc.(Honours) Geography
Choice Based Credit System (CBCS)

Course effective from the academic year 2019-20

IIIrd Semester

This is approved in the Academic Council held on 8/11/2019

GAUHATI UNIVERSITY

Guwahati-781014

September 2019

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Class 1 Hour 1	Duration	Credit
1 Theory Class	1 Hour	1
1 Tutorial Class	1 Hour	1
1 Practical Class	2 Hours	1

Credit and Marks distribution scheme for CBCS Curriculum: Honours Course (IIIrd Semester)

Semester	Course Type	Paper Code	Paper Name	Credits	Full Marks
Semester III Credit: 28 Marks: 500	Honours Core	GGY - HC - 3016:	Economic Geography	4+2=6	100
		GGY - HC - 3026:	Geography of India with Special Reference to North- East India	4+2=6	100
		GGY - HC - 3036:	Quantitative Methods in Geography	4+2=6	100
	Skill Enhancement Course (any one)	GGY - SE - 3044:	River Basin Studies	2+2=4	100
		GGY - SE - 3054:	Thematic Cartography	2+2=4	100
	Generic Elective paper (any one)	GGY - HG - 3066:	Economic Geography	4+2=6	100
		GGY - HG - 3076:	Cartographic Methods	4+2=6	100

Subject	Semester	Paper type	Paper Code	Paper name	Total Marks	Marks Distribution					Paper Credit
						External		Internal			
						Theory	Practical	Sessional	GD/Assignments	Attendance	
Geography	IIIrd	Honours Core	GGY-HC-3016	Economic Geography (Theory + Practical)	100	60	20	10	6	4	4+2=6
Geography	IIIrd	Honours Core	GGY-HC-3026	Geography of India with special reference to North-East India (Theory + Practical)	100	60	20	10	6	4	4+2=6
Geography	IIIrd	Honours Core	GGY-HC-3036	Quantitative Methods in Geography (Theory + Practical)	100	60	20	10	6	4	4+2=6
Geography	IIIrd	Skill Enhancement Course	GGY - SE - 3044	River Basin Studies (Theory + Practical)	100	60	20	10	6	4	2+2=4
Geography	IIIrd	Skill Enhancement Course	GGY - SE - 3054	Thematic Cartography (Theory + Practical)	100	60	20	10	6	4	2+2=4
Geography	IIIrd	Generic Elective*	GGY-HG-3066	Economic Geography (Theory + Practical)	100	60	20	10	6	4	4+2=6
Geography	IIIrd	Generic Elective*	GGY-HG-3076	Cartographic Methods (Theory + Practical)	100	60	20	10	6	4	4+2=6

*Honours Geography students have to take generic subjects from other disciplines

NB:Theexaminationsforthepracticalcouses onGGY-HC3016,GGY-HC-3026andGGY-HC-3036willbeheldfortwodays.Therewillbetwoquestionsof8 markseach alongwith2marksforvivaand2marksforpracticalnotebookforeachpaper.The studentswillprepareonepracticalnote-bookforevaluationhavingthree partsforpaperGGY-HC-3016,GGY-HC-3026andGGY-HC-3036.Examinerswillsubmitmarksinthreeseparatemarksfolio.

Core Course

CBCS-based U.G. Course in Geography, 2019

Syllabus of Core Course

Course Name: Economic Geography

Paper Code: GGY-HC-3016

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

***Course Objectives*:**

- This is a core paper that intends to introduce students to the principles of economic geography and associated patterns and processes of major economic activities in the world.
- It seeks to develop new insights among students on the relevance of economy geography and associated problems in contemporarytimes.

***Course Outcomes*:**

- The paper will be useful for students in developing ideas on how geographical aspects organise economic space and will offer perspectives to students if they wish to pursue a researchprogramme.
- The paper will be useful for students preparing for UGC NET/SLET exams and other competitive exams including the civilservices.

Part 1: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Meaning, scope and approaches ofEconomicGeography. **(3classes)**

2. Economic activity: meaning and classification; Production system: Role of land, labour andcapital. **(3classes)**

3. Agriculture: Factors influencing agriculture; types of agriculture; Von Thunen's model of agricultural location; Factors influencing cultivation of wheat, rice, coffee and tea, and theirdistributionandproductionindifferentpartsoftheworld. **(10classes)**

4. Manufacturing: Factors influencing industrial location; Classification of industry; Weber's theory of industrial location; Factors, distribution and production of iron and steel, cotton textileandITindustriesintheworld;Specialeconomiczonesandtechnologyparks.

(10classes)

5. Transport system: Modes of transport, factors influencing transport development and role of transport in resource mobilization and economicdevelopment. **(7classes)**

6. Trade: Factors influencing trade in different countries of the world; Trade relations of India with the countries like USA, Russia andJapan. **(7classes)**

Part II: Practical
Credit: 2 (20 Marks)
(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each

1. Trend of rice, wheat and iron & steel production in the world/USA/India since 1960 using moving average and leastsquaresmethods. **(4assignments)**

2. Trend of production of wheat, rice, maize and barley in the world/USA since 1960 using Band-graph. **(2assignments)**

3. Trend of balance of trade relations (export and import value) of India with USA, China and Japaninrespectofmajorcommoditiessince1990usingBar-graph.**(2 assignments)**

4. Regional variation in fertilizer consumption and agricultural productivity in rice, wheat and barleyinselectedcountriesoftheworldusingBar-graph. **(1assignment)**

5. Inter-state/Inter-nation volume of movement of selected commodities and Inter-city movementoftraffic/businN.E.Indiathroughflowcartogram.**(2assignments)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 marks)

2. Viva-voce (2 marks)

Reading List:

1. Alexander J. W., 1963: Economic Geography, Prentice-Hall Inc., Englewood Cliffs, NewJersey.
2. Coe N. M., Kelly P. F. and Yeung H. W., 2007: Economic Geography: A Contemporary Introduction,Wiley-Blackwell.
3. HodderB.W.andLeeRoger,1974:EconomicGeography,TaylorandFrancis.
4. Combes P., Mayer T. and Thisse J. F., 2008: Economic Geography: The Integration of Regions and Nations, Princeton UniversityPress.
5. Wheeler J. O., 1998: Economic Geography,Wiley..
6. Durand L., 1961: Economic Geography,Crowell.
7. Bagchi-Sen S. and Smith H. L., 2006: Economic Geography: Past, Present and Future, Taylor andFrancis.
8. Willington D. E., 2008: Economic Geography, HusbandPress.
9. Clark, Gordon L.; Feldman, M.P. and Gertler, M.S., eds. 2000: TheOxford
10. Saxena, H.M., 2013: Economic Geography, Rawat Publications,Jaipur.

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CBCS-based U.G. Course in Geography, 2019

Syllabus of Core Course

Course Name: Geography of India with Special Reference to N.E. India

Paper Code: GGY-HC-3026

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives:

- ThisisacorepaperwhichintendstointroducestudentstoIndiaasageographicalentity.
- It seeks to develop new insights among students on significant geographical dimensions of the country along with its north-easternpart.
- A field study is incorporated to make the students understand regional diversity of India with respect to its land, people andeconomy.

Course outcomes:

- The paper will be useful for students in developing understanding on Indian geography and its various dimensions.
- It will also be useful for students preparing for various competitive examinations including civil services.

Part 1: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. India's location and its significance;administrativedivisions. **(2classes)**
2. Physical setting: Physiographic divisions and their characteristics; Climate and its seasonal and regional characteristics; vegetation; soil types and itsdistribution. **(8classes)**
3. Population: Trend of growth, spatial variation in growth and distribution; Age and sex composition; Linguistic andreligiouscomposition. **(6classes)**
4. Agriculture: Regional distribution and production patterns of rice, wheat andmillet. **(4classes)**
5. Industry: Distribution and production patterns of iron and steel, cotton textile and fertilizers;Roleoftransportsysteminindustrialdevelopment. **(6classes)**
6. North-East India: Land of seven sisters and its locational significance; physiographic framework; forest cover; agricultural practices including shifting cultivation; industrial development scenario; population growth, distribution and ethniccomposition.**(14 classes)**

Part II: Practical and Field Report
Credit: 2 (20 Marks)
(20 classes of 2 hour duration each)

Unit1: Practical Works (10 marks)

(2 Questions of 5 markseach)

1. Trend of population growth and growth rates in India and N.E. India since 1901 using Census data(Source:censusindia.gov.in). **(2assignments)**

2. ChoroplethmappingtoshowspatialvariationindecennialpopulationgrowthrateinIndia. **(1assignment)**

3. Spatial variation in the patterns of religious composition of population in India and Social compositionofpopulation(SC,STandGeneral)inN.E.Indiausingpie-graph. **(2assignments)**

4. Trend of foodgrains production (rice, wheat, maize, barley, jowar and bajra) in India since 1950-51usingband-graph. **(1assignment)**

5. Map showing distribution of major tribal groups in North-EastIndia. **(1assignment)**

Unit2: Field Report (6 Marks)

6. Preparation of field report based on field study of observational knowledge about the geographicalpersonalityofanypartofIndia/N.E.Indiaundertheguidanceofteacher(s). (Evaluation of Field Report: 4 marks and Viva-voce: 2 marks)

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 marks)

2. Viva-voce (2 marks)

Reading List:

1. Deshpande C. D., 1992: India: A Regional Interpretation, ICSSR, NewDelhi.
2. Johnson,B.L.C.,ed.2001.GeographicalDictionaryofIndia.VisionBooks,NewDelhi.
3. Mandal R. B. (ed.), 1990: Patterns of Regional Geography – An Intenational Perspective. Vol. 3 –IndianPerspective.
4. Sdyasuk Galina and P Sengupta (1967): Economic Regionalisation of India, Census of India
5. Sharma, T. C. 2003: India - Economic and Commercial Geography. Vikas Publ., New Delhi.
6. Singh R. L., 1971: India: A Regional Geography, National Geographical Society of India.
7. Singh, Jagdish 2003: India - A Comprehensive & Systematic Geography, GyanodayaPrakashan,Gorakhpur.
8. Spate O. H. K. and Learmonth A. T. A., 1967: India and Pakistan: A General and Regional Geography,Methuen.
9. Tirtha, Ranjit 2002: Geography of India, RawatPubls., Jaipur & NewDelhi.

10. Pathak, C. R. 2003: Spatial Structure and Processes of Development in India. Regional Science Assoc.,Kolkata.
11. Tiwari, R.C. (2007) Geography of India. PrayagPustakBhawan,Allahabad.
12. Sharma, T.C. (2013) Economic Geography of India. Rawat Publication,Jaipur
13. Bhagabati, A.K., Bora, A. K. and Kar, B.K.: Geography of Assam, Rajesh Publications, NewDelhi.
14. Taher, M and Ahmed, P.: Geography of North East India, Mani ManikPrakash, Guwahati.
15. Das,M..M.:PeasantAgricultureinAssam,Inter–IndiaPublications,NewDelhi.
16. Gopal Krishnan, R : Geography of North EastIndia
17. Bhattacharya, P.2006 : Trend in Tourism Potentiality, BaniMandir,Guwahati
18. Bhagabati,A.K.(ed):BiodiversityofAssam,EasternBookHouse,Guwahati
19. Bhattacharyya, N.N. : North East India, Rajesh Publication, NewDelhi
20. Srivastava, S.C. : Demographic Profile of N.E. India, MittalPublications.

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CBCS-based U.G. Course in Geography, 2019

Syllabus of Core Course

Course Name: Quantitative Methods in Geography

Paper Code: GGY-HC-3036

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

The paper Quantitative Methods in Geography throws light on the importance of data in geography. It deals with the methods and techniques of data collection, data tabulation, data interpretation and analysis through the application of some basic statistical measures. This paper provides an understanding of the pure and applied nature of geography along with the key elements in thediscipline.

Course Outcomes:

- Thorough understanding of the statistical methods and techniques used in geographical studies;
- Understanding of tabulation, analysis and interpretation of geographicaldata.

Part 1: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Quantification and its significance in geographical study; advantages and limitations of quantitative methodsingeography. **(4classes)**
2. Geographical Data: Nature, types and sources; scale of measurement (nominal, ordinal, intervalandratio). **(4classes)**
3. Measures of central tendency (mean, median and mode) and dispersion (range, quartile deviation, mean deviation, standard deviation and coefficient of variation) and their applications in geographicaldataanalysis. **(8classes)**
4. Sampling techniques: meaning of sampling and its need; types of sampling (simple random andstratifiedrandom). **(6classes)**
5. Time series analysis and its applications in geographical studies; Basic techniques of timeseriesdataanalysis(semi-average,movingaverageandleastsquares).**(6classes)**
6. Correlation and Regression Analysis: Meaning of correlation; Bi-variate coefficient of correlation (Spearman's rank correlation and Pearson's product-moment correlation); linear regression analysis; and their applications in geographical dataanalysis.**(12 classes)**

Part II: Practical
Credit: 2 (20 Marks)
(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each

1. Tabulation/Grouping of geographical data for making frequency distribution table; Preparation of Histogram, Frequency Polygonand FrequencyCurve.**(1+1assignments)**
2. Computation of mean, median and mode for ungrouped and grouped geographical data; Determination of median and mode using graphical methods; Determination of the locationofspatialmeancentreofsettlements(usingcentrographicmeasure).

   (2+1+1 assignments)
3. Computation of the values of standard deviation and coefficient of variation of ungrouped and grouped data relating to some geographical phenomena (rainfall, landholding, income, production, etc) for comparison of distribution patterns. **(1+1assignments)**
4. Analysis of time series data of some geographical phenomena (rainfall, production, export value, import value, etc) using moving average and least squares methods.

   (2 assignments)
5. Computation of coefficient of correlation between two logically associated geographical phenomena using Spearman's rank correlation and Pearson's product-moment correlation formulae; Preparation of scatter diagram and fitting the line of linear regression of Y on X foranysetofbi-variatedatarelatingtomeaningfulgeographicalphenomena.

   (2+1 assignments)

Unit II: Practical Note-Book and Viva-voce (4 Marks)
1. Evaluation of Practical Note-Book (2 marks)
2. Viva-voce (2 marks)

Reading List:

1. Hammond P. and McCullagh P. S., 1978: *Quantitative Techniques in Geography: An Introduction*, Oxford UniversityPress.
2. Sarkar, A. (2013) *Quantitative Geography: techniques and presentations*. Orient Black Swan Private Ltd., NewDelhi.
3. Yeates M., 1974: *An Introduction to Quantitative Analysis in Human Geography*, McGraw Hill, NewYork.
4. Mathews, J.A., 1987: *Quantitative and Statistical Approaches to Geography: A Practical Manual* Pergamon,Oxford.
5. Mahmood, A., 1999: *Statistical Methods in Geographical Studies*, Rajesh Publications, NewDelhi.
6. Elhance, D.N., 1972: *Fundamentals of Statistics*, KitabMahal,Allahabad
7. Monkhouse, F.J. & Wilkinson, H.R., 1989: *Maps & Diagrams*, B.I. Publications, New Delhi
8. Gregory, S., 1963: *Statistical Methods and Geographers*, Longman,London.

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CBCS-based U.G. Course in Geography, 2019

Syllabus of Skill EnhancementPapers

Course Name: River Basin Studies

Paper Code: GGY–SE-3044

Total Credit: 4 (2+2)

Total Marks: 100

(Theory: 40, Practical: 40 and Internal Assessment: 20)

Course Objectives:

- The main objective of this course is to develop understanding among the honours students about the river basin and the functioning of itselements.
- To train the students for acquiring necessary skill for understanding geomorphology in the field.

Course Outcomes:

- At the end of the course, the students will be able to learn use of a few instruments like rotameter, planimeter, Dumpy Level,etc.
- To learn the basics of morphometric analysistechniques.
- To acquaint with the field methods of river studies in across-section.

Part I: Theory

Credit: 2 (40 Marks)

(20 classes of 1 hour duration each)

1. Concept of river basin, catchment area andwatershed. **(3classes)**
2. Concept of fluvial system operating in a river basin; Input-output components in relation tothehydrologicalcycle;Riverbasinasafundamentalgeomorphicunit. **(5classes)**
3. Understandingthelinear,arealandreliefaspectsofariverbasin. **(4classes)**
4. Concept of sediment production zone, sediment transfer zone and sediment deposition zone andassociatedprocesses. **(4classes)**
5. Sources of water flow in a river basin; Concept of basin runoff and channel discharge; factors affectingbasinrunoff. **(4classes)**

Part II: Practical

Credit: 2 (40 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (32 Marks)

(To attempt 3 questions in total,2 carrying 12 marks each and 1 carrying 8 marks)

1. Delineation of a river basin along with drainage network from topographical sheet and preparation of a basin physiography map; conduct of morphometric analysis: Computationofbifurcationratio,lengthratioandbasincirculatoryratio.**(4 assignments)**

2. Relationship analysis using semi-log graph paper between stream order and stream number;streamorderandaveragestreamlength;streamorderanddrainagearea.

(3assignments)

3. Cross-sectional survey of a river and construction of profiles at least at three points (Field-basedassignment) **(1assignment)**

4. Preparationofstreamfrequencyanddrainagedensitymapsofariverbasin.

(2 assignments)

5. Estimation of basin runoff for winter and summer months taking monthly water discharge data and preparation ofahydrograph. **(1assignment)**

Unit II: Practical Note-Book and Viva-voce (8 Marks)
1. Evaluation of Practical Note-Book (4 Marks)
2. Viva-voce (4 Marks)

Reading List:

1. Bloom A. L., 2003: Geomorphology: A Systematic Analysis of Late Cenozoic Landforms, Prentice-Hall of India, NewDelhi.
2. BridgesE.M.,1990:WorldGeomorphology,CambridgeUniversityPress,Cambridge.
3. Christopherson, Robert W., (2011), Geosystems: An Introduction to Physical Geography, 8 Ed., Macmillan PublishingCompany
4. Kale V. S. and Gupta A., 2001: Introduction to Geomorphology, Orient Longman, Hyderabad.
5. KnightonA.D.,1984:FluvialFormsandProcesses,EdwardArnoldPublishers,London.
6. Richards K. S., 1982: Rivers: Form and Processes in Alluvial Channels, Methuen, London.
7. Selby, M.J., (2005), Earth's Changing Surface, Indian Edition,OUP
8. Skinner, Brian J. and Stephen C. Porter (2000), The Dynamic Earth: An Introduction to Physical Geology, 4th Edition, John Wiley andSons.
9. Strahler, A. N. and Strahler, A. H., 2008: Modern Physical Geography, John Wiley & Sons, NewYork.
10. Thornbury W. D., 1968: Principles of Geomorphology,Wiley.
11. Steers, J.A., 1988: The Unstable Earth, Kalyani Publishers, NewDelhi.
12. Monkhouse, F.J. and Wilkinson, H.R., 1989: Maps and Diagrams, B.I. Publications Ltd., Mumbai.
13. Singh R. L. and Singh R. P. B., 1999: Elements of Practical Geography, Kalyani Publishers.
14. Singh, L.R., 2013: Fundamentals of Practical Geography, ShardaPustakBhawan, Allahabad.
15. Sarkar, A., 2015: Practical Geography: A Systematic Approach. Orient Black Swan Private Ltd., NewDelhi
16. Misra, R. P. and Ramesh, A., 1989: Fundamentals of Cartography, Concept Publishing Company, NewDelhi.

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Skill Enhancement Course for Honours
CBCS-based U.G. Course in Geography, 2019
Syllabus of Skill Enhancement Paper
Course Name: Thematic Cartography
Paper Code: GGY–SE-3054
Total Credit: 4 (2+2)
Total Marks: 100
(Theory: 40, Practical: 40 and Internal Assessment: 20)

Course Objectives:

This course on thematic cartography provides a general understanding of methods and techniques and importance in geographic study. It more particularly focuses on various themes of cartographic techniques; principles of different types of symbols, methods for preparation of maps or plan in different environment and representation of various features of the earth's surface using different cartographictechniques.

Course outcomes:

- Understanding the importance of various techniques of preparation of maps in geographicalstudy
- General understanding of preparation of different types of plan andmaps.
- An acquaintance of different cartographic techniques for representation of various facets of earth'ssurface.

Part I: Theory

Credit: 2 (40 Marks)
(20 classes of 1 hour duration each)

1. Thematic cartography: meaningandimportance. **(2classes)**
2. Thematic Mapping: Principles and techniques of representation of physical and human geographic data (point,line,polygon). **(5classes)**
3. Concepts and principles of cartographic overlayandmapping. **(3classes)**
4. Conceptofbasemap;Types of thematic map;mapreading;mapdesign,layoutandtypography. **(5classes)**
5. Techniques of interpretation of Topographical maps, satellite imageries and aerial photographs forthematicmapping. **(5classes)**

Part II: Practical

Credit: 2 (40 Marks)
(20 classes of 2 hour duration each)

Unit I: Practical Works (32 Marks)

(To attempt 3 questions in total,2 carrying 12 marks each and 1 carrying 8 marks)

1. Preparation of an administrative/physical map of India containing necessary map elements usingappropriatetypography. **(1Assignment)**
2. Preparation of thematic maps for representing human geographic data using choropleth, isopleth, dot, sphere and proportionate circle techniques. **(5Assignments)**
3. Interpretation of topographical maps for preparation of thematic maps through overlay method (taking point, line and area layers) to show relationship between relief and agriculture; and relief, drainageandsettlements. **(2Assignments)**
4. Locational accessibility mapping based on travel time through isochroniccartogram. **(1Assignment)**
5. Preparation of landuse/landcover map through visual interpretation of satellite imagery using appropriateclassificationscheme. **(1 Assignment)**

Unit II: Practical Note-Book and Viva-voce (8 Marks)

1. Evaluation of Practical Note-Book (4 Marks)
2. Viva-voce (4 Marks)

Reading List:

1. Anson R. and Ormelling F. J., 1994: *International Cartographic Association: Basic Cartographic Vol.,* PergamanPress.
2. GuptaK.K.andTyagi,V.C.,1992:*WorkingwithMap*,SurveyofIndia,DST,NewDelhi.
3. MisraR.P.andRamesh,A.,1989:*FundamentalsofCartography*,Concept,NewDelhi.
4. MonkhouseF.J.andWilkinsonH.R.,1973:*MapsandDiagrams*,Methuen,London.
5. Rhind D. W. and Taylor D. R. F., (eds.), 1989: *Cartography: Past, Present and Future*, Elsevier, International CartographicAssociation.
6. RobinsonA.H.,2009:*ElementsofCartography*,JohnWileyandSons,NewYork.
7. Singh R. L. and Singh R. P. B., 1999: *Elements of Practical Geography*, Kalyani Publishers.
8. Sarkar, A. (2015) *Practical Geography: A Systematic Approach*. Orient Black Swan Private Ltd., NewDelhi
9. Singh, L.R., 2013: *Fundamentals of Practical Geography*, ShardaPustakBhawan, Allahabad.
10. Talukder,S.,2008:*IntroductiontoMapProjections*,EBHPublishers(India),Guwahati.

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Generic Elective Course for Honours

CBCS-based U.G. Course in Geography, 2019

Syllabus of Generic ElectivePapers

Course Name: Economic Geography

Paper Code:GGY-HG-3066

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

- This is a generic elective paper with a view to make the students of other honours subjects understand the basic principles of economic geography and associated patterns and processes of major economic activities in theworld.
- It seeks to develop insights among the students about the relevance of studying economic geography and understanding contemporary economic problems from geographical perspective.

Course Outcomes:

This paper will be useful for the students in developing understanding on how geographical factors organize economic space, and to acquire knowledge about spatial patterns of various economic activities on the earth.

Part 1: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Meaning and scope of EconomicGeography. **(3classes)**

2. Economic activity: meaning and classification; Production system: Role of land, labour and capital; Resource: Conceptandclassification. **(6classes)**

3. Agriculture: Factors influencing agriculture; types of agriculture; Factors influencing cultivationofwheat,riceandtea,andtheirdistributionandproductionintheworld.

(10 classes)

4. Manufacturing: Factors influencing industrial location; types of industry; Factors, distributionandproductionofironandsteelandcottontextileindustryintheworld.

(10classes)

5. Transport system: Modes of transport, factors influencing transport development and role of transport in resource mobilization and industrialdevelopment. **(6classes)**

6. Trade: Factors influencing trade; Trade relations of India with the countries like Bhutan, NepalandBangladesh. **(5classes)**

Part II: Practical
Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Trend of rice, wheat and iron & steel production in the world/India since 1960 using movingaveragemethod. **(3assignments)**
2. Trend of production of wheat, rice, maize and barley in the world/India since 1960 using Band-graph. **(2assignments)**
3. Trend of balance of trade relations (export and import value) of India with Bangladesh, Nepal and Bhutan in respect of major commodities since 1990 usingBar-graph. **(2assignments)**
4. Regional variation in fertilizer consumption and agricultural productivity in rice, wheat and barley in selected countries of the world using Bar-graph. **(1assignment)**
5. Inter-state and Inter-nation volume of movement of selected commodities through flow cartogram. **(2assignments)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 marks)

2. Viva-voce (2 marks)

ReadingList:

1. Alexander J. W., 1963: Economic Geography, Prentice-Hall Inc., Englewood Cliffs, New Jersey.
2. Coe N. M., Kelly P. F. and Yeung H. W., 2007: Economic Geography: A Contemporary Introduction,Wiley-Blackwell.
3. Hodder B. W. and Lee Roger, 1974: Economic Geography, Taylor andFrancis.
4. Combes P., Mayer T. and Thisse J. F., 2008: Economic Geography: The Integration of Regions and Nations, Princeton UniversityPress.
5. Wheeler J. O., 1998: Economic Geography,Wiley..
6. Durand L., 1961: Economic Geography,Crowell.
7. Bagchi-Sen S. and Smith H. L., 2006: Economic Geography: Past, Present and Future, Taylor andFrancis.
8. Willington D. E., 2008: Economic Geography, HusbandPress.
9. Clark, Gordon L.; Feldman, M.P. and Gertler, M.S., eds. 2000: The Oxford.
10. Saxena, H.M., 2013: Economic Geography, Rawat Publications,Jaipur.

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Generic Elective Course for Honours

CBCS-based U.G. Course in Geography, 2019

Syllabus of Generic ElectivePapers

Course Name: Cartographic Methods

Paper Code:GGY-HG-3076

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

This course on Cartographic Methods provides a general understanding of the field of cartography including its modern developments and importance in geographic study. It more particularly focuses on various types of map scale and their construction; principles of map projection and construction of selected few; and preparation of thematic maps through the representation of various geographical data using different cartographic techniques and methods.

Course Outcomes:

- Understandingtheimportanceofvariouscartographictechniquesingeographicalstudy
- General understanding of map type, map scale and mapcontent.
- An acquaintance of different cartographic techniques for representation of various facets of physical and human geographic data of anyarea.

Part 1: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Meaningofcartographyanditsneedingeography;TraditionalversusDigitalcartography. **(6classes)**

2. Shapeandsizeoftheearth;Coordinatesystem(latitudeandlongitude). **(4classes)**

3. Map:Meaning,scaleandclassification;mapasatoolinspatialanalysis. **(6classes)**

4. Map Projection: meaning and classification (zenithal, conical and cylindrical); choice of mapprojection. **(16classes)**

5. Thematic map: meaning and types; Choroplethand Isoplethmapping. **(8classes)**

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Construction of graphical scale; Computation work for conversion of mapscale **(2+4Assignments)**
2. Construction of graticule of map projection along with properties and uses: Zenithal polar gnomonic, Simple conical with one standard parallel, simple cylindrical and Gall's stereographiccylindrical. **(4Assignments)**
3. Representation of physical and human geographic data through Choropleth and Isopleth mapping andPiecartogram. **(6Assignments)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 marks)
2. Viva-voce (2 marks)

Reading List:

1. Bloom A. L., 2003: Geomorphology: A Systematic Analysis of Late Cenozoic Landforms, Prentice-Hall of India, NewDelhi.
2. BridgesE.M.,1990:WorldGeomorphology,CambridgeUniversityPress,Cambridge.
3. Christopherson, Robert W., (2011), Geosystems: An Introduction to Physical Geography, 8 Ed., Macmillan PublishingCompany
4. Kale V. S. and Gupta A., 2001: Introduction to Geomorphology, Orient Longman, Hyderabad.
5. KnightonA.D.,1984:FluvialFormsandProcesses,EdwardArnoldPublishers,London.
6. Richards K. S., 1982: Rivers: Form and Processes in Alluvial Channels, Methuen, London.
7. Selby, M.J., (2005), Earth's Changing Surface, Indian Edition,OUP
8. Skinner, Brian J. and Stephen C. Porter (2000), The Dynamic Earth: An Introduction to Physical Geology, 4th Edition, John Wiley andSons.
9. Strahler, A. N. and Strahler, A. H., 2008: Modern Physical Geography, John Wiley & Sons, NewYork.
10. Thornbury W. D., 1968: Principles of Geomorphology,Wiley.
11. Steers, J.A., 1988: The Unstable Earth, Kalyani Publishers, NewDelhi.
12. Monkhouse, F.J. and Wilkinson, H.R., 1989: Maps and Diagrams, B.I. Publications Ltd., Mumbai.
13. Singh R. L. and Singh R. P. B., 1999: Elements of Practical Geography, Kalyani Publishers.

14. Singh, L.R., 2013: Fundamentals of Practical Geography, ShardaPustakBhawan, Allahabad.
15. Sarkar, A., 2015: Practical Geography: A Systematic Approach. Orient Black Swan Private Ltd., NewDelhi
16. Misra, R. P. and Ramesh, A., 1989: Fundamentals of Cartography, Concept Publishing Company, NewDelhi.

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Syllabus for
BA/B.Sc.(Honours) Geography
Choice Based Credit System (CBCS)

Course effective from the academic year 2019-20

4th Semester

This is approved in the Academic Council held on 8/11/2019

Department of Geography

GAUHATI UNIVERSITY

Guwahati-781014

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Class 1 Hour 1	Duration	Credit
1 Theory Class	1 Hour	1
1 Tutorial Class	1 Hour	1
1 Practical Class	2 Hours	1

Credit and Marks distribution scheme for CBCS Curriculum: HonoursCourse (4thSemester)

Semester IV Marks 500 Credit 28	Honours Core	GGY - HC - 4016:	Environmental Geography and Disaster Management	4+2	100
		GGY - HC - 4026:	Population and Settlement Geography	4+2	100
		GGY - HC - 4036:	Remote Sensing , GIS and GPS	4+2	100
	Skill Enhancement Course (Any one)	GGY - SE - 4044:	Advanced Statistical Techniques for Spatial Analysis	2+2	100
		GGY - SE - 4054:	Surveying Techniques	2+2	100
	Generic Elective Paper (Any one)*	GGY - HG - 4066:	Geography of India with Reference N.E. India	4+2=6	100
		GGY - HG - 4076:	Population and Settlement Geography	4+2=6	100

Subject	Semester	Paper type	Paper Code	Paper name	Total Marks	Marks Distribution					Paper Credit
						External (80)		Internal (20)			
						Theory	Practical	Sessional	Practical /Assignments	Attendance	
Geography	4th	HonoursCore	GGY - HC - 4016:	Environmental Geography and Disaster Management	100	60	20	10	6	4	4+2=6
			GGY - HC - 4026:	Population and Settlement Geography	100			10	6	4	4+2=6
			GGY - HC - 4036:	Remote Sensing , GIS and GPS	100			10	6	4	4+2=6
		Skill Enhancement Course (Any one)	GGY - SE - 4044:	Advanced Statistical Techniques for Spatial Analysis	100	40	40	10	6	4	2+2=4
			GGY - SE - 4054:	Surveying Techniques	100	40	40	10	6	4	2+2=4
		Generic Elective (Any one)	GGY - HG - 4066:	Geography of India with Reference N.E. India	100	60	20	10	6	4	4+2=6
			GGY - HG - 4076:	Population and Settlement Geography	100	60	20	10	6	4	4+2=6

CBCS-based U.G. Course in Geography, 2019
Syllabus of Core Course
Name: Environmental Geography and Disaster Management
Paper Code: GGY-HC-4016
Total Credit: 6 (4+2)
Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives

● This is a core paper which intends to introduce students to geography and environment interface.

● It seeks to develop new insights among students on the relevance of environmental studies from a spatial perspective.

Course outcomes

● This paper will be useful for students in developing ideas on environmental issues including disasters that geographers usually address.

● This paper will be useful for students preparing for different competitive exams including the civil services.

Part I: Theory

Credit: 4 (60 Marks)

(40 Classes of 1 hour each)

1. Environmental Geography: Nature, Scope and Significance **(4 Classes)**

2. Human-Environment Relationships – Historical progression, Adaptation in different Biomes. **(6 Classes)**

3. Major Global Environmental Problems: Pollution, Deforestation, Desertification, Global Warming, and Bio-Depletion. **(10 Classes)**

4. Meaning of Hazard, Disaster, Risk and Vulnerability; Types of hazard/disaster (Natural and Manmade). **(4 Classes)**

5. Disaster Management Cycle and Phases: Prevention, Preparedness, Response, Rehabilitation, Reconstruction and Mitigation, **(4 Classes)**

6. Major Hazards and Disasters, and their Management: Flood, Earthquake, Wildfire, and Chemical and Nuclear explosions. **(6 Classes)**

7. National Environmental Policy and National Disaster Management Plan: Environmental Protection Act 1986 and DisasterManagement Act 2005. **(6 Classes)**

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of two hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Exploring satellite imageries and toposheets to observe bank line change of Brahmaputra river from any selected stretch in three different time periods and preparation of map therefrom. (1 exercise)

   (Goalpara,Palashbari, Nimatighat, etc.)

   Satellite images can be downloaded from https://earthexplorer.usgs.gov/

   Survey of India toposheets can be downloaded freely from https://soinakshe.uk.gov.in/mtr/

2. Mapping of major wetlands in a district and computation of shape and size(area) based distribution. (1 exercise)

3. Preparation of a map of a nearby wetland and identify the changes in dimension, water level and encroachment it faced during the last one decade. Present your data in tabular form along with the map (field-based). (1 exercise)

4. Preparation of a long-term precipitation time series curve for any selected station of N.E. India using moving average method by downloading the annual rainfall data for any district/station of Assam for at least 30 years from the portal https://www.indiawaterportal.org/met_data/. Students can also explore the web portal https://mausam.imd.gov.in/ to get an idea of different types of weather data in India and their historical and present distribution. (1 exercise)

5. Drawing of a diagram of disaster management cycle with reference to some disasters (flood and earthquake) in North-East India and to indicate the activities associated with each step. (2 exercises)
6. Drawing of a map of Assam showing the major fault lines thereon. Also to plot at least 50 epicentres in last few years and to explain the areas of their concentration by taking the help of Bhookamp app. (1 exercise)

7. Preparation of a disaster vulnerability map of Assam/ N.E. India based on data of natural disasters (Flood/earthquake/landslide/bank erosion) with respect to their occurrence and frequency in different areas. (1 exercise)

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 Marks)

2. Viva-voce (2 Marks)

Reading List:

1. Chandna R. C., 2002: Environmental Geography, Kalyani, Ludhiana.
2. Cunninghum W. P. and Cunninghum M. A., 2004: Principals of EnvironmentalScience: Inquiry and Applications, Tata Macgraw Hill, New Delhi.
3. Goudie A., 2001: The Nature of the Environment, Blackwell, Oxford.
4. Singh, R.B. (Eds.) (2009) Biogeography and Biodiversity. Rawat Publication, Jaipur
5. Miller G. T., 2004: Environmental Science: Working with the Earth, Thomson BrooksCole, Singapore.
6. MoEF, 2006: National Environmental Policy-2006, Ministry of Environment and Forests, Government of India.
7. Singh, R.B. and Hietala, R. (Eds.) (2014) Livelihood security in Northwestern Himalaya: Case studies from changing socio-economic environments in Himachal Pradesh, India. Advances in Geographical and Environmental Studies, Springer
8. Odum, E. P. et al, 2005: Fundamentals of Ecology, Ceneage Learning India. 9. Singh S., 1997: Environmental Geography, PrayagPustakBhawan. Allahabad.
10. UNEP, 2007: Global Environment Outlook: GEO4: Environment For Development, United Nations Environment Programme.
11. Singh, M., Singh, R.B. and Hassan, M.I. (Eds.) (2014) Climate change and biodiversity: Proceedings of IGU Rohtak Conference, Volume 1. Advances in Geographical and Environmental Studies, Springer
12. Singh, R.B. (1998) Ecological Techniques and Approaches to Vulnerable Environment, New Delhi, Oxford & IBH Pub..
13. Alcántara-Ayala, I. (2002). Geomorphology, natural hazards, vulnerability and prevention of natural disasters in developing countries. *Geomorphology*, *47*(2-4), 107-124.
14. Goudie, A., & Ayala, I. A. (2010). *Geomorphological hazards and disaster prevention*.Cambridge University Press.
15. https://www.undrr.org/publications
16. http://sdmassam.nic.in/dmp.html#ddmp
17.https://ndma.gov.in/sites/default/files/PDF/DM_act2005.pdf
18. http://sdmassam.nic.in/pdf/publication/undp/disaster_management_in_india.pdf.

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CBCS-basedU.G. Course in Geography, 2019

Syllabus of Core Course

Course Name: Population and Settlement Geography

Paper Code: GGY-HC-4026

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives

- This paper is a core paper that intends to introduce students to the basic concepts of population and settlement geography and how the differential characteristics of population and settlement influence the overall development process of an area.
- It seeks to develop understanding among students about the significance of population geography and settlement geography and their inter-relationship.

Course outcomes

- The paper will be useful for students in developing ideas about spatio-temporal changes in the characteristics of population and settlement and the factors associated with them.
- The paper will be useful for students preparing for various competitive exams including the civil services.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

Unit I: Population Geography (40 Marks) **26 Classes**

1. Defining the field of population geography: nature and scope; Its relation with demography. **(3 Classes)**

2. Sources, characteristics and problems of population data; Perspectives on Census of India publications – Primary Census Abstract, District Census Hand-Book, Sample Registration System, etc. **(4 Classes)**

3. Distribution and density of population: Factors influencing population distribution and density; global pattern of population distribution; population density regions in the world. **(4 Classes)**

4. Population Growth: Trend of global population growth; components of population growth–fertility, mortality and migration; factors influencing fertility and mortality; push and pull factors of migration;spatial variations in population growth in the world.

(8 Classes)

5. Theories of population growth: Malthusian Theory and Demographic Transition Theory.
(3 Classes)

6. Population composition and associated characteristic patterns in global contexts: Age-Sex Composition; Rural-Urban Composition; Contemporary population issues – population ageing, declining sex ratio, pandemics. **(4 Classes)**

Unit II: Settlement Geography (20 Marks) **14 Classes**

1. Defining the field of settlement of geography: Nature and scope. **(2 Classes)**

2. Rural and urban settlements: Factors influencing distribution pattern of settlements; Types of rural settlements; Characteristics of rural and urban settlements.
(4 Classes)

3. Morphology of rural and urban settlements; Burgess theory of internal structure of a town.
(4 Classes)

4. Concept of settlement hierarchy, primate city and urban fringe;Christaller's Central Place Theory. **(4 Classes)**

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Trend of population growth in Assam/N.E. India/India through line graph; Calculation and graphical representation of trend of decadal and annual growth rates of population in Assam/N.E. India/India.
(3 Exercises)

2. Choropleth map to show spatial pattern of decadal variation in population growth in Assam/N.E. India/India. (1 Exercise)

3. Choropleth map showing spatial pattern of population density in Assam/India. (1 Exercise)

4. Calculation of distribution pattern of settlements in an area using Nearest Neighbour Analysis.

(1 Exercise)

5. Map showing spatial variation in social/religious/rural-urban composition of population in Assam/N.E. India using pie-graph. (1 Exercise)

6. Choropleth map showing spatial pattern of level of urbanization in Assam/N.E. India. (1 Exercise)

7. Map showing distribution of towns and their varied population size with spheres in Assam/N.E. India. (1 Exercise)

8. Flow cartogram showing direction and volume of migration into Assam/N.E. India from different parts of India. (1 Exercise)

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 Marks)
2. Viva-voce (2 Marks)

Reading List:

1. Barrett H. R., 1995: *Population Geography*, Oliver and Boyd.

2. Bhende A. and Kanitkar T., 2000: *Principles of Population Studies*, Himalaya Publishing House.

3. Chandna R. C. and Sidhu M. S., 1980: *An Introduction to Population Geography*, Kalyani Publishers.

4. Chandna R. C., 2014, Geography of Population: *Concepts, Determinants and Patterns*, Kalyani Publishers.

5. Clarke J. I., 1965: *Population Geography*, Pergamon Press, Oxford.

6. Jones, H. R., 2000: *Population Geography,* 3rd ed. Paul Chapman, London.

7. Lutz W., Warren C. S. and Scherbov S., 2004: *The End of the World Population Growth in the 21st Century*, Earthscan.

8. Newbold, K. B., 2009: *Population Geography: Tools and Issues*, Rowman and Littlefield Publishers.

9. Pacione, M., 1986: *Population Geography: Progress and Prospect*, Taylor and Francis.

10. Wilson, M. G. A., 1968: *Population Geography*, Nelson.

11. Panda, B. P. (1988): JanasankyaBhugol, M P Hindi Granth Academy,Bhopal.

12. Maurya, S. D. (2009) JansankyaBhugol, ShardaPustakBhawan, Allahabad.

13. Chandna, R. C. (2006), JansankhyaBhugol, Kalyani Publishers, Delhi.

14. Roy, D. (2015), *Population Geography*, Books and Allied (P) Ltd., Kolkata.

15. Ahmad, A., Noin, D. and Sharma, H.N. (eds), 1997, *Demographic Transition: The Third World Scenario*, Rawat Publications, Jaipur and New Delhi, 1997.

16. Money, D.C., 1972: Patterns of Settlement, Evan Brothers, London.

17. Peters, G.L. and Larkin, R.P., 1979: *Population Geography: Problems, Concepts andProspects,* Kendall/ Hunt Iowa.

18. Singh, R.L. and Singh, K.N., (eds), 1975: *Readings in Rural Settlement Geography*, BHU, Varanasi.

19. Singh, R.Y., 1994: *Geography of Settlements*, Rawat Publications, Jaipur and New Delhi.

20. Maurya, S. D., 2014:*Settlement Geography*, ShardaPustakBhawan, Allahabad.

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CBCS-based U.G. Course in Geography, 2019

Syllabus of Honours Core Course

Course Name: Remote Sensing, GIS and GPS

Paper Code: GGY-HC-4036

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60; Practical: 20; Internal Assessment: 20)

Course objectives

- This paper is a core paper that intends to introduce students to the interface of Remote Sensing and GIS
- It seeks to develop new insights among students on the relevance of geospatial studies within the field of geography.

Course outcomes

- The paper remains useful for students in developing skills in spatial data analysis if they wish to pursue a research programme.
- The paper will be useful for students preparing for different competitive exams including the civil services.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

Unit 1: Remote Sensing (30 Marks)

1. Remote Sensing: Definition and History of Development. (3 classes)
2. Principles of Remote Sensing System: Energy sources, EMR and its interaction with Atmosphere and Earth Features; Platform, Sensor and Resolutions;Aerial and Satellite Remote Sensing;Fundamentals of Photogrammetry. (8 classes)
3. Remote Sensing data products, sources and characteristics; Elements of Image Interpretation (Visual & Digital); Digital Image Processing: Image Enhancement and Classification (Supervised and Un-supervised). (6classes)
4. Application of Remote Sensing: Land, Vegetation and Water (3 classes)

Unit 2: GIS (20 Marks)

1. Geographical Information System (GIS): Definition, Development, Components, and Functions; Open source GIS. (4 classes)

2. GIS Data Types &Structures: Spatial and Non-Spatial Data; Raster and Vector Data Structure, Database Management System (DBMS). (4 classes)
3. Data Layer Extraction and Spatial Analysis: Buffer, proximity and overlay analysis. (3 Classes)

4. Application of GIS in geographical studies (Land Suitability analysis, Network analysis, Flood damage estimation) (3 classes)

Unit 3: GPS (10 Marks)

1. Global Positioning System (GPS): Types, basicprinciples and functions; Different Navigational Systems. (3 classes)
2. Application of GPS in surveying and mapping. (3 classes)

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Visual Interpretation of Aerial photograph and Satellite Imagery and preparation of thematic maps based on appropriate classification scheme. 2 assignments

2. Analysis of aerial photographs and satellite image: Determination of photo scale and object height from aerial photo (Using Sterescope); Digital classification of satellite image: supervised and unsupervised. 3 assignments

3. Geo-referencing and Data layer creation: Map scanning, geometric correction, digitization of different layers using point, line and polygon, attribute data input and their thematic representation, Buffer creation, Overlay analysis. 3 Assignments

4. GPS data collection, plotting and mapping of various features within college campus.
   2 Assignments

N.B.: Basic Remote Sensing and GIS Software's for practical works: Arc GIS/Erdas Professional /Q-GIS/SAGA GIS.

Unit II: Practical Note-Book and Viva-voce (4 Marks)

3. Evaluation of Practical Note-Book (2 Marks)
4. Viva-voce (2 Marks)

Reading List:

1. Campbell J. B., 2007: *Introduction to Remote Sensing*, Guildford Press.

2. Jensen J. R., 2004: *Introductory Digital Image Processing: A Remote Sensing Perspective*, Prentice Hall.

3. Joseph, G. 2005: *Fundamentals of Remote Sensing*, United Press India.

4. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: *Remote Sensing and Image Interpretation*, Wiley. (Wiley Student Edition).

5. Nag P. and Kudra, M., 1998: *Digital Remote Sensing*, Concept, New Delhi.

6. Rees W. G., 2001: *Physical Principles of Remote Sensing*, Cambridge University Press.

7. Singh R. B. and Murai S., 1998: *Space-informatics for Sustainable Development*, Oxford and IBH Pub.

8. Wolf P. R. and Dewitt B. A., 2000: *Elements of Photogrammetry: With Applications in GIS*, McGraw-Hill.

9. Sarkar, A. (2015): Practical Geography: A Systematic Approach. Orient Black Swan Private Ltd., New Delhi.

10. Chauniyal, D.D. (2010): SudurSamvedanevamBhogolikSuchanaPranali, ShardaPustak Bhawan, Allahabad.

11. Burrough, P.A. and McDonnel, R.A.,1998: *Principles of Geographical InformationSystems*, Oxford University Press.

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CBCS-basedU.G. Course in Geography, 2019

Syllabus of Skill Enhancement Course

Course Name: **Advanced Statistical Techniques for Spatial Analysis**

Paper Code: GGY-SE-4044

Total Credit: 4 (2+2)

Total Marks: 100

(Theory: 40, Practical: 40 and Internal Assessment: 20)

Course objectives

This skill enhancement course on Advanced Spatial Statistical Techniques basically deals with understanding the application of different statistical measures for analysing data relating to various geographical phenomena. Besides, this course provides basic knowledge about handling various geographical data (spatial and non-spatial) for understanding spatial and temporal patterns by applying different statistical measures like variability/disparity index, correlation and regression analysis, etc.

Course outcomes

- It provides general understanding of geographical data and application of various statistical measures for their meaningful analysis.
- Acquiring basic knowledge about probability and normal distributions and their applications for sample data collection and analysis.
- Understanding the patterns and processes associated with various geographical phenomena through application of different statistical techniques.

Part I: Theory

Credit: 2 (40 Marks)

(30 classes of 1 hour duration each)

1. Statistics and Geography: Role of statistics in geographical studies; Nature of geographical data and selection of statistical techniques for spatial analysis (Basic understanding) (3 Classes)

2. Application of the measures of central tendency (mean, median, mode and weighted mean) and dispersion (standard deviation, coefficient of variation, coefficient of skewness and standard distance) in geographical data analysis and spatial distribution pattern analysis.

   (6

   Classes)

3. Application of probability distributions (Normal, poisson and binomial) in understanding various geographical phenomena; Characteristics/Properties of normal distribution. (4 Classes)

4. Meaning and importance of sampling in geographical studies;Types of sampling (probability and non-probability sampling) and their relative merits and demerits; Concept of large and small samples. (6 Classes)

5. Correlation and regression analysis in geography: Rank correlation and product-moment correlation coefficient; Linear regression and regression residuals; Concept of multiple correlation and regression. (6 Classes)

6. Introduction to the concept and application of Location quotient; Disparity or Differential index; Nearest Neighbour Analysis; Data standardization through ranking method for computation of composite score. (5 Classes)

Part II: Practical

Credit: 2 (40 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (32 Marks)

(To attempt 4 questions carrying 8 marks each)

1. Setting of hypothetical data of a geographical phenomenon for normal, positively skewed and negatively skewed distributions, calculation of mean, median, mode and coefficient of skewness, and representation of the positions of mean, median and mode in the respective frequency distribution curves. (3 Exercises)

2. Graphical representation of median and mode for a given set of grouped data of a geographical attribute. (2 Exercises)

3. Determination of the spatial mean centre(s) of population/urban population in Assam/N.E. India. (1 Exercise)

4. Computation of correlation coefficient (both rank and product-moment), fitting of regression line of Y on X and preparation of regression residual map for a set of meaningful bi-variate geographical data of Assam/N.E. India/India. (3 Exercises)

5. Analysis of appropriate geographical data for computation/representation of LQ, gender disparity in literacy or work participation, and composite scores of socio-economic development (ranking technique). (3 Exercises)

Note: Any Statistical Software Package (SPSS, MS Excel, R, etc.) may also be used for practice.

Unit II: Practical Note-Book and Viva-voce (8 Marks)

1. Evaluation of Practical Note-Book (4 Marks)
2. Viva-voce (4 Marks)

Reading List:

1. Bart James E and GerldM.Barber, 1996: Elementary Statistics for Geographers, TheGuieford Press, London.

2. Eldon, D., 1983: Statistics in Geography: A Practical Approach, Blackwell, London.

3. Cressie, N.A.C., 1991: Statistics for Spatial Analysis, Wiley, New York.

4. Gregory, S., 1978: Statistical Methods and the Geographer (4th Edition), Longman, London.
5. Haining, R.P., 1990: Spatial Data Analysis in the Social and Environmental Science, Cambridge University Press, Cambridge.
6. Mc Grew, Jr. And Cahrles, B. M., 1993: An Introduction to Statistical Problem Solving in Geography, W.C. Brocan Publishers, New Jersey.
7. Mathews, J.A., 1987: Quantitative and Statistical Approaches to Geography: A Practical Manual Pergamon, Oxford.
8. S.K., 1998: Statistics for Geoscientists: Techniques and Applications, Concept Publishing Company, New Delhi.
9. Wei, W.S.,1990: Time Series Analysis: Variate and Multivariate Methods , Addison Wesley Publishing.
10. Yeates, Mauris, 1974: An Introduction to Quantitative Analysis in Human Geography, McGrawhill, New York.
11. Mahmood, A., 2002: *Statistical Methods in Geographical Studies*, Rajesh Publications, New Delhi.
12. Sarkar, A., 2013: *Quantitative Geography: Techniques and Presentations*, Orient Black Swan, New Delhi.

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CBCS-based U.G. Course in Geography, 2019

Syllabus of Skill Enhancement Course

Course Name: Surveying Techniques

Paper Code: GGY-SE-4054

Total Credit: 4 (2+2)

Total Marks: 100

(Theory: 40, Practical: 40 and Internal Assessment: 20)

Course Objectives:

This course on Surveying Techniques provides a general understanding of the field of survey including its modern tools and importance in geographic study. It more particularly focuses on various types of survey instruments; principles of different types of surveying, methods of carrying out survey for preparation of map/plan in different environment by presentation of various aspects of the area.

Course Outcomes:

● Understanding the importance of various surveying techniques in geographical study
● General understanding of preparation procedures of different types of plan and map
● An acquaintance of different surveying techniques for representation of various spatial objects/
Phenomena.

Part I: Theory

Credit: 2 (40 Marks)

(20 classes of 1 hour duration each)

1. Surveying: Its meaning, types and significance in geography. (2 Classes)

2. Principles of surveying: plane and geodetic surveying; Principles of triangulation. (3Classes)

3. Techniques of surveying by Plane Table, Prismatic Compass, Theodolite and Dumpy Level. (8Classes)

4. Methods of radiation, intersection, traversing, contouring and leveling in surveying. (4Classes)

5. GPS: Basic concept, principles and utilities; surveying by Total Station. (3Classes)

Part II: Practical

Credit: 2 (40 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (32 Marks)

(To attempt 2 questions carrying 16 marks each)

1. Preparation of a plan or a map of an area within the college campus or any suitable area using Plane Table (applying both radiation and intersection methods) (2 Assignments)

2. Open and Closed Traverse Surveying with Prismatic Compass: Preparation of plan along with
adjustment of closing errors. (2 Assignments)

3. Closed Traverse Surveying with Theodolite: Plotting of data for preparation of a plan through computation of Reduced Bearing, Consecutive Co-ordinates and Independent Co-ordinates; Measurement of height of object/objects using Theodolite (2 Assignments)

4. Profile levelling and contouring in a selected area by Dumpy Level (2 Assignments)

5. Preparing a map of a short trail along with prominent features by using hand-held GPS and associated software/freeware. (2 Assignments)

Unit II: Practical Note-Book and Viva-voce (8 Marks)

1. Evaluation of Practical Note-Book (4 Marks)

2. Viva-voce (4 Marks)

Reading List:

1. Campbell, J., 1984: Introductory Cartography, Prentice Hall Inc., Englewood Cliff.
2. Misra, R.P. and Ramesh, A., 1995: Fundamentals of Cartography, Concept Publishing Company, NewDelhi.
3. Robinson, A.H., et al: Elements of Cartography, John Wiley & Sons, New York.
4. Raisz, E.: Principles of Cartography, McGraw Hills, London.
5. Kenetkar, T.P. and Kulkarni, S.U.: Surveying and Levelling, Vol. I & II, VidyarthiGrithaPrakashan, Pune.
6. Das, A.K.2021: Pocket Size Handbook on Handling of GPS for Field Studies, GTAD and Aranyak, Guwahati (In PDF format).

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CBCS-based U.G. Course in Geography, 2019

Syllabus of Generic Elective Course

Course Name: Geography of India with Reference N.E. India

Paper Code: GGY-HG-4066

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives

- This is an elective paper which intends to introduce students to India as a geographical entity.
- It seeks to develop new insights among students on significant geographical dimensions of the country along with its north-eastern part.
- A field study is incorporated to make the students understand regional diversity of India with respect to its land, people and economy.

Course outcome

- The paper will be useful for students in developing understanding on Indian geography and its various dimensions.
- It will also be useful for students preparing for various competitive examinations includingcivil services.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. India's location and its significance; administrative divisions. **(3classes)**

2. Physical setting: Major Physiographic Regions and their Characteristics; Drainage System (Himalayan and Peninsular). **(5 classes)**

3. Climate: Seasonal Weather Characteristics; Climatic Divisions; Indian Monsoon (mechanism and characteristics). **(5 classes)**

4. Population Growth and distribution; Characteristics and Composition of population (rural-urban, age, sex, occupational, literacy and religious), Population Policies of India. **(5classes)**

5. Agriculture: Environmental, Technological and Institutional Factors affecting Indian Agriculture; Distribution and Production of Rice, Wheat and Tea; Agro Climatic Zones; Food Security. **(5classes)**

6. Distribution and characteristics/potential of Natural Resources: Soil, Vegetation, Water, Mineral Resources (Coal, Petroleum and Iron ore). **(5classes)**

7. Factors influencing Industrial development in the country; Industrial Regions and their characteristics; Industrial Policies in India; Distribution and production patterns of iron and steel and cotton textile. **(4classes)**

8. North-East India: Land of seven sisters and its locational significance; physiographic framework; forest cover; agricultural practices including shifting cultivation; industrial development scenario; population growth pattern. **(8 classes)**

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (10 marks)

(2 questions of 5 marks each)

1. Trend of population growth and growth rates in India and N.E. India/Assam since 1901 using Census of India data (Source: censusindia.gov.in) **(2 assignments)**

2. Choropleth mapping to show spatial variation in decennial population growth rate in India /N E India/Assam. **(1 assignment)**

3. Spatial variation in the patterns of religious composition of population in India and Social composition of population (SC, ST and General) in N.E. India using pie-graph. **(2 assignments)**

4. Trend of food grains production (rice, wheat, maize, barley, jowar and bajra) in India since 1950-51 using band-graph. **(1 assignment)**

5. Map showing distribution of major tribal groups in North-East India **(1 assignment)**

Unit 2: Field Report (6 Marks)

6. Preparation of field report based on field study through observational knowledge about the geographical personality of any part of India/N.E. India/Assam under the guidance of teacher(s). (Evaluation of the Content of Field Report; 4 Marks; Viva-voce on Field Report: 2 Marks)

Unit 3: Practical Note-Book and Viva-voce (4 Marks)

7. Evaluation of Practical Note-Book (2 Marks)

8. Viva-voce (2 Marks)

Reading List:

1. Deshpande C. D., 1992: India: A Regional Interpretation, ICSSR, New Delhi.
2. Johnson, B. L. C., ed. 2001. Geographical Dictionary of India.Vision Books, New Delhi.
3. Mandal R. B. (ed.), 1990: Patterns of Regional Geography – An Intenational Perspective. Vol. 3 –Indian Perspective.
4. Sdyasuk Galina and P Sengupta (1967): Economic Regionalisation of India, Census of

India
5. Sharma, T. C. 2003: India - Economic and Commercial Geography. Vikas Publ., New Delhi.
6. Singh R. L., 1971: India: A Regional Geography, National Geographical Society of India.
7. Singh, Jagdish 2003: India - A Comprehensive & Systematic Geography, Gyanodaya Prakashan, Gorakhpur.
8. Spate O. H. K. and Learmonth A. T. A., 1967: India and Pakistan: A General and Regional Geography, Methuen.
9. Tirtha, Ranjit 2002: Geography of India, RawatPubls., Jaipur & New Delhi.
10. Pathak, C. R. 2003: Spatial Structure and Processes of Development in India. Regional Science Assoc., Kolkata.
11. Tiwari, R.C. (2007) Geography of India. PrayagPustakBhawan, Allahabad
12. Sharma, T.C. (2013) Economic Geography of India. Rawat Publication, Jaipur
13. Bhagabati, A.K., Bora, A. K. and Kar, B.K.: Geography of Assam, Rajesh Publications, New Delhi.
14. Taher, M and Ahmed, P.: Geography of North East India, Mani ManikPrakash, Guwahati.
15. Das, M..M.: Peasant Agriculture in Assam, EBH_India Publishers, Guwahati.
16. Gopal Krishnan, R : Geography of North East India.
17. Bhattacharya, P.2006 : Trend in Tourism Potentiality, BaniMandir, Guwahati.
18. Bhagabati, A.K. (ed) : Biodiversity of Assam, Eastern Book House, Guwahati.
19. Bhattacharyya, N.N. : North East India, Rajesh Publication, New Delhi.
20. Srivastava, S.C. : Demographic Profile of N.E. India, Mittal Publications, New Delhi.

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CBCS-basedU.G. Course in Geography, 2019

Syllabus of Core Course

Course Name: Population and Settlement Geography

Paper Code: GGY-HG-4076

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives

- This paper is a generic paper that intends to introduce students to the basic concepts of population and settlement geography and how the differential characteristics of population and settlement influence the overall development process of an area.
- It seeks to develop understanding among students about the significance of population geography and settlement geography and their inter-relationship.

Course outcomes

- The paper will be useful for students in developing ideas about spatio-temporal changes in the characteristics of population and settlement and the factors associated with them.
- The paper will be useful for students preparing for various competitive exams including the civil services.

Part I: Theory
Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

Unit I: Population Geography (40 Marks) 26

Classes

1. Defining the field of population geography: meaning and scope; its relation with demography.
(3
Classes)

2. Sources of population data; perspectives on Census of India publications – Primary Census Abstract, District Census Hand-Book, Sample Registration System, etc. (2 Classes)

3. Distribution and density of population: Factors influencing population distribution and density; global pattern of population distribution. (4 Classes)

4. Population Growth: Trend of global population growth; components of population growth–fertility, mortality and migration; push and pull factors of migration; spatial variations in population growth in the world. (8 Classes)

5. Theories of population growth: Malthusian Theory and Demographic Transition Theory. (3 Classes)

6. Population composition and associated characteristic patterns in global contexts: Age-Sex Composition; Rural-Urban Composition; Population ageing. (6 Classes)

Unit II: Settlement Geography (20 Marks) 14 Classes

1. Defining the field of settlement of geography: Meaning and scope. (3 Classes)

2. Rural and urban settlements: Factors influencing distribution pattern of settlements; Types of rural settlements; Morphology and Characteristics of rural and urban settlements. (7 Classes)

3. Concept of settlement hierarchy and urban fringe;Christaller's Central Place Theory. (4 Classes)

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Trend of population growth in Assam/N.E. India through line graph; Calculation and graphical representation of trend of decadal growth rates of population in Assam/N.E. India/India. (2 Exercises)

2. Choropleth map to show spatial pattern of decadal variation in population growth in Assam/N.E. India/India. (1 Exercise)

3. Choropleth map showing spatial pattern of population density in Assam/India. (1 Exercise)

4. Map showing spatial variation in social/religious/rural-urban composition of population in Assam/N.E. India using pie-graph. (1 Exercise)

5. Choropleth map showing spatial pattern of level of urbanization in Assam/N.E. India. (1 Exercise)

6. Flow cartogram showing direction and volume of migration into Assam/N.E. India from different parts of India. (1 Exercise)

7. Map showing distribution of towns and their varied population size with spheres in Assam/N.E. India. (1 Exercise)

Unit II: Practical Note-Book and Viva-voce (4 Marks)

5. Evaluation of Practical Note-Book (2 Marks)
6. Viva-voce (2 Marks)

Reading List:

1. Barrett H. R., 1995: *Population Geography*, Oliver and Boyd.
2. Bhende A. and Kanitkar T., 2000: *Principles of Population Studies*, Himalaya Publishing House.
3. Chandna R. C. and Sidhu M. S., 1980: *An Introduction to Population Geography*, Kalyani Publishers.
4. Chandna R. C., 2014, Geography of Population: *Concepts, Determinants and Patterns*, Kalyani Publishers.
5. Clarke J. I., 1965: *Population Geography*, Pergamon Press, Oxford.
6. Jones, H. R., 2000: *Population Geography,* 3rd ed. Paul Chapman, London.
7. Lutz W., Warren C. S. and Scherbov S., 2004: *The End of the World Population Growth in the 21st Century*, Earthscan.
8. Newbold, K. B., 2009: *Population Geography: Tools and Issues*, Rowman and Littlefield Publishers.
9. Pacione, M., 1986: *Population Geography: Progress and Prospect*, Taylor and Francis.
10. Wilson, M. G. A., 1968: *Population Geography*, Nelson.
11. Panda, B. P. (1988): JanasankyaBhugol, M P Hindi Granth Academy,Bhopal.
12. Maurya, S. D. (2009) JansankyaBhugol, ShardaPustakBhawan, Allahabad.
13. Chandna, R. C. (2006), JansankhyaBhugol, Kalyani Publishers, Delhi.
14. Roy, D. (2015), *Population Geography*, Books and Allied (P) Ltd., Kolkata.
15. Ahmad, A., Noin, D. and Sharma, H.N. (eds), 1997, *Demographic Transition: The Third World Scenario*, Rawat Publications, Jaipur and New Delhi, 1997.
16. Money, D.C., 1972: Patterns of Settlement, Evan Brothers, London.
17. Peters, G.L. and Larkin, R.P., 1979: *Population Geography: Problems, Concepts andProspects,* Kendall/ Hunt Iowa.
18. Singh, R.L. and Singh, K.N., (eds), 1975: *Readings in Rural Settlement Geography*, BHU, Varanasi.
19. Singh, R.Y., 1994: *Geography of Settlements*, Rawat Publications, Jaipur and New Delhi.
20. Maurya, S. D., 2014:*Settlement Geography*, ShardaPustakBhawan, Allahabad.

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Syllabus for
BA/B.Sc.(Honours) Geography
Choice Based Credit System (CBCS)

Course effective from the academic year 2019-20

5th Semester

This is approved in the Academic Council held on 8/11/2019

Department of Geography
GAUHATI UNIVERSITY
Guwahati-781014

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Class 1 Hour 1	Duration	Credit
1 Theory Class	1 Hour	1
1 Tutorial Class	1 Hour	1
1 Practical Class	2 Hours	1

Credit and Marks distribution scheme for CBCS Curriculum: Honours Course (5thSemester)

Semester V Marks 400 Credit 24	Honours Core	GGY - HC - 5016	Social and Political Geography	4+2=6	100
		GGY - HC - 5026	Field Techniques in Geography	4+2=6	100
	Discipline Specific Elective (Any two)	GGY - HE - 5036:	Geography of Transportation	4+2=6	100
		GGY - HE - 5046:	Regional Development and Planning	4+2=6	100
		GGY - HE - 5056:	Urban Geography	4+2=6	100
		GGY - HE - 5066:	Agricultural Geography	4+2=6	100

Subject	Semester	Paper type	Paper Code	Paper name	Total Marks	Marks Distribution					Paper Credit
						External (80)		Internal (20)			
						Theory	Practical	Sessional	Practical /Assignments	Attendance	
Geography	5th	HonoursCore	GGY - HC - 5016	Social and Political Geography	100	60	20	10	6	4	4+2=6
			GGY - HC - 5026	Field Techniques in Geography	100	60	20	10	6	4	4+2=6
		Discipline Specific Elective (Any two)	GGY - HE - 5036:	Geography of Transportation	100	60	20	10	6	4	4+2=6
			GGY - HE - 5046:	Regional Development and Planning	100	60	20	10	6	4	4+2=6
			GGY - HE - 5056:	Urban Geography	100	60	20	10	6	4	4+2=6
			GGY - HE - 5066:	Agricultural Geography	100	60	20	10	6	4	4+2=6

CBCS-based U.G. Course in Geography, 2019

Syllabus of Honours Core Course

Course Name: Social and Political Geography

Paper Code: GGY-HC-5016

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives:

- To appreciate the social and political dimensions of geographic phenomena.
- Understand how geography influences political issues and their spatial dimensions.

Course outcome:

- This course will help equip the students to comprehend various social and political aspects of phenomena and their interface within the realm of geography.
- The paper will be very useful for students preparing for various competitive examinations including civil services.

Part 1: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

Unit 1: Social Geography (30 Marks) 20 Classes

1. Social Geography: Meaning and scope; its approaches of study; and contemporary trend of its development. (4 Classes)
2. Concept and types of social space and social groups. (4 Classes)
3. Social Well-being: Concept and Component: Housing, Health and Education; Concept ofHuman development and its measurements. (4 Classes)
4. Contribution of race, religion, language and ethnicity in promoting diversity in India. (4 Classes)
5. Social Geographies of inclusion and exclusion: Caste system, slums, gated communities, communal conflicts and crime; Gender identity. (4 Classes)

Unit 2: Political Geography (30 Marks) 20 Classes

1.Political Geography: Nature, scope and recent trends; Approaches to its study. (4 Classes)

2. Concept of state, nation, and nation-state; Attributes of State.(3 Classes)

3. Concept of frontiers and boundaries; boundary problems with reference to India and North-East India; Concept of buffer zones.(5 Classes)

4. Concept of Geopolitics, Heartland and Rimland; Mackinder'sHeartland Theory.

(4 Classes)

5.Concept of colonialism, neo colonialism and lebensraum. (4 Classes)

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each

1. Mapping the spatial patterns of human development in India and Assam using HDI.**(2 Exercises)**

2. Construction of Ternary Diagram representing social composition of population in India/North East India. **(1 Exercise)**

3. Level of Social well-being with the help of composite Z-score in India /North-East India. **(1 Exercise)**

4. Sex disparity in literacy in India/North-East Indiausing Sopher's Disparity Index. (**1 Exercise)**

5.Computation of Shape Index for selected states of India and countries. (**2 Exercises)**

6. Construction of a map of India/North-East India highlighting the major inter-state boundary conflict zones. **(2 Exercises)**

7**.** Reorganization of the states of North-East India during Pre and Post Independence periods

(up to the present). (**3 Exercises**)

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 marks)

2. Viva-voce (2marks)

Reading List:

<u>Social Geography</u>

1. Ahmad, A., 1999: Social Geography, Rawat Publications, Jaipur and New Delhi.
2. Ahmad, A., (ed), 1993: Social Structure and Regional development: A Social Geography Perspective, Rawat Publications, Jaipur.
3. Carter, John and Trevor, Jones. 1989: Social Geography: An Introduction to Contemporary Issues, Edward Arnold, London.
4. Eyles, J.: 'Social Geography', in Johnston, R.J., et al, The Dictionary of Human Geography.
5. Jones, E. and Eyles, J., 1977: An Introduction to Social Geography, Oxford University Press, Oxford and New York.
6. Jones, E,(ed), 1975: Readings in Social Geography, Oxford University Press, Oxford.
7. Sharma, H.N., 2000: 'Social Geography' in Singh, J. (ed.) Progress in Indian Geography (1996-2000), INSA, New Delhi.
8. Smith, D.M., 1977: Human Geography: A Welfare Approach, Edward Arnold, London.
9. Sopher, D.E. (ed), 1980: An Exploration of India: Geographical Perspectives on Society and Culture, Longman, London.
10. Srinivas, M.N., 1986: India: Social Structure, Hindustan Publishing Corporation, Delhi.
11. Taher, M., 1994: An Introduction to Social Geography: Concept and Theories, NEIGS, Guwahati. 37

<u>Political Geography</u>

1. Adhikari , S.,1996 : Political Geography, Rawat Publications, Jaipur and New Delhi.
2. De Blij, H.J.,1972 : Systematic Political Geography, John Wiley , New York.
3. Dikshit, R.D.,1982 : Political Geography : A Contemporary Perspective, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
4. Muir, R.,1975 : Modern Political Geography , Macmillan Ltd., London.
5. Pounds, N.J.G.,1972 : Political Geography, McGraw Hill , New York.
6. Prescott, J.R.V.,1972 : Political Geography, Methuen, London.
7. Sukhwal, B.L., 1979: Modern Political Geography of India, Sterling, New Delhi. Taylor, P.J., 1989: Political Geography, Longman, London.

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CBCS-basedU.G. Course in Geography, 2019

Syllabus of Honours Core Course

Course Name: Field Techniques in Geography

Paper Code: GGY-HC-5026

Total Credit: 6 (4+2)

Total Marks 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives:

This paper on Field Techniques in Geography is of pedagogical importance as it helps the students of geography to acquire the first hand experience about the geography of a particular area. It also helpsthe students to learn the various techniques of data collection from the field andto understand any pre-defined problem in proper perspective.

Course outcomes:

- This course will help students to proceed with a research problem and the steps she/he should adopt and the tools and craft to be employed for doing quality research.
- Students perceive fieldwork to be beneficial to their learning, because through it they experience 'geographical reality', and have deeper understanding of the subject.
- The students will have a chance to interact with respondents and collect data through questionnaire directly from the field.
- This course will develop understanding about designing and writing a field report.

Part I: Theory

Credit: 4 (60 Marks)

(40 Classes of 1 hour each)

1. Geography and Field Studies: Geography as a field science; Need of field work in geography; Nature of field studies in physical geography and human geography. (4 classes)

2. Concept of Case Study and Its identification in the varying geographical contexts (Physical/Human/Rural/Urban/Environmental). (4 classes)

3. Tools and Techniques in Field Studies:Nature of data and their collection techniques relating to various geographical phenomena (Physical and Human); Structure of field survey questionnaire; Collection of Physical geographic data: Observations and photography, field interview, questionnaire survey, Equipment/Measurement-based survey, etc; Collection of Human geographic data: Questionnaire survey, Participant observation, PRA, Focus group interview/discussion, etc. (14 classes)

4. Surveying: Concept of ground surveying and mapping;Conduct of traverse surveying with Prismatic Compass; Profile levelling and contouring with Dumpy Level; Pont distribution survey with GPS; Field mapping of Village, River bank, Wetland, Landslides, Market, etc through Transect, Quadrant and sketch map. (14 classes)

5. Preparation of Field Study Report and its broad design: Basis of selection of the theme of field study; Objectives, Methods of data collection, Location/Situation of the study area, Data Analysis and mapping, Interpretation/Findings. (4 classes)

Part II: Field Book

Credit: 2 (20 Marks)

(20 classes of two hour duration each)

Unit I: Field Book Preparation and Evaluation (15 Marks)

Based on understanding of various field techniques of geography in theory course the students shall undertake the following field assignments within or nearby the College campus and some other area, as the case may be, under the guidance of respective teachers. The students shall present their assignments in A4 size paper as a Field Book and submit the same with teachers' signature in binding form (Spiral or Kutcha binding) for evaluation in the examination. The evaluation shall be based on average of marks given by the external examiner and internal examiner.

<u>Contents of Field Book</u>:

1. Field observations of a near-by area and preparation of a brief report (within 4-5 pages) about the prevailing physical and human landscape of the area along with its spot photograph.
(2 Assignments)
2. Preparation of two field survey questionnaire/schedule (within 2 pages each) for collection of data relating to two different broad phenomena/problems (one on physical phenomenon and another on human phenomenon), and processing, tabulation and graphical representation of the same.
(2 Assignments)
3. Closed traverse surveying within College campus with Prismatic Compass and plotting of some details within the polygon, and preparation of a plan with appropriate scale and error correction, if any. (1 Assignment)

4. Longitudinal profile levelling and contouring in College campus and any nearby area with Dumpy Level, and plotting of collected data in the forms of longitudinal profile and contour map. (2 Assignments)

5. Collection of point data from an area with handheld GPS and preparation of a GPS data table and distribution map with down-loaded data. (1 Assignment)

6. Preparation of field map of a village, urban locality/market, river bank/wetland and its adjoining area or their any section through Transect, Quadrant and sketch map along with a spot photograph of the same. (3 Assignments)

Unit II: Viva-voce (5 Marks)

Reading List:

1. Creswell J., 1994: *Research Design: Qualitative and Quantitative Approaches* Sage Publications.
2. Dikshit, R. D. 2003. The Art and Science of Geography: Integrated Readings. Prentice-Hall of India, New Delhi.

3. Evans M., 1988: "Participant Observation: The Researcher as Research Tool" in *Qualitative Methods in Human Geography*, eds. J. Eyles and D. Smith, Polity.

4. Mukherjee, Neela 1993. Participatory Rural Appraisal: Methodology and Application. Concept Publs. Co., New Delhi.

5. Mukherjee, Neela 2002. Participatory Learning and Action: with 100 Field Methods. Concept Publs. Co., New Delhi.

6. Robinson A., 1998: "*Thinking Straight and Writing That Way*", in *Writing Empirical Research Reports: A Basic Guide for Students of the Social and Behavioural Sciences*, eds. by F. Pryczak and R. Bruce Pryczak, Publishing: Los Angeles.

7. Special Issue on "Doing Fieldwork" *The Geographical Review* 91:1-2 (2001).

8. Stoddard R. H., 1982: *Field Techniques and Research Methods in Geography*, Kendall/Hunt.

10. Wolcott, H. 1995. The Art of Fieldwork.Alta Mira Press, Walnut Creek, CA.

11. Monkhouse, F.J. and Wilkinson, H.R., 1989: Maps and Diagrams, B.I. Publications Ltd., Mumbai.

12. Singh R. L. and Singh R. P. B., 1999: Elements of Practical Geography, Kalyani Publishers.

13. Singh, L.R., 2013: Fundamentals of Practical Geography, ShardaPustakBhawan, Allahabad.

14. Sarkar, A., 2015: Practical Geography: A Systematic Approach. Orient Black Swan Private Ltd., New Delhi.

15. Misra, R. P. and Ramesh, A., 1989: Fundamentals of Cartography, Concept Publishing Company, New Delhi.

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CBCS-basedU.G. Course in Geography, 2019

Syllabus of Discipline Specific Elective Course

Course Name: Geography of Transportation

Paper Code: GGY-HE-5036

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

- This is a discipline-specific elective paper which intends to introducethe students to the significance of transport studies in geography.
- The students will be exposed to the ideasof various facets of transport network, modes of transportation and flow analysis.

Course Outcome:

- The students will be able to understand and analyse the principal issues confronting the transportation systems from geographical perspectives.
- The students will get an insight into various transportation systemsfrom global and India perspectives.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Nature, scope and development of Transport Geography. (2 Classes)
2. Factors associated with development of transport system: Physical, Economic, Social and Cultural, and Institutional. (5 Classes)
3. Evolution of transport network; Characteristics and relative significance of different modes of Transport (Roads, Railways, Airways and Waterways). (6 Classes)
4. Transport Network Connectivity and Accessibility: Measures/Indices of connectivity and accessibility; models of spatial interaction and flow; Concept of Taaffee, Morril and Gould's Transport Model. (9 Classes)
5. Transport planning for Regional Development: Concept of coordinated transport planning and development; Transport development and resource mobilization; Concept of urban transport network planning; Management of urban traffic Congestion. (9 Classes)
6. Transport Systems in India: Development of Railways, Roadways, Airways and Waterways, and their coordination; National Transport Policy and Planning; Development of National Highways; Rapid transit systems in mega cities of India; Role of transport development in N.E. India for promotion of Act East Policy and border trades. (9 Classes)

Part II: Practical
Credit: 2 (20 Marks)
(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Computation of road network connectivity patterns in Assam/N.E. India using graph-theoretic measures (Alpha, Beta andGamma indices).(3 assignments)
2. Computation of road transport accessibility in Assam/N.E. India using Connectivity Matrix and Konig Number. (2 assignments)
3. Computation of road transport accessibility of selected towns of Assam/N.E. India using Detour Index. (1 assignment)
4. Preparation of Traffic flow cartogram of Assam/N.E. India showing movement of commodities/Passengers/Buses from different places. (2 assignments)
5. Urban population potential mapping based on major towns of Assam/N.E. India. (1 assignment)
6. Computation and mapping of spatial patterns of road density in N.E. India. (1assignment)
7. Mapping of spatial patterns of transport development level in N.E. India using a simple composite index (Ranking Method). (1 assignment)

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 Marks)
2. Viva-voce (2 Marks)

Reading List:

1. Bamford, C.G. and Robinson, H. (1978), Geography of Transport, Macdonald and Evans, London.
2. Bhaduri S. (1992), Transport and Regional Development, Concept Publishing Company, New Delhi.
3. Eliot Hurst, M.E. (1972), A Geography of Economic Behavior: An Introduction, Duxbury Press, California.

4. Hammond, R. and McCullagh, P.S. (1989), Quantitative Techniques in Geography: An Introduction, Clarendon Press, Oxford.
5. Hoyle, Band and Knowles, R. (2000), Modern Transport Geography, John Wiley and Sons, New York.
6.Hoyle, B.S. (1973) Transport and Development, McMillan, London
7. Husain, M. and Zaidi, S.S.H. (1996), Environmental Management in India, Concept Publications Pvt. Ltd. New Delhi.
8. Majid Husain (1994): Transport Geography, Anmol Publication Pvt. Ltd, New Delhi.
9. Raza, M. and Aggarwal, Y.P. (1985), Transport Geography of India, Concept Publishing Company, New Delhi.
10. Saxena, H.M. (2010), Transport Geography, Rawat Publications, New Delhi.
11.Taaffe, E.J. and Gauthier, H.L. (1973) Geography of Transportation, Prentice Hall Englewood Cliff, New Jersey.
12. Vaidya, B.C. (1998), Reading's in Transport Geography, Devika Publications, Delhi.

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CBCS-basedU.G. Course in Geography, 2019

Syllabus of Discipline Specific Elective Course

Course Name: Regional Development and Planning

Paper Code: GGY-HE–5046

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives:

- This paper intends to introduce students to the rationale underlying the relevance of balanced regional development and spatial inequalities from geographical perspective.
- It seeks to develop new insights among students on the issue of development and associated regional disparities in development.

Course outcomes:

- The paper will be useful for students in developing ideas on disparities within and between countries and their fallout.
- The paper will help provide theoretical insights and perspectives to students, if they wish to pursue a higher studies or research in future.
- The paper will be very useful for students preparing for various competitive examinations including civil services.

Part I: Theory
Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

Unit I: Regional Planning (30 marks) (20 Classes)

1. Region: Concept, types and delineation techniques of a region. (4 Classes)
2. Regional planning:Evolution and types; Objectives and principles of Regional Planning. (5 Classes)
3. Regional Planning in India: Macro, meso and micro level planning; Local level planning and Panchayati Raj (GPDP); Participatory approach in planning; NITI Aayog. (6 Classes)
4. Planning regions of India with special reference to North-East India. (5 Classes)

Unit-II: Regional Development (30 marks) (20 Classes)

5. Concept of Development: Growth versus development; Concept of sustainable development and balanced development. (4 Classes)
6. Regional Development theories and models: Concept and basic ideas of Growth Pole Model of Perroux; Cumulative Causation Theory ofMyrdalandStages of Economic Growth model of Rostow. (6 Classes)
7. Human development: Meaning and concept of Human Development Index; Concept of Happiness Index. (4 Classes)
8. Disparity of Regional Development in India:Development indicators; Measuringlevel of development; Pattern of regional development in India with special reference to North-East India; Role of NEC and DoNER Ministry towards development of the NE Region. (6 Classes)

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Delineation of agriculturalproductivityregions in Assam/NE India by using weighted index number and Bhatia's method. (2 Assignments)
2. Delineation of influence zones of selected urban centres of Assam/ NE India by using Reilly's Breaking Point formula. (2 Assignments)
3. Preparation of land use maps of any suitable area for two different points of timefor identifying the changes in settlement, agriculture land, forest cover, water bodies, etc. during the period; and representation of data generated from there in a graph. (2 Assignments)
4. Preparation of a choropleth map to show regional disparity in development in India andN. E. Indiabased on selected indicators using Ranking Method and Composite Z-Score method. (2 Assignments)
5. Preparation of flow cartogram to show volume of inter-state movement of different commodities in India/NE India.(2 Assignments)

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 Marks)

2. Viva-voce (2 Marks)

Reading List:

1. Bhargava, G. 2001. *Development of India's Urban, Rural, and Regional Planning in 21st Century: Policy Perspective*, Gyan Publishing House.
2. Blij H. J. De, 1971: *Geography: Regions and Concepts*, John Wiley and Sons.
3. Chand, M., Puri, V.K. 2000. *Regional Planning In India*, Allied Publishers Ltd.
4. Chandana, R.C. 2016. *Regional Planning and Development*, 6th ed, Kalyani Publishers.
5. ClavalP.l, 1998: *An Introduction to Regional Geography,* Blackwell Publishers, Oxford and Massachusetts.
6. Friedmann J. and Alonso W. (1975): *Regional Policy - Readings in Theory and Applications,* MIT Press, Massachusetts.
7. Glasson, J. 2017. *Contemporary Issues in Regional Planning*, Routledge.
8. Gore C. G., 1984: *Regions in Question: Space, Development Theory and Regional Policy*, Methuen, London.
9. Gore C. G., Köhler G., Reich U-P. andZiesemer T., 1996*: Questioning Development; Essays on the Theory, Policies and Practice of Development Intervention*, MetropolisVerlag, Marburg.
10. Haynes J., 2008: *Development Studies,* Polity Short Introduction Series.
11. Johnson E. A. J., 1970: *The Organization of Space in Developing Countries*, MIT Press, Massachusetts.
12. Misra, R.P. 1992. *Regional Planning: Concepts, Techniques, Policies and Case Studies,* Concept Publishing.
13. Peet R., 1999: *Theories of Development*, TheGuilford Press, New York.
14. Ray, J. 2001. *Introduction to Development & Regional Planning*, Orient Blackswan.
15. UNDP 2001-04: *Human Development Report*, Oxford University Press.
16. World Bank 2001-05: *World Development Report,* Oxford University Press, New
17. https://sustainabledevelopment.un.org/partnership/?p=2212.

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CBCS-basedU.G. Course in Geography, 2019
Syllabus of Discipline Specific Elective Course

Course Name: Urban Geography
Paper Code: GGY-HE-5056

Total Credit: 6 (4+2)
Total Marks: 100
(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives

- This paper introduces the students to the field of urban geography and its major aspects.
- It seeks to develop new insights among students on the relevance of an urban geography and associated problems in a rapidly urbanizing world.

Course outcomes

- The paper will be useful for students in developing ideas on how geographical factors organize urban spaces and how geographers seek to address various urban problems and issues.
- It will help build skills among students seeking advanced studies on urban development and planning.
- The paper will be very useful for students preparing for various competitive examinations including civil services.

Part I: Theory

Credit: 4 (60 Marks)
(40 classes of 1 hour duration each)

1. Urban Geography: Nature and scope; approaches and trends in urban geography. **(4 classes)**
2. Origin and growth of towns in global and national contexts; Types and characteristics of towns; Functional classification of towns; Schemes of city classification (J.M. Houston's, G. Taylor's and L. Mumford schemes). **(8 classes)**
3. Patterns of Urbanisation in developed and developing countries; Components of urbanization and urban population growth. **(4 classes)**
4. Organization of urban space: Urban morphology and land use structure; Theories on the internal structure of town: the Sector Theory of Homer and Hoyt, and the Multiple Nuclei Theory of Harris and Ullman **(4 classes)**

5. Concept of city-region, urban agglomeration, urban sprawl, umland and periphery, rural-urban dichotomy and continuum, urban fringe, satellite town, new town, smart city. **(4 classes)**
6. Urban Systems: Concept of urban system and hierarchy; Christaller's Central Place Theory; the rank-size distribution of cities; concept of primate city. **(6 classes)**
7. Urban issues and problems: Housing, slums, civic amenities (transportation and drinking water), traffic congestion, pollution (air, noise, water), and crime.

   (5 classes)
8. Urbanization and urban development planning in India: Trend and regional patterns of urbanization; national urban development policies and programmes; emerging urban issues of selected cities (Delhi NCR, Mumbai,Guwahati). **(5 classes)**

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Plotting of million cities of India by using proportionate sphere method. **(1 Exercise)**
2. Map showing distribution of class I and II urban centres in Assam/NE India by using proportionate sphere method. **(1 Exercise)**
3. Determination of spatial mean centres of urban settlements using weighted (Population as weight) centrographic measure in Assam and NE India. **(2 Exercises)**
4. Calculation of distribution pattern of urban settlements in a District/State of N.E. India using Nearest Neighbour Analysis. **(1 Exercise)**
5. Choropleth map showing spatial pattern of level of urbanization in Assam and N.E. India. **(2 Exercises)**
6. Determination of rank-size relationship of urban centres in Assam/N.E. India/India. **(1 Exercise)**
7. Urban population potential mapping based on selected urban centres of Assam/N.E. India. **(1 Exercise)**
8. Delineation of urban influence zones of selected urban centres of Assam/N.E. India using Reilly's breaking point formula. **(1 Exercise)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 Marks)
2. Viva-voce (2 Marks)

Reading List:

1. Bala, R. (1986): Urbanisation in India, Rawat, Jaipur.
2. Bansal, S.C. (2010): Urban Geography, MeenakshiPrakashan, Meerut.
3. Fyfe N. R. and Kenny J. T., 2005: *The Urban Geography Reader*, Routledge.
4. Graham S. and Marvin S., 2001: *Splintering Urbanism: Networked Infrastructures,TechnologicalMobilities and the Urban Condition*, Routledge.
5. Hall T., 2006: *Urban Geography*, Taylor and Francis.
6. Kaplan D. H., Wheeler J. O. and Holloway S. R., 2008: *Urban Geography*, John Wiley.
7. Knox P. L. and McCarthy L., 2005: *Urbanization: An Introduction to Urban Geography*, Pearson Prentice Hall New York.
8. Knox P. L. and Pinch S., 2006: *Urban Social Geography: An Introduction*, Prentice-Hall.
9. Kundu, A. (1992): *Urban Development and Urban Research in India*, Khanna Publication, New Delhi.
10. Nangia, S. (1976): *Delhi Metropolitan Region: A Study in Settlement Geography*, Rajesh Publication, New Delhi.
11. Pacione M., 2009: *Urban Geography: A Global Perspective*, Taylor and Francis.
12. Ramachandran R (1989): Urbanisation and Urban Systems of India, Oxford University Press, New Delhi
13. Sassen S., 2001: *The Global City: New York, London and Tokyo*, Princeton University Press.
14. Siddhartha K and Mukherjee S, (1996): *Cities, Urbanisation and Urban Systems*, Transworld media and communication, New Delhi
15. Singh, R.B. (Eds.) (2001) Urban Sustainability in the Context of Global Change, Science Pub., Inc., Enfield (NH), USA and Oxford & IBH Pub., New Delhi.
16. Singh, R.B. (Ed.) (2015) Urban development, challenges, risks andresilience in Asian megacities Advances in Geographical and Environmental Studies, Springer.

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CBCS-basedU.G. Course in Geography, 2019

Syllabus of Discipline-Specific Elective Course

Course Name: Agricultural Geography

Paper Code: GGY-HE-5066

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

- As a discipline-specific elective paper it intends to introduce the students to the basic concepts of agriculture and agricultural geography.
- It seeks to develop understanding among students about the significance of Agricultural Geography.
- To understand how different types of agriculture have developed in different areas and how they are similar to or different from one another.

Course Outcome:

- This paper will be useful for students in developing ideas about agricultural practices and their distribution and characteristics.
- This paper will also be useful tothe students in understanding the world agricultural systems.
- This paper will help develop understanding of location of agricultural activities and associated contemporary problems and challenges.

Part I: Theory

Credit: 4 (60 Marks)

(40 Classes of 1 hour each)

1. Agricultural Geography: Meaning and Scope, Significance; Its approaches of study. (3 classes)
2. Factorsinfluencing agriculture: Physical, Socio-economic, Infra-structural and Institutional. (4 classes)
3. Agricultural Systems and Types: Global Agricultural Systems; Agricultural types: Intensive and Extensive, Subsistence and Commercial, Plantation Farming, Mixed Farming, Horticulture and Market Gardening. (8 classes)
4. Von Thunen'sModel of Agricultural Location; Concept of Land Rent and Market forces. (4 classes)
5. Concept of cropping patterns: Crop Combination (Nelson's Method), Crop concentration, Intensity of cropping and Crop rotation. (5 classes)
6. Agricultural Modernization and Development: Concept of agricultural modernization; Inputs of agricultural modernization (mechanization, Irrigation, HYV seeds, fertilizers etc.); Concept of crop productivity and agricultural development.(8 classes)

7. Factors, distribution and production patterns of rice, wheat and sugarcane in the world. (4 classes)
8. India's agriculture: Major characteristics and problems; Green revolution; agro-climatic regions. (4 classes)

Part II: Practical

Credit: 2 (20 Marks)

20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Trend of production of major food grains (rice, wheat, maize etc.) in India/ selected States using moving average method. (1 Exercise)
2. Preparation of the crop- combination Map of Assam/ North East India based on Nelson's method. (1 Exercise)
3. Agricultural productivity pattern in Brahmaputra Valley/Assam/ N E India based on Kendall's Ranking Method. (1 Exercise)
4. Mapping of spatial pattern of Intensity of Cropping in Assam/ North East India Exercises) (1 Exercise)
5. Spatial variation in land use pattern in Brahmaputra valley/ North East India with Pie diagram.(1Exercises)
6. Spatial pattern of crop concentration in North East India/ Assam using Location Quotient Method. (1 Exercise)
7. Spatial pattern of level of agricultural development in Assam/ N E India using Composite Z-Score. (2Exercises)
8. Correlation and regression analysis between irrigation and cropping intensity in Assam/N.E. India. (2 Exercises)

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 Marks)

2. Viva-voce (2 Marks)

Reading List:

1. Basu, D.N., and Guha, G.S. (1996). Agro-Climatic Regional Planning in India, Vol.I& II. New Delhi, India: Concept Publication.
2. Das M.M (2018): PeasantAgriculture in Assam, EBH (India) Publishers, Guwahati.
3. De, N.K., Jana, N.C. 1997: The Land: Multifaceted Appraisal and Management, Sribhumi Publishing.

6. Hussain, M. (1996). Systematic Agricultural Geography, Jaipur, India: Rawat Publications
7. Hussain, M. 1978. Agricultural Geography, Rawat Publication, Jaipur Knowles.
8. R and Wareing, J.1990. Economic and Social Geography, Made Simple Books,
9. RupaMonkhouse, F.J., Wilkinson, H.R. 1971. Maps and Diagrams: Their Compilation and Construction, 3rd ed (2017 reprint), Alphaneumera-Kolkata.
10. Sarkar, A. 2015. Practical Geography: A Systematic Approach, 3rd ed, Orient Blackswan Private Ltd.
11. Shafi, M., 2006: Agricultural Geography, Doring Kindersley India Pvt. Ltd., New Delhi.
12. Singh, J., and Dhillon, S.S., 1984: Agricultural Geography, Tata McGraw Hill, New Delhi.

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Syllabus for
BA/B.Sc.(Honours) Geography
Choice Based Credit System (CBCS)

Course effective from the academic year 2019-20

6th Semester

This is approved in the Academic Council held on 8/11/2019

Department of Geography
GAUHATI UNIVERSITY

Guwahati-781014

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Class 1 Hour 1	Duration	Credit
1 Theory Class	1 Hour	1
1 Tutorial Class	1 Hour	1
1 Practical Class	2 Hours	1

Credit and Marks distribution scheme for CBCS Curriculum: HonoursCourse (6thSemester)

Semester VI Marks 400 Credit 24	Honours Core	GGY - HC - 6016	Geographical Thought	4+2=6	100
		GGY - HC - 6026	Research Methods in Geography and Project Work	4+2=6	100
	Discipline Specific Elective (Any two)	GGY - HE - 6036	Geography of Health	4+2=6	100
		GGY - HE - 6046:	Hydrology	4+2=6	100
		GGY - HE - 6056:	Geography of Tourism	4=2=6	100
		GGY - HE - 6066:	Geography of Resources and Development	4+2=6	100

Subject	Semester	Paper type	Paper Code	Paper name	Total Marks	Marks Distribution					Paper Credit
						External (80)		Internal (20)			
						Theory	Practical	Sessional	Practical /Assignments	Attendance	
Geography	6th	HonoursCore	GGY - HC - 6016	Geographical Thought	100	60	20	10	6	4	4+2=6
			GGY - HC - 6026	Research Methods in Geography and Project Work	100	60	20	10	6	4	4+2=6
		Discipline Specific Elective (Any two)	GGY - HE - 6036:	Geography of Health	100	60	20	10	6	4	4+2=6
			GGY - HE - 6046:	Hydrology	100	60	20	10	6	4	4+2=6
			GGY - HE - 6056:	Geography of Tourism	100	60	20	10	6	4	4+2=6
			GGY - HE - 6066:	Geography of Resources and Development	100	60	20	10	6	4	4+2=6

CBCS-based U.G. Course in Geography, 2019

Syllabus of Core Course

Course Name: Geographical Thought

Paper Code: GGY-HC-6016

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives:

- This course introduces the students to the theoretical development of geography over time.
- This course presents contemporary and post-modern perspectives, along with the models that act as a guiding force of the discipline to understand various geographical phenomena in proper perspectives.

Course outcomes:

- This course develops a comprehensive understanding of the discipline;
- This course helps the students to apply the historic and contemporary perspective to explain and approach the real world geographic problems.

Part 1: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Early development of Geography: Ancient,dark age, medieval, and age of exploration and discoveries. **(8 classes)**
2. Foundation of modern geography: Contribution of the German, French, British and American geographers. **(6 classes)**
3. Evolution of geographical thought: Determinism, possibilism, neo-determinism, human ecology, cultural landscape and areal differentiation. **(8 classes)**
4. Recent trends in geography: Quantitative revolution and its impact, logical positivism, locational school of thought, behaviouralism, humanistic geographyand post-modernism. **(10 classes)**
5. Geographical debates: Regional and systematic; ideographic and nomothetic. **(4 classes)**
6. Models in geography:Meaning, types and significance; basic concepts of Gravity Model, Spatial Diffusion Model and Distance Decay Model. **(4 classes)**

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Mapping of routes of exploration and discoveries (Marco Polo, Christopher Columbus, Vasco-da gama, and James Cook**)** **(1 Exercise)**

2. Intensity of spatial interactionof Guwahati city with neighbouring urban centres. (**1 Exercise**)

3. Mapping of population potential surfaces in Assam using the gravitymodel. **(1 Exercise)**

4. Demarcation of urban influence zone by using Reily's breaking point formula. **(1 Exercise)**

5. Population Density gradient analysis of Guwahati or any other city. **(1 Exercise)**

6. Trend of development of paradigms in geography (from Environmental Determinism to Post Modernism) through time-scale graph indicating advocates, tentative time of emergence and overriding theme. **(1 Exercise)**

7. Preparation of a world map highlighting the major developments of geography (Greek, Arab, France, Germany, Russia, UK and USA) indicating the contribution, name of the contributor and year of contribution. **(1 Exercise)**

8. Greek and Arabian contributions to the development of Geography in different ages (Name of contributor and name of contribution at different points of time) through time-scale graph.

(1 Exercise)

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 Marks)
2. Viva-voce (2 Marks)

Reading List:

1. Arentsen M., Stam R. and Thuijis R., 2000: Post-modern Approaches to Space, ebook.
2. Bhat, L.S. (2009) Geography in India (Selected Themes). Pearson
3. Bonnett A., 2008: What is Geography? Sage.
4. Dikshit R. D., 1997: Geographical Thought: A Contextual History of Ideas, Prentice– Hall India.
5. Hartshone R., 1959: Perspectives of Nature of Geography, Rand MacNally and Co.
6. Holt-Jensen A., 2011: Geography: History and Its Concepts: A Students Guide, SAGE.
7. Hussain, M., 1989: Evolution of Geographic Thought, Rawat Publications, Jaipur.
8. Johnston R. J., (Ed.): Dictionary of Human Geography, Routledge.
9. Johnston R. J., 1997: Geography and Geographers, Anglo-American Human Geography since 1945, Arnold, London.
10. Kapur A., 2001: Indian Geography Voice of Concern, Concept Publications.
11. Martin Geoffrey J., 2005: All Possible Worlds: A History of Geographical Ideas, Oxford.
12. Soja, Edward 1989. Post-modern Geographies, Verso, London. Reprinted 1997: Rawat Publ., Jaipur and New Delhi.

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<u>CBCS-basedU.G. Course in Geography, 2019</u>

Syllabus of Honours Core Course

Course Name: Research Methods in Geography and Project Work

Paper Code: GGY-HC-6026

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

The paper on Research Methods will enable the students:

- To understand how to approach a research problem and to formulate research objectives and research questions in proper perspective. In addition, knowledge of formulation of hypothesis and testing, framing of questionnaires, techniques of collection of both qualitative and quantitative data and their analysis.
- To develop understanding of the basics and utility of review of literature and preparation of research report.

Course Outcomes:

- This course will help the students to proceed with a research problem and the steps she/he should adopt and the tools and craft to be employed while doing quality research.

Part I: Theory

Credit: 4 (60 Marks)

(40 Classes of 1 hour each)

1. Meaning and significance of research; types of research; Basics of research methodology; Review of literature and its need; Ethics of research. (6 Classes)

2. Geographic Research: Meaning and Characteristics; Formulation of research problem. (4 Classes)

3. Research Design: Statement of the problem, Review of research works, Objectives, Research questions, Hypotheses, Database and methodology, Significance, Organization of the Work and Referencing. (10 Classes)

4. Data Collection: Types and Sources of Data; Methods of primary data collection (both qualitative and quantitative, and physical and human geographic data); Concept of sample survey; Pilot survey; Data processing (Manual and computerised). (10 Classes)

5. Statistical Analysis of Data: Qualitative data analysis; Quantitative data analysis; Data representation (Manual and computerised). (5 Classes)

6. Structure of a Research Report: Preliminaries; Text; Tables, Figures and Appendices; Citations, References and Bibliography; Research/Project Report Writing; Executive Summary.

(5 Classes)

Part II: Project Report

Credit: 2 (20 Marks)

(21 classes of two hour duration each)

Project Report Preparation and Evaluation (20 Marks)

1. Each student will have to prepare a Project Report on a suitable geographical problem under the guidance of respective teacher following appropriate methodology, data base and literature review.
2. Length of the Report: 30-40 printed A4 size pages (font size 12 in Times New Roman with 1.5 spacing) including text, tables, figures, references, etc.
3. The project report in binding form (Kutcha or Spiral binding) duly signed by the guide concerned has to be submitted to the department at least 3 days before the scheduled date of examination.
4. The marks distribution of the Project Report in the final semester examination is as follows:
   (i) Total marks: 20
   (ii) Evaluation of Content: 15 (average between external examiner and internal teacher guide)
   (iii) Viva-voce: 5 (exclusively by the external examiner)

Reading List:

1. Creswell J., 1994: *Research Design: Qualitative and Quantitative Approaches* Sage Publications.
2. Dikshit, R. D. 2003. The Art and Science of Geography: Integrated Readings. Prentice-Hall of India, New Delhi.
3. Evans M., 1988: "Participant Observation: The Researcher as Research Tool" in *Qualitative Methods in Human Geography*, eds. J. Eyles and D. Smith, Polity.
4. Kothari, C. R., 1993: *Research Methodology: Methods and Techniques*, 2nd ed., Wiley Eastern Ltd., New Delhi.
5. Misra, H.N. and Singh, V.P., 1998: *Research Methodology in Geography*, Concept Publishing Company, New Delhi.
6. Misra, R.P. (2002) Research Methodology, Concept Publications, New Delhi.
7. Mukherjee, Neela 1993. Participatory Rural Appraisal: Methodology and Application. Concept Publs. Co., New Delhi.
8. Mukherjee, Neela 2002. Participatory Learning and Action: with 100 Field Methods. Concept Publs. Co., New Delhi

9. Robinson A., 1998: "*Thinking Straight and Writing That Way*", in *Writing Empirical Research Reports: A Basic Guide for Students of the Social and Behavioural Sciences*, eds. By F. Pryczak and R. Bruce Pryczak, Publishing: Los Angeles.
10. Special Issue on "Doing Fieldwork" *The Geographical Review* 91:1-2 (2001).
11. Stoddard R. H., 1982: *Field Techniques and Research Methods in Geography*, Kendall/Hunt.
12. Wolcott, H. 1995. The Art of Fieldwork.Alta Mira Press, Walnut Creek, CA.
13. Yadav, H. (2013) ShodhPravidhiEvamMatratamakBhugol, Raja Publications, Delhi.

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CBCS-based UG Course in Geography, 2019

Syllabus of Discipline Specific Elective

Course Name: Geography of Health

Paper Code: GGY-HE–6036

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives:

This course basically deals with understanding the concept of health and geography of health as a field of study. It throws light on the factors determining human health and occurrence of various types of diseases in relation to ecology. It also provides information about human health in relation to global climate change in general and disease pattern in relation to varying environmental contexts in India in particular.

Course outcomes:

- Understanding of the concept of human health and healthcarefrom the perspectiveof geography.
- Acquiring knowledge about factors influencing human health and occurrence of diseases in varying ecological settings.
- Providing useful information about the impact of global climate change on human health and occurrence of various diseases in different ecological settings in India.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Geography of Health: Definition and significance; approaches of study: ecological, social and spatial; dualism between medical geography and geography of health. **(6 classes)**

2. Disease ecology: ecology and human health; geographical factors affecting human health; factors influencing disease transmission (pathological, physical, environmental, social, cultural and economic); Diffusion of diseases and their causes in varied biotic, physical and cultural environments. **(8 classes)**

3. Classification of diseases: genetic, zoonotic, communicable, non-communicable, occupational, deficiency diseases and malnutrition. **(4 classes)**

4. Disease occurrence: emergence, re-emergence and persistence; modes of transmission of major diseases (Malaria, Japanese encephalitis, tuberculosis, hepatitis, AIDS and COVID-19) and their broad global distribution.
   (8 classes)

5. Heathcare systems: Meaning and components; Universal government-funded health system; Role of WHO and UNICEF in global health care; SDG3 for good health and Well-being; Healthcare services in India: family welfare, immunization, National Health Mission and itsprogrammes, health for all programmes, challenges to health care system during pandemic situation like COVID-19. **(8 classes)**

6. Environment, human habit and health: Basic concept and ideas realting to food habit and health, occupation and health, environmental degradation and health, lifestyle and human health. **(6 classes)**

Part II: Practical
Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

9. Mapping of health status indicators (hospital beds, primary health centres, doctors, para-medics, etc.) in Assam/N.E. India using Z-score method. **(1 Exercise)**
10. Trend of infant mortality and maternal mortality rates in India in relation to selected developed and developing counties using line graph. **(3 Exercises)**
11. Choropleth mapping of infant mortality in India at state level. **(1 Exercise)**
12. Correlation analysis between any physical determinants (monthly rainfall/monthly average temparature) and epidemiological incidence of a disease (monthly malaria cases) in any district of Assam. **(1 Exercise)**
13. Map showing spatial variation of disease incidence rate in India/N.E. India at state level. **(1 Exercise)**
14. Mapping of seasonal variation in the occurrence of Covid-19 cases in Assam at district level using pie graph. **(1 Exercise)**
15. Preparation of questionnaire for healthcare and health status survey. **(1 Exercise)**
16. Computation of distribution pattern of hospitals, health centres, etc. using nearest neighbour analysis. **(1 Exercise)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)
1. Evaluation of Practical Note-Book (2 Marks)
2. Viva-voce (2 Marks)

Reading List:

1. AkhtarRais (Ed.), 1990 : Environment and Health Themes in Medical Geography, Ashish Publishing House, New Delhi.
2. Anthamatten P, (2011), Introduction to the Geography of Health, Rawat Publications, Jaipur
3. Avon Joan L. and Jonathan A Patzed.2001 : Ecosystem Changes and Public Health,Baltimin, John Hopling Unit Press(ed).
4. Banerji, D. (1986) :Social Sciences and Health Services in India, LokPrakashan,New Delhi.
5. Bradley,D.,1977: Water, Wastes and Health in Hot Climates, John Wiley Chichesten.
6. Brown, T., McLafferty, S., Moon, G. (2010): A Companion to Health and Medical Geography, Wiley Blackwell, UK
7. Christaler George and HristopolesDionissios, 1998: Spatio Temporal Environment Health Modelling , Boston Kluwer Academic Press.
8. Cliff, A.D. and Peter,H., 1988 : Atlas of Disease Distributions, Blackwell Publishers, Oxford.
9. Curtis, S. (2004): Health and Inequality: Geographical Perspectives, Sage Publications, London
10. Gatrell, A.,andLoytonen, 1998 : GIS and Health, Taylor and Francis Ltd, London.
11. Hardham T. and Tannav M.,(eds): Urban Health in Developing Countries; Progress, Projects, Earthgoan, London.
12. Mishra, R.P.(1970): Medical Geography of India, National Book Trust ofIndia.
13. Mishra, R.P.(2002)), Geography of health : a treatise on geography of life and death

    in India, Concept Publishing Co., New Delhi
14. Murray C. and A. Lopez, 1996 : The Global Burden of Disease, Harvard University Press.
15. Moeller Dade wed., 1993: Environmental Health, Cambridge, Harward Univ. Press.
16. National Health Missionhttps://nhm.gov.in/
17. National Health Portal India https://www.nhp.gov.in/healthprogramme/national-health-programmes
18. Phillips, D.andVerhasselt, Y., 1994: Health and Development, Routledge, London.
19. Shaw, M., Dorling, D. and Mitchell, R, (2002) Health, Place and Society, Pearson, London
20. Tromp, S., 1980: Biometeorology: The Impact of Weather and Climate on Humans and their Environment, Heydon and Son.

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CBCS-based U.G. Course in Geography, 2019

Syllabus of Discipline Specific Elective

Course Name: Hydrology

Paper Code: GGY-HE-6046

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

- To create knowledge base about basic hydrological concepts.
- To know about the hydrological concepts and their applications in river basin studies.

Course outcomes:

After completion of this course the students will be able to speak on the basic concepts of hydrology and its application in river basin studies. Students will also have a practical orientation of the concepts both in laboratory and in the field.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

Unit I: Principles of Hydrology (30 Marks) **(20 classes)**

1. Meaning and Scope of hydrology; Importance of hydrological studies in geography with special reference to physical geography. (4 classes)

2. Hydrological cycle: Components and water flow pathways- precipitation, infiltration, evaporation, transpiration, surface runoff, storage, through flow, ground water flow; Water distribution on the earth and the water budget; Concept of rainfall intensity and duration, rainfall frequency. (8 classes)

3. Runoff characteristics: Concept of surface runoff, Generation of surface runoff and Effects of soil, vegetation and ground slope; Concept of runoff hydrographs.(4 classes)

4. Ground water hydrology: Concept of water table and the aquifer, Fluctuation of ground water table, Ground water movements and recharge. (4 classes)

Unit II: River and Basin Hydrology (30 Marks) **(20 classes)**

1. Basin or catchment hydrology: Precipitation characteristics/types and pattern in relation to basin physiographic units; Concept of basin runoff; Factors affecting basin runoff: Geology and soils, vegetation and land use, physiographic characteristics, meteorological agents and channel and floodplain morphology. (6 classes)

2. River Hydrology: Sources of river flow, Types of flow, Factors causing river flow variation; Concepts of water discharge, Effects of water discharge on channel morphology; Concepts of discharge hydrographs and the stage-discharge hydrographs. (6 classes)

3. Flood hydrology: Definition of flood; Flood occurrence pattern- seasonality and frequency; Flood types- single and multiple event floods, seasonal floods, flash floods, snowmelt flood. (4 classes)
4. Anthropogenic activities and river basin hydrology: Human impacts and factors causing anomalies in river and basin hydrological regimes, Human induced hydrological hazards. (4 classes)

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. To estimate runoff from daily water discharge data and to compare the seasonal variation patterns of basin runoff taking
   i. Two major tributaries of Brahmaputra river, one north bank and one south bank tributary and also taking
   ii. Two months -one winter and one summer months (December and July)
   (2 Exercises)
2. To prepare discharge hydrographs of Brahmaputra and any one of its major tributaries atleast for three years taking a gap of five years and to analyse the trend of discharge pattern in the rivers. **(2 Exercises)**
3. To prepare a stage-discharge hydrograph of Brahmaputra at any two gauge sites for a particular year and to compare the patterns in discharge and stage variations in the river. **(2 Exercises)**
4. To construct stage-discharge rating curves separately for all months of the year, for monsoon months (may to October) and for non-monsoon months (November to April taking monthly average data of a period of 5/10 years for Brahmaputra or one of its major tributaries and to analyse the seasonal relationship pattern between stage and discharge . **(2 Exercises)**
5. To prepare a rainfall variability map of Assam/Brahmaputra Valley based on relevant necessary data and to analyse the rainfall variability pattern. **(1 Exercise)**
6. Collection and mapping of monthly /seasonal fluctuation data of ground water level of selected wells (at least 10) in a locality (village/ward). **(1 Exercise)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 marks).
2. Viva-voce (2 marks).

Reading List:

1. Madan Mohan and Mimi Das Saikia, 2009, Hydrology , PHI Learning Pvt. Ltd
2. Subramanya, K. (2013). *Engineering hydrology, 4e*. Tata McGraw-Hill Education.
3. Chorley, R. J. (Ed.). (2019). *Introduction to fluvial processes*. Routledge.
4. Brutsaert, W. (2005). *Hydrology: an introduction*. Cambridge University Press.
5. Maidment, D. R. (1993). *Handbook of hydrology* (Vol. 9780070, p. 397323). New York: McGraw-Hill.
6. Te Chow, V. (2010). *Applied hydrology*. Tata McGraw-Hill Education.
7. Davie, T. (2008). *Fundamentals of hydrology*. Routledge.
8. Sharp, J. J., &Sawden, P. G. (2013). *BASIC hydrology*. Elsevier.
9. Dingman, S. L. (2015). *Physical hydrology*. Waveland press.
10. Lane, B. (2002). Statistical Methods in Hydrology.

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CBCS-based U.G. Course in Geography, 2019

Discipline Specific Elective Paper

Course Name: Geography of Tourism

Paper Code: GGY–HE-6056

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

This paper introduces the students to the field of tourism from the lens of geography and itsspecificities. It seeks to develop new insights among students on how tourism and allied activities areshaped by geography of an area and also how such activities areresponsible in shaping economic, social and environmental context from globe to local levels.

Course Outcomes:

- The paper will be useful for students in developing ideas on how geographical factors tangent on tourism activities and how geographers seek to address issues of development and carrying capacities of varied environments.

- It will also build skills for students seeking to enroll in a research programme and/or provide openings for them to work with tourism/eco-tourism planning agencies.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Geography of Tourism: Nature and scope; Concepts and Issues of tourism; Recreation and leisure inter-relations;Robinson's geographical parameters of tourism. (4 classes)

2.Factors and types of tourism: Nature tourism, Cultural tourism, Medical tourism, Agri-tourism, Adventure tourism, Pilgrimage, etc. (6classes)

3. Recent trends in tourism: International and Domestic (India); Eco-Tourism; Sustainable tourism; Meetings, Incentives, Conventions and Exhibitions (MICE) (12classes)

4. Impact of tourism oneconomy,environment andsociety. (6 classes)

5. Tourism development in India: Tourism infrastructures; Case studies of tourism development inHimalaya,Desert,Coastal Areas and North-East India with special reference to Assam; NationalTourism Policiesand prospects. (12 classes)

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Trend of growth of tourist arrivals in the World/India/Assam since 1960 using Movingaverage method and least squares method. (4 assignments)

2. Trend of tourist arrivals in the north-eastern states of India and a few top-ranking tourist arriving states of India since 1980 using Band-graph. (2 assignments)

3.Line Graph showing pattern of tourist arrival (Domestic and International)in relation to rainfall and temperature in a year for selected tourist spots of North-East India / Assam. (2 assignments)

4. Spatial Patterns of Seasonal variation (Spring, Summer, Autumn and Winter) in tourist arrival in capital cities of North-East Indian states using Pie diagram and Bar Diagram. (2 assignments)

4. Preparation of a transport connectivity (road, railway and air) map of Assam/North-East India for major tourist destinations. (1 assignment)

5. Preparationof a tourist map of North-East India showinglocations of important nationalparks and wildlife sanctuaries from tourism potential perspectives (indicating the major highlights of the respective destinations including distance from Guwahati city within box) (2 assignments)

6.Preparationof a tourist guide map of North-East India showing location of major tourist destinations and road connectivity routes from Guwahati city. (1 assignment)

7. Mapping of trekking route in a hilly area suitable for adventure tourism using GPS (Field based). (1 assignment)

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 marks).

2. Viva-voce (2 marks).

Reading List:

1. Bhattacharya, P. (2011): Tourism in Assam: Trend and Potentialities, Banimandia, Guwahati

2. Dhar, P.N. (2006) International Tourism: Emerging Challenges and Future Prospects. Kanishka, New Delhi.

3. Hall, M. and Stephen, P. (2006) Geography of Tourism and Recreation – Environment, Place and Space, Routledge, London.

4. Kamra, K. K. and Chand, M. (2007) Basics of Tourism: Theory, Operation and Practise, Kanishka Publishers, Pune.

5. Page, S. J. (2011) Tourism Management: An Introduction, Butterworth-Heinemann-USA. Chapter 2.

6. Raj, R. and Nigel, D. (2007) Morpeth Religious Tourism and Pilgrimage Festivals Management: An International perspective by, CABI, Cambridge, USA, www.cabi.org.

7. Tourism Recreation and Research Journal, Center for Tourism Research and Development, Lucknow

8. Singh Jagbir (2014) "Eco-Tourism" Published by - I.K. International Pvt. Ltd. S-25, Green Park Extension, Uphaar Cinema Market, New Delhi, India (www.ikbooks.com).

9. Market Research Division, Dept. of Tourism, Govt. of India, India Tourist Statistics (available in PDF form), New Delhi

10. UNWTO: Tourism Barometer (available in their web portal to have a fresh glimpse of global tourism statistics/ other relevant sites may also be consulted)

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CBCS-based U.G. Course in Geography, 2019
Syllabus of Discipline Specific Elective (Honours Course)
Course Name: Geography of Resources and Development
Paper Code: GGY-HE-6066
Total Credit: 6 (4+2)
Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

● This paper intends to introduce the students about basic concepts of resource and resource management, and its relevance to sustainable development.

● To get acquainted with different concepts of development with special focus on economic development.

Course Outcomes:

● This paper will be useful to students in developing ideas on different aspects of resources, and the linkages with development issues that geographers usually address.

● This paper will also be useful for students preparing for different competitive examinations including the civil services.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. **Geography of Resources and Development**: Concept of resource; Relationship between resource- base and development; Significance of resource and development studies in geography; Classification and characteristics of resources. **(6 classes)**

2. **Natural Resources for Development**: Distribution, utilisation, and management of land (soil), water, forests, minerals and energy resources in the World and their contribution to development. **(8 classes)**

3. **Development and Environment**: Concept of Development; Urban and Rural Development; Rationale use of resources and the concept of Sustainable Development; Environment and development, Sustainable Development Goals, natural resources management for sustainable rural livelihood. **(8 classes)**

4. **Global issues of Natural Resources and Development**: Sustainable Natural Resource Management; United Nations Framework of Classification for Resources (UNFC); Applications of geospatial technology in sustainable natural resource management; Resource and development planning: Conservation of resources , and integrated environment and resource management. **(10 classes)**

5. **Pattern of Economic Development and Resource use**: Patterns of development between developed and developing countries; Resource management in developed countries (USA, Israel and Japan) and resource management in developing countries (Nepal, Bangladesh and Ethiopia); Concept of equity in resource use; Green technology.

(8 classes)

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Determination of levels of development in India/North-East India/Assam based on few development indicators using simple composite index and ranking method. **(2 Assignments)**
2. Mapping of physiological density of population in Assam at district level or North-East India at state level. **(1 Assignment)**
3. Mapping of spatial variation of category-wise forest cover (very dense, moderate dense and open forest) in Assam/ North-East India using Pie diagram for two points of time based on data from the recent Forest Survey of India's report *(available at: https://fsi.nic.in/forest-report-2019).* **(2 Assignments)**
4. Identification of important natural resources/resource sites (e.g. Reserve Forests/Wildlife sanctuaries/national parks, mineral resources, Rivers, Grasslands, Wetlands, etc.) within 100km radius around the state capitals of North-East India using Google Earth Platform. **(1 Assignment)**
5. Preparation of resource potential map of North-East India at state level showing spatial variation in production of selected commodities (rice, maize, coal, petroleum, hydro power, tea, etc.) using simple composite index. **(1 Assignment)**
6. Correlation and regression analysis of irrigation and intensity of cropping in Assam/North-East India. **(1 Assignment)**
7. Time series analysis of the trend of Coal/Crude oil/Natural gas production in India using moving average method and least squares method. (2 **Assignments)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)
1. Evaluation of Practical Note-Book (2 marks)

2. Viva-voce (2 marks).

Reading List:

1. Cutter S. N., Renwich H. L. and Renwick W., 1991: Exploitation, Conservation and Preservation: A Geographical Perspective on Natural Resources Use, John Wiley and Sons, New York.
2. Gadgil M. and Guha R., 2005: The Use and Abuse of Nature: Incorporating This Fissured Land: An Ecological History of India and Ecology and Equity, Oxford University Press. USA.
3. Holechek J. L. C., Richard A., Fisher J. T. and Valdez R., 2003: Natural Resources: Ecology, Economics and Policy, Prentice Hall, New Jersey.
4. Jones G. and Hollier G., 1997: Resources, Society and Environmental Management, Paul Chapman, London.
5. Klee G., 1991: Conservation of Natural Resources, Prentice Hall, Englewood.
6. Mather A. S. and Chapman K., 1995: Environmental Resources, John Wiley and Sons, New York.
7. Mitchell B., 1997: Resource and Environmental Management, Longman Harlow, England.
8. Owen S. and Owen P. L., 1991: Environment, Resources and Conservation, Cambridge University Press, New York.
9. Rees J., 1990: Natural Resources: Allocation, Economics and Policy, Routledge.London.
10. Gilg A. W., 1985: An Introduction to Rural Geography, Edwin Arnold, London.
11. Krishnamurthy, J. 2000: Rural Development - Problems and Prospects, RawatPubls., Jaipur
12. Lee D. A. and Chaudhri D. P. (eds.), 1983: Rural Development and State, Methuen, London.
13. Misra R. P. and Sundaram, K. V. (eds.), 1979: Rural Area Development: Perspectives and Approaches, Sterling, New Delhi.
14. 7. Ramachandran H. and Guimaraes J.P.C., 1991: Integrated Rural Development in Asia – Leaning from Recent Experience, Concept Publishing, New Delhi.
15. Robb P. (ed.), 1983: Rural South Asia: Linkages, Change and Development, Curzon Press.

16. Agyeman, Julian, Robert D. Bullard and Bob Evans (Eds.) (2003) Just Sustainabilities: Development in an Unequal World. London: Earthscan. (Introduction and conclusion.).
17. Ayers, Jessica and David Dodman (2010) “Climate change adaptation and development I: the state of the debate”. Progress in Development Studies 10 (2): 161-168.
18. Baker, Susan (2006) Sustainable Development. Milton Park, Abingdon, Oxon; New York, N.Y.: Routledge. (Chapter 2, “The concept of sustainable development”).
19. Brosius, Peter (1997) “Endangered forest, endangered people: Environmentalist representations of indigenous knowledge”, Human Ecology 25: 47-69.

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Syllabus for

BA/B.Sc.(Regular) Geography

Choice Based Credit System (CBCS)

Course effective from the academic year 2019-20

This is approved in the Academic Council held on 8/11/2019

GAUHATI UNIVERSITY

Guwahati-781014

June, 2019

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Credit and marks distribution scheme for CBCS curriculum in Geography, RegularCourse

Semester	Course Type	Paper Code	Paper Name	Credits	Full Marks
SemesterI Credit:22 Marks:400	Compulsory paper (for Arts Stream)	ENG-CC-1016	English Compulsory paper	6	100
	Ability enhancement Course	ENG-AE-1014/ ASM-AE-1014	English Communication Paper, Assamese/ MIL Communication paper	4	100
	Regular Core (Geography)	GGY-RC-1016	Physical Geography	4+2=6	100
	Regular Core 1(other subject)	YYY-RC-1016	Subject Y	6	100
	Regular Core 2(other subject) for science stream	ZZZ-RC-1016	Subject Z	6	100
Semester II Credit: 22 Marks: 400	Compulsory paper (for Arts Stream)	ENG-CC-2016	English Compulsory paper	6	100
	Ability enhancement Course	ENV-AE-2014	Environmental Science	4	100
	Regular Core (Geography)	GGY-RC-2016	Human Geography	4+2	100
	Regular Core 1(other subject)	YYY-RC-2016	Subject Y	6	100
	Regular Core 2(other subject) for science stream	ZZZ-RC-2016	Subject Z	6	100
Semester III Credit: 22 Marks: 400	Compulsory paper (for Arts Stream)	ASM - CC – 3016	Assamese/MIL Compulsory paper	6	100
	(any one)	ALT- CC- 3016	Alternative English Compulsory Paper	6	100
	Regular Core (Geography)	GGY - RC - 3016	Economic Geography	4+2	100
	Regular Core 1(other subject)	YYY-RC-3016	Subject Y	6	100

	Regular Core 2(other subject) for science stream	ZZZ-RC-3016	Subject Z	6	100
	Skill Enhancement Course (Any one)	GGY-SE-3024	Regional Development and Planning	2+2	100
		GGY-SE-3034	Thematic Cartography	2+2	100
Semester IV Marks 400 Credit 22	Compulsory paper (for Arts Stream)	ASM - CC – 4016	Assamese/MIL Compulsory paper	6	100
	(any one)	ALT- CC- 4016	Alternative English Compulsory paper	6	100
	Regular Core (Geography)	GGY - RC - 4016:	Geography of India with special reference to N.E. India	4+2	100
	Regular Core 1(other subject)	YYY-RC-4016	Subject Y	6	100
	Regular Core 2(other subject) for science stream	ZZZ-RC-4016	Subject Z	6	100
	Skill Enhancement Course (Any one)	GGY-SE-4024	Surveying Techniques	2+2	100
		GGY-SE4034	Remote Sensing, GIS and GPS	2+2	100
Semester V Marks 400 Credit 22	Discipline Specific Elective 1	GGY - RE - 5016:	Environmental Geography and Disaster Management	4+2	100
	Discipline Specific Elective 2 (any one)	GGY - RE - 5026:	Cartographic and Quantitative Techniques	4+2	100
	Discipline Specific Elective 3 (Generic Elective for Arts Stream)	GGY - RE - 5036:	Population and Settlement Geography	4+2	100
	Skill Enhancement Course (Any one)	GGY-SE-5044	Computer aided Data Analysis and Graphical Presentation	2+2	100
		GGY-SE-5054	Geography of Tourism	2+2	100

Semester VI Marks 400 Credit 22	Discipline Specific Elective 1 Discipline Specific Elective 2 (any one)	GGY-RE-6016:	Social and Political Geography	4+2	100
		GGY-RE-6026	Geography of Resources and Development	4+2	100
	Discipline Specific Elective 3 (Generic Elective for Arts Stream)	GGY-RE-6036:	Geography of Health	4+2	100
	Skill Enhancement Course (Any One)	GGY-SE-6044	Field Techniques and Project work	2+2	100
		GGY-SE-6054	Environmental Impact Assessment	2+2	100

Syllabus for
BA/B.Sc.(Regular) Geography
Choice Based Credit System (CBCS)

Course effective from the academic year 2019-20

1st Semester

This is approved in the Academic Council held on 8/11/2019

GAUHATI UNIVERSITY

Guwahati-781014
June, 2019

Class 1 Hour 1	Duration	Credit
1 Theory Class	1 Hour	1
1 Tutorial Class	1 Hour	1
1 Practical Class	2 Hours	1

Credit and marks distribution scheme for CBCS curriculum in Geography, Regular Course

Semester	Course Type	Paper Code	Paper Name	Credits	Full Marks
SemesterI Credit:22 Marks:400	Compulsory paper (for Arts Stream)	ENG-CC-1016	English Compulsory paper	6	100
	Ability enhancement Course	ENG-AE-1014/ ASM-AE-1014	English Communication Paper, Assamese/ MIL Communication paper	4	100
	Regular Core (Geography)	GGY-RC-1016	Physical Geography	4+2=6	100
	Regular Core 1(other subject)	YYY-RC-1016	Subject Y	6	100
	Regular Core 2(other subject) for science stream	ZZZ-RC-1016	Subject Z	6	100

Subject	Semester	Paper type	Paper Code	Paper name	Total Marks	Marks Distribution					Paper Credit
						External		Internal			
						Theory	Practical	Sessional	Practical /Assignments	Attendance	
Geography	1	Regular Core	GGY-RC- 1016	Physical Geography* (Theory+ Practical)	100	60	20	10	6	4	4+2=6

Core Course

CBCS-based U.G. Course in Geography, 2019

Syllabus of Regular Core Paper

Course Name: Physical Geography

Paper Code: GGY-RC-1016

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives:

- To provide a general idea about the topographic and surficial characteristics of the earth's surface to thestudents.
- To make the students aware of the dynamic geomorphic processes responsible for the development of landforms of varied types andnature.
- To impact applied scientific knowledge on landform development based on geomorphic concepts, principles andtheories.

Course outcomes:

- The students will learn that the earth is unstable and it is undergoing constant changes due to dynamic earth'sprocesses.
- The students will come to know about the meaning and scope of geomorphology, which a major branch of PhysicalGeography.
- After gaining knowledge based on the contents embodied in this paper, the students will be able to realize the importance of geomorphological knowledge as applied in various developmental activities executed on the land and over the earth'ssurface.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. PhysicalGeography–DefinitionandScope,ComponentsofEarthSystem. **(8classes)**

2. Atmosphere – Composition and the vertical structure, Heat Balance, Global Circulation Pattern, Monsoon, Koppen'sClimaticClassification. **(12classes)**

3. Lithosphere–InternalStructureofEarthbasedonSeismicEvidence **(8classes)**

4. EndogeneticandExogeneticprocesses,WorksofRiver,FluvialCycleofErosion–Davis

(12 classes)

Part II: Practical
Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical works (16 marks)
(2 Questions of 8 marks each)

1. Relief representation from the topographical sheet (v-shaped valley, u-shaped valley, conical hill, cliff,uniformslope). **(8Assignments)**
2. Profile Drawing (Serial andsuperimposed). **(4Assignments)**
3. Rainfall-Temperature Graph, Climograph and Hythergraph **(4Assignments)**

Unit 3: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-book (2 Marks)
2. Viva-voce on Practical Works (2 Marks)

Reading List:

1. ConservaH.T.,2004:Illustrated Dictionary of Physical Geography, Author House, USA.
2. Gabler R. E., Petersen J. F. and Trapasso, L. M., 2007: Essentials of Physical Geography (8th Edition), Thompson, Brooks/Cole,USA.
3. Garrett N., 2000: Advanced Geography, Oxford University Press.
4. Goudie, A., 1984: The Nature of the Environment: An Advanced Physical Geography, Basil Blackwell Publishers, Oxford.
5. Hamblin, W. K., 1995: Earth's Dynamic System, Prentice-Hall,N.J.
6. Husain M., 2002: Fundamentals of Physical Geography, Rawat Publications,Jaipur.
7. Monkhouse,F.J.2009:PrinciplesofPhysicalGeography,PlatinumPublishers,Kolkata.
8. Strahler A. N. and Strahler A. H., 2008: Modern Physical Geography, John Wiley & Sons, NewYork.

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Syllabus for
BA/B.Sc.(Regular) Geography
Choice Based Credit System (CBCS)

Course effective from the academic year 2019-20

IInd Semester

This is approved in the Academic Council held on 8/11/2019

GAUHATI UNIVERSITY

Guwahati-781014

June, 2019

Class 1 Hour 1	Duration	Credit
1 Theory Class	1 Hour	1
1 Tutorial Class	1 Hour	1
1 Practical Class	2 Hours	1

Credit and marks distribution scheme for CBCS curriculum in Geography, Regular Course

Semester	Course Type	Paper Code	Paper Name	Credits	Full Marks
Semester II Credit: 22 Marks: 400	Ability enhancement Course	ENV-AE-2014	Environmental Studies	4	100
	Regular Core (Geography)	GGY-RC-2016	Human Geography	4+2=6	100
	Regular Core 1(other subject)	YYY-RC-2016	Subject Y	6	100
	Regular Core 2(other subject) for science stream	ZZZ-RC-2016	Subject Z	6	100

Subject	Semester	Paper type	Paper Code	Paper name	Total Marks	Marks Distribution					Paper Credit
						External		Internal			
						Theory	Practical	Sessional	Practical /Assignments	Attendance	
Geography	II	RegularCore	GGY-RC-2016	HumanGeography * (Theory + Practical)	100	60	20	10	6	4	4+2=6

Core Course

CBCS-based U.G. Course in Geography, 2019

Syllabus of Regular Core Paper

Course Name: Human Geography

Paper Code: GGY-RC-2016

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives:

- This paper is a core paper that intends to introduce students to human geography and how humankind transforms and gets transformed by geographicspace.
- It seeks to develop new insights among students on the relevance of human-environmental relationships and how a spatial perspective shapes theserelationships.

Course outcomes:

- The paper will be useful for students in developing ideas on human-environment issuesthat geographers usually address in theanthropocene.
- The paper will be useful for students preparing for UGC NET/SLET exams and other competitive exams including the civilservices.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Field of human geography: meaning, scopeandimportance. **(8classes)**

2. Conceptsofman-environmentrelationship:DeterminismandPossibilism. **(8classes)**

3. Impact of environment on man; impact of man on environment; population growth and environmental changes; house types in differentenvironmentalconditions. **(10classes)**

4. Globalpatternsofracial,religiousandlinguisticcompositionofpopulation. **(7classes)**

5. Origin, growth and characteristics of rural and urban settlements; Patterns of rural settlements;PatternsofurbanizationinIndiaandN.E.India. **(7classes)**

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1 (Practical Works): 16 Marks

(2 Questions of 8 marks each)

1. TraditionalhousetypesofselectedethnicgroupsofNorth-EastIndia. **(1 assignment)**

2. Trend of population growth in the world in relation to five most populous countries of the world using linegraph.. **(1assignment)**

3. Religious composition of population in the world and three most populous countries of the worldusingpie-graph. **(2assignments)**

4. Spatial patterns of urban population in Assam and N.E. India at state level through choroplethmap. **(2assignments)**

5. Drawing of major rural settlement types/patterns; Morphological diagram of a village andatown(preferablybasedonstudent'sownvillageandtown). **(3 assignments)**

Unit 2 (Practical Note-Book and Viva-voce): 4 Marks

1. Practical Note-Book Evaluation (2 marks)
2. Viva-voce (2 marks)

Reading List:

1. Chandna, R.C. (2010) Population Geography, KalyaniPublisher.
2. Hassan, M.I. (2005) Population Geography, Rawat Publications,Jaipur
3. Daniel,P.A.andHopkinson,M.F.(1989)TheGeographyofSettlement,Oliver&Boyd, London.
4. JohnstonR;GregoryD,PrattG.etal.(2008)TheDictionaryofHumanGeography,
5. Blackwell Publication.
6. Jordan-Bychkov et al. (2006) The Human Mosaic: A Thematic Introduction to Cultural Geography. W. H. Freeman and Company, NewYork.
7. Kaushik, S.D. (2010) ManavBhugol, Rastogi Publication,Meerut.
8. Maurya,S.D.(2012)ManavBhugol,ShardaPustakBhawan.Allahabad.
9. Hussain, Majid (2012) ManavBhugol. Rawat Publications,Jaipur.

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Syllabus for
BA/B.Sc.(Regular) Geography
Choice Based Credit System (CBCS)

Course effective from the academic year 2019-20

IIIrd Semester

This is approved in the Academic Council held on 8/11/2019

GAUHATI UNIVERSITY

Guwahati-781014

June, 2019

Class 1 Hour 1	Duration	Credit
1 Theory Class	1 Hour	1
1 Tutorial Class	1 Hour	1
1 Practical Class	2 Hours	1

Credit and marks distribution scheme for CBCS curriculum in Geography, Regular Course

Semester	Course Type	Paper Code	Paper Name	Credits	Full Marks
Semester III Credit: 22 Marks: 400	Compulsory paper (for Arts Stream)	ASM - CC – 3016	Assamese/MIL Compulsory paper	6	100
	(any one)	ALT- CC- 3016	Alternative English Compulsory Paper	6	100
	Regular Core (Geography)	GGY - RC - 3016	Economic Geography (Theory + Practical)	4+2	100
	Regular Core 1(other subject)	YYY - RC - 3016	Subject Y	6	100
	Regular Core 2(other subject) for science stream	ZZZ - RC - 3016	Subject Z	6	100
	Skill Enhancement Course (Any one)	GGY-SE-3024	Regional Development and Planning (Theory + Practical)	2+2	100
		GGY-SE-3034	Thematic Cartography (Theory + Practical)	2+2	100

Subject	Semester	Paper type	Paper Code	Paper name	Total Marks	Marks Distribution					Paper Credit
						External		Internal			
						Theory	Practical	Sessional	Practical /Assignments	Attendance	
Geography	III	Regular Core	GGY-RC-3016	EconomicGeography * (Theory +Practical)	100	60	20	10	6	4	4+2=6
Geography	III	Skill Enhancement Course	GGY-SE-3024	Regional Development and Planning * (Theory + Practical)	100	40	40	10	6	4	2+2=4
Geography	III	Skill Enhancement Course	GGY-SE-3034	Thematic Cartography * (Theory + Practical)	100	40	40	10	6	4	2+2=4

Core Course

CBCS-basedU.G. Course in Geography, 2019

Syllabus of Regular Core Paper

Course Name: Economic Geography

Paper Code: GGY-RC–3016

Total Credit: 6 (4+2)

Total Marks 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

- This is a regular core paper with a view to make the students understand the basic principles of economic geography and associated patterns and processes of major economic activities in theworld.
- It seeks to develop insights among the students about the relevance of studying economic geography and understanding contemporary economic problems from geographical perspectives.

Course Outcomes:

- This paper will be useful for the students in developing understanding on how geographical factors organize economic space, and to acquire knowledge about spatial patterns of various economic activities on theearth.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Meaning and scope of EconomicGeography. **(3classes)**

2. Economic activity: meaning and classification; Production system: Role of land, labour and capital; Resource: Conceptandclassification. **(6classes)**

3. Agriculture: Factors influencing agriculture; types of agriculture; Factors influencing cultivationofwheat,riceandtea,andtheirdistributionandproductionintheworld.

(10 classes)

4. Manufacturing: Factors influencing industrial location; types of industry; Factors, distributionandproductionofironandsteelandcottontextileindustryintheworld.

(10classes)

5. Transport system: Modes of transport, factors influencing transport development and role of transport in resource mobilization and industrialdevelopment. **(6classes)**

6. Trade: Factors influencing trade; Trade relations of India with the countries like Bhutan, NepalandBangladesh. **(5classes)**

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1 (Practical Works): 16 Marks
(2 Questions of 8 marks each)

1. Trend of rice, wheat and iron & steel production in the world/India since 1960 using movingaveragemethod. **(3assignments)**
2. Trend of production of wheat, rice, maize and barley in the world/India since 1960 using Band-graph. **(2assignments)**
3. Trend of balance of trade relations (export and import value) of India with Bangladesh, Nepal and Bhutan in respect of major commodities since 1990 usingBar-graph. **(2assignments)**
4. Regional variation in fertilizer consumption and agricultural productivity in rice, wheat and barley in selected countries of the world using Bar-graph. **(1assignment)**
5. Inter-state and Inter-nation volume of movement of selected commodities through flow cartogram. **(2assignments)**

Unit 2 (Practical Note-Book and Viva-voce): 4 Marks

1. Practical Note-Book Evaluation (2 marks)
2. Viva-voce (2 marks)

Reading List:

1. Alexander J. W., 1963: Economic Geography, Prentice-Hall Inc., Englewood Cliffs, NewJersey.
2. Coe N. M., Kelly P. F. and Yeung H. W., 2007: Economic Geography: A Contemporary Introduction,Wiley-Blackwell.
3. HodderB.W.andLeeRoger,1974:EconomicGeography,TaylorandFrancis.
4. Combes P., Mayer T. and Thisse J. F., 2008: Economic Geography: The Integration of Regions and Nations, Princeton UniversityPress.
5. Wheeler J. O., 1998: Economic Geography,Wiley.
6. Durand L., 1961: Economic Geography,Crowell.
7. Bagchi-Sen S. and Smith H. L., 2006: Economic Geography: Past, Present and Future, Taylor andFrancis.
8. Willington D. E., 2008: Economic Geography, HusbandPress.
9. Clark, Gordon L.; Feldman, M.P. and Gertler, M.S., eds. 2000: TheOxford.
10. Saxena, H.M., 2013: Economic Geography, Rawat Publications,Jaipur.

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Skill Enhancement Course

CBCS-basedU.G. Course in Geography, 2019

Syllabus of Skill Enhancement Paper

Course Name: Regional Planning and Development

Paper Code: GGY–SE-3024

Total Credit: 4 (2+2)

Total Marks: 100

(Theory: 40, Practical: 40 and Internal Assessment: 20)

Course Objectives:

- This is a skill paper for geography regular students with a view to introduce students to the rationale underlying the relevance of regional planning for balanced regionaldevelopment.
- It seeks to develop new insights among students on the issue of development and disparities among geographicalregions.

Course Outcomes:

- The paper will be useful for students in developing ideas on disparities within and between countries and theirfallout.
- The paper will help provide theoretical insights and perspectives to students if they wish to pursue a research programme infuture.

Part I: Theory

Credit: 2 (40 Marks)

(20 classes of 1 hour duration each)

1. Concept of region and regional development; types of region (formal, functional and ad-hoc); conceptofregionalization. **(4Classes)**
2. Regional development planning and its need; levels of regional planning (macro, mesoandmicro). **(4Classes)**
3. Characteristics of an ideal planning region; Planning regions of India with special reference toAgro-Ecologicalregions. **(4Classes)**
4. Theories and models in regional planning: Growth Pole Model of Perroux; Friedmann's core-preiphery model; Myrdal's cumulative causation theory; Rostow's Growth Model and their relevance in Indiancontext. **(6Classes)**
5. Concept of development and measuring development; Indicators for measuring development level (Economic, Social and Environmental); Human Development Index; RoleofNECinthedevelopmentofnorth-eastregion. **(2Classes)**

Part II: Practical

Credit: 2 (40 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (32 Marks)

(To attempt 3 questions in total, 2 carrying 12 marks each and one carrying 8 marks)

1. Regionalization using methods of (a) Overlapping of different themes and (b) Ranking using mean andstandarddeviation. **(3Assignments)**
2. Demarcationoffunctional(urbaninfluence)zoneusingReilly'sbreakingpointformula. **(1Assignment)**
3. Mapping regional disparity in socio-economic development in India at state/UT level using Simple Composite Index and Ranking Index **(2Assignments)**
4. Determination of road network connectivity of North-East India (state level) and Assam (regional level) using alpha, beta and gamma indices. **(2 Assignments)**
5. Identification of resource rich and resource poor regions in N.E. India (state level) based on availability of selected major resources in relation to population using simple composite index andrankingindex. **(2Assignments)**
6. Mapping regional variation in level of agricultural development in N.E. India (at state level)/Assam (district level) usingrankingindex. **(2Assignments)**

Unit II: Practical Note-Book and Viva-voce (8 Marks)

1. Evaluation of Practical Note-Book (4 Marks)
2. Viva-voce (4 Marks)

Reading List:

1. Blij H. J. De, 1971: *Geography. Regions and Concepts,* John Wiley andSons.
2. C1ava1 P.1, 1998: *An Introduction to Regional Geography,* Blackwell Publishers, Oxford andMassachusetts.
3. Friedmann, J. and Alonso, W. (1975): *Regional Policy - Readings in Theory and Applications,* MIT Press,Massachusetts.
4. GoreC.G.,1984:*RegionsinQuestion.Space,DevelopmentTheoryandRegionalPolicy,*
5. Methuen,London.
6. Gore C. G., Köhler G., Reich U-P. andZiesemer T., 1996: *Questioning Development; Essays on the Theory, Policies and Practice of Development Intervention,* Metropolis-Verlag,Marburg.
7. Haynes J., 2008: *Development Studies,* Polity Short IntroductionSeries.
8. Johnson E. A. J., 1970: *The Organization ofspace in Developing Countries,* MIT Press,Massachusetts.
9. Peet R., 1999: *Theories ofDevelopment,* The Guilford Press,New York.
10. UNDP 2001-04: *Human Development Report,* Oxford UniversityPress.
11. World Bank 2001-05: *World Development Report,* Oxford University Press,New York.

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Skill Enhancement Course
CBCS-based U.G. Regular Course in Geography, 2019
Syllabus of Skill Enhancement Course
Course Name: Thematic Cartography
Paper Code: GGY–SE-3034
Total Credit: 4 (2+2)
Total Marks: 100
(Theory: 40, Practical: 40 and Internal Assessment: 20)

Course Objectives:

This course on thematic cartography provides a general understanding of methods and techniques and importance in geographic study. It more particularly focuses on various themes of cartographic techniques; principles of different types of symbols, methods for preparation of maps or plan in different environment and representation of various features of the earth's surface using different cartographictechniques.

Course Outcomes:

- Understanding the importance of various techniques of preparation of maps in geographicalstudy
- General understanding of preparation of different types of plan andmaps.
- An acquaintance of different cartographic techniques for representation of various facets of earth'ssurface.

Part I: Theory

Credit: 2 (40 Marks)

(20 classes of 1 hour duration each)

1. Thematic cartography: Meaningandimportance. **(3classes)**
2. Thematic Mapping: Principles and techniques of representation of physical and human geographic data (point,line,polygon). **(5classes)**
3. Concepts and principles of cartographic overlayandmapping. **(4classes)**
4. Conceptofbasemap;Types of thematic map;mapreading;mapdesign,layoutandtypography. **(5classes)**
5. Techniques of interpretation of Topographical maps, satellite imageries and aerial photographs forthematicmapping. **(3classes)**

Part II: Practical

Credit: 2 (40 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (32 Marks)

(To attempt 3 questions in total, 2 carrying 12 marks each and one carrying 8 marks)

1. Preparation of an administrative/physical map of India containing necessary map elements usingappropriatetypography. **(1Assignment)**
2. Preparation of thematic maps for representing human geographic data using choropleth, isopleth, dot, sphere and proportionate circle techniques. **(5Assignments)**
3. Interpretation of topographical maps for preparation of thematic maps through overlay method (taking point, line and area layers) to show relationship between relief and agriculture; and relief, drainageandsettlements. **(2Assignments)**
4. Locational accessibility mapping based on travel time through isochroniccartogram. **(1Assignment)**
5. Preparation of landuse/landcover map through visual interpretation of satellite imagery using appropriateclassificationscheme. **(1 Assignment)**

Unit II: Practical Note-Book and Viva-voce (8 Marks)

1. Evaluation of Practical Note-Book (4 Marks)

2. Viva-voce (4 Marks)

Reading List:

1. Anson R. and Ormelling F. J., 1994: *International Cartographic Association: Basic Cartographic Vol.,* PergamanPress.
2. Gupta K.K. and Tyagi, V. C., 1992: *Working with Map*, Survey of India, DST, New Delhi.
3. MisraR.P.andRamesh,A.,1989:*FundamentalsofCartography*,Concept,NewDelhi.
4. MonkhouseF.J.andWilkinsonH.R.,1973:*MapsandDiagrams*,Methuen,London.
5. Rhind D. W. and Taylor D. R. F., (eds.), 1989: *Cartography: Past, Present and Future*, Elsevier, International CartographicAssociation.
6. RobinsonA.H.,2009:*ElementsofCartography*,JohnWileyandSons,NewYork.
7. Singh R. L. and Singh R. P. B., 1999: *Elements of Practical Geography*, Kalyani Publishers.
8. Sarkar, A. (2015) *Practical Geography: A Systematic Approach*. Orient Black Swan Private Ltd., NewDelhi
9. Singh, L.R., 2013: *Fundamentals of Practical Geography*, ShardaPustakBhawan, Allahabad.
10. Talukder,S.,2008:*IntroductiontoMapProjections*,EBHPublishers(India),Guwahati.

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Syllabus for
BA/B.Sc.(Regular) Geography
Choice Based Credit System (CBCS)

Course effective from the academic year 2019-20

4th Semester

This is approved in the Academic Council held on 8/11/2019

GAUHATI UNIVERSITY

Guwahati-781014

June, 2019

Class 1 Hour 1	Duration	Credit
1 Theory Class	1 Hour	1
1 Tutorial Class	1 Hour	1
1 Practical Class	2 Hours	1

Credit and marks distribution scheme for CBCS curriculum in Geography, Regular Course

Semester IV Marks 400 Credit 22	Compulsory paper (for Arts Stream)	ASM - CC – 4016	Assamese/MIL Compulsory paper	6	100
	(any one)	ALT- CC- 4016	Alternative English Compulsory paper	6	100
	Regular Core (Geography)	GGY - RC - 4016:	Geography of India with special reference to N.E. India	4+2	100
	Regular Core 1(other subject)	YYY-RC-4016	Subject Y	6	100
	Regular Core 2(other subject) for science stream	ZZZ-RC-4016	Subject Z	6	100
	Skill Enhancement Course (Any one)	GGY-SE-4024	Surveying Techniques	2+2	100
		GGY-SE4034	Remote Sensing, GIS and GPS	2+2	100

Subject	Semester	Paper type	Paper Code	Paper name	Total Marks	Marks Distribution					Paper Credit
						External		Internal			
						Theory	Practical	Sessional	Practical /Assignments	Attendance	
Geography	4th	Regular Core	GGY - RC - 4016:	Geography of India with special reference to N.E. India	100	60	20	10	6	4	4+2=6
		Skill Enhancement Course	GGY-SE-4024	Surveying Techniques	100	40	40	10	6	4	2+2=4
			GGY-SE4034	Remote Sensing, GIS and GPS	100	40	40	10	6	4	2+2=4

CBCS-based U.G. Course in Geography, 2019

Syllabus of Regular Course

Course Name: Geography of India with Reference N.E. India

Paper Code: GGY-RC-4016

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives

- This is a core paper of regular course students which intends to introduce them to India as a geographical entity.
- It seeks to develop new insights among students on significant geographical dimensions of the country along with its north-eastern part.
- A field study is incorporated to make the students understand regional diversity of India with respect to its land, people and economy.

Course outcome

- The paper will be useful for students in developing understanding on Indian geography and its various dimensions.
- It will also be useful for students preparing for various competitive examinations includingcivil services.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. India's location and its significance; administrative divisions. **(2 classes)**

2. Physical setting: Major Physiographic Regions and their Characteristics; Drainage System (Himalayan and Peninsular). **(5 classes)**

3.Climate: Seasonal Weather Characteristics; Climatic Divisions; Indian Monsoon (mechanism and characteristics). **(5 classes)**

4. Population Growth and distribution; Characteristics and Composition of population (rural-urban, age, sex, occupational, literacy and religious), Population Policies of India. **(4 classes)**

5. Agriculture: Environmental, Technological and Institutional Factors affecting Indian Agriculture; Distribution and Production of Rice, Wheat and Tea; Agro Climatic Zones; Food Security. **(4 classes)**

6. Distribution and characteristics/potential of Natural Resources: Soil, Vegetation, Water, Mineral Resources (Coal, Petroleum and Iron ore). **(4 classes)**

7. Factors influencing Industrial development in the country; Industrial Regions and their

characteristics; Industrial Policies in India; Distribution and production patterns of iron and steel and cotton textile. **(4classes)**

8. North-East India: Land of seven sisters and its locational significance; physiographic framework; forest cover; agricultural practices including shifting cultivation; industrial development scenario; population growth pattern. **(8 classes)**

Part II: Practical
Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical works (10 marks)
(2 Questions of 5 marks each)

1. Trend of population growth and growth rates in India and N.E. India/Assam since 1901 using Census of India data (Source: censusindia.gov.in) **(2 assignments)**

2. Choropleth mapping to show spatial variation in decennial population growth rate in India /N E India/Assam. **(1 assignment)**

3. Spatial variation in the patterns of religious composition of population in India and Social composition of population (SC, ST and General) in N.E. India using pie-graph. **(2 assignments)**

4. Trend of food grains production (rice, wheat, maize, barley, jowar and bajra) in India since
1950-51 using band-graph. **(1 assignment)**

5. Map showing distribution of major tribal groups in North-East India **(1 assignment)**

Unit 2: Field Report (6 Marks)
6. Preparation of field report based on field study through observational knowledge about the geographical personality of any part of India/N.E. India/Assam under the guidance of teacher(s). (Evaluation of the Content of Field Report; 4 Marks; Viva-voce on Field Report: 2 Marks)

Unit 3: Practical Note-Book and Viva-voce (4 Marks)
7. Evaluation of Practical Note-book (2 Marks)
8. Viva-voce on Practical Works (2 Marks)

Reading List:

1. Deshpande C. D., 1992: India: A Regional Interpretation, ICSSR, New Delhi.
2. Johnson, B. L. C., ed. 2001. Geographical Dictionary of India.Vision Books, New Delhi.
3. Mandal R. B. (ed.), 1990: Patterns of Regional Geography – An Intenational Perspective. Vol. 3 –Indian Perspective.
4. Sdyasuk Galina and P Sengupta (1967): Economic Regionalisation of India, Census of India
5. Sharma, T. C. 2003: India - Economic and Commercial Geography. Vikas Publ., New Delhi.
6. Singh R. L., 1971: India: A Regional Geography, National Geographical Society of India.
7. Singh, Jagdish 2003: India - A Comprehensive & Systematic Geography, Gyanodaya Prakashan, Gorakhpur.
8. Spate O. H. K. and Learmonth A. T. A., 1967: India and Pakistan: A General and Regional Geography, Methuen.
9. Tirtha, Ranjit 2002: Geography of India, RawatPubls., Jaipur & New Delhi.
10. Pathak, C. R. 2003: Spatial Structure and Processes of Development in India. Regional Science Assoc., Kolkata.
11. Tiwari, R.C. (2007) Geography of India. PrayagPustakBhawan, Allahabad
12. Sharma, T.C. (2013) Economic Geography of India. Rawat Publication, Jaipur
13. Bhagabati, A.K., Bora, A. K. and Kar, B.K.: Geography of Assam, Rajesh Publications, New Delhi.
14. Taher, M and Ahmed, P.: Geography of North East India, Mani ManikPrakash, Guwahati.
15. Das, M..M.: Peasant Agriculture in Assam, EBH_India Publishers, Guwahati.
16. Gopal Krishnan, R : Geography of North East India.
17. Bhattacharya, P.2006 : Trend in Tourism Potentiality, BaniMandir, Guwahati.
18. Bhagabati, A.K. (ed) : Biodiversity of Assam, Eastern Book House, Guwahati.
19. Bhattacharyya, N.N. : North East India, Rajesh Publication, New Delhi.
20. Srivastava, S.C., : Demographic Profile of N.E. India, Mittal Publications, New Delhi.

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CBCS-based U.G. Regular Course in Geography, 2019

Syllabus of Skill Enhancement Course

Course Name: Surveying Techniques

Paper Code: GGY-SE-4024

Total Credit: 4 (2+2)

Total Marks: 100

(Theory: 40, Practical: 40 and Internal Assessment: 20)

Course objectives

This course on Surveying Techniques provides a general understanding of the field of survey including its modern tools and importance in geographic study. It more particularly focuses on various types of survey instruments; principles of different types of surveying, methods of carrying out survey for preparation of map/plan in different environment by presentation of various aspects of the area.

Course outcomes

● Understanding the importance of various surveying techniques in geographical study
● General understanding of preparation procedures of different types of plan and map
● An acquaintance of different surveying techniques for representation of various spatial objects/
Phenomena.

Part I: Theory

Credit: 2 (40 Marks)

(20 classes of 1 hour duration each)

1. Surveying: Its meaning, types and significance in geography. (2Classes)

2. Principles of surveying: plane and geodetic surveying; Principles of triangulation. (3Classes)

3. Techniques of surveying by Plane Table, Prismatic Compass, Theodolite and Dumpy Level. (8Classes)

4. Methods of radiation, intersection, traversing, contouring and leveling in surveying. (4Classes)

5. GPS: Basic concept, principles and utilities; surveying by Total Station. (3Classes)

Part II: Practical
Credit: 2 (40 Marks)
(20 classes of 2 hour duration each)

Unit I: Practical Works (32 Marks)

To attempt 2 questions carrying 16 marks each

1. Preparation of a plan or a map of an area within the college campus or any suitable area using Plane Table (applying both radiation and intersection methods) (2 Assignments)

2. Open and Closed Traverse Surveying with Prismatic Compass: Preparation of plan along with adjustment of closing errors. (2 Assignments)

3. Closed Traverse Surveying with Theodolite: Plotting of data for preparation of a plan through computation of Reduced Bearing, Consecutive Co-ordinates and Independent Co-ordinates; Measurement of height of object/objects using Theodolite (2 Assignments)

4. Profile levelling and contouring in a selected area by Dumpy Level (2 Assignments)

5. Preparing a map of a short trail along with prominent features by using hand-held GPS and associated software/freeware. (2 Assignments)

Unit II: Practical Note-Book and Viva-voce (8 Marks)

1. Evaluation of Practical Note-Book (4 Marks)

2. Viva-voce (4 Marks)

Reading List:

1. Campbell, J., 1984: Introductory Cartography, Prentice Hall Inc., Englewood Cliff.
2. Misra, R.P. and Ramesh, A., 1995: Fundamentals of Cartography, Concept Publishing Company, NewDelhi.
3. Robinson, A.H., et al: Elements of Cartography, John Wiley & Sons, New York.
4. Raisz, E.: Principles of Cartography, McGraw Hills, London.
5. Kenetkar, T.P. and Kulkarni, S.U.: Surveying and Levelling, Vol. I & II, VidyarthiGrithaPrakashan, Pune.
6. Das, A.K.2021: Pocket Size Handbook on Handling of GPS for Field Studies, GTAD and Aranyak, Guwahati (In PDF format).

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<u>CBCS-based U.G. Regular Course in Geography, 2019</u>
Syllabus of Skill Enhancement Course
Course Name: Remote Sensing, GIS and GPS

Code: GGY-SE-4034
Total Credit: 4 (2+2)
Total Marks: 100
(Theory: 40, Practical: 40 and Internal Assessment: 20)

Course objectives

- This paper is a core paper that intends to introduce students to the interface of Remote Sensing and GIS
- It seeks to develop new insights among students on the relevance of geospatial studies within the field of geography.

Course outcomes

- The paper remains useful for students in developing skills in spatial data analysis if they wish to pursue a research programme.
- The paper will be useful for students preparing for different competitive exams including the civil services.

Part I: Theory

Credit: 2 (40 Marks)

(20 classes of 1 hour duration each)

Unit 1: Remote Sensing (25 Marks)

1. Remote Sensing: Definition and Development; Platform and types. (2classes)
2. Principles of Remote Sensing: Electro Magnetic Radiation (EMR) and its interaction with atmosphere and earth features; Fundamentals of Satellite Remote Sensing and Photogrammetry; Resolutions. (4classes)
3. Remote Sensing Data Products and their characteristics (Landsat, Spot, IRS) (2classes)
4. Image interpretation: Visual interpretation; Concept of Supervised and unsupervised classification. (3classes)
5. Application of Remote Sensing: Land use and Land cover and Agriculture. (2classes)

Unit 2: GIS and GPS (15 Marks)

1. Geographical Information System (GIS): Definition, Components and Functions. (2 classes)
2. Data types of GIS; Raster and Vector Data Model. (1classe)
3. Data Sources and characteristics; Data input and Management; Concept of spatial analysis (Buffer and overlay). (2Classes)
4. Application of GIS (Natural Resource Management) (1classe)
5. GPS: Types, principles and functions. (1classe)

Part II: Practical
Credit: 2 (40 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (32 Marks)

To attempt 4 questions carrying 8 marks each

1. Visual Interpretation of satellite imagery and preparation of thematic maps using suitable classification scheme. (Flood and LULC mapping) 2 assignments
2. Visual interpretation of aerial photograph and preparation of thematic map using stereoscope; Determination of photo scale 2 assignments
3. Unsupervised classification of satellite imagery and preparation of thematic maps (Physical/cultural features) 2 assignments
4. Spatial data input for GIS application: Map scanning and Geo-referencing 1 Assignment
5. Digitization of different layers using point, line and polygon, attribute data input and their thematic representation (Administrative Divisions/Drainage/Road/Headquarter/ Population Density/Literacy) 3 assignments
6. GPS survey, plotting and preparation of map (waypoint, trekking and area). 2 Assignments

N.B: Basic Remote Sensing and GIS Software's for practical works: Arc GIS/Erdas Professional /Q-GIS/SAGA GIS.

Unit II: Practical Note-Book and Viva-voce (8 Marks)

1. Evaluation of Practical Note-Book (4 Marks)
2. Viva-voce (4 Marks)

Reading List:

1. Campbell J. B., 2007: *Introduction to Remote Sensing*, Guildford Press.

2. Jensen J. R., 2004: *Introductory Digital Image Processing: A Remote Sensing Perspective*, Prentice Hall.

3. Joseph, G. 2005: *Fundamentals of Remote Sensing*, United Press India.

4. Lillesand T. M., Kiefer R. W. and Chipman J. W., 2004: *Remote Sensing and Image Interpretation*, Wiley. (Wiley Student Edition).

5. Nag P. and Kudra, M., 1998: *Digital Remote Sensing*, Concept, New Delhi.

6. Rees W. G., 2001: *Physical Principles of Remote Sensing*, Cambridge University Press.

7. Singh R. B. and Murai S., 1998: *Space-informatics for Sustainable Development*, Oxford and IBH Pub.

8. Wolf P. R. and Dewitt B. A., 2000: *Elements of Photogrammetry: With Applications in GIS*, McGraw-Hill.

9. Sarkar, A. (2015): Practical Geography: A Systematic Approach. Orient Black Swan Private Ltd., New Delhi.

10. Chauniyal, D.D. (2010): SudurSamvedanevamBhogolikSuchanaPranali, ShardaPustak Bhawan, Allahabad.

10. Burrough, P.A. 1998: *Principles of Geographical InformationSystems*, Oxford University Press.

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Syllabus for
BA/B.Sc.(Regular) Geography
Choice Based Credit System (CBCS)

Course effective from the academic year 2019-20

5th Semester

This is approved in the Academic Council held on 8/11/2019

GAUHATI UNIVERSITY

Guwahati-781014

June, 2019

Class 1 Hour 1	Duration	Credit
1 Theory Class	1 Hour	1
1 Tutorial Class	1 Hour	1
1 Practical Class	2 Hours	1

Credit and marks distribution scheme for CBCS curriculum in Geography, Regular Course

Semester V Marks 400 Credit 22	Discipline Specific Elective 1	GGY - RE - 5016:	Environmental Geography and Disaster Management	4+2	100
	Discipline Specific Elective 2 (any one)	GGY - RE - 5026:	Cartographic and Quantitative Techniques	4+2	100
	Discipline Specific Elective 3 (Generic Elective for Arts Stream)	GGY - RE - 5036:	Population and Settlement Geography	4+2	100
	Skill Enhancement Course (Any one)	GGY-SE-5044	Computer aided Data Analysis and Graphical Presentation	2+2	100
		GGY-SE-5054	Geography of Tourism	2+2	100

Subject	Semester	Paper type	Paper Code	Paper name	Total Marks	Marks Distribution					Paper Credit
						External		Internal			
						Theory	Practical	Sessional	Practical /Assignments	Attendance	
Geography	5th	Discipline Specific Elective 1 & 2 (Any one)	GGY - RE - 5016:	Environmental Geography and Disaster Management	100	60	20	10	6	4	4+2=6
			GGY - RE - 5026:	Cartographic and Quantitative Techniques	100	60	20	10	6	4	4+2=6
		Discipline Specific Elective 3 (Generic Elective for Arts Stream)	GGY - RE - 5036:	Population and Settlement Geography	100	60	20	10	6	4	4+2=6
		Skill Enhancement Course (Any one)	GGY-SE-5044	Computer aided Data Analysis and Graphical Presentation	100	40	40	10	6	4	2+2=4
			GGY-SE-5054	Geography of Tourism	100	40	40	10	6	4	2+2=4

CBCS-based U.G. Course in Geography, 2019

Syllabus of Regular Course (Discipline specific elective)

Course Name: Environmental Geography and Disaster Management

Paper Code: GGY-RE-5016

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

● This is a discipline specific elective paper which intends to introduce students to geography and environment interface.

● It seeks to develop new insights among students on the relevance of environmental studies from spatial perspective.

Course Outcomes:

● The paper will be useful for students in developing ideas on environmental issues including disasters that geographers usually address.

● The paper will also be useful for students preparing for different competitive exams including the civil services.

Part I: Theory

Credit: 4 (60 Marks)

(40 Classes of 1 hour each)

1. Environmental Geography: Nature, Scope and Significance. **(4 Classes)**

2. Human-Environment Relationships – Historical progression; Adaptation in different Biomes. **(6 Classes)**

3. Major Global Environmental Problems: Pollution, Deforestation, Desertification, Global Warmingand Bio-Depletion. **(10 Classes)**

4. Meaning of Hazard, Disaster, Risk and Vulnerability; Types of hazard/disaster (Natural and Manmade). **(4 Classes)**

5. Disaster Management Cycle and Phases: Prevention, Preparedness, Response, Rehabilitation, Reconstruction and Mitigation, **(4 Classes)**

6. Major Hazards and Disasters, and their Management: Flood, Earthquake, Wildfire, and Chemical and Nuclear explosions. **(6 Classes)**

7. National Environmental Policy and National Disaster Management Plan: Environmental Protection Act 1986 and DisasterManagement Act 2005. **(6 Classes)**

Part II: Practical
Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Exploring satellite imageries and toposheets to observe bank line change of theBrahmaputra river from any selected stretch in three different time periods and preparation of map therefrom. **(1 exercise)**
   (Goalpara, Palasbari, Nimatighat, etc.)
   Satellite images can be downloaded from https://earthexplorer.usgs.gov/
   Survey of India toposheets can be downloaded freely from https://soinakshe.uk.gov.in/mtr/

2. Mapping of major wetlands in a district and computation of shape and size(area) for their classification. **(1 exercise)**

3. Preparation of a map of a nearby wetland and to identify the changes in dimension, water level and encroachment it faced during the last one decade. Presentation of data in tabular form along with the map (field-based). **(1 exercise)**

4. Preparation of a long-term precipitation time series curve for any selected station of N.E. India using moving average method by downloading the annual rainfall data for any district/station of Assam for at least 30 years from the portal.https://www.indiawaterportal.org/met_data/. Students can also explore the web portal https://mausam.imd.gov.in/ to get an idea of different types of weather data in India and their historical and present distribution. **(1 exercise)**

5. Drawing of a diagram of disaster management cycle with reference to some disasters (flood and earthquake) in North-East India and to indicate the activities associated with each step. **(2 exercise)**

6. Drawing of a map of Assam showing the major fault lines thereon. Also to plot at least 50 epicentres in last few years and to explain the areas of their concentration with the help of Bhookamp app. **(1 exercise)**

7. Preparation of a disaster vulnerability map of Assam/ N.E. India based on data of natural disasters (Flood/earthquake/landslide/bank erosion) with respect to their occurrence and frequency in different areas. **(1 exercise)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 Marks)
2. Viva-voce (2 Marks)

Reading List:

1. Chandna R. C., 2002: Environmental Geography, Kalyani, Ludhiana.
2. Cunninghum W. P. and Cunninghum M. A., 2004: Principals of EnvironmentalScience: Inquiry and Applications, Tata Macgraw Hill, New Delhi.
3. Goudie A., 2001: The Nature of the Environment, Blackwell, Oxford.
4. Singh, R.B. (Eds.) (2009) Biogeography and Biodiversity. Rawat Publication, Jaipur
5. Miller G. T., 2004: Environmental Science: Working with the Earth, Thomson BrooksCole, Singapore.
6. MoEF, 2006: National Environmental Policy-2006, Ministry of Environment and Forests, Government of India.
7. Singh, R.B. and Hietala, R. (Eds.) (2014) Livelihood security in Northwestern Himalaya: Case studies from changing socio-economic environments in Himachal Pradesh, India. Advances in Geographical and Environmental Studies, Springer
8. Odum, E. P. et al, 2005: Fundamentals of Ecology, Ceneage Learning India. 9. Singh S., 1997: Environmental Geography, PrayagPustakBhawan. Allahabad.
10. UNEP, 2007: Global Environment Outlook: GEO4: Environment For Development, United Nations Environment Programme.
11. Singh, M., Singh, R.B. and Hassan, M.I. (Eds.) (2014) Climate change and biodiversity: Proceedings of IGU Rohtak Conference, Volume 1. Advances in Geographical and Environmental Studies, Springer
12. Singh, R.B. (1998) Ecological Techniques and Approaches to Vulnerable Environment, New Delhi, Oxford & IBH Pub..
13. Alcántara-Ayala, I. (2002). Geomorphology, natural hazards, vulnerability and prevention of natural disasters in developing countries. *Geomorphology*, *47*(2-4), 107-124.
14. Goudie, A., & Ayala, I. A. (2010). *Geomorphological hazards and disaster prevention*.Cambridge University Press.
15. https://www.undrr.org/publications
16. http://sdmassam.nic.in/dmp.html#ddmp
17.https://ndma.gov.in/sites/default/files/PDF/DM_act2005.pdf
18. http://sdmassam.nic.in/pdf/publication/undp/disaster_management_in_india.pdf.

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CBCS-basedU.G. Course in Geography, 2019
Syllabus of Regular Elective Course
Course Name: Quantitative and Cartographic Techniques in Geography
Paper Code: GGY-RE-5026
Total Credit: 6 (4+2)
Total Marks 100
(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:
This course on Quantitative and Cartographic Methods provides a general understanding of the application of quantitative and cartographic techniques in geographical studies. It basically deals with understanding of statistical analysis of geographical data and their graphical representation and mapping using various cartographic techniques.

Course Outcomes:
- Understanding the importance of various statistical and cartographic techniques in geographical studies.
- General understanding of geographical data, map type, map scale and map content.
- An acquaintance of different cartographic techniques for representation of various physical and human geographic data.

Part I: Theory
Credit: 4 (60 Marks)
(40 classes of 1 hour duration each)

Unit 1 (Quantitative Techniques): 30 Marks (20 Classes)

1. Quantification and its significance in geographical study. (2 classes)
2. Geographical Data: Nature, types and sources; Concept of sampling and types of sampling(simple random and stratified random). (4 classes)
3. Measures of central tendency (mean, median and mode) and dispersion (range, standard deviation and coefficient of variation), and their applications in geographical data analysis. (8 classes)
4. Correlation and Regression Analysis: Meaning of correlation; Bi-variate coefficient of correlation (Spearman's rank correlation and Pearson's product-moment correlation); Linear regression analysis; and their applications in geographical data analysis. (6 classes)

Unit 2 (Cartographic Techniques): 30 Marks (20 Classes)

1. Meaning of cartography and its need in geography; Traditional versus Digital cartography. (4 classes)

2. Shape and size of the earth; Coordinate system (latitude and longitude). (2 classes)

3. Map: Meaning, scale and classification; map as a tool in spatial analysis. (4 classes)

4. Map Projection: Meaning and classification (zenithal, conical and cylindrical); choice of map projection. (8 classes)

5. Thematic map: meaning and types; Choropleth and Isopleth mapping. (2 classes)

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1 (Practical Works): 16 Marks

(2 Questions of 8 marks each)

1. Tabulation/Grouping of geographical data for making frequency distribution table; Preparation of Histogram, Frequency Polygon and Frequency Curve. (1 assignment)

2. Computation of mean, median and mode for ungrouped and grouped geographical data; and Determination of median and mode using graphical methods. (1+1+1 assignments)

3. Computation of the values of standard deviation and coefficient of variation of ungrouped and grouped data relating to some geographical phenomena (rainfall, landholding, income, production, etc) for comparison of distribution patterns. (2 assignments)

4. Computation of coefficient of correlation between two logically associated geographical phenomena using Spearman's rank correlation and Pearson's product-moment correlation formulae; Preparation of scatter diagram and fitting the line of linear regression of Y on X for any set of bi-variate data relating to meaningful geographical phenomena. (2 assignments)

5. Construction of graphical scale; Computation work for conversion of map scales. (3 Assignments)

6. Construction of graticuleof map projection along with properties and uses: Zenithal polar gnomonic, Simple conical with one standard parallel, simple cylindrical and Gall's stereographic cylindrical. (4 Assignments)

7. Representation of physical and human geographic data through Choropleth and Isopleth mapping and Pie cartogram. (3 Assignments)

Unit 2 (Practical Note-Book and Viva-voce): 4 Marks

1. Practical Note-Book Evaluation (2 marks)

2. Viva-voce (2 marks)

Reading List:

Quantitative Methods in Geography:

1. Hammond P. and McCullagh P. S., 1978: *Quantitative Techniques in Geography: An Introduction*, Oxford University Press.
2. Sarkar, A. (2013) *Quantitative Geography: techniques and presentations*. Orient Black Swan Private Ltd., New Delhi.
3. Yeates, M., 1974: *An Introduction to Quantitative Analysis in Human Geography*, McGraw Hill, New York.
4. Mathews, J.A., 1987: *Quantitative and Statistical Approaches to Geography: A Practical Manual*Pergamon, Oxford.
5. Mahmood, A., 1999: *Statistical Methods in Geographical Studies*, Rajesh Publications, New Delhi.
6. Elhance, D.N., 1972: *Fundamentals of Statistics*, KitabMahal, Allahabad
7. Monkhouse, F.J. & Wilkinson, H.R., 1989: *Maps & Diagrams*, B.I. Publications, New Delhi
8. Gregory, S., 1963: *Statistical Methods and Geographers*, Longman, London

Cartographic Methods in Geography:

1. Monkhouse, F.J. and Wilkinson, H.R., 1989: Maps and Diagrams, B.I. Publications Ltd.,Mumbai.
2. Singh R. L. and Singh, R. P. B., 1999: Elements of Practical Geography, Kalyani Publishers.
3. Singh, L.R., 2013: Fundamentals of Practical Geography, ShardaPustakBhawan, Allahabad.
4. Sarkar, A., 2015: Practical Geography: A Systematic Approach. Orient Black Swan Private Ltd., New Delhi
5. Misra, R. P. and Ramesh, A., 1989: Fundamentals of Cartography, Concept Publishing Company, New Delhi.

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CBCS-basedU.G. Course in Geography, 2019
Syllabus of Regular Elective Course

Course Name: Population and Settlement Geography
Paper Code: GGY-RE-5036

Total Credit: 6 (4+2)
Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives

- This paper is a generic paper that intends to introduce students to the basic concepts of population and settlement geography and how the differential characteristics of population and settlement influence the overall development process of an area.
- It seeks to develop understanding among students about the significance of population geography and settlement geography and their inter-relationship.

Course outcomes

- The paper will be useful for students in developing ideas about spatio-temporal changes in the characteristics of population and settlement and the factors associated with them.
- The paper will be useful for students preparing for various competitive exams including the civil services.

Part I: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

Unit I: Population Geography (40 Marks) 26

Classes

1. Defining the field of population geography: meaning and scope; its relation with demography. (3 Classes)
2. Sources of population data; Perspectives on Census of India publications – Primary Census Abstract, District Census Hand-Book, Sample Registration System, etc. (2 Classes)

3. Distribution and density of population: Factors influencing population distribution and density; global pattern of population distribution. (4 Classes)

4. Population Growth: Trend of global population growth; components of population growth–fertility, mortality and migration; push and pull factors of migration; spatial variations in population growth in the world. (8 Classes)

5. Theories of population growth: Malthusian Theory and Demographic Transition Theory. (3 Classes)

6. Population composition and associated characteristic patterns in global contexts: Age-Sex Composition; Rural-Urban Composition; Population ageing. (6 Classes)

Unit II: Settlement Geography (20 Marks) 14 Classes

1. Defining the field of settlement of geography: Meaning and scope. (3 Classes)

2. Rural and urban settlements: Factors influencing distribution pattern of settlements; Types of rural settlements; Morphology and Characteristics of rural and urban settlements. (7 Classes)

3. Concept of settlement hierarchy and urban fringe;Christaller's Central Place Theory. (4 Classes)

Part II: Practical

Credit: 2 (20 Marks)
(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Trend of population growth in Assam/N.E. India through line graph; Calculation and graphical representation of trend of decadal growth rates of population in Assam/N.E. India/India. (2 Exercises)

2. Choropleth map to show spatial pattern of decadal variation in population growth in Assam/N.E. India/India. (1 Exercise)

3. Choropleth map showing spatial pattern of population density in Assam/India. (1 Exercise)

4. Map showing spatial variation in social/religious/rural-urban composition of population in Assam/N.E. India using pie-graph. (1 Exercise)

5. Choropleth map showing spatial pattern of level of urbanization in Assam/N.E. India. (1 Exercise)

6. Flow cartogram showing direction and volume of migration into Assam/N.E. India from different parts of India. (1 Exercise)

7. Map showing distribution of towns and their varied population size with spheres in Assam/N.E. India. (1 Exercise)

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 Marks)
2. Viva-voce (2 Marks)

Reading List:

1. Barrett H. R., 1995: *Population Geography*, Oliver and Boyd.
2. Bhende A. and Kanitkar T., 2000: *Principles of Population Studies*, Himalaya Publishing House.
3. Chandna R. C. and Sidhu M. S., 1980: *An Introduction to Population Geography*, Kalyani Publishers.
4. Chandna R. C., 2014, *Geography of Population*: *Concepts, Determinants and Patterns*, Kalyani Publishers.
5. Clarke J. I., 1965: *Population Geography*, Pergamon Press, Oxford.
6. Jones, H. R., 2000: *Population Geography,* 3rd ed. Paul Chapman, London.
7. Lutz W., Warren C. S. and Scherbov S., 2004: *The End of the World Population Growth in the 21st Century*, Earthscan.
8. Newbold, K. B., 2009: *Population Geography: Tools and Issues*, Rowman and Littlefield Publishers.
9. Pacione, M., 1986: *Population Geography: Progress and Prospect*, Taylor and Francis.
10. Wilson, M. G. A., 1968: *Population Geography*, Nelson.
11. Panda, B. P. (1988): JanasankyaBhugol, M P Hindi Granth Academy,Bhopal.
12. Maurya, S. D. (2009) JansankyaBhugol, ShardaPustakBhawan, Allahabad.
13. Chandna, R. C. (2006), JansankhyaBhugol, Kalyani Publishers, Delhi.
14. Roy, D. (2015), *Population Geography*, Books and Allied (P) Ltd., Kolkata.
15. Ahmad, A., Noin, D. and Sharma, H.N. (eds), 1997, *Demographic Transition: The Third World Scenario*, Rawat Publications, Jaipur and New Delhi, 1997.
16. Money, D.C., 1972: Patterns of Settlement, Evan Brothers, London.
17. Peters, G.L. and Larkin, R.P., 1979: *Population Geography: Problems, Concepts andProspects,* Kendall/ Hunt Iowa.
18. Singh, R.L. and Singh, K.N., (eds), 1975: *Readings in Rural Settlement Geography*, BHU, Varanasi.
19. Singh, R.Y., 1994: *Geography of Settlements*, Rawat Publications, Jaipur and New Delhi.
20. Maurya, S. D., 2014:*Settlement Geography*, ShardaPustakBhawan, Allahabad.

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<u>CBCS-based U.G. Regular Course in Geography, 2019</u>

Syllabus of Skill Enhancement Course

Course Name: Computer Aided Data Analysis and Graphical Presentation

Paper Code: GGY- SE–5044

Total Credit: 4 (2+2)

Total Marks: 100

(Theory: 40, Practical: 40 and Internal Assessment: 20)

Course objectives:

- This paper is a core paper that intends to introduce the students to the interface of computer technology and its application in data analysis and representation.
- It seeks to develop new insights among the students on the use of computer technology in the field of geography.

Course outcomes:

- This paper shall prove to be very useful to the students in developing skills in data analysis and graphical presentation using various softwares including MS-Excel.
- This paper will also be useful for students preparing for different competitive exams including the civil services.

Part I: Theory

Credit: 2 (40 Marks)

(20 classes of 1 hour duration each)

1. Knowing Computer: Basic components of computer system; Major developments in hardwares and softwares and their utilities; Major computer applications and associated recent developments. (5classes)
2. Concept of Computing: Handling of numerical data in computer; Database Management System (DBMS): Data formats, Data entry and Data tabulation. (3classes)
3. Computer operations in geographical data analysis: Basic knowledge of MS Excel, SPSS and R. (3classes)
4. Geographical Data Analysis using MS Excel: Basic functions, performing computation of basic statistics (Central Tendency, Dispersion, Correlation).(3 classes)
5. Graphical representation of geographical data using MS Excel: Basic functions, Concept and types of majorcharts and graphs, and their relationship with geographical data; Basic ideas of graphical representation of geographical data (Bar,

Pie, Line, Scatter plot and Regression line). (3 classes)

6. Basics of Internet Browsing and Data acquisition: Concept of internet browsing; web sources for various geographical data; Geographical data acquisition from online portals. (3 classes)

Part II: Practical

Credit: 2 (40 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (32 Marks)

(To attempt 3 questions in total,2 carrying 12 marks each and 1 carrying 8 marks)

1. Processing and tabulation of excel data and preparation of frequency distribution table using filtering method (For attributeslike age structure, sex composition, caste composition, education and occupation, production, etc.). (3 assignments)

2. Preparation of Bar Diagram (Simple and Composite) using geographical data (State/District wise population and production of foodgrains in India). (2 assignments)
3. Preparation of Pie Diagram using geographical data (Land use or Population composition in Assam /N.E. India). (1 assignment)

4. Preparation of trend graph using time series data of production/population growth of Assam/N.E. India/India. (2 assignments)
5. Computation and analysis of geographical data using basic statistical techniques (Mean, Median, Mode, Correlation and Regression) (5 assignments)
6. Preparation of a Power Point presentation of the above mentioned assignments (At least 5)using MS office package. (1assignment)

Unit II: Practical Note-Book and Viva-voce (8 Marks)

1. Evaluation of Practical Note-Book (4 Marks)

2. Viva-voce (4 Marks)

Reading List:

1. Anita Goel, Computer Fundamentals, Pearson, 2010

2. Comdex: Hardware and Networking Course Kit, DreamTech press

3. E. Balaguruswamy, Computer Fundamentals and C Programming, Tata McGraw Hill.

4. Bartee, Thomas C. (1977): Digital Computer Fundamental; McGraw Hill.

5. Chauhan, S.; Chauhan, A. and Gupta, K. (2006): Fundamental of Computer; Firewall Media.

6. Flake, L.J.; McClintock, C.E. and Turner, S. (1989): Fundamental of Computer Education; Wordsworth Pub. Co.

7. Leon, A .and Leon,M.(1999): Introduction to Computer, USB Publishers' Distributors Ltd.

8. Malvino, A.P. and Leach, D.P. (1981): Digital Principles and Applications; Tata McGraw Hill.

9. Rajaraman, V. (2003): Fundamentals of Computer, Prentice Hall Publisher

10. Sarkar, A. and Gupta, S.K (2002): Elements of Computer Science, S Chand and Company, New Delhi Blissmer (1996): Working with MS Word; Houghton Mifflin Co.

11. Johnson, Steve (2007): Microsoft Power Point 2007; Pearson Paravia Bruno.

12. Walkenbach, John (2007): Excel 2007 Bible; John Wiley.

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<u>CBCS-based U.G. Course in Geography, 2019</u>

Syllabus for Skill Enhancement Course (Regular Course)

Course Name: Geography of Tourism

Paper Code: GGY–SE-5054
Total Credit: 4 (2+2)
Total Marks: 100

(Theory: 40, Practical: 40 and Internal Assessment: 20)

Course Objectives:
This paper introduces the students to the field of tourism from the lens of geography and itsspecificities. It seeks to develop new insights among students on how tourism and allied activities areshaped by geography of an area and also how such activities areresponsible in shaping economic, social and environmental context from globe to local levels.
Course Outcomes:

- The paper will be useful for students in developing ideas on how geographical factors
  tangent on tourism activities and how geographers seek to address issues of development and carrying capacities of varied environments.

- It will also build skills for students seeking to enroll in a research programme and/or provide openings for them to work with tourism/eco-tourism planning agencies.

Part I: Theory
Credit: 2 (40 Marks)

(20 classes of 1 hour duration each)

1. Geography of Tourism: Nature and scope; Concepts and issues of tourism; Recreation and leisure inter-relations;Robinson's geographical parameters of tourism.(3classes)
2.Factors and types of tourism: Nature tourism, Cultural tourism, Medical tourism, Adventure tourism, Pilgrimage, etc. (4classes)
3. Recent Trends in tourism: International and Domestic (India); Eco-Tourism, Sustainable Tourism. (4classes)
4. Impact of tourism oneconomy,environment andsociety. (4classes)

5. Tourism development in India: Tourism infrastructures; Case studies of tourism development inHimalaya, Desert and North-East India with special reference to Assam; National tourism policiesand prospects. (5classes)

Part II: Practical
Credit: 2 (40 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (32 Marks)

(To attempt 3 questions in total,2 carrying 12 marks each and 1 carrying 8 marks)

1. Trend of growth of tourist arrivals in the world/India/Assam since 1960 using Movingaverage method and least squares method. (4 assignments).

2. Trend of tourist arrivals in the north-eastern states of India and few top ranking tourist arriving states of India since 1980 using Band-graph. (2 assignments)

3.Line Graph showing pattern of tourist arrival (Domestic and International)in relation to rainfall and temperature in a year for selected tourist spots of North-East India / Assam. (2 assignments)

4. Spatial Patterns of Seasonal variation (Spring, Summer, Autumn and Winter) in tourist arrival in capital cities of North-East Indian States using Pie diagram and Bar Diagram.

(2 assignments)

4. Preparation of a transport connectivity (road, railway and air) map of Assam and North-East India for major tourist destinations. (1 assignment)

5. Preparationof a tourist map of North-East India showinglocations of important nationalparks and wildlife sanctuaries from tourism potential perspectives (indicating the major highlights of the respective destinations including distance from Guwahati city within box). (2 assignments)

6.Preparationof a tourist guide map of North-East India showing location of major tourist destinations and road connectivity routes from Guwahati city. (1 assignment)

Unit II: Practical Note-Book and Viva-voce (8 Marks)

1. Evaluation of Practical Note-Book (4 Marks)

2. Viva-voce (4 Marks)

Reading List:

1. Bhattacharya, P. (2011): Tourism in Assam: Trend and Potentialities, Banimandia, Guwahati

2. Dhar, P.N. (2006) International Tourism: Emerging Challenges and Future Prospects. Kanishka, New Delhi.

3. Hall, M. and Stephen, P. (2006) Geography of Tourism and Recreation – Environment, Place and Space, Routledge, London.

4. Kamra, K. K. and Chand, M. (2007) Basics of Tourism: Theory, Operation and Practise, Kanishka Publishers, Pune.

5. Page, S. J. (2011) Tourism Management: An Introduction, Butterworth-Heinemann-USA. Chapter 2.

6. Raj, R. and Nigel, D. (2007) Morpeth Religious Tourism and Pilgrimage Festivals Management: An International perspective by, CABI, Cambridge, USA, www.cabi.org.

7. Tourism Recreation and Research Journal, Center for Tourism Research and Development, Lucknow

8. Singh Jagbir (2014) "Eco-Tourism" Published by - I.K. International Pvt. Ltd. S-25, Green Park Extension, Uphaar Cinema Market, New Delhi, India (www.ikbooks.com).

9. Market Research Division, Dept. of Tourism, Govt. of India, India Tourist Statistics (available in PDF form), New Delhi

10. UNWTO: Tourism Barometer (available in their web portal to have a fresh glimpse of global tourism statistics/ other relevant sites may also be consulted)

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Syllabus for

BA/B.Sc.(Regular) Geography
Choice Based Credit System (CBCS)

Course effective from the academic year 2019-20

6th Semester

This is approved in the Academic Council held on 8/11/2019

GAUHATI UNIVERSITY
Guwahati-781014
June, 2019

Class 1 Hour 1	Duration	Credit
1 Theory Class	1 Hour	1
1 Tutorial Class	1 Hour	1
1 Practical Class	2 Hours	1

Credit and marks distribution scheme for CBCS curriculum in Geography, Regular Course

Semester VI Marks 400 Credit 22	Discipline Specific Elective 1 &2 (any one)	GGY-RE-6016:	Social and Political Geography	4+2	100
		GGY-RE-6026:	Geography of Resources and Development	4+2	100
	Discipline Specific Elective 3 (Generic Elective for Arts Stream)	GGY-RE-6036:	Geography of Health	4+2	100
	Skill Enhancement Course (Any One)	GGY-SE-6044	Field Techniques and Project work	2+2	100
		GGY-SE-6054	Environmental Impact Assessment	2+2	100

Subject	Semester	Paper type	Paper Code	Paper name	Total Marks	Marks Distribution					Paper Credit
						External		Internal			
						Theory	Practical	Sessional	Practical /Assignments	Attendance	
Geography	5th	Discipline Specific Elective 1 & 2 (Any one)	GGY-RE-6016:	Social and Political Geography	100	60	20	10	6	4	4+2=6
			GGY-RE-6026:	Geography of Resources and Development	100	60	20	10	6	4	4+2=6
		Discipline Specific Elective 3 (Generic Elective for Arts Stream)	GGY-RE-6036:	Geography of Health	100	60	20	10	6	4	4+2=6
		Skill Enhancement Course (Any one)	GGY-SE-6044	Field Techniques and Project work	100	40	40	10	6	4	2+2=4
			GGY-SE-6054	Environmental Impact Assessment	100	40	40	10	6	4	2+2=4

CBCS-based U.G. Course in Geography, 2019

Syllabus forDiscipline-Specific Elective Course (Regular)

Course Name: Social and Political Geography

Paper Code: GGY-RE-6016

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

- To appreciate the social and political dimensions of geographic phenomena.
- Understand how geography influences political issues and their spatial dimensions.

Course Outcomes:

- This course will help equip the students to comprehend various social and political aspects of phenomena and their interface within the realm of geography.
- The paper will be very useful for students preparing for various competitive examinations including civil services.

Part 1: Theory

Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

Unit 1: Social Geography (30 Marks) (20 Classes)

1. Social Geography: Meaning, Scope and approaches of study. (4 Classes)
2. Concept and types of social space and social groups. (4 Classes)
3. Social Well-being: Concept and components: Housing, health and education; Concept ofhuman development and its measurements. (4 Classes)
4. Contribution of race, religion, language andethnicity in promoting diversity in India. (3 Classes)
5. Social geographies of inclusion and exclusion: Basic concept and characteristics of caste system, slums, social crime and gender identity. (4 Classes)

Unit 2: Political Geography (30 Marks) (20 Classes)

1. Political Geography: Nature, scope and approaches to its study. (4Classes)
2. Concept of state, nation, and nation-state; Attributes of state.(3Classes)
3. Concept of frontiers and boundaries; boundary problems with reference to India and North-East India; Concept of buffer zones.

(5Classes)

4. Concept of Geopolitics; Mackinder's Heartland Theory. (4Classes)

Part II: Practical
Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)

(Two questions of 8 marks each

1. Mapping the patterns of human development in India and Assam using HDI**(1 Exercise)**
2. Construction of Ternary diagram representing social composition of population in India /North- East India **(1 Exercise)**
3. Sex disparity in literacy in India /North-East India using a simple Index.(**1 Exercise)**
4. Computation of Shape Index for selected states and countries.(**2 Exercises)**
5. Construction of a map of India/North-East India highlighting the major inter-state boundary conflict zones. **(2 Exercises)**
6. Reorganization of states of North-East India during Pre and Post Independence periods (up to the present). **(3 Exercises)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 Marks)
2. Viva-voce (2 Marks)

Reading List:

Social Geography

1. Ahmad, A., 1999: Social Geography, Rawat Publications, Jaipur and New Delhi.
2. Ahmad, A., (ed), 1993: Social Structure and Regional development: A Social Geography Perspective, Rawat Publications, Jaipur.
3. Carter, John and Trevor, Jones. 1989: Social Geography: An Introduction to Contemporary Issues, Edward Arnold, London.
4. Eyles, J.: 'Social Geography', in Johnston, R.J., et al, The Dictionary of Human Geography.
5. Jones, E. and Eyles, J., 1977: An Introduction to Social Geography, Oxford University Press, Oxford and New York.
6. Jones, E,(ed), 1975: Readings in Social Geography, Oxford University Press, Oxford.
7. Sharma, H.N., 2000: 'Social Geography' in Singh, J. (ed.) Progress in Indian Geography (1996-2000), INSA, New Delhi.
8. Smith, D.M., 1977: Human Geography: A Welfare Approach, Edward Arnold, London.
9. Sopher, D.E. (ed), 1980: An Exploration of India: Geographical Perspectives on Society and Culture, Longman, London.
10. Srinivas, M.N., 1986: India: Social Structure, Hindustan Publishing Corporation, Delhi.
11. Taher, M., 1994: An Introduction to Social Geography: Concept and Theories, NEIGS, Guwahati. 37

Political Geography

1. Adhikari , S.,1996 : Political Geography, Rawat Publications, Jaipur and New Delhi.
2. De Blij, H.J.,1972 : Systematic Political Geography, John Wiley , New York.
3. Dikshit, R.D.,1982 : Political Geography : A Contemporary Perspective, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
4. Muir, R.,1975 : Modern Political Geography , Macmillan Ltd., London.
5. Pounds, N.J.G.,1972 : Political Geography, McGraw Hill , New York.
6. Prescott, J.R.V.,1972 : Political Geography, Methuen, London.
7. Sukhwal, B.L., 1979: Modern Political Geography of India, Sterling, New Delhi. Taylor, P.J., 1989: Political Geography, Longman, London.

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CBCS-based U.G. Course in Geography, 2019

Syllabus of Discipline Specific Elective

Course Name: Geography of Resources and Development

Paper Code: GGY-RE-6026

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course Objectives:

● This paper intends to introduce the students about basic concepts of resource and resource management, and its relevance to sustainable development.

● To get acquainted with different concepts of development with special focus on economic development.

Course Outcomes:

● This paper will be useful to students in developing ideas on different aspects of resources, and the linkages with development issues that geographers usually address.

● This paper will also be useful for students preparing for different competitive examinations including the civil services.

Part I: Theory

Credit: 4 (60 Marks)

(40 lasses of 1 hour duration each)

1.**Geography of Resources and Development**: Concept of resource; Relationship between resource- base and development; Significance of resource and development studies in geography; Classification and Characteristics of resources. **(6 classes)**

2. **Natural Resources for Development**: Distribution, Utilisation, and Management of land (soil), water, forests, minerals and energy resources in the World and their contribution to development. **(8 classes)**

3. **Development and Environment**: Concept of development; Rationale use of resources and the concept of sustainable development; Environment and development; Sustainable Development Goals;Concept of rural livelihood. **(8 classes)**

4. **Global issues of Natural Resources and Development**: Sustainable Natural Resource Management; United Nations Framework of Classification for Resources (UNFC);Resource and development planning: Conservation of resources, integrated environment and resource management **(10 classes)**

5. **Pattern of Economic Development and Resource use**: Patterns of development in developed and developing countries;Resource management in developed countries (Israel and Japan) and Resource management in developing countries (Nepal and Bangladesh); Concept of Green technology. **(8 classes)**

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit 1: Practical Works (16 Marks)
(Two questions of 8 marks each)

1. Determination of levels of development in India/North-East India/Assam based on few development indicators using simple composite index and ranking method. **(2 Assignments)**

2. Mapping of physiological density of population in Assam at district level or North-East India at state level. **(1 Assignment)**

3. Mapping of spatial variation of category-wise forest cover(very dense, moderate dense and open forest) in Assam/ North-East India using Pie diagram based on data from the recent Forest Survey of India's report *(available at: https://fsi.nic.in/forest-report-2019)* **(1 Assignment)**

4. Identification of important natural resources/ resource sites (e.g. Reserve Forests/Wildlife sanctuaries/national parks, mineral resources, rivers, grasslands, wetlands, etc.) within 100km radius around the state capitals of North-East Indiausing Google Earth Platform. **(1 Assignment)**

5. Preparation of resource potential map of North-East India at state level showing spatial variation in production of selected commodities (rice, maize, coal, petroleum, hydro power, tea, etc.) using simple composite index. **(1 Assignment)**

6. Correlation analysis of irrigation and intensity of cropping in Assam/ North-East India. **(1 Assignment)**

7. Time series analysis of the trend of Coal/Crude oil/Natural gas production in India using moving average method. **(1 Assignment)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 marks).

2. Viva-voce (2 marks).

Reading List:

1. Cutter S. N., Renwich H. L. and Renwick W., 1991: Exploitation, Conservation and Preservation: A Geographical Perspective on Natural Resources Use, John Wiley and Sons, New York.
2. Gadgil M. and Guha R., 2005: The Use and Abuse of Nature: Incorporating This Fissured Land: An Ecological History of India and Ecology and Equity, Oxford University Press. USA.
3. Holechek J. L. C., Richard A., Fisher J. T. and Valdez R., 2003: Natural Resources: Ecology, Economics and Policy, Prentice Hall, New Jersey.
4. Jones G. and Hollier G., 1997: Resources, Society and Environmental Management, Paul Chapman, London.
5. Klee G., 1991: Conservation of Natural Resources, Prentice Hall, Englewood.
6. Mather A. S. and Chapman K., 1995: Environmental Resources, John Wiley and Sons, New York.
7. Mitchell B., 1997: Resource and Environmental Management, Longman Harlow, England.
8. Owen S. and Owen P. L., 1991: Environment, Resources and Conservation, Cambridge University Press, New York.
9. Rees J., 1990: Natural Resources: Allocation, Economics and Policy, Routledge.London.
10. Gilg A. W., 1985: An Introduction to Rural Geography, Edwin Arnold, London.
11. Krishnamurthy, J. 2000: Rural Development - Problems and Prospects, RawatPubls., Jaipur
12. Lee D. A. and Chaudhri D. P. (eds.), 1983: Rural Development and State, Methuen, London.
13. Misra R. P. and Sundaram, K. V. (eds.), 1979: Rural Area Development: Perspectives and Approaches, Sterling, New Delhi.
14. 7. Ramachandran H. and Guimaraes J.P.C., 1991: Integrated Rural Development in Asia – Leaning from Recent Experience, Concept Publishing, New Delhi.
15. Robb P. (ed.), 1983: Rural South Asia: Linkages, Change and Development, Curzon Press.
16. Agyeman, Julian, Robert D. Bullard and Bob Evans (Eds.) (2003) Just Sustainabilities: Development in an Unequal World. London: Earthscan. (Introduction and conclusion.).
17. Ayers, Jessica and David Dodman (2010) “Climate change adaptation and development I: the state of the debate”. Progress in Development Studies 10 (2): 161-168.
18. Baker, Susan (2006) Sustainable Development. Milton Park, Abingdon, Oxon; New York, N.Y.: Routledge. (Chapter 2, “The concept of sustainable development”).
19. Brosius, Peter (1997) “Endangered forest, endangered people: Environmentalist representations of indigenous knowledge”, Human Ecology 25: 47-69.

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CBCS-based UG Course in Geography, 2019

Syllabus of Discipline Specific Elective (Regular Course)

Course Name: Geography of Health

Paper Code: GGY-RE–6036

Total Credit: 6 (4+2)

Total Marks: 100

(Theory: 60, Practical: 20 and Internal Assessment: 20)

Course objectives:

This course basically deals with understanding the concept of health and geography of health as a field of study. It throws light on the factors determining human health and occurrence of various types of diseases in relation to ecology. It also provides information about human health in relation to global climate change in general and disease pattern in relation to varying environmental contexts in India in particular.

Course outcomes:

- Understanding of the concept of human health and healthcarefrom the perspectiveof geography.
- Acquiring knowledge about factors influencing human health and occurrence of diseases in varying ecological settings.
- Providing useful information about the impact of global climate change on human health and occurrence of various diseases in different ecological settings in India.

Part I: Theory
Credit: 4 (60 Marks)

(40 classes of 1 hour duration each)

1. Geography of Health: Definition and significance; approaches of study: ecological, social and spatial. **(6 classes)**
2. Disease ecology: ecology and human health; geographical factors affecting human health; factors influencing disease transmission (pathological, physical, environmental, social, cultural and economic). **(8 classes)**
3. Classification of diseases: genetic, zoonotic, communicable, non-communicable, occupational, deficiency diseases and malnutrition. **(4 classes)**
4. Disease occurrence: Emergence, re-emergence and persistence; Modes of transmission of major diseases (Japanese encephalitis, hepatitis, AIDS and COVID-19) and their broad global distribution. **(8 classes)**
5. Heathcare Systems: Meaning and components; Universal government-funded health system; Role of WHO and UNICEF in global health care; Health care services in

India: Family welfare, Immunization, National Health Mission and its programmes, Challenges to healthcare system during pandemic situation like COVID-19. **(8 classes)**

6. Environment, human habit and health: Basic concept and ideas realting to food habit and health, occupation and health, environmental degradation and health, and lifestyle and human health. **(6 classes)**

Part II: Practical

Credit: 2 (20 Marks)

(20 classes of 2 hour duration each)

Unit I: Practical Works (16 Marks)

(Two questions of 8 marks each)

1. Mapping of health status indicators (hospital beds, primary health centres, doctors, para medics, etc.) in Assam/N.E. India using Z-score method. **(1 Exercise)**
2. Trend of infant mortality and maternal mortality rates in India using line graph. **(2 Exercises)**
3. Choropleth mapping of infant mortality in India at state level. **(1 Exercise)**
4. Map showing spatial variation of disease incidence rate in India/N.E. India at state level. **(1 Exercise)**
5. Mapping of seasonal variation in the occurrence of Covid-19 cases in Assam at district level using pie graph. **(1 Exercise)**
6. Preparation of questionnaire for health care and health status survey. **(1 Exercise)**
7. Graph showing relationship of disease (JE, Malaria, etc.) occurrence pattern due to monthly variation of rainfall and average temperature in any district of Assam. **(1 Exercise)**

Unit II: Practical Note-Book and Viva-voce (4 Marks)

1. Evaluation of Practical Note-Book (2 Marks)
2. Viva-voce (2 Marks)

Reading List:

1. AkhtarRais (Ed.), 1990 : Environment and Health Themes in Medical Geography, Ashish Publishing House, New Delhi.
2. Anthamatten P, (2011), Introduction to the Geography of Health, Rawat Publications, Jaipur
3. Avon Joan L. and Jonathan A Patzed.2001 : Ecosystem Changes and Public Health,Baltimin, John Hopling Unit Press(ed).
4. Banerji, D. (1986) :Social Sciences and Health Services in India, LokPrakashan,New Delhi.
5. Bradley,D.,1977: Water, Wastes and Health in Hot Climates, John Wiley Chichesten.
6. Brown, T., McLafferty, S., Moon, G. (2010): A Companion to Health and Medical Geography, Wiley Blackwell, UK
7. Christaler George and HristopolesDionissios, 1998: Spatio Temporal Environment Health Modelling , Boston Kluwer Academic Press.
8. Cliff, A.D. and Peter,H., 1988 : Atlas of Disease Distributions, Blackwell Publishers, Oxford.
9. Curtis, S. (2004): Health and Inequality: Geographical Perspectives, Sage Publications, London
10. Gatrell, A.,andLoytonen, 1998 : GIS and Health, Taylor and Francis Ltd, London.
11. Hardham T. and Tannav M.,(eds): Urban Health in Developing Countries; Progress, Projects, Earthgoan, London.
12. Mishra, R.P.(1970): Medical Geography of India, National Book Trust ofIndia.
13. Mishra, R.P.(2002)), Geography of health : a treatise on geography of life and death

    in India, Concept Publishing Co., New Delhi
14. Murray C. and A. Lopez, 1996 : The Global Burden of Disease, Harvard University Press.
15. Moeller Dade wed., 1993: Environmental Health, Cambridge, Harward Univ. Press.
16. National Health Missionhttps://nhm.gov.in/
17. National Health Portal India https://www.nhp.gov.in/healthprogramme/national-health-programmes
18. Phillips, D.andVerhasselt, Y., 1994: Health and Development, Routledge, London.
19. Shaw, M., Dorling, D. and Mitchell, R, (2002) Health, Place and Society, Pearson, London
20. Tromp, S., 1980: Biometeorology: The Impact of Weather and Climate on Humans and their Environment, Heydon and Son.

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CBCS-basedU.G. Course in Geography, 2019

Syllabus of Regular Skill Course

Course Name: Field Techniques in Geography and Project Work

Paper Code: GGY-SE-6044

Total Credit: 4 (2+2)

Total Marks: 100

(Theory: 40, Practical: 40 and Internal Assessment: 20)

Course objectives:

This paper on Field Techniques in Geography is of pedagogical importance as it helps the students of geography to acquire the first hand experience about the geography of a particular area. It also helpsthe students to learn the various techniques of data collection from the field andto understand any pre-defined problem in proper perspective.

Course outcomes:

- This course will help students to proceed with a research problem and the steps she/he should adopt and the tools and craft to be employed for doing quality research.
- Students perceive fieldwork to be beneficial to their learning, because through it they experience ‘geographical reality’, and have deeper understanding of the subject.
- The students will have a chance to interact with respondents and collect data through questionnaire directly from the field.
- This course will develop understanding about designing and writing a field report.

Part I: Theory

Credit: 2 (40 Marks)

(20 Classes of 1 hour each)

1. Geography and Field Studies: Geography as a field science; Need of field work in geography; Nature of field studies in physical geography and human geography (Basic ideas only). (2classes)

2. Concept of Case Study and Its identification in the varying geographical contexts (Physical/Human/Rural/Urban/Environmental). (2classes)

3. Tools and Techniques in Field Studies:Nature of data and their collection techniques relating to various geographical phenomena (Physical and Human); Structure of field survey questionnaire; Collection of Physical geographic data: Observations and photography, field interview, questionnaire survey, etc; Collection of Human geographic data: Questionnaire survey, Focus group interview/discussion, etc. (6classes)

4. Surveying: Concept of ground surveying and mapping;Conduct of traverse surveying with Prismatic Compass; Profile levelling and contouring with Dumpy Level; Point distribution survey with GPS; Field mapping of Village, River bank, Landslides, Market, etc through transect and sketch map. (7classes)

5. Preparation of ProjectReport: Basis of selection of the theme of field-based project work; Basic concept of citation, referencing and bibliography; Broad design of project report: Preliminaries; Text; Tables, Figures and Appendices; Project Report Writing; Executive Summary. (3Classes)

Part II: Field Book and Project Report
Credit: 2 (40 Marks)

(20 classes of two hour duration each)

Unit I: Field Book Preparation and Evaluation (15 Marks)

Based on understanding of various field techniques of geography in theory course the students shall undertake the following field assignments within or nearby the College campus and some other area, as the case may be, under the guidance of respective teachers. The students shall present their assignments in A4 size paper as a Field Book and submit the same with teachers' signature in binding form (Spiral or Kutcha binding) for evaluation in the examination. This field book shall be evaluated by the external examiner.

<u>Contents of Field Book</u>:

1. Field observations of a near-by area and preparation of a brief report (within 4-5 pages) about the prevailing physical and human landscape of the area along with its spot photograph.
(1 Assignment)
2. Preparation of two field survey questionnaire/schedule (within 1 page each) for collection of data relating to two different broad phenomena/problems (one on physical phenomenon and another on human phenomenon), and processing, tabulation and graphical representation of the same. (2 Assignments)
3. Closed traverse surveying within College campus with Prismatic Compass and plotting of some details within the polygon, and preparation of a plan with appropriate scale and error correction, if any. (1 Assignment)

4. Longitudinal profile levelling/Contouring in College campus or any nearby area with Dumpy Level, and plotting of collected data in the form of longitudinal profile / contour map. (1 Assignment)
5. Preparation of field map of a village, urban locality/market, river bank/wetland and its adjoining area or their any section through Transect and sketch map along with a spot photograph of the same. (2 Assignments)

Unit II: Project Report Preparation and Evaluation (15 Marks)

1. Each student will have to prepare a Project Report on a suitable geographical problem under the guidance of respective teacher following appropriate methodology, data base and literature review.
2. Length of the Report: 25-30 printed A4 size pages (font size 12 in Times New Roman with 1.5 spacing) including text, tables, figures, references, etc.

3. The project report in binding form (Kutcha or Spiral binding) duly signed by the guide concerned has to be submitted to the department at least 3 days before the scheduled date of examination.
4. The content and quality of the project report shall be evaluated as an average of the marks out of 15 given by the external examiner and the teacher guide.

Unit III: Viva-voce of Field Book and Project Report (10 Marks)

(i) Viva-voce on Field Book: 5 Marks

(ii) Viva-voce on Project Report: 5 Marks

(The viva-voce of the above shall be conducted by the external examiner)

Reading List:

1.Creswell J., 1994: *Research Design: Qualitative and Quantitative Approaches* Sage Publications.

2. Dikshit, R. D. 2003. The Art and Science of Geography: Integrated Readings. Prentice-Hall of India, New Delhi.

3. Evans M., 1988: “Participant Observation: The Researcher as Research Tool” in *Qualitative Methods in Human Geography*, eds. J. Eyles and D. Smith, Polity.

4. Mukherjee, Neela 1993. Participatory Rural Appraisal: Methodology and Application. Concept Publs. Co., New Delhi.

5. Mukherjee, Neela 2002. Participatory Learning and Action: with 100 Field Methods. Concept Publs. Co., New Delhi.

6. Robinson A., 1998: "*Thinking Straight and Writing That Way*", in *Writing Empirical Research Reports: A Basic Guide for Students of the Social and Behavioural Sciences*, eds. by F. Pryczak and R. Bruce Pryczak, Publishing: Los Angeles.

7. Special Issue on “Doing Fieldwork” *The Geographical Review* 91:1-2 (2001).

8. Stoddard R. H., 1982: *Field Techniques and Research Methods in Geography*, Kendall/Hunt.

10. Wolcott, H. 1995. The Art of Fieldwork.Alta Mira Press, Walnut Creek, CA.

11. Monkhouse, F.J. and Wilkinson, H.R., 1989: Maps and Diagrams, B.I. Publications Ltd., Mumbai.

12. Singh R. L. and Singh R. P. B., 1999: Elements of Practical Geography, Kalyani Publishers.

13. Singh, L.R., 2013: Fundamentals of Practical Geography, ShardaPustakBhawan, Allahabad.

14. Sarkar, A., 2015: Practical Geography: A Systematic Approach. Orient Black Swan Private Ltd., New Delhi.

15. Misra, R. P. and Ramesh, A., 1989: Fundamentals of Cartography, Concept Publishing Company, New Delhi.

16. Kothari, C. R., 1993: *Research Methodology: Methods and Techniques*, 2nd ed., Wiley Eastern Ltd., New Delhi.

17. Misra, H.N. and Singh, V.P., 1998: *Research Methodology in Geography*, Concept Publishing Company, New Delhi.

18. Misra, R.P. (2002) Research Methodology, Concept Publications, New Delhi.

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CBCS-based U.G. Course in Geography, 2019

Syllabus of Regular Skill Enhancement Course

Course Name: Environmental Impact Assessment

Paper Code: GGY-SE-6054

Total Credit: 4 (2+2)

Total Marks: 100

(Theory: 40, Practical: 40 and Internal Assessment: 20)

Course Objectives:

● This is a skill enhancement paper which intends to familiarize the students with the concept of environmental impact assessment.

● It seeks to develop the skill among the students to do an EIA study, necessary steps, and procedures.

Course Outcomes:

● This paper will be useful for students in developing ideas on environmental impact assessment.

● This paper will also be useful for students who wish to work in environmental organizations, NGOs, environmental policy making, etc.

Part I: Theory

Credit: 2 (40 Marks)

(20 Classes of 1 hour duration each)

1. Nature and types of environmental impacts; Meaning, scope and nature of Environmental Impact Assessment (EIA). **(2classes)**

2. Origin and development of Environmental Impact Assessment; History of EIA in India; Current issues of environmental impact assessment. **(3classes)**

3. Screening procedures: Scoping and environmental baseline assessment; Consideration of alternatives, baseline formulation and parameter identification, and impact identification. **(3classes)**

4. Predicting Environmental Impacts and determining impact significance: Impact prediction, evaluation and mitigation. **(3classes)**

5. Managing project impacts-post decision monitoring: Participation (public hearing), presentation and review, Monitoring and auditing of EIA. **(4classes)**

6. Legal, Policy and Regulatory framework of environmental impact assessment in India; ESPOO convention, General case studies of EIA (Wetlands in urban environment, highway Construction, brick kilns, big dam, etc.). **(5classes)**

Part II: Field Knowledge Assessment and Project Report

Credit: 2 (40 Marks)

20 classes of two hour duration each)

Unit I: Practical Knowledge Evaluation (15 Marks)

The students while appearing in the practical examination shall have to answer three questions (each carrying 5 marks) relating to their practical field-based knowledge on different aspects of environmental impact assessment.

Unit II: Project Report Preparation and Evaluation (15 Marks)

The students will visit a nearby industry/development project/road construction project/ecologically sensitive area to make assessment of nature and magnitude environmental impacts in the respective area under the guidance of teacher(s) concerned and to prepare an environmental impact analysis report thereof.

1. Each student will have to prepare an EIA Report on a suitable problem under the guidance of respective teacher following appropriate methodology, data base and literature review.
2. Length of the Report: 25-30 printed A4 size pages (font size 12 in Times New Roman with 1.5 spacing) including text, tables, figures, references, etc.
3. The project report in binding form (Kutcha or Spiral binding) duly signed by the guide concerned has to be submitted to the department at least 3 days before the scheduled date of examination.
4. The content and quality of the project report shall be evaluated as an average of the marks out of 15 given by the external examiner and the teacher guide.

Unit III: Viva-voce on Project Report (10 Marks)

(The viva-voce shall be conducted by the external examiner)

Reading List:

1. Glasson, J. and Therivel, R., 2019. *Introduction to environmental impact assessment*. Routledge.
2. Canter, L.W., 1982. Environmental impact assessment. *Impact Assessment*, *1*(2), pp.6-40.
3. Erickson, P.A., 1994. *A practical guide to environmental impact assessment*. Academic Press Inc..
4. Modak, P. and Biswas, A.K., 1999. *Conducting environmental impact assessment in developing countries*. United Nations University Press.
5. Trivedy, R. K., & Raman, N. S. (2002). *Industrial Pollution and Environmental Management*. Scientific Publishers.
6. Therivel, R., & Wood, G. (Eds.). (2017). *Methods of environmental and social impact assessment*. Routledge.
7. Lawrence, D. P. (2005). Environmental impact assessment: Practical solutions to recurrent problems, part 1. *Environmental Quality Management*, *14*(4), 39-62.

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B.Sc. Biotechnology (Regular) Syllabus- CBCS

This is approved in the Academic Council held on 08.11.2019

Department of Biotechnology,

GAUHATI UNIVERSITY

Gopinath Bordoloi Nagar, Guwahati 781014, Assam, India.

CHOICE BASED CREDIT SYSTEM (CBCS)

B.Sc. (General/Regular) Biotechnology

COURSE STRUCTURE

	Type	CORE	AEC	SEC	DSE
	Credit	6 (60T+ 40P)	4 (100T)	4 (60T + 40P)	6(4T+2P) 60T + 40P
Semester I		DSC-1 A (BIT-RC-1016)	AECC1 (ENG-AE-1014)		
Semester II		DSC-1 B (BIT-RC-2016)	AECC1 (ENG-AE-1014)		
Semester III		DSC-1 C (BIT-RC-3016)		SEC-1 (BIT-SE-3014)	
Semester IV		DSC-1 D (BIT-RC-4016)		SEC-2 (BIT-SE-4014)	
Semester V				SEC-3 (BIT-SE-5014	DSE-1 A (BIT-RE-5016)
Semester VI				SEC-4 (BIT-SE-6014	DSE-1 B (BIT-RE-6016)

LIST OF PAPERS:

Semester I	DSC-1 A	BIT-RC-1016	Biotechnology & Human Welfare	6 credits (60T + 40P marks)
	AECC1	ENG-AE-1014	English/ EVS/ MIL communication	4 credits
Semester II	DSC-1 B	BIT-RC-2016	Developmental Biology	6 credits (60T + 40P marks)
	AECC1	ENG-AE-1014	English/ EVS/ MIL communication	4 credits
Semester III	DSC-1C	BIT-RC-3016	Bioethics and Biosafety	6 credits (60T + 40P marks)
	SEC1	BIT-SE-3014	Enzymology	4 credits (60T + 40P marks)
Semester IV	DSC-1 D	BIT-RC-4016	Entrepreneurship Development	6 credits (60T + 40P marks)
	SEC2	BIT-SE-4014	Industrial Fermentations	4 credits (60T + 40P marks)
Semester V	SEC-3	BIT-SE-5014	Ecology & Environmental Management	4 credits (60T + 40P marks)
	DSE-1 A	BIT-RE-5016	Bioinformatics	6 credits (60T + 40P marks)
Semester VI	SEC-4	BIT-SE-6014	Biostatistics	4 credits (60T + 40P marks)
	DSE 1 B	BIT-RE-6016	Dissertation/ Project	6 credits (60T + 40P marks)

CONTENT:

BIOTECHNOLOGY AND HUMAN WELFARE

UNIT I **(10 Periods)**

Protein engineering for industry: food, pharmaceutical, beverage, tanning and textile.

UNIT II **(10 Periods)**

N_2 fixing microbes for sustainable agriculture. Plant-microbe interaction, stress response in plants, qualitative improvement of livestock.

UNIT III **(15 Periods)**

Polyaromatic hydrocarbons, polycyclic biphenyls, non-chlorinated organic pollutants, biodegradation, bioremediation, degradation of hydrocarbons and agricultural wastes, bioplastics, biopolymers and biosurfactants.

UNIT IV **(12 Periods)**

Biotechnology in forensic science, criminology, paternity determination using various methods of DNA finger printing.

UNIT V **(13 Periods)**

Biotechnology in modern medicine- overview, therapeutic agents, vaccines, gene therapy, diagnostics, monoclonal antibodies, anti-venoms and chemotherapeutic agents.

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Ethanolic fermentaion using yeast.
2. Isolation of *Rhizobium*/*Azotobacter*/*Azospirillum*, etc from soil/plant parts.
3. Microscopic observation of infected plant parts (sugarcane/rice/brinjal/legumes).
4. Estimation of residual halogens (chlorine/fluorine) in waste water/effluent.
5. Human DNA isolation from buccal swab/hair/urine using isolation kit.
6.visit to advanced laboratory/Universities.

SUGGESTED READING

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international Publishers

Contact person: Dr. Sujoy Bose, Department of Biotechnology, GU

DEVELOPMENTAL BIOLOGY

5 credit (L) + 1 T

UNIT I: Gametogenesis and Fertilization **(10 Periods)**

Definition, scope & historical perspective of development Biology, Gametogenesis, Spermatogenesis, Oogenesis, Differentiation of eggs, spermatogenesis, Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II: Early embryonic development **(20 Periods)**

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

UNIT III: Embryonic Differentiation (20 Periods)
Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT IV: Organogenesis (10 Periods)
Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals**.**

TUTORIALS:

SUGGESTED READING

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
1. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

Contact person: Dr. Sujoy Bose, Department of Biotechnology, GU

BIOETHICS AND BIOSAFETYUNIT

UNIT- I: (20 Periods)
Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

UNIT II (15 Periods)
Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.

UNIT IV (15 Periods)
Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level, Concept of BSL and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

PRACTICALS
1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence.

7. Case study on handling and disposal of radioactive waste

SUGGESTED READING

1. Entrepreneurship: New Venture Creation : David H. Holt
2. Patterns of Entrepreneurship : Jack M. Kaplan
3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

Contact person: Dr. H.K. Sarma

ENZYMOLOGY

UNIT – I **(15 Periods)**

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, complementarity, enzyme activity, Michaelis-Menten hypothesis, and Lineweaver Burke plot, specific activity, and common features of active sites.

Enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate,lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

UNIT - II **(15 Periods)**

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis.

Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).

Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity,

Kinetics of enzyme activity, Michaelis-Menten equation and its derivation,

Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories,

Significance of activation energy and free energy.

UNIT – III **(15 Periods)**

Two substrate reactions (Random, ordered and ping-pong mechanism). Enzyme inhibition and types of inhibition, determination of Ki, suicide inhibitor.

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples-: chymotrypsin, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase.

Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

UNIT – IV **(12 Periods)**

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Models of Allosteric enzymes. Negative cooperativity and half site reactivity. Macromolecular interaction: Enzyme interaction, Protein ligand binding, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes– types and significance with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Abzymes. Multifunctional enzyme-eg Pyruvate dehydrogenase complex.

UNIT – IV **(8 Periods)**

Enzyme Technology: Methods for large scale production of enzymes.
Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization ofenzymes. Basic kinetics of immobilized enzymes.

PRACTICALS

1. Purification of an enzyme from any natural resource.
2. Quantitative estimation of proteins by Bradford/Lowry's method.
3. Perform assay for the purified enzyme.
4. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.

SUGGESTED READING

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons, 1995.
4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004
7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002

Contact person: Dr Mohammad Imtiyaj Khan, Department of Biotechnology, Gauhati University. 9844162330, imtiyaj@gauhati.ac.in.

ENTERPRENEURSHIP DEVELOPMENT

UNIT I **(10 Periods)**

Introduction - Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

UNIT II **(12 Periods)**
Establishing an enterprise**,** Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility. Finance in projects.

UNIT III **(15 Periods)**
Financing the enterprise, Importance of finance / loans and repayments, Characteristics of finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

UNIT IV **(13 Periods)**
Marketing management**,** Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

UNIT V **(10 Periods)**
Entrepreneurship and international business, Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.
Project Report on a selected product should be prepared and submitted.

SUGGESTED READING

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons.

Contact person – Mr. Debasish Borbora (Debasish.borbora@gauhati.ac.in.)

INDUSTRIAL FERMENTATIONS

UNIT I **(12 Periods)**

Biotechnology and bioprocess engineering – principles and steps involved. Media ingredients for industrial fermentation, media formulation, optimization, and sterilization. Inoculum production for bacterial and fungal processes. Strain development. Fermentation material and energy balance, microbial growth kinetics, growth cycle, batch, fed-batch and continuous fermentation. Aeration (O_2, N_2, CO_2) antifoam and buffers.

UNIT II **(15 Periods)**
Microbial products of pharmacological interest, chemotherapeutic products, antibiotics, amino acids, vitamins, steroids and enzymes. Secondary metabolism – its significance and products.

Cell immobilization techniques in industrial processing, enzymes in organic synthesis, enzymes in food sciences, textile industries and tanning and leather industries. Production of industrial chemicals viz., acetic acid, propionic acid, butyric acid. Ethanol fermentation and bio-hydrogen. Production of microbial polysaccharides, microbial insecticides, microbial biosurfactants.

UNIT III **(13 Periods)**

Downstream processing - Separation characteristics of proteins and enzymes, purification methodologies. Cell disruption methods for intracellular products, homogenization, sonication, enzyme digestion. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra-centrifugation, Supercritical fluid extraction, liquid extraction, ion-exchange recovery, precipitation, distillation, drying of biological products. Product recovery and yield.

UNIT IV **(20 Periods)**

Rate equations for enzyme kinetics, simple and complex reactions. Mathematical derivation of growth kinetics, batch and continuous culture operations. Basic design of a fermenter, aseptic operation and containment, agitator and sparger design, and baffles. Process parameters, measurement of temperature, pressure, pH, dissolved oxygen, foaming, and flow rate of liquids and gases. Types of fermenters, Single stage Continuously Stirred Tank Reactor, bubble column, airlift, packed bed, fluidized bed, membrane type, solid state and photobiorectors.

PRACTICALS

1. Isolation of industrially important microorganisms
2. Production of Industrially important Enzyme by submerged fermentation (Lab scale)
3. Production of Industrially important Enzyme by solid state fermentation
4. Study of Microbial Growth Kinetics
5. Production of alcohol by viable yeast cells
6. Cell disruption by ultrasonication.
7. Soxhlet extraction of plant metabolites and usage of flash evaporator.

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology.2nd edition. Panima Publishing Co. New Delhi.
3. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
4. Salisbury, Whitaker and Hall. Principles of fermentation Technology,
5. Bioprocess Engineering, Basic Concepts, II Ed. Michael L Shuler, Fikret Kargi, Prentice Hall of India pvt. Ltd. 2002.

Contact person – Mr. Debasish Borbora (Debasish.borbora@gauhati.ac.in.) and Dr. Dr H.K. Sarma (hridip@gauhati.ac.in)

ECOLOGY AND ENVIRONMENT MANAGEMENT

UNIT-I **(12 Periods)**

Scope of Ecology. Development & Evolution of Ecosystem. Principles & Concepts of

Ecosystem. Structure and strata of ecosystem. Types of ecosystem including habitats, niche and biomes. Evolution of early life and changes in earth's atmosphere. Whittaker's classification of kingdoms, monera, protists, fungi, plant, and animal kingdoms. Darwin's and Wallace theories of evolution and inheritance.

UNIT II **(20 Periods)**

Energy transfer in an Ecosystem. Food chain, food web, Energy budget, Production and decomposition in a system. Ecological efficiencies, trophic structure and energy pyramids, Ecological energetics, principles pertaining to limiting factors, Bio-geochemical cycles (N,C,P cycles). Population ecology – populations and communities, attributes of populations, introduction to Mendelian and population genetics, Hardy Weinberg's law, genetic drift, gene flow.. Intraspecific interactions, commensalism, mutualism, competition and predation. Species diversity, richness, stability and disturbance.

UNIT-III **(18 Periods)**

Aquatic and terrestrial communities; rare communities. Primary and secondary productivity - basic concepts. Primary and secondary ecological succession – water, forests, and lands. Invasive species and control. Adaptation and behaviour under various ecological conditions. Pollution and environmental health related to soil, water, air, food, pesticides, metals, solvents, radiations, carcinogen, and poisons. Basics of detecting environmental pollutants, indicators of pollution.

UNIT-IV **(10 Periods)**

Environmental biotechnology, approaches for the protection and preservation of environment. Bioremediation, waste water management. Analysis of air pollutants and mitigation of greenhouse gases. Estimation of physico-chemical parameters of water and soil quality, BOD, COD, DO, heavy metals and suspended solids. Principle, instrumentation and application of UV spectroscopy, flame spectrometry and atomic absorption spectroscopy.

PRACTICALS

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem.
2. Determination of population density in a terrestrial or plant community and calculation of the Simpson's and Shannon- Weiner diversity index munity.
3. Study of fecundity table of three types of survivorship curves from zooplanktons collected from natural source.
4. Study of the types of soil, their texture by sieve method and rapid tests for –pH, phosphorous, chlorides, nitrates, carbonates and organic carbon
5. Study any five endangered/ threatened species- one from each class of Whittaker's classification.

SUGGESTED READING

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge, University Press.
2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
3. Joseph, B., Environmental studies, Tata Mc Graw Hill.
4. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5thedition) Books/Cole,Thompson Learning, Inc.
5. Thakur, I S, Environmental Biotechnology, I K Publication.

Contact person –Dr. Dr H.K. Sarma (hridip@gauhati.ac.in)

BIOINFORMATICS

UNIT I **(10 Periods)**

Basic computer applications in biology, History of Bioinformatics. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II **(20 Periods)**

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR,

UNIT III **(20 Periods)**

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Concept of Homology search, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT IV **(10 Periods)**

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

PRACTICALS

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

SUGGESTED READING

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

Contact Person: **Dr. S.S. Swargiary.**
Dr. Pranjan Barman, pranjan.barman@gauhati.ac.in (call +91 9859947743 M)

BIOSTATISTICS

UNIT I **(12 Periods)**

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of

Skewness and Kurtosis.

UNIT II **(18 Periods)**
Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT III **(18 Periods)**
Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT IV **(12 Periods)**
Correlation and Regression. Emphasis on examples from Biological Sciences.

PRACTICALS
1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square

SUGGESTED READING
1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield™ Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

Contact person –Dr. Dr H.K. Sarma (hridip@gauhati.ac.in), Dr S.S. Swargiary (swargiary.ss77@gauhati.ac.in)

Important Notes:

1. **Faculty Numbers and Specialization requirements**: For Teaching in B.Sc. (Major/ Regular) in Biotechnology (**5 compulsory permanent posts** + 1 additional Guest Faculty post as per requirement of the semester)

Post no.	Specialization		Post no.	Specialization
1	Biochemistry & Physiology		4	Bioinformatics & Bioinstrumentation or Biostatistics
2	Molecular Biology & Genetic Engineering		5	Industrial Biotechnology or Plant Biotechnology
3	Microbiology and Immunology			

2. For each core paper, the distribution of marks will be as follow-
   Theory : 60 marks (50 final exams + 10 internal assessment)
   Practical : 40 mark

   Internal assessment marks should be assessed as follows:

1 (one) Mid Term Examination, Theory papers : 5 marks
1 (one) Seminar presentation per theory papers : 3 marks
1 (one) Assignment (in group/ individually) : 2 marks

3. Practicals will be assessed in the presence of external evaluator (Faculty) from the parent Department of the Affiliating University)
4. Dissertation projects can be done either individually or in groups but has to be done in house.

CHOICE BASED CREDIT SYSTEM

Syllabus

For
B.Sc. BOTANY HONOURS

DEPARTMENT OF BOTANY
GAUHATI UNIVERSITY
GUWAHATI-781014

Effective from Academic Session 2019-2020

Preamble

Today plant science is a fusion of the traditional components with the modern aspects of biochemistry, molecular biology and biotechnology. Over the years, plant science (Botany) has shown enormous gain in information and applications owing to tremendous inputs from research in all its aspects. With global recognition of the need for conservation, field plant biologists have contributed significantly in assessing plant diversity. Taxonomists have explored newer dimensions for the classification of plants. New insights have been gained in functional and structural aspects of plant development by utilizing novel tools and techniques for botanical research. Challenging areas of teaching and research have emerged in ecology and reproductive biology. Concern for ever increasing pollution and climate change is at its highest than ever before. Keeping these advancements in view, a revision of the curriculum at the undergraduate level is perfectly timed as sought by UGC from the beginning of 2019 session, the Botany students of Gauhati Universities shall have the benefit of a balanced, carefully-crafted course structure taking care of different aspects of plant science, namely plant diversity, physiology,genetics, biochemistry, molecular biology, reproduction, anatomy, taxonomy, ecology, economic botany and the impact of environment on the growth and development of plants. All these aspects have been given due weightage over the six semesters. Keeping the employment entrepreneurship in mind, applied courses have also been introduced. These courses shall provide the botany students hands on experience and professional inputs. On the whole, the curriculum is a source of lot of information and is supported by rich resource materials. It is hoped that a student graduating in Botany with the new curriculum will be a complete botanist at Honours level.

Students should opt for atleast 1 or 2 Generic Electives from other life sciences like Zoology/Microbiology/Biotechnology / Biochemistry and Chemistry. They should, however, opt atleast one generic elective from Chemistry Course besides life Sciences.

<u>Scheme for Choice Based Credit System in B. Sc. Botany Honours</u>

Semester		**CORE COURSE(14)**	**Ability Enhancement Compulsory Course(AEC)(2)**	**Skill Enhancement Course (SEC) (2)**	**Discipline Specific Elective (DSE) (4)**	**Generic Elective: (GE) (4)**
I	Core Course I	Phycology and Microbiology	English communication			GE-1
	Core Course II	Biomolecules and Cell Biology				
II	Core Course III	Mycology and Phytopathology	Environmental Studies			GE-2
	Core Course IV	Archegoniate				
III	Core Course V	Morphology and Anatomy of Angiosperm		SEC -1		GE-3
	Core Course VI	Economic Botany				
	Core Course VII	Genetics				
IV	Core Course VIII	Molecular Biology		SEC -2		GE-4
	Core Course IX	Plant Ecology and Phytogeography				
	Core Course X	Plant Systematics				
V	Core Course XI	Reproductive Biology of Angiosperms			DSE-1	
	Core Course XII	Plant Physiology			DSE-2	
VI	Core Course XIII	Plant Metabolism			DSE -3	
	Core Course XIV	Plant Biotechnology			DSE-4	

Course Structure for CBCS in B. Sc. Botany Hounours as per requirement of UGC

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	**Ability Enhancement Compulsory Course-I**	English communications	-
	BOT-HC-1016	Phycology and Microbiology	4
	BOT-HC-1016 (**Practical)**	Phycology and Microbiology	2
	BOT-HC-1026	Biomolecules and Cell Biology	4
	BOT-HC-1026 (**Practical)**	Biomolecules and Cell Biology-Practical	2
II	**Ability Enhancement Compulsory Course-II**	Environmental Studies	-
	BOT-HC-2016	Mycology and Phytopathology	4
	BOT-HC-2016 **(Practical)**	Mycology and Phytopathology-Practical	2
	BOT-HC-2026	Archegoniate	4
	BOT-HC-2026 **(Practical)**	Archegoniate- Practical	2
III	BOT-HC-3016	Morphology Anatomy and of Angiosperm	4
	BOT-HC-3016 (**Practical)**	Morphology Anatomy and of Angiosperm –Practical	2
	BOT-HC-3026	Economic Botany	4
	BOT-HC-3026 (**Practical)**	Economic Botany-Practical	2
	BOT-HC-3036	Genetics	4
	BOT-HC-3036 (**Practical)**	Genetics- Practical	2
	1. BOT-SE-3014 2. BOT-SE-3024	SEC-1 (any one) 1. Biofertilizers 2. Herbal Technology	4

IV	BOT-HC-4016	Molecular Biology	4
	BOT-HC-4016 (**Practical)**	Molecular Biology- Practical	2
	BOT-HC-4026	Plant Ecology and Phytogeography	4
	BOT-HC-4026 (**Practical)**	Plant Ecology and Phytogeography – practical	2
	BOT-HC-4036	Plant Systematics	4
	BOT-HC-4036 (**Practical)**	Plant Systematics Practical	2
	1. BOT-SE-4014 2. BOT-SE-4024 3. BOT-SE-4034	SEC-II (any one) 1. Nursery and Gardening 2. Floriculture 3. Intellectual Property Rights	4
V	BOT-HC-5016	Reproductive Biology of Angiosperms	4
	BOT-HC-5016 (**Practical)**	Reproductive Biology of Angiosperm - Practical	2
	BOT-HC-5026	Plant Physiology	4
	BOT-HC-5026 (**Practical)**	Plant Physiology- Practical	2
	BOT-HE-5016	DSE-1 Natural Resource Management	4
	BOT-HE-5016 (**Practical)**	DSE-1 Practical Natural Resource Management – Practical	2
	BOT-HE-5026	DSE-2 Horticultural Practices and Post-Harvest Technology	4
	BOT-HE-5026 **(Practical/Tutorial)**	DSE-2 Practical Horticultural Practices and Post-Harvest Technology-Practical	2

VI	BOT-HC-6016	Plant Metabolism	4	
	BOT-HC-6016 (**Practical / Tutorial)**	Plant Metabolism- Practical	2	
	BOT-HC-6026	Plant Biotechnology	4	
	BOT-HC-6026 (**Practical /Tutorial)**	Plant Biotechnology- Practical	2	
	BOT-HE-6016	DSE-3 Industrial and Environment Ecology	4	
	BOT-HE-6016 (**Practical)**	DSE-3 Industrial and Environment Ecology-Practical	2	
	Discipline Centric Elective-4 (Theory & practical / Project Work)	Either of 1 or 2 below		
	BOT-HE-6026	DSE-4 1.Analytical Techniques in Plant Sciences	4	6
	BOT-HE-6026 (**Practical)**	DSE-4 1.Analytical Techniques in Plant Sciences-Practical	2	
	BOT-HE-6036	DSE-4 2. Project Work/ Dissertation	6	
Total Credits in B. Sc. Botany Honours: 116				

List of Papers
B. Sc Honours Botany Under CBCS

Core Papers

1	BOT-HC-1016	: Phycology and Microbiology
2	BOT-HC-1026	: Biomolecules and Cell Biology
3	BOT-HC-2016	: Mycology and Phytopathology
4	BOT-HC-2026	: Archegoniate
5	BOT-HC-3016	: Morphology and Anatomy of Angiosperm
6	BOT-HC-3026	: Economic Botany
7	BOT-HC-3036	: Genetics
8	BOT-HC-4016	: Molecular Biology
9	BOT-HC-4026	: Plant Ecology and Phytogeography
10	BOT-HC-4036	: Plant Systematics
11	BOT-HC-5016	: Reproductive Biology of Angiosperms
12	BOT-HC-5026	: Plant Physiology
13	BOT-HC-6016	: Plant Metabolism
14	BOT-HC-6026	: Plant Biotechnology

Discipline Specific Elective (DSE) Papers

1	BOT-HE-5016	: Natural Resource Management
2	BOT-HE-5026	: Horticultural Practices and Post-Harvest Technology
3	BOT-HE-6016	: Industrial and Environmental Microbiology
4	BOT-HE-6026	: Analytical Techniques in Plant Sciences
5	BOT-HE-6036	: Project work/Dissertation

Generic Elective (GE)

1	BOT-HG-1016	: Biodiversity (Microbes, Algae, Fungi and Archegoniate)
2	BOT-HG-2016	: Plant Ecology and Taxonomy
3	BOT-HG-3016	: Plant Physiology and Metabolism
4	BOT-HG-3026	: Environmental Biotechnology
5	BOT-HG-4016	: Plant Anatomy and Embryology
6	BOT-HG-4026	: Economic Botany and Plant Biotechnology

Ability Enhancement Course Compulsory

1	: English/MIL communication
2	: Environmental Studies

Skill Enhancement Paper

1	BOT-SE-3014	: Biofertilizers (SEC-I)
2	BOT-SE-3024	: Herbal Technology (SEC-I)
3	BOT-SE-4014	: Nursery and Gardening (SEC-II)
4	BOT-SE-4024	: Floriculture (SEC-II)
5	BOT-SE-4034	: Intellectual Property Rights (SEC-II)

Core Courses

Semester-I

1

BOT-HC-1016
Phycology and Microbiology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

1.1 THEORY

Unit 1 : *Introduction to microbial world* **(10 lectures)**

Scope of microbes in industry and environment; Microbial nutrition, growth and metabolism [Only an overview of microbial metabolism- the concept of anabolism (Biosynthesis) and catabolism (ATP-generating Pathways-Respiration and Fermentation)].

Unit 2 : *Viruses* **(7 lectures)**

Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases.

Unit 3 : *Bacteria* **(7 lectures)**

Discovery, general characteristics; Types-archaebacteria, eubacteria, actinomycetes, mycoplasma, rickettsia, chlamydiae and sphaeroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria with reference to their role in agriculture and industry (Alcohol and Antibiotic production).

Unit 4 : *Algae* **(10 lectures)**

General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; methods of reproduction; Classification; Evolutionary significance of *Prochloron*; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Role of algae in the environment, agriculture, biotechnology and industry, Economic importance of Diatoms.

Unit 5 : *Cyanophyta and Xanthophyta* **(8 lectures)**

Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of *Nostoc* and *Vaucheria*.

Unit 6 : *Chlorophyta, Charophyta and Bacillariophyta* **(10 lectures)**

General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Volvox*, *Oedogonium*, *Coleochaete*, *Chara*. General Account of Bacillariophyta.

Unit 7 : *Phaeophyta and Rhodophyta* **(8 lectures)**

Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus*, *Fucus* and *Polysiphonia*.

1.2 PRACTICAL

Microbiology

1. Electron micrographs/Models of viruses – T-Phage and TMV/ Line drawings/ Photographs of Lytic and Lysogenic Cycle.

2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule.

3. Gram staining.

4. Isolation of soil microflora.

5. Endospore staining with malachite green using the (endospores taken from soil bacteria).

Phycology

1. Study of vegetative and reproductive structures of *Nostoc*, *Volvox*, *Oedogonium*, *Chara*, *Vaucheria*, *Ectocarpus*, *Fucus* and *Polysiphonia*,*Procholoron* through electron micrographs, permanent slides.

Suggested Readings

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
6. Pelczar, M.J. (2001). Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
7. Sharma, P.D. (2009). Microbiology, latest edition, Rastogi Publication, Meerut.

2

BOT-HC-1026
Biomolecules and Cell Biology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

2.1 THEORY

Unit 1 : *Biomolecules* **(20 lectures)**

Types and significance of chemical bonds; Structure and properties of water; pH and buffers.

Carbohydrates : Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.

Lipids : Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.

Proteins : Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins.

Nucleic acids : Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, C, D, Z types of DNA; Types of RNA.

Unit 2 : *Bioenergenetics* **(4 lectures)**

Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule.

Unit 3 : *Enzymes* **(6 lectures)**

Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theroy), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.

Unit 4 : ***The cell*** **(4 lectures)**

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

Unit 5 : ***Cell wall and plasma membrane*** **(4 lectures)**

Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.

Unit 6 : ***Cell organelles*** **(16 lectures)**

Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.

Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.

Endomembrane system: Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes

Unit 7 : ***Cell division*** **(6 lectures)**

Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, role of protein kinases.

2.2 PRACTICAL

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo/Crinum*.
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* and *Vallisnaria* leaf.
4. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
5. Cytochemical staining of : DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
6. Study the phenomenon of plasmolysis and deplasmolysis.
7. Study different stages of mitosis and meiosis (Demostration).

Suggested Readings

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco

Semester-II

3

BOT-HC-2016
Mycology and Phytopathology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

3.1 THEORY

Unit 1 : *Introduction to Fungi* **(10 lectures)**

General characteristics; Status of Fungi in living system; Thallus organization, modification of hyphae; Cell and Cell wall composition; Nutrition, flagella, septum, homothallism and heterothallism, cell division.

History of Classification (Hidetta *et al.* 2007); Classification of Fungi (Ainsworth, 1973, Webster 1977) up to sub-division with diagnostic characters and examples.

General characteristics of Myxomycota, Oomycota, Zygomycota, Ascomycota, Basidiomycota and Deuteromycota.

Unit 2 : *Mastigomycotina (Chytridiomycetes and Oomycetes)* **(6 lecture)**

Characteristic features; Reproduction; Life cycle with reference to *Synchytrium, Phytophthora* and *Albugo.*

Unit 3 : *Zygomycotina* **(2 lecture)**

Characteristic features; Reproduction; Life cycle with reference to Rhizophus.

Unit 4 : *Ascomycotina* **(10 lectures)**

General characteristics (asexual and sexual fruiting bodies); Life cycle, Heterokaryosis and parasexuality; Life cycle and classification with reference to *Saccharomyces*, *Aspergillus*, *Penicillium, Neurospora* and *Peziza.*

Unit 5 : *Basidiomycotina* **(8 lectures)**

General characteristics; Life cycle and Classification with reference to black stem rust on wheat *Puccinia* (Physiological Specialization), loose and covered smut (symptoms only), *Agaricus*; Bioluminescence, Fairy Rings and Mushroom Cultivation.

Unit 6 : *Deuteromycotina (Fungi Imperfecti)* **(3 lectures)**

General characteristics; Thallus organization; Reproduction; Classification with special reference to *Alternaria* and *Colletotrichum.*

Unit 7 : *Allied Fungi- Myxomycota* **(3 lectures)**

General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.

Unit 8 : *Symbiotic associations* **(3 lectures)**

Lichen – Occurrence; General characteristics; Range of thallus organization; Internal structure and nature of associations of algal and fungal partners; Reproduction.

Mycorrhiza- Ectomycorrhiza, Endomycorrhiza and their significance.

Unit 9 : *Applied Mycology* **(5 Lectures)**

Role of fungi in biotechnology; food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Pharmaceutical (Secondary metabolites); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.

Unit 10 : *Phytopathology* **(10 lectures)**

Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine.

Bacterial diseases – Citrus canker and angular leaf spot of cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.

3.2 PRACTICAL

1. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
2. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of

Sexual stage from permanent slides/photographs.

3. *Peziza*: sectioning through ascocarp.
4. *Alternaria:* Specimens/photographs and temporary mounts.
5. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
6. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
7. Study of phaneroplasmodium from actual specimens and /or photograph.Study of *Stemonitis* sporangia.
8. *Albugo:* Study of symptoms of plants infected with *Albugo*; asexual phase study through section/ temporary mounts and sexual structures through permanent slides.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
10. Phytopathology: Bottle specimens, Herbarium specimens should be made of bacterial diseases, Viral diseases, Fungal diseases (Locally available).
11. Applied mycology: Photographs of Mycorrhizae, Fungi used in medicine (Cylindriocarpon, Tolyposporium, Ganoderma, Cephalosporium – any one), fungi used as biological control agents (fungi used in control of seedling, soil borne, post-harvest diseases and in control of nematodes, insects and weeds – any one), photographs/mounts of spores of fungi causing human infections (Aspergillus, Candida, Cryptococcus, Histoplasma, Microsporum, Trichophyton – any one).

Suggested Readings

1. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.
6. College Botany, Vol. II. – Gangulee and Kar, New Central Book Agency, Kolkata.
7. Studies in Botany, Vol. I. – Mitra, Mitra, Choudhury. Moulik Library, Kolkata.
8. Text Book of Botany, Vol. I & II. – Hait, Ghosh and Bhattacharya, New Central Book Agency, Kolkata.

4

BOT-HC-2026
Archegoniate

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

4.1 THEORY

Unit 1: *Introduction* **(4 lectures)**

Unifying features of archegoniates; Transition to land habit; Alternation of generations.

Unit 2: *Bryophytes* **(6 lectures)**

General characteristics; Adaptations to land habit; Classification; Range of thallus organization.

Unit 3: *Type Studies- Bryophytes* **(12 lectures)**

Classification, morphology, anatomy and reproduction of *Riccia, Marchantia, Anthoceros*, *Sphagnum* and *Polytrichum*; Reproduction and evolutionary trends in *Riccia*, *Marchantia*, *Anthoceros, Sphagnum* and *Polytrichum.* Ecological and economic importance of bryophytes.

Unit 4: *Pteridophytes* **(6 lectures)**

General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*).

Unit 5: *Type Studies- Pteridophytes* **(14 lectures)**

Classification, morphology, anatomy and reproduction of *Psilotum, Lycopodium, Selaginella*, *Equisetum, Pteris* and *Marsilea*. Apogamy and apospory, heterospory and seed habit, telome theory, stelar evolution; Ecological and economic importance.

Unit 6: *Gymnosperms* **(18 lectures)**

General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus, Ginkgo* and *Gnetum*; Ecological and economic importance.

4.2 PRACTICAL

1. **Riccia** – Morphology of thallus.
2. **Marchantia**- Morphology of thallus and reproductive parts; vertical and transverse section of thallus; vertical section of Gemma cup, Antheridiophore and Archegoniophore.Sphagnum- Morphology of plant, whole mount of leaf.
3. **Sphagnm**- Morphology of plant; whole mount of leaf.
4. **Polytrichum**- Morphology of vegetative and reproductive parts; Transverse Section of rhizome, whole mount of leaf; Longitudinal Section through antheridial and archegonial heads; L.S. of capsule.
5. **Lycopodium**- Morphology of plant, whole mount of leaf; transverse section of stem; Longitudinal Section of strobilus; morphology of sporophyll.
6. **Selaginella**- Morphology of plant, whole mount of leaf with ligule, transverse section of stem and rhizophore; longitudinal section of strobilus; morphology of sporophyll.
7. **Equisetum**- Morphology of plant, transverse section of internode, longitudinal and transverse section of strobilus, whole mount of sporangiophore and spore.
8. **Pteris**- Morphology of plant, transverse section of rachis, vertical section of leaflets through sorus; whole mount of prothallus with sex (permanent slide).
9. **Marsilea**- Morphology of plant, transverse section of rhizome and petiole; vertical transverse and vertical longitudinal section of sporocarp.
10. **Cycas**- Morphology of plant; morphology and transverse section of coralloid roots; transverse section of leaflets; Longitudinal Section of male and female cone; morphology of microsporophyll and megasporophyll; Longitudinal section of ovule (permanent slide).
11. **Pinus**- Morphology of plant; transverse section of Needle; longitudinal section of male cone and female cone; whole mount of Microspores.
12. **Ginkgo**- Morphology of plants and reproductive structures (only photographs).
13. **Gnetum**- Morphology of plant; Morphology of male and female strobilus; vertical section of ovule (permanent slide).

Suggested Readings

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.
6. Vashistha, B. R., Sinha, A.K. and Kumar, A. (Latest edition). Botany for Degree Students: Bryophyta. S. Chand Publishing 7361, Ram Nagar, Qutab Road, New Delhi-110055.
7. Vashistha, B. R., Sinha, A.K. and Kumar, A. (Latest edition). Botany for Degree Students: Gymnosperm. S. Chand Publishing 7361, Ram Nagar, Qutab Road, New Delhi-110055.
8. Vashistha, B. R., Sinha, A.K. and Kumar, A. (Latest edition). Botany for Degree Students: Pteridophytes. S. Chand Publishing 7361, Ram Nagar, Qutab Road, New Delhi-110055.

Semester-III

5

BOT-HC-3016
Morphology and Anatomy of Angiosperms

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

5.1 THEORY

Unit 1: *Morphology* **(4 Lectures)**

Morphology of inflorescence, stamens and carpel, fruit; Telome theory, phyllode theory; Role of morphology in plant classification.

Unit 2: *Introduction and scope of plant Anatomy* **(4 Lectures)**

Application in systematics, forensics and pharmacognosy.

Unit 3: *Structure and Development of Plant Body* **(6 Lectures)**

Internal organization of plant body: The three tissue systems, types of cells and tissues. Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development.

Unit 4: *Tissues* **(11 Lectures)**

Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.

Unit 5: ***Apical meristems*** **(14 Lectures)**

Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

Unit 6: ***Vascular Cambium and Wood*** **(14 Lectures)**

Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.

Unit 7: ***Adaptive and Protective Systems*** **(7 Lectures)**

Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.

5.2 PRACTICAL

1. Study of special types of inflorescence – Cyathium, Hypanthodium, Verticillaster, Hypanthium.
2. Study of special types of fruits- Superior fruits (*Dillenia*); Aggregate fruits (Custard apple, *Michelia*, Periwinkles, *Polyalthia*); Multiple fruits (Pine apple, Jack fruits).
3. Study of anatomical details through permanent slides/temporary stain mounts / macerations / museum specimens with the help of suitable examples.
4. Apical meristem of root, shoot and vascular cambium.
5. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
6. Root: monocot, dicot, secondary growth.
7. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
8. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
9. Adaptive Anatomy: xerophytes, hydrophytes.
10. Secretory tissues: cavities, lithocysts and laticifers.

Suggested Readings

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. Evert, R.F. (2006) Esau’s Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.

6

BOT-HC-3026
Economic Botany

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

6.1 THEORY

Unit 1: ***Origin of Cultivated Plants*** **(6 lectures)**

Centres of Origin, their importance with reference to Vavilov's work. Introductions, domestication and loss of crop genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Unit 2: ***Cereals*** **(6 lectures)**

Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.

Unit 3: ***Legumes*** **(6 lectures)**

Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.

Unit 4: ***Sources of sugars and starches*** **(4 lectures)**

Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.

Unit 5: ***Spices*** **(6 lectures)**

Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper.

Unit 6: ***Beverages*** **(4 lectures)**

Tea, Coffee (morphology, processing & uses).

Unit 7: ***Sources of oils and fats*** **(10 lectures)**

General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.

Unit 8: ***Natural Rubber*** **(3 lectures)**

Para-rubber: tapping, processing and uses.

Unit 9: ***Drug-yielding plants*** **(8 lectures)**

Therapeutic and habit-forming drugs with special reference to C*inchona, Digitalis, Papaver* and *Cannabis*; Tobacco (Morphology, processing, uses and health hazards).

Unit 10: ***Timber plants*** **(3 Lectures)**

General account with special reference to teak and pine.

Unit 11: ***Fibers*** **(4 lectures)**

Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).

6.2 PRACTICAL

1. **Cereals**: Study of useful parts: Rice/Bean (habit sketch, study of paddy and grain, starch grain, micro-chemical test).
2. **Legumes**: Bean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. **Beverages**: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
4. **Sources of oils and fats**: Coconut and Mustard.
5. **Rubber**:Specimen, photograph/model of tapping, samples of rubber products.
6. **Test for alkaloids:** Neem, *Vinca rosea*.
7. **Fiber-yielding plants**: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin).

Suggested Readings

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.

7

BOT-HC-3036
Genetics

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

7.1 THEORY

Unit 1: ***Mendelian genetics and its extension*** **(16 lectures)**

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.

Unit 2: ***Extrachromosomal Inheritance*** **(7 lectures)**

Chloroplast inheritance: Variegation in Four o'clock plant; Mitochondrial inheritance in yeast; Maternal effects-shell coiling in snail; Kappa particles in *Paramecium*.

Unit 3: ***Linkage, crossing over and chromosome mapping*** **(12 lectures)**

Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.

Unit 4: ***Variation in chromosome number and structure*** **(8 lectures)**

Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy

Unit 5: ***Gene mutations*** **(7 lectures)**

Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method. Role of Transposons in mutation. DNA repair mechanisms.

Unit 6: ***Fine structure of gene*** **(4 lectures)**

Classical vs molecular concepts of gene; Ciston, Racon, Muton, rII locus

Unit 7. ***Population and Evolutionary Genetics*** **(6 lectures)**

Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

7.2 PRACTICAL

1. Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios.
3. Chromosome mapping using point test cross data.
4. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
5. Permanent Slides showing Translocation Ring, Photograph showing Laggards and Inversion Bridge.

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

Semester-IV

8

BOT-HC-4016
Molecular Biology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

8.1 THEORY

Unit 1: ***Nucleic acids : Carriers of genetic information*** **(4 lectures)**

Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.

Unit 2: ***The Structures of DNA and RNA / Genetic Material*** **(10 lectures)**

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, denaturation and renaturation, cot curves; Organization of DNA-Prokaryotes, Viruses, Eukaryotes. Organelle DNA -- mitochondria and chloroplast DNA. The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Unit 3: ***The replication of DNA*** **(10 lectures)**

Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA; Enzymes involved in DNA replication.

Unit 4: ***Central dogma and genetic code*** **(2 lectures)**

Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features)

Unit 5: ***Transcription*** **(18 lectures)**

Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli*. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.

Unit 6: ***Processing and modification of RNA*** **(8 lectures)**

Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing(5' cap, 3' poly A tail); Ribozymes; RNA editing and mRNA transport.

Unit 7: ***Translation*** **(8 lectures)**

Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.

8.2 PRACTICAL

1. DNA isolation from any plant material.
2. DNA estimation by diphenylamine reagent/UV Spectrophotometry (Demostration).
3. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
4. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
5. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Suggested Readings

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc.,

   U.S.A. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

9

BOT-HC-4026
Plant Ecology and Phytogeography

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

9.1 THEORY

Unit 1 : *Introduction* **(4 lectures)**

Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.

Unit 2 : *Soil* **(8 lectures)**

Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.

Unit 3 : *Water* **(4 lectures)**

Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.

Unit 4 : *Adoptation of plants to various environmental factors* **(6 lectures)**

Light, temperature, wind and fire

Unit 5 : *Biotic interactions* **(2 lectures)**

Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.

Unit 6 : *Population ecology* **(4 lectures)**

Population characteristics, Growth curve, population regulation, r and k selection. Ecological speciation: Allopatric/ Sympatric and Parapatric speciation.

Unit 7 : *Plant communities* **(8 lectures)**

Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

Unit 8 : *Ecosystems* **(4 lectures)**

Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.

Unit 9 : *Functional aspects of ecosystem* **(8 lectures)**

Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

Unit 10 : *Phytogeography* **(12 lectures)**

Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Vegetation types of NE India with special reference to Assam.

9.2 PRACTICAL

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH of various soil and water samples using pH meter.
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
6. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each).

(b). Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).

7. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
8. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
9. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
10. Field visit to familiarise students with ecology of different sites.

Suggested Readings

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.
6. Smith and Smith(2012): Elements of Ecology. Pearson Publisher (Sixth edition).
7. Bhattacharya, K., Ghosh, A.K. and Hait, G. (2017). A text Book of Botany (Ecology, Environmental Biology, Economic Botany and Pharmacognosy). New Central Book Agency (P) Ltd.
8. Ambasht and Ambasht (2002): A text book of Plant Ecology. CBS publisher and Distributors.
9. Agarwal, A.K. and Deo, P.P. (2006). Plant Ecology. Agrobios (India)
10. William D Bowmen, Sally D Hacker and Michael L. Cain (2018) Ecology, Oxford University Press
11. Verma, P.S. and Agarwal V. K.(2003) Environmental Biology-Principles of Ecology. S Chand & Company Ltd, Ramnagar, New Delhi-110055.

10

BOT-HC-4036
Plant Systematics

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

10.1 THEORY

Unit 1 : ***Significance of Plant systematics*** **(8 lectures)**

Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Functions and importance of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Concept of taxa (family, genus, species); Categories and taxonomic hierarchy.

Unit 2 : ***Botanical nomenclature*** **(10 lectures)**

Principles and rules (ICN); Ranks and names; Typification, author citation, Effective and valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

Unit 3 : ***Systems of classification*** **(12 lectures)**

Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG) classification.

Unit 4 : ***Numerical taxonomy and cladistics*** **(10 lectures)**

Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).

Unit 5 : *Phylogeny of Angiosperms* **(12 lectures)**

Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

Unit 6 : *Angiospermic Families* **(8 lectures)**

Detail study of the following families:
Magnoliaceae, Fabaceae, Asteraceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Musaceae, Zingiberaceae, Poaceae.

10.2 PRACTICAL

1. Study of vegetative and floral characters of locally available angiospermic plants belonging to the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Fabaceae, Solanaceae, Acanthaceea, Lamiaceae, Euphorbiaceae, Musaceae, Orchidaceae.

2. Field visit to familiarise students with vegetation of an area and identification of plant species / Visit to Academic or Research Institutions.

3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Suggested Readings

1. Singh, (2012). *Plant Systematics:* Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
2. Jeffrey, C. (1982). An Introduction to *Plant Taxonomy.* Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). *Flora* of Delhi. CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of *Plant Systematics*. Harper and Row, New York.
6. Pandey, B.P. (2018). A Textbook of Botany: Angiosperm. S. Chand Publishing, 7361, Ram Nagar, Qutab Road, New Delhi-110055.

Semester-V

11

BOT-HC-5016
Reproductive Biology of Angiosperms

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

11.1 THEORY

Unit 1 : *Introduction* **(4 lectures)**

History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope.

Unit 2 : *Reproductive development* **(6 lectures)**

Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.

Unit 3 : *Anther and pollen biology* **(10 lectures)**

Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

Unit 4 : *Ovule* **(10 lectures)**

Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac.

Unit 4 : ***Pollination and fertilization*** **(6 lectures)**

Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.

Unit 5 : ***Self incompatibility*** **(10 lectures)**

Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and *in vitro* pollination; Modification of stigma surface, parasexual hybridization; Cybrids, *in vitro* fertilization.

Unit 6 : ***Embryo, Endosperm and Seed*** **(8 lectures)**

Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed structure, importance and dispersal mechanisms

Units 7 : ***Polyembryony and apomixis*** **(6 lectures)**

Introduction; Classification; Causes and applications.

11.2 PRACTICAL

1. ***Anther*****:** Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.

3. ***Pollen grains:*** Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazolium test.germination: Calculation of percentage germination in different media using hanging drop method.

4. ***Ovule:*** Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).

5. ***Female gametophyte through permanent slides/ photographs:*** Types, ultrastructure of mature egg apparatus.

6. Intra-ovarian pollination; Test tube pollination through photographs.

7. ***Endosperm:*** Dissections of developing seeds for endosperm with free-nuclear haustoria.

8. ***Embryogenesis:*** Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages.

Suggested Readings

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.
5. Bhattacharya, Majimdar and Bhattacharya. (2012). A Textbook of Palynology: Basic and Applied. New Central Book Agency (P) Ltd. Guwahati.

12

BOT-HC-5026
Plant Physiology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

12.1 THEORY

Unit 1 : *Plant-water relations* **(10 lectures)**

Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap– cohesion-tension theory.Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement. Plant response to water stress.

Unit 2 : *Mineral nutrition* **(8 lectures)**

Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents, Ion antagonism and toxicity.

Unit 3 : *Nutrient Uptake* **(8 lectures)**

Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.

Unit 4 : *Translocation in the phloem* **(8 lectures)**

Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

Unit 5 : *Plant growth regulators* **(14 lectures)**

Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.

Unit 6 : *Physiology of flowering* **(6 lectures)**

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.

Unit 7 : *Phytochrome, crytochromes and phototropins* **(6 lectures)**
Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

12.2 PRACTICAL

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of light on the rate of transpiration in excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To study the effect of different concentrations of IAA on Gram/Pea/Moong root (IAA Bioassay).
6. To study the induction of amylase activity in germinating Maize/Bean grains.
7. Effect of carbon dioxide concentration on the rate of photosynthesis.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

Semester-VI

13

BOT-HC-6016
Plant Metabolism

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

13.1 THEORY

Unit 1 : *Concept of metabolism* **(8 lectures)**
Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes; classification, nomenclature and importance of enzyme; concept of coenzyme, apoenzyme and prosthetic group; enzyme inhibition (allosteric, covalent modulation and Isozymes).

Unit 2 : *Carbon assimilation* **(12 lectures)**
Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C_4-pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction.

Unit 3 : *Carbohydrate metabolism* **(2 lectures)**
Synthesis and catabolism of sucrose and starch.

Unit 4 : *Carbon Oxidation* **(10 lectures)**
Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

Unit 5 : *ATP-Synthesis* **(8 lectures)**
Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism

(oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.

Unit 6 : *Lipid metabolism* **(8 lectures)**

Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.

Unit 7: *Nitrogen metabolism* **(8 lectures)**

Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

Unit 8 : *Mechanisms of signal transduction* **(4 lectures)**

Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.

13.2 PRACTICAL

1. Chemical separation of photosynthetic pigments.
2. Estimation of sugar content by Somogyi method.
3. Determination of TAN in plant materials.
4. To compare the rate of respiration in different parts of a plant (Demonastration).
5. Estimation of protein in a sample by Biuret method.
6. Separation of amino acids by paper chromatography.
7. Demonstration of Thin layer chromatography (TLC).
8. Quantitative analysis of absorption spectrum of photosynthetic pigments.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

14

BOT-HC-6026
Plant Biotechnology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

14.1 THEORY

Unit 1 : *Plant Tissue Culture* **(16 lectures)**

Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Unit 2 : *Recombinant DNA technology* **(12 lectures)**

Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).

Unit 3 : *Gene Cloning* **(10 lectures)**

Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR

Unit 4 : ***Methods of gene transfer*** **(8 lectures)**

Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

Unit 5 : ***Applications of Biotechnology*** **(14 lectures)**

Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products– Human Growth Hormone; Humulin; Biosafety concerns.

14.2 PRACTICAL

1. (a) Preparation of MS medium.

   (b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Isolation of plasmid DNA.
8. Restriction digestion and gel electrophoresis of plasmid DNA.

Suggested Readings

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5^{th} edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5^{th} edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

Discipline Specific Elective

1

BOT-HE-5016
Natural Resource Management

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

1.1 THEORY

Unit 1 : ***Natural resources*** **(2 lectures)**
Definition and types.

Unit 2 : ***Sustainable utilization*** **(8 lectures)**
Concept, approaches (economic, ecological and socio-cultural).

Unit 3 : ***Land*** **(8 lectures)**
Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

Unit 4 : ***Water*** **(8 lectures)**
Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

Unit 5 : ***Biological Resources*** **(10 lectures)**

Biodiversity-definition and types; Significance; Threats; Management strategies; Bio-prospecting; IPR; CBD; National Biodiversity Action Plan).

Unit 6 : ***Forests*** **(6 lectures)**

Definition, Cover and its significance (with special reference to India); Major and minor forestproducts; Depletion; Management.

Unit 7 : ***Energy*** **(6 lectures)**

Renewable and non-renewable sources of energy.

Unit 8 : ***Contemporary practices in resource management*** **(8 lectures)**

EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

Unit 9 : ***National and international efforts in resource management and conservation*** **(4 lectures)**

1.2 PRACTICAL

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Collection of data on forest cover of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Uses of GPS and GIS (Mapping of an area).

Suggested Readings

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

2

BOT-HE-5026
Horticultural Practices and Post-Harvest Technology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

2.1 THEORY

Unit 1 : *Introduction* **(4 lectures)**
Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.

Unit 2 : *Ornamental plants* **(4 lectures)**
Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (opuntia, agave and spurges)] Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms, semul, coraltree).

Unit 3 : *Fruit and vegetable crops* **(4 lectures)**
Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits).

Unit 4 : *Horticultural techniques* **(8 lectures)**
Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.

Unit 5 : *Landscaping and garden design* **(6 lectures)**
Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.

Unit 6 : *Floriculture* **(6 lectures)**

Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.

Unit 7 : *Post-harvest technology* **(10 lectures)**

Importance of post harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; Methods of minimizing loses during storage and transportation; Food irradiation - advantages and disadvantages; food safety.

Unit 8 : *Disease control and management* **(8 lectures)**

Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological andchemical methods for pest control); Quarantine practices; Identification of common diseases andpests of ornamentals, fruits and vegetable crops.

Unit 9 : *Horticultural crops - conservation and management* **(10 lectures)**

Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.

Unit 10 : *Field trip*

Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at suitable locations.

Suggested Readings

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
5. Capon, B. (2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.

3

BOT-HE-6016
Industrial and Environmental Microbiology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

3.1 THEORY

Unit 1 : ***Scope of microbes in industry and environment*** **(6 lectures)**

Unit 2 : ***Bioreactors/Fermenters and fermentation processes*** **(12 lectures)**

Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratory, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.

Unit 3: Microbial production of industrial products **(12 lectures)**

Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase or lipase activity, Organic acid (citric acid or glutamic acid), alcohol (Ethanol) and antibiotic (Penicillin)

Unit 4: Microbial enzymes of industrial interest and enzyme immobilization **(8 lectures)**

Microorganisms for industrial applications and hands on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase**).**

Unit 5: Microbes and quality of environment. **(6 lectures)**

Distribution of microbes in air; Isolation of microorganisms from soil, air and water.

Unit 6: Microbial flora of water. **(8 lectures)**

Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.

Unit 7: Microbes in agriculture and remediation of contaminated soils. **(8 lectures)**

Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

3.2 PRACTICAL

1. Principles and functioning of instruments in microbiology laboratory
2. Hands on sterilization techniques and preparation of culture media.
3. Pure culture techniques.

Suggested Readings

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

4

BOT-HE-6026
Analytical Techniques in Plant Sciences

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

4.1 THEORY

Unit 1 : *Imaging and related techniques* **(15 lectures)**
Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2 : *Cell fractionation* **(8 lectures)**
Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, $CsCl_2$gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3 : *Radioisotopes* **(4 lectures)**
Use in biological research, auto-radiography, pulse chase experiment.

Unit 4 : *Spectrophotometry* **(4 lectures)**
Principle and its application in biological research.

Unit 5 : *Chromatography* **(8 lectures)**
Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 6 : *Characterization of proteins and nucleic acids* **(6 lectures)**
Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

Unit 7 : *Biostatistics* **(15 lectures)**
Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

4.2 PRACTICAL

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate sugars by thin layer chromatography.
4. Isolation of chloroplasts by differential centrifugation.
5. To separate chloroplast pigments by column chromatography.
6. To estimate protein concentration through Lowry's methods.
7. To separate proteins using PAGE.
8. To separation DNA (marker) using AGE.
9. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).

Suggested Readings

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

5

BOT-HE-6036
Project Work/Dissertation

Credits : 6

Generic Elective Courses

1

BOT-HG-1016
Biodiversity (Microbes, Algae, Fungi and Archegoniate)

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

1.1 THEORY

Unit 1 : *Microbes* **(10 lectures)**

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2 : *Algae* **(12 lectures)**

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia*. Economic importance of algae.

Unit 3 : *Fungi* **(12 lectures)**

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium,Alternaria* (Ascomycota), *Puccinia, Agaricus* (Basidiomycota); Symbiotic Associations-Lichens:

General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

Unit 4 : Introduction to Archegoniate (**2 lectures)**

Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Unit 5 : ***Bryophytes*** **(10 lectures)**

General characteristics, adaptations to land habit, Classification, Range of thallus organization.Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*.(Developmental details not to be included).Ecology and economic importance ofbryophytes with special mention of *Sphagnum*.

Unit 6 : ***Pteridophytes*** **(8 lectures)**

General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*.(Developmental details not to be included).Heterospory and seed habit, stelar evolution.Ecological and economical importance of Pteridophytes.

Unit 7: Gymnosperms (6 lectures)

General characteristics; Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included). Ecological and economical importance.

1.2 PRACTICAL

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium, Vaucheria, Fucus* and Polysiphonia* through temporary preparations and permanent slides.
5. ***Rhizopus and Penicillium*****:** Asexual stage from temporary mounts and sexual structures through permanent slides.
6. ***Puccinia***: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
7. ***Agaricus***: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
8. **Lichens**: Study of growth forms of lichens (crustose, foliose and fruticose)
9. **Mycorrhiza**: ecto mycorrhiza and endo mycorrhiza (Photographs)
10. ***Marchantia***- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).

11. ***Funaria***- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
12. ***Selaginella***- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
13. ***Equisetum***- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
14. ***Pteris***- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
15. **Cycas**- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
16. ***Pinus***- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, , l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

2

BOT-HG-2016
Plant Ecology and Taxonomy

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

2.1 THEORY

Unit 1 : *Introduction* **(2 lectures)**

Unit 2 : *Ecological factors* **(10 lectures)**

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes

Unit 3 : *Plant communities* **(6 lectures)**

Characters; Ecotone and edge effect; Succession; Processes and types

Unit 4 : *Ecosystem* **(8 lectures)**

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous

Unit 5 : *Phytogeography* **(4 Lectures)**

Principle biogeographical zones; Endemism.

Unit 6 : *Introduction to plant taxonomy* **(2 Lectures)**

Identification, Classification, Nomenclature.

Unit : 7 *Identification* **(4 Lectures)**

Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

Unit : 8 *Taxonomic evidences from palynology, cytology, phytochemistry and molecular data*.

(6 lectures)

Unit 9 : Taxonomic hierarchy **(2 lectures)**

Ranks, categories and taxonomic groups

Unit 10 : Botanical nomenclature **(6 lectures)**

Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 11 : Classification **(6 lectures)**

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

Unit 12 : Biometrics, numerical taxonomy and cladistics **(4 lectures)**

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

2.1 PRACTICAL

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Study of morphological adaptations of hydrophytes and xerophytes (four each).
3. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
4. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
5. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):Brassicaceae , Solanaceae, Lamiaceae.
6. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Suggested Readings

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
3. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

3

BOT-HG--3016
Plant Physiology and Metabolism

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

3.1 THEORY

Unit 1 : *Plant-water relations* **(8 lectures)**
Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Unit 2 : *Mineral nutrition* **(8 lectures)**
Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit 3 : *Translocation in phloem* **(6 lectures)**
Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading

Unit 4 : *Photosynthesis* **(12 lectures)**
Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C_3, C_4 and CAM pathways of carbon fixation; Photorespiration.

Unit 5 : *Respiration* **(6 lectures)**
Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 6 : *Enzymes* **(4 lectures)**
Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Unit 7 : *Nitrogen metabolism* **(4 lectures)**
Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit 8 : *Plant growth regulators* **(6 lectures)**
Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

Unit 9 : *Plant response to light and temperature* **(6 lectures)**
Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

3.2 PRACTICAL

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of light on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency.
4. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
5. To study the effect of bicarbonate concentration on O_2 evolution in photosynthesis.

Demonstration experiments

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

Suggested Readings

1. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.

3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

4

BOT-HG-3026
Environmental Biotechnology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

4.1 THEORY

Unit 1 : ***Environment*** **(4 lectures)**

Basic concepts and issues, global environmental problems - ozone depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities, their impact and biotechnological approaches for management.

Unit 2 : ***Environmental problems*** **(6 lectures)**

Environmental pollution - types of pollution, sources of pollution, measurement of pollution, methods of measurement of pollution, fate of pollutants in the environment, Bioconcentration, bio/geomagnification.

Unit 3 : ***Microbiology of waste water treatment*** **(8 lectures)**

Aerobic process - activated sludge, oxidation ponds, trickling filter, towers, rotating discs, rotating drums, oxidation ditch. Anaerobic process - anaerobic digestion, anaerobic filters, up-flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar and antibiotic industries.

Unit 4 : ***Xenobiotic compounds*** **(10 lectures)**

Organic (chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants) and inorganic (metals, radionuclides, phosphates, nitrates). Bioremediation of xenobiotics in environment - ecological consideration, decay behavior and degradative plasmids, molecular techniques in bioremediation.

Unit 5 : ***Role of immobilized cells/enzymes in treatment of toxic compounds*** **(6 lectures)**

Biopesticides, bioreactors, bioleaching, biomining, biosensors, biotechniques for air pollution abatement and odour control.

Unit 6 : ***Sustainable Development*** **(8 lectures)**

Economics and Environment: Economic growth, Gross National Productivity and the quality of life, Tragedy of Commons, Economics of Pollution control, Cost-benefit and cost effectiveness analysis, WTO and Environment, Corporate Social Responsibility, Environmental awareness and Education; Environmental Ethics.

Unit 7 : ***International Legislations, Policies for Environmental Protection*** **(6 lectures)**

Stockholm Conference (1972) and its declaration, WCED (1983) and Brundtland Report (1987), Rio Earth Summit-UNCED (1992) and its declaration, Montreal Protocol - 1987, Basel Convention (1989), Kyoto Protocol- 1997, Ramsar Convention 1971.

Unit 8 : ***National Legislations, Policies for Pollution Management*** **(6 lectures)**

Salient features of Wild life protection act 1972, Water Pollution (Prevention and Control) Act-1974, Forest conservation act 1980, Air Pollution (Prevention and Control) Act-1981, National Environmental Policy -2006, Central and State Pollution Control Boards: Constitution and power.

Unit 9 : ***Public Participation for Environmental Protection*** **(6 lectures)**

Environmental movement and people’s participation with special references to Gandhamardan, Chilika and Narmada Bachao Andolan, Chipko and Silent valley Movement; Women and Environmental Protection, Role of NGO in bringing environmental awareness and education in the society.

4.2 PRACTICAL

1. Water/Soil analysis - DO, salinity, pH, chloride, total hardness, alkalinity, acidity, nitrate, calcium, Magnesium and phosphorus.
2. Gravimetric analysis-Total solid, dissolved solid, suspended solid in an effluent
3. Microbial assessment of air (open plate and air sample) and water

Suggested Readings

1. Waste water engineering - treatment, disposal and reuse, Metcalf and Eddy Inc., Tata McGraw Hill, New Delhi.
2. Environmental Chemistry, AK. De, Wiley Eastern Ltd, New Delhi.
3. Introduction to Biodeterioration, D.Allsopp and K.J. Seal, ELBS / Edward Arnold.
4. Bioremidation, Baaker, KH and Herson D.S., 1994. Mc.GrawHill Inc, NewYork.
5. Industrial and Environmental Biotechnology - Nuzhat Ahmed, Fouad M. Qureshi and Obaid Y. Khan, 2006. Horizon Press.
6. Environmental Molecular Biology, Paul. A, Rochelle, 2001.Horizon Press.
7. Environmental Protection and Laws by Jadhav and Bhosale, V.M.Himalaya publ. House 13. Biodiversity Assessment and Conservation by PC Trivedi, Agrobios publ.

5

BOT-HG-4016
Plant Anatomy and Embryology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

5.1 THEORY

Unit 1: ***Meristematic and permanent tissues*** **(8 lectures)**
Root and shoot apical meristems; Simple and complex tissues

Unit 2: ***Organs*** **(4 lectures)**
Structure of dicot and monocot root stem and leaf.

Unit 3: ***Secondary Growth*** **(8 lectures)**
Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood)

Unit 4: ***Adaptive and protective systems*** **(8 lectures)**
Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 5: ***Structural organization of flower*** **(8 lectures)**
Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

Unit 6: ***Pollination and fertilization*** **(8 lectures)**
Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 7: ***Embryo and endosperm*** **(8 lectures)**
Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-endosperm relationship

5.2 PRACTICAL

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla*stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous / campylotropous (permanent slides)
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.

Suggested Readings

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.

2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

6

BOT-HG- 4026
Economic Botany and Plant Biotechnology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

6.1 THEORY

Unit 1 : *Origin of Cultivated Plants* **(4 lectures)**
Concept of centres of origin, their importance with reference to Vavilov's work.

Unit 2 : *Cereals* **(4 lectures)**
Wheat -Origin, morphology, uses

Unit 3 : *Legumes* **(6 lectures)**
General account with special reference to Gram and soybean

Unit 4 : *Spices* **(6 lectures)**
General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)

Unit 5 : *Beverages* **(4 lectures)**
Tea (morphology, processing, uses)

Unit 6 : *Oils and Fats* **(4 lectures)**
General description with special reference to groundnut

Unit 7 : *Fibre Yielding Plants* **(4 lectures)**
General
4description with special reference to Cotton (Botanical name, family, part used,morphology and uses)

Unit 8 : *Introduction to biotechnology* **(2 lecture)**

Unit 9 : *Plant tissue culture* **(8 lectures)**

Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications

Unit 10 : Recombinant DNA Techniques **(18 lectures)**

Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection.Molecular diagnosis of human disease, Human gene Therapy.

6.2 PRACTICAL

1. Study of economically important plants : Wheat, Gram, Rice, Soybean, Black pepper, Curcuma, Clove, Tea, Cotton, Groundnut through specimens, sections and microchemical tests
2. Familiarization with basic equipment in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

Suggested Readings

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4^{th} edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

Skill Enhancement Courses

1

BOT-SE-3014
Biofertilizers (SEC - I)

Total Lectures : 60 Credits : 4

Unit 1 : General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

(8 lectures)

Unit 2 : *Azospirillum:* isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms.*Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication. **(16 lectures)**

Unit 3 : Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.

(8 lectures)

Unit 4 : Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

(16 lectures)

Unit 5 : Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. **(12 lectures)**

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

2

BOT-SE-3024
Herbal Technology (SEC - I)

Total Lectures : 60 Credits : 4

Unit 1: Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants. **(12 Lectures)**

Unit 2: Pharmacognosy - systematic position m edicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka. **(12 Lectures)**

Unit 3: Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster). **(12 Lectures)**

Unit 4: Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds) **(16 Lectures)**

Unit 5: Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy) **(8 Lectures)**

Suggested Readings

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

3

BOT-SE-4014

Nursery and Gardening (SEC - I)

Total Lectures : 60 Credits : 4

Unit 1: Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants. **(8 Lectures)**

Unit 2: Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion – Seed production technology - seed testing and certification. **(12 Lectures)**

Unit 3: Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants – green house - mist chamber, shed root, shade house and glass house. **(12 Lectures)**

Unit 4: Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting. **(16 Lectures)**

Unit 5: Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures. **(12 Lectures)**

Suggested Readings

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
5. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

4

BOT-SE-4024
Floriculture (SEC - I)

Total Lectures : 60 Credits : 4

Unit 1: Introduction: History of gardening; Importance and scope of floriculture and landscape gardening. **(4 Lectures)**

Unit 2: Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators. **(16 lectures)**

Unit 3: Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai. **(8 lectures)**

Unit 4: Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India. **(8 lectures)**

Unit 5: Landscaping Places of Public Importance: Landscaping highways and Educational institutions. **(8 lectures)**

Unit 6: Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold,Rose, Lilium, Orchids). **(12 lectures)**

Unit 7: Diseases and Pests of Ornamental Plants. **(4 lectures)**

Suggested Readings

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

5

BOT-SE-4034

Intellectual Property Rights (SEC - II)

Total Lectures : 60 Credits : 4

Unit 1: Introduction to intellectual property right (IPR) **(4 lectures)**

Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

Unit 2 : Patents **(6 Lectures)**

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement.

Unit 3: Copyrights **(6 Lectures)**

Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.

Unit 4: Trademarks **(6 Lectures)**

Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name.

Unit 5: Geographical Indications **(6 Lectures)**

Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.

Unit 6: Protection of Traditional Knowledge **(8 Lectures)**

Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, needfor a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

Unit 7: Industrial Designs **(4 Lectures)**

Objectives, Rights, Assignments, Infringements, Defences of Design Infringement

Unit 8 : Protection of Plant Varieties **(4 Lectures)**

Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

Unit 9 : Information Technology Related Intellectual Property Rights **(8 Lectures)**

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection

Unit 10 : Biotechnology and Intellectual Property Rights. **(8 Lectures)**

Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.

Suggested Readings

1. N.S. Gopalakrishnan & T.G. Agitha, (2009) Principles of Intellectual Property Eastern Book Company, Lucknow.
2. Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet & Maxweel.
3. Ajit Parulekar and Sarita D' Souza, (2006) Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.
4. B.L.Wadehra (2000) Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India.
5. P. Narayanan (2010) Law of Copyright and Industrial Designs; Eastern law House, Delhi.

APPENDIX I

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	**Ability Enhancement Compulsory Course-I**	English communications	2
	Core course-I	Phycology and Microbiology	4
	Core Course-I Practical	Phycology and Microbiology	2
	Core course-II	Biomolecules and Cell Biology	4
	Core Course-II Practical	Biomolecules and Cell Biology- Practical	2
	Generic Elective -1	GE-1	4
	Generic Elective -1 Practical/ Tutorial	GE-1 Practical	2
II	**Ability Enhancement Compulsory Course-II**	Environmental Studies	2
	Core course-III	Mycology and Phytopathology	4
	Core Course-III Practical	Mycology and Phytopathology- Practical	2
	Core course-IV	Archegoniate	4
	Core Course-IV Practical	Archegoniate- Practical	2

	Generic Elective -2	GE-2	4
	Generic Elective -2 -- Practical	GE-2 Practical	2
III	**Core course-V**	Morphology and Anatomy of Angiosperm	4
	Core Course-V Practical	Morphology and Anatomy of Angiosperm- Practical	2
	Core course-VI	Economic Botany	4
	Core Course-VI Practical	Economic Botany-Practical	2
	Core course-VII	Genetics	4
	Core Course-VII Practical	Genetics- Practical	2
	Skill Enhancement Course-1	SEC-1	4
	Generic Elective -3	GE-3	4
	Generic Elective -3 Practical	GE-3 Practical	2
IV	**Core course-VIII**	Molecular Biology	4
	Course-VIII Practical	Molecular Biology- Practical	2
	Core course-IX	Plant Ecology and Phytogeography	4
	Course-IX Practical	Plant Ecology and Phytogeography - practical	2
	Core course-X	Plant Systematics	4
	Core Course- X Practical	Plant Systematics	2

		Practical	
	Skill Enhancement Course-2	SEC-2	4
	Generic Elective -4	GE-4	4
	Generic Elective - 4 Practical	GE-4 Practical	2
V	**Core course-XI**	Reproductive Biology of Angiosperms	4
	Core Course-XI Practical	Reproductive Biology of Angiosperms - Prcatical	2
	Core course-XII	Plant Physiology	4
	Core Course-XII Practical	Plant Physiology-Practical	2
	Discipline Specific Elective -1	DSE-1	4
	Discipline Specific Elective -1 Practical	DSE-1 Practical	2
	Discipline Specific Elective -2	DSE-2	4
	Discipline Specific Elective-2 -Practical /Tutorial	DSE-2 Practical	2
VI	**Core course-XIII**	Plant Metabolism	4
	Core Course-XIII -Practical /Tutorial	Plant Metabolism-Practical	2
	Core course-XIV	Plant	4

		Biotechnology	
	Core Course-XIV - Practical /Tutorial	Plant Biotechnology-Practical	2
	Discipline Centric Elective -3	DSE-3	4
	Discipline Centric Elective -3 Practical /Tutorial	DSE-3 Practical	2
	Project Work	DSE-4 Practical	6
			Total: 144

Choice Based Credit System

Syllabus

For

B. Sc. Botany (Regular)

DEPARTMENT OF BOTANY
GAUHATI UNIVERSITY
GUWAHATI-781014

Effective from Academic Session 2019-2020

Scheme for Choice Based Credit System in B. Sc. with Botany (Regular)

	DISCIPLINE CORE COURSE (12)	**Ability Enhancement Compulsory Course (AECC) (2)**	**Skill EnhancementCourse (SEC)** (2)	**Discipline Specific Elective DSE (6)**
I	Discipine-1 Botany Paper I: Biodiversity (Microbes, Algae, Fungi and Archegoniate)	English/MIL Communication		
II	Discipine-1 Botany Paper II: Plant Ecology and Taxonomy	Environmental Studies		
III	Discipine-1 Botany Paper III: Plant Anatomy and Embryology		SEC-1	
IV	Discipine-1 Botany		SEC -2	
	Paper IV: Plant Physiology and Metabolism			
V			SEC -3	DSE-Botany Paper I
VI			SEC -4	DSE-Botany Paper II

Course Structure for CBCS in B. Sc. with Botany (Regular) as per requirement of UGC

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	ENG-AE 1014	English/MIL communications	4
	BOT-RC-1016	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	4
	BOT-RC-1016 (Practical)	Biodiversity (Microbes, Algae, Fungi and Archegoniate) –Practical	2
II	ENV-AE 2014	Environmental Studies	4
	BOT-RC-2016	Plant Ecology and Taxonomy	4
	BOT-RC-2016 (Practical)	Plant Ecology and Taxonomy -Practical	2
III	BOT-RC-3016	Plant Physiology and Metabolism	4
	BOT-RC-3016 (Practical)	Plant Physiology and Metabolism –Practical	2
	1. BOT- SE-3014 2. BOT-SE-3024	RSE-1 (Any one) 1.Biofertilizers 2.Herbal Technology	4
IV	BOT-RC-4016	Plant Anatomy and Embryology	4
	BOT-RC-4016(Practical)	Plant Anatomy and Embryology-Practical	2
	1. BOT-SE-4014 2. BOT-SE-4024 3. BOT-SE-4034	RSE -2 (Any one) 1.Nursery and Gardening 2. Floriculture 3. Intellectual Property Right	4
V	1. BOT-SE-5014 2. BOT-SE-5024	RSE -3 Any one) 1.Medicinal Botany 2. Plant Diversity and Human Welfare	4
	1. BOT-RE-5016 2. BOT-RE-5026 3. BOT-RE-5036	RDS- I (any one) 1. Cell and Molecular Biology 2. Economic Botany and Biotechnology 3. Genetics and Plant Breeding	4
	RDS -1(Practical)	RDS-Botany Paper I –Practical	2
VI	1. BOT-SE-6014 2. BOT-SE-6024	RSE -4 (Any one) 1. Ethnobotany 2. Mushroom Culture Technology	2
	RDS -Either of 1 or 2 below:		

	1. BOT-RE-6016	RDS-2 (Any one) 1. Analytical Techniques in Plant Sciences	4	6
	1. BOT-RE-6016 (Practical)	2. Analytical Techniques in Plant Sciences -Practical	2	
	2. BOT-RE-6026	2. Dissertation	6	
Total Credits in Botany			**52**	

Legends:

RC: Core Papers
RE: Discipline Specific Elective Papers
SE: Skill Enhancement Papers

List of Papers with BSc. Botany (Regular) under CBCS

Core Papers

1	BOT-RC-1016	: Biodiversity (Microbes, Algae, Fungi and Archegoniate)
2	BOT-RC-2016	: Plant Ecology and Taxonomy
3	BOT-RC-3016	: Plant Physiology and Metabolism
4	BOT-RC-4016	: Plant Anatomy and Embryology

Discipline Specific Elective Papers (Any two)

1	BOT-RE-5016	: Cell and Molecular Biology
2	BOT-RE-5026	: Economic Botany and Biotechnology
3	BOT-RE-5036	: Genetics and Plant Breeding
4	BOT-RE-6016	: Analytical Techniques in Plant Sciences
5	BOT-RE-6026	: Dissertation

Ability Enhancement Compulsory Courses

1	ENG-AE-1014	: English/MIL
2	ENV-AE-2014	: Environmental Studies

Skill Enhancement Papers (Any four)

1	BOT-SE-3014	: Biofertilizers
2	BOT-SE-3024	: Herbal Technology
3	BOT-SE-4014	: Nursery and Gardening
4	BOT-SE-4024	: Floriculture
5	BOT-SE-4034	: Intellectual Property Right
6	BOT-SE-5014	: Medicinal Botany
7	BOT-SE-5024	: Plant Diversity and Human Welfare
8	BOT-SE-6014	: Ethnobotany
9	BOT-SE-6024	: Mushroom Culture Techniques

Core Courses

Semester-I

1

BOT-RC-1016
Biodiversity (Microbes, Algae, Fungi and Archegoniate)

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

1.1 Theory

Unit 1 : *Microbes* **(10 Lectures)**

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2 : *Algae* **(12 Lectures)**

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia. Economic importance of algae.

Unit 3 : *Fungi* **(12 Lectures)**

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of Rhizopus (Zygomycota) Penicillium, Alternaria (Ascomycota), Puccinia, Agaricus (Basidiomycota); Symbiotic Associations-Lichens:

General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

Unit 4 : ***Introduction to Archegoniate*** **(2 Lectures)**

Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Unit 5 : ***Bryophytes*** **(10 Lectures)**

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of Marchantia and Funaria. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of Sphagnum.

Unit 6 : ***Pteridophytes*** **(8 Lectures)**

General characteristics, classification, Early land plants (Cooksonia and Rhynia). Classification (up to family), morphology, anatomy and reproduction of Selaginella, Equisetum and Pteris. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes.

Unit 4 : ***Gymnosperms*** **(6 Lectures)**

General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of Cycas and Pinus. (Developmental details not to be included). Ecological and economical importance.

1.2 Practical

1 EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.

2 Types of Bacteria from temporary/permanent slides/photographs; Binary Fission; Conjugation; Structure of root nodule.

3 Gram staining

4 Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Oedogonium, Vaucheria, Fucus* and Polysiphonia through temporary preparations and permanent slides.

5 *Rhizopus and Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.

6 *Puccinia:* Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.

7 *Agaricus:* Specimens of button stage and full grown mushroom; Sectioning of gills of Agaricus.

8 Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)

9 Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)

10 *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).

11 *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.

12 *Selaginella*- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).

13 *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).

14 *Pteris*- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).

15 *Cycas*- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).

16 *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, , l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.

2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.

3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.

4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.

5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

Semester-II

2

BOT-RC-2016
Plant Ecology and Taxonomy

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

2.1 Theory

Unit 1 : ***Introduction*** **(2 Lectures)**

Unit 2 : ***Ecological factors*** **(10 Lectures)**

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes.

Unit 3 : ***Plant communities*** **(6 Lectures)**

Characters; Ecotone and edge effect; Succession; Processes and types.

Unit 4 : ***Ecosystem*** **(8 Lectures)**

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous

Unit 5 : ***Phytogeography*** **(4 Lectures)**

Principal biogeographical zones; Endemism

Unit 6 : ***Introduction to plant taxonomy*** **(2 Lectures)**

Identification, Classification, Nomenclature.

Unit 7 : ***Identification*** **(4 Lectures)**

Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

Unit 8 : Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. **(6 Lectures)**

Unit 9 : ***Taxonomic hierarchy*** **(2 Lectures)**

Ranks, categories and taxonomic groups

Unit 10 : ***Botanical nomenclature*** **(6 Lectures)**

Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 11 : ***Classification*** **(6 Lectures)**

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

Unit 12 : ***Biometrics, numerical taxonomy and cladistics*** **(4 Lectures)**

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

2.1 Practical

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Study of morphological adaptations of hydrophytes and xerophytes (four each).

3. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
4. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
5. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Brassicaceae, Solanaceae, Lamiaceae.
6. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Suggested Readings

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
3. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

Semester-III

3

BOT-RC-3016
Plant Physiology and Metabolism

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

3.1 Theory

Unit 1 : ***Plant-water relations*** **(8 Lectures)**

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Unit 2 : ***Mineral nutrition*** **(8 Lectures)**

Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit 3 : ***Translocation in phloem*** **(6 Lectures)**

Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

Unit 4 : ***Photosynthesis*** **(12 Lectures)**

Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

Unit 5 : ***Respiration*** **(6 Lectures)**

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 6 : ***Enzymes*** **(4 Lectures)**

Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Unit 7 : ***Nitrogen metabolism*** **(4 Lectures)**

Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit 8 : ***Plant growth regulators*** **(6 Lectures)**

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

Unit 9 : ***Plant response to light and temperature*** **(6 Lectures)**

Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

3.2 **Practical**

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of light on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency.
4. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
5. To study the effect of bicarbonate concentration on O2 evolution in photosynthesis.

Demonstration experiments

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

Suggested Readings

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

Semester-IV

4

BOT-RC-4016
Plant Anatomy and Embryology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

4.1 Theory

Unit 1 : ***Meristematic and permanent tissues*** **(8 Lectures)**

Root and shoot apical meristems; Simple and complex tissues.

Unit 2 : ***Organs*** **(4 Lectures)**

Structure of dicot and monocot root stem and leaf.

Unit 3 : ***Secondary Growth*** **(8 Lectures)**

Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).

Unit 4 : ***Adaptive and protective systems*** **(8 Lectures)**

Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 5 : ***Structural organization of flower*** **(8 Lectures)**

Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

Unit 6 : ***Pollination and fertilization*** **(8 Lectures)**

Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 7 : ***Embryo and endosperm*** **(8 Lectures)**

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo- endosperm relationship.

Unit 8 : ***Apomixis and polyembryony*** **(8 Lectures)**

Definition, types and practical applications.

4.2 Practical

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides).
4. Root: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (Nerium leaf); Hydrophyte (Hydrilla stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous (permanent slides)
9. Female gametophyte: Polygonum (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.

Suggested Readings

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.

2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

Discipline Specific Elective Papers

Two (2) be selected from each of the three disciplines

1

BOT-RE-5016
Cell and Molecular Biology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

1.1 Theory

Unit 1: *Techniques in Biology* **(8 Lectures)**

Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis.

Unit 2 : *Cell as a unit of Life* **(2 Lectures)**

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.

Unit 3 : *Cell Organelles* **(20 Lectures)**

Mitochondria: Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA.

Chloroplast Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA.

ER, Golgi body & Lysosomes: Structures and roles.

Peroxisomes and Glyoxisomes: Structures, composition, functions in animals and plants and biogenesis.

Nucleus: Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

Unit 4 : *Cell Membrane and Cell Wall* **(6 Lectures)**

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall.

Unit 5 : *Cell Cycle* **(6 Lectures)**

Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.

Unit 6 : *Genetic material* **(6 Lectures)**

DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material.

DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi–conservative, semi discontinuous RNA priming , Ǿ (theta) mode of replication , replication of linear , ds-DNA, replicating the 5′end of linear chromosome including replication enzymes.

Unit 7 : *Transcription (Prokaryotes and Eukaryotes)* **(6 Lectures)**

Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code.

Unit 8 : *Regulation of gene expression* **(6 Lectures)**

Prokaryotes:Lac operon and Tryptophan operon ; and in Eukaryotes.

1.2 Practical

1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
2. Study of the photomicrographs of cell organelles.
3. To study the structure of plant cell through temporary mounts.
4. Study of mitosis and meiosis (temporary mounts and permanent slides).
5. Study of plasmolysis and deplasmolysis on Rhoeo leaf.

6. Measure the cell size (either length or breadth/diameter) by micrometry.
7. Study the structure of nuclear pore complex by photograph (from Gerald Karp)Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
8. Study DNA packaging by micrographs.
9. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.

Suggested Readings

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

2

BOT-RE-5026
Economic Botany and Biotechnology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

2.1 Theory

Unit 1 : ***Origin of Cultivated Plants*** **(4 Lectures)**

Concept of centres of origin, their importance with reference to Vavilov's work

Unit 2 : ***Cereals*** **(4 Lectures)**

Wheat -Origin, morphology, uses

Unit 3 : ***Legumes*** **(4 Lectures)**

General account with special reference to Gram and soybean

Unit 4 : ***Spices*** **(4 Lectures)**

General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)

Unit 5 : Beverages **(2 Lectures)**

Tea (morphology, processing, uses)

Unit 6 : Oils and Fats **(2 Lectures)**

General description with special reference to groundnut

Unit 7 : *Fiber Yielding Plants* **(2 Lectures)**

General description with special reference to Cotton (Botanical name, family, part used, morphology and uses).

Unit 8 : *Introduction to biotechnology* **(2 lecture)**

Unit 9 : *Plant tissue culture* **(8 Lectures)**

Micro propagation ; haploid production through androgenesis and gynogenesis; brief account of embryo & endosperm culture with their applications

Unit 10 : *Recombinant DNA Techniques* **(18 Lectures)**

Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.

Unit 11 : Bioinformatics **(5 Lectures)**

Introduction, branches, Aim, Scope and research areas, Biological data base and the retrieval system.

Unit 12 :Applications of Bioinformatics **(5 Lectures)**

Molecular Phylogeny; Basics in Proteomics and Genomics and their applications in crop improvement, Drug Discovery.

2.2 Practical

1. Study of economically important plants : Rice, Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut, Curcuma, through specimens, sections and microchemical tests
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.
5. Data base searching, and retrieval of Sequence from databases.
6. Sequence alignment, Homology and construction of Phylogenetic tree.

Suggested Readings

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
4. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
5. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley Blackwell.
6. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. _II Edition. Benjamin Cummings.

3

BOT-RE-5036
Genetics and Plant Breeding

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

3.1 Theory

Unit 1 : Heredity **(20 Lectures)**

1. Brief life history of Mendel
2. Terminologies
3. Laws of Inheritance
4. Modified Mandelian Ratios: 2:1- lethal Genes; 1:2:1- Co- dominance, incomplete dominance; 9:7; 9:4:3; 13:3; 12:3:1.
5. Chi Square
6. Pedigree Analysis
7. Cytoplasmic Inheritance: Shell Coiling in Snail, Kappa particles in Paramecium, leaf variegation in Mirabilis jalapa, Male sterility.
8. Multiple allelism
9. Pleiotropism
10. Chromosome theory of Inheritance.

Unit 2 : Sex-determination and Sex-linked Inheritance **(4 Lectures)**

Unit 3 : *Linkage and Crossing over* **(8 Lectures)**

Linkage: concept & history, complete & incomplete linkage, bridges experiment, coupling & repulsion, recombination frequency, linkage maps based on two and three factor crosses.

Crossing over: concept and significance, cytological proof of crossing over.

Unit 4 : ***Mutations and Chromosomal Aberrations*** **(4 Lectures)**

Types of mutations, effects of physical & chemical mutagens. Numerical chromosomal changes: Euploidy, Polyploidy and Aneuploidy ; Structural chromosomal changes: Deletions, Duplications, Inversions & Translocations.

Unit 5 : ***Plant Breeding*** **(4 lectures)**

Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

Unit 6 : Methods of crop improvement (8 lectures)

Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

Unit 7 : Quantitative inheritance (4 lectures)

Concept, mechanism, examples. Monogenic vs polygenic Inheritance.

Unit 8 : ***Inbreeding depression and heterosis*** **(4 lectures)**

History, genetic basis of inbreeding depression and heterosis; Applications.

Unit 9 : ***Crop improvement and breeding*** **(4 lectures)**

Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

3.2 Practical

1. Mendel's laws through seed ratios. Laboratory exercises in probability and chi- square.
2. Chromosome mapping using point test cross data.
3. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
4. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes through photographs.
5. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
6. Hybridization techniques - Emasculation, Bagging (For demonstration only).
7. Induction of polyploidy conditions in plants (For demonstration only).

Suggested Readings

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
5. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
6. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
7. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.
8. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

4

BOT-RE-6016
Analytical Techniques in Plant Sciences

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

4.1 Theory

Unit 1 : ***Imaging and related techniques*** **(15 Lectures)**

Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2 : ***Cell fractionation*** **(8 Lectures)**

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2 gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3 : ***Radioisotopes*** **(4 Lectures)**

Use in biological research, auto-radiography, pulse chase experiment.

Unit 4: ***Spectrophotometry*** **(4 Lectures)**

Principle and its application in biological research.

Unit 5 : *Chromatography* **(8 Lectures)**

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 6 : *Characterization of proteins and nucleic acids* **(6 Lectures)**

Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

Unit 7 : *Biostatistics* **(15 Lectures)**

Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

4.2 Practicals

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate sugars by thin layer chromatography.
4. Isolation of chloroplasts by differential centrifugation.
5. To separate chloroplast pigments by column chromatography.
6. To estimate protein concentration through Lowry's methods.
7. To separate proteins using PAGE.
8. To separate DNA (marker) using AGE.
9. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).

Suggested Readings

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw- Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

5

BOT-RE-6026
Dissertation

Credits : 6

Skill Enhancement Papers (Any four)

1

BOT-SE-3014
Biofertilizers

Total Lectures : 60 Credits : 4

Unit 1: General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

(8 Lectures)

Unit 2: Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.

(16 Lectures)

Unit 3: Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.

(8 Lectures)

Unit 4: Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

(16 Lectures)

Unit 5: Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.

(12 Lectures)

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

2

BOT-SE-3024
Herbal Technology

Total Lectures : 60 Credits : 4

Unit 1: Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.

(12 Lectures)

Unit 2: Pharmacognosy - systematic position m edicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

(12 Lectures)

Unit 3: Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; Catharanthus roseus (cardiotonic), Withania somnifera (drugs acting on nervous system), Clerodendron phlomoides (anti-rheumatic) and Centella asiatica (memory booster).

(12 Lectures)

Unit 4: Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds)

(16 Lectures)

Unit 5: Medicinal plant banks micro propagation of important species (Withania somnifera, neem and tulsi- Herbal foods-future of pharmacognosy)

(8 Lectures)

Suggested Readings

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

3

BOT-SE-4014
Nursery and Gardening

Total Lectures : 60 Credits : 4

Unit 1: Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.

(8 Lectures)

Unit 2: Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification.

(12 Lectures)

Unit 3: Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glass house.

(12 Lectures)

Unit 4: Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.

(16 Lectures)

Unit 5: Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

(12 Lectures)

Suggested Readings

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
5. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

4

BOT-SE-4024
Floriculture

Total Lectures : 60 Credits : 4

Unit 1: Introduction: History of gardening; Importance and scope of floriculture and landscape gardening.

(4 Lectures)

Unit 2: Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

(16 Lectures)

Unit 3: Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai.

(8 Lectures)

Unit 4: Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India.

(8 Lectures)

Unit 5: Landscaping Places of Public Importance: Landscaping highways and Educational institutions.

(8 Lectures)

Unit 6: Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold,Rose, Lilium, Orchids).

(12 Lectures)

Unit 7: Diseases and Pests of Ornamental Plants.

(4 Lectures)

Suggested Readings

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

5

BOT-SE-4034
Intellectual Property Rights

Total Lectures : 60 Credits : 4

Unit 1 : ***Introduction to intellectual property right (IPR)*** **(4 lectures)**

Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples.IPR and WTO (TRIPS, WIPO).

Unit 2 : ***Patents*** **(6 Lectures)**

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement.

Unit 3 : ***Copyrights*** **(6 Lectures)**

Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.

Unit 4 : ***Trademarks*** **(6 Lectures)**

Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name.

Unit 5: ***Geographical Indications*** **(6 Lectures)**

Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.

Unit 6 : *Protection of Traditional Knowledge* **(8 Lectures)**

Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, needfor a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

Unit 7 : *Industrial Designs* **(4 Lectures)**

Objectives, Rights, Assignments, Infringements, Defences of Design Infringement

Unit 8 : *Protection of Plant Varieties* **(4 Lectures)**

Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers.National gene bank, Benefit sharing.Protection of Plant Varieties and Farmers' Rights Act, 2001.

Unit 9 : *Information Technology Related Intellectual Property Rights* **(8 Lectures)**

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection

Unit 10 : *Biotechnology and Intellectual Property Rights.* **(8 Lectures)**

Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.

Suggested Readings

1. N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001).
2. Manjula Guru & M.B. Rao, Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
3. P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).
4. Arthur Raphael Miller, Micheal H.Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
5. Jayashree Watal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.

6

BOT-SE-5014
Medicinal Botany

Total Lectures : 60 Credits : 4

Unit 1: History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.

(20 Lectures)

Unit 2: Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

(20 Lectures)

Unit 3: Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases.

(20 Lectures)

Suggested Readings

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.

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BOT-SE-5024
Plant Diversity and Human Welfare

Total Lectures : 60 Credits : 4

Unit 1: Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at theecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes.

(16 Lectures)

Unit 2: Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss, Management of Plant Biodiversity: Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication.

(16 Lectures)

Unit 3: Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, In situ and ex situ conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development.

(16 Lectures)

Unit 4: Role of plants in relation to Human Welfare; a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses. (12 Lectures)

Suggested Readings

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi

8

BOT-SE-6014
Ethnobotany

Total Lectures : 60 Credits : 4

Unit 1 : ***Ethnobotany*** **(12 Lectures)**

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

Unit 2: ***Methodology of Ethnobotanical studies*** (12 Lectures)

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.

Unit 3 : ***Role of ethnobotany in modern Medicine*** (20 Lectures)

Medico-ethnobotanical sources in India;Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) Azadiractha indica b) Ocimum sanctum c) Vitex negundo. d) Gloriosa superba e) Tribulus terrestris f) Pongamia pinnata g) Cassia auriculata h) Indigofera tinctoria. Role of ethnobotany in modern medicine with special example Rauvolfia sepentina, Trichopus zeylanicus, Artemisia,Withania.

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

Unit 4 : ***Ethnobotany and legal aspects*** (16 Lectures)

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

Suggested Readings

1) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2) S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
3) Lone et al,. Palaeoethnobotany
4) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
5) S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
6) Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
7) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah. 8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996 9)

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BOT-SE-6024
Mushroom Culture Technology

Total Lectures : 60 Credits : 4

Unit 1: Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus.

(10 Lectures)

Unit 2: Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation

- Low cost technology, Composting technology in mushroom production.

(24 Lectures)

Unit 3: Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in saltsolutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

(16 Lectures)

Unit 4: Food Preparation : Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, ExportValue. (10 Lectures)

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

Appendix

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course-I	English/MIL communications/ Environmental Science	4
	Core course - Botany Paper I	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	4
	Core Course - Paper I Practical/Tutorial	Biodiversity (Microbes, Algae, Fungi and Archegoniate) Lab	2
	Discipline- 2 Paper I	DSC- 2 Paper I	4
	Discipline- 2 Paper I Practical	DSC- 2 Paper I Practical	2
	Discipline - 3 Paper I	DSC- 3 Paper I	4
	Discipline - 3 Paper I Practical	DSC- 2 Paper I Practical	2
II	Ability Enhancement Compulsory Course-II	English/MIL communications/ Environmental Science	4
	Core course-Botany Paper II	Plant Ecology and Taxonomy	4
	Core Course- Botany Paper II Practical/Tutorial	Plant Ecology and Taxonomy Lab	2
	Discipline - 2 Paper II	DSC- 2 Paper 2	4
	Discipline -2 Paper II Practical	DSC- 2 Paper 2 Practical	2
	Discipline - 3 Paper II	DSC- 3 Paper 2	4
	Discipline - 3 Paper II Practical	DSC- 3 Paper 2 Practical	2
III	Core course- Botany Paper III	Plant Anatomy and Embryology	4
	Core Course- Botany Paper III Practical/Tutorial	Plant Anatomy and Embryology Practical	2
	Discipline - 2 Paper III	DSC- 2 Paper III	4
	Discipline - 2 Paper III Practical	DSC- 2 Paper III Practical	2
	Discipline - 3 Paper III	DSC- 3 Paper III	4
	Discipline - 3 Paper III Practical	DSC- 3 Paper III Practical	4
	Skill Enhancement Course -1	SEC-1	4
IV	Core course- Botany Paper IV	Plant Physiology and Metabolism	4
	Course- Botany Paper IV Practical	Plant Physiology and Metabolism Practical	2
	Discipline - 2 Paper IV	DSC- 2 Paper IV Theory	4

	Discipline - 2 Paper IV Practical	DSC- 2 Paper IV Practical	2
	Discipline - 3 Paper IV	DSC- 3 Paper IV Theory	4
	Discipline - 3 Paper IV Practical	DSC- 3 Paper IV	2
	Skill Enhancement Course -2	SEC -2	4
V	Skill Enhancement Course -3	SEC -3	4
	Discipline Specific Elective –Botany Paper I	DSE-Botany Paper I	4
	Discipline Specific Elective –Botany Paper I Practical	DSE-Botany Paper I Practical	2
	Discipline Specific Elective – Discipline 2 Paper I	DSE-Discipline 2 Paper I	4
	Discipline Specific Elective – Discipline 2 Paper I Practical	DSE-Discipline 2 Paper I Practical	2
	Discipline Specific Elective – Discipline 3 Paper I	DSE- Discipline 3 Paper I	4
	Discipline Specific Elective – Discipline 3 Paper I Practical	DSE-Discipline 2 Paper I Practical	2
VI	Skill Enhancement Course -4	SEC -4	4
	Discipline Specific Elective –Botany Paper II	DSE-Botany Paper II	4
	Discipline Specific Elective –Botany Paper II Practical	DSE-Botany Paper II Practical	2
	Discipline Specific Elective – Discipline 2 Paper II	DSE-Discipline 2 Paper II	6
	Discipline Specific Elective – Discipline 2 Paper II Practical	DSE-Discipline 3 Paper II Practical	6
	Discipline Specific Elective – Discipline 3 Paper II	DSE- Discipline 3 Paper II	6
	Discipline Specific Elective – Discipline 3 Paper II Practical	DSE- Discipline 3 Paper II Practical	6
Total Credits			**132**

B.Sc. Botany Regular
Course Outcomes

Core Papers

BOT-RC-1016 : Biodiversity (Microbes, Algae, Fungi and Archegoniate)

CO1. Understand the origin, structure, reproduction pattern and economic importance of virus and bacteria
CO2. Knowledge on characteristics features, classifications, reproductive mechanisms, life cycle pattern and ecology of different genera of algae and fungi
CO3. Understand the importance/significance and mechanism of symbiotic associations of algae-fungi and fungi-higher plants
CO4. Knowledge on archegoniate and alternation of generations
CO5. Knowledge on classifications, reproductive mechanisms, ecology, evolution and economic significances of bryophyte, pteridophyte and gymnosperm
CO6. Knowledge on T phage and TMV, lytic and lysogenic cycles of viruses
CO7. Know about different types of bacteria, their structure and reproduction types, gram staining procedures
CO8. Knowledge on morphology, anatomy and reproductive structures of different general of algae, fungi, bryophytes, pteridophyte and gymnosperms

BOT-RC-2016 : Plant Ecology and Taxonomy

CO1. Basic knowledge on Ecology, Know about ecological factors, law of tolerance, Adaptation of hydrophytes and xerophytes
CO2. Knowledge on plant communities and its characteristics, processes and types of succession
CO3. Understanding concept of ecosystem and its structure, knowledge on production and productivity in ecological pyramids, biogeochemical cycles of Carbon, Nitrogen and Phosphorus
CO4. Knowledge on phytogeography and principle of biogeographical zones of India
CO5. Knowledge on plant taxonomy, its identification, Classification and Nomenclature
CO6. Understanding on plant Identification, importance of herbarium and botanical gardens of the world and India, documentation and Keys

CO7. Knowledge on taxonomic evidences from palynology, cytology, phytochemistry and molecular data, understanding about taxonomic hierarchy such as ranks, categories and taxonomic groups

CO8. Knowledge on Botanical nomenclature, binominal system Principles and rules (ICN), classifications and types of classification

CO9. Knowledge on characters used in taxonomy and variations of biometrics, numerical taxonomy and cladistics

CO10. Practical Knowledge on ecological instruments such as Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter

CO11. Practical knowledge on determination of minimal quadrat size for the study of herbaceous vegetation by species area curve method

CO12. Practical knowledge on Quantitative analysis of herbaceous vegetation for frequency and comparison with Raunkiaer's frequency distribution law

CO13. Practical knowledge on vegetative and floral characters of plant family Brassicaceae, Solanaceae and Lamiaceae

CO14. Hands on preparation of herbarium sheet with proper mounting and pressing of dried wild plant specimen

BOT-RC-3016 : Plant Physiology and Metabolism

CO1. Knowledge on different types of plant-water relationship, their significance and factors

CO2. Knowledge on different mineral nutrients, their roles on plants, different types of transport and their mechanisms, knowledge on different carriers, channels and pumps

CO3. Understanding phloem loading and unloading, pressure flow model

CO4. Knowledge on different types of photosynthetic pigments, Photosystem I and II, electron transport and mechanism of ATP synthesis, different types of pathways of photorespiration and carbon fixation

CO5. Basic knowledge on different pathways of respiration

CO6. Knowledge on structure and properties of enzyme and their catalysis and inhibition mechanisms

CO7. Knowledge on biological nitrogen fixation and metabolism

CO8. Knowledge on discovery and physiological roles of different plant growth regulators, Understanding plant responses to light and temperature

CO9. Knowledge on estimation of osmotic potential, Understanding on effects of light on transpiration, Basic idea on stomatal index and frequency, knowledge on enzyme activity and effect of pH, Knowledge on bicarbonate concentration and O2 evolution in photosynthesis of some plants

CO10. Understanding on Bolting, RQ and root respiration, Knowledge on auxin's role on rooting, basic idea on transpiration suction

BOT-RC-4016 : Plant Anatomy and Embryology

CO1. Understand the meristematic and permanent tissue of plants

CO2. Knowledge on the structure of monocot and dicot root, stem and leaf

CO3. Basic knowledge on vascular cambium, secondary growth in root and stem

CO4. Knowledge on epidermis, cuticle, stomata, adaptation in xerophytes and helophytes

CO5. Knowledge on the structure of anther and pollen, structure and types of ovules, types of embryo sacs, organization and ultrastructure of mature embryo sac

CO6. Understand the mechanism of pollination and adaptations, double fertilization, seed structure, and dispersal mechanism

CO7. Knowledge on endosperm types, structure, functions, and embryo-endosperm relationship

CO8. Basic knowledge on apomixis, polyembryony and their applications

CO9. Knowledge on meristems, parenchyma, collenchyma, sclerenchyma, xylem, phloem, anatomy of root, stem, and leaf, adaptations in xerophytes, helophytes, structure of anther, types of ovules, female gametophyte, pollination, seed dispersal embryo and endosperm

Discipline Specific Elective Papers

BOT-RE-5016 : Cell and Molecular Biology

CO1. Understand the basic principle, function and working of microscopy used in research

CO2. Learn about the basics of cell and cell theory

CO3. Learn about the structure, composition and function of different cell organelles

CO4. Understand the structure and functions of cell membrane, membrane proteins and carbohydrates, membrane permeability and cell wall

CO5. Learn about cell cycle and its regulation at molecular level

CO6. Knowledge on history of DNA discovery, experiments related to DNA as the genetic material, structure and types of DNA and different modes of replication

CO7. Learn about types and structure of RNA, various types of RNA polymerases, basic knowledge on prokaryotic and eukaryotic translation and genetic code

CO8. Understand about regulation of gene expression in prokaryotes and eukaryotes

CO9. Practical knowledge on prokaryotic cells (bacteria), viruses and eukaryotic cells with the help of light and electron micrographs

CO10. Practical knowledge on photomicrographs of cell organelles

CO11. Practical knowledge on the structure of plant cell through temporary mounts

CO12. Practical knowledge on mitosis and meiosis

CO13. Practical knowledge on plasmolysis and deplasmolysis

CO14. Practical knowledge on micrometry

CO15. Understand the structure of nuclear pore complex by photograph and learn about special chromosomes either by slides or photographs.

CO16. Practical knowledge on micrograph study of DNA packaging

CO17. Practical knowledge on karyotype and ideogram preparation

BOT-RE-5026 : Economic Botany and Biotechnology

CO1. Learn about the centres of origin of cultivated plants with special reference to Vavilov's work

CO2. Learn about the origin, morphology and uses of cereals

CO3. Understand about legumes with special reference to Gram and soybean

CO4. Learn about botanical name, family, part used, morphology and uses of spices with special reference to clove and black pepper

CO5. Knowledge on morphology, processing and uses of tea

CO6. Learn about fats and oils with special reference to groundnut

CO7. Knowledge on botanical name, family, parts used, morphology and uses of fiber yielding plants with special reference to cotton

CO8. A brief knowledge on biotechnology

CO9. Knowledge on plant tissue culture techniques

CO10. Learn about blotting techniques, DNA fingerprinting, molecular markers, DNA sequencing and types of PCR. Knowledge on hybridoma technology, ELISA, molecular diagnosis of human disease, and human gene Therapy

CO11. Understand the aim, scope and branches of bioinformatics, repositories of Biological Data Knowledge and retrieval system

CO12. Learn about molecular phylogeny, basics in proteomics and genomics and their applications in crop improvement and drug discovery

PRACTICAL

CO13. Practical knowledge on economically important plants through specimens, sections and microchemical tests

CO14. Practical knowledge on basic equipments used in tissue culture

CO15. Understand anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation through photograph

CO16. Practical knowledge on molecular techniques

CO17. Practical knowledge on data base searching, and retrieval of Sequence from databases

CO18. Practical knowledge on sequence alignment, Homology and Phylogenetic tree

BOT-RE-5036 : Genetics and Plant Breeding

CO1. Understand laws of inheritance, modified mendelian ratios, chi square, pedigree analysis, cytoplasmic inheritance, multiple allelism, pleiotropism and chromosomal theory of inheritance.

CO2. Understand basics of sex determination and sex-linked inheritance

CO3. Learn about types of linkage, bridges experiment, coupling & repulsion, recombination frequency, linkage maps, crossing over and cytological proof of crossing over

CO4. Knowledge on types of mutation, mutagens, numerical and structural chromosomal changes

CO5. Learn about basics of plant breeding, important achievements and undesirable consequences of plant breeding

CO6. Learn about centres of origin and domestication of crop plants, plant genetic resources; acclimatization, selection methods, hybridization procedure, advantages and limitations

CO7. Understand the concept and mechanism of quantitative inheritance

CO8. Understand genetic basis of inbreeding depression and heterosis.

CO9. Learn about role of mutations, polyploidy, distant hybridization and role of biotechnology in crop improvement.

PRACTICAL

CO10. Practical knowledge on Mendel's law

CO11. Practical knowledge on chromosome mapping using point test cross data

CO12. Practical knowledge on incomplete dominance and gene interaction

CO13. Knowledge of aneuploidy: Down's, Klinefelter's and Turner's syndromes through photographs

CO14. Practical knowledge of Translocation Ring, Laggards and Inversion Bridge

CO15. Practical knowledge of hybridization technique

CO16. Practical knowledge on induction of polyploidy conditions in plants

BOT-RE-6016 : Analytical Techniques in Plant Sciences

CO1. Learn about principle of microscopy, flow cytometry, applications of fluorescence microscopy, chromosome banding, FISH, chromosome painting; transmission and scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching

CO2. Knowledge on different types of centrifugation, marker enzymes

CO3. Learn about use of Radioisotopes in biological research, auto-radiography, pulse chase experiment

CO4. Learn about principle and application of spectrophotometer in biological research

CO5. Knowledge on different chromtoghrapic techniques used in research

CO6. Learn about mass spectrometry, X-ray diffraction, X-ray crystallography, characterization of proteins and nucleic acids, electrophoresis

CO7. Understand various statistical methods of analysis, measures of central tendency: arithmetic mean, mode, median; measures of dispersion: Range, mean deviation, variation, standard deviation, chi-square test for goodness of fit

PRACTICAL

CO8. Understand the concept of blotting technique, DNA finger printing, DNA sequencing and PCR through photograph

CO9. Understand the concept of ELISA

CO10. Practical knowledge on TLC

CO11. Practical knowledge on isolation of Chloroplasts by differential centrifugation

CO12. Practical knowledge on column chromatography

CO13. Practical knowledge on protein estimation through Lowry's method

CO14. Practical knowledge on PAGE

CO15. Practical knowledge on separation of DNA (marker) using AGE

CO16. Practical knowledge on different microscopic techniques using photographs/micrographs

BOT-RE-6026 : Dissertation

CO1. Practical knowledge on addressing relevant scientific questions through experimentation

Skill Enhancement Papers

BOT-SE-3014 : Biofertilizers

CO1. Basic knowledge on the microbes used as biofertilizer, and understanding the process of their isolation, identification, mass multiplication, carrier based inoculants and knowledge on Actinorrhizal symbiosis
CO2. Concept on the general characteristics, isolation, mass multiplication carrier based inoculants of *Azospirillum* and *Azotobacter* also the knowledge on the crop response to *Azotobacter*
CO3. Basic knowledge on Cyanobacteria including factors affecting growth of Cyanobacteria, concept on the nitrogen fixation and use of blue green algae in rice cultivation
CO4. Brief knowledge on the Mycorrhizal association and understand the details of various types, taxonomy, occurrence, distribution and growth parameters of Mycorrhiza
CO5. Details about the organic farming, maintenance and recycling of biodegradable waste material and understand the methods of making biocompost and vermicompost with application

BOT-SE-3024 : Herbal Technology

CO1. Concept on the plants used as traditional medicine, and understanding the process of cultivation, harvesting, processing, storage, marketing and utilization of medicinal plants
CO2. Brief knowledge on medicinal drugs obtained from plants and comprehensive idea about systematic position, medicinal uses of Tulsi, Ginger, Fenu greek, Indian goose berry and Ashoka
CO3. Concept on the phytochemistry of medicinal herbs and identification, utilization of medicinal plants
CO4. Basic knowledge on quality control, owing the medicinal properties of herbal drugs including the secondary metabolites and concept of drug adulteration, types, methods of drug evaluation
CO5. Understand the process of micro propagation of important medicinal plant species.

BOT-SE-4014 : Nursery and Gardening

CO1. Brief idea about objectives, scope, infrastructure and maintenance of Nursery
CO2. Concept on structure, types and dormancy of seeds and brief idea about seed storage including types and process and knowledge on seed production technology
CO3. Knowledge on various modes of vegetative propagation and maintenance of plants in green house
CO4. Brief idea about development and maintenance of gardening including scope and types and understand the various gardening operations including management of pests and diseases
CO5. Detail knowledge on managements of seeds and seedlings and concept about cultivation, storage and

marketing of important vegetables

BOT-SE-4024 : Floriculture

CO1. Basic knowledge including history, importance and scope of floriculture
CO2. Brief idea about Nursery management and garden operations and knowledge on the terms related to gardening and concept about role of plant growth regulators
CO3. Covers the knowledge of various ornamental plants and concept of cultivations of plants in pots and knowledge about Bonsai
CO4. Idea about various garden designs and features of such gardens and knowledge about some famous gardens of India
CO5. Knowledge about the process of making garden more attractive by altering the existing design in places of public importance, highways and educational institute

BOT-SE-4034 : Intellectual Property Right

CO1. Knowledge on IPR, their types and infringement
CO2. Understanding about traditional knowledge and their protection, bio-prospecting and bio-piracy.
CO3. Knowledge on protection of plant varieties, farmer rights
CO4. Knowledge on Information technology related IPR; data, database, chips and domain name protection
CO5. Knowledge on novelty, bio-based patenting, and moral issues associated with biotechnological inventions

BOT-SE-5014 : Medicinal Botany

CO1. Knowledge on medicinal plants and indigenous medicinal sciences/systems of India
CO2. Understanding about the endangered and endemic medicinal plants, conservation issues and types
CO3. Knowledge on ethno-medicinal gardens, nursery and its classifications and components
CO4. Understanding ethno-botany, folk medicines and ethnic communities; Knowledge on applications of ethno-medicine/natural products for treatment of jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases

BOT-SE-5024 : Plant Diversity and Human Welfare

CO1. Understanding diversity of plants at genetic, species and ecosystems level, Knowledge on agro-biodiversity, cultivated and wild taxa, importance of plants and microbes and their uses
CO2. Understanding importance of biodiversity, their loss and management/conservation strategies and types of conservation, Knowledge on various associations/organizations associated with biodiversity conservations
CO3. Understanding sustainable developments, Knowledge on importance of plants in human welfare

BOT-SE-6014 : Ethnobotany

CO1. Understanding the concept of ethno-botany and its relation to other branches of science, Knowledge on ethnic/tribal groups of India, their life styles and plants used by them for various purposes and their role in conservation of medicinal plants
CO2. Knowledge on methodologies of ethno-botanical studies, importance of ethno-botany in modern medicine and to protect the interest of ethnic groups

BOT-SE-6024 : Mushroom Culture Techniques

CO1. Understanding concept of mushroom culture technology, Knowledge on edible and poisonous mushrooms, medicinal values of mushrooms and types of edible mushrooms
CO2. Understanding the cultivation techniques of mushrooms and factors associated with their cultivations, Knowledge on low cost technology for mushroom production
CO3. Knowledge on storage and nutraceutical values of mushrooms, Understanding on food preparations and marketing of mushrooms

Gauhati University

Syllabus for B.Sc.(Honors) Chemistry

Choice Based Credit System (CBCS)

Course effective from academic year 2019-20

This is approved in the Academic Council held on 08/11/2019

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Gauhati University

Guwahati::Assam

Contents

Preamble

The choice based credit system is naturally the next logical step in a credit based semester system. This makes the system the more learner-centric. A CBCS offers the student a diversity of courses to choose from and the autonomy to decide on the place, pace and the time of learning.

The Gauhati University has decided to introduce the CBCS system at the under graduate level from the session 2019-20. The CBCS syllabus for the B.Sc. (Honours) is prepared in the model of syllabus prepared by the UGC.

A student opting for honours course in chemistry must have and passed the Mathematics as a subject in the Senior Secondary level examination.

Course Structure

Course	*Credits Theory+ Practical
I. Core Course **(14 Papers)** **Core Course Practical / Tutorial*** **(14 Papers)**	14×4= 56 14×2= 28
II. Elective Course **(8 Papers)** A.1. Discipline Specific Elective **(4 Papers)** A.2. Discipline Specific Elective Practical/Tutorial***(4 Papers)**	4×4=16 4×2=8
B.1. Generic Elective/ Interdisciplinary **(4 Papers)** B.2. Generic Elective Practical/ Tutorial* **(4 Papers)**	4×4=16 4×2=8
III. Ability Enhancement Courses 1. **Ability Enhancement Compulsory** **(2 Papers of 2 credit each)** Environmental Studies English/MIL Communication 2. **Ability Enhancement Elective** (Skill Based) (Minimum 2) **(2 Papers of 2 credit each)**	2×4=8 2×4=8
Total	**148**

***Core and DSE courses without practicals will have tutorial and have credit distribution of : 5 credits for theory and 1 credit for tutorial, total 6 credits, same as the papers with practical**

Structure of BSc Honours(Chemistry) Programme

Semester	Type	Core	AECC	SEC	DSE	GEN
	Credits	14 × 6 = 84	2 × 4 = 8	2 × 4 = 8	4 × 6 = 24	4 × 6 = 24
I		CHE-HC-1016 CHE-HC-1026	ENG-AE-1014			XXX-HG-1XX6
II		CHE-HC-2016 CHE-HC-2026	ENV-AE-2014			XXX-HG-2XX6
III		CHE-HC-3016 CHE-HC-3026 CHE-HC-3036		CHE-SE-3YY4†		XXX-HG-3XX6
IV		CHE-HC-4016 CHE-HC-4026 CHE-HC-4036		CHE-SE-4YY4†		XXX-HG-4XX6
V		CHE-HC-5016 CHE-HC-5026			CHE-HE-5YY6‡ CHE-HE-5YY6‡	
VI		CHE-HC-6016 CHE-HC-6016			CHE-HE-6YY6‡ CHE-HE-6YY6‡	

SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B. Sc. Honours (Chemistry)

SEMESTER	COURSE CODE	COURSE NAME	Credits
I	ENG-AE-1014	English Communications	4
	CHE-HC-1016	Inorganic Chemistry-I Inorganic Chemistry-I Lab	4+2=6
	CHE-HC-1026	Physical Chemistry-I Physical Chemistry-I Lab	4+2=6
	AAA-HG-1YY6*	GE-1 Generic Elective -1 Practical/Tutorial	4+2/5+1=6
		Total Credits in Semester I	22
II	Ability Enhancement Compulsory Course-II**	Environmental Studies	4
	CHE-HC-2016	Organic Chemistry-I Organic Chemistry-I Lab	4+2=6
	CHE-HC-2026	Physical Chemistry-II Physical Chemistry-II Lab	4+2=6
	AAA-HG-2YY6*	GE-2 Generic Elective -2 Practical/Tutorial	4+2/5+1=6
		Total Credits in Semester II	22
III	CHE-HC-3016	Inorganic Chemistry-II Inorganic Chemistry-II Lab	4+2=6
	CHE-HC-3026	Organic Chemistry-II Organic Chemistry-II Lab	4+2=6
	CHE-HC-3036	Physical Chemistry-III Physical Chemistry-III Lab	4+2=6
	CHE-SE-3YY4†	SEC-1	4
	AAA-HG-3YY6*	GE-3 Generic Elective -3 Practical/Tutorial	4+2/5+1=6
		Total Credits in Semester III	28
IV	CHE-HC-4016	Inorganic Chemistry-III Inorganic Chemistry-III Lab	4+2=6
	CHE-HC-4026	Organic Chemistry-III Organic Chemistry-III Lab	4+2=6
	CHE-HC-4036	Physical Chemistry-IV Physical Chemistry-IV Lab	4+2=6
	CHE-SE-4YY4†	SEC -2	4
	AAA-HG-4YY6*	GE-4 Generic Elective -4 Practical	4+2/5+1=6
		Total Credits in Semester IV	28
V	CHE-HC-5016	Organic Chemistry-IV	4+2=6

		Organic Chemistry-IV Lab	
	CHE-HC-5026	**Physical Chemistry-V**	**4+2=6**
		Physical Chemistry-V Lab	
	CHE-HE-5YY6‡	**DSE-1**	**4+2=6**
		DSE-1 Lab	
	CHE-HE-5YY6‡	**DSE-2**	**4+2=6**
		DSE-2 Lab	
Total Credits in Semester V			**24**
VI	**CHE-HC-6016**	**Inorganic Chemistry-IV**	**4+2=6**
		Inorganic Chemistry-IV Lab	
	CHE-HC-6026	**Organic Chemistry-V**	**4+2=6**
		Organic Chemistry-V Lab	
	CHE-HE-6YY6‡	**DSE-3**	**4+2=6**
		DSE-3 Lab	
	CHE-HE-6YY6‡	**DSE-4**	**4+2=6**
		DSE-3 Lab/tutorial	
Total Credits in Semester VI			**24**
Grand Total Credits			**148**

Generic Electives (Other Discipline) - GE 1 to GE 4

1. Mathematics
2. Physics
3. Economics
4. Computer Science
5. Zoology
6. Botany
7. Statistics
8. Geology
9. Biotechnology
10. Anthropology

**** a) Generic Electives (GE) are to be taken preferably from Physics and Mathematics disciplines.***

b) Students can choose minimum of two GE papers from two different disciplines or four papers from one discipline.

c) Some Universities in India require at least two mathematics papers to be studied by the student for admission into M. Sc. (Chemistry).

‡ Discipline Specific Elective Papers: (Credit: 06 each) (4 papers to be selected)-

DSE for Semester V

DSE-1(Any One from the following)

1. **CHE-HE-5016:** Applications of Computers in Chemistry (4) + Lab (2)
2. **CHE-HE-5026:** Analytical Methods in Chemistry (4) + Lab (2)
3. **CHE-HE-5036:** Molecular Modelling & Drug Design (4) + Lab (2)

DSE-2(Any One from the following)

4. **CHE-HE-5046:** Novel Inorganic Solids (4) + Lab (2)
5. **CHE-HE-5056:** Polymer Chemistry (4) + Lab (2)
6. **CHE-HE-5066:** Instrumental Methods of Analysis (4) + Lab (2)

DSE for Semester VI

DSE-3(Any One from the following)

7. **CHE-HE-6016:** Green Chemistry (4) + Lab (2)
8. **CHE-HE-6026:** Industrial Chemicals & Environment (4) + Lab (2)
9. **CHE-HE-6036:** Inorganic Materials of Industrial Importance (4) + Lab (2)

DSE-4(Any One from the following)

10. **CHE-HE-6046:** Research Methodology for Chemistry (5) + Tutorials (1)
11. **CHE-HE-6056:** Dissertation

† Skill Enhancement Courses (04 papers) (Credit: 04 each)

SEC for Semester III

Any One from the following

1. **AAA-SE-3014 :** English (Syllabus will be available on the GU website)
2. **CHE-SE-3024:** IT Skills for Chemists
3. **CHE-SE-3034:** Basic Analytical Chemistry
4. **CHE-SE-3044:** Chemical Technology & Society
5. **CHE-SE-3054:** Chemoinformatics
6. **CHE-SE-3064:** Business Skills for Chemists
7. **CHE-SE-3074:** Intellectual Property Rights

SEC for Semester IV

Any One from the following

8. **CHE-SE-4014:** Analytical Clinical Biochemistry
9. **CHE-SE-4024:** Green Methods in Chemistry
10. **CHE-SE-4034:** Pharmaceutical Chemistry
11. **CHE-SE-4044:** Chemistry of Cosmetics & Perfumes
12. **CHE-SE-4054:** Pesticide Chemistry
13. **CHE-SE-4064:** Fuel Chemistry

****Ability Enhancement Compulsory Courses (02 papers) (Credit: 04 each)**

AECC for Semester I

1. **ENG-AE-1014: English Communications** (https://sites.google.com/a/gauhati.ac.in/syllabus-ug-cbcs/aecc/english-a)

AECC for Semester II

2. **ENV-AE-2014: Environmental Studies** (Syllabus will be available on the GU website)

CORE COURSE (HONOURS IN CHEMISTRY)

Semester I

CHE-HC-1016: INORGANIC CHEMISTRY-I

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

***Course Objectives**: This course aims at giving students theoretical understanding about the basic constituents of matter – atoms, ions and molecules in terms of their electronic structure and reactivity. Structure and bonding in/of these are to be dealt with basic quantum chemistry treatment. Reactivity of chemical species based on their electron transfer affinity is introduced. Further, periodic classification of elements in the periodic table and changes in properties along the periods and groups to be studied in detail. Accompanying laboratory course is designed for students to have hands-on experience of basic quantitative analytical techniques related to volumetric titrations.*

***Learning Outcome:** On successful completion, students would have clear understanding of the concepts related to atomic and molecular structure, chemical bonding, periodic properties and redox behaviour of chemical species. Students will also have hands on experience of standard solution preparation in different concentration units and learn volumetric estimation through acid-base and redox reactions.*

Atomic Structure:

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

(14 Lectures)

Periodicity of Elements:

s, *p*, *d*, *f* block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to *s* & *p*-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
(b) Atomic radii (van der Waals)
(c) Ionic and crystal radii.
(d) Covalent radii (octahedral and tetrahedral)
(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
(f) Electron gain enthalpy, trends of electron gain enthalpy.
(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

(16 Lectures)

Chemical Bonding:
(i) *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.
(ii) *Covalent bond:* Lewis structure, Valence Bond theory (Heitler-London approach).
Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule,
Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl,BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths.
Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.
Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.
(iii) *Metallic Bond:* Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
(iv) *Weak Chemical Forces:* van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions.Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

(26 Lectures)

Oxidation-Reduction:
Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.

(4 Lectures)

Recommended Books:

1. Lee, J. D. Concise Inorganic Chemistry, 5th Ed., Oxford University Press, 2008.
2. Douglas, B.E. and Mc Daniel, D.H., Concepts and Models of Inorganic Chemistry, 3rd Ed. Wiley India, 2006.
3. Cotton, F.A., Wilkinson, G. and Gaus, P. L., Basic Inorganic Chemistry, 3rd Ed., Wiley, 2007.
4. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. 6th Ed., Wiley-VCH, 2007.
5. Atkins, P.W. & Paula, J. Physical Chemistry, 11th Ed., Oxford University Press, 2018.
6. Housecroft, C. E. and Sharpe, A. G. Inorganic Chemistry, 5th Ed., Pearson, 2018.
7. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, Literary Licensing, LLC, 2012.

LAB

60 Lectures

(A) Titrimetric Analysis

(i) Calibration and use of common laboratory apparatus
(ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.
(ii) Estimation of carbonate and bicarbonate present together in a mixture.
(iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(ii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Recommended Books:

1. Mendham, J. et al.: Vogel's Text Book of Quantitative Chemical Analysis; 6th Ed. Pearson Education, 2009.

CHE-HC-1026: PHYSICAL CHEMISTRY I

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course objective: *This course contains states of matter- gaseous, liquid and solid sates along with ionic equilibria. A small unit of molecular and crystal symmetry is also there in the course.*

Learning outcome: *In gaseous state unit the students will learn the kinetic theory of gases, ideal gas and real gases. In liquid state unit, the students are expected to learn the qualitative treatment of the structure of liquid along with the physical properties of liquid, viz, vapour pressure, surface tension and viscosity. In the molecular and crystal symmetry unit they will be introduced to the elementary idea of symmetry which will be useful to understand solid state chemistry and group theory in some higher courses. In solid state unit the students will learn the basic solid state chemistry application of x-ray crystallography for the determination of some very simple crystal structures. The students will also learn another important topic "ionic equilibria" in this course.*

Gaseous state:

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.

Maxwell distribution and its use in evaluating molecular velocities (average, root meansquare and most probable) and average kinetic energy.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, *Z*, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. Van der Waals equation of state, its derivation and application in explaining real gas behaviour,mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

(18 Lectures)

Liquid state:

Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.

Qualitative discussion of structure of water.

(6 Lectures)

Molecular and Crystal Symmetry

Elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices.

(6 Lectures)

Solid state:

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices,; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Liquid crystals (Introductory idea)

(10 Lectures)

Ionic equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases,pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment).

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity,buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.

Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.

Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

(20 Lectures)

Recommended Books:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press (2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
5. Puri, B. R.; Sharma, L. R.; Pathania, M. S. Principles of Physical Chemistry, Vishal Publishing Co. (2017)
6. Kapoor, K. L. A Textbook of Physical Chemistry (Volume 1) McGraw Hill Education; Sixth edition (2019)

LAB

60 Lectures

1. **Surface tension measurements.**
    a. Determine the surface tension by (i) drop number (ii) drop weight method.
    b. Study the variation of surface tension of detergent solutions with concentration.
2. **Viscosity measurement using Ostwald's viscometer**.
    a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
    b. Study the variation of viscosity of sucrose solution with the concentration of solute.

3. Indexing of a given powder diffraction pattern of a cubic crystalline system.

4. pH metry

a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
b. Preparation of buffer solutions of different pH
    i. Sodium acetate-acetic acid
    ii. Ammonium chloride-ammonium hydroxide
c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
d. Determination of dissociation constant of a weak acid.

Recommended Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.*; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

Semester II

CHE-HC-2016: ORGANIC CHEMISTRY I

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objectives: *This course is inducted to apprise students with introduction to organic compounds, electron displacement, type of reagents and reaction intermediates. The chemistry of aliphatic and aromatic hydrocarbon, conformational analysis of cycloalkanes and basic stereochemical phenomena are included.*

Students are expected to learn different classes learn, explain, describe and analyze different classes of organic compounds, their reactivities and mechanisms along with stereo chemical considerations.

Learning Outcome: *Students will be able to identify different classes of organic compounds, describe their reactivity and explain/analyze their chemical and stereo chemical aspects.*

Basics of Organic Chemistry

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules,Influence of hybridization on bond properties.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.

Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges;Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

(8 Lectures)

Stereochemistry:
Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

(16 Lectures)

Chemistry of Aliphatic Hydrocarbons

A. Carbon-Carbon sigma bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

B. Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions and their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation,ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

C. Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

(24 Lectures)

Aromatic Hydrocarbons

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

(12 Lectures)

Recommended Books:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. *Organic Chemistry* (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.

4. Nasipuri, D. *Stereochemistry of Organic Compounds*, Wiley Eastern Limited.

5. Kalsi, P. S. *Stereochemistry Conformation and Mechanism*, New Age International, 2005.

6. Subrata Sen Gupta, *Basic Stereochemistry of Organic Molecules*, Oxford Higher Education.

7. Dhillon, R. S.; Singh, I. P. & Baskar, C. *Stereochemistry*, Narosa.

8. Loudon, G. M. *Organic Chemistry*, Oxford.

9. Sykes, P. *A guidebook to Mechanism in Organic Chemistry,* Pearson Education, 2003.

10. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry,* Second edition, Oxford University Press, 2012.

LAB

60 Lectures

1. Checking the calibration of the thermometer

2. Purification of organic compounds by crystallization using the following solvents:
    a. Water
    b. Alcohol
    c. Alcohol-Water

3. Determination of the melting points of above compounds and unknown organic Compounds.
4. Effect of impurities on the melting point – mixed melting point of two unknown organic Compounds.
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and use of thiele tube method)

6. Chromatography
    a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
    b. Separation of a mixture of two sugars by ascending paper chromatography
    c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Recommended Books

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009).

2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson (2012)

3. Vogel, A. I. *Elementary Practical Organic Chemistry*, Part 2: *Qualitative Organic Analysis*, CBS Publishers and Distributors.

4. Bhattacharyya, R. C, *A Manual of Practical Chemistry.*

5. Dutta, S, *B. Sc. Honours Practical Chemistry*, Bharati Book Stall.

CHE-HC-2026: PHYSICAL CHEMISTRY II

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objective: *In this course the chemical thermodynamics, chemical equilibrium, solutions and colligative properties will be taught to the students. Another unit of this course is systems of variable compositions.*

Learning Outcome: *In this course the students are expected to learn laws of thermodynamics, thermochemistry, thermodynamic functions, relations between thermodynamic properties, Gibbs Helmholtz equation, Maxwell relations etc. Moreover the students are expected to learn partial molar quantities, chemical equilibrium, solutions and colligative properties. After completion of this course, the students will be able to understand the chemical systems from thermodynamic point of view.*

Chemical Thermodynamics:

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law: Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; spontaneous process-enthalpy change, entropy change and free energy change considerations. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

(36 Lectures)

Systems of Variable Composition:
Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

(8 Lectures)

Chemical Equilibrium:
Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p, K_c and K_x. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

(8 Lectures)

Solutions and Colligative Properties:
Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions.

Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point,(iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

(8 Lectures)

Recommended Books

1. Peter, A. & Paula, J. de. *Physical Chemistry 9th Ed.*, Oxford University Press (2011).
2. Castellan, G. W. *Physical Chemistry 4th Ed.*, Narosa (2004).
3. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).
4. McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
6. Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill (2010).
7. Metz, C.R. *2000 solved problems in chemistry,* Schaum Series (2006)
8. Puri, B. R.; Sharma, L. R.; Pathania, M. S. Principles of Physical Chemistry, Vishal Publishing Co.; 47th Ed. (2017)
9. Kapoor, K. L. A Textbook of Physical Chemistry (Volume 2) McGraw Hill Education; Sixth edition (2019)

LAB

60 Lectures

Thermochemistry
(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).

(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(c) Calculation of the enthalpy of ionization of ethanoic acid.

(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
(e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.

(f) Determination of enthalpy of hydration of copper sulphate.

(g) Study of the solubility of benzoic acid in water and determination of ΔH.

Any other experiment carried out in the class.

Recommended Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
2. Athawale, V. D. & Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi (2001).

Semester III

CHE-HC-3016: INORGANIC CHEMISTRY-II

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objective: *This course starts with the basic principles of metallurgy so as to acquaint the students with the application of the redox chemistry they have learnt in the earlier course on inorganic chemistry. Concepts of protonic and non-protonic acids and bases are introduced for students to appreciate different types of chemical reactions. Periodic behavior of s and p block elements related to their electronic structure and their reactivity is included to acquaint students with the principles governing their reactivity. This course further intend to apprise students about the variety of compounds of the main group elements including oxides, hydrides, nitrides, interhalogens, noble gases and inorganic polymers. As part of the accompanying lab course, experiments involving iodo- and iodi-metric titrations are included for the students to explore other varieties of redox titration. Preparation of simple inorganic compounds is introduced to give hands-on experience of inorganic synthesis.*
Learning Outcome: *On successful completion of this course students would be able to apply theoretical principles of redox chemistry in the understanding of metallurgical processes.*

Students will be able to identify the variety of s and p block compounds and comprehend their preparation, structure, bonding, properties and uses. Experiments in this course will boost their quantitative estimation skills and introduce the students to preparative methods in inorganic chemistry.

General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

(6 Lectures)

Acids and Bases

Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids,types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle.

(8 Lectures)

Chemistry of *s* and *p* Block Elements:

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of *s* and *p* block elements.

Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrogen compounds, boranes, carboranes and graphitic compounds, silanes, oxides and oxoacids of nitrogen, phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

(30 Lectures)

Noble Gases:

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).

(8 Lectures)

Inorganic Polymers:

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Silicates – clays and zeolites, polyphosphazenes, metal-organic framework compounds (MOFs).

(8 Lectures)

Recommended Books:

1. Lee, J. D., Concise Inorganic Chemistry, 5th Ed., Oxford University Press, 2008.
2. Douglas, B.E. and Mc Daniel, D.H., Concepts and Models of Inorganic Chemistry, 3rd Ed. Wiley India, 2006.
3. Greenwood, N.N. & Earnshaw, A., Chemistry of the Elements, 2nd Ed., Elsevier India, 2010.

4. Cotton, F.A., Wilkinson, G. and Gaus, P. L., Basic Inorganic Chemistry, 3rd Ed., Wiley, 2007.
5. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. 6th Ed., Wiley-VCH, 2007.
6. Miessler, G. L. & Tarr, D. A., Inorganic Chemistry 4th Ed., Pearson, 2010.
7. Weller, M., Armstrong, F., Rourke, J. & Overton, T., Inorganic Chemistry 6th Ed. 2015.

LAB

60 Lectures

(A) Iodo / Iodimetric Titrations

(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).

(ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically

(iii) Estimation of available chlorine in bleaching powder iodometrically.

(B) Inorganic preparations

(i) Cuprous Chloride, CuCl

(ii) Preparation of manganese(III) phosphate, $MnPO_4.H_2O$

(iii) Preparation of aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

Recommended Books:

1. Mendham, J. et al.: Vogel's Text Book of Quantitative Chemical Analysis ; 6th Ed. Pearson Education, 2009.
2. Marr, G. and Rockett, R.W. *Practical Inorganic Chemistry*, Van Nostrand Reinhold. 1972.

CHE-HC-3026: ORGANIC CHEMISTRY-II

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Course Objectives: *This course is intended to apprise students about different classes of organic compounds, including halogenated hydrocarbons, alcohols, phenols, epoxides, carbonyl compounds and carboxylic and sulfonic acids.*

Students are expected to learn and differentiate between various organic functional groups; explain, analyze and design transformations between different functional groups.

Learning Outcome: *Students will be able to describe and classify organic compounds in terms of their functional groups and reactivity.*

Chemistry of Halogenated Hydrocarbons:

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

(16 Lectures)

Alcohols, Phenols, Ethers and Epoxides:

Alcohols: preparation,properties and relative reactivity of 1°,2°,3°alcohols, Bouveault-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

(**16 Lectures)**

Carbonyl Compounds:

Preparation, properties, structure and reactivity;

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$,$NaBH_4$, MPV, PDC and PGC);

Addition reactions of unsaturated carbonyl compounds: Michael addition.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

(**14 Lectures)**

Carboxylic Acids and their Derivatives:

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids;

Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmannbromamide degradation and Curtius rearrangement.

(10 Lectures)

Sulphur containing compounds:
Preparation and reactions of thiols, thioethers and sulphonic acids.

(4 Lectures)

Recommended Books:

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3. Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.

4. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry*, Second edition, Oxford University Press, 2012.

5. Keeler, J., Wothers, P. *Chemical Structure and Reactivity – An Integrated approach*, Oxford University Press.

6. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.

7. Carey, F. A.; Sundberg, R. J. *Advanced Organic Chemistry: Reactions and Synthesis (Part B)*, Springers.

LAB

60 Lectures

1. Test of functional groups like alcohols, phenols, carbonyl and carboxylic acid group.
2. Organic preparations:
    - i. Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*toluidines *o*-, *m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method:
        - a. Using conventional method.
        - b. Using green approach
    - ii. Benzolyation of one of the following amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine) and one of the following phenols (β-naphthol, resorcinol, pcresol) by Schotten-Baumann reaction.
    - iii. Oxidation of ethanol/ isopropanol (Iodoform reaction).
    - iv. Bromination of any one of the following:
        - a. Acetanilide by conventional methods
        - b. Acetanilide using green approach (Bromate-bromide method)
    - v. Nitration of any one of the following:
        - a. Acetanilide/nitrobenzene by conventional method
        - b. Salicylic acid by green approach (using ceric ammonium nitrate).

vi. Selective reduction of *meta* dinitrobenzene to *m*-nitroaniline.
vii. Reduction of *p*-nitrobenzaldehyde by sodium borohydride.
viii. Hydrolysis of amides and esters.
ix. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
x. *S*-Benzylisothiouronium salt of one each of water soluble and water insoluble acids(benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
xi. Aldol condensation using either conventional or green method.
xii. Benzil-Benzilic acid rearrangement.

The above preparations should be done using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.

Recommended Books

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)

2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson (2012)

3. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press (2000).

4. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis*, University Press (2000).

5. Vogel, A. I. *Elementary Practical Organic Chemistry*, Part 1: *Small scale Preparations*, CBS Publishers and Distributors.

CHE-HC-3036: PHYSICAL CHEMISTRY-III

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objective: *The aim of this course is to teach students four important topics of physical chemistry- phase equilibria, chemical kinetics, surface chemistry and catalysis. Phase equilibria and chemical kinetics will be discussed in detail but surface chemistry and catalysis will be introduced to the students.*

Learning Outcome:*The students are expected to learn phase rule and its application in some specific systems. They will also learn rate laws of chemical transformation, experimental methods of rate law determination, steady state approximation etc. in chemical kinetics unit. After attending this course the students will be able to understand different types of surface adsorption processes and basics of catalysis including enzyme catalysis, acid base catalysis and particle size effect on catalysis.*

Phase Equilibria:

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solidliquid,liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications.

Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation.

Nernst distribution law: its derivation and applications.

(28 Lectures)

Chemical Kinetics

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (iv) chain reactions.

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Reaction mechanism- steady-state approximation and rate determining step approximation methods.

(18 Lectures)

Catalysis:

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

(8 Lectures)

Surface chemistry:

Physical adsorption, chemisorption, adsorption isotherms, nature of adsorbed state.

(6 Lectures)

Recommended Books:

1. Peter Atkins & Julio De Paula, *Physical Chemistry 9th Ed.,* Oxford University Press(2010).
2. Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
3. McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.:New Delhi (2004).
4. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
6. Zundhal, S.S. *Chemistry concepts and applications* Cengage India (2011).
7. Ball, D. W. *Physical Chemistry* Cengage India (2012).
8. Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).
9. Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill (2011).
10. Metz, C. R. *Physical Chemistry 2nd Ed.,* Tata McGraw-Hill (2009).

11. Puri, B. R.; Sharma, L. R.; Pathania, M. S. Principles of Physical Chemistry, Vishal Publishing Co.; 47th Ed. (2017)
12. Kapoor, K. L. A Textbook of Physical Chemistry (Volume 5) McGraw Hill Education; 5th edition (2017)

LAB

60 Lectures

I. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.

II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:

a. simple eutectic and

b. congruently melting systems.

III. Distribution of acetic/ benzoic acid between water and cyclohexane.

IV. Study the equilibrium of at least one of the following reactions by the distribution method:

(i) $I_2(aq) + I \rightarrow I_3(aq)^{2+}$

(ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$

V. Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:
    a. Acid hydrolysis of methyl acetate with hydrochloric acid.
    b. Saponification of ethyl acetate.
3. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

VI. Adsorption

I. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Recommended Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.*; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

Semester IV

CHE-HC-4016: INORGANIC CHEMISTRY-III

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objective: *This course introduces students to coordination chemistry. Various aspects like nomenclature, structure, bonding, variety and reactivity of the coordination compounds are included for the students to appreciate.*
Bioinorganic chemistry is included in this course to acquaint students on the useful and harmful aspects of metals in biological systems.
Through the accompanying lab course, experiments related to gravimetric analysis, synthesis of coordination compounds and separation of metal ions using chromatography is included. This will broaden the experimental skills of the students where students will learn about various aspects of experiment design depending upon the requirements like synthesis, estimation or separation.
Learning Outcome: *On successful completion, students will be able name coordination compounds according to IUPAC, explain bonding in this class of compounds, understand their various properties in terms of CFSE and predict reactivity. Students will be able to appreciate the general trends in the properties of transition elements in the periodic table and identify differences among the rows.*
Through the experiments students not only will be able to prepare, estimate or separate metal complexes/compounds but also will be able to design experiments independently which they should be able to apply if and when required.

Coordination Chemistry:
Coordination compounds, types of ligands, Werner's theory, IUPAC nomenclature and isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers.

Valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δ_o), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δ_o, Δ_t).Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspects of ligand field and MO Theory.
Chelate effect, polynuclear complexes, labile and inert complexes.

(26 Lectures)

Transition Elements:

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Frost diagrams). Difference between the first, second and third transition series.

Chemistry of Ti, V, Cr Mn, Fe and Co (Chemistry of first -row transition elements) in various oxidation states as halides, oxides, hydroxides.

(18 Lectures)

Lanthanoids and Actinoids:
Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

(6 Lectures)

Bioinorganic Chemistry:
Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine.

Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

(10 Lectures)

Recommended Books:

1. Cotton, F.A., Wilkinson, G. and Gaus, P. L., Basic Inorganic Chemistry, 3rd Ed., Wiley, 2007.
2. Huheey, J. E., Keiter, E. A., Keiter, R. L., Medhi, O. K., Inorganic Chemistry: Principles of Structure and Reactivity, 4th Ed., Pearson Education India, 2006.
3. Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry, Panima Publishing Company, 1994.
4. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. 6th Ed., Wiley-VCH, 2007.
5. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
6. Greenwood, N.N. & Earnshaw, A., Chemistry of the Elements, 2nd Ed., Elsevier India, 2010.

LAB

60 Lectures

Gravimetric Analysis:

i. Estimation of nickel(II) using dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN
iii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.
iv. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).

Inorganic Preparations:

i. Tetraamminecopper(II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
ii. *Cis* and *trans* $K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III)
iii. Tetraamminecarbonatocobalt (III) ion
iv. Potassium tris(oxalato)ferrate(III)

Chromatography of metal ions
Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i. Ni(II) and Co(II)
ii. Fe(III) and Al(III)

Recommended Book:

1. Mendham, J. et al.: Vogel's Textbook of Quantitative Chemical Analysis ; 6th Ed. Pearson Education, 2009.

2. Marr, G. and Rockett, R.W. *Practical Inorganic Chemistry*, Van Nostrand Reinhold. 1972.
3. *Inorganic Syntheses*, Vol. 1-10.

CHE-HC-4026: ORGANIC CHEMISTRY-III

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objectives*: The course intrudes students to different classes of N-based compounds, including alkaloids and terpenoids and their potential application.*

Students are expected to learn about different classes of N-based compounds; their structures, synthesis and reactivity.

Learning Outcome: *Students shall demonstrate the ability to identify and classify different types of N-based derivatives, alkaloids and hetrocyclic compounds/explain their structure mechanism and reactivity/critically examine their synthesis and reactions mechanism.*

Nitrogen Containing Functional Groups

Preparation and important reactions of nitro and compounds, nitriles and isonitriles

Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2°and 3° amines with Hinsberg reagent and nitrous acid.

Diazonium Salts: Preparation and their synthetic applications.

(18 Lectures)

Polynuclear Hydrocarbons

Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.

(8 Lectures)

Heterocyclic Compounds
Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom;
Synthesis, reactions and mechanism of substitution reactions of:
Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis),Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine.
Indole: Fischer indole synthesis and Madelung synthesis).

Quinoline and isoquinoline: Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner- Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction

(22 Lectures)

Alkaloids

Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

(6 Lectures)

Terpenes

Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral, Neral and α-terpineol.

(6 Lectures)

Recommended Books:

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

4. Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc.

5. Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P) Ltd. Pub.

6. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry*, Oxford University Press.

7. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan (2010).

(2010).

LAB

60 Lectures

1. Detection N, S, halogens in organic compounds.
2. Functional group test for nitro, amine and amide groups.
3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)

Recommended Books

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic*

Chemistry, 5th Ed., Pearson (2012)
3. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press (2000).
4. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis*, University Press (2000).

CHE-HC-4036: PHYSICAL CHEMISTRY-IV

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objective: *The aim of this course is to introduce students with primarily two areas of physical chemistry- electrochemistry and electrical and magnetic properties of atoms and molecules. It contains three units- conductance, electrochemistry and electrical & magnetic properties of atoms and molecules.*

Learning Outcome: *In this course the students will learn theories of conductance and electrochemistry. Students will also understand some very important topics such as solubility and solubility products, ionic products of water, conductometric titrations etc. The students are also expected to understand the various parts of electrochemical cells along with Faraday's Laws of electrolysis. The students will also gain basic theoretical idea of electrical & magnetic properties of atoms and molecules.*

Conductance
Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivityand their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules.

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

(20 Lectures)

Electrochemistry
Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials.

Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation). Applications of electrolysis in metallurgy and industry.

(28 Lectures)

Electrical & Magnetic Properties of Atoms and Molecules
Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.

(12 Lectures)

Recommended Books:

1. Atkins, P.W & Paula, J.D. *Physical Chemistry*, 9th Ed., Oxford University Press (2011).
2. Castellan, G. W. *Physical Chemistry 4th Ed.*, Narosa (2004).
3. Mortimer, R. G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP (2009).
4. Barrow, G. M., *Physical Chemistry 5th Ed.*, Tata McGraw Hill: New Delhi (2006).
5. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).
6. Rogers, D. W. *Concise Physical Chemistry* Wiley (2010).
7. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. *Physical Chemistry 4th Ed.*, John Wiley & Sons, Inc. (2005).
8. Puri, B. R.; Sharma, L. R.; Pathania, M. S. Principles of Physical Chemistry, Vishal Publishing Co.; 47th Ed. (2017)
9. Kapoor, K. L. A Textbook of Physical Chemistry (Volume 1) McGraw Hill Education; Sixth edition (2019)

LAB

60 Lectures

Conductometry

I. Determination of cell constant
II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
III. Perform the following conductometric titrations:
- i. Strong acid vs. strong base
- ii. Weak acid vs. strong base
- iii. Mixture of strong acid and weak acid vs. strong base
- iv. Strong acid vs. weak base

Potentiometry

I Perform the following potentiometric titrations:
- i. Strong acid vs. strong base
- ii. Weak acid vs. strong base
- iii. Dibasic acid vs. strong base
- iv. Potassium dichromate vs. Mohr's salt

Recommended Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R.

Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

Semester V

CHE-HC-5016: ORGANIC CHEMISTRY-IV

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objectives*: This course introduces students to nucleic acids, amino acids and pharmaceutical compounds.*

Students will be familiarized with the importance of nucleic acids, amino acids and develop basic understanding of enzymes, bioenergetics and pharmaceutical compounds.

Learning Outcome*: Students will be able to explain/describe the important features of nucleic acids, amino acids and enzymes and develop their ability to examine their properties and applications.*

Nucleic Acids
Components of nucleic acids; Nucleosides and nucleotides;

Synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine;
Polynucleotides: DNA and RNA

(9 Lectures)

Amino Acids, Peptides and Proteins

Amino acids, Peptides and their classification.

α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pK_a values, isoelectric point and electrophoresis;

Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis

(16 Lectures)

Enzymes
Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes.
Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action

(including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

(8 Lectures)

Lipids

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenntion of fats and oils, saponification value, acid value, iodine number, rancidity.

(6 Lectures)

Concept of Energy in Biosystems

Cells obtain energy by the oxidation of foodstuff (organic molecules).
Introduction to metabolism (catabolism, anabolism).
ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change.
Agents for transfer of electrons in biological redox systems: NAD^+, FAD.
Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis, fermentation, Krebs cycle.
Overview of catabolic pathways of fat and protein.
Interrelationship in the metabolic pathways of protein, fat and carbohydrate.
Calorific value of food, standard calorie content of food types.

(9 Lectures)

Pharmaceutical Compounds: Structure and Importance

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (turmeric), azadirachtin (neem), vitamin C and antacid (ranitidine).

(12 Lectures)

Recommended Books:

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.
2. Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.

LAB

60 Lectures

1. Estimation of glycine by Sorenson's formalin method.
2. Study of the titration curve of glycine.
3. Estimation of proteins by Lowry's method.
4. Study of the action of salivary amylase on starch at optimum conditions.
5. Effect of temperature on the action of salivary amylase.
6. Saponification value of an oil or a fat.
7. Determination of Iodine number of an oil/ fat.
8. Isolation and characterization of DNA from onion/ cauliflower/peas.

Recommended Books:

1. Arthur, I. V. *Quantitative Organic Analysis*, Pearson.

2. Plummer, D. T. *An Introduction to Practical Biochemistry*, 3rd Edition, McGraw Hill.

CHE-HC-5026: PHYSICAL CHEMISTRY V

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objective: *The aim of this course is to introduce the students with three important areas- quantum chemistry, molecular spectroscopy and photochemistry. In quantum chemistry unit the students will be taught the postulates of quantum mechanics and the application of quantum mechanical ideas in some simple systems such as particle in a box, rigid rotor, simple harmonic oscillator etc. In spectroscopy unit, rotational, vibrational, Raman, electronic, spin resonance, and electronic spectroscopy will be introduced.*

Learning Outcome: *After completion of this course the students are expected to understand the application of quantum mechanics in some simple chemical systems such as hydrogen atom or hydrogen like ions. The students will also learn chemical bonding in some simple molecular systems. They will able to understand the basics of various kinds of spectroscopic techniques and photochemistry.*

Quantum Chemistry:

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy Extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.

Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.

Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).
Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

(24 Lectures)

Molecular Spectroscopy:
Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

(24 Lectures)

Photochemistry
Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

(12 Lectures)

Recommended Books:

1. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata
   McGraw-Hill: New Delhi (2006).
2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
3. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
4. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
5. Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015).

6. Kapoor, K. L. A Textbook of Physical Chemistry (Volume 4) McGraw Hill Education; 5th edition (2017)
7. Sen, B. K. Quantum Chemistry- Including Spectroscopy, Kalyani Publishers; 4th edition (2011)
8. McQuarrie, D. A. Quantum Chemistry, Viva Books (2016)

LAB

60 Lectures

UV/Visible spectroscopy

I. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV).
II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.
III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Colourimetry

I. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration
II. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.
III. Study the kinetics of iodination of propanone in acidic medium.
IV. Determine the amount of iron present in a sample using 1,10-phenathroline.
V. Determine the dissociation constant of an indicator (phenolphthalein).
VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.
VII. Analysis of the given vibration-rotation spectrum of HCl(g)

Recommended Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

Semester VI

CHE-HC-6016: INORGANIC CHEMISTRY-IV

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objective: *The unit on reaction mechanism is included for the students to get acquainted with the kinetic and thermodynamic factors governing the reaction path and stability of inorganic compounds.*
Organometallic compounds are introduced so as to apprise students about the importance of metal carbon bond to form complexes and their application as catalysts. Students are expected to learn factors leading to stability of organometallic compounds, their synthesis, reactivity and uses.
Qualitative inorganic analysis is included to give students an idea and hands on experience of application of inorganic chemistry. Students should learn how differential reactivity under different conditions of pH can be used to identify variety of ions in a complex mixture.
Experiments related to synthesis and characterization of coordination compounds are included to supplement their theoretical knowledge.

Learning Outcome: *By studying this course the students will be expected to learn about how ligand substitution and redox reactions take place in coordination complexes.*
Students will also learn about organometallic compounds, comprehend their bonding, stability, reactivity and uses. They will be familiar with the variety of catalysts based on transition metals and their application in industry.
On successful completion, students in general will be able to appreciate the use of concepts like solubility product, common ion effect, pH etc. in analysis of ions and how a clever design of reactions, it is possible to identify the components in a mixture.
With the experiments related to coordination compound synthesis, calculation of 10Dq, controlling factors etc. will make the students appreciate the concepts of theory in experiments.

Mechanism of Inorganic Reactions
Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans-effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes. Electron transfer reactions.

(18 Lectures)

Organometallic Compounds
Definition and classification of organometallic compounds on the basis of bond type.
Concept of hapticity of organic ligands.
Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.
Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.
Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich

condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

(22 Lectures)

Transition Metals in Catalysis

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinson's Catalyst)
2. Hydroformylation (Co catalysts)
3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)
5. Synthesis gas by metal carbonyl complexes

(10 Lectures)

Theoretical Principles in Qualitative Inorganic Analysis (H_2S Scheme)

Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.

(10 Lectures)

Recommended Books:

1. Vogel, A.I. *Qualitative Inorganic Analysis*, Longman, 1972.
2. Svehla, G. & Sivasankar, B., *Vogel's Qualitative Inorganic Analysis*, 7th Ed., Prentice Hall, 2012.
3. Cotton, F.A., Wilkinson, G. and Gaus, P. L., *Basic Inorganic Chemistry*, 3rd Ed., Wiley, 2007.
4. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. 6th Ed., Wiley-VCH, 2007.
5. Huheey, J. E., Keiter, E. A., Keiter, R. L., Medhi, O. K., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th Ed., Pearson Education India, 2006.
6. Sharpe, A.G. *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005
7. Douglas, B.E. and Mc Daniel, D.H., Concepts and Models of Inorganic Chemistry, 3rd Ed. Wiley India, 2006.
8. Greenwood, N.N. & Earnshaw, A., Chemistry of the Elements, 2nd Ed., Elsevier India, 2010.
9. Lee, J. D., Concise Inorganic Chemistry, 5th Ed., Oxford University Press, 2008.
10. Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
11. Shriver, D.D. & Atkins, P., *Inorganic Chemistry 2nd Ed.*, Oxford University Press, 1994.
12. Basolo, F. & Person, R. *Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution* 2nd Ed.., John Wiley & Sons Inc; NY.
13. Purcell, K.F. & Kotz, J.C., *Inorganic Chemistry*, W.B. Saunders Co. 1977
14. Miessler, G. L. & Tarr, D. A., Inorganic Chemistry 4th Ed., Pearson, 2010.
15. Crabtree, Robert H. *The Organometallic Chemistry of the Transition Metals. j* New York, NY: John Wiley, 2000.
16. Spessard, Gary O., &Gary L. Miessler. *Organometallic Chemistry*. Upper Saddle River, NJ: Prentice-Hall, 1996.

LAB

60 Lectures

- Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested: CO_3^{2-} , NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+},, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}
- Mixtures should preferably contain one interfering anion, **or** insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) **or** combination of anions e.g. $CO_3^{2-}$and SO_3^{2-}, NO_2 and NO_3^-, Cl^- and Br^-, Cl^- and I^-, Br^- and I^-, NO_3^- and Br^-, NO_3^- and I^-.
- Spot tests should be done whenever possible.
- Synthesis of ammine complexes of Ni(II) and their ligand exchange reactions involving bidentate ligands like acetylacetone, dimethylglyoxime, glycine, etc.
- Preparation of acetylacetanato complexes of Cu^{2+}/Fe^{3+}.
- Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs. thermodynamic factors.
- Determination of ε_{max} value from UV-visible spectra of complexes.
- Measurement of 10 Dq by spectrophotometric method, verification of spectrochemical series.

Recommended Books

1. Vogel's *Qualitative Inorganic Analysis*, Revised by G. Svehla.
2. Marr, G. and Rockett, R.W. *Practical Inorganic Chemistry*, Van Nostrand Reinhold. 1972.

CHE-HC-6026: ORGANIC CHEMISTRY-V

(Credits: Theory-04, Lab -02)

Theory: 60 Lectures

(24 Lectures)

Course Objectives: *This is a basic course in organic spectroscopy and provides introduction to carbohydrate chemistry, dyes and polymers.*

Students are expected to learn about the different spectroscopic techniques and their applications in organic chemistry. Students shall be apprised with carbohydrate chemistry, dyes and polymers and their structure, reactivity and chemical properties.

Learning Outcome: *Students will be able to explain/describe basic principles of different spectroscopic techniques and their importance in chemical/organic analysis. Students shall be able to classify/identify/critically examine carbohydrates, polymers and dye materials.*

Spectroscopy

Introduction to absorption and emission spectroscopy.

UV Spectroscopy: Types of electronic transitions, λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward

Rules for calculation of λmax for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpetation of NMR spectra of simple compounds.

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

Applications of IR, UV and NMR for identification of simple organic and inorganic molecules.

(24 Lectures)

Carbohydrates

Occurrence, classification and their biological importance.

Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation;

Disaccharides – Structure elucidation of maltose, lactose and sucrose.

Polysaccharides – Elementary treatment of starch, cellulose and glycogen.

(16 Lectures)

Dyes

Classification, Colour and constitution; Mordant and Vat Dyes; Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet; Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes synthesis of Alizarin and Indigotin; Edible Dyes with examples.

(8 Lectures)

Polymers

Introduction and classification.

Number average molecular weight, Weight average molecular weight, Degree of polymerization, Polydispersity Index.

Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene);

Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives;

Introduction to liquid crystal polymers; Biodegradable and conducting polymers with examples.

(12 Lectures)

Recommended Books:

1. Banwell, C. N. & Mc.Cash, E. M. *Fundamentals of Molecular Spectroscopy*, 4th Edition, McGraw Hill.

2. Pavia, Lampman, Kriz & Vyvyan, *Introduction to Spectroscopy*, 5th Edition, CENGAGE Learing.

3. Silverstein, R. M.; Webster, F. X.; Kiemle, D. J. & Bryce, D. L. *Spectrometric Identification of Organic Compounds*, 8th Edition, Wiley.

4. Kemp, W. *Organic Spectroscopy*, Palgrave.

5. Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P) Ltd. Pub.

6. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

7. Billmeyer, F. W. *Textbook of Polymer Science*, John Wiley & Sons, Inc.

8. Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. *Polymer Science*, New Age International (P) Ltd. Pub.

9. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

10. Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc.

11. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry*, Oxford University Press.

12. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Prakashan (2010).

LAB

60 Lectures

1. Extraction of caffeine from tea leaves.
2. Preparation of sodium polyacrylate.
3. Preparation of urea formaldehyde.
4. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars
5. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols etc.
6. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
7. Preparation of methyl orange.

Recommended Books:

1. Vogel, A.I. *Quantitative Organic Analysis*, Part 3, Pearson (2012).

2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson (2012)
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press (2000).
5. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis*, University Press (2000).

CHEMISTRY-Discipline Specific Electives (DSE)

CHE-HE-5016: APPLICATIONS OF COMPUTERS IN CHEMISTRY

(Credits: Theory-04, Lab -02)
Theory: 60 Lectures

Course Objective: *This course intends to make learners familiar with basics of computer language, computer programming, handling of experimental data, curve fitting etc to analyze experimental results. This basic knowledge will help the students to perform and interpret results of various chemistry practicals.*

Learning Outcome: *After the completion of this course it will help the student to interpret laboratory data, curve fitting of experimental work, also perform quantum mechanical calculations for various molecular models.*

Basics:
Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

Numerical methods:
Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton-Raphson method, Binary bisection and Regula-Falsi.

Differential calculus: Numerical differentiation.

Integral calculus: Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values.

Simultaneous equations: Matrix manipulation: addition, multiplication. Gauss-Siedal method.

Interpolation, extrapolation and curve fitting: Handling of experimental data.

Conceptual background of molecular modelling: Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods.

Recommended Books:

1. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
2. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
3. Noggle, J. H. *Physical chemistry on a Microcomputer.* Little Brown & Co. (1985).
4. Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* Jaico Publishing House: Delhi (1996).

LAB

60 Lectures

Computer programs based on numerical methods for

1. Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid).

2. Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).

3. Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values.

4. Matrix operations. Application of Gauss-Siedel method in colourimetry.

5. Simple exercises using molecular visualization software.

Recommended Books:

1. McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).
2. Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005).
3. Steiner, E. The Chemical Maths Book Oxford University Press (1996).
4. Yates, P. Chemical Calculations. 2nd Ed. CRC Press (2007).
5. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
6. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
7. Noggle, J. H. *Physical Chemistry on a Microcomputer.* Little Brown & Co. (1985).
8. Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* Jaico Publishing House: Delhi (1996).

CHE-HE-5026: ANALYTICAL METHODS IN CHEMISTRY

(Credits: Theory-04, Lab -02)

Theory: 60 Lectures

Course Objective: *This is an elective course designed to complement the needs of students who wish to learn more about the qualitative/quantitative characterization and separation techniques. The content of this course aims to cover some of the widely used instrumental techniques for characterization of samples. Experiments included aim at giving students hands on experience using different instrumental techniques and chemical analysis.*
Learning outcome: *On successful completion students will be have theoretical understanding about choice of various analytical techniques used for qualitative and quantitative characterization of samples. At the same time through the experiments students will gain hands on experience of the discussed techniques. This will enable students to take judicious decisions while analyzing different samples.*

Qualitative and quantitative aspects of analysis:

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

(5 Lectures)

Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;

Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of metal complex composition using Job's method of continuous variation and mole ratio method.

Infrared Spectroscopy: Basic principles of instrumentation (choice of source, monochromator & detector) for continuous wave and Fourier transform spectrometers; sampling techniques.

Structure elucidation through interpretation of data. Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, and detector, choice of flame and Burner designs. Techniques of atomization and sample introduction. Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

(25 Lectures)

Thermal methods of analysis:

Theory of thermogravimetry (TG), basic principle of instrumentation.
Techniques for quantitative estimation of Ca and Mg from their mixture.

(5 Lectures)

Electroanalytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

(10 Lectures)

Separation techniques:

Solvent extraction: Classification, principle and efficiency of the technique.

Mechanism of extraction: extraction by solvation and chelation.

Technique of extraction: batch, continuous and counter current extractions.

Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique.

Mechanism of separation: adsorption, partition & ion exchange.

Development of chromatograms: frontal, elution and displacement methods.

Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC).

Role of computers in instrumental methods of analysis.

(15 Lectures)

Recommended Books:

1. Mendham, J. et al.: Vogel's Text Book of Quantitative Chemical Analysis ; 6th Ed. Pearson Education, 2009.
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. CBS Publishers & Distributors, 2004.
3. Christian, Gary D: Analytical Chemistry, 6th Ed. Wiley India (P) Ltd., 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, 4th Ed. W. H. Freeman, 2008.

5. Khopkar, S.M.: Basic Concepts of Analytical Chemistry, 3rd Ed. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, 6th Ed. Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. and Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.1979
8. Ditts, R.V. *Analytical Chemistry: Methods of separation.*Van Nostrand, New York, 1974.

LAB

60 Lectures

1. Separation Techniques

I. Chromatography:

(a) Separation of mixtures

(i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.

(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values.

(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions:

(i) To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+}- DMG complex in chloroform, and determine its concentration by spectrophotometry.

(ii) Solvent extraction of zirconium with amberliti LA-1, separation from a mixture of irons and gallium.

3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

4. Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques.

5. Analysis of soil:

(i) Determination of pH of soil.

(ii) Total soluble salt

(iii) Estimation of calcium, magnesium, phosphate, nitrate

6. Ion exchange:

(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.

(ii) Separation of metal ions from their binary mixture.
(iii) Separation of amino acids from organic acids by ion exchange chromatography.

7. Spectrophotometry

(i) Determination of pKa values of indicator using spectrophotometry.
(ii) Structural characterization of compounds by infrared spectroscopy.
(iii) Determination of dissolved oxygen in water.
(iv) Determination of chemical oxygen demand (COD).
(v) Determination of Biological oxygen demand (BOD).
(vi) Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

Recommended Books:

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
9. Ditts, R.V. *Analytical Chemistry: Methods of separation.* Van Nostrand, New York, 1974.

CHE-HE-5036: MOLECULAR MODELLING & DRUG DESIGN

(Credits: Theory-04, Lab -02)
Theory: 60 Lectures

Course Objective: *The course introduces students to the basic principles of computer assisted drug design, modelling and the important theoretical concepts and programming.*
Learning Outcome: *Students will be able to identify basic components of computer and programming as applied to computer assisted design and modelling of molecules.*

Introduction to Molecular Modelling:

Introduction. Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.

(10 Lectures)

Force Fields:

Fields. Bond Stretching. Angle Bending. Introduction to nonbonded interactions. Electrostatic interactions. van der Waals Interactions. Hydrogen bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.

(14 Lectures)

Energy Minimization and Computer Simulation:

Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods. Simple thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors.

(12 Lectures)

Molecular Dynamics & Monte Carlo Simulation:

Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers.

(12 Lectures)

Structure Prediction and Drug Design:

Structure prediction - Introduction to comparative Modeling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design,

Drug Discovery – Chemoinformatics – QSAR.

(12 Lectures)

Recommended Books:

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

LAB

60 Lectures

i. Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds.

ii. (a) Perform a conformational analysis of butane. (b) Determine the enthalpy of isomerization of *cis* and *trans* 2-butene.
iii. Visualize the electron density and electrostatic potential maps for LiH, HF, N_2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules.
iv. (a) Relate the charge on the hydrogen atom in hydrogen halides with their acid character. (b) Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.
v. (a) Compare the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Note the dipole moment of each molecule. (b) Show how the shapes affect the trend in boiling points: (118 ºC, 100 ºC, 108 ºC, 82 ºC, respectively).
vi. Build and minimize organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound: (a) alkyl halide (b) aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester (j) amide.
vii. (a) Determine the heat of hydration of ethylene. (b) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
viii. Arrange 1-hexene, 2-methyl-2-pentene, (*E*)-3-methyl-2-pentene, (*Z*)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.
ix. (a) Compare the optimized bond angles H_2O, H_2S, H_2Se. (b) Compare the HAH bond angles for the second row dihydrides and compare with the results from qualitative MO theory.

Note: Software: ChemSketch, ArgusLab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, or any similar software.

Recommended Books:

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

CHE-HE-5046: NOVEL INORGANIC SOLIDS

(Credits: Theory-04, Lab -02)
Theory: 60 Lectures

Course Objective: *This introductory course intends to make learners familiar with a wide variety of technologically important and emerging materials. It will prepare the learners for studying materials further at the master's level. Prior completion of one introductory UG level course on inorganic and physical chemistry will be essential.*
Learning outcome: *After the completion of this course it will also be possible for the students to opt for studying an interdisciplinary master's programme with an emphasis on the synthesis and applications of various materials or take up a job in the materials production and/or processing industry.*

Synthesis and modification of inorganic solids:

Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods.

(10 Lectures)

Inorganic solids of technological importance:

Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments.

Molecular material and fullerides, molecular materials & chemistry – one-dimensional metals, molecular magnets, metal containing liquid crystals.

(10 Lectures)

Nanomaterials:

Overview of nanostructures and nanomaterials: classification.

Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires. Bio-inorganic nanomaterials, DNA and nanomaterials, natural and artificial nanomaterials, bionano composites.

(10 Lectures)

Introduction to engineering materials for mechanical construction:

Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminium and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials.

(10 Lectures)

Composite materials:

Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.

(10Lectures)

Speciality polymers:

Ceramics & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications.

(10 Lectures)

Recommended Books:

1. Shriver & Atkins. Inorganic Chemistry, Peter Alkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)
2. Smart, L. E., Moore, E. A., Solid State Chemistry: An Introduction, 4th Ed., CRC Press, 2012.
3. Poole, C. P., Ovens, F. J., Introduction to Nanotechnology, Wiley India, 2009.

4. Murty, B. S., Shankar, P., Raj, B., Rath, B, B., Murday, J. Textbook of Nanoscience and Nanotechnology, Springer, 2013.

LAB

60 Lectures

1. Determination of cation exchange capacity.

2. Synthesis of oxides by ceramic method.

3. Synthesis of hydrogel by co-precipitation method.

4. Synthesis of silver and gold metal nanoparticles.

Recommended Book:

1. Fahlman, B. D., Materials *Chemistry*, Springer (2011).

CHE-HE-5056: POLYMER CHEMISTRY

(Credits: Theory-06, Lab -02)
Theory: 60 Lectures

Course objective: *This is an introductory level course in polymer chemistry. The aim of the course is to introduce the theory and applications of polymer chemistry to the students. Some industrially important polymers and conducting polymers, a promising class of polymeric materials for next generation devices will also be introduced in this course.*

Learning outcome: *After completion of this course the students will learn the definition and classifications of polymers, kinetics of polymerization, molecular weight of polymers, glass transition temperature, and polymer solutions etc. They also learn the brief introduction of preparation, structure and properties of some industrially important and technologically promising polymers.*

Introduction and history of polymeric materials:

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

(4 Lectures)

Functionality and its importance:

Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.

(8 Lectures)

Kinetics of Polymerization:

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

(8 lectures)

Crystallization and crystallinity:

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

(4 Lectures)

Nature and structure of polymers-Structure Property relationships.

(2 Lectures)

Determination of molecular weight of polymers (M_n, M_w, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

(8 Lectures)

Glass transition temperature (Tg) and determination of Tg, Free volume theory,

WLF equation, Factors affecting glass transition temperature (Tg).

(8 Lectures)

Polymer Solution – Criteria for polymer solubility, Solubility parameter,

Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

(8 Lectures)

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,
Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

(10 Lectures)

Recommended Books:

1. *Seymour's Polymer Chemistry,* Marcel Dekker, Inc.
2. G. Odian: Principles of Polymerization, John Wiley.
3. F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
4. P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
5. R.W. Lenz: Organic Chemistry of Synthetic High Polymers.

LAB

60 Lectures

1. **Polymer synthesis**

    1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) /Methyl Acrylate (MA) / Acrylic acid (AA).
        a. Purification of monomer
        b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)
    2. Preparation of nylon 66/6

    1. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
        a. Preparation of IPC
        b. Purification of IPC
        c. Interfacial polymerization
    3. Redox polymerization of acrylamide
    4. Precipitation polymerization of acrylonitrile
    5. Preparation of urea-formaldehyde resin
    6. Preparations of novalac resin/resold resin.
    7. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight by viscometry:
    (a) Polyacrylamide-aq.$NaNO_2$ solution
    (b) (Poly vinyl proplylidine (PVP) in water

2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

*at least 7 experiments to be carried out.

Recommended Books:

1. Malcohm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.
2. Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003)
3. Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)
4. Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)

5. Petr Munk and Tejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002)
6. L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005)
7. Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005)
8. Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

CHE-HE-5066: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objective: *Students shall be introduced to the fundamental concepts/theory and application of different analytical techniques, as applied to chemistry.*
Learning Outcome: *Students shall be able to explain the theoretical basis of different analytical techniques, identify the experimental requirements and compare/analyze the data/results thereof.*

Introduction to spectroscopic methods of analysis:

Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.

(4 Lectures)

Molecular spectroscopy:
Infrared spectroscopy:
Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.

UV-Visible/ Near IR – emission, absorption, fluorescence and photoaccoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoaccoustic, fluorescent tags).

(16 Lectures)

Separation techniques
Chromatography: Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.

Immunoassays and DNA techniques

Mass spectroscopy: Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).

(16 Lectures)

Elemental analysis:

Mass spectrometry (electrical discharges).

Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

(8 Lectures)

NMR spectroscopy: **P**rinciple, Instrumentation, Factors affecting chemical shift, Spincoupling, Applications.

(4 Lectures)

Electroanalytical Methods: Potentiometry & Voltammetry

(4 Lectures)

Radiochemical Methods

(4 Lectures)

X-ray analysis and electron spectroscopy (surface analysis)

(4 Lectures)

Recommended books:

1. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).
2. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.
3. P.W. Atkins: Physical Chemistry.
4. G.W. Castellan: Physical Chemistry.
5. C.N. Banwell: Fundamentals of Molecular Spectroscopy.
6. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
7. W.J. Moore: Physical Chemistry.

LAB

60 Lectures

1. Safety Practices in the Chemistry Laboratory
2. Determination of the isoelectric pH of a protein.
3. Titration curve of an amino acid.
4. Determination of the void volume of a gel filtration column.

5. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
6. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
7. IR Absorption Spectra (Study of Aldehydes and Ketones)
8. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
9. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)
10. Separation of Carbohydrates by HPLC
11. Determination of Caffeine in Beverages by HPLC
12. Potentiometric Titration of a Chloride-Iodide Mixture
13. Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple
14. Nuclear Magnetic Resonance
15. Use of fluorescence to do “presumptive tests” to identify blood or other body fluids.
16. Use of “presumptive tests” for anthrax or cocaine
17. Collection, preservation, and control of blood evidence being used for DNA testing
18. Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Ychromosome only or multiple chromosome)
19. Use of sequencing for the analysis of mitochondrial DNA
20. Laboratory analysis to confirm anthrax or cocaine
21. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives
22. Detection of illegal drugs or steroids in athletes
23. Detection of pollutants or illegal dumping
24. Fibre analysis

At least 10 experiments to be performed.

Recommended Books:

1. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler and Stanley Crouch (ISBN 0-495-01201-7).
2. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.

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CHE-HE-6016 : GREEN CHEMISTRY

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objective: *The learners will be taught about the emerging discipline of green chemistry particularly to differentiate as to how the principles of green chemistry may be applied to organic synthesis.*
Learning Outcome: *Apart from introducing learners to the principles of green chemistry, this course will make them conversant with applications of green chemistry to organic synthesis. Students will be prepared for taking up entry level jobs in the chemical industry. They also will have the option of studying further in the area.*

Introduction to Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

(4 Lectures)

Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

(24 Lectures)

Examples of Green Synthesis/ Reactions

1. Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, citral, ibuprofen, paracetamol, furfural.
2. Microwave assisted reactions in water: Oxidation of toluene, alcohols. Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Diels-Alder Reaction. Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, benzimidazoles.
3. Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of “Clayan”, a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.

(24 Lectures)

Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Solventless reactions; Green chemistry in sustainable development.

(8 Lectures)

Recommended Books:

1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
2. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
3. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
4. M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
5. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

LAB

60 Lectures

1. Safer starting materials

The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch.

(i) Effect of concentration on clock reaction

(ii) Effect of temperature on clock reaction.

2. Using renewable resources

Preparation of biodiesel from vegetable oil.

3. Avoiding waste

Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied

(I) Triethylamine ion + OH^- → propene + trimethylpropene + water

(II) 1-propanol $\xrightarrow{H_2SO_4/\Delta}$ propene + water

The other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

4. Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide

Alternative Green solvents

5. Diels Alder reaction in water

Reaction between furan and maleic acid in water and at room temperature rather than in benzene and reflux.

6. Extraction of D-limonene from orange peel using liquid CO_2 prepared form dry ice.

7. Mechanochemical solvent free synthesis of azomethines

8. Co-crystal controlled solid state synthesis (C_2S_3) of N-organophthalimide using phthalic anhydride and 3-aminobenzoic acid.

Alternative sources of energy

9. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).

10. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Recommended Books:

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. *Green Chemistry Experiment:*

A monograph, I.K International Publishing House Pvt Ltd. New Delhi. Bangalore CISBN 978-93-81141-55-7 (2013).
5. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
6. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society (2008).
7. Pavia, D. L. Lampman, G. H. & Kriz, G.S. *W B Introduction to Organic Laboratory Techniques: A Microscale Approach*, 4th Ed., Brooks/Cole; 2007.

CHE-HE-6026: INDUSTRIAL CHEMICALS AND ENVIRONMENT

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objectives: *This course provides an introduction to the various industrial gases and inorganic chemicals, their manufacturing processes, applications, storage and the hazards of handling them. Contribution of these industrial chemicals towards air and water pollution and their effects on living organisms and the environment has also been covered. Students are also expected to learn about metallurgy, energy generation industry and the pollution threat they pose. This course also discusses about management of the different kinds of wastes, their safe disposal and the importance of practicing green chemistry in chemical industry.*

Learning Outcomes: *After successful completion of the course, students would have learnt about the manufacture, applications and safe ways of storage and handling gaseous and inorganic industrial chemicals. Students will get to know about industrial metallurgy and the energy generation industry. Students will also learn about environmental pollution by various gaseous, liquid wastes and nuclear wastes and their effects on living beings. Finally, the students will learn about industrial waste management, their safe disposal and the importance of environment friendly "green chemistry" in chemical industry.*

Industrial Gases and Inorganic Chemicals
Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.
Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

(10 Lectures)

Industrial Metallurgy
Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

(4 Lectures)

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by SO_2, CO_2, CO, NO_x, H_2S and other foul smelling gases. Methods of estimation of CO, NO_x, SO_x and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc.
Sludge disposal.

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

(30 Lectures)

Energy & Environment
Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.
Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

(10 Lectures)

Biocatalysis
Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

(6 Lectures)

Recommended Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
7. S.E. Manahan, Environmental Chemistry, CRC Press (2005).

8. G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
9. A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

LAB
60 Lectures

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method.
7. Measurement of dissolved CO_2.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Recommended Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

CHE-HE-6036: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objectives: *To learn the synthetic process, properties and the utility of the industrially important inorganic materials (such as silicates, ceramics, cements, fertilizers, paints, batteries, alloys and explosives).*
To provide opportunity to learn some of the industrial process such as surface coating and catalysis in relevant to industry where heterogeneous catalysis dominates.
Experiments are aimed at helping learners acquire hands on experience in qualitative and quantitative analysis of the inorganic materials which are basically manufactured in chemical industries.
To learn some industrial techniques such as surface coating etc..

Learning Outcome: *This course will establish the basic foundation of industrial inorganic chemistry among the students. This will be helpful for pursuing further studies of industrial chemistry in future. Experiments will help the Students to gather the experience of qualitative and quantitative chemical analysis. Students will be capable of doing analysis of the inorganic materials which are used in our daily life. They will have insight of the industrial processes.*

Silicate Industries

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides,fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and thesetting process, quick setting cements.

(16 Lectures)

Fertilizers:
Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate,compound and mixed fertilizers, potassium chloride, potassium sulphate.

(8 Lectures)

Surface Coatings:
Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels,emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

(10 Lectures)

Batteries:
Primary and secondary batteries, battery components and their role, Characteristics of battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

(6 Lectures)

Alloys:
Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

(10 Lectures)

Catalysis:

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.

Phase transfer catalysts, application of zeolites as catalysts.

(6 Lectures)

Chemical explosives:

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

(4 Lectures)

Recommended Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
4. Karl Heinz Büchel, Hans-Heinrich Moretto Peter, Woditsch; *Industrial Inorganic Chemistry*, Wiley-VCH.
5. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
6. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
7. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
8. B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut

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LAB

60 Lectures

1. Determination of free acidity in ammonium sulphate fertilizer.
2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Electroless metallic coatings on ceramic and plastic material.
5. Determination of composition of dolomite (by complexometric titration).
6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
7. Analysis of Cement.
8. Preparation of pigment (zinc oxide).

Recommended Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.

7. B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut

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CHE-HE-6046: RESEARCH METHODOLOGY FOR CHEMISTRY

(Credits: Theory-05, Tutorials-01)
Theory: 75 Lectures

Course Objectives:
This course is introduced to impart knowledge about the basic concepts of research and to provide a road map for conducting research
Students are expected to identify, explain and apply basic concepts of research; acquire information, recognize various issues related to research and to learn instrumental methods required for research in chemistry.
Learning Outcome:
After completing this course, students should be able to construct a rational research proposal to generate fruitful output in terms of publications and patents in the field of chemical sciences.

Literature Survey:
Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.
Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index,Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and
communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus.

Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information.
(20 Lectures)

Methods of Scientific Research and Writing Scientific Papers:

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation.

Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.
(20 Lectures)

Chemical Safety and Ethical Handling of Chemicals:
Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of

laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

(12 Lectures)

Data Analysis

The Investigative Approach: Making and Recording Measurements. SI Units and their use.Scientific method and design of experiments.

Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests.Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting,fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, *r* and its abuse. Basic aspects of multiple linear regression analysis.

(13 Lectures)

Electronics

Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

(10 Lectures)

Recommended Books

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) *Practical skills in chemistry*. 2nd Ed. Prentice-Hall, Harlow.
2. Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry*. Oxford University Press.
3. Topping, J. (1984) *Errors of observation and their treatment.* Fourth Ed., Chapman Hall, London.
4. Harris, D. C. *Quantitative chemical analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
5. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis.* Cambridge Univ. Press (2001) 487 pages.
6. Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
7. OSU safety manual 1.01.

CHE-HE-6056: DISSERTATION

Student will complete a project work and then prepare a report on that.

Skill Enhancement Courses

CHE-SE-3024: IT SKILLS FOR CHEMISTS

(Credits: 04)

60 Lectures

Course Objective: *The objectives of the proposed course are:*

1) *To provide the basic knowledge of mathematics which are needed to pursue chemistry as major subject.*
2) *To provide the necessary training for the basic programming knowledge.*
3) *The course provides information technology literacy and basic skills training for learners with limited experience.*
4) *To familiarize with the Introductory writing activities and Handling numeric data.*

Learning Outcome: *Course learning outcomes focus on skill development related to basic computer operations and information technology. After completing the course the incumbent is able to use the computer for basic purposes of preparing his personnel/business letters, viewing information on Internet (the web), sending mails, using internet banking services etc. After opting this course the students are expected to accumulate the skills in writing activities and Handling numeric data.*

Mathematics

Fundamentals, mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, interconversion of units, constants and variables, equation of a straight line, plotting graphs.

Uncertainty in experimental techniques: Displaying uncertainties, measurements in chemistry, decimal places, significant figures, combining quantities.

Uncertainty in measurement: types of uncertainties, combining uncertainties. Statistical treatment. Mean, standard deviation, relative error. Data reduction and the propagation of errors. Graphical and numerical data reduction. Numerical curve fitting: the method of least squares (regression).

Algebraic operations on real scalar variables (e.g. manipulation of van der Waals equation in different forms).Roots of quadratic equations analytically and iteratively (e.g. pH of a weak acid). Numerical methods of finding roots (Newton-Raphson, binary –bisection, e.g. pH of a weak acid not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions).

Differential calculus: The tangent line and the derivative of a function, numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).

Numerical integration (Trapezoidal and Simpson's rule, e.g. entropy/enthalpy change from heat capacity data).

Computer programming:

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Errors (Syntax and Logical), Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

BASIC programs for curve fitting, numerical differentiation and integration (Trapezoidal rule, Simpson's rule), finding roots (quadratic formula, iterative, Newton-Raphson method).

HANDS ON

Introductory writing activities: Introduction to word processor and structure drawing (ChemSketch) software. Incorporating chemical structures, chemical equations, expressions from chemistry (e.g. Maxwell-Boltzmann distribution law, Bragg's law, van der Waals equation, etc.) into word processing documents/Latex.

Handling numeric data: Spreadsheet software (Excel), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs. Incorporating tables and graphs into word processing documents. Simple calculations, plotting graphs using a spreadsheet (Planck's distribution law, radial distribution curves for hydrogenic orbitals, gas kinetic theory- Maxwell-Boltzmann distribution curves as function of temperature and molecular weight), spectral data, pressure-volume curves of van der Waals gas (van der Waals isotherms), data from phase equilibria studies. Graphical solution of equations.

Numeric modelling: Simulation of pH metric titration curves. Excel functions LINEST and Least Squares. Numerical curve fitting, linear regression (rate constants from concentrationtime data, molar extinction coefficients from absorbance data), numerical differentiation (e.g. handling data from potentiometric and pH metric titrations, pK_a of weak acid), integration (e.g. entropy/enthalpy change from heat capacity data).

Statistical analysis: Gaussian distribution and Errors in measurements and their effect on data sets. Descriptive statistics using Excel. Statistical significance testing: The *t* test. The *F* test.

Presentation: Presentation graphics

Recommended Books:

1. McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).
2. Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005).
3. Steiner, E. The Chemical Maths Book Oxford University Press (1996).
4. Yates, P. Chemical calculations. 2nd Ed. CRC Press (2007).
5. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
6. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
7. Noggle, J. H. *Physical chemistry on a Microcomputer*. Little Brown & Co. (1985).
8. Venit, S.M. *Programming in BASIC: Problem solving with structure and style*. Jaico Publishing House: Delhi (1996).

CHE-SE-3034: BASIC ANALYTICAL CHEMISTRY

(Credits: 04)

60 Lectures

Course Objective: *To familiarize students with different micro and semimicro analytical techniques and help develop the ability to use modern instrumental methods for chemical analysis of food, soil, air and water.*

Learning Outcome: *Upon completion of this course, students shall be able to explain the basic principles of chemical analysis, design/implement microscale and semimicro experiments, record, interpret and analyze data following scientific methodology.*

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators
a. Determination of pH of soil samples.
b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.
a. Determination of pH, acidity and alkalinity of a water sample.
b. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration.
a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
b. Analysis of preservatives and colouring matter.

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.
a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).
b. To compare paint samples by TLC method.

Ion-exchange: Column, ion-exchange chromatography etc.
Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Analysis of cosmetics: Major and minor constituents and their function
a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Suggested Applications (Any one):
a. To study the use of phenolphthalein in trap cases.
b. To analyze arson accelerants.
c. To carry out analysis of gasoline.
Suggested Instrumental demonstrations:

a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Recommended Books:

1. Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.
2. Skoog & Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry *2nd Ed.*, W.H. Freeman and Co., N.Y. USA(1982).
8. Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16(1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall.
10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.
11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York (1995).

CHE-SE-3044: CHEMICAL TECHNOLOGY & SOCIETY

(Credits: 04)
Theory: 60 Lectures

Course Objective: *The objective of the course is to enable students to have a firsthand understanding of different types of equipments needed in chemical technology and offer them concepts regarding some important parameters. The syllabus also emphasizes the dynamic nature of the relations between society on one hand and technological achievement from chemical industries on the other hand. In other words, it tries to explore societal and technological issues from a chemical perspective.*
Learning Outcome: *Students shall be familiarized with processes and terminologies in chemical industry, like mass balance, energy balance etc… Learners will be able to use chemical and scientific literacy as a means to better understand the topics related to the society.*

Chemical Technology
Different types of equipments needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.
Concept of relative humidity, molal humidity, dew point, partial saturation.
Material Balance: Recycle, bypass in batch, stage wise and continuous operations in systems with and without chemical reactions.
Energy balance: Energy balance of systems with and without chemical reactions.

Society
Social issues related to soil, air and water pollution.

Energy crisis of modern society and search for alternatives such as energy from natural sources (i.e. solar and renewable forms), and from nuclear fission, biofuel etc.
Pros and cons of use of materials like plastics and polymers and their natural analogues,
Genetic engineering and the manufacture of drugs (proteins and nucleic acids, and molecular reactivity and interconversions)

Recommended Book:

1. John W. Hill, Terry W. McCreary & Doris K. Kolb, *Chemistry for changing times* 13th Ed.
2. E.J. Hackett, O. Amsterdamska, M. Lynch and J. Wajcman (eds.), The Handbook of Science and Technology Studies, The MIT Press, 2008.
3. D. MacKenzie and J. Wajcman (eds.), The Social Shaping of Technology, The Open University Press, 1999.

CHE-SE-3054: CHEMOINFORMATICS

(Credits: 04)
Theory: 60 Lectures

Learning Objectives: *The primary objective of this course is to familiarize the students with the use of various computer software and information technology. The students are expected to learn different chemical search engines and utilize them for molecular modelling and structure elucidation with a final goal to compute NMR, IR, mass and other spectra that can be later compared with the experimental data. The course also provides sufficient information and hands on exercises on the use of cheminformatics, with a special emphasis on its application in modern drug discovery.*

Learning Outcomes: *On the successful completion of the course, the students should be able to explain, interpret and critically examine the utility of computers and software tools to solving chemistry related problems. Recognize, apply, compare and predict chemical structures, properties, and reactivity and; solve chemistry related problems.*

Employ critical thinking and scientific reasoning to design and safely implement laboratory experiments and keep the records of the same.

Compile, interpret and analyze the qualitative/quantitative data and communicate the same in a scientific literature

Introduction to Chemoinformatics: History and evolution of chemoinformatics, Use of chemoinformatics, Prospects of chemoinformatics, Molecular Modelling and Structure elucidation.

Representation of molecules and chemical reactions: Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification.

Searching chemical structures: Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.

Applications: Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Model Building; Modeling Toxicity; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra; Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Target Identification and Validation; Lead Finding and Optimization; Analysis of HTS data; Virtual Screening; Design of Combinatorial Libraries; Ligand-Based and Structure Based Drug design; Application of Chemoinformatics in Drug Design.

Hands-on Exercises

Recommended Books:

1. Andrew R. Leach & Valerie, J. Gillet (2007) *An introduction to Chemoinformatics.* Springer: The Netherlands.
2. Gasteiger, J. & Engel, T. (2003) *Chemoinformatics: A text-book.* Wiley-VCH.
3. Gupta, S. P. (2011) *QSAR & Molecular Modeling.* Anamaya Pub.: New Delhi.

CHE-SE-3064: BUSINESS SKILLS FOR CHEMISTS

(Credits: 04)

Theory: 60 Lectures

Course Objective: *To familiarize students with important concepts of business operations and intellectual rights as applied to chemical industry.*

Learning outcome: *students shall be able to explain and/or analyze the important steps of business operations, finance and intellectual property as applied to chemical industry.*

Chemistry in Industry

Current challenges and opportunities for the chemistry-using industries, role of chemistry in India and global economies.

Basics of Business and Management

Key business concepts: Business plans, market need, project management and routes to market.

Management Functions and skills, principles of motivation, forms of business organization including partnerships and companies.

Marketing Skills

Understanding basics of marketing and marketing mix strategies with cases.

Human Resource Management (HRM) Skills

Managerial HRM functions viz. recruitment, training and development and compensation.

Financial Management Skills

An overview of financial and cost accounting with cases, managerial finance functions.

Intellectual Property Rights

Concept of intellectual property rights, patents.

Recommended books

1. http://www.rsc.org/learn-chemistry/resources/business-skills-for-chemists/OnlineCourse/
2. Philip Kotler, Keven Lane Keller Marketing Management 15th Ed., Pearson Education; Fifteenth edition (10 August 2017)
3.

CHE-SE-3074: INTELLECTUAL PROPERTY RIGHTS (IPR)

(Credits: 04)
Theory: 60 Lectures

Course Objective: *In this era of liberalization and globalization, the perception about science and its practices has undergone dramatic change. The importance of protecting the scientific discoveries, with commercial potential or the intellectual property rights is being discussed at all levels – statutory, administrative, and judicial. With India ratifying the WTO agreement, it has become obligatory on its part to follow a minimum acceptable standard for protection and enforcement of intellectual property rights. The purpose of this course is to apprise the students about the multifaceted dimensions of this issue.*

Learning Outcome: *After completing this course, students will have in-depth understanding about the importance and types of IPR. This course will also provide the clarity on the legal and economic aspects of the IP system.*

Introduction to Intellectual Property:

Historical Perspective, Different Types of IP, Importance of protecting IP.

Copyrights

Introduction, How to obtain, Differences from Patents.

Trade Marks

Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc.
Differences from Designs.

Patents

Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

Geographical Indications

Definition, rules for registration, prevention of illegal exploitation, importance to India.

Industrial Designs

Definition, How to obtain, features, International design registration.

Layout design of integrated circuits

Circuit Boards, Integrated Chips, Importance for electronic industry.

Trade Secrets

Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

Different International agreements

(a) Word Trade Organization (WTO):
(i) General Agreement on Tariffs & Trade (GATT), Trade
Related Intellectual Property Rights (TRIPS) agreement
(ii) General Agreement on Trade related Services (GATS)
(iii) Madrid Protocol
(iv) Berne Convention
(v) Budapest Treaty

(b) Paris Convention

WIPO and **TRIPS, IPR** and Plant Breeders Rights, IPR and Biodiversity
IP Infringement issue and enforcement – Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

Recommended Books:

1. N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).
2. Manjula Guru & *M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
3. P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy*, Tata McGraw-Hill (2001).
4. Arthur Raphael Miller, Micheal H.Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell*, West Group Publishers (2000).
5. Jayashree Watal, *Intellectual property rights in the WTO and developing countries,* Oxford University Press, Oxford.

CHE-SE-4014: ANALYTICAL CLINICAL BIOCHEMISTRY

(Credits: 04)
THEORY: 60 Lectures

Course objective: *This course is intended to apprise students with various clinically relevant biomolecules, their structures and physiological roles. Students are also expected to learn the basics of analysis of pathological samples (blood and urine).*

Learning outcome: *Students will be able to identify various molecules relevant to a particular pathological condition and their estimation protocols.*

Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins:

Review of concepts studied in the core course.

Carbohydrates: Biological importance of carbohydrates, metabolism, cellular currency of energy (ATP), glycolysis, alcoholic and lactic acid fermentations, Krebs cycle, Isolation and characterization of polysachharides.

Proteins: Classification, biological importance, primary and secondary, tertiary and quaternary structures of proteins: α-helix and β- pleated sheets, isolation, characterization, denaturation of proteins.

Enzymes: Nomenclature, characteristics, classification, active site, mechanism of enzyme action, stereospecificity of enzymes, effect of pH, temperature on enzyme activity, , enzyme inhibitors, coenzymes and cofactors introduction to biocatalysis: importance in "Green Chemistry" and chemical industry.

Lipids: Classification, biological importance of triglycerides and phosphoglycerides and cholesterol, lipid membrane, liposomes and their biological functions and underlying applications.

Lipoproteins.

Properties, functions and biochemical functions of steroid hormones.

Biochemistry of peptide hormones.

Structure of DNA (Watson-Crick model) and RNA, genetic code, biological roles of DNA and RNA: replication, transcription and translation, introduction to gene therapy.

Biochemistry of disease: A diagnostic approach by blood/ urine analysis:

Blood: Composition and functions of blood, blood coagulation, blood collection and preservation of samples, anemia, regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

Urine: Collection and preservation of samples, formation of urine, composition and estimation of constituents of normal and pathological urine.

Practicals:

Identification and estimation of the following:
1. Carbohydrates - qualitative and quantitative analysis.
2. Lipids - qualitative and quantitative analysis.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Detection of cholesterol using Liebermann- Burchard reaction.
6. Isolation of protein.
7. Determination of concentration of protein by the Biuret reaction.
8. Determination of nucleic acid concentration.
9. Separation of nucleic acids.

Recommended Books:

1. David L. Nelson and Michael M. Cox: Lehninger Principles of Biochemistry
2. T.G. Cooper: Tool of Biochemistry.
3. Keith Wilson and John Walker: Practical Biochemistry.
4. Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
5. Thomas M. Devlin: Textbook of Biochemistry.
6. Jeremy M. Berg, John L Tymoczko, Lubert Stryer: Biochemistry.
7. G. P. Talwar and M Srivastava: Textbook of Biochemistry and Human Biology.
8. O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods.

CHE-SE-4024: GREEN METHODS IN CHEMISTRY

(Credits: 04)
Theory: 60 Lectures

Course Objectives: *This course introduces students to the utilization of green chemistry from industrial perspective and provides exposure to methods by which environmental problems are evaluated and designing of sustainable solutions.*

Learning Outcome: *Students shall be able to describe and evaluate chemical products and processes from environmental perspective, define and propose sustainable solutions and critically assess the methods for waste reduction and recycling.*

Tools of Green chemistry, Twelve principles of Green Chemistry, with examples.

The following Real world Cases in Green Chemistry should be discussed:
1 A green synthesis of ibuprofen which creates less waste and fewer byproducts (Atom economy).
2 Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.
3 Environmentally safe antifoulant.
4 CO_2 as an environmentally friendly blowing agent for the polystyrene foam sheet packaging market.
5 Using a catalyst to improve the delignifying (bleaching) activity of hydrogen peroxide.

6 A new generation of environmentally advanced preservative: getting the chromium and arsenic out of pressure treated wood.
7. Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
8 Development of a fully recyclable carpet: cradle to cradle carpeting.

Recommended Books:

1. Manahan S.E. (2005) Environmental Chemistry, CRC Press
2. Miller, G.T. (2006) Environmental Science 11th edition. Brooks/Cole
3. Mishra, A. (2005) Environmental Studies. Selective and Scientific Books, New

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CHE-SE-4034: PHARMACEUTICAL CHEMISTRY

(Credits: 04)
Theory: 60 Lectures

Course Objective: *This primary objective of this course is to introduce students to the fundamentals of drug design and development process, drugs for various diseases available in market, their mode of action and side effects. Students are expected to learn the biosynthetic procedures of various bio-relevant small molecules.*

Learning Outcome: *Students will be able to appreciate the drug development process, identify various small molecules used for treatments different ailments and other physiological processes.*

Drugs & Pharmaceuticals:
Drug discovery, design and development; basic retrosynthetic approach, synthesis of the representative drugs of the following classes: analgesics, antipyretic, anti-inflammatory (aspirin, paracetamol, ibuprofen), antibiotics (chloramphenicol), antibacterial and antifungal (sulphonamides, sulphanethoxazol, sulphacetamide, trimethoprim), antiviral (acyclovir), drugs effecting central nervous system (phenobarbital, diazepam), cardiovascular (glyceryl trinitrate), antilaprosy (dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation:
Aerobic and anaerobic fermentation, production of (i) ethanol and citric acid, (ii) antibiotics (penicillin, cephalosporin, chloromycetin and streptomycin), (iii) lysine, glutamic acid, vitamin B2, vitamin B12 and vitamin C.

Practicals:

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (antacid).

Recommended Books:

1. Graham L. Patrick: *An Introduction to Medicinal Chemistry, Oxford University* Press, UK.
2. Gareth Thomas: *Fundamentals of Medicinal Chemistry*, Wiley.

3. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi.

4. William O. Foye, Thomas L., Lemke, David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt. Ltd. New Delhi.

CHE-SE-4044: CHEMISTRY OF COSMETICS & PERFUMES

(Credits: 04)
60 Lectures

Course Objective: *This course intends to apprise students about the chemical knowledge related to some of the commonly used cosmetics. Laboratory experiments for preparation of talcum powder, shampoo etc. are included to give hands on experience.*

Learning Outcome: *Students will learn about the preparation and chemistry involved with the production different cosmetic. This may encourage students to take up entry level jobs at cosmetics industry or venture into commercial production of cosmetics as an entrepreneur.*

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

Practicals

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.
5. Preparation of face cream.
6. Preparation of nail polish and nail polish remover.

Recommended Books:

1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.

CHE-SE-4054: PESTICIDE CHEMISTRY

(Credits: 04)
60 Lectures

Course Objective*: This is a brief and introductory course on pesticides, through which the students will be introduced to various classes of pesticides, their synthesis, applications and possible hazards of their uses.*

***Learning Outcome**: Students will be able to explain or describe and critically examine different types of pesticides, their activity/toxicity and their applications and the need for the search of an alternative based on natural products.*

Definition of pesticides, general introduction to pesticides (natural and synthetic), benefits and adverse effects of pesticides. Classification, mode of action, toxicity and methods of pesticides residue analysis. Synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene); organophosphate (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor)

Practicals:

1. To calculate acidity/alkalinity in given sample of pesticides formulations as per BIS specifications.
2. Preparation of simple organophosphates, phosphonates and thiophosphates.

Recommended Book:

1. R. Cremlyn: Pesticides, Preparation and Mode of Action, John Wiley & Sons, New York, 1978
2. RPBateman, Pesticide Applications, AAB Press, 2004
3. Principles of Pesticide chemistry: S K Handa, Ed. by Agrobios (India), 2008
4. Pesticide Science & Biotechnology: R Greenhalgh and T R Robers, IUPAC, Blackwell Scientific Publications, 1987
5. The Chemical Process Industries: D N Shreve
6. Pesticide Chemistry : G Matolesy, M. Nadasy, V. Andriska, Elsevier Sc. Publisher, USA, 1988

CHE-SE-4064: FUEL CHEMISTRY

(Credits: 04)
60 Lectures

***Course Objectives:** This course discusses about the chemistry of various sources of energy. Students are expected to learn about the composition of coal and petroleum products, their extraction, purification methods and usage. A section also covers classification and applications of natural and synthetic lubricants. Students will also learn about the determination and significance of various industrially relevant physical parameters for different fuels and lubricants.*

Learning Outcomes: *At the end of this course students will learn about the classes of renewable and non-renewable energy sources. Students will learn about the composition of coal and crude petroleum, their classification, isolation of coal and petroleum products and their usage in various industries. They will also learn to determine industrially significant physical parameters for fuels and lubricants.*

Fuel Chemistry

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal.Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants.

Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Recommended Books:

1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. B.K. Sharma: *Industrial Chemistry,* Goel Publishing House, Meerut.

Gauhati University

B.Sc. with Chemistry
&
Chemistry as Generic Elective

Choice Based Credit System (CBCS)

Course effective from academic year 2019-20

This is approved in the Academic Council held on 08/11/2019

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Gauhati University

Guwahati::Assam

Table of Contents

Preamble

The choice based credit system is naturally the next logical step in a credit based semester system. This makes the system the more learner-centric. A CBCS offers the student a diversity of courses to choose from and the autonomy to decide on the place, pace and the time of learning.

The Gauhati University has decided to introduce the CBCS system at the under graduate level from the session 2019-20. The CBCS syllabus for the B.Sc. (Regular) is prepared in the model of syllabus prepared by the UGC.

Course Structure, B.Sc. with Chemistry

Course	*Credits	
	Theory+ Practical	Theory + Tutorial
I. Core Course Theory (12 Papers) 04 Courses from each of the 03 disciplines of choice	12×4= 48	14×5=60
Core Course Practical/ Tutorial* (12 Papers) 04 Courses from each of the 03 disciplines of choice	12×2= 24	12×1= 12
II. Elective Course (6 Papers) Two papers from each discipline of choice including paper of interdisciplinary nature.**)**	6×4=24	6×5=30
Elective Course Practical / Tutorials* (6 Practical / Tutorials*) Two papers from each discipline of choice including paper of interdisciplinary nature.**)**	6×2=12	6×1=6
III. Ability Enhancement Courses 1. **Ability Enhancement Compulsory (2 Papers of 2 credit each)** Environmental Studies English/MIL Communication	2×4=8	2×4=8
2. **Ability Enhancement Elective** (Skill Based) **(4 Papers of 2 credit each)**	4×4=16	4×4=16
Total	**132**	**132**

***Core and DSE courses without practical will have tutorial and have credit distribution of : 5 credits for theory and 1 credit for tutorial, total 6 credits, same as the papers with practical**

Structure of B.Sc. Regular Programme

Semester	Type	Core	AECC	SEC	DSE
	Credits	$12 \times 6 = 72$	$2 \times 4 = 8$	$4 \times 4 = 16$	$6 \times 6 = 36$
I		XXX-RC-1016	ENG-AE-1014/		
		CHE-RC-1016	ASM- AE-1014		
		ZZZ-RC-1016			
II		XXX-RC-2016	ENV-AE-2014		
		CHE-RC-2016			
		ZZZ-RC-2016			
III		XXX-RC-3016		XXX-SE-3YY4*	
		CHE-RC-3016			
		ZZZ-RC-3016			
IV		XXX-RC-4016		XXX-SE-4XX4*	
		CHE-RC-4016			
		ZZZ-RC-4016			
V				XXX-SE-5XX4*	XXX-RE-5XX6
					CHE-RE-5YY6†
					ZZZ-RE-5XX6
VI				XXX-SE-6XX4*	XXX-RE-6XX6
					CHE-RE-6YY4†
					ZZZ-RE-6XX6

Scheme for Choice Based Credit System in B. Sc. with Chemistry.

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	**ENG-AE-1014/ASM- AE-1014**	**English/MIL communications**	**4**
	XXX-RC-1016	**DSC 1A**	6
	CHE-RC-1016	**CHEMISTRY1** Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	4+2=6
		Lab- CHEMISTRY1	
	ZZZ-RC-1016	**DSC 3A**	6
		Total Credits in Semester I	22
II	**ENV-AE-2014**	**Environmental Studies**	4
	XXX-RC-2016	**DSC 1B**	6
	CHE-RC-2016	**CHEMISTRY2-** *s*- and *p*-Block Elements, Transition Elements, Coordination Chemistry States of Matter & Chemical Kinetics	4+2=6
		Lab- CHEMISTRY2	
	ZZZ-RC-2016	**DSC 3B**	6
		Total Credits in Semester II	22
III	**XXX-RC-3016**	**DSC 1C**	6
	CHE-RC-3016	**CHEMISTRY3** Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I	4+2=6
		Lab- CHEMISTRY3	
	ZZZ-RC-3016	**DSC 3C**	6
	XXX-SE-3YY4*	**SEC-1**	4
		Total Credits in Semester III	**22**
IV	**XXX-RC-4016**	**DSC 1D**	6
	CHE-RC-4016	**CHEMISTRY4** Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II	4+2=6
		Lab- CHEMISTRY4	
	ZZZ-RC-4016	**DSC 3D**	6
	XXX-SE-4XX4*	**SEC-2**	4
		Total Credits in Semester IV	22
V	**XXX-SE-5XX4***	**SEC-3**	4
	XXX-RE-5XX6	**DSE-1A**	6
	CHE-RE-5YY6†	**DSE-2A**	6
		Lab- DSE-2A	
	ZZZ-RE-5XX6	**DSE-3A**	6
		Total Credits in Semester V	22
VI	**XXX-SE-6XX4***	**SEC-4**	4
	XXX-RE-6XX6	**DSE-1B**	6
	CHE-RE-6YY6†	**DSE-2B**	6
		Lab-DSE-2B	
	ZZZ-RE-6XX6	**DSE-3B**	6
		Total Credits in Semester VI	22

Grand Total Credits	132

Core courses for B. Sc. with Chemistry (Credit: 06 each) /Chemistry as Generic Elective for other disciplines (Credit: 06 each)

CHE-RC/HG-1016. CHEMISTRY1: Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons (4) + Lab (2)

CHE-RC/HG-2016. CHEMISTRY2: *s*- and *p*-Block Elements, Transition Elements, Coordination Chemistry States of Matter & Chemical Kinetics (4) + Lab (2)

CHE-RC/HG-3016. CHEMISTRY3: Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I (4) + Lab (2)

CHE-RC/HG-4016. CHEMISTRY4: Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II (4) + Lab (2)

† Discipline Specific Elective Papers: (Credit: 06 each) (2 papers to be selected)- DSE 1-2

DSE for Semester V

DSE-1(Any One from the following)

1. **CHE-RE-5016.** Applications of Computers in Chemistry (4) + Lab (2)
2. **CHE-RE-5026.** Analytical Methods in Chemistry (4) + Lab (2)
3. **CHE-RE-5036.** Molecular Modelling & Drug Design (4) + Lab (2)
4. **CHE-RE-5046.** Novel Inorganic Solids (4) + Lab (2)
5. **CHE-RE-5056.** Polymer Chemistry (4) + Lab (2)
6. **CHE-RE-5066.** Instrumental Methods of Analysis (4) + Lab (2)

DSE for Semester VI

DSE-2(Any One from the following)

7. **CHE-RE-6016.** Green Chemistry (4) + Lab (2)
8. **CHE-RE-6026.** Industrial Chemicals & Environment (4) + Lab (2)
9. **CHE-RE-6036.** Inorganic Materials of Industrial Importance (4) + Lab (2)
10. **CHE-RE-6046.** Research Methodology for Chemistry (5) + Tutorials (1)
11. **CHE-RE-6056.** Dissertation (6)

*** Skill Enhancement Courses (04 papers) (Credit: 04 each)- SEC1 to SEC4**
(Students may choose SEC papers from same or different disciplines)

SEC for Semester III

Any One from the following

1. **AAA-SE-3014:** English (Syllabus will be available on the GU website)
2. **CHE-SE-3024:** IT Skills for Chemists
3. **CHE-SE-3034:** Basic Analytical Chemistry

SEC for Semester IV

Any One from the following

4. **CHE-SE-4014:** Analytical Clinical Biochemistry
5. **CHE-SE-4024:** Green Methods in Chemistry
6. **CHE-SE-4034:** Pharmaceutical Chemistry

SEC for Semester V

Any One from the following

7. **CHE-SE-5014:** Chemical Technology & Society
8. **CHE-SE-5024:** Chemoinformatics

9. **CHE-SE-5034:** Business Skills for Chemists
10. **CHE-SE-5044:** Intellectual Property Rights

SEC for Semester VI

Any One from the following
11. **CHE-SE-6014:** Chemistry of Cosmetics & Perfumes
12. **CHE-SE-6024:** Pesticide Chemistry
13. **CHE-SE-6034:** Fuel Chemistry

Ability Enhancement Compulsory Courses (02 papers) (Credit: 04 each)- AECC1 to AECC2

AECC for Semester I

1. **ENG-AE-1014: English Communications** (https://sites.google.com/a/gauhati.ac.in/syllabus-ug-cbcs/aecc/english-a)

AECC for Semester II

2. **ENV-AE-2014: Environmental Studies**

Core courses for B. Sc. with Chemistry /Chemistry as Generic Elective

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Semester I

CHE-RC/HG-1016: CHEMISTRY1

ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

(Credits: Theory-04, Lab-02)

Theory: 60 Lectures

Course Objective: *This course may be divided into two broad parts-inorganic and organic chemistry. In inorganic chemistry part the students will be taught atomic structure, chemical bonding and molecular structure. The organic chemistry part contains fundamentals of organic chemistry, stereochemistry and aliphatic hydrocarbons.*

Learning Outcome: *After completion of this course the students will learn the atomic structure through the basic concepts of quantum mechanics. They will understand the chemical bonding through VB and MO approaches. In organic part, the students are* *expected to learn basic ideas used in organic chemistry, stereochemistry, functional groups, alkanes, alkenes, alkynes etc.*

Section A: Inorganic Chemistry-1 **(30 Periods)**

Atomic Structure: *Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.*

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantum number (m_s).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

(14 Lectures)

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.
Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods

(including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.

(16 Lectures)

Section B: Organic Chemistry-1 **(30 Periods)**

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

(8 Lectures)

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis* – *trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

(10 Lectures)

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

(12 Lectures)

Recommended Books:

1. J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S.
2. F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
3. Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*, John Wiley.
4. James E. Huheey, *Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.
5. T. W. Graham Solomon: *Organic Chemistry, John Wiley and Sons*.
6. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
7. E. L. Eliel: *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
8. I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
9. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
10. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand

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LAB: CHEMISTRY1

ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

60 Lectures

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.

2. Estimation of oxalic acid by titrating it with $KMnO_4$.

3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.

5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)

2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)

(a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography

(b) Identify and separate the sugars present in the given mixture by paper chromatography.

Recommended Books:

1. Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
3. Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
4. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

Semester II

CHE-RC/HG-2016: CHEMISTRY2

***s*- AND *p*-BLOCK ELEMENTS, TRANSITION ELEMENTS, COORDINATION CHEMISTRY STATES OF MATTER & CHEMICAL KINETICS**

(Credits: Theory-04, Lab-02)

Theory: 60 Lectures

Course Objective: *This course may be divided into two broad parts-inorganic and physical chemistry. Three units-main group elements, transition elements and co-ordination chemistry will be taught in the inorganic chemistry part. The physical chemistry part contains states of matter and chemical kinetics.*

Learning Outcome: *After completion of this course the students will learn periodic properties in main group elements, transition metals (3d series). They will also learn the crystal field theory in coordination chemistry unit. In physical chemistry part, the students are expected to learn kinetic theory of gases, ideal gas and real gases, surface tension, viscosity , basic solid state chemistry and chemical kinetics.*

***s*- and *p*-Block Elements**

Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-Rochow scales). Allotropy in C, S, and P.

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

(10 Lectures)

Transition Elements (3d series)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

(6Lectures)

Coordination Chemistry

Coordination compounds, types of ligands, Werner's theory, IUPAC nomenclature and isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers.

Drawbacks of VBT. Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for *Oh* and *Td* complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

(14 Lectures)

***Section B: Physical Chemistry-3* (30 Lectures)**

Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. Van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO_2.

Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.

Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

(8 Lectures)

Liquids

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

(6 Lectures)

Solids

Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

(8 Lectures)

Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

(8 Lectures)

Reference Books:

1. Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
2. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
5. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry,* Wiley.
7. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
8. Wulfsberg, G. *Inorganic Chemistry,* Viva Books Pvt. Ltd.
9. Rodgers, G.E. *Inorganic & Solid State Chemistry,* Cengage Learning India Ltd., 2008.

LAB: CHEMISTRY2

s- AND *p*-BLOCK ELEMENTS, TRANSITION ELEMENTS, COORDINATION CHEMISTRY STATES OF MATTER & CHEMICAL KINETICS

60 Lectures

Section A: Inorganic Chemistry

Semi-micro qualitative analysis using H_2S of mixtures - not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

CO_3^{2-} , NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+},, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}

(Spot tests should be carried out wherever feasible)

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.

2. Draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound ($KMnO_4$/ $CuSO_4$) and estimate the concentration of the same in a given solution.
3. Determine the composition of the Fe^{3+}-salicylic acid complex solution by Job's method.
4. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
5. Estimation of total hardness of a given sample of water by complexometric titration.
6. Determination of concentration of Na^+ and K^+ using Flame Photometry.

Section B: Physical Chemistry

(I) Surface tension measurement (use of organic solvents excluded).

a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

b) Study of the variation of surface tension of a detergent solution with concentration.

(II) Viscosity measurement (use of organic solvents excluded).

a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

b) Study of the variation of viscosity of an aqueous solution with concentration of solute.

(III) Chemical Kinetics

Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Saponification of ethyl acetate.

c. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate

Reference Books:

1. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
2. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

Semester III

CHE-RC/HG-3016: CHEMISTRY 3

CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I

(Credits: Theory-04, Lab-02)

Theory: 60 Lectures

Course Objective: *This course contains two broad parts- physical and and organic chemistry. In physical chemistry part the students will be taught chemical energetics,* *chemical equilibrium and ionic equilibrium. In organic chemistry part, the students will be introduced to different classes of organic compounds.*

Learning Outcome: *After completion of this course the students will able to understand the chemical system from thermodynamic points of view. They will also learn two very important topics in chemistry- chemical equilibrium and ionic equilibrium. In organic chemistry part, the students are expected to learn various classes of organic molecules-alkyl halides, aryl halides, alcohols, phenols, ethers, aldehydes and ketones.*

Section A: Physical Chemistry-1 **(30 Lectures)**

Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

(10 Lectures)

Chemical Equilibrium:
Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG_0, Le Chatelier's principle. Relationships between K_p, K_c and K_x for reactions involving ideal gases.

(8 Lectures)

Ionic Equilibria:
Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

(12 Lectures)

Section B: Organic Chemistry-2 **(30 Lectures)**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

(8 Lectures)

Alkyl and Aryl Halides

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions.

Preparation: from alkenes *and* alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.
Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).
Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

(8 Lectures)

Alcohols, Phenols and Ethers (Upto 5 Carbons)

Alcohols: *Preparation:* Preparation of 1^o, 2^o and 3^o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts. *Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

(14 Lectures)

Recommended Books:

1. T. W. Graham Solomons: *Organic Chemistry, John Wiley and Sons*.
2. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
3. I.L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
4. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
5. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.
6. G. M. Barrow: *Physical Chemistry* Tata McGraw---Hill (2007).

7. G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
8. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry* Cengage Lening India Pvt. Ltd., New Delhi (2009).
9. B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
10. R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

LAB: CHEMISTRY3

CHEMICAL ENERGETICS, EQUILIBRIA &
FUNCTIONAL ORGANIC CHEMISTRY-I
60 Lectures

Section A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

b) Preparation of buffer solutions:

(i) Sodium acetate-acetic acid

(ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
   (a) Bromination of Phenol/Aniline
   (b) Benzoylation of amines/phenols
   (c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

Recommended Books

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

Semester IV

CHE- RC/HG-4016: CHEMISTRY4

SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY
(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objective: *This course may be divided into two broad parts-physical and organic chemistry. In 1st part of this course students will be introduced to solutions, phase equilibrium and electrochemistry. The 2nd part contains carboxylic acid and derivatives, amines and diazonium salt and biochemistry.*

Learning Outcome: *After completion of this course the students learn solutions, phase rule and its application in specific cases, basics of conductance and electrochemistry. Students will also learn some important topics of organic and biochemistry- carboxylic acids, amines, amino acids, peptides, proteins and carbohydrates.*

***Section A: Physical Chemistry-2* (30 Lectures)**

Solutions
Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperaturecomposition
curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule.
Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Phase Equilibrium
Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).

Conductance
Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions.

Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acidbase).

Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data.

Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge.

pH determination using hydrogen electrode and quinhydrone electrode.

Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

Section B: Organic Chemistry-3 **(30 Lectures)**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Carboxylic acids and their derivatives

Carboxylic acids (aliphatic and aromatic)

Preparation: Acidic and Alkaline hydrolysis of esters.

Reactions: Hell – Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (Upto 5 carbons)

Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion.

Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction,Perkin condensation.

(6 Lectures)

Amines and Diazonium Salts

Amines (Aliphatic and Aromatic): (Upto 5 carbons)

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.

Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: *Preparation:* from aromatic amines.
Reactions: conversion to benzene, phenol, dyes.

(6 Lectures)

Amino Acids, Peptides and Proteins:

Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis.

Reactions of Amino acids: ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides by degradation Edmann degradation (Nterminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & Cactivating groups and Merrifield solid-phase synthesis.

(10 Lectures)

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

(8 Lectures)

Recommended Books:

1. G. M. Barrow: *Physical Chemistry* Tata McGraw---Hill (2007).
2. G. W. Castellan: *Physical Chemistry* 4th Ed. Narosa (2004).
3. J. C. Kotz, P. M. Treichel, J. R. Townsend, *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
4. B. H. Mahan: *University Chemistry*, 3rd Edn. Narosa (1998).
5. R. H. Petrucci, *General Chemistry*, 5th Edn., Macmillan Publishing Co.: New York (1985).
6. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.*, W. H. Freeman.
10. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.*, W. H. Freeman

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LAB: CHEMISTRY4

SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL ORGANIC CHEMISTR-II

60 Lectures

Section A: Physical Chemistry

Distribution

Study of the equilibrium of one of the following reactions by the distribution method:

$I_2(aq) + I^-(aq) \rightleftharpoons I_3^-(aq)$

$Cu^{2+}(aq) + xNH_3(aq) \rightleftharpoons [Cu(NH_3)x]^{2+}$

Phase equilibria
a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Conductance
IV. Determination of cell constant
V. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
VI. Perform the following conductometric titrations:
v. Strong acid vs. strong base
vi. Weak acid vs. strong base

Potentiometry
Perform the following potentiometric titrations:
v. Strong acid vs. strong base
vi. Weak acid vs. strong base
vii. Potassium dichromate vs. Mohr's salt

Section B: Organic Chemistry

I Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

II

1. Separation of amino acids by paper chromatography
2. Determination of the concentration of glycine solution by formylation method.
3. Titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. Determination of the saponification value of an oil/fat.
7. Determination of the iodine value of an oil/fat
8. Differentiation between a reducing/nonreducing sugar.
9. Extraction of DNA from onion/ cauliflower

Recommended Books:

1. A.I. Vogel: Textbook of Practical Organic Chemistry, Prentice Hall, 5th Edn.
2. F. G. Mann & B. C. Saunders: Practical Organic Chemistry, Orient Longman, 1960.
3. B.D. Khosla: Senior Practical Physical Chemistry, R. Chand & Co.
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press.

Discipline Specific Elective (DSE)

CHE-RE-5016: APPLICATIONS OF COMPUTERS IN CHEMISTRY

(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objective: *This course intends to make learners familiar with basics of computer language, computer programming, handling of experimental data, curve fitting etc to analyze experimental results. This basic knowledge will help the students to perform and interpret results of various chemistry practicals.*

Learning Outcome: *After the completion of this course it will help the student to interpret laboratory data, curve fitting of experimental work, also perform quantum mechanical calculations for various molecular models.*

Basics:
Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

Numerical methods:
Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton-Raphson method, Binary bisection and Regula-Falsi.

Differential calculus: Numerical differentiation.

Integral calculus: Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values.

Simultaneous equations: Matrix manipulation: addition, multiplication. Gauss-Siedal method.

Interpolation, extrapolation and curve fitting: Handling of experimental data.
Conceptual background of molecular modelling: Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods.

Recommended Books:

1. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
2. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
3. Noggle, J. H. *Physical chemistry on a Microcomputer.* Little Brown & Co. (1985).
4. Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* Jaico Publishing House: Delhi (1996).

LAB: APPLICATIONS OF COMPUTERS IN CHEMISTRY

60 Lectures

Computer programs based on numerical methods for

1. Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid).

2. Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).

3. Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values.

4. Matrix operations. Application of Gauss-Siedel method in colourimetry.

5. Simple exercises using molecular visualization software.

Recommended Books:

1. McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).
2. Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005).
3. Steiner, E. The Chemical Maths Book Oxford University Press (1996).
4. Yates, P. Chemical Calculations. 2nd Ed. CRC Press (2007).
5. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
6. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
7. Noggle, J. H. *Physical Chemistry on a Microcomputer.* Little Brown & Co. (1985).
8. Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* Jaico Publishing House: Delhi (1996).

CHE-RE-5026: ANALYTICAL METHODS IN CHEMISTRY

(Credits: Theory-04, Lab -02)

Theory: 60 Lectures

Course Objective: *This is an elective course designed to complement the needs of students who wish to learn more about the qualitative/quantitative characterization and separation techniques. The content of this course aims to cover some of the widely used instrumental techniques for characterization of samples. Experiments included aim at giving students hands on experience using different instrumental techniques and chemical analysis.*

Learning outcome: *On successful completion students will be have theoretical understanding about choice of various analytical techniques used for qualitative and quantitative characterization of samples. At the same time through the experiments students will gain hands on experience of the discussed techniques. This will enable students to take judicious decisions while analyzing different samples.*

Qualitative and quantitative aspects of analysis:

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

(5 Lectures)

Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;

Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of metal complex composition using Job's method of continuous variation and mole ratio method.

Infrared Spectroscopy: Basic principles of instrumentation (choice of source, monochromator & detector) for continuous wave and Fourier transform spectrometers; sampling techniques.

Structure elucidation through interpretation of data. Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, and detector, choice of flame and Burner designs. Techniques of atomization and sample introduction. Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

(25 Lectures)

Thermal methods of analysis:

Theory of thermogravimetry (TG), basic principle of instrumentation.
Techniques for quantitative estimation of Ca and Mg from their mixture.

(5 Lectures)

Electroanalytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

(10 Lectures)

Separation techniques:

Solvent extraction: Classification, principle and efficiency of the technique.

Mechanism of extraction: extraction by solvation and chelation.

Technique of extraction: batch, continuous and counter current extractions.

Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique.

Mechanism of separation: adsorption, partition & ion exchange.

Development of chromatograms: frontal, elution and displacement methods.

Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC).

Role of computers in instrumental methods of analysis.

(15 Lectures)

Recommended Books:

1. Mendham, J. et al.: Vogel's Text Book of Quantitative Chemical Analysis ; 6th Ed. Pearson Education, 2009.
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. CBS Publishers & Distributors, 2004.
3. Christian, Gary D: Analytical Chemistry, 6th Ed. Wiley India (P) Ltd., 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, 4th Ed. W. H. Freeman, 2008.
5. Khopkar, S.M.: Basic Concepts of Analytical Chemistry, 3rd Ed. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, 6th Ed. Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. and Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.1979
8. Ditts, R.V. *Analytical Chemistry: Methods of separation.*Van Nostrand, New York, 1974.

LAB: ANALYTICAL METHODS IN CHEMISTRY

60 Lectures

1. Separation Techniques

I. Chromatography:

(a) Separation of mixtures

(i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.

(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values.

(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions:

(i) To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+}- DMG complex in chloroform, and determine its concentration by spectrophotometry.

(ii) Solvent extraction of zirconium with amberliti LA-1, separation from a mixture of irons and gallium.

3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

4. Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques.

5. Analysis of soil:

(i) Determination of pH of soil.

(ii) Total soluble salt

(iii) Estimation of calcium, magnesium, phosphate, nitrate

6. Ion exchange:

(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.

(ii) Separation of metal ions from their binary mixture.

(iii) Separation of amino acids from organic acids by ion exchange chromatography.

7. Spectrophotometry

(i) Determination of pKa values of indicator using spectrophotometry.

(ii) Structural characterization of compounds by infrared spectroscopy.

(iii) Determination of dissolved oxygen in water.

(iv) Determination of chemical oxygen demand (COD).

(v) Determination of Biological oxygen demand (BOD).

(vi) Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by

Job's method.

Recommended Books:

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
9. Ditts, R.V. *Analytical Chemistry: Methods of separation.* Van Nostrand, New York, 1974.

CHE-RE-5036: MOLECULAR MODELLING & DRUG DESIGN
(Credits: Theory-04, Lab-02)
Theory: 60 Lectures

Course Objective: *The course introduces students to the basic principles of computer assisted drug design, modelling and the important theoretical concepts and programming.*
Learning Outcome: *Students will be able to identify basic components of computer and programming as applied to computer assisted design and modelling of molecules.*

Introduction to Molecular Modelling:
Introduction. Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.

(10 Lectures)

Force Fields:

Fields. Bond Stretching. Angle Bending. Introduction to nonbonded interactions. Electrostatic interactions. van der Waals Interactions. Hydrogen bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.

(14 Lectures)

Energy Minimization and Computer Simulation:

Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods. Simple thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors.

(12 Lectures)

Molecular Dynamics & Monte Carlo Simulation:

Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers.

(12 Lectures)

Structure Prediction and Drug Design:

Structure prediction - Introduction to comparative Modeling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design,

Drug Discovery – Chemoinformatics – QSAR.

(12 Lectures)

Recommended Books:

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

LAB: MOLECULA MODELLING & DRUG DESIGN

60 Lectures

i. Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds.
ii. (a) Perform a conformational analysis of butane. (b) Determine the enthalpy of isomerization of *cis* and *trans* 2-butene.
iii. Visualize the electron density and electrostatic potential maps for LiH, HF, N_2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules.
iv. (a) Relate the charge on the hydrogen atom in hydrogen halides with their acid character. (b) Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.
v. (a) Compare the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Note the dipole moment of each molecule. (b) Show how the shapes affect the trend in boiling points: (118 ºC, 100 ºC, 108 ºC, 82 ºC, respectively).
vi. Build and minimize organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound: (a) alkyl halide (b) aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester (j) amide.

vii. (a) Determine the heat of hydration of ethylene. (b) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
viii. Arrange 1-hexene, 2-methyl-2-pentene, (*E*)-3-methyl-2-pentene, (*Z*)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.
ix. (a) Compare the optimized bond angles H_2O, H_2S, H_2Se. (b) Compare the HAH bond angles for the second row dihydrides and compare with the results from qualitative MO theory.

Note: Software: ChemSketch, ArgusLab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, or any similar software.

Recommended Books:

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

CHE-RE-5046: NOVEL INORGANIC SOLIDS
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

Course Objective: *This introductory course intends to make learners familiar with a wide variety of technologically important and emerging materials. It will prepare the learners for studying materials further at the master's level. Prior completion of one introductory UG level course on inorganic and physical chemistry will be essential.*
Learning outcome: *After the completion of this course it will also be possible for the students to opt for studying an interdisciplinary master's programme with an emphasis on the synthesis and applications of various materials or take up a job in the materials production and/or processing industry.*

Synthesis and modification of inorganic solids:

Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods.

(10 Lectures)

Inorganic solids of technological importance:

Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments.

Molecular material and fullerides, molecular materials & chemistry – one-dimensional metals, molecular magnets, metal containing liquid crystals.

(10 Lectures)

Nanomaterials:
Overview of nanostructures and nanomaterials: classification.
Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires.

Bio-inorganic nanomaterials, DNA and nanomaterials, natural and artificial nanomaterials, bionano composites.

(10 Lectures)

Introduction to engineering materials for mechanical construction:
Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminium and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials.

(10 Lectures)

Composite materials:
Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.

(10Lectures)

Speciality polymers:

Ceramics & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications.

(10 Lectures)

Recommended Books:

1. Shriver & Atkins. Inorganic Chemistry, Peter Alkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)
2. Smart, L. E., Moore, E. A., Solid State Chemistry: An Introduction, 4th Ed., CRC Press, 2012.
3. Poole, C. P., Ovens, F. J., Introduction to Nanotechnology, Wiley India, 2009.
4. Murty, B. S., Shankar, P., Raj, B., Rath, B, B., Murday, J. Textbook of Nanoscience and Nanotechnology, Springer, 2013.

LAB: NOVEL INORGANIC SOLIDS
60 Lectures

1. Determination of cation exchange capacity.

2. Synthesis of oxides by ceramic method.

3. Synthesis of hydrogel by co-precipitation method.

4. Synthesis of silver and gold metal nanoparticles.

Recommended Book:

1. Fahlman, B. D., Materials *Chemistry*, Springer (2011).

CHE-RE-5056: POLYMER CHEMISTRY

(Credits: Theory-06, Lab-02)
Theory: 60 Lectures

Course objective: *This is an introductory level course in polymer chemistry. The aim of the course is to introduce the theory and applications of polymer chemistry to the students. Some industrially important polymers and conducting polymers, a promising class of polymeric materials for next generation devices will also be introduced in this course.*

Learning outcome: *After completion of this course the students will learn the definition and classifications of polymers, kinetics of polymerization, molecular weight of polymers, glass transition temperature, and polymer solutions etc. They also learn the brief introduction of preparation, structure and properties of some industrially important and technologically promising polymers.*

Introduction and history of polymeric materials:

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

(4 Lectures)

Functionality and its importance:

Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.

(8 Lectures)

Kinetics of Polymerization:

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

(8 lectures)

Crystallization and crystallinity:

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

(4 Lectures)

Nature and structure of polymers-Structure Property relationships.

(2 Lectures)

Determination of molecular weight of polymers (M_n, M_w, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

(8 Lectures)

Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

(8 Lectures)

Polymer Solution – Criteria for polymer solubility, Solubility parameter,

Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

(8 Lectures)

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,
Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

(10 Lectures)

Recommended Books:

1. *Seymour's Polymer Chemistry,* Marcel Dekker, Inc.
2. G. Odian: Principles of Polymerization, John Wiley.
3. F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
4. P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
5. R.W. Lenz: Organic Chemistry of Synthetic High Polymers.

LAB: POLYMER CHEMISTRY

60 Lectures

1. **Polymer synthesis**

    1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) /Methyl Acrylate (MA) / Acrylic acid (AA).
        a. Purification of monomer
        b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)
    2. Preparation of nylon 66/6

    1. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
        a. Preparation of IPC
        b. Purification of IPC
        c. Interfacial polymerization
    3. Redox polymerization of acrylamide
    4. Precipitation polymerization of acrylonitrile
    5. Preparation of urea-formaldehyde resin
    6. Preparations of novalac resin/resold resin.

7. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight by viscometry:
   (a) Polyacrylamide-aq.$NaNO_2$ solution
   (b) (Poly vinyl proplylidine (PVP) in water

2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

*at least 7 experiments to be carried out.

Recommended Books:

1. Malcohm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.
2. Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003)
3. Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)
4. Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)
5. Petr Munk and Tejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002)
6. L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005)
7. Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005)
8. Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

CHE-RE-5066: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

(Credits: Theory-04, Lab -02)

Theory: 60 Lectures

Course Objective: *Students shall be introduced to the fundamental concepts/theory and application of different analytical techniques, as applied to chemistry.*

Learning Outcome: *Students shall be able to explain the theoretical basis of different analytical techniques, identify the experimental requirements and compare/analyze the data/results thereof.*

Introduction to spectroscopic methods of analysis:

Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.

(4 Lectures)

Molecular spectroscopy:

Infrared spectroscopy:

Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.

UV-Visible/ Near IR – emission, absorption, fluorescence and photoaccoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoaccoustic, fluorescent tags).

(16 Lectures)

Separation techniques

Chromatography: Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.

Immunoassays and DNA techniques

Mass spectroscopy: Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).

(16 Lectures)

Elemental analysis:

Mass spectrometry (electrical discharges).

Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence
Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

(8 Lectures)

NMR spectroscopy: **P**rinciple, Instrumentation, Factors affecting chemical shift, Spincoupling, Applications.

(4 Lectures)

Electroanalytical Methods: Potentiometry & Voltammetry

(4 Lectures)

Radiochemical Methods

(4 Lectures)

X-ray analysis and electron spectroscopy (surface analysis)

(4 Lectures)

Recommended books:

1. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).
2. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.
3. P.W. Atkins: Physical Chemistry.
4. G.W. Castellan: Physical Chemistry.
5. C.N. Banwell: Fundamentals of Molecular Spectroscopy.
6. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
7. W.J. Moore: Physical Chemistry.

LAB: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS
60 Lectures

1. Safety Practices in the Chemistry Laboratory
2. Determination of the isoelectric pH of a protein.
3. Titration curve of an amino acid.
4. Determination of the void volume of a gel filtration column.
5. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
6. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
7. IR Absorption Spectra (Study of Aldehydes and Ketones)
8. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
9. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)
10. Separation of Carbohydrates by HPLC
11. Determination of Caffeine in Beverages by HPLC
12. Potentiometric Titration of a Chloride-Iodide Mixture
13. Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple
14. Nuclear Magnetic Resonance
15. Use of fluorescence to do “presumptive tests” to identify blood or other body fluids.
16. Use of “presumptive tests” for anthrax or cocaine
17. Collection, preservation, and control of blood evidence being used for DNA testing
18. Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Ychromosome only or multiple chromosome)
19. Use of sequencing for the analysis of mitochondrial DNA
20. Laboratory analysis to confirm anthrax or cocaine

21. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives
22. Detection of illegal drugs or steroids in athletes
23. Detection of pollutants or illegal dumping
24. Fibre analysis

At least 10 experiments to be performed.

Recommended Books:

1. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler and Stanley Crouch (ISBN 0-495-01201-7).
2. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.

CHE-RE-6016: GREEN CHEMISTRY
(Credits: Theory-04, Lab -02)
Theory: 60 Lectures

Course Objective: *The learners will be taught about the emerging discipline of green chemistry particularly to differentiate as to how the principles of green chemistry may be applied to organic synthesis.*
Learning Outcome: *Apart from introducing learners to the principles of green chemistry, this course will make them conversant with applications of green chemistry to organic synthesis. Students will be prepared for taking up entry level jobs in the chemical industry. They also will have the option of studying further in the area.*

Introduction to Green Chemistry
What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry.
Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

(4 Lectures)

Principles of Green Chemistry and Designing a Chemical synthesis
Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

(24 Lectures)

Examples of Green Synthesis/ Reactions
1. Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, citral, ibuprofen, paracetamol, furfural.
2. Microwave assisted reactions in water: Oxidation of toluene, alcohols.
Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement,

Diels-Alder Reaction.
Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, benzimidazoles.
3. Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of “Clayan”, a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.

(24 Lectures)

Future Trends in Green Chemistry
Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Solventless reactions; Green chemistry in sustainable development.

(8 Lectures)

Recommended Books:

1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
2. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
3. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
4. M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
5. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

LAB: GREEN CHEMISTRY
60 Lectures

1. Safer starting materials
The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch.

(i) Effect of concentration on clock reaction
(ii) Effect of temperature on clock reaction.

2. Using renewable resources
Preparation of biodiesel from vegetable oil.

3. Avoiding waste

Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied

(I) Triethylamine ion + OH^- → propene + trimethylpropene + water

(II) 1-propanol $\xrightarrow{H_2SO_4/\Delta}$ propene + water

The other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

4. Use of enzymes as catalysts
Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide

Alternative Green solvents

5. Diels Alder reaction in water
Reaction between furan and maleic acid in water and at room temperature rather than in benzene and reflux.
6. Extraction of D-limonene from orange peel using liquid CO_2 prepared form dry ice.
7. Mechanochemical solvent free synthesis of azomethines
8. Co-crystal controlled solid state synthesis (C_2S_3) of N-organophthalimide using phthalic anhydride and 3-aminobenzoic acid.
Alternative sources of energy
9. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
10. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Recommended Books:

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. *Green Chemistry Experiment: A monograph*, I.K International Publishing House Pvt Ltd. New Delhi. Bangalore CISBN 978-93-81141-55-7 (2013).
5. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
6. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry,* American Chemical Society (2008).
7. Pavia, D. L. Lampman, G. H. & Kriz, G.S. *W B Introduction to Organic Laboratory Techniques: A Microscale Approach,* 4th Ed., Brooks/Cole; 2007.

CHE-RE-6026: INDUSTRIAL CHEMICALS AND ENVIRONMENT
(Credits: Theory-04, Lab -02)
Theory: 60 Lectures

Course Objectives: *This course provides an introduction to the various industrial gases and inorganic chemicals, their manufacturing processes, applications, storage and the hazards of handling them. Contribution of these industrial chemicals towards air and water pollution and their effects on living organisms and the environment has also been covered. Students* *are also expected to learn about metallurgy, energy generation industry and the pollution threat they pose. This course also discusses about management of the different kinds of wastes, their safe disposal and the importance of practicing green chemistry in chemical industry.*

Learning Outcomes: *After successful completion of the course, students would have learnt about the manufacture, applications and safe ways of storage and handling gaseous and inorganic industrial chemicals. Students will get to know about industrial metallurgy and the energy generation industry. Students will also learn about environmental pollution by various gaseous, liquid wastes and nuclear wastes and their effects on living beings. Finally, the students will learn about industrial waste management, their safe disposal and the importance of environment friendly "green chemistry" in chemical industry.*

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

(10 Lectures)

Industrial Metallurgy

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

(4 Lectures)

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by SO_2, CO_2, CO, NO_x, H_2S and other foul smelling gases. Methods of estimation of CO, NO_x, SO_x and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

(30 Lectures)

Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

(10 Lectures)

Biocatalysis

Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

(6 Lectures)

Recommended Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
7. S.E. Manahan, Environmental Chemistry, CRC Press (2005).
8. G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
9. A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

LAB: INDUSTRIAL CHEMICALS & ENVIRONMENT

60 Lectures

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method.
7. Measurement of dissolved CO_2.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Recommended Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

CHE-RE-6036: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE
(Credits: Theory-04, Lab -02)
Theory: 60 Lectures

Course Objectives: *To learn the synthetic process, properties and the utility of the industrially important inorganic materials (such as silicates, ceramics, cements, fertilizers, paints, batteries, alloys and explosives).*
To provide opportunity to learn some of the industrial process such as surface coating and catalysis in relevant to industry where heterogeneous catalysis dominates.
Experiments are aimed at helping learners acquire hands on experience in qualitative and quantitative analysis of the inorganic materials which are basically manufactured in chemical industries.
To learn some industrial techniques such as surface coating etc..

Learning Outcome: *This course will establish the basic foundation of industrial inorganic chemistry among the students. This will be helpful for pursuing further studies of industrial chemistry in future. Experiments will help the Students to gather the experience of qualitative and quantitative chemical analysis. Students will be capable of doing analysis of the inorganic materials which are used in our daily life. They will have insight of the industrial processes.*

Silicate Industries

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides,fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and thesetting process, quick setting cements.

(16 Lectures)

Fertilizers:

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate,compound and mixed fertilizers, potassium chloride, potassium sulphate.

(8 Lectures)

Surface Coatings:

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels,emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

(10 Lectures)

Batteries:

Primary and secondary batteries, battery components and their role, Characteristics of battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

(6 Lectures)

Alloys:

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

(10 Lectures)

Catalysis:

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.

Phase transfer catalysts, application of zeolites as catalysts.

(6 Lectures)

Chemical explosives:

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

(4 Lectures)

Recommended Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
4. Karl Heinz Büchel, Hans-Heinrich Moretto Peter, Woditsch; *Industrial Inorganic Chemistry*, Wiley-VCH.
5. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.

6. P. C. Jain, M. Jain: *Engineering Chemistry,* Dhanpat Rai & Sons, Delhi.
7. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry,* Vikas Publications, New Delhi.
8. B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut

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LAB: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

60 Lectures

1. Determination of free acidity in ammonium sulphate fertilizer.
2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Electroless metallic coatings on ceramic and plastic material.
5. Determination of composition of dolomite (by complexometric titration).
6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
7. Analysis of Cement.
8. Preparation of pigment (zinc oxide).

Recommended Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes,* Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics,* Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's *Handbook of Industrial Chemistry,* CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry,* Vikas Publications, New Delhi.
7. B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut

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CHE-RE-6046: RESEARCH METHODOLOGY FOR CHEMISTRY

(Credits: Theory-05, Tutorials-01)

Theory: 75 Lectures

Course Objectives:

This course is introduced to impart knowledge about the basic concepts of research and to provide a road map for conducting research

Students are expected to identify, explain and apply basic concepts of research; acquire information, recognize various issues related to research and to learn instrumental methods required for research in chemistry.

Learning Outcome:

After completing this course, students should be able to construct a rational research proposal to generate fruitful output in terms of publications and patents in the field of chemical sciences.

Literature Survey:

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index,Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus.

Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information.

(20 Lectures)

Methods of Scientific Research and Writing Scientific Papers:

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation.

Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.

(20 Lectures)

Chemical Safety and Ethical Handling of Chemicals:

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

(12 Lectures)

Data Analysis

The Investigative Approach: Making and Recording Measurements. SI Units and their use.Scientific method and design of experiments.

Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests.Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting,fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, *r* and its abuse. Basic aspects of multiple linear regression analysis.

(13 Lectures)

Electronics

Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

(10 Lectures)

Recommended Books

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) *Practical skills in chemistry*. 2nd Ed. Prentice-Hall, Harlow.
2. Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry*. Oxford University Press.
3. Topping, J. (1984) *Errors of observation and their treatment.* Fourth Ed., Chapman Hall, London.
4. Harris, D. C. *Quantitative chemical analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
5. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis.* Cambridge Univ. Press (2001) 487 pages.
6. Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
7. OSU safety manual 1.01.

CHEM-HE-6056: Dissertation

Student will complete a project work and then prepare a report on that.

Skill Enhancement Course (SEC)

AAA-SE-3014: ENGLISH

(Credits: 04)
60 Lectures

Syllabus will be available at GU website

CHE-SE-3024: IT SKILLS FOR CHEMISTS

(Credits: 04) 60 Lectures

Course Objective: *The objectives of the proposed course are:*

1) *To provide the basic knowledge of mathematics which are needed to pursue chemistry as major subject.*
2) *To provide the necessary training for the basic programming knowledge.*
3) *The course provides information technology literacy and basic skills training for learners with limited experience.*
4) *To familiarize with the Introductory writing activities and Handling numeric data.*

Learning Outcome: *Course learning outcomes focus on skill development related to basic computer operations and information technology. After completing the course the incumbent is able to use the computer for basic purposes of preparing his personnel/business letters, viewing information on Internet (the web), sending mails, using internet banking services etc. After opting this course the students are expected to accumulate the skills in writing activities and Handling numeric data.*

Mathematics

Fundamentals, mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, interconversion of units, constants and variables, equation of a straight line, plotting graphs.

Uncertainty in experimental techniques: Displaying uncertainties, measurements in chemistry, decimal places, significant figures, combining quantities.

Uncertainty in measurement: types of uncertainties, combining uncertainties. Statistical treatment. Mean, standard deviation, relative error. Data reduction and the propagation of errors. Graphical and numerical data reduction. Numerical curve fitting: the method of least squares (regression).

Algebraic operations on real scalar variables (e.g. manipulation of van der Waals equation in different forms).Roots of quadratic equations analytically and iteratively (e.g. pH of a weak acid). Numerical methods of finding roots (Newton-Raphson, binary –bisection, e.g. pH of a weak acid not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions).

Differential calculus: The tangent line and the derivative of a function, numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).

Numerical integration (Trapezoidal and Simpson's rule, e.g. entropy/enthalpy change from heat capacity data).

Computer programming:

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Errors (Syntax and Logical), Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

BASIC programs for curve fitting, numerical differentiation and integration (Trapezoidal rule, Simpson's rule), finding roots (quadratic formula, iterative, Newton-Raphson method).

HANDS ON

Introductory writing activities: Introduction to word processor and structure drawing (ChemSketch) software. Incorporating chemical structures, chemical equations, expressions from chemistry (e.g. Maxwell-Boltzmann distribution law, Bragg's law, van der Waals equation, etc.) into word processing documents/Latex.

Handling numeric data: Spreadsheet software (Excel), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs. Incorporating tables and graphs into word processing documents. Simple calculations, plotting graphs using a spreadsheet (Planck's distribution law, radial distribution curves for hydrogenic orbitals, gas kinetic theory- Maxwell-Boltzmann distribution curves as function of temperature and molecular weight), spectral data, pressure-volume curves of van der Waals gas (van der Waals isotherms), data from phase equilibria studies. Graphical solution of equations.

Numeric modelling: Simulation of pH metric titration curves. Excel functions LINEST and Least Squares. Numerical curve fitting, linear regression (rate constants from concentrationtime data, molar extinction coefficients from absorbance data), numerical differentiation (e.g. handling data from potentiometric and pH metric titrations, pK_a of weak acid), integration (e.g. entropy/enthalpy change from heat capacity data).

Statistical analysis: Gaussian distribution and Errors in measurements and their effect on data sets. Descriptive statistics using Excel. Statistical significance testing: The *t* test. The *F* test.

Presentation: Presentation graphics

Recommended Books:

1. McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).
2. Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005).
3. Steiner, E. The Chemical Maths Book Oxford University Press (1996).
4. Yates, P. Chemical calculations. 2nd Ed. CRC Press (2007).
5. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
6. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
7. Noggle, J. H. *Physical chemistry on a Microcomputer.* Little Brown & Co. (1985).
8. Venit, S.M. *Programming in BASIC: Problem solving with structure and style*. Jaico Publishing House: Delhi (1996).

CHE-SE-3034: BASIC ANALYTICAL CHEMISTRY

(Credits: 04) 60 Lectures

Course Objective: *To familiarize students with different micro and semimicro analytical techniques and help develop the ability to use modern instrumental methods for chemical analysis of food, soil, air and water.*

Learning Outcome: *Upon completion of this course, students shall be able to explain the basic principles of chemical analysis, design/implement microscale and semimicro experiments, record, interpret and analyze data following scientific methodology.*

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators
a. Determination of pH of soil samples.
b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.
a. Determination of pH, acidity and alkalinity of a water sample.
b. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration.
a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
b. Analysis of preservatives and colouring matter.

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.
a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).
b. To compare paint samples by TLC method.

Ion-exchange: Column, ion-exchange chromatography etc.
Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Analysis of cosmetics: Major and minor constituents and their function
a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Suggested Applications (Any one):
a. To study the use of phenolphthalein in trap cases.
b. To analyze arson accelerants.
c. To carry out analysis of gasoline.
Suggested Instrumental demonstrations:

a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Recommended Books:

1. Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.
2. Skoog & Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry *2nd Ed.*, W.H. Freeman and Co., N.Y. USA(1982).
8. Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16(1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall.
10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.
11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York (1995).

CHE-SE-4014: ANALYTICAL CLINICAL BIOCHEMISTRY
(Credits: 04) 60 Lectures

Course objective: *This course is intended to apprise students with various clinically relevant biomolecules, their structures and physiological roles. Students are also expected to learn the basics of analysis of pathological samples (blood and urine).*

Learning outcome: *Students will be able to identify various molecules relevant to a particular pathological condition and their estimation protocols.*

Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins:

Review of concepts studied in the core course.

Carbohydrates: Biological importance of carbohydrates, metabolism, cellular currency of energy (ATP), glycolysis, alcoholic and lactic acid fermentations, Krebs cycle, Isolation and characterization of polysachharides.

Proteins: Classification, biological importance, primary and secondary, tertiary and quaternary structures of proteins: α-helix and β- pleated sheets, isolation, characterization, denaturation of proteins.

Enzymes: Nomenclature, characteristics, classification, active site, mechanism of enzyme action, stereospecificity of enzymes, effect of pH, temperature on enzyme activity, , enzyme inhibitors, coenzymes and cofactors introduction to biocatalysis: importance in "Green Chemistry" and chemical industry.

Lipids: Classification, biological importance of triglycerides and phosphoglycerides and cholesterol, lipid membrane, liposomes and their biological functions and underlying applications.

Lipoproteins.

Properties, functions and biochemical functions of steroid hormones.

Biochemistry of peptide hormones.

Structure of DNA (Watson-Crick model) and RNA, genetic code, biological roles of DNA and RNA: replication, transcription and translation, introduction to gene therapy.

Biochemistry of disease: A diagnostic approach by blood/ urine analysis:

Blood: Composition and functions of blood, blood coagulation, blood collection and preservation of samples, anemia, regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

Urine: Collection and preservation of samples, formation of urine, composition and estimation of constituents of normal and pathological urine.

Practicals:

Identification and estimation of the following:
1. Carbohydrates - qualitative and quantitative analysis.
2. Lipids - qualitative and quantitative analysis.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Detection of cholesterol using Liebermann- Burchard reaction.
6. Isolation of protein.
7. Determination of concentration of protein by the Biuret reaction.
8. Determination of nucleic acid concentration.
9. Separation of nucleic acids.

Recommended Books:
1. David L. Nelson and Michael M. Cox: Lehninger Principles of Biochemistry
2. T.G. Cooper: Tool of Biochemistry.
3. Keith Wilson and John Walker: Practical Biochemistry.
4. Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
5. Thomas M. Devlin: Textbook of Biochemistry.
6. Jeremy M. Berg, John L Tymoczko, Lubert Stryer: Biochemistry.
7. G. P. Talwar and M Srivastava: Textbook of Biochemistry and Human Biology.
8. O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods.

CHE-SE-4024: GREEN METHODS IN CHEMISTRY
(Credits: 04) 60 Lectures

Course Objectives: *This course introduces students to the utilization of green chemistry from industrial perspective and provides exposure to methods by which environmental problems are evaluated and designing of sustainable solutions.*

Learning Outcome: *Students shall be able to describe and evaluate chemical products and processes from environmental perspective, define and propose sustainable solutions and critically assess the methods for waste reduction and recycling.*

Tools of Green chemistry, Twelve principles of Green Chemistry, with examples.

The following Real world Cases in Green Chemistry should be discussed:
1 A green synthesis of ibuprofen which creates less waste and fewer byproducts (Atom economy).
2 Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.
3 Environmentally safe antifoulant.
4 CO_2 as an environmentally friendly blowing agent for the polystyrene foam sheet packaging market.
5 Using a catalyst to improve the delignifying (bleaching) activity of hydrogen peroxide.
6 A new generation of environmentally advanced preservative: getting the chromium and arsenic out of pressure treated wood.
7. Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
8 Development of a fully recyclable carpet: cradle to cradle carpeting.

Recommended Books:
1. Manahan S.E. (2005) Environmental Chemistry, CRC Press
2. Miller, G.T. (2006) Environmental Science 11th edition. Brooks/Cole
3. Mishra, A. (2005) Environmental Studies. Selective and Scientific Books, New
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CHE-SE-4034: PHARMACEUTICAL CHEMISTRY
(Credits: 04) 60 Lectures

Course Objective: *This primary objective of this course is to introduce students to the fundamentals of drug design and development process, drugs for various diseases available in market, their mode of action and side effects. Students are expected to learn the biosynthetic procedures of various bio-relevant small molecules.*

Learning Outcome: *Students will be able to appreciate the drug development process, identify various small molecules used for treatments different ailments and other physiological processes.*

Drugs & Pharmaceuticals:
Drug discovery, design and development; basic retrosynthetic approach, synthesis of the representative drugs of the following classes: analgesics, antipyretic, anti-inflammatory (aspirin, paracetamol, ibuprofen), antibiotics (chloramphenicol), antibacterial and antifungal (sulphonamides, sulphanethoxazol, sulphacetamide, trimethoprim), antiviral (acyclovir), drugs effecting central nervous system (phenobarbital, diazepam), cardiovascular (glyceryl trinitrate), antilaprosy (dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation:
Aerobic and anaerobic fermentation, production of (i) ethanol and citric acid, (ii) antibiotics (penicillin, cephalosporin, chloromycetin and streptomycin), (iii) lysine, glutamic acid, vitamin B2, vitamin B12 and vitamin C.

Practicals:

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (antacid).

Recommended Books:

1. Graham L. Patrick: *An Introduction to Medicinal Chemistry, Oxford University* Press, UK.
2. Gareth Thomas: *Fundamentals of Medicinal Chemistry*, Wiley.
3. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry,* Vallabh Prakashan, Pitampura, New Delhi.
4. William O. Foye, Thomas L., Lemke, David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt. Ltd. New Delhi.

CHE-SE-5014: CHEMICAL TECHNOLOGY & SOCIETY
(Credits: 04) 60 Lectures

Course Objective: *The objective of the course is to enable students to have a firsthand understanding of different types of equipments needed in chemical technology and offer them concepts regarding some important parameters. The syllabus also emphasizes the dynamic nature of the relations between society on one hand and technological achievement from chemical industries on the other hand. In other words, it tries to explore societal and technological issues from a chemical perspective.*
Learning Outcome: *Students shall be familiarized with processes and terminologies in chemical industry, like mass balance, energy balance etc… Learners will be able to use chemical and scientific literacy as a means to better understand the topics related to the society.*

Chemical Technology

Different types of equipments needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.
Concept of relative humidity, molal humidity, dew point, partial saturation.
Material Balance: Recycle, bypass in batch, stage wise and continuous operations in systems with and without chemical reactions.
Energy balance: Energy balance of systems with and without chemical reactions.

Society
Social issues related to soil, air and water pollution.
Energy crisis of modern society and search for alternatives such as energy from natural sources (i.e. solar and renewable forms), and from nuclear fission, biofuel etc.
Pros and cons of use of materials like plastics and polymers and their natural analogues,
Genetic engineering and the manufacture of drugs (proteins and nucleic acids, and molecular reactivity and interconversions)

Recommended Book:

1. John W. Hill, Terry W. McCreary & Doris K. Kolb, *Chemistry for changing times* 13th Ed.
2. E.J. Hackett, O. Amsterdamska, M. Lynch and J. Wajcman (eds.), The Handbook of Science and Technology Studies, The MIT Press, 2008.
3. D. MacKenzie and J. Wajcman (eds.), The Social Shaping of Technology, The Open University Press, 1999.

CHE-SE-5024: CHEMOINFORMATICS

(Credits: 04) 60 Lectures

Learning Objectives: *The primary objective of this course is to familiarize the students with the use of various computer softwares and information technology. The students are expected to learn different chemical search engines and utilize them for molecular modelling and structure elucidation with a final goal to compute NMR, IR, mass and other spectra that can be later compared with the experimental data. The course also provides sufficient information and hands on exercises on the use of cheminformatics, with a special emphasis on its application in modern drug discovery.*

Learning Outcomes: *On the successful completion of the course, the students should be able to explain, interpret and critically examine the utility of computers and software tools to solving chemistry related problems. Recognize, apply, compare and predict chemical structures, properties, and reactivity and; solve chemistry related problems.*

Employ critical thinking and scientific reasoning to design and safely implement laboratory experiments and keep the records of the same.

Compile, interpret and analyze the qualitative/quantitative data and communicate the same in a scientific literature

Introduction to Chemoinformatics: History and evolution of chemoinformatics, Use of chemoinformatics, Prospects of chemoinformatics, Molecular Modelling and Structure elucidation.

Representation of molecules and chemical reactions: Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification.

Searching chemical structures: Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.

Applications: Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Model Building; Modeling Toxicity; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra; Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Target Identification and Validation; Lead Finding and Optimization; Analysis of HTS data; Virtual Screening; Design of Combinatorial Libraries; Ligand-Based and Structure Based Drug design; Application of Chemoinformatics in Drug Design.

Hands-on Exercises

Recommended Books:

1. Andrew R. Leach & Valerie, J. Gillet (2007) *An introduction to Chemoinformatics.* Springer: The Netherlands.
2. Gasteiger, J. & Engel, T. (2003) *Chemoinformatics: A text-book.* Wiley-VCH.
3. Gupta, S. P. (2011) *QSAR & Molecular Modeling.* Anamaya Pub.: New Delhi.

CHE-SE-5034: BUSINESS SKILLS FOR CHEMISTS
(Credits: 04) 60 Lectures

Course Objective: *To familiarize students with important concepts of business operations and intellectual rights as applied to chemical industry.*
Learning outcome: *students shall be able to explain and/or analyze the important steps of business operations, finance and intellectual property as applied to chemical industry.*

Chemistry in Industry
Current challenges and opportunities for the chemistry-using industries, role of chemistry in India and global economies.

Basics of Business and Management
Key business concepts: Business plans, market need, project management and routes to market.

Management Functions and skills, principles of motivation, forms of business organization including partnerships and companies.

Marketing Skills

Understanding basics of marketing and marketing mix strategies with cases.

Human Resource Management (HRM) Skills
Managerial HRM functions viz. recruitment, training and development and compensation.

Financial Management Skills
An overview of financial and cost accounting with cases, managerial finance functions.

Intellectual Property Rights
Concept of intellectual property rights, patents.

Recommended books

1. http://www.rsc.org/learn-chemistry/resources/business-skills-for-chemists/OnlineCourse/
2. Philip Kotler, Keven Lane Keller Marketing Management 15th Ed., Pearson Education; Fifteenth edition (10 August 2017)

CHE-SE-5044: INTELLECTUAL PROPERTY RIGHTS
(Credits: 04) 60 Lectures

Course Objective: *In this era of liberalization and globalization, the perception about science and its practices has undergone dramatic change. The importance of protecting the scientific discoveries, with commercial potential or the intellectual property rights is being discussed at all levels – statutory, administrative, and judicial. With India ratifying the WTO agreement, it has become obligatory on its part to follow a minimum acceptable standard for protection and enforcement of intellectual property rights. The purpose of this course is to apprise the students about the multifaceted dimensions of this issue.*

Learning Outcome: *After completing this course, students will have in-depth understanding about the importance and types of IPR. This course will also provide the clarity on the legal and economic aspects of the IP system.*

Introduction to Intellectual Property:

Historical Perspective, Different Types of IP, Importance of protecting IP.

Copyrights

Introduction, How to obtain, Differences from Patents.

Trade Marks

Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc.
Differences from Designs.

Patents

Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

Geographical Indications

Definition, rules for registration, prevention of illegal exploitation, importance to India.

Industrial Designs

Definition, How to obtain, features, International design registration.

Layout design of integrated circuits

Circuit Boards, Integrated Chips, Importance for electronic industry.

Trade Secrets

Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

Different International agreements

(a) Word Trade Organization (WTO):
(i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement
(ii) General Agreement on Trade related Services (GATS)
(iii) Madrid Protocol
(iv) Berne Convention
(v) Budapest Treaty

(b) Paris Convention

WIPO and **TRIPS, IPR** and Plant Breeders Rights, IPR and Biodiversity
IP Infringement issue and enforcement – Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

Recommended Books:

1. N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).
2. Manjula Guru & *M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
3. P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy*, Tata McGraw-Hill (2001).
4. Arthur Raphael Miller, Micheal H.Davis; *Intellectual Property: Patents, Trademarks*

and Copyright in a Nutshell, West Group Publishers (2000).
5. Jayashree Watal, *Intellectual property rights in the WTO and developing countries,* Oxford University Press, Oxford.

CHE-SE-6014: CHEMISTRY OF COSMETICS & PERFUMES
(Credits: 04) 60 Lectures

Course Objective: *This course intends to apprise students about the chemical knowledge related to some of the commonly used cosmetics. Laboratory experiments for preparation of talcum powder, shampoo etc. are included to give hands on experience.*

Learning Outcome: *Students will learn about the preparation and chemistry involved with the production different cosmetic. This may encourage students to take up entry level jobs at cosmetics industry or venture into commercial production of cosmetics as an entrepreneur.*

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold,

vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

Practicals

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.
5. Preparation of face cream.
6. Preparation of nail polish and nail polish remover.

Recommended Books:

1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.

CHE-SE-6024: PESTICIDE CHEMISTRY
(Credits: 04) 60 Lectures

Course Objective*: This is a brief and introductory course on pesticides, through which the students will be introduced to various classes of pesticides, their synthesis, applications and possible hazards of their uses.*

Learning Outcome*: Students will be able to explain or describe and critically examine different types of pesticides, their activity/toxicity and their applications and the need for the search of an alternative based on natural products.*

Definition of pesticides, general introduction to pesticides (natural and synthetic), benefits and adverse effects of pesticides. Classification, mode of action, toxicity and methods of pesticides residue analysis. Synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene); organophosphate (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor)

Practicals:

1. To calculate acidity/alkalinity in given sample of pesticides formulations as per BIS specifications.
2. Preparation of simple organophosphates, phosphonates and thiophosphates.

Recommended Book:

1. R. Cremlyn: Pesticides, Preparation and Mode of Action, John Wiley & Sons, New York, 1978
2. RPBateman, Pesticide Applications, AAB Press, 2004
3. Principles of Pesticide chemistry: S K Handa, Ed. by Agrobios (India), 2008
4. Pesticide Science & Biotechnology: R Greenhalgh and T R Robers, IUPAC, Blackwell Scientific Publications, 1987
5. The Chemical Process Industries: D N Shreve
6. Pesticide Chemistry : G Matolesy, M. Nadasy, V. Andriska, Elsevier Sc. Publisher, USA, 1988

CHE-SE-6034: FUEL CHEMISTRY
(Credits: 04) 60 Lectures

Course Objectives: *This course discusses about the chemistry of various sources of energy. Students are expected to learn about the composition of coal and petroleum products, their extraction, purification methods and usage. A section also covers classification and applications of natural and synthetic lubricants. Students will also learn about the determination and significance of various industrially relevant physical parameters for different fuels and lubricants.*

Learning Outcomes: *At the end of this course students will learn about the classes of renewable and non-renewable energy sources. Students will learn about the composition of coal and crude petroleum, their classification, isolation of coal and petroleum products and* *their usage in various industries. They will also learn to determine industrially significant physical parameters for fuels and lubricants.*

Fuel Chemistry

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal.Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants.

Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Recommended Books:

1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.

Syllabus of
B. Sc. (Regular) with Computer Science

(CHOICE BASED CREDIT SYSTEM)

This is approved in the Academic Council held on 8/11/2019

B.Sc. PROGRAM WITH COMPUTER SCIENCE (Regular):

Program Objectives:

Upon successful completion of a general course in computer science, students will be able to:

1. Demonstrate proficiency in problem-solving techniques using the computer.
2. Demonstrate proficiency in at least one high-level programming language and one operating system.
3. Demonstrate proficiency in the analysis of complex problems and the synthesis of solutions to those problems.
4. Demonstrate comprehension of modern software engineering principles.
5. Demonstrate a breadth and depth of knowledge in the discipline of computer science.

Program Learning Outcomes:

The goals of the computer science department are to prepare students for graduate training in some specialized area of computer science, to prepare students for jobs in industry, business or government, and to provide support courses for students in technology, mathematics and other fields requiring computing skills.

Program Structure:

The B. Sc program with Computer Science (Regular) is a three-year course divided into six-semesters. A student is required to complete 132 credits for the completion of the course and the award of the degree.

	Year	**Semester**	**Semester**
Part- I	First Year	Semester – I : 22	Semester – II : 22
Part - II	Second Year	Semester – III:22	Semester – IV: 22
Part – III	Third Year	Semester – V: 22	Semester – VI: 22

Program Implementation Requirement:

The program is a three-year course divided into six-semesters. For proper implementation of the UGCBCS program the following infrastructure are necessary:

(a) Sufficient lab facilities with computers and software
(b) At least 3 full teaching faculties.

Instruction for questions paper setter:

Question Paper setter should set from the prescribed text books, mentioned in the syllabus.

Course Structure

Details of courses under (B.Sc. with Computer Science Regular):

Course	***Credits**	
	Theory + Practical	**Theory + Tutorial**
I. Core Course (6 Credits)		
(12 Papers)	12X4= 48	12X5=60
04 Courses from each of the 03 disciplines of choice		
Core Course Practical / Tutorial*		
(12 Practical/Tutorials***)**	12X2=24	12X1=12
04 Courses from each of the 03 disciplines of choice		
II. Elective Course (6 Credits)		
(6 Papers)	6X4=24	6X5=30
Two papers from each discipline of choice including paper of interdisciplinary nature		
Elective Course Practical / Tutorial*	6 X 2=12	6X1=6
Two papers from each discipline of choice including paper of interdisciplinary nature		
Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester		
III. Ability Enhancement Courses		
1. **Ability Enhancement Compulsory Courses (AECC) (2 Papers of 4 credit each)**	2 X 4=8	2 X 4=8
Environmental Science		
English Communication		
2. **Skill Enhancement Courses (SEC) (4 Papers of 4 credit each)**	4 X 4=16	4 X 4=16
Total credit	**132**	**132**

* wherever there is a practical there will be no tutorial and vice-versa

Credit allocation (B.Sc. Computer Science Regular):

SEMESTER	COURSE OPTED	COURSE NAME	CREDITS
I	Ability Enhancement Compulsory Course-I	English/MIL communications/ Environmental Science	4
	Core course-I	Problem Solving using Computer	4
	Core Course-I Practical/Tutorial	Software Lab using Python	2
	Core course-II	DSC 2A	6
	Core Course-III	DSC 3A	6
II	Ability Enhancement Compulsory Course-II	English/MIL communications/ Environmental Science	4
	Core course-IV	Database Management Systems	4
	Core Course-IV Practical/Tutorial	Database Management Systems Lab	2
	Core course-V	DSC 2B	6
	Core Course-VI	DSC 3B	6
III	Core course-VII	Operating Systems	4
	Core Course-VII Practical/Tutorial	Operating Systems Lab	2
	Core course-VIII	DSC 2C	6
	Core Course-IX	DSC 3C	6
	Skill Enhancement Course -1	SEC-1	4
IV	Core course-X	Computer System Architecture	4
	Course-X Practical/Tutorial	Computer System Architecture Lab	2
	Core course-XI	DSC 2D	6
	Course-XII	DSC 3D	6
	Skill Enhancement Course -2	SEC -2	4
V	Skill Enhancement Course -3	SEC -3	4
	Discipline Specific Elective -1	DSE-1A	6
	Discipline Specific Elective -2	DSE-2A	6
	Discipline Specific Elective -3	DSE-3A	6
VI	Skill Enhancement Course -4	SEC -4	4
	Discipline Specific Elective -4	DSE-1B	6
	Discipline Specific Elective -5	DSE-2B	6
	Discipline Specific Elective -6	DSE-3B	6
Total Credits			132

CBCS Course Structure for B.Sc. (Regular.) Computer Science Program

SEMESTER WISE PLACEMENT OF THE COURSES

SEMESTER	CORE COURSE (12)	ABILITY ENHANCEMENT COMPULSORY COURSE(AECC) (2)	SKILL ENHANCEMENT COURSE (SEC) (4)	ELECTIVE: DISCIPLINE SPECIFIC DSE (6)
I	***Problem Solving using Computer*** **(CSC-RC-1016)** DSC – 2A DSC – 3A	**ENG-AE-1014**		
II	***Database Management Systems*** **(CSC-RC-2016)** DSC – 2B DSC – 3B	**ENV-AE-2014**		
III	***Operating Systems*** **(CSC-RC-3016)** DSC – 2C DSC – 3C		SEC -1 (any one) ***(i) Office Automation Tools*** **(CSC-SE-3014)** ***(ii) Multimedia Applications*** **(CSC-SE-3024)**	
IV	***Computer System Architecture*** **(CSC-RC-4016)** DSC – 2D DSC – 3D		SEC – 2 (any one) ***(i)System Administration and Maintenance*** **(CSC-SE-4014)** ***(ii) HTML Programming*** **(CSC-SE-4024)**	
V			SEC – 3 (any one) ***(i) Programming with VB/GAMBAS*** **(CSC-SE-5014)** ***(ii) HP Programming*** **(CSC-SE-5024)**	DSE – 1A **(CSC-RE-5016)** ***Project Work /Dissertation*** DSE – 2A DSE – 3A
VI			SEC – 4 (any one) ***(i) Programming with SCILAB*** **(CSC-SE-6014)** ***(ii) Android Programming*** **(CSC-SE-6024)**	DSE – 1B (any one) ***(i) Programming in Java*** **(CSC-RE-6016)** ***(ii) Computer Networks*** **(CSC-RE-6026)** ***(iii) Mobile Applications*** **(CSC-RE-6036)** ***(iv) E-Commerce Technologies*** **(CSC-RE-6046)** DSE – 2B DSE – 3B

Detailed Syllabus

CSC-RC-1016: Problem Solving_using Computers

4 Lectures, 4 Practical, Credits 6 (4+2)
Theory: 60 Lectures, Practical: 60 Lectures
End Semester Marks:
Theory: 60 Marks, Practical: 20 Marks
Internal Marks:
Sessional: 10 Marks, Practical: 6 Marks, Attendance: 4 Marks

UNIT 1: Computer Fundamentals **(3 Lectures)**

Introduction to Computers: Characteristics of Computers, Uses of computers, Types and generations of Computers.

UNIT 2: Basic Computer Organization **(4 Lectures)**

Basic Computer Organization - UNITs of a computer, CPU, ALU, memory hierarchy, registers, I/O devices.

UNIT 3: Planning the Computer Program **(3 Lectures)**

Concept of problem solving, Problem definition, Program design, Debugging, Types of errors in programming, Documentation.

UNIT 4: Techniques of Problem Solving **(4 Lectures)**

Flowcharting, decision table, algorithms, Structured programming concepts, Programming methodologies viz. top-down and bottom-up programming.

UNIT 5: Overview of Programming **(4 Lectures)**

Structure of a Python Program, Elements of Python

UNIT 6: Introduction to Python **(8 Lectures)**

Python Interpreter, Using Python as calculator, Python shell, Indentation. Atoms, Identifiers and keywords, Literals, Strings, Operators (Arithmetic operator, Relational operator, Logical or Boolean operator, Assignment, Operator, Ternary operator, Bit wise operator, Increment or Decrement operator).

UNIT 7: Creating Python Programs **(10 Lectures)**

Input and Output Statements, Control statements (Looping- while Loop, for Loop, Loop Control, Conditional Statement- if...else, Difference between break, continue and pass).

UNIT 8: Structures **(10 Lectures)**

Numbers, Strings, Lists, Tuples, Dictionary, Date & Time, Modules, Defining Functions, Exit function, default arguments.

UNIT 9: Introduction to Advanced Python **(14 Lectures)**

Objects and Classes, Inheritance, Regular Expressions, Event Driven Programming, GUI

Programming.

REFERENCE BOOKS:

1. P. K. Sinha & Priti Sinha , “Computer Fundamentals”, BPB Publications, 2007.
2. Dr. Anita Goel, Computer Fundamentals, Pearson Education, 2010.
3. T. Budd, Exploring Python, TMH, 1st Ed, 2011
4. Python Tutorial/Documentation www.python.org 2010
5. Allen Downey, Jeffrey Elkner, Chris Meyers , How to think like a computer scientist : learning with Python , Freely available online.2012

6. http://docs.python.org/3/tutorial/index.html
7. http://interactivepython.org/courselib/static/pythonds
8. http://www.ibiblio.org/g2swap/byteofpython/read/

LABORATORY:

<u>Section: A (Simple programs)</u>

1. Write a menu driven program to convert the given temperature from Fahrenheit to Celsius and vice versa depending upon user’s choice.
2. WAP to calculate total marks, percentage and grade of a student. Marks obtained in each of the three subjects are to be input by the user. Assign grades according to the following criteria :
   Grade A: Percentage >=80
   Grade B: Percentage>=70 and <80
   Grade C: Percentage>=60 and <70
   Grade D: Percentage>=40 and <60
   Grade E: Percentage<40
3. Write a menu-driven program, using user-defined functions to find the area of rectangle, square, circle and triangle by accepting suitable input parameters from user.
4. WAP to display the first n terms of Fibonacci series.
5. WAP to find factorial of the given number.
6. WAP to find sum of the following series for n terms: 1 – 2/2! + 3/3! - - - - - n/n!
7. WAP to calculate the sum and product of two compatible matrices.

Section: B (Visual Python):

All the programs should be written using user defined functions, wherever possible.

1. Write a menu-driven program to create mathematical 3D objects
   I. curve
   II. sphere

III. cone
IV. arrow
V. ring
VI. Cylinder.

2. WAP to read n integers and display them as a histogram.
3. WAP to display sine, cosine, polynomial and exponential curves.
4. WAP to plot a graph of people with pulse rate p vs. height h. The values of p and h are to be entered by the user.
5. WAP to calculate the mass m in a chemical reaction. The mass m (in gms) disintegrates according to the formula m=60/(t+2), where t is the time in hours. Sketch a graph for t vs. m, where t>=0.
6. A population of 1000 bacteria is introduced into a nutrient medium. The population p grows as follows:

   P(t) = (15000(1+t))/(15+ *e)*

   where the time t is measured in hours. WAP to determine the size of the population at given time t and plot a graph for P vs t for the specified time interval.

7. Input initial velocity and acceleration, and plot the following graphs depicting equations of motion:
   I. velocity wrt time (v=u+at)
   II. distance wrt time (s=u*t+0.5*a*t*t)
   III. distance wrt velocity (s=(v*v-u*u)/2*a)

CSC-RC-2016 : Database Management Systems

4 Lectures 4 Practical, Credits 6 (4+2)
Theory: 60 Lectures, Practical: 60 Lectures

UNIT 1: Introduction to Database Management Systems **(10 Lectures)**

Characteristics of database approach, data models, DBMS architecture and data independence.

UNIT 2: Entity Relationship and Enhanced ER Modelling **(15 Lectures)**

Entity types, relationships, SQL- 99: Schema Definition, constraints, and object modeling.

UNIT 3: Relational Data Model **(15 Lectures)**

Basic concepts, relational constraints, relational algebra, SQL queries.

UNIT 4: Database Design **(20 Lectures)**

ER and EER to relational mapping, functional dependencies, normal forms up to third normal orm.

REFERENCE BOOKS:

1. R. Elmasri, S.B. Navathe, Fundamentals of Database Systems 6th Edition, Pearson Education, 2010.
2. R. Ramakrishanan, J. Gehrke, Database Management Systems 3rd 2002. Edition, McGraw-Hill,
3. A. Silberschatz, H.F. Korth, S. Sudarshan, Database System Concepts 6th Edition, McGraw Hill, 2010.
4. R. Elmasri, S.B. Navathe Database Systems Models, Languages, Design and application Programming, 6th Edition, Pearson Education,2013.

Software Lab based on Database Management Systems

Note: MyAccess/MySQL may be used.

The following concepts must be introduced to the students:

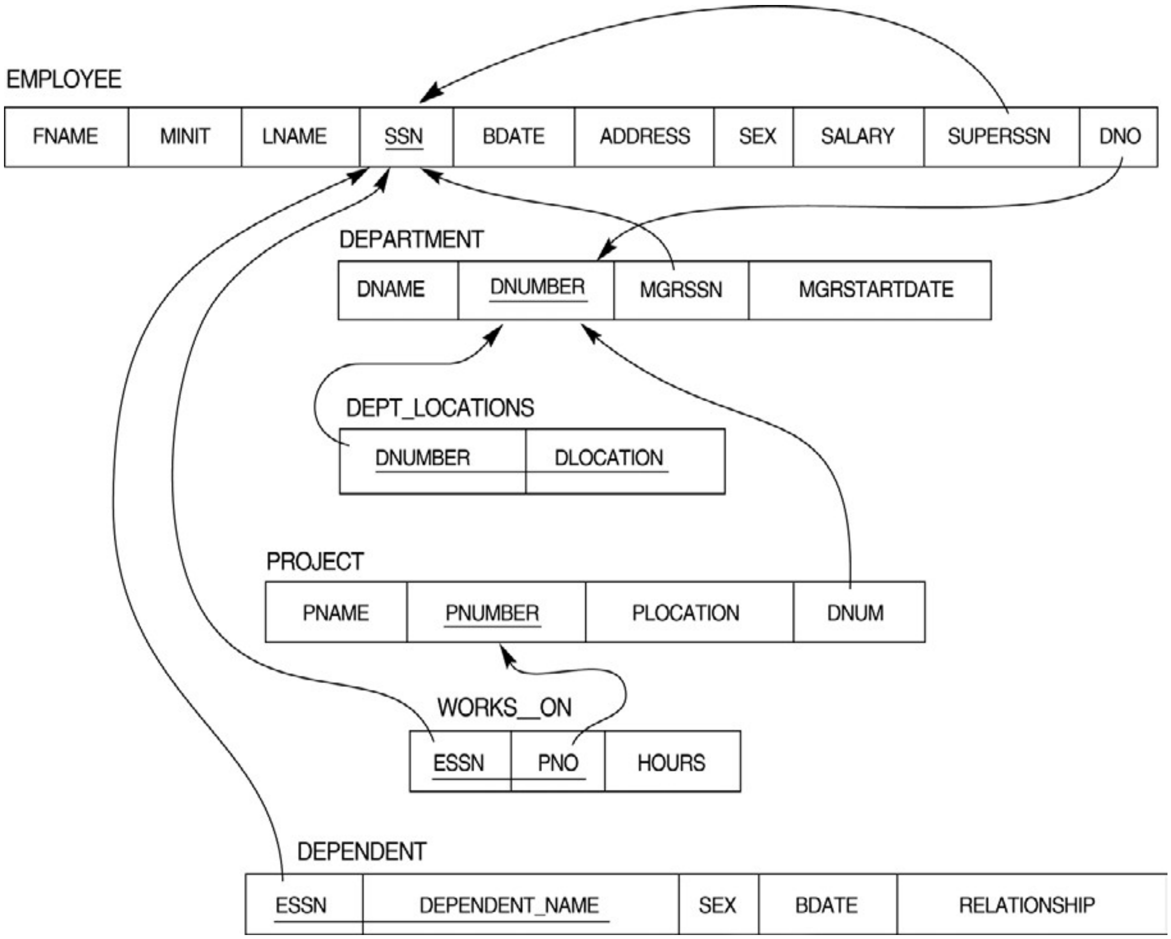
DDL Commands

- Create table, alter table, drop table

DML Commands

- Select , update, delete, insert statements
- Condition specification using Boolean and comparison operators (and, or, not,=,<>,>,<,>=,<=)
- Arithmetic operators and aggregate functions(Count, sum, avg, Min, Max)
- Multiple table queries (join on different and same tables)
- Nested select statements
- Set manipulation using (any, in, contains, all, not in, not contains, exists, not exists, union, intersect, minus, etc.)
- Categorization using group by……..having
- Arranging using order by

Relational Database Schema - COMPANY



Questions to be performed on above schema

1. Create tables with relevant foreign key constraints
2. Populate the tables with data
3. Perform the following queries on the database :
    1. Display all the details of all employees working in the company.
    2. Display ssn, lname, fname, address of employees who work in department no 7.
    3. Retrieve the birthdate and address of the employee whose name is 'Franklin T. Wong'
    4. Retrieve the name and salary of every employee
    5. Retrieve all distinct salary values
    6. Retrieve all employee names whose address is in ‘Bellaire’

7. Retrieve all employees who were born during the 1950s
8. Retrieve all employees in department 5 whose salary is between 50,000 and 60,000(inclusive)
9. Retrieve the names of all employees who do not have supervisors
10. Retrieve SSN and department name for all employees
11. Retrieve the name and address of all employees who work for the 'Research' department
12. For every project located in 'Stafford', list the project number, the controlling department number, and the department manager's last name, address, and birthdate.
13. For each employee, retrieve the employee's name, and the name of his or her immediate supervisor.
14. Retrieve all combinations of Employee Name and Department Name
15. Make a list of all project numbers for projects that involve an employee whose last name is 'Narayan' either as a worker or as a manager of the department that controls the project.
16. Increase the salary of all employees working on the 'ProductX' project by 15%. Retrieve employee name and increased salary of these employees.
17. Retrieve a list of employees and the project name each works in, ordered by the employee's department, and within each department ordered alphabetically by employee first name.
18. Select the names of employees whose salary does not match with salary of any employee in department 10.
19. Retrieve the name of each employee who has a dependent with the same first name and same sex as the employee.
20. Retrieve the employee numbers of all employees who work on project located in Bellaire, Houston, or Stafford.
21. Find the sum of the salaries of all employees, the maximum salary, the minimum salary, and the average salary. Display with proper headings.
22. Find the sum of the salaries and number of employees of all employees of the ‘Marketing’ department, as well as the maximum salary, the minimum salary, and the average salary in this department.
23. Select the names of employees whose salary is greater than the average salary of all employees in department 10.
24. For each department, retrieve the department number, the number of employees in the department, and their average salary.
25. For each project, retrieve the project number, the project name, and the number of employees who work on that project.

26. Change the location and controlling department number for all projects having more than 5 employees to ‘Bellaire’ and 6 respectively.
27. For each department having more than 10 employees, retrieve the department no, no of employees drawing more than 40,000 as salary.
28. Insert a record in Project table which violates referential integrity constraint with respect to Department number. Now remove the violation by making necessary insertion in the Department table.
29. Delete all dependents of employee whose ssn is ‘123456789’.
30. Delete an employee from Employee table with ssn = ‘12345’(make sure that this employee has some dependents, is working on some project, is a manager of some department and is supervising some employees). Check and display the cascading effect on Dependent and Works on table. In Department table MGRSSN should be set to default value and in Employee table SUPERSSN should be set to NULL
31. Perform a query using alter command to drop/add field and a constraint in Employee table.

CSC-RC-3016: Operating Systems

4 Lectures 4 Practical, Credits 6 (4+2)
Theory: 60 Lectures, Practical: 60 Lectures

UNIT 1: Introduction **(2 Lectures)**

System Software, Resource Abstraction, OS strategies.

UNIT 2: Types of operating systems **(2 Lectures)**

Multiprogramming, Batch, Time Sharing, Single user and Multiuser, Process Control & Real Time Systems.

UNIT 3: Operating System Organization **(10 Lectures)**

Factors in operating system design, basic OS functions, implementation consideration; process modes, methods of requesting system services – system calls and system programs.

UNIT 4: Process Management **(15 Lectures)**

System view of the process and resources, initiating the OS, process address space, process abstraction, resource abstraction, process hierarchy, Thread model.

UNIT 5: Scheduling **(12 Lectures)**

Scheduling Mechanisms, Strategy selection, non-pre-emptive and pre-emptive strategies.

UNIT 6: Memory Management **(12 Lectures)**

Mapping address space to memory space, memory allocation strategies, fixed partition, variable partition, paging, virtual memory

UNIT 7: Shell Introduction and Shell Scripting **(7 Lectures)**

1. What is shell and various type of shell, Various editors present in linux
2. Different modes of operation in vi editor
3. What is shell script, Writing and executing the shell script
4. Shell variable (user defined and system variables)
5. System calls, Using system calls
6. Pipes and Filters
7. Decision making in Shell Scripts (If else, switch), Loops in shell
8. Functions
9. Utility programs (cut, paste, join, tr , uniq utilities)
10. Pattern matching utility (grep)

REFERENCE BOOKS:

1. A Silberschatz, P.B. Galvin, G. Gagne, Operating Systems Concepts, 8th Edition, John Wiley Publications 2008.
2. A.S. Tanenbaum, Modern Operating Systems, 3rd Edition, Pearson Education 2007.
3. G. Nutt, Operating Systems: A Modern Perspective, 2nd Edition Pearson Education 1997.
4. W. Stallings, Operating Systems, Internals & Design Principles, 5th Edition, Prentice Hall of India. 2008.
5. M. Milenkovic, Operating Systems- Concepts and design, Tata McGraw Hill 1992.

SOFTWARE LAB BASED ON OPERATING SYSTEMS

Note: Following exercises can be performed using Linux or Unix

1. Usage of following commands:
   ls, pwd, tty, cat, who, who am I, rm, mkdir, rmdir, touch, cd.
2. Usage of following commands:
   cal, cat(append), cat(concatenate), mv, cp, man, date.
3. Usage of following commands:
   chmod, grep, tput (clear, highlight), bc.
4. Write a shell script to check if the number entered at the command line is prime or not.
5. Write a shell script to modify "cal" command to display calendars of the specified months.
6. Write a shell script to modify "cal" command to display calendars of the specified range of months.
7. Write a shell script to accept a login name. If not a valid login name display message – "Entered login name is invalid".
8. Write a shell script to display date in the mm/dd/yy format.
9. Write a shell script to display on the screen sorted output of "who" command along with the total number of users .
10. Write a shell script to display the multiplication table any number,
11. Write a shell script to compare two files and if found equal asks the user to delete the duplicate file.
12. Write a shell script to find the sum of digits of a given number.
13. Write a shell script to merge the contents of three files, sort the contents and then display them page by page.
14. Write a shell script to find the LCD(least common divisor) of two numbers.
15. Write a shell script to perform the tasks of basic calculator.
16. Write a shell script to find the power of a given number.
17. Write a shell script to find the factorial of a given number.
18. Write a shell script to check whether the number is Armstrong or not.
19. Write a shell script to check whether the file have all the permissions or not.
20. Program to show the pyramid of special character "*".

CSC-SE-3014: Office Automation Tools

02 Lectures 04 Practical, Credits 4 (2+2)

Theory: 20 Lectures Practical: 20 Lectures

UNIT 1: Introduction to open office/MS office/Libre office **(3 Lectures)**

UNIT 2: Word Processing **(6 Lectures)**

Formatting Text, Pages, Lists, Tables

UNIT 3: Spreadsheets **(6 Lectures)**

Worksheets, Formatting data, creating charts and graphs, using formulas and functions, macros, Pivot Table

UNIT 4: Presentation Tools **(5 Lectures)**

Adding and formatting text, pictures, graphic objects, including charts, objects, formatting slides, notes, hand-outs, slide shows, using transitions, animations.

REFERENCE BOOKS:

1. Sushila Madan , Introduction to Essential tools, JBA, 2009.
2. Anita Goel, Computer Fundamentals, Pearson, 2012

COMPUTER LAB BASED ON OFFICE AUTOMATION:

Practical List for WORD:

1. Create a **telephone directory**.

   - The heading should be 16-point Arial Font in bold
   - The rest of the document should use 10-point font size
   - Other headings should use 10-point Courier New Font.
   - The footer should show the page number as well as the date last updated.

2. Design a time-table form for your college.

   - The first line should mention the name of the college in 16-point Arial Font and should be bold.
   - The second line should give the course name/teacher's name and the department in 14-point Arial.
   - Leave a gap of 12-points.
   - The rest of the document should use 10-point Times New Roman font.
   - The footer should contain your specifications as the designer and date of creation.

3. Create the following one page documents.

   (a) Compose a note inviting friends to a get-together at your house, including a list of things to bring with them.

(b) Design a certificate in landscape orientation with a border around the document.

4. Create the following document: A newsletter with a headline and 2 columns in portrait orientation, including at least one image surrounded by text.

5. Convert following text to a table, using comma as delimiter

   Type the following as shown (do not bold).
   Color, Style, Item
   Blue, A980, Van
   Red, X023, Car
   Green, YL724, Truck

   Name, Age, Sex
   Bob, 23, M
   Linda, 46, F
   Tom, 29, M

6. Prepare a grocery list having four columns (Serial number, the name of the product, quantity and price) for the month of April, 06.
   - Font specifications for Title (Grocery List): 14-point Arial font in bold and italics.
   - The headings of the columns should be in 12-point and bold.
   - The rest of the document should be in 10-point Times New Roman.
   - Leave a gap of 12-points after the title.

7. XYZ Publications plans to release a new book designed as per your syllabus. Design the first page of the book as per the given specifications.
   (a) The title of the book should appear in bold using 20-point Arial font.
   (b) The name of the author and his qualifications should be in the center of the page in 16-point Arial font.
   (c) At the bottom of the document should be the name of the publisher and address in 16-point Times New Roman.
   (d) The details of the offices of the publisher (only location) should appear in the footer.

8. Create the following one page documents.
   a) Design a Garage Sale sign.
   b) Make a sign outlining your rules for your bedroom at home, using a numbered list.

9.Enter the following data into a table given on the next page.

Salesperson	**Dolls**	**Trucks**	**Puzzles**
Amit	1327	1423	1193
Shivi	1421	3863	2934
Om	5214	3247	5467
Ananya	2190	1278	1928
Anupama	1201	2528	1203
Maharshi	4098	3079	2067

Add a column Region (values: S, N, N, S, S, S) between the Salesperson and Dolls columns to the given table Sort your table data by Region and within Region by Salesperson in ascending order:

Practical List for EXCEL

Q1. Create a student worksheet containing roll numbers, names and total marks. Open a document in Word and insert the excel worksheet using:-

i) Copy/Paste
ii) Embedding
iii) Linking

Q2. The term wise marks for APS class of 20 students are stored in 3 separate sheets named term1, term2 and term3. Create 4th worksheet that contains student names and their total and average marks for the entire year. Give proper headings using headers. Make the column headings bold and italic. The 4th worksheet should contain college name as the first line. Make it bold, italic and center it.

Q3. Using a simple pendulum, plot 1-T and 1-T^2 graph.

I	t1	t2	t3	Mean(t)	T=t/20	T_2
70						
80						
90						
100						

Q4. Consider the following employee worksheet:-

Full Name (First Last)	Grade 1/2/3	Basic Salary	HRA	PF	Gross	Net	(VA) Vehicle Allowance

HRA is calculated as follows:

Grade	HRA %(of Basic)
1	40%
2	35%
3	30%

Gross = Basic + HRA + VA
Net = Gross –PF
PF is 8% for all Grades
VA is 15000, 10000 and 7000 for Grades 1, 2 and 3.

i) Find max, min and average salary of employees in respective Grade
ii) Count no. of people where VA>HRA
iii) Find out most frequently occurring grade.
iv) Extract records where employee name starts with "A" has HRA>10000
v) Print Grade wise report of all employees with subtotals of net salary and also grand totals. Use subtotal command.
vi) Extract records where Grade is 1 or 2 and salary is between 10000 and 20000 both inclusive.

Q5. In a meeting of a marketing department of an organization it has been decided that price of selling an item is fixed at Rs40. It was resolved to increases the sell of more of more items and getting the profit of Rs40,000/.Use Goal Seek of find out how many items you will have to sell to meet your profit figure.

Q6. To study the variation in volume with pressure for a sample of an air at constant temperature by plotting a graph for P – V and P-I/V. Sample observations are:-

Pressure(P)	Volume (V)	I/V	PV	P/V
75	20			
78.9	19			
83.3	18			
88.2	17			

Q7. Plot the chart for marks obtained by the students (out of 5) vs. frequency (total number of students in class is 50).

Q8. Create the following worksheet(s) containing an year wise sale figure of five salesmen in Rs.

Salesman	2002	2003	2004	2005
MOHAN	10000	12000	20000	50000
MITRA	15000	18000	50000	60000
SHIKHA	20000	22000	70000	70000
ROHIT	30000	30000	100000	80000
MANGLA	40000	45000	125000	90000

Apply the following Mathematical & Statistical functions:

i) Calculate the commission for each salesman under the condition :-
   a) If total sales is greater than Rs. 3, 00,000/-, then commission is 10% of total sale made by the salesman.
   b) Otherwise, 4% of total sale.

ii) Calculate the maximum sale made by each salesman.

iii) Calculate the maximum sale made in each year.

iv) Calculate the minimum sale made by each salesman.

v) Calculate the minimum sale made in each year.

vi) Count the no. of sales persons.

vii) Calculate the cube of sales made by Mohan in the year 2002.

viii) Find the difference in sales by salesman Mitra between the year 2002 and 2003. Find the absolute value of difference.

ix) Also calculate the Mode, Stddev, Variance, Median for the sale made by each salesman.

ix) Calculate the year wise Correlation coefficient between the sales man Mohan and Mitra year wise

Q9. The following table gives an year wise sale figure of five salesmen in Rs.

Salesman	2000	2001	2002	2003
S1	10000	12000	20000	50000
S2	15000	18000	50000	60000
S3	20000	22000	70000	70000
S4	30000	30000	100000	80000
S5	40000	45000	125000	90000

v) Calculate total sale year wise.
vi) Calculate the net sales made by each salesman
vii) Calculate the commission for each salesman under the condition :-
    c) If total sales is greater than Rs. 4, 00,000/-, then commission is 5% of total sale made by the salesman.
    d) Otherwise, 2% of total sale.
viii) Calculate the maximum sale made by each salesman.
ix) Calculate the maximum sale made in each year.
x) Draw a bar graph representing the sale made by each salesman.
xi) Draw a pie graph representing the sale made by salesmen in year 2001.

Q10. Consider the following worksheet for APS 1^{st} year students:-

S.No.	Name	PH	CH	BY	MT	CS	Total Marks	%	Grade
1									
2									

Grade is calculated as follows:-

If % >=90 Grade A
If % >=80 & <90 Grade B
If % >=70 & <80 Grade C
If % >=60 & <70 Grade D
Otherwise students will be declared fail.

i) Calculate Grade using if function
ii) Sort the data according to total marks
iii) Apply filter to display the marks of the students having more than 65% marks.
iv) Draw a pie chart showing % marks scored in each subject by the topper of the class.
v) Draw the doughnut chart of the data as in (iv)
vi) Enter the S.No. of a student and find out the Grade of the student using VLOOKUP.
vii) Extract all records where name
    a) Begins with “A”
    b) Contains “A”
    c) Ends with “A”

Practical List for Power Point:

1. Create five Power point slides. Each slide should support different format. In these slides explain areas of applications of IT. Make slide transition time as 10 seconds.
2. Create five Power Point slides to give advantages/disadvantages of computer, application of computers and logical structure of computer.
3. Create five Power Point slides detailing the process of internal assessment. It should be a self-running demo.

CSC-SE-3024: Multimedia Applications

02 Lectures 04 Practical, Credits 4 (2+2)

Theory: 20 Lectures Practical: 20 Lectures

UNIT 1: Multimedia **(2 Lectures)**

Introduction to multimedia, Components, Uses of multimedia.

UNIT 2: Making Multimedia **(4 Lectures)**

Stages of a multimedia project, Requirements to make good multimedia, Multimedia Hardware - Macintosh and Windows production Platforms, Hardware peripherals - Connections, Memory and storage devices, Multimedia software and Authoring tools.

UNIT 3: Text **(2 Lectures)**

Fonts & Faces, Using Text in Multimedia, Font Editing & Design Tools, Hypermedia &Hypertext.

UNIT 4: Images **(3 Lectures)**

Still Images – Bitmaps, Vector Drawing, 3D Drawing & rendering, Natural Light & Colors, Computerized Colors, Color Palletes, Image File Formats.

UNIT 5: Sound **(3 Lectures)**

Digital Audio, MIDI Audio, MIDI vs Digital Audio, Audio File Formats.

UNIT 5: Video **(3 Lectures)**

How Video Works, Analog Video, Digital Video, Video File Formats, Video Shooting and Editing.

UNIT 6: Animation **(3 Lectures)**

Principle of Animations. Animation Techniques, Animation File Formats.

BOOKS RECOMMENDED:

1. Tay Vaughan, "Multimedia: Making it work", TMH, Eighth edition. 2006
2. Ralf Steinmetz and Klara Naharstedt, "Multimedia: Computing, Communications Applications", Pearson,1995.
3. Keyes, "Multimedia Handbook", TMH. 2000.
4. K. Andleigh and K. Thakkar, "Multimedia System Design", PHI,2000

SOFTWARE LAB BASED ON MULTIMEDIA (FLASH AS A MULTIMEDIA S/W):

Practical exercises based on concepts listed in theory using Flash.

FLASH: Concept of Frame, Key frames, Frame rate, Timeline, Tween, Layers, Symbols, Embedding audio/video and embedding on the web page

1. Draw an animation to show a bouncing ball.
2. Draw an animation to show a moving stick man.
3. Draw an animation to show a fainting banana.
4. Draw an animation to show sunrise and sunset.
5. Draw an animation to show a disappearing house.

6. Draw an animation to show two boats sailing in river
7. Draw an animation to show a scene of cricket match.
8. Draw an animation to help teach a poem or a song
9. Draw an animation to show cartoon with a message
10. Make a movie showing Shape Tweening.
11. Make a movie showing Motion Tweening.
12. Add sound and button to the movie

CSC-RC-4016: Computer System Architecture

4 Lectures 4 Practical, Credits 6 (4+2)
Theory: 60 Lectures, Practical: 60 Lectures

UNIT 1: Introduction **(12 Lectures)**

Logic gates, boolean algebra, combinational circuits, circuit simplification, flip-flops and sequential circuits, decoders, multiplexors, registers, counters and memory units.

UNIT 2: Data Representation and basic Computer Arithmetic **(8 Lectures)**

Number systems, complements, fixed and floating point representation, character representation, addition, subtraction, magnitude comparison.

UNIT 3: Basic Computer Organization and Design **(18 Lectures)**

Computer registers, bus system, instruction set, timing and control, instruction cycle, memory reference, input-output and interrupt.

UNIT 4: Central Processing UNIT **(10 Lectures)**

Register organization, arithmetic and logical micro-operations, stack organization, micro programmed control.

UNIT 5: Programming the Basic Computer **(8 Lectures)**

Instruction formats, addressing modes, instruction codes, machine language, assembly language, input output programming.

UNIT 6: Input-output Organization **(4 Lectures)**

Peripheral devices, I/O interface, Modes of data transfer, direct memory access.

REFERENCE BOOKS:

1. M. Mano, Computer System Architecture, Pearson Education 1992.
2. A. J. Dos Reis, Assembly Language and Computer Architecture using C++ and JAVA, Course Technology, 2004
3. W. Stallings, Computer Organization and Architecture Designing for Performance, 8th Edition, Prentice Hall of India ,2009
4. Digital Design, M.M. Mano, Pearson Education Asia, 1979

COMPUTER SYSTEM ARCHITECTURE LAB

Practical: 60 Lab Periods

Memory 4096 words 16 bits per word	Instruction format 0 3 4 15 Opcode | Address

Basic Computer Instructions

Memory Reference	Register Reference	Input-Output

1. Create a machine based on the following architecture:
Register Set

IR	DR	AC	AR	PC	FGI	FGO	S	I	E
0 15	0 15	0 15	011	011	1 Bit	1 Bit	1 Bit	1 bit	1 Bit

Symbol	Hex		Symbol	Hex	Symbol	Hex
AND	0xxx		CLA	E800	INP	F800
ADD	2xxx		CLE	E400	OUT	F400
ISZ	Cxxx		INC	E020		
AND_I	1xxx	Indirect Addressing	SPA	E010		
ADD_I	3xxx		SNA	E008		
LDA_I	5xxx		SZA	E004		
STA_I	7xxx		SZE	E002		
BUN_I	9xxx		HLT	E001		
BSA_I	Bxxx					
ISZ_I	Dxxx					

Refer to Chapter-5 of Morris Mano for description of instructions.

ii) Create the micro operations and associate with instructions as given in the chapter (except interrupts). Design the register set, memory and the instruction set. Use this machine for the assignments of this section.

iii) Create a Fetch routine of the instruction cycle.

iv) Simulate the machine to determine the contents of AC, E, PC, AR and IR registers in hexadecimal after the execution of each of following register reference instructions:

a. CLA
b. CLE
c. CMA
d. CME
e. CIR
f. CIL
g. INC
h. SPA
i. SNA
j. SZA
k. SZE
l. HLT

Initialize the contents of AC to $(A937)_{16}$, that of PC to $(022)_{16}$ and E to 1.

5. Simulate the machine for the following memory-reference instructions with I= 0 and address part = 082. The instruction to be stored at address 022 in RAM. Initialize the memory word at address 082 with the operand B8F2 and AC with A937. Determine the contents of AC, DR, PC, AR and IR in hexadecimal after the execution.

   a. ADD
   b. AND
   c. LDA
   d. STA
   e. BUN
   f. BSA
   g. ISZ

6. Simulate the machine for the memory-reference instructions referred in above question with I= 1 and address part = 082. The instruction to be stored at address 026 in RAM. Initialize the memory word at address 082 with the value 298. Initialize the memory word at address 298 with operand B8F2 and AC with A937. Determine the contents of AC, DR, PC, AR and IR in hexadecimal after the execution.

7. Modify the machine created in Practical 1 according to the following instruction format:

Instruction format

0 – 2	3	4 – 15
Opcode	I	Address

   a. The instruction format contains a 3-bit opcode, a 1-bit addressing mode and a 12-bit address. There are only two addressing modes, I = 0 (direct addressing) and I = 1 (indirect addressing).
   b. Create a new register I of 1 bit.

Create two new microinstructions as follows :

   i. Check the opcode of instruction to determine type of instruction (Memory Reference/Register Reference/Input-Output) and then jump accordingly.
   ii. Check the I bit to determine the addressing mode and then jump accordingly.

CSC-SE-4014: System Administration and Maintenance

02 Lectures 04 Practical, Credits 4 (2+2)
Theory: 20 Lectures Practical: 20 Lectures

UNIT 1: Linux/Unix **(8 Lectures)**

- Basics of operating system, services,
- Installation and configuration, maintenance
- What is Linux/Unix Operating systems, Kernel, API, CLI, GUI,
- Difference between Linux/Unix and other operating systems
- Features and Architecture
- Linux features, advantages, disadvantages

UNIT 2: Windows **(12 Lectures)**

- Windows as operating system, history, versions.
- PC hardware, BIOS, Devices and drivers,
- Kernel Configuration and building
- Application installation, configuration and maintenance
- Server services and Client services
- Difference between Windows XP/windows7 and windows server 2003/2008

SOFTWARE LAB BASED ON SYSTEM ADMINISTRATION AND MAINTENANCE LINUX:

Linux Desktop tour. Configuring desktop environment and desktop settings.

Basic Commands : Terminal, shell,Cat, ls, cd, date, cal, man, echo, pwd, Mkdir, rm, rmdir Ps, kill
Package Installation Synaptic package manager

Windows:

Creating users – Admin and regular. Path of their personal files. Adding and changing passwords. Difference between workgroup and domain. Concept of roles. user profiles – creating and roaming Concept of Active Directory. Creating active directory in windows 2003/2008.
Process and Disk management Windows Task manager. File systems – NTFS, FAT.
Services Control Panel

C:/program Files, C:/system C:/windows Add /remove new hardware (like printer), Add/remove new programmes.
Network Administration Ipconfig,Ping, tracert, route, hostname, net, netstat, whoami Set manual IP address, check connectivity – ipv4, ipv6
Administrator Tools Control Panel -> Administrative Tools Computer Management, Local security Policy, Performance Monitor, Task Scheduler, Antivirus and firewall.
Misc Start->Accessories->System tools -> All options (Remote desktop, backup/restore etc.) **LAN** – sharing printer, files and folder over the network.

CSC-SE-4024: HTML Programming

02 Lectures 04 Practical, Credits 4 (2+2)

Theory: 20 Lectures Practical: 20 Lectures

UNIT 1: Introduction **(1 Lecture)**

UNIT 2: The Basics **(2 Lectures)**

- The Head, the Body
- Colors, Attributes
- Lists, ordered and unordered

UNIT 3: Links **(3 Lectures)**

- Introduction
- Relative Links, Absolute Links
- Link Attributes
- Using the ID Attribute to Link Within a Document

UNIT 4: Images **(3 Lectures)**

- Putting an Image on a Page
- Using Images as Links
- Putting an Image in the Background

UNIT 5: Tables **(5 Lectures)**

- Creating a Table
- Table Headers
- Captions
- Spanning Multiple Columns
- Styling Table

UNIT 6: Forms **(6 Lectures)**

- Basic Input and Attributes
- Other Kinds of Inputs
- Styling forms with CSS
- Where To Go From Here

REFERENCE BOOKS:

1. Introduction to HTML and CSS, O'Reilly , 2010
2. Jon Duckett, HTML and CSS, John Wiely, 2012

SOFTWARE LAB BASED ON HTML

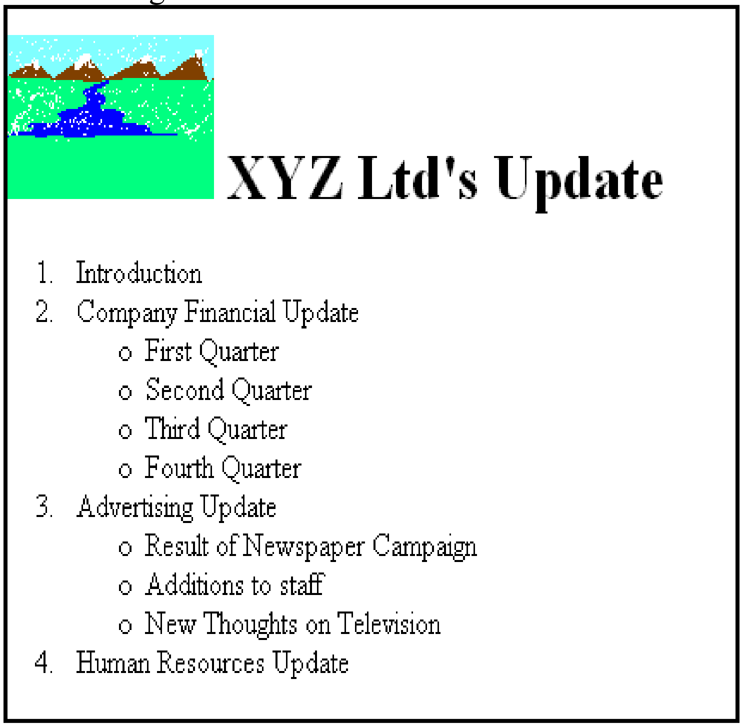
Create an HTML document with the following formatting options:

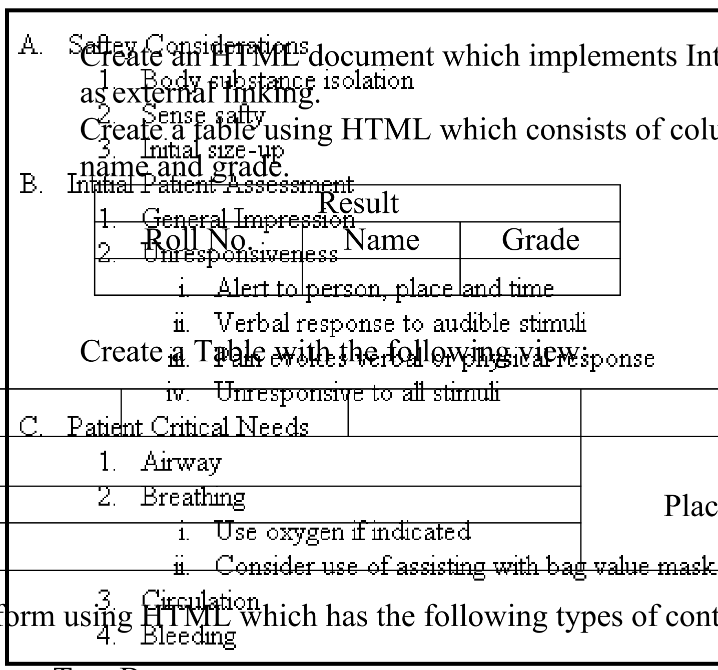
I. Bold
II. Italics
III. Underline
IV. Headings (Using H1 to H6 heading styles)
V. Font (Type, Size and Color)
VI. Background (Colored background/Image in background)
VII. Paragraph
VIII. Line Break
IX. Horizontal Rule
X. Pre tag

Create an HTML document which consists of:

I. Ordered List
II. Unordered List

III. Nested List
IV. Image





Create an HTML document which implements Internal linking as well as external linking.

Create a table using HTML which consists of columns for Roll No., Student's name and grade.

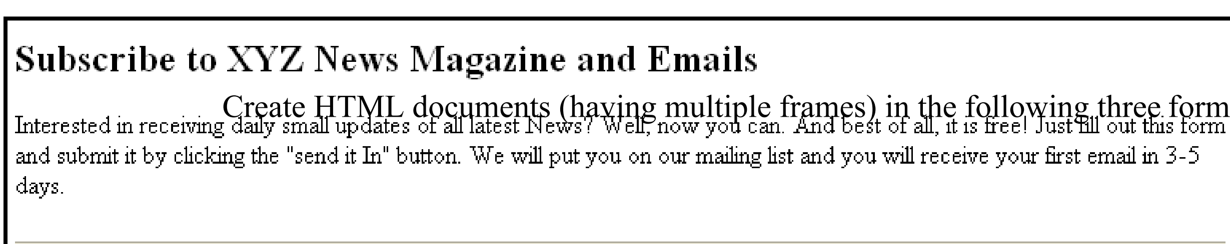
<table>
<tr><th colspan="3">Result</th></tr>
<tr><td>Roll No.</td><td>Name</td><td>Grade</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

Create a Table with the following view:

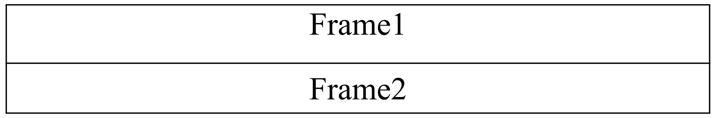
<table>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3"></td><td colspan="2" rowspan="3">Place an image here</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3"></td></tr>
</table>

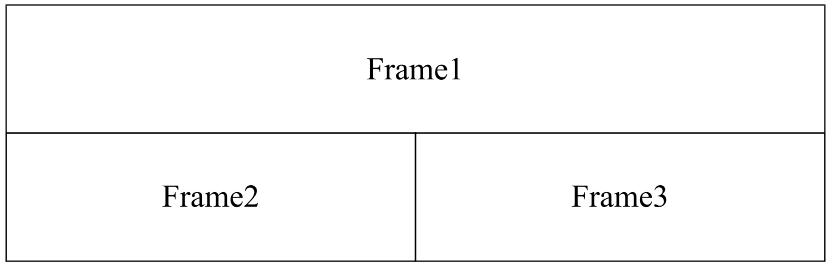
Create a form using HTML which has the following types of controls:

I. Text Box
II. Option/radio buttons
III. Check boxes
IV. Reset and Submit buttons



Create HTML documents (having multiple frames) in the following three formats:


Frame1
Frame2


Frame1
Frame2
Frame3

CSC-SE-5014: Programming with VB/GAMBAS

02 Lectures 04 Practical, Credits 4 (2+2)
Theory: 20 Lectures Practical: 20 Lectures

UNIT 1: GUI Environment **(2 Lectures)**

Introduction to graphical user interface (GUI), programming language (procedural, object oriented, event driven), the GUI environment, compiling, debugging, and running the programs.

UNIT 2: Controls **(4 Lectures)**

Introduction to controls textboxes, frames, check boxes, option buttons, images, setting borders and styles, the shape control, the line control, working with multiple controls and their properties, designing the user interface, keyboard access, tab controls, default & cancel property, coding for controls.

UNIT 3: Operations **(3 Lectures)**

Data types, constants, named & intrinsic, declaring variables, scope of variables, val function, arithmetic operations, formatting data.

UNIT 4: Decision Making **(5 Lectures)**

If statement, comparing strings, compound conditions (and, or, not), nested if statements, case structure, using if statements with option buttons & check boxes, displaying message in message box, testing whether input is valid or not**.**

UNIT 5: Forms Handling **(3 Lectures)**

Multiple forms creating, adding, removing forms in project, hide, show method, load, unload statement, me keyword, referring to objects on a different forms.

UNIT 6: Iteration Handling: **(3 Lectures)**

Do/loops, for/next loops, using msgbox function, using string function.

BOOK RECOMMENDED:

1. Julia Case Bradley, Anita C. Millispangh, Programming in Visual Basic 6.0, Tata Mcgraw Hill Edition 2000 (Fourteenth Reprint 2004).

SOFTWARE LAB BASED ON VISUAL BASIC:

Practical exercises based on concepts listed in theory using VB.

1. Write a VB application to compute the sum of two variables.
2. Write a VB application to compute the factorial of a number n.
3. Write a VB application to compute the Fibonacci series of a number n.
4. Write a VB application to compute the series of prime numbers till number n.
5. Write a VB application to compute the maximum of three numbers.
6. Write a VB application to compute the sum of odd numbers and even numbers in an array of n integers.
7. Write a VB application to compare the strings.
8. Write a VB application to make a calculator.
9. Write a VB application to choose your hobbies from a list.
10. Write a VB application to illustrate the use of color radio button.
11. Write a VB application to illustrate the use of color scroll bar form.
12. Write a VB application to illustrate the use of color scroll bar label text.
13. Write a VB application to illustrate the use of color text box.

14. Write a VB application to show a timer.

CSC-SE-5024: PHP Programming

02 Lectures 04 Practical, Credits 4 (2+2)

Theory: 20 Lectures Practical: 20 Lectures (1 +2 Lab)

UNIT 1: Introduction to PHP **(4 Lectures)**

PHP introduction, inventions and versions, important tools and software requirements (like Web Server, Database, Editors etc.), PHP with other technologies, scope of PHP, Basic Syntax, PHP variables and constants, Types of data in PHP , Expressions, scopes of a variable (local, global), PHP Operators : Arithmetic, Assignment, Relational , Logical operators, Bitwise , ternary and MOD operator, PHP operator Precedence and associativity

UNIT 2: Handling HTML form with PHP **(2 Lectures)**

Capturing Form Data, GET and POST form methods, Dealing with multi value fields, Redirecting a form after submission

UNIT 3: PHP conditional events and Loops **(3 Lectures)**

PHP IF Else conditional statements (Nested IF and Else), Switch case, while, For and Do While Loop, Goto, Break, Continue and Exit

UNIT 4: PHP Functions **(3 Lectures)**

Function, Need of Function, declaration and calling of a function, PHP Function with arguments, Default Arguments in Function, Function argument with call by value, call by reference, Scope of Function Global and Local

UNIT 5: String Manipulation and Regular Expression **(4 Lectures)**

Creating and accessing String , Searching & Replacing String, Formatting, joining and splitting String, String Related Library functions, Use and advantage of regular expression over inbuilt function, Use of preg_match(), preg_replace(), preg_split() functions in regular expression

UNIT 6: Array **(4 Lectures)**

Anatomy of an Array ,Creating index based and Associative array ,Accessing array, Looping with Index based array, with associative array using each() and foreach(), Some useful Library function

SOFTWARE LAB BASED ON PHP:

1. Create a PHP page using functions for comparing three integers and print the largest number.
2. Write a function to calculate the factorial of a number (non-negative integer). The function accept the number as an argument.
3. WAP to check whether the given number is prime or not.
4. Create a PHP page which accepts string from user. After submission that page displays the reverse of provided string.
5. Write a PHP function that checks if a string is all lower case.
6. Write a PHP script that checks whether a passed string is palindrome or not? (A palindrome is word, phrase, or sequence that reads the same backward as forward, e.g., madam or nurses run)
7. WAP to sort an array.
8. Write a PHP script that removes the whitespaces from a string.
   Sample string : 'The quick " " brown fox'

   Expected Output : Thequick""brownfox

9. Write a PHP script that finds out the sum of first n odd numbers.
10. Create a login page having user name and password. On clicking submit, a welcome message should be displayed if the user is already registered (i.e.name is present in the database) otherwise error message should be displayed.
11. Write a PHP script that checks if a string contains another string.
12. Create a simple 'birthday countdown' script, the script will count the number of days between current day and birth day.
13. Create a script to construct the following pattern, using nested for loop.

    ```
    *
    * *
    * * *
    * * * *
    * * * * *
    ```

14. Write a simple PHP program to check that emails are valid.
15. WAP to print first n even numbers.
16. $color = array('white', 'green', 'red")
    Write a PHP script which will display the colors in the following way :
    Output : white, green, red,

    - green
    - red
    - white
17. Using switch case and dropdown list display a “Hello” message depending on the language selected in drop down list.
18. Write a PHP program to print Fibonacci series using recursion.
19. Write a PHP script to replace the first 'the' of the following string with 'That'.

    Sample : 'the quick brown fox jumps over the lazy dog.'
    Expected Result : That quick brown fox jumps over the lazy dog.

CSC-RE-5016: Project Work/Dissertation

4 Lectures 4 Practical, Credits 6 (4+2)
Theory: 60 Lectures, Practical: 60 Lectures

- The students will be allowed to work on any project based on the concepts studied in core/elective or skill based elective courses.
- The group size should be maximum of three (03) students.
- Each group will be assigned a teacher as a supervisor who will handle both their theory as well lab classes.
- A maximum of Four (04) projects would be assigned to one teacher.
- Theory classes will cover project management techniques.

CSC-SE-6014: Programming with SCILAB

02 Lectures 04 Practical, Credits 4 (2+2)
Theory: 20 Lectures Practical: 20 Lectures

UNIT 1 **(2 Lectures)**

Introduction to Programming: Components of a computer, working with numbers, Machine code, software hierarchy.

UNIT 2 **(3 Lectures)**

Programming Environment: SCILAB Environment, Workspace, Working Directory, Expressions, Constants, Variables and assignment statement, Arrays.

UNIT 3 **(3 Lectures)**

Graph Plots: Basic plotting, Built in functions, Generating waveforms, Sound replay, load and save.

UNIT 4 **(4 Lectures)**

Matrices and Some Simple Matrix Operations, Sub- Matrices.

UNIT 5 **(4 Lectures)**

Procedures and Functions: Arguments and return values

UNIT 6 **(3 Lectures)**

Control Statements: Conditional statements: If, Else, Else-if, Repetition statements: While, for loop.

UNIT 7 **(4 Lectures)**

Manipulating Text: Writing to a text file, Reading from a text file, Randomizing and sorting a list, searching a list.

REFERENCE BOOKS:

1. M.Affouf, SCILAB by Example , CreateSpace Independent Publishing Platform,2012
2. H. Ramchandran, A.S. Nair, SCILAB , S.Chand, 2011

SOFTWARE LAB BASED ON SCILAB:

1. Write a program to assign the following expressions to a variable A and then to print out the value of A.
   a. (3+4)/(5+6)
   b. $2\pi^2$
   c. $\sqrt{2}$) $\times 0.4567\times10^{-4}$
   d. (0.0000123 + 5.67×10^{-3}

2. Celsius temperatures can be converted to Fahrenheit by multiplying by 9, dividing by 5, and adding 32. Assign a variable called C the value 37, and implement this formula to assign a variable F the Fahrenheit equivalent of 37 Celsius.
3. Set up a vector called N with five elements having the values: 1, 2, 3, 4, 5. Using N, create assignment statements for a vector X which will result in X having these values:
   a. 2, 4, 6, 8, 10
   b. 1/2, 1, 3/2, 2, 5/2
   c. 1, 1/2, 1/3, 1/4, 1/5
   d. 1, 1/4, 1/9, 1/16, 1/25
4. A supermarket conveyor belt holds an array of groceries. The price of each product (in pounds) is [0.6, 1.2 ,0.5, 1.3] ; while the numbers of each product are [3, 2 ,1 ,5]. Use MATLAB to calculate the total bill.

5. The sortrows(x) function will sort a vector or matrix X into increasing row order. Use this function to sort a list of names into alphabetical order.
6. The "identity" matrix is a square matrix that has ones on the diagonal and zeros elsewhere. You can generate one with the eye() function in MATLAB. Use MATLAB to find a matrix B, such that when multiplied by matrix A=[1 2; -1 0] the identity matrix I=[1 0; 0 1] is generated. That is A*B=I.
7. Create an array of N numbers. Now find a single MATLAB statement that picks out from that array the 1,4,9,16,…,√Nth entries, i.e. those numbers which have indices that are square numbers.
8. Draw a graph that joins the points (0,1), (4,3), (2,0) and (5,-2).
9. The seeds on a sunflower are distributed according to the formula below. Plot a small circle at each of the first 1000 co-ordinates :

$$r_n = \sqrt{n}$$

$$\theta_n = \frac{137.51}{180}\pi n$$

10. Calculate 10 approximate points from the function y=2x by using the formulae:
    i. $x_n = n$
    ii. $y_n = 2n + \text{rand} - 0.5$

    Fit a line of best fit to these points using the function polyfit() with degree=1, and generate co-ordinates from the line of best fit using polyval(). Use the on-line help to find out how to use these functions. Plot the raw data and the line of best fit.
11. Calculate and replay 1 second of a sinewave at 500Hz with a sampling rate of 11025Hz. Save the sound to a file called "ex35.wav". Plot the first 100 samples.
12. Calculate and replay a 2 second chirp. That is, a sinusoid that steadily increases in frequency with time, from say 250Hz at the start to 1000Hz at the end.
13. Build a square wave by adding together 10 odd harmonics: 1f, 3f, 5f, etc. The amplitude of the nth harmonic should be 1/n. Display a graph of one cycle of the result superimposed on the individual harmonics.
14. Write a function called FtoC (ftoc.m) to convert Fahrenheit temperatures into Celsius. Make sure the program has a title comment and a help page. Test from the command window with:
    i. FtoC(96)
    ii. lookfor Fahrenheit
    iii. help FtoC
15. Write a program to input 2 strings from the user and to print out (i) the concatenation of the two strings with a space between them, (ii) a line of asterisks the same length as the concatenated strings, and (iii) the reversed concatenation. For example:
    i. Enter string 1: Mark

ii. Enter string 2: <u>Huckvale</u>
iii. Mark Huckvale
iv. ******
v. elavkcuH kraM

CSC-SE-6024: Android Programming

02 Lectures 04 Practical, Credits 4 (2+2)
Theory: 20 Lectures Practical: 20 Lectures

UNIT 1: Introduction **(2 Lectures)**

History of Android, Introduction to Android Operating Systems, Android Development Tools, Android Architecture.

UNIT 2: Overview of object oriented programming using Java **(4 Lectures)**

OOPs Concepts: Inheritance, Polymorphism, Interfaces, Abstract class, Threads, Overloading and Overriding, Java Virtual Machine.

UNIT 3: Development Tools **(5 Lectures)**

Installing and using Eclipse with ADT plug-in, Installing Virtual machine for Android sandwich/Jelly bean (Emulator), configuring the installed tools, creating a android project – Hello Word, run on emulator, Deploy it on USB-connected Android device.

UNIT 4: User Interface Architecture **(3 Lectures)**

Application context, intents, Activity life cycle, multiple screen sizes.

UNIT 5: User Interface Design **(3 Lectures)**

Form widgets, Text Fields, Layouts, Button control, toggle buttons, Spinners (Combo boxes), Images, Menu, and Dialog.

UNIT 6: Database **(3 Lectures)**

Understanding of SQLite database, connecting with the database.

REFERENCE BOOK:

1. Android application development for java programmers. By James C. Sheusi. Publisher: Cengage Learning, 2013.

ONLINE READING / SUPPORTING MATERIAL:

1. http://www.developer.android.com
2. http://developer.android.com/about/versions/index.html
3. http://developer.android.com/training/basics/firstapp/index.html
4. http://docs.oracle.com/javase/tutorial/index.htm (Available in the form of free downloadable ebooks also).
5. http://developer.android.com/guide/components/activities.html
6. http://developer.android.com/guide/components/fundamentals.html
7. http://developer.android.com/guide/components/intents-filters.html.
8. http://developer.android.com/training/multiscreen/screensizes.html
9. http://developer.android.com/guide/topics/ui/controls.html
10. http://developer.android.com/guide/topics/ui/declaring-layout.html
11. http://developer.android.com/training/basics/data-storage/databases.html

Software Lab Based on Android Programming:

1. Create "Hello World" application. That will display "Hello World" in the middle of the screen in the emulator. Also display "Hello World" in the middle of the screen in the Android Phone.
2. Create an application with login module. (Check username and password).
3. Create spinner with strings taken from resource folder (res >> value folder) and on changing the spinner value, Image will change.
4. Create a menu with 5 options and selected option should appear in text box.
5. Create a list of all courses in your college and on selecting a particular course teacher-in-charge of that course should appear at the bottom of the screen.
6. Create an application with three option buttons, on selecting a button colour of the screen will change.
7. Create and Login application as above. On successful login, pop up the message.
8. Create an application to Create, Insert, update, Delete and retrieve operation on the database.

CSC-RE-6016: Programming in Java

Total marks: 150 (Theory: 80, Practical: 40, Internal Assessment: 30)
4 Lectures 4 Practical, Credits 6 (4+2)
Theory: 60 Lectures, Practical: 60 Lectures

UNIT 1: Introduction to Java **(1 Lecture)**

Features of Java, JDK Environment

UNIT 2: Object Oriented Programming Concept **(10 Lectures)**

Overview of Programming, Paradigm, Classes, Abstraction, Encapsulation, Inheritance, Polymorphism, Difference between C++ and JAVA

UNIT 3: Java Programming Fundamental **(10 Lectures)**

Structure of java program, Data types, Variables, Operators, Keywords, Naming Convention, Decision Making (if, switch),Looping(for, while) ,Type Casting

UNIT 4: Classes and Objects **(10 Lectures)**

Creating Classes and objects, Memory allocation for objects, Constructor, Implementation of Inheritance, Implementation of Polymorphism, Method Overloading, Method Overriding, Nested and Inner classes

UNIT 5: Arrays and Strings **(6 Lectures)**

Arrays, creating an array, Types of Arrays, String class Methods, String Buffer methods.

UNIT 6: Abstract Class, Interface and Packages **(8 Lectures)**

Modifiers and Access Control, Abstract classes and methods, Interfaces, Packages Concept, Creating user defined packages

UNIT 7: Exception Handling **(4 Lectures)**

Exception types, Using try catch and multiple catch, Nested try, throw, throws and finally, Creating User defined Exceptions.

UNIT 8: File Handling **(5 Lectures)**

Byte Stream, Character Stream, File IO Basics, File Operations, Creating file, Reading file, Writing File

UNIT 9: Applet Programming **(6 Lectures)**

Introduction, Types Applet, Applet Life cycle, Creating Applet, Applet tag

REFERENCE BOOK:

1. Ivan Bayross, Web Enabled Commercial Application Development Using Html, Dhtml,javascript, Perl Cgi , BPB Publications, 2009.
2. Cay Horstmann, BIG Java, Wiley Publication , 3rd Edition., 2009
3. Herbert Schildt , Java 7, The Complete Reference, , 8th Edition, 2009.
4. E Balagurusamy , Programming with JAVA, TMH, 2007

SOFTWARE LAB BASED ON JAVA

1. WAP to find the largest of n natural numbers.
2. WAP to find whether a given number is prime or not.
3. Write a menu driven program for following:
   a. Display a Fibonacci series
   b. Compute Factorial of a number
   c. WAP to check whether a given number is odd or even.
   d. WAP to check whether a given string is palindrome or not.
4. WAP to print the sum and product of digits of an Integer and reverse the Integer.
5. Write a program to create an array of 10 integers. Accept values from the user in that array. Input another number from the user and find out how many numbers are equal to the number passed, how many are greater and how many are less than the number passed.
6. Write a program that will prompt the user for a list of 5 prices. Compute the average of the prices and find out all the prices that are higher than the calculated average.
7. Write a program in java to input N numbers in an array and print out the Armstrong numbers from the set.
8. Write java program for the following matrix operations:
   a. Addition of two matrices
   b. Summation of two matrices
   c. Transpose of a matrix
   d. Input the elements of matrices from user.
9. Write a java program that computes the area of a circle, rectangle and a Cylinder using function overloading.
10. Write a Java for the implementation of Multiple inheritance using interfaces to calculate the area of a rectangle and triangle.
11. Write a java program to create a frame window in an Applet. Display your name, address and qualification in the frame window.
12. Write a java program to draw a line between two coordinates in a window.
13. Write a java program to display the following graphics in an applet window.
    a. Rectangles
    b. Circles
    c. Ellipses
    d. Arcs
    e. Polygons
14. Write a program that reads two integer numbers for the variables a and b. If any other character except number (0-9) is entered then the error is caught by NumberFormatException object. After that ex.getMessage() prints the information about the error occurring causes.
15. Write a program for the following string operations:
    a. Compare two strings
    b. Concatenate two strings
    c. Compute length of a string
16. Create a class called Fraction that can be used to represent the ratio of two integers. Include appropriate constructors and methods. If the denominator becomes zero, throw and handle an exception.

CSC-RE-6026: Computer Networks

4 Lectures 4 Practical, Credits 6 (4+2)
Theory: 60 Lectures, Practical: 60 Lectures

UNIT 1: Basic concepts **(16 Lectures)**

Components of data communication, standards and organizations, Network Classification, Network Topologies ; network protocol; layered network architecture; overview of OSI reference model; overview of TCP/IP protocol suite.

UNIT 2: Physical Layer **(6 Lectures)**

Cabling, Network Interface Card, Transmission Media Devices- Repeater, Hub, Bridge, Switch, Router, Gateway.

UNIT 3: Data Link Layer **(8 Lectures)**

Framing techniques; Error Control; Flow Control Protocols; Shared media protocols - CSMA/CD and CSMA/CA.

UNIT 4: Network Layer **(8 Lectures)**

Virtual Circuits and Datagram approach, IP addressing methods – Subnetting; Routing Algorithms (adaptive and non-adaptive)

UNIT 5: Transport Layer **(6 Lectures)**

Transport services, Transport Layer protocol of TCP and UDP

UNIT 6: Application Layer **(10 Lectures)**

Application layer protocols and services – Domain name system, HTTP, WWW, telnet, FTP, SMTP

UNIT 7: Network Security **(6 Lectures)**

Common Terms, Firewalls, Virtual Private Networks

REFERENCE BOOKS:

1. B.A. Forouzan: Data Communication and Networking, 4th Edition, Tata McGraw Hill, 2007.
2. D.E. Comer, Internetworking with TCP/IP, Vol. I, Prentice Hall of India, 1998.
3. W. Stalling, Data & Computer Communication, 8th edition, Prentice Hall of India, 2006.
4. D. Bertsekas, R. Gallager, Data Networks, 2nd edition, Prentice Hall of India, 1992.

SOFTWARE LAB BASED ON COMPUTER NETWORKS:

Implement the concepts of Computer Networks such as:

1. Simulate Checksum Algorithm.
2. Simulate CRC Algorithm
3. Simulate Stop & Wait Protocol.
4. Simulate Go-Back-N Protocol.
5. Simulate Selective Repeat Protocol.

CSC-RE-6036: Mobile Applications

4 Lectures 4 Practical, Credits 6 (4+2)
Theory: 60 Lectures, Practical: 60 Lectures

UNIT 1: Event Driven Programming **(7 Lectures)**

UI event loop, Threading for background tasks, Outlets / actions, delegation, notification, Model View Controller (MVC) design pattern.

UNIT 2: Mobile application issues **(8 Lectures)**

Limited resources (memory, display, network, file system), input / output (multi-touch and gestures), sensors (camera, compass, accelerometer, GPS)

UNIT 3: Development tools **(8 Lectures)**

Apple iOS tool chain: Objective-C, Xcode IDE, Interface Builder, Device simulator.

UNIT 4: Frameworks (8 Lectures)

Objective-C and Foundation Frameworks, Cocoa Touch, UIKit, Others: Core Graphics, Core Animation, Core Location and Maps, Basic Interaction.

UNIT 4: Common UI's for mobile devices **(7 Lectures)**

Navigation Controllers, Tab Bars, Table Views, Modal views, UI Layout.

UNIT 5: Data Persistence **(8 Lectures)**

Maintaining state between application invocations, File system, Property Lists, SQLite, Core Data

UNIT 6: Remote Data-Storage and Communication **(8 Lectures)**

"Back End" / server side of application, RESTful programming, HTTP get, post, put, delete, database design, server side JavaScript / JSON

UNIT 7: Code signing **(6 Lectures)**

Security, Keychain, Developers and App Store License Agreement

REFERENCE BOOKS:

- Rajiv Ramnath, Roger Crawfis, and Paolo Sivilotti, Android SDK 3 for Dummies, Wiley, 2011.
- Valentino Lee, Heather Schneider, and Robbie Schell, Mobile Applications: Architecture, Design, and Development, Prentice Hall, 2004.
- Brian Fling, Mobile Design and Development, O'Reilly Media, 2009. Maximiliano
- Firtman, Programming the Mobile Web, O'Reilly Media, 2010.
- Christian Crumlish and Erin Malone, Designing Social Interfaces, O'Reilly Media, 2009.

SOFTWARE LAB BASED ON MOBILE APPLICATIONS:

- Installing Android Environment
- Create Hello World Application
- Sample Application about Android Resources
- Sample Application about Layouts
- Sample Application about Intents
- Sample Application I about user interfaces
- Sample Application about Animations

- Make a Project based on above labs
- Sample Application about Android Data
- Sample Application about SQLite I
- Sample Application about SQLite II
- Project Presentation

CSC-RE-6046: E-Commerce Technologies

4 Lectures 4 Practical, Credits 6 (4+2)
Theory: 60 Lectures, Practical: 60 Lectures

UNIT 1: An introduction to Electronic commerce **(10 Lectures)**

What is E-Commerce (Introduction And Definition), Main activities E-Commerce, Goals of E-Commerce, Technical Components of E-Commerce, Functions of E-Commerce, Advantages and disadvantages of E-Commerce, Scope of E-Commerce, Electronic Commerce Applications, Electronic Commerce and Electronic, Business models (C2B,C2C, B2B, B2C,B2G,G2B,G2C)

UNIT 2: The Internet and WWW **(10 Lectures)**

Evolution of Internet, Domain Names and Internet Organization (.edu, .com, .mil, .gov, .net etc.) , Types of Network, Internet Service Provider, World Wide Web, Internet & Extranet, Role of Internet in B2B Application, building own website, Cost, Time, Reach, Registering a Domain Name, Web promotion, Target email, Banner, Exchange, Shopping Bots

UNIT 3: Internet Security **(10 Lectures)**

Secure Transaction, Computer Monitoring, Privacy on Internet, Corporate Email privacy, Computer Crime(Laws, Types of Crimes), Threats, Attack on Computer System, Software Packages for privacy, Hacking, Computer Virus(How it spreads, Virus problem, virus protection, Encryption and Decryption, Secret key Cryptography, DES, Public Key Encryption, RSA, Authorization and Authentication, Firewall, Digital Signature(How it Works)

UNIT 4: Electronic Data Exchange **(10 Lectures)**

Introduction, Concepts of EDI and Limitation, Applications of EDI, Disadvantages of EDI, EDI model, Electronic Payment System: Introduction, Types of Electronic Payment System, Payment Types, Value Exchange System, Credit Card System, Electronic Fund Transfer, Paperless bill, Modern Payment Cash, Electronic Cash

UNIT 5: Planning for Electronic Commerce **(10 Lectures)**

Planning Electronic Commerce initiates, Linking objectives to business strategies, Measuring cost objectives, Comparing benefits to Costs, Strategies for developing electronic commerce web sites

UNIT 6: Internet Marketing **(10 Lectures)**

The PROS and CONS of online shopping, The cons of online shopping, Justify an Internet business, Internet marketing techniques, The E-cycle of Internet marketing, Personalization e-commerce.

REFERENCE BOOKS -

1. G.S.V.Murthy, E-Commerce Concepts, Models, Strategies- :- Himalaya Publishing House, 2011.
2. Kamlesh K Bajaj and Debjani Nag , E- Commerce , 2005.
3. Gray P. Schneider , Electronic commerce, International Student Edition, 2011,
4. Henry Chan, Raymond Lee, Tharam Dillon, Elizabeth Chang, E Commerce, Fundamentals and Applications, Willey Student Edition, 2011

SOFTWARE LAB BASED ON E-COMMERCE TECHNOLOGIES

E-commerce concepts are to be implemented in developing a website using a combination of following technologies:

1. HyperText Markup Language (HTML)
2. Cascading Style Sheets (CSS)
3. JavaScript
4. ASP
5. PHP
6. XML
7. Joomla

BSc Instrumentation (Regular) Syllabus (CBCS)

Revision Cycle 2.0, August 2019

Department of Instrumentation & USIC, Gauhati University
Web : https://gauhati.ac.in
GUWeb : http://web.gauhati.ac.in/syllabus

BSc Instrumentation (Regular) Syllabus (CBCS)
iusic@gauhati.ac.in

August 2019

Legends : L - Lecture P - Practical H - Home Assignments T - Tutorial
This is approved in the Academic Council held on 08.11.2019

Subject Mapping for BSc in Instrumentation under CBCS 2019

B Sc in Instrumentation (Honours)

Semester	Type	Core	AECC	SEC	DSE	GE
	Credit	14×6=84	2×4=8	2×4=8	4×6=24	4×6=24
I		INS-HC-1016				INS-HG-1016
		INS-HC-1026	ENG-AE-1014			
II		INS-HC-2016				INS-HG-2016
		INS-HC-2026	ENV-AE-2014			
III		INS-HC-3016		INS-SE-3xx4		INS-HG-3016
		INS-HC-3026				
		INS-HC-3036				
IV		INS-HC-4016		INS-SE-4xx4		INS-HG-4xx6
		INS-HC-4026				
		INS-HC-4036				

B Sc in Instrumentation (Regular)

Semester	Type	Core	AECC	SEC	DSE
	Credit	14×6=84	2×4=8	2×4=8	4×6=24
I		INS-RC-1016			
		xxx-RC-1016	ENG-AE-1014		
		yyy-RC-1016			
II		INS-RC-2016			
		xxx-RC-2016	ENV-AE-2014		
		yyy-RC-2016			
III		INS-RC-3016		INS-SE-3xx4	
		xxx-RC-3016			
		yyy-RC-3016			
IV		INS-RC-4016		INS-SE-4xx4	
		xxx-RC-4016			
		yyy-RC-4016			

Course Structure for BSc in Instrumentation (Regular) under CBCS 2019

Semester	Type	Core	AECC	SEC	DSE
	Credit	**14×6=84**	**2×4=8**	**2×4=8**	**4×6=24**
I		INS-RC-1016 xxx-RC-1016 yyy-RC-1016	ENG-AE-1014		
II		INS-RC-2016 xxx-RC-2016 yyy-RC-2016	ENV-AE-2014		
III		INS-RC-3016 xxx-RC-3016 yyy-RC-3016		INS-SE-3xx4	
IV		INS-RC-4016 xxx-RC-4016 yyy-RC-4016		INS-SE-4xx4	
V				INS-SE-5xx4	INS-RE-5xx6 yyy-RE-5yy6 zzz-RE-5zz6
VI				INS-SE-6xx4	INS-RE-6xx6 yyy-RE-6yy6 zzz-RE-6zz6

List of Papers

Core Papers

1. INS-RC-1016: Basic Circuit Theory and Network Analysis
2. INS-RC-2016: Transducers and Sensors
3. INS-RC-3016: Electronic Instrumentation
4. INS-RC-4016: Analytical Instrumentation

Discipline Specific Elective (DSE) Papers

1. INS-RE-5016: Microprocessors
2. INS-RE-5026: Biomedical Instrumentation
3. INS-RE-5036: Communication Systems
4. INS-RE-6016: Embedded System and Robotics
5. INS-RE-6026: Control Systems
6. INS-RE-6036: Power Electronics

Skill Enhancement (SEC) Papers

1. INS-SE-4014: Programming in C
2. INS-SE-4024: Programming using MATLAB
3. INS-SE-5014: Testing and Calibration
4. INS-SE-5024: PLC and SCADA
5. INS-SE-6014: Virtual Instrumentation
6. INS-SE-6024: VLSI Design and Verification

Contents

Part I

Core Papers

1

INS-RC-1016 Basic Circuit Theory and Network Analysis

Total Lectures : 60 **Credits : 6 (Theory : 04, Lab : 02)**

Course Outcomes

- CO1: Describe the basic network theorem
- CO2: Explain basics of analog electronics (BJT, FET, MOSFET)
- CO3: Describe boolean algebra, combinational and sequential logic circuits

1.1 Theory (Lectures 60)

1.1.1 Unit I : *Circuit Concepts and Circuit Analysis* (Lectures 22)

Voltage and Current Sources.
Inductors: Fixed and Variable inductors, Self and mutual inductance.
Capacitors: Principles of capacitance, Parallel plate capacitor, Permittivity, Definition of Dielectric Constant, Dielectric strength, Energy stored in a capacitor, Air, Paper, Mica, Teflon, Ceramic, Plastic and Electrolytic capacitor, capacitors in series and parallel.
Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis.
RC Circuit, RL Circuit, RLC Circuits.
Sinusoidal Voltage and Current, AC/DC power source and power distribution. Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Voltage-Current relationship in Resistor, Inductor and Capacitor.
Passive Filters: Low Pass, High Pass, Band Pass and Band Stop.

1.1.2 Unit II : *Network Theorems* (Lectures 08)

Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem.

1.1.3 Unit III : *Analog Electronics* (Lectures 15)

PN Junction diode and device power rating, Basic transistor action, Transistor current components and amplification. Transistor configurations: Common Base (CB), Common Emitter (CE) and Common Collector (CC) configuration, I-V characteristics.
Concept of feedback, negative and positive feedback, Negative feedback, advantages and disadvantages of negative feedback, Barkhausen criteria for oscillations.
Junction Field Effect Transistor (JFET), Construction of JFET, Construction of MOSFET.

1.1.4 Unit IV : *Digital Electronics* (Lectures 15)

Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Truth Tables of OR, AND, NOT, XOR, XNOR, Universal (NOR and NAND) Gates, Basic postulates and fundamental theorems of Boolean algebra, Combinational Logic Analysis and Design, Adder, Subtractor, Encoder and Decoder, Multiplexers and Demultiplexers, Sequential logic design, Latches and Flip flops , S-R Flip flop, J-K Flip flop, T and D type Flip flops, Introduction to registers and counters.

1.2 Basic Circuit Theory and Network Analysis Lab

1. Familiarization with
   (a) Resistance in series, parallel and series - Parallel, Type, Wattage, Tolerance, and Temperature coefficient.
   (b) Capacitors- Tolerance, Voltage rating, Type of capacitor, Capacitors & Inductors in series & Parallel.
   (c) Multimeter (Analog and Digital) - Checking of components.
   (d) Voltage sources in series, parallel and series - Parallel.
   (e) Voltage and Current dividers.
2. To study the Half wave rectifier and Full wave rectifier.
3. To study power supply using zener diode andf regulated power supply.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. Design a Half and Full Adder.
6. Design a Half and Full Subtractor.
7. Flip Flop Type and its uses

1.3 *Suggested books*

1. Horowitz and Hill: Art of electronics, Cambridge University Press
2. R. F. Coughlin and Driscoll, Op-amps and linear ICs, Prentice Hall
3. Millman and Halkias, Electronic devices and circuits, McGraw-Hill
4. Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, Prentice-Hall
5. A.P.Godse, U.A.Bakshi,Electronics Devices and Circuits, Technical Publications
6. Albert Paul Malvino, Donald P. Leach, Digital principles and applications, McGraw-Hill

2

INS-RC-2016 Transducers and Sensors

Total Lectures : 60 **Credits : 6 (Theory : 04, Lab : 02)**

Course Outcomes

- CO1: Describe general characteristics of a measurement system.
- CO2: Explain the principle and applications of sensors and transducers.
- CO3: Explain different signal conditioning techniques.

2.1 Theory (Lectures 60)

2.1.1 Unit I : *Basic Concepts of Instrumentation* (Lectures 15)

Generalized instrumentation systems block diagram representation, Scope of instrumentation in Industrial organization.
Static characteristics: accuracy, sensitivity, linearity, precision, resolution, threshold, range, hysteresis, dead band, backlash, drift.
Errors: systematic errors, instrumental errors, environmental errors, random errors, loading errors, random errors, source of errors in measuring instruments .
Uncertainties types, propagation of uncertainties.

2.1.2 Unit II : *Transducers* (Lectures 22)

Principle and working of following types: Displacement transducers - Resistive (Potentiometric, Strain Gauges - Types, Gauge Factor, bridge circuits, Semi-conductor strain gauge), Capacitive (diaphragm), Inductive (LVDT-Principle and characteristics)
Optical Transducer: photo-conductive, photo emissive, photo voltaic, semiconductor, LDR Temperature Transducer: electrical and non-electrical.
Load cell pressure transducer.

2.1.3 Unit III : *Signal Conditioning* (Lectures 23)

Basic Operational Amplifier (input offset voltage, input offset current, input bias current, differential input resistance, input capacitance, offset voltage adjustment range, input voltage range, common mode rejection ratio, slew rate, supply voltage rejection ratio), Concept of differential amplifiers, Inverting, Non-inverting, Summing and difference amplifier, Basic comparator, Level detector, Sample and hold systems, Active filters, Instrumentation Amplifier.

2.2 Operational Amplifiers and Application Lab

1. Measurement of Temperature using Temperature Sensors/RTD
2. Measuring change in resistance using LDR
3. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an opamp.
4. Designing of a First Order Low-pass filter using op-amp.
5. Designing of a First Order High-pass filter using op-amp.

2.3 *Suggested books*

1. Ramón Pallás-Areny, John G. Webster, Sensors and Signal Conditioning, Wiley.
2. Rangan, Mani, Sharma: Instrumentation devices and systems, Tata McGraw Hill
3. A.K. Sawhney, A Course in Electrical and Electronic and Instrumentation, Dhanpat Rai and Sons

3

INS-RC-3016 Electronic Instrumentation

Total Lectures : 60 Credits : 6 (Theory : 04, Lab : 02)

Course Outcomes

- CO1: Describe different techniques of DC and AC measurements.
- CO2: Explain different Signal Generators and Displays.
- CO3: Illustrate different techniques of flow, speed and acceleration measurement.
- CO4: Elaborate different methods of measuring humidity, moisture and pressure.
- CO5: Perform experiments on different measurements techniques.

3.1 Theory (Lectures 60)

3.1.1 Unit I : *DC and AC Measurement* (Lectures 15)

DC and AC indicating Instruments: Accuracy and precision - Basic Measurement Instruments-DC Bridges and applications: Wheatstone, Kelvin, AC Bridges: General form of AC bridge balance, comparison bridges, Maxwell, Hay, Schering, Wien, DC measurement: DC voltmeter, ammeter, ohmmeter, multimeter, AC measurement: voltmeter, ammeter. Digital type voltmeters, digital multimeter, Digital LCR meter. Digital frequency meter.

3.1.2 Unit II : *Signal Generators and Displays* (Lectures 15)

Signal Generators and Displays: Types of generators and their operation: Audio oscillator, Function generators, Pulse generators, RF generators. Cathode Ray Oscilloscope (CRO) and applications, Block diagram of a General Purpose Oscilloscope and its basic operation, electrostatic focusing and deflection, screens for CRT and graticules, CRT Connections, CRO probes. Types of CRO's: dual trace oscilloscope, digital storage oscilloscope, Sampling oscilloscope. Amplitude, Frequency, Phase measurements, Lissajous Figures.

3.1.3 Unit III : *Measurement of Flow, Speed and Acceleration* (Lectures 15)

Flow Meters (Introduction, definitions and Units, classification), Mechanical type flowmeters, Theory of fixed restriction variable head type flow meters, orifice plate, venturi tube, Tachometers(Mechanical, Electric, Contact less), Accelerometers (Elementary, Seismic and Practical accelerometers).

3.1.4 Unit IV : *Measurement of Humidity, Moisture and Pressure* (Lectures 15)

Basic principles, hygrometers, psychrometers, humidity charts, dew point, measurement systems for humidity. Units of pressure, manometers, different types, elastic type pressure gauges, Bourden type bellows, diaphragms.

3.2 Electronic Instrumentation Lab

1. Study and operation of Multimeters (Analog and Digital), Function Generator, Regulated Power Supplies, CRO.
2. Study the generation of Lissajous figures to find unknown frequency and phase shift.
3. Frequency measurement using Wein Bridge.
4. Experiment on working of thermocouple.
5. Experiment on control of various functions using RTD

3.3 *Suggested books*

1. David A. Bell, ?Electronic Instrumentation and Measurements? Oxford Higher Education
2. H.S. Kalsi, ?Electronic Instrumentation? Mc Graw Hill
3. A. K. Sawhney, ?A Course in Electrical and Electronic Measurements and Instrumentation? Dhanpat Rai & Co

4

INS-RC-4016 Analytical Instrumentation

Total Lectures : 60 Credits : 6 (Theory : 04, Lab : 02)

Course Outcomes

- CO1: Describe different Molecular and Infrared Spectro-analytical Methods
- CO2: Elaborate the principles and applications of different atomic spectroscopic methods.
- CO3: Explain separation methods and column chromatography methods.
- CO4: Explain gas chromatography method.
- CO5: Perform experiments on different analytical methods such as spectrophotometry, gas chromatography and HPLC

4.1 Theory (Lectures 60)

4.1.1 Unit I : *Molecular and Infrared Spectro-analytical Methods* (Lectures 20)

Molecular Spectro-analytical Methods of Analysis: Colorimetry and Spectrophotometry: Introduction, theory: molecular energy levels, types of molecular transitions, Lambert-Beer's Law and limitations, types of sources, monochromators and detectors, Instrumentation of single beam and double beam instrument.
Infrared Spectroscopy: Theory, diatomic molecules as a simple harmonic oscillator, instrumentation, sample handling techniques. Introduction to Fourier Transform Infrared Spectroscopy (FTIR).

4.1.2 Unit II : *Atomic Spectroscopy* (Lectures 15)

Principle, comparison of atomic and molecular spectroscopy, atomic transitions, atomic absorption, atomisation process, types of flames- fuel/ oxidant combinations, instrumentation of spectrophotometers; Interferences: spectral, chemical and ionization; applications. Atomic emission spectroscopy (AES): Flame photometer and its instrumentation, analysis using standard addition method, applications.

4.1.3 Unit III : *Chromatography* (Lectures 15)

Separation methods: Theory of chromatography; instrumentation and applications of Thin layer chromatography (TLC).
Column chromatography: Principle, process of elution through a column, chromatogram, band broadening, capacity factor, selectivity factor , Column efficiency, number of plates, plate height, column resolution.

4.1.4 Unit IV : *Gas Chromatography* (Lectures 10)

Carrier gases, different type of injection systems, columns, stationary phases and detectors. Isothermal mode, temperature programming mode, analysis by internal standard method, applications.

4.2 Analytical Instrumentation Lab

1. Determination of pKa value for a dye using double beam spectrophotometer.
2. Spectrometric determination of iron in water sample using double beam spectrophotometer.
3. Determination of concentrations of sodium, calcium, lithium and potassium in sample using flame photometer.
4. Determination of concentration of potassium ions in sample by standard addition method using flame photometer
5. Qualitative analysis of samples using Gas chromatography
6. Qualitative analysis of samples using High Performance Liquid Chromatography.

4.3 *Suggested books*

1. R S Khandpur, Handbook of Analytical Instruments, McGraw-Hill Education
2. Patranabis, Principles of Instrumentation, TMH
3. Galen W. Ewing: Instrumental methods of Chemical Analysis, McGraw Hill International
4. Willard, Merritt, Dean, Settle: Instrumental methods of Analysis, CBS Publisher
5. Skoog, Holler, Nieman: Principles of Instrumental Analysis
6. Gillian McMahon, Analytical Instrumentation, A Guide to Laboratory, Portable and Miniaturized Instruments

Part II

Discipline Specific Elective Papers

5

INS-RE-5016
Option 1: Microprocessors

Total Lectures : 60 Credits : 6 (Theory : 04, Lab : 02)

Course Outcomes

- CO1: Explain the architecture and instruction set of 8085 microprocessor
- CO2: Implement assembly language programming for 8085 microprocessor
- CO3: Describe the interfacing techniques of peripheral devices

5.1 Theory (Lectures 60)

5.1.1 Unit I : *8085 Microprocessor* (Lectures 25)

Introduction to 8085 Microprocessor, Pin description of 8085, Architecture, register of 8085, addressing mode. Instruction Type and Instruction Set, Machine Cycle, Instruction Cycle.
Hardware Interfacing or Types of I/O Addressing-Interfacing Memory and Peripheral (I/o Mapped I/O and memory mapped I/O).

5.1.2 Unit II : *Programming* (Lectures 20)

Assembly Language Programming Stacks and Subroutine, Interrupts of 8085-Hardware and Software interrupts. Difference between RISC and CISC Processor.

5.1.3 Unit III : *Peripherals* (Lectures 15)

Interfacing ICs, Programmable Peripheral Interface: Intel 8255.

5.2 Microprocessors Lab

1. To write an assembly language program to perform basic mathematical operations (addition, subtraction, multiplication, division)

2. To write an assembly language program to arrange the given list of number in ascending / descending order
3. To write an assembly language program to calculate N!
4. To write an assembly language program to separate prime numbers in a given list of number
5. To write an assembly language program to convert a number from one number system to another.

5.3 *Suggested books*

1. Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, PRI

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INS-RE-5026
Option 2: Biomedical Instrumentation

Total Lectures : 60 Credits : 6 (Theory : 04, Lab : 02)

Course Outcomes

- CO1: Describe the man-instrumentation system, biomedical instruments and different transducers used in biomedical
- CO2: Explain the origin of bio-potential and design criterion of bio-amplifiers
- CO3: Illustrate the Principles of bio-electrodes and electrodes and electrolyte interface
- CO4: Explain the basics of different imaging techniques used in biomedical
- CO5: Perform Experiments to record ECG signals and count pulses

6.1 Theory (Lectures 60)

6.1.1 Unit I : *Biomedical Instrumentation* (Lectures 13)

Components of man Instrument system, types of biomedical systems, design factors and limitations of biomedical instruments, terms and transducers to measure various physiological events.

6.1.2 Unit II : *Biopotentials & Bioamplifiers* (Lectures 20)

Biopotentials & Bioamplifiers: Introduction to bio-electric potential, types and origin of bio-potential.
Bioamplifiers: bio-amplifier, general considerations for signal conditioners preamplifiers, sources of noise in low level measurement.

6.1.3 Unit III : *Bioelectrodes* (Lectures 12)

Electrodes (Body surface electrodes, Internal electrodes, Micro electrodes), electrolyte interface, electrode circuit model, impedance and polarization, Properties of electrodes.

6.1.4 Unit IV : *Medical Imaging System* (Lectures 15)

Thermal imaging system, IR detectors, applications, radiography, conventional X-ray, properties, generation of X-ray, Fluoroscopy.

6.2 Biomedical Instrumentation Lab

1. Characterization of bio potential amplifier for ECG signals.
2. Study on ECG simulator.
3. Measurement of pulse rate using photoelectric transducer & pulse counting for known period.

6.3 *Suggested books*

1. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer ?Biomedical Instrumentation and Measurements?, Prentice Hall India

7

INS-RE-5036
Option 3: Communication Systems

Total Lectures : 60 Credits : 6 (Theory : 04, Lab : 02)

Course Outcomes

- CO1: Describe basic communication system
- CO2: Describe and compare the different types analog modulation techniques
- CO3: Describe different types of transmitters and receivers
- CO4: Describe the principle and applications of digital modulation techniques

7.1 Theory (Lectures 60)

7.1.1 Unit I : *Basic Communication System* (Lectures 11)

Block diagram, Information source and input transducer, Transmitter medium, Noise, Receiver, Destination, Necessity for modulation, Types of communication systems.

7.1.2 Unit II : *Analog Modulation* (Lectures 20)

Definition - AM waveforms - Frequency spectrum and band width - Modulation index - DSBSC, SSB, Definition-Relationship between FM & PM - Frequency deviation - Spectrum and transmission BW of FM, comparison of AM and FM systems.

7.1.3 Unit III : *Radio Transmitter and Receiver* (Lectures 19)

AM transmitters-High level and low level transmitters - SSB transmitters, FM transmitters.
AM receivers-operation - performance parameters - Communication Transceivers - Block diagram - SSB receiver - FM receivers - Block diagram.

7.1.4 Unit IV : *Digital Communication* (Lectures 10)

Principle and applications of ASK and FSK.

7.2 Communication Systems Lab

1. Study of Amplitude Modulation and Demodulation
2. Study of Frequency Modulation and Demodulation
3. Study of Single Side Band Modulation and Demodulation
4. Study of AM Transmitter and Receiver
5. Study FM Transmitter and Receiver
6. Study of Pulse Width Modulation

7.3 *Suggested books*

1. G. Kennedy and Davis, Electronic communication system, TMH, New Delhi
2. Simon Haykin, Communication Systems, Wiley

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INS-RE-6016
Option 1: Embedded System and Robotics

Total Lectures : 60 **Credits : 6 (Theory : 04, Lab : 02)**

Course Outcomes

- CO1: Explain architecture of 8085, 8086 microprocessor and 8051 microcontroller
- CO2: Illustrate the features, applications and design trends of embedded systems
- CO3: Describe interfacing of different peripherals with 8051 microcontroller
- CO4: Illustrate the applications of embedded systems in robotics and their features

8.1 Theory (Lectures 60)

8.1.1 Unit I : *Introduction to RISC microcontrollers* (Lectures 18)

Von- Neumann and Harvard architectures, Introduction to 8051 family microcontrollers, 8051 architecture, Register banks and Special Function Registers, Block Diagram, Addressing Modes, Instruction Set, Timers, Counters, Stack Operation.

8.1.2 Unit II : *Introduction to Embedded Systems* (Lectures 14)

Overview of Embedded Systems, Features, Requirements and Applications of Embedded Systems, Recent Trends in the Embedded System Design, Common architectures for the ES design, Embedded Software design issues, Communication Software, Introduction to Development and Testing Tools.

8.1.3 Unit III : *8051 Interfacing* (Lectures 16)

8051 interfacing with Keyboard, display Units (LED, 7-segment display, LCD), ADC, DAC, Stepper motor.

8.1.4 Unit IV : *Robotics* (Lectures 12)

Overview of Robotics, Use of Embedded Systems in Robotics, Robots and Computer Vision.

8.2 Embedded System and Robotics Lab

1. Write a program to multiply two 16 bit unsigned numbers.
2. Write a program to add N 8 bit unsigned integer numbers.
3. Write a program to arrange the unsigned integer numbers in ascending/descending order.
4. Interface a display to the micro controller and display number sequentially in a regular interval.
5. Write a program for LED blinking in a predetermined fashion using 8051
6. Write a Program to OUT an 8 - bit value on an 8051.
7. Write a program for a simple counter, where the count has to be displayed on a 7 - segment LED display.
8. Write a program for interfacing LCD display using 8051.
9. Write a program to convert an analog voltage to digital bits using 8051
10. Write a program to convert a digital signal to analog signal using 8051
11. Write a program for temperature sensor interfacing through serial port on 8051.
12. Write a program for P W M control of DC motor using 8051.
13. Write a program to drive a stepper motor using 8051.

8.3 *Suggested books*

1. The 8051 Microcontroller and Embedded systems: M. A. Mazidi, J.G. Mazidi, R.D. McKinlay, Prentice Hall, 2nd Edition.
2. Programming and Customizing the 8051 Microcontroller, Myke Predko, McGraw Hill.C and 8051, Schultz Thomas W.
3. Robotics: Fundamental Concepts and Analysis, Ashitava Ghosal, Oxford, 1st Edition

9

INS-RE-6026
Option 2: Control Systems

Total Lectures : 60 **Credits : 6 (Theory : 04, Lab : 02)**

Course Outcomes

- CO1: Describe modelling and controlling of physical parameters. CO2: Illustrate block diagram representation of systems. CO3: Explain time domain analysis of different systems. CO4: Explain Frequency domain analysis of different systems. CO5: Perform experiments on applications of control mechanisms.

9.1 Theory (Lectures 60)

9.1.1 Unit I : *Introduction* (Lectures 18)

Introduction of control systems, open loop and closed loop control systems, mathematical modelling of physical systems (Electrical, Mechanical and Thermal), derivation of transfer function, servomotors.
Laplace transformation and differential equations.

9.1.2 Unit II : *Block Diagram Representation* (Lectures 15)

Block diagram representation, block diagram transformation rules, reduction of block diagram, block diagram representation of electrical system.

9.1.3 Unit III : *Time Domain Analysis* (Lectures 15)

Time domain performance criteria, transient response of first, second & higher order systems, steady state errors and static error constants, performance indices, response with P, PI and PID Controllers.

9.1.4 Unit IV : *Frequency Domain Analysis* (Lectures 12)

Correlation between time and frequency response, Polar and inverse polar plots, frequency domain specifications, Logarithmic plots (Bode Plots), gain and phase margins.

9.2 Control Systems Lab

1. Time domain analysis of 1 st order systems RL and RC.
2. To study position control of DC motor.
3. To study speed control of DC motor.
4. 4To study frequency response of Lead and Lag networks.
5. Study of P, PI and PID controller.

9.3 *Suggested books*

1. Katsuhiko Ogata, ?Modern Control Engineering?, Pearson Benjamin C Kuo, ?Automatic Control Systems?, Wiley

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INS-RE-6036
Option 3: Power Electronics

Total Lectures : 60 Credits : 6 (Theory : 04, Lab : 02)

Course Outcomes

- CO1: Describe basics of power devices such as SCR, Diacs, Triacs and application of SCR
- CO2: Describe the principles of different motors viz AC, DC, induction, single and three phase, synchronous, stepper and servo motors and their driving and controlling circuits.
- CO3: Explain AC and DC generators, comparison, classification of transformers, efficiency and losses of transformer
- CO4: Illustrate design, development and application of regulated power supply, UPS and SMPS.
- CO5: Perform experiments on design, fabrication and study of I-V characteristics of SCR, DIAC, TRIAC and characteristics and speed control of DC motor

10.1 Theory (Lectures 60)

10.1.1 Unit I : *Basic Power Devices and Circuits* (Lectures 18)

SCR, Diacs and Triacs, Two transistor model of SCR, Resistive and RC triggering circuits. Applications of SCR: Basic series inverter circuit, Chopper circuit - Basic concept, step up and step down choppers.

10.1.2 Unit II : *Types of Motors and Motor Drives* (Lectures 20)

Constructional features and characteristics of DC Motors, AC Motors, Induction Motors, Single and three phase Motors, Synchronous Motors, Stepper Motors, and Servo Motors.
Motor driving and speed control circuits and their applications, motor starters.

10.1.3 Unit III : *Generators and AC machines* (Lectures 12)

AC and DC generators, comparison between generator and motor action, Types of transformers, Transformer Construction, E.M.F. equation, Transformer Losses, Condition for maximum efficiency.

10.1.4 Unit IV : *Power Supplies* (Lectures 10)

Regulated power supply, Uninterrupted power supply (UPS) and Switched mode power supply (SMPS).

10.2 Power Electronics Lab

1. Study of I-V characteristics of SCR.
2. Study of I-V characteristics of DIAC.
3. Study of I-V characteristics of TRIAC.
4. Load characteristics of D.C. motor.
5. Speed control of D.C. motor

10.3 *Suggested books*

1. M. H. Roshid, Power Electronics: Circuits devices and applications
2. Bogdan M. Wilamowski, J. David Irwin, Fundamentals of Industrial Electronics
3. Power Electronics, Principles and Applications, Joseph Vithayathil

Part III

Skill Enhancement Papers

11

INS-SE-4014
Option 1: Programming in C

Total Lectures : 40　　**Credits : 4 (Theory : 04)**

Course Outcomes

- CO1: Explain the basics of C programming
- CO2: Demonstrate the use of different types of functions in C, and explain the significance of storage classes
- CO3: Explain the significance of arrays to store multiple values under the same name. Demonstrate the use of pointers to access data directly from memory location and their comparison to arguments functions.

11.1 Theory (Lectures 40)

11.1.1 Unit I : *Introduction* (Lectures 15)

Algorithm / pseudo code, flowchart, program development steps, structure of C program, identifiers, basic data types and sizes, Constants, variables, Operators, expressions, Input-output statements, if and switch statements, loops- while, do-while and for statements, break, continue, goto and labels.

11.1.2 Unit II : *Functions* (Lectures 10)

Parameter passing, storage Lectures- extern, auto, register, static, scope rules, block structure, user defined functions, standard library functions, recursive functions, header files, C preprocessor, example C programs.

11.1.3 Unit III : *Arrays and Pointers* (Lectures 15)

Arrays concept, declaration, accessing elements, storing elements, arrays and functions, two dimensional and multidimensional arrays, applications of arrays. pointers- concepts, initialization of pointer variables, pointers and function arguments, address arithmetic, Character pointers and functions, pointers to pointers, pointers and multidimensional arrays, dynamic memory managements functions, command line arguments, C program examples.

1. Byron Gottfried, Programming with C (Schaum's Outlines), McGraw Hill Education India (2017), 3rd Edition.
2. S.S. Sastry, Introductory Methods of Numerical analysis, Prentice Hall of India, New Delhi (2003) 3rd Edition.

12

INS-SE-4024
Option 2: Programming using MATLAB

Total Lectures : 40 Credits : 4 (Theory : 04)

Course Outcomes

- CO1: Describe the basic features and introductory programming techniques of MATLAB.
- CO2: Describe editing, debugging and programming of MATLAB program.
- CO3. Illustrate with examples graphics and plotting in MATLAB

12.1 Theory (Lectures 40)

12.1.1 Unit I : *Introduction* (Lectures 15)

Features, MATLAB Windows(Editor, Work Space, Command History, Command Window),Operations with Variables, Naming and Checking Existence, Clearing Operations, Introduction to Arrays, File Types Data and Data Flow in MATLAB: Matrix Operations & Operators, Reshaping Matrices, Importing Exporting of Data, Arrays, Data types, File Input-Output, Communication with External Devices.

12.1.2 Unit II : *Editing, Debugging and Programming* (Lectures 15)

Editing and Debugging M Files: Writing Script Files, Writing Functions, Error Correction, M-Lint Automatic Code Analyzer, Saving Files.
Programming: Flow Control, Conditional Statements, Error Handling, Work with Multidimensional Array, Cell Array & Characters, Developing User Defined Function, Scripts and Other Functions.

12.1.3 Unit III : *Graphics* (Lectures 10)

Simple Graphics, Graphic Types, Plotting Functions, Creating Plot & Editing Plot (2DGraphics Handles, GUI (Graphical User Interface).

12.2 *Suggested books*

1. Rudra Pratap, ?Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers?, Oxford Universities Press
2. Raj Kumar Bansal, Ashok Kumar Goel and Monoj Kumar Sarma?Matlab and its Applications in Engineering?, PEARSON

13

INS-SE-5014
Option 1: Testing and Calibration

Total Lectures : 40 Credits : 4 (Theory : 04)

Course Outcomes

- CO1: Explain the basics of Calibration and Standardization Practices
- CO2: Describe different measurement techniques viz voltage dividers, comparators, bridges, lock in amplifiers and calibration.
- CO3: Describe different standardization techniques of production plants, comparison between different calibration methods and calibration modeling.
- CO4: Illustrate sensor testing and calibration techniques, computing of errors and evaluation of uncertainties in measurement.

13.1 Theory (Lectures 40)

13.1.1 Unit I : *Calibration and Standardization Practices Units* (Lectures 10)

Fundamental and Derived Units, Standards: Primary, Secondary and Tertiary standards, Standardizations and Technique: Standardizations of Electrical (voltage, current, frequency, RLC and others), Mechanical (mass, displacement, velocity, acceleration, torque, flow, level, temperature, pressure etc.) and other parameters.

13.1.2 Unit II : *Measurement and Calibration* (Lectures 10)

Inductive voltage dividers, AC and DC comparators, Programmable synthetic signal sources and power supplies, Quad bridge, Automatic AC bridges, Phase sensitive detectors, Lock-in-amplifiers, Digital phase and frequency measurements.

13.1.3 Unit III : *Standardization and Calibration Modeling* (Lectures 10)

Standardization in Production Plants and manufacturing houses, Reliability studies and inspection, Product Standardization techniques, Calibration: Calibration of measuring Instruments, Theory and Principles (absolute and secondary or comparison method), Setup, Modeling.

13.1.4 Unit IV : *Various Testing and Calibration Systems* (Lectures 10)

Sensor calibration and testing, Analytical methods in calibrating.
Automated test and calibration systems: GPIB based systems, machine computation of errors and uncertainties in measurement.

13.2 *Suggested books*

1. Ramón Pallás-Areny, John G. Webster, Sensors and Signal Conditioning, Wiley.
2. Jon S. Wilson, Sensor Technology Handbook, Elsevier
3. Rangan, Mani, Sharma: Instrumentation devices and systems, Tata McGraw Hill
4. Nakara, Chaudhari: Instrumentation, Measurement and Analysis, Tata McGraw Hill
5. E.O. Doeblin: Measurement systems, McGraw Hill
6. A.K. Sawhney, A Course in Electrical and Electronic and Instrumentation, Dhanpat Rai and Sons
7. David A. Bell, Electronic Instrumentation and Measurements, Prentice Hall of India Private Limited

14

INS-SE-5024
Option 2: PLC and SCADA

Total Lectures : 40   Credits : 4 (Theory : 04)

Course Outcomes

- CO1: Describe briefly PLC and PLC?s applications
- CO2: Illustrate a PLC program for different applications
- CO3: Explain different control mechanisms used in industries
- CO4: Elaborate different components of SCADA and communications used in industry

14.1 Theory (Lectures 40)

14.1.1 Unit I : *Programmable Logic Controllers* (Lectures 10)

Programmable Logic Controllers (PLC), input/output systems, CPU, memory Unit, Programmer Units, Peripheral devices, Controller programming tools, Programming of PLCs, PLC Hardware Environment.

14.1.2 Unit II : *Programming* (Lectures 10)

Programming of PLC, programming languages, Basics of programming, Ladder programming, ladder programming rules.

14.1.3 Unit III : *Control Mechanisms* (Lectures 10)

Single loop control, Centralized control, Distributed control systems, Open systems, SCADA systems, Types of data available, Data communication components and protocols.

14.1.4 Unit IV : *SCADA* (Lectures 10)

Supervisory Control and Data acquisition (SCADA) Systems, Types of supervisory systems, Distributed Digital Control Systems (DCS), Direct digital control (DDC), Components of SCADA Systems, field data interface devices, communication network and other details.

14.2 *Suggested books*

1. W. Bolton, ?Programmable logic controllers?, Elseviers
2. John W. Webb, Ronald A. Reis, ?Programmable Logic Controllers Principles and Applications?, Pearson India Education Services Pvt. Ltd.
3. Curtis D. Johnson, ?Process Control Instrumentation Technology?, Prentice Hall India

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INS-SE-6014
Option 1: Virtual Instrumentation

Total Lectures : 40 Credits : 4 (Theory : 04)

Course Outcomes

- CO1: Describe the LabVIEW program Environment
- CO2: Describe the features and programming techniques in NI-LabVIEW
- CO3: Illustrate data acquisition basics with different communication protocols.

15.1 Theory (Lectures 40)

15.1.1 Unit I : *Introduction* (Lectures 15)

The LabVIEW Programming Environment: Controls/ Indicators, Auto indexing, Debugging, Timing issues (counters), Importing pictures, Simple programming structures and Timing Issues, Basic operations, controls and indicators.

15.1.2 Unit II : *Programming Techniques* (Lectures 15)

VIS and sub-VIS, Debugging a VI and Sub-VI's, loops & charts, arrays, clusters, graphs, case & sequence structures, formula modes, local and global variable, string & file input, Graphical programming in data flow.

15.1.3 Unit III : *Data Acquisition Basics* (Lectures 10)

ADC, DAC, DIO, Counters & timers, PC Hardware structure, timing, interrupts, DMA, Software and Hardware Installation. GPIB/IEEE 608 concepts, and embedded system buses - PCI, EISA, CPCI, and USB & VXI.

15.2 *Suggested books*

1. Essick, Hands on Lab View for Scientists and Engineers, Oxford University Press

2. Taqi Mohiuddin , Matthew R. Nawrocki , Rick Bitter, Labview Advanced Programming Techniques, Book World Enterprises

3. Jovitha Jerome, Virtual Instrumentation Using LabVIEW, PHI Learning Private Limited

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INS-SE-6024
Option 2: VLSI Design and Verification

Total Lectures : 40 Credits : 4 (Theory : 04)

Course Outcomes

- CO1: Explain the basics of metal oxide semiconductor technology
- CO2: Explain the basics of VLSI and its various applications
- CO3: Illustrate the background and basics concepts of hardware description languages

16.1 Theory (Lectures 40)

16.1.1 Unit I : *MOS Technology and Circuits* (Lectures 17)

MOS Technology and VLSI, Process parameters and considerations for BJT, MOS and CMOS, Electrical properties of MOS circuits and Device modeling, MOS Circuit Design Process, MOS Layers, Stick diagram, Layout diagram, Propagation delays, Examples of combinational logic design, Sealing of MOS circuits.

16.1.2 Unit II : *Analog VLSI and High speed VLSI* (Lectures 13)

Introduction to Analog VLSI, Realization of Neutral Networks and Switched capacitor filters, Sub-micron technology and GaAs VLSI technology.

16.1.3 Unit III : *Hardware Description Languages* (Lectures 10)

VHDL background and basic concepts, structural specifications of hardware design organization and parameterization.

16.2 *Suggested books*

1. CMOS VLSI Design : A Circuits and Systems Perspective, Neil H.E. Weste, David Harris, Ayan Banerjee, Pearson, 3rd edition

2. Basic VLSI Design, Douglas A. Pucknell, Prentice Hall India Learning Private Limited; 3 edition.
3. Microelectronic Circuits: Theory and Applications, Kenneth C. Smith, Adel S. Sedra, Oxford, 6th edition.

Syllabus

Mathematics (Honours)

Version 2

submitted to

Gauhati University

under the

Choice Based Credit System

By

Department of Mathematics

Gauhati University

“This is approved in the Academic Council held on 08/11/2019”

1. Introduction to CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

2. Outline of Choice Based Credit System:

2.1 Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2.2 Elective Course: Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

2.2.1 Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

2.2.2 Dissertation/Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

2.2.3 Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

3. Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course: The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They are

((i) Environmental Science(ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

3.1 AE Compulsory Course (AECC): Environmental Science, English Communication/MIL Communication.

3.2 AE Elective Course (AEEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

4. BACHELOR OF MATHEMATICS (Hons.) Programme Details:

4.1. Programme Objectives:

Students who choose BMATH(H) Programme, develop the ability to think critically, logically and analytically and hence use mathematical reasoning in everyday life.

Pursuing a degree in mathematics will introduce the students to a number of interesting and useful ideas in preparations for a number of mathematics careers in education, research, government sector, business sector and industry.

The program covers the full range of mathematics. The course lays a structured foundation of Calculus, Real and Complex analysis, Algebra, Differential equations and Mathematical modelling, Number theory, Graph theory, Mechanics and C-programming.

An exceptionally broad range of topics covering Pure and Applied Mathematics:Linear Algebra, Metric spaces, Statistics, Linear Programming and Applications, Mathematical Finance, and Bio-Mathematics cater to varied interests and ambitions.Also, to carry out the hand on sessions in Computer lab using various CAS software to have a deep conceptual understanding of the above tools to widen the horizon of students' self-experience.

4.2. Programme Learning Outcomes: The completion of the BMATH(H) Programme shall enable a student to:

i) Communicate mathematics effectively by oral, written, computational and graphic means.
ii) Create mathematical ideas from basic axioms.
iii) Gauge the hypothesis, theories, techniques and proofs provisionally.
iv) Utilize mathematics to solve theoretical and applied problems by critical understanding, analysis and synthesis.
v) Identify applications of mathematics in other disciplines and in the real world, leading to enhancement of career prospects in a plethora of fields.
vi) Appreciate the requirement of lifelong learning through continued education and research.

4.3. Programme Structure: The BMATH(H) programme is a three-year course divided into six-semesters. A student is required to complete 148 credits for the completion of course and the award of degree.

		Semester	***Semester***
Part – I	First Year	Semester I : 22	Semester II: 22
Part – II	Second Year	Semester III: 28	Semester IV: 28
Part – III	Third Year	Semester V: 24	Semester VI: 24

4.4. Programme Implementation Requirement:

The BMATH(H) programme is a three-year course divided into six-semesters. For proper implementation of the UGCBCS programme the following infrastructure are necessary:

(a) Sufficient lab facilities with computers and software
(b) Atleast 7 faculties for Honours and5 faculties without Honours.

4.5.Instruction for questions paper setter: Question Paper setter should set from the prescribed text books,mentioned in the syllabus.

5. Credit allocation (B.Sc. Honours):

Course	*Credits	
	Theory+Practical	Theory+Tutorial
I Core Course (6 credits)		
(14 papers)	14X4=56	14x5=70
Core Course Practical / Tutorial* (14 Papers)	14x2=28	14x1=14
I. Elective Course (6 credits) (8 Papers)		
A.1. Discipline Specific Elective(4 Papers)	4x4=16	4x5=20
A.2. Discipline Specific Elective Practical/ Tutorial* (4 Papers)	4×2 = 8	4×1 = 4
B.1. Generic Elective/ Interdisciplinary(4 Papers)	4x4=16	4x5=20
B.2. Generic Elective Practical/ Tutorial* (4 Papers)	4x2=8	4x1=4
Optional dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th semester		
1.Ability Enhancement Compulsory Courses (AECC) (2 Papers of 4 credit each)	2x4=4	2x4=8
Environmental Science		
English Communication		
2. Skill Enhancement Courses (SEC)(Minimum 2)(2 Papers of 4 credit each)	2x4=8	2x4=8
Total credit	148	148

*Wherever there is practical, there will be no tutorial and vice-versa

CBCS Course Structure for B.Sc. (Hons.) Mathematics Programme
SEMESTER WISE PLACEMENT OF THE COURSES

Sem	Core Course(14)	Ability Enhancement Compulsory Course (AECC)(2)	Skill Enhancement Course (SEC)(2)	Discipline SpecificElective (DSE)(4)	GenericElective(GE)(4) (Otherthan Mathematics Honours)
I	MAT-HC-1016: Calculus(including practical)	ENG-AE-1014			MAT-HG-1016 / MAT-RC-1016 MAT-HG 1026
	MAT-HC-1026: Algebra				
II	MAT-HC-2016: Real Analysis	ENV-AE-2014			MAT-HG-2016 / MAT-RC-2016 MAT-HG-2026
	MAT-HC-2026: Differential Equations(including practical)				
III	MAT-HC-3016: Theory of Real Functions		MAT-SE-3014 MAT-SE-3024		MAT-HG-3016 / MAT-RC-3016 MAT-HG-3026
	MAT-HC-3026: Group Theory-I				
	MAT-HC-3036: Analytical Geometry				
IV	MAT-HC-4016:Multivariate Calculus		MAT-SE-4014 MAT-SE-4024		MAT-HG-4016 / MAT-RC-4016 MAT-HG-4026
	MAT-HC-4026: Numerical Methods (including practical)				
	MAT-HC-4036: Ring Theory				
V	MAT-HC-5016: Riemann Integration and Metric spaces			DSE-1 MAT-HE-5016 MAT-HE-5026 MAT-HE-5036	
	MAT-HC-5026: Linear Algebra			DSE-2 MAT-HE-5046 MAT-HE-5056 MAT-HE-5066	
VI	MAT-HC-6016: Complex Analysis			DSE-3 MAT-HE-6016 MAT-HE-6026 MAT-HE-6036 MAT-HE-6046	
	MAT-HC-6026: Partial Differential Equations (including practical)			DSE-4 MAT-HE-6056 MAT-HE-6066 MAT-HE-6076	
				Project In lieu of DSE-3 and DSE-4	

Legends:HC: Core Papers **HE: Discipline Specific Elective Papers**

SE: Skill Enhancement PapersHG: Generic Elective Papers

Core Papers:

1. MAT-HC-1016: Calculus (including practical)
2. MAT-HC-1026: Algebra
3. MAT-HC-2016: Real Analysis
4. MAT-HC-2026: Differential Equations(including practical)
5. MAT-HC-3016: Theory of Real Functions
6. MAT-HC-3026: Group Theory-I
7. MAT-HC-3036: Analytical Geometry
8. MAT-HC-4016:Multivariate Calculus
9. MAT-HC-4026: Numerical Methods (including practical)
10. MAT-HC-4036: Ring Theory
11. MAT-HC-5016: Riemann Integration and Metric spaces
12. MAT-HC-5026: Linear Algebra
13. MAT-HC-6016: Complex Analysis
14. MAT-HC-6026: Partial Differential Equations (including practical)

Skill Enhancement Course (SEC) papers

SEC 1(choose one)

(i) MAT-SE-3014: Computer Algebra Systems and Related Software
(ii) MAT-SE-3024: Combinatorics and Graph Theory

SEC 2 (choose one)
(i) MAT-SE-4014: R-Programming
(ii) MAT-SE-4024: LATEX and HTML

Discipline Specific Electives (DSE) papers

DSE 1 (choose one)
(i) MAT-HE-5016: Number Theory
(ii) MAT-HE-5026: Mechanics
(iii) MAT-HE-5036: Probability and Statistics

DSE 2 (choose one)
(i) MAT-HE-5046: Linear Programming
(ii) MAT-HE-5056: Spherical Trigonometry and Astronomy
(iii) MAT-HE-5066: Programming in C

DSE-3 (choose one)
(i) MAT-HE-6016: Boolean Algebra and Automata Theory
(ii) MAT-HE-6026: Bio-Mathematics
(iii) MAT-HE-6036: Mathematical Modeling
(iv) MAT-HE-6046: Hydromechanics

DSE 4 (choose one)
(i) MAT-HE-6056: Rigid Dynamics
(ii) MAT-HE-6066: Group Theory II
(iii) MAT-HE-6076: Mathematical Finance

Project (in lieu of DSE3 and DSE4)

Generic Elective (GE) papers

GE 1 (choose one)

(i). MAT-HG-1016/MAT-RC-1016: Calculus
(ii). MAT-HG-1026: Analytic Geometry

GE 2 (Choose one)

(i). MAT-HG-2016/MAT-RC-2016: Algebra
(ii). MAT-HG-2026: Discrete Mathematics

GE 3 (choose one)

(i). MAT-HG-3016/MAT-RC-3016: Differential Equations
(ii). MAT-HG-3026: Linear Programming

GE 4 (choose one)

(i). MAT-HG-4016/MAT-RC-4016: Real Analysis
(ii). MAT-HG-4026: Numerical Analysis

Detailed Syllabus

SEMESTER-I

MAT-HC-1016: Calculus (including practical)

Total marks: 100 (Theory: 60, Practical 20, Internal Assessment: 20)

Lectures 2 Practical, Credits 6 (4+2) *Each unit carry equal credit*

Course Objectives: The primary objective of this course is to introduce the basic tools of calculus and geometric properties of different conic sections which are helpful in understanding their applications in planetary motion, design of telescope and to the real world problems. Also, computer lab will help to have a deep conceptual understanding of the above tools in true sense.

Course Learning Outcomes: This course will enable the students to:
i) Learn first and second derivative tests for relative extremum and apply the knowledge in problems in business, economics and life sciences.
ii) Sketch curves in a plane using its mathematical properties in different coordinate systems.
iii) Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.
iv) Understand the calculus of vector functions and its use to develop the basic principles of planetary motion.

UNIT 1: Higher order derivatives, Leibnitz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hopital's rule, applications in business, economics and life sciences.

[1]: Chapter 4 (Sections 4.3-4.7).
[2]: Chapter 6 (Section 6.1-6.8), Chapter 10 (Section 10.1-10.6).

UNIT 2: Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x\, dx$, $\int \cos^n x\, dx$, $\int \tan^n x\, dx$, $\int \sec^n x\, dx$, $\int (\log x)^n\, dx$, $\int \sin^n x \cos^m x\, dx$, volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution.

[1]: Chapter 9 (Sections 9.4).
[2]: Chapter 7 (Sections 7.1-7.5), Chapter 5 (Section 5.1-5.5 (excluding arc length by numerical methods))

UNIT 3: Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration, modelling ballistics and planetary motion, Kepler's second law.

[1] Chapter 9 (Section 9.3), Chapter 10

Practical / Lab work to be performed on a computer:

List of the practical to be done using Matlab / Mathematica / Maple / Scilab / Maxima etc.

(i). Plotting the graphs of the following functions: ax, $[x]$ (greatest integer function), $\sqrt{ax+b}, |ax+b|, c\pm|ax+b|, x^{\pm n}, x^{1/n}$ $, n\in Z$
$|x|/x$, $\sin(1/x), x\sin(1/x)$, and , $e^{\pm 1/x}$ for $x \neq 0$.
e^{ax+b}, $\log(ax+b)$, $1/(ax+b)$, $\sin(ax+b)$, $\cos(ax+b)$, $|\sin(ax+b)|$, $|\cos(ax+b)|$.
Observe and discuss the effect of changes in the real constants a, b and c on the graphs.

(ii). Plotting the graphs of polynomial of degree 4 and 5, the graphs of their first andsecond derivatives, and analysis of these graphs in context of the concepts covered in Unit 1.

(iii). Sketching parametric curves, e.g., Trochoid, Cycloid, Epicycloid and Hypocycloid.

(iv). Tracing of conic in cartesian coordinates.

(v). Obtaining surface of revolution of curves.

(vi). Graph of hyperbolic functions.

(vii). Computation of limit, Differentiation, Integration and sketching of vector-valued functions.

(viii). Complex numbers and their representations, Operations like addition, Multiplication, Division, Modulus. Graphical representation of polar form.

(ix). Find numbers between two real numbers and plotting of finite and infinite subset of R

Text Books:

1. M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus (3rd Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
2. H. Anton, I. Bivens and S. Davis, Calculus (10th Edition), John Wiley and sons (Asia), Pt Ltd., Singapore, 2011.

MAT-HC-1026:Algebra

Total marks: 100(Theory: 80 Internal Assessment: 20)

Per week:5 Lectures 1 Tutorial, Credits 6,*Each unit carry equal credit*

Course Objectives: The primary objective of this course is to introduce the basic tools of set theory, functions, induction principle, theory of equations, complex numbers, number theory, matrices and determinant to understand their connection with the real-world problems.

Course Learning Outcomes: This course will enable the students to:
i) Employ De Moivre's theorem in a number of applications to solve numerical problems.
ii) Learn about equivalent classes and cardinality of a set.
iii) Use modular arithmetic and basic properties of congruences.
iv) Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix.
v) Learn about the solution sets of linear systems using matrix method and Cramer's rule

UNIT-1: Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications.
[1]: Chapter 2

UNIT-2: Statements and logic, statements with quantifier, compound statements, implications, proofs in Mathematic; Sets, operations on sets, family of sets, power sets, Cartesian product; Functions, one-one, onto functions and bijections, Composition of functions, Inverse of a function, Image and Inverse image of subsets; Relation, Equivalence relations, Equivalence classes and partitions of a set, congruence modulo n in integers; Induction Principles, the well-ordering principle, greatest common divisor of integers.
[2] Chapters 1 – 5.

UNIT 3: Systems of Linear Equations, row reduction and echelon forms, vector equations, the matrix equation Ax =b, solution sets of linear systems, linear independence, introduction to linear transformations, the matrix of a linear transformation; Matrix operations, inverse of a matrix, characterizations of invertible matrices; Determinants, Cramer's rule
[3]: Chapter 1 (Sections 1.1 – 1.9); Chapter 2 (Sections, 2.1 – 1.3); Chapter 3 (Sections 3.1 – 3.3)

Text Books:

1. TituAndreescu and DorinAndrica, Complex Numbers from A to .... Z, Birkhauser, 2006.
2. A. Kumar, S. Kumaresan and B.K. Sarma, A Foundation Course in Mathematics, Narosa, 2018.
3. David C. Lay, Linear Algebra and its Applications (3rd Edition), Pearson Education Asia, Indian

Reprint, 2007.

Reference Books:

1. S. Barnard and J.M. Child, Higher Algebra, Arihant, 2016.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory (3rd Edition), Pearson Education (Singapore) Pvt. Ltd., Indian Reprint, 2005.
3. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.

GENERIC ELECTIVE PAPERS

MAT-HG-1016/ MAT-RC-1016:Calculus

Total Marks: 100(Theory: 80, Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial Credits**:** 6,*Each unit carry equal credit*

Course Objectives: Calculus is referred as 'Mathematics of change' and is concerned with describing the precise way in which changes in one variable relate to the changes in another. Through this course, students can understand the quantitative change in the behaviour of the variables and apply them on the problems related to the environment.

Course Learning Outcomes: The students who take this course will be able to:
i) Understand continuity and differentiability in terms of limits.
ii) Describe asymptotic behavior in terms of limits involving infinity.
iii) Use derivatives to explore the behavior of a given function, locating and classifying its extrema, and graphing the function.
iv) Understand the importance of mean value theorems.

Unit 1: Graphs of simple concrete functions such as polynomial, Trigonometric, Inverse trigonometric, Exponential and logarithmic functions
[1] Chapter 1 (Sections 1.1 to 1.3), and Chapter 7 (Sections 7.2, 7.3, and 7.6)

Unit 2: Limits and continuity of a function including approach, Properties of continuous functions including Intermediate value theorem.
[2] Chapter 1

Unit 3: Differentiability, Successive differentiation, Leibnitz theorem, Recursion formulae for higher derivatives.
[2] Chapter 3 (Sections 3.2, 3.3, and 3.6), and Exercise 26, page 184.

Unit 4: Rolle's theorem, Lagrange's mean value theorem with geometrical interpretations and simple applications, Taylor's theorem, Taylor's series and Maclaurin's series, Maclaurin's series expansion of functions such as heir use in polynomial approximation and error estimation.
[1] Chapter 4 (Sections 4.2, and 4.3), [2] Chapter 9 (Sections 9.8, and 9.9)

Unit 5: Functions of two or more variables, Graphs and level curves of functions of two variables, Partial differentiation up to second order.
[2] Chapter 13 (Sections 13.1, and 13.3)

Text books:

1. Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). *Thomas' Calculus* (13^{th}ed). Pearson Education, Delhi. Indian Reprint 2017.
2. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). John Wiley & Sons Singapore Pte. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi

MAT-HG-1026: Analytic Geometry

Total Marks: 100(Theory: 80, Internal Assessment: 20)

Per week: 5 Lectures, 1 Tutorial Credits**:** 6,*Each unit carry equal credit*

Course Objectives: The primary objective of this course is to introduce the basic tools of two dimensional coordinate systems, general conics, and three dimensional coordinates systems. Also, introduces the vectors in coordinate systems with geometrical properties

Course Learning Outcomes: This course will enable the students to:
i) Transform coordinate systems, conic sections
ii) Learn polar equation of a conic, tangent, normal and related properties
iii) Have a rigorous understanding of the concept of three dimensional coordinate systems
iv) Understand geometrical properties of dot product, cross product of vectors

UNIT 1: Transformation of coordinates, pair of straight lines. Parabola, parametric coordinates, tangent and normal, ellipse and its conjugate diameters with properties, hyperbola and its asymptotes, general conics: tangent, condition of tangency, pole and polar, centre of a conic, equation of pair of tangents, reduction to standard forms, central conics, equation of the axes, and length of the axes, polar equation of a conic, tangent and normal and properties.
[1] Chapter 3, 4, 10

UNIT 2: Three-Dimensional Space: Vectors
Rectangular coordinates in 3-space, Spheres and Cylindrical surfaces, Vector viewed geometrically,Vectors in coordinates system, Vectors determine by length and angle, Dot product, Cross product and their geometrical properties, Parametric equations of lines in 2-space and 3-space.
[1] Chapter 11 (11.1, 11.2, 11.3 to 11.5)

Text Books:
1. R. M. Khan, Analytical Geometry of two and three dimension and vector analysis. New Central Book agency 2012.
2. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). John Wiley & Sons Singapore Pte. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi.

Reference Book:
1. E. H. Askwith, The Analytical Geometry of the Conic Sections, Nabu Press (27 February 2012)
2. R. J. T. Bell, Coordinate Solid Geometry, Macmillan, 1983.

SEMESTER-II

MAT-HC-2016: Real Analysis

Total marks: 100(Theory: 80 Internal Assessment: 20)

Per week: 5 Lectures 1 Tutorial, Credits 6, *Each unit carry equal credit*

Course Objectives: The course will develop a deep and rigorous understanding of real line □ and of defining terms to prove the results about convergence and divergence of sequences and series of real numbers. These concepts have wide range of applications in real life scenario.

Course Learning Outcomes: This course will enable the students to:
i) Understand many properties of the real line R, including completeness and Archimedean properties.
ii) Learn to define sequences in terms of functions from N to a subset of R.
iii) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.

iv) Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

UNIT 1: Algebraic and order properties of R, absolute value and real line, bounded sets, supremum and infimum, completeness property of R, the Archimedean property, the density theorem, intervals, nested interval theorem.
[1] Chapter 2

UNIT-2: Real sequences, limit of a sequence, convergent sequence, bounded sequence, limit theorems, monotone sequences, monotone convergence theorem, subsequences, monotone subsequence theorem, Bolzano Weierstrass theorem for sequences, Cauchy sequences, Cauchy's convergence criterion, properly divergence sequences.
[1] Chapter 3

UNIT 3: Infinite series, convergence and divergence of infinite series, Cauchy criterion, Tests for convergence: comparison test, limit comparison test, ratio test, root test, integral test, Absolute convergence, rearrangement theorem, alternating series, Leibniz test, conditional (nonabsolute) convergence.
[1] Chapter 9 Sections 9.1-3.

Text Book:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons, 2002.

Reference Books:

1. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, *An Introduction to Analysis,* Jones & Bartlett, Second Edition, 2010.
2. A. Kumar and S. Kumaresan, *Basic Course in Real Analysis*, CRC Press, 2014.
3. K. A. Ross, Elementary Analysis: The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

MAT-HC-2026: Differential Equations(including practical)

Total Marks: 100: (Theory 60, Practical 20, Internal assessment 20)
Per week: 4 Lectures 2 Practical, Credits 6(4+2)*Each unit carry equal credit*

Course Objectives: The main objective of this course is to introduce the students to the exciting world of differential equations, mathematical modeling and their applications.

Course Learning Outcomes: The course will enable the students to:
i) Learn basics of differential equations and mathematical modeling.
ii) Formulate differential equations for various mathematical models.
iii) Solve first order non-linear differential equations and linear differential equations of higher order using various techniques.
iv) Apply these techniques to solve and analyze various mathematical models.

UNIT 1: Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.
[2] Chapter 1 (Sections 1.1, and 1.6), [3] Chapter 2, [2] Chapter 1 (Section 1.4, pages 35 to 38), and Chapter 2 (Section 2.3). [3] Chapter 3 (Section 3.3, A and B with Examples 3.8, 3.9)

UNIT 2: Introduction to compartmental model, exponential decay model, exponential growth of population, limited growth of population, limited growth with harvesting.
[1] Chapter 2 (Sections 2.1, 2.5, and 2.6), [1] Chapter 2 (Sections 2.7, and 2.8), [1] Chapter 3 (Sections 3.1 to 3.3)

UNIT 3: General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.
[2] Chapter 3 (Sections 3.1 to 3.3, Sections 3.4 (pages 172 to 177), and 3.5), [1] Chapter 5 (Sections 5.1, 5.2, 5.4, and 5.9), and Chapter 6 (Sections 6.1 to 6.4).

List of Practical (using any software)

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Lake pollution model (with constant/seasonal flow and pollution concentration).
6. Case of single cold pill and a course of cold pills.
7. Limited growth of population (with and without harvesting).

Text Books:

1. Barnes, Belinda &Fulford, Glenn R. (2015). *Mathematical Modelling with Case Studies, Using* Maple *and* MATLAB (3rd ed.). CRC Press, Taylor & Francis Group.
2. Edwards, C. Henry, Penney, David E., &Calvis, David T. (2015). *Differential Equation and Boundary Value Problems*: *Computing and Modeling* (5th ed.). Pearson Education.
3. Ross, Shepley L. (2004). *Differential Equations* (3rd ed.). John Wiley & Sons. India

Reference Books:

1. Martha L Abell, James P Braselton, *Differential Equations with MATHEMATICA*, 3rd Ed., Elsevier Academic Press, 2004.
2. Ross, Clay C. (2004). *Differential Equations*: *An Introduction with Mathematica* (2nd ed.). Springer.

GENERIC ELECTIVE PAPERS

MAT-HG-2016/MAT-RC-2016: Algebra

Total Marks: 100(Theory: 80, Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial Credits:6, *Each unit carry equal credit*

Course Objectives: The primary objective of this course is to introduce the basic tools of theory of equations, complex numbers, number theory, matrices, determinant, along with algebraic structures like group, ring and vector space to understand their connection with the real-world problems.

Course Learning Outcomes: This course will enable the students to:
i) Learn how to solve the cubic and biquadratic equations, also learn about symmetric functions of the roots for cubic and biquadratic
ii) Employ De Moivre's theorem in a number of applications to solve numerical problems.
iii) Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix. Finding inverse of a matrix with the help of Cayley-Hamilton theorem
iv) Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, ring etc.
v) Learn about the concept of linear independence of vectors over a field, and the dimension of a vector space

Unit 1: Theory of Equations and Expansions of Trigonometric Functions:
Fundamental Theorem of Algebra, Relation between roots and coefficients of *n*th degree equation, Remainder and Factor Theorem, Solutions of cubic and biquadratic equations, when some conditions on roots of the equation are given, Symmetric functions of the roots for cubic and biquadratic; De Moivre's

theorem (both integral and rational index), Solutions of equations using trigonometry and De Moivre's theorem, Expansion for in terms of powers of in terms of cosine and sine of multiples of x.
[2] Chapter 3, 4 [3] Chapter 7 (Sections 7.6 and 7.7)

Unit 2: Matrices:
Types of matrices, Rank of a matrix, Invariance of rank under elementarytransformations, Reduction to normal form, Solutions of linear homogeneous and nonhomogeneous equations with number of equations and unknowns up to four; Cayley-Hamilton theorem, Characteristic roots and vectors.
[4] Chapter 3 (Sections 3.2, 3.5, and 3.7,Section 3.9)Chapter 2 (Sections 2.1 to 2.5)Chapter 7 (Section 7.1, and Example 7.2.2)

Unit 3: Groups, Rings and Vector Spaces:
Integers modulo n, Permutations, Groups, Subgroups, Lagrange's theorem, Euler's theorem, Symmetry Groups of a segment of a line, and regular n-gons for n = 3, 4, 5, and 6; Rings and subrings in the context of C[0,1] and Definition and examples of a vector space, Subspace and its properties, Linear independence, Basis and dimension of a vector space.
[1] Chapter 1 (Section 1.4), and Chapter 2 (Section 2.3)Chapter 3 (Sections 3.1, and 3.2)(Sections 3.2, 3.3, and 3.6) and Chapter 5 (Section 5.1)
[4] Chapter 4 (Sections 4.1, 4.3, and 4.4)

Text Books:

1. Beachy, John A., & Blair, William D. (2006). *Abstract Algebra* (3rd ed.). Waveland Press, Inc.
2. Burnside, William Snow (1979). *The Theory of Equations*, Vol. 1 (11th ed.) S. Chand & Co. Delhi. Fourth Indian Reprint.
3. Gilbert, William J., & Vanstone, Scott A. (1993). *Classical Algebra* (3rd ed.). Waterloo Mathematics Foundation, Canada.
4. Meyer, Carl D. (2000). *Matrix Analysis and Applied Linear Algebra*. Society for Industrial and Applied Mathematics (Siam).

Reference Books:

1. Dickson, Leonard Eugene (2009). *First Course in The Theory of Equations*. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785)
2. Gilbert, William J. (2004). *Modern Algebra with Applications* (2nd ed.). John Wiley & Sons.

MAT-HG-2026: Discrete Mathematics

Total Marks:100 (Theory: 80 Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial, Credits:6, *Each unit carry equal credit*

Course Objectives: The course aims at introducing the concepts of ordered sets, lattices, sublattices and homomorphisms between lattices. It also includes introduction to modular and distributive lattices along with complemented lattices and Boolean algebra. Then some important applications of Boolean algebra are discussed in switching circuits.

Course Learning outcomes: After the course, the student will be able to:
i) Understand the notion of ordered sets and maps between ordered sets.
ii) Learn about lattices, modular and distributive lattices, sublattices and homomorphisms between lattices.
iii) Become familiar with Boolean algebra, Boolean homomorphism, Karnaugh diagrams, switching circuits and their applications.

Unit 1: Ordered Sets

Definitions, Examples and basic properties of ordered sets, Order isomorphism, Hasse diagrams, Dual of an ordered set, Duality principle, Maximal and minimal elements, Building new ordered sets, Maps between ordered sets.
[1] Chapter 1 (Sections 1.1 to 1.5 and 1.14 to 1.26, and 1.34 to 1.36)
[3] Chapter 1 [Section 1 (1.1 to 1.3)]

Unit 2: Lattices
Lattices as ordered sets, Lattices as algebraic structures, Sublattices, Products and homomorphisms; Definitions, Examples and properties of modular and distributive lattices, The M3 – N5 Theorem with applications, Complemented lattice, Relatively complemented lattice, Sectionally complemented lattice. homomorphisms.
[1] Chapter 2 (Sections 2.1 to 2.19)Chapter 4 (Sections 4.1 to 4.11)
[3] Chapter 1 [Section 1 (1.5 to 1.20)]Chapter 2 [Section 2 (2.1 to 2.14)]

Unit 3: Boolean Algebras and Switching Circuits
Boolean Algebras, De Morgan's laws, Boolean homomorphism, Representation theorem; Boolean polynomials, Boolean polynomial functions, Disjunctive normal form and conjunctive normal form, Minimal forms of Boolean polynomial, Quinn-McCluskey method, Karnaugh diagrams, Switching circuits and applications of switching circuits.
[3] Chapter 1 (Sections 3, 4 and 6) Chapter 2 (Sections 7 and 8).

Text Books:
1. Davey, B. A., & Priestley, H. A. (2002). *Introduction to Lattices and Order* (2nd ed.). Cambridge University press, Cambridge.
2. Goodaire, Edgar G., & Parmenter, Michael M. (2011). *Discrete Mathematics with Graph Theory* (3rd ed.). Pearson Education (Singapore) Pvt. Ltd. Indian Reprint.
3. Lidl, Rudolf & Pilz, Gunter. (2004). *Applied Abstract Algebra* (2nd ed.), Undergraduate Texts in Mathematics. Springer (SIE). Indian Reprint.

SEMESTER-III
MAT-HC-3016: Theory of Real Functions
Total Marks: 100(Theory 80 Internal assessment 20)
Per week: 5 Lectures 1 Tutorial, Credits,*Each unit carry equal credit*

Course Objectives: It is a basic course on the study of real valued functions that would develop an analytical ability to have a more matured perspective of the key concepts of calculus, namely; limits, continuity, differentiability and their applications

Course Learning Outcomes: This course will enable the students to:
i) Have a rigorous understanding of the concept of limit of a function.
ii) Learn about continuity and uniform continuity of functions defined on intervals.
iii) Understand geometrical properties of continuous functions on closed and bounded intervals.
iv) Learn extensively about the concept of differentiability using limits, leading to a better understanding for applications.
v) Know about applications of mean value theorems and Taylor's theorem

UNIT 1: Cluster point or limit point of a set, limits of a function (ε-δ approach), sequential criterion for limits, divergence criteria,limit theorems, one sided limits, infinite limits and limits at infinity.
[1] Chapter 4

UNIT 2: Continuous functions, sequential criterion for continuity and discontinuity,algebra of continuous functions,continuous functions on intervals, maximum-minimum theorem, intermediate value theorem, location of roots theorem, preservation of intervals theorem,uniform continuity, uniform continuity theorem.

[1] Chapter 5

UNIT 3: Differentiability of a function at a point and in an interval, Caratheodory's theorem, chain rule, derivative of inverse function, Rolle's theorem, mean value theorem, Darboux's theorem, Cauchy mean value theorem, L'Hospital's rules, Taylor's theorem and applications to inequalities, Taylor's series expansions of exponential and trigonometric functions, ln(1 + x), 1/(ax+b) and $(1+x)^n$.
[1] Chapter 6, and Taylor series as in Section 9.4.

Text Book:
1. R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, 2015.

Reference Books:
1. Ajit Kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, Indian Edn. 2014.
2. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004.
3. A.Mattuck, Introduction to Analysis, Prentice Hall, 1999.
4. S.R. Ghorpade and B.V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.

MAT-HC-3026: Group Theory - I

Total Marks: 100 (Theory 80 Internal assessment 20)

Per week 5 Lectures 1 Tutorial Credits,*Each unit carry equal credit*

Course Objectives: The objective of the course is to introduce the fundamental theory of groups and their homomorphisms. Symmetric groups and group of symmetries are also studied in detail. Fermat's Little theorem is studied as a consequence of the Lagrange's theorem on finite groups.

Course Learning Outcomes: The course will enable the students to:
i) Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc.
ii) Link the fundamental concepts of groups and symmetrical figures.
iii) Analyze the subgroups of cyclic groups and classify subgroups of cyclic groups.
iv) Explain the significance of the notion of cosets, normal subgroups and factor groups.
v) Learn about Lagrange's theorem and Fermat's Little theorem.
vi) Know about group homomorphisms and group isomorphisms.

UNIT 1: Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups. Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups. Properties of cyclic groups, classification of subgroups of cyclic groups.
[1]: Chapters 1, Chapter 2, Chapter 3 (including Exercise 20 on page 66 and Exercise 2 on page 86), Chapter 4.

UNIT 2: Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem. External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.
[1]: Chapter 5 (till end of Theorem 5.7), Chapter 7 (till end of Theorem 7.2, including Exercises 6 and 7 on page 168), Chapter 8 (till the end of Example 2), Chapter 9 (till end of Example 10, Theorem 9.3 and 9.5).

UNIT 3: Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.
[1]: Chapter 6 (till end of Theorem 6.2), Chapter 10.

Text Book:
1. Gallian, Joseph. A. (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited, Delhi. Fourth impression, 2015.

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. G. Santhanam, Algebra, Narosa Publishing House, 2017.
3. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
4. David S. Dummit and Richard M. Foote, Abstract Algebra (2nd Edition), John Wiley and Sons (Asia) Pvt. Ltd, Singapore, 2003.

MAT-HC-3036: Analytical Geometry

Total Marks: 100: (Theory 80, Internal assessment 20)

Per week: 5 Lectures 1 Tutorial Credits 6,*Each unit carry equal credit*

Course Objectives: The primary objective of this course is to introduce the basic tools of two dimensional coordinates systems, general conics, and three dimensional coordinate systems.

Course Learning Outcomes: This course will enable the students to:

i) Learn conic sections and transform co-ordinate systems
ii) Learn polar equation of a conic, tangent, normal and properties
iii) Have a rigorous understanding of the concept of three dimensional coordinates systems

UNIT 1: Transformation of coordinates, pair of straight lines. Parabola, parametric coordinates, tangent and normal, ellipse and its conjugate diameters with properties, hyperbola and its asymptotes, general conics: tangent, condition of tangency, pole and polar, centre of a conic, equation of pair of tangents, reduction to standard forms, central conics, equation of the axes, and length of the axes, polar equation of a conic, tangent and normal and properties.
[1] Chapter 3,4, 10

UNIT 2: Plane, straight lines and shortest distance. Sphere, cone and cylinder, central conicoids, ellipsoid, hyperboloid of one and two sheets, diametral planes, tangent lines, director sphere, polar plane, section with a given centre
[2] Chapters 4,5,6,7 (upto page 125)

Text Books:

1. R. M. Khan, Analytical Geometry of two and three dimension and vector analysis. New Central Book agency 2012.
2. R. J. T. Bell, Coordinate Solid Geometry, Macmillan, 1983.

Reference Book:

1. E. H. Askwith, The Analytical Geometry of the Conic Sections,Nabu Press (27 February 2012)

SKILL ENHANCEMENT COURSE

SEC-1

MAT-SE-3014: Computer Algebra Systems and Related Software

Total marks: 100 (Theory 60, Internal assessment 20, Practical 20)

Per week; 2 Lectures 2 Practical, Credits 4(2+2)*Each unit carry equal credit*.

Course Objectives: This course aims at familiarizing students with the usage of mathematical softwares (/Mathematica/MATLAB/Maxima/Maple) and the statistical software **R**. The basic emphasis is on plotting and working with matrices using CAS. Data entry and summary commands will be studied in **R**. Graphical representation of data shall also be explored.

Course Learning Outcomes: This course will enable the students to:

i) Use of softwares; Mathematica/MATLAB/Maxima/Maple etc. as a calculator, for plotting functions and animations
ii) Use of CAS for various applications of matrices such as solving system of equations and finding eigenvalues and eigenvectors.
iii) Understand the use of the statistical software **R** as calculator and learn to read and get data into **R.**

iv) Learn the use of **R** in summary calculation, pictorial representation of data and exploring relationship between data.
v) Analyze, test, and interpret technical arguments on the basis of geometry

Unit 1: Introduction to CAS and Applications:
Computer Algebra System (CAS), Use of a CAS as a calculator, Computing and plotting functions in 2D, Plotting functions of two variables using Plot3D and Contour Plot, Plotting parametric curves surfaces, Customizing plots, Animating plots, Producing tables of values, working with piecewise defined functions, Combining graphics.
[1] Chapter 12 (Sections 12.1 to 12.5)
[2] Chapter 1, and Chapter 3 (Sections 3.1 to 3.6, and 3.8) Chapter 6 (Sections 6.2, and 6.3)

Unit 2: Working with Matrices:
Simple programming in a CAS, Working with matrices, Performing Gauss elimination, operations (transpose, determinant, inverse), Minors and cofactors, Working with large matrices, Solving system of linear equations, Rank and nullity of a matrix, Eigenvalue, eigenvector and diagonalization.
[2] Chapter 7 (Sections 7.1 to 7.8)

Practical:
Six practicals should be done by each student. The teacher can assign practical from the exercises from [1,2].

Text Books:

1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.
2. Torrence, Bruce F., & Torrence, Eve A. (2009). *The Student's Introduction to Mathematica:A Handbook for Precalculus, Calculus, and Linear Algebra* (2nd ed.). Cambridge University Press

MAT-SE-3024: Combinatorics and Graph Theory

Total marks: 100(Theory 80, Internal Assessment 20)

Per week: 4 Lectures, Credits4, *Each unit carry equal credit*.

Course Objectives: This course aims to provide the basic tools of conuting principles, pigeonhole principle. Also introduce the basic concepts of graphs, Eulerian and Hamiltonian graphs, and applications to dominoes, Diagram tracing puzzles, Knight's tour problem and Gray codes.

Course Learning Outcomes: This course will enable the students to:
i) Learn about the counting principles, permutations and combinations, Pigeonhole principle
ii) Understand the basics of graph theory and learn about social networks, Eulerian and Hamiltonian graphs, diagram tracing puzzles and Knight's tour problem.

Unit 1: Basic counting principles, Permutations and combinations, the inclusion-exclusion principle, Pigeonhole principle.
[2] Chapter 1 (Sections 1.1, 1.2, 1.3), Chapter 2 (Sections 2.1, 2.2) Chapter 4 (Section 4.1) Chapter 8 (Section 8.1).
Unit 2: Graphs, Diagraphs, Networks and subgraphs, Vertex degree, Paths and cycles, Regular and bipartite graphs, Four cube problem, Social networks, Exploring and travelling, Eulerian and Hamiltonian graphs, Applications to dominoes, Diagram tracing puzzles, Knight's tour problem, Gray codes.
[1] Chapter 1 (Section 1.1), and Chapter 2

Text Books:

1. Aldous, Joan M., & Wilson, Robin J. (2007). *Graphs and Applications*: *An Introductory Approach*. Springer. Indian Reprint.

2. Sharad S. Sane, Combinatorial Techniques, Hindustan Book Agency, 2013.

Reference Books:

1. Michael Towusend, Discrete Mathematics; Applied Combinatorics and Graph Theory, Benjamin-Cummings Pub Co (March 1, 1987)
2. K.R. Parthasarathi, Basic Graph Theory,Tata McGraw-Hill, 1994.
3. C.L. Liu and D. Mohapatra_ Elements of discrete mathematics, McGraw Hill, Computer Science Series. 2017

GENERIC ELECTIVE PAPERS

MAT-HG-3016/MAT-RC-3016: Differential Equations

Total Marks: 100(Theory: 80, Internal Assessment: 20)

Per week: 5 Lectures, 1 Tutorial, Credits: 6,*Each unit carry equal credit*

Course Objectives: The main objective of this course is to introduce the students to the exciting world of ordinary differential equations, mathematical modeling and their applications.

Course Learning Outcomes: The course will enable the students to:

i) Learn basics of differential equations and mathematical modelling.

ii) Solve first order non-linear differential equations and linear differential equations of higher order using various techniques.

Unit 1: First Order Ordinary Differential Equations

First order exact differential equations, Integrating factors, Rules to find an integrating factor

[1] Chapter 1 (Section 1.1,1.2 1.4), [2] Chapter 1 (Sections 1.1, and 1.2)Chapter 2 (Sections 2.1, and 2.2)

Linear equations and Bernoulli equations, Orthogonal trajectories and oblique trajectories; Basictheory of higher order linear differential equations, Wronskian, and its properties; Solving differential equation by reducing its order.

[2] Chapter 2 (Sections 2.3, and 2.4), Chapter 3 (Section 3.1), and Chapter 4 (Section 4.1)

Unit 2: Second Order Linear Differential Equations

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation; Simultaneous differential equations.

[1] Chapter 2 (Section 2.2), [2] Chapter 4 (Sections 4.2, 4.3, 4.4, 4.5,4.6) Chapter 7 (Sections 7.1, 7.3)

Text Books:

1. Kreyszig, Erwin (2011). *Advanced Engineering Mathematics* (10th ed.). John Wiley &Sons, Inc. Wiley India Edition 2015.
2. Ross, Shepley L. (1984). *Differential Equations* (3rd ed.). John Wiley & Sons, Inc

MAT-HG-3026: Linear Programming

Total Marks: 100 (Theory: 80 Internal Assessment: 20)

Per week: 5 Lectures, 1 Tutorial Credits: 6,*Each unit carry equal credit*

Course Objectives: This course develops the ideas underlying the Simplex method. The course covers Linear rogramming problems with applications to transportation, assignment and game problem. Such problems arise in manufacturing resource planning and financial sectors.

Course Learning Outcomes: This course will enable the students to:

i) Learn about the graphical solution of linear programming problem with two variables.

ii) Learn about the relation between basic feasible solutions and extreme points.
iii) Understand the theory of the simplex method used to solve linear programming problems.
iv) Learn about two-phase and big-M methods to deal with problems involving artificial variables.
v) Learn about the relationships between the primal and dual problems.
vi) Solve transportation and assignment problems.
vii) Apply linear programming method to solve two-person zero-sum game problems.

Unit 1: The Linear Programming Problem**:** Standard, Canonical and matrix forms, Graphical solution. Hyperplanes, Extreme points, Convex and polyhedral sets. Basic solutions; Basic Feasible Solutions; Reduction of any feasible solution to a basic feasible solution; Correspondence between basic feasible solutions and extreme points.

[1] Chapter 1 (Section 1.1, 1.4 and 1.6)
[2] Chapter 2 (Sections 2.16, 2.19 and 2.20), Chapter 3 (Sections 3,2, 3.4 and 3.10)

Unit 2: Simplex Method**:** Optimal solution, Termination criteria for optimal solution of the Linear Programming Problem, Unique and alternate optimal solutions, Unboundedness; Simplex Algorithm and its Tableau Format; Artificial variables, Two-phase method, Big-M method.
[1] Chapter 3 (Sections 3.3, 3.6, 3.7 and 3.8)

Unit 3: Motivation and Formulation of Dual problem; Primal-Dual relationships; Fundamental Theorem of Duality; Complimentary Slackness.
[1] Chapter 4 (Sections 4.1 to 4.3)
[1] Chapter 6 (Section 6.1, and 6.2, up to Example 6.4)

Unit 4: Applications
*Transportation Problem***:** Definition and formulation; Methods of finding initial basic feasible solutions; North West corner rule. Least cost method; Vogel's Approximation method; Algorithm for solving Transportation Problem.
*Assignment Problem***:** Mathematical formulation and Hungarian method of solving.
*Game Theory***:** Basic concept, Formulation and solution of two-person zero-sum games, Games with mixed strategies, Linear Programming method of solving a game.
[3] Chapter 5 (Sections 5.1, 5.3, and 5.4)
[2] Chapter 11 (Sections 11.12, and 11.13)

Text Books:
1. Bazaraa, Mokhtar S., Jarvis, John J. and Sherali, Hanif D. (2010). *Linear Programmingand Network Flows* (4th ed.). John Wiley and Sons.
2. Hadley, G. (1997). *Linear Programming*. Narosa Publishing House. New Delhi.
3. Taha, Hamdy A. (2010). *Operations Research*: *An Introduction* (9th ed.). Pearson.

Reference Books:

1. Hillier, Frederick S. & Lieberman, Gerald J. (2015). *Introduction to Operations Research* (10th ed.). McGraw-Hill Education (India) Pvt. Ltd.
2. Thie, Paul R., &Keough, G. E. (2014). *An Introduction to Linear Programming andGame Theory*. (3rd ed.). Wiley India Pvt. Ltd.

SEMESTER-IV

MAT-HC-4016: Multivariate Calculus

Total Marks: 100 (Theory80, Internal assessment 20)
Per week: 5 lectures 1 Tutorial, Credits 6,*Each unit carry equal credit*
(Use of Scientific calculator is allowed)

Course Objectives: To understand the extension of the studies of single variable differential and integral calculus to functions of two or more independent variables. Also, the emphasis will be on the use of Computer Algebra Systems by which these concepts may be analyzed and visualized to have a better understanding. This course will facilitate to become aware of applications of multivariable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.

Course Learning Outcomes: This course will enable the students to:
i) Learn the conceptual variations when advancing in calculus from one variable to multivariable discussion.
ii) Understand the maximization and minimization of multivariable functions subject to the given constraints
iii) Learn about inter-relationship amongst the line integral, double and triple integral formulations.
iv) Familiarize with Green's, Stokes' and Gauss divergence theorems

UNIT 1: Functions of several variables, Level curves and surfaces, Limits and continuity, Partial differentiation, Higher order partial derivative, Tangent planes, Total differential and differentiability, Chain rule, Directional derivatives, The gradient, Maximal and normal property of the gradient, Tangent planes and normal lines.
[1] Chapter 11 (Sections 11.1 and 11.2, 11.3 and 11.4,11.5, 11.6)

UNIT 2: Extrema of functions of two variables, Method of Lagrange multipliers, Constrained optimization problems; Definition of vector field, Divergence and curl.
[1] Chapter 11 [Section 11.7 (up to page 605)], Section 11.8 (pages 610-614)], Chapter13 (Section 13.1)

UNIT 3: Double integration over rectangular and nonrectangular regions, Double integrals in polar coordinates, Triple integral over a parallelepiped and solid regions, Volume by triple integrals,triple integration in cylindrical and spherical coordinates, Change of variables in doubleandtriple integrals.
[1] Chapter 12 (Sections 12.1-12.4)

UNIT 4: Line integrals, Applications of line integrals**:** Mass and Work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral; Surface integrals, Stokes' theorem, The Gauss divergence theorem.
[1] Chapter 12 (Sections 12.5 and 12.6) Chapter 13 (Section 13.2, 13.3), [Sections 13.4 (pages 712 to 716), 13.5 (pages 723 to 726)]

Textbook:
[1] Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). *Calculus* (3rd ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Indian Reprint 2011

Reference Books:
1. Marsden, J. E., Tromba, A., & Weinstein, A. (2004). *Basic Multivariable Calculus*. Springer (SIE). First Indian Reprint.
2. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
3. M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus (3 Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
4. James Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.

MAT-HC-4026: Numerical Methods (including practical)

Total marks: 100: (Theory: 60, Practical 20, Internal Assessment: 20)
Per week: 4 Lectures, 2 Practical, Credits 6(4+2), *Each unit carry equal credit*

Course Objectives: To comprehend various computational techniques to find approximate value for possible root(s) of non-algebraic equations and to find the approximate solutions of system of linear equations and ordinary differential equations. Also, use of Computer Algebra System (CAS) by which the numerical problems can be solved both numerically and analytically, and to enhance the problem solving skills.

Course Learning Outcomes: The course will enable the students to:
i) Learn some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.
ii) Know about methods to solve system of linear equations, such as False position method, Fixed point iteration method, Newton's method, Secant method and LU decomposition.
iii) Interpolation techniques to compute the values for a tabulated function at points not in the table.
iv) Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.

UNIT 1: Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method, LU decomposition.
[1] Chapter 1 (Sections 1.1-1.2), Chapter 2 (Sections 2.1-2.5), Chapter 3 (Section 3.5, 3.8).

UNIT 2: Lagrange and Newton interpolation: linear and higher order, finite difference operators.
[1] Chapter 5 (Sections 5.1, 5.3) [2] Chapter 4 (Section 4.3).

UNIT 3: Numerical differentiation: forward difference, backward difference and central difference. Integration: trapezoidal rule, Simpson's rule, Euler's method.
[1]: Chapter 6 (Sections 6.2, 6.4), Chapter 7 (Section 7.2)
Note: Emphasis is to be laid on the algorithms of the above numerical methods.

***Practical / Lab work to be performed on a compute*r:**
Use of computer aided software (CAS), for example *Matlab* / *Mathematica* / *Maple* / *Maxima* etc., for developing the following Numerical programs:

(i) Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
(ii) To find the absolute value of an integer.
(iii) Enter 100 integers into an array and sort them in an ascending order.
(iv) Any two of the following
(a) Bisection Method
(b) Newton Raphson Method
(c) Secant Method
(d) RegulaiFalsi Method
(v) LU decomposition Method
(vi) Gauss-Jacobi Method
(vii) SOR Method or Gauss-Siedel Method
(viii) Lagrange Interpolation or Newton Interpolation
(ix) Simpson's rule.

Note: For any of the CAS *Matlab* / *Mathematica* / *Maple* / *Maxima* etc., Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

Text Books:

1. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
2. M. K. Jain, S. R. K. IyengarandR. K. Jain, *Numerical Methods for Scientific and Engineering Computation*, New age International Publisher, India, 5th edition, 2007.

Reference Book:

1. C. F. Gerald and P. O. Wheatley, *Applied Numerical Analysis*, Pearson Education, India,7th edition, 2008

MAT-HC-4036: Ring Theory

Total Marks: 100: (Theory80 Internal Assessment: 20)

Per week: 5 Lectures, 1 Tutorial,Credits 6,*Each unit carry equal credit*

Course Objectives: The objective of this course is to introduce the fundamental theory of rings and their corresponding homomorphisms. Also introduces the basic concepts of ring of polynomials and irreducibility tests for polynomials over ring of integers.

Courses Learning Outcomes: On completion of this course, the student will be able to:
i) Appreciate the significance of unique factorization in rings and integral domains.
ii) Learn about the fundamental concept of rings, integral domains and fields.
iii) Know about ring homomorphism and isomorphism theorems of rings.
iv) Learn about the polynomial rings over commutative rings, integral domains, Euclidean domains, and UFD

UNIT 1: Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideals, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals. Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients.
[1]: Chapter 12, Chapter 13, Chapter 14, Chapter 15.

UNIT 2: Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in Z[x]**.** Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains.
[1]: Chapter 16, Chapter 17, Chapter 18.

Text Books:

1. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.

Reference Books:

1. John B. Fraleigh (2002), A First Course in Abstract Algebra, 7th Ed., Pearson.
2. M. Artin (2011), Abstract Algebra, 2nd Ed., Pearson.
3. D.A.R. Wallace (1998), Groups, Rings and Fields, Springer Verlag London Ltd.
4. G. Santhanam (2017), Algebra, Narosa Publishing House.

SKILL ENHANCEMENT COURSE
SEC-2
MAT-SE-4014: R Programming

Total marks: 100 (Theory 60, Internal assessment 20, Practical 20)

Per week: 2 Lectures 2 Practical, Credits 4(2+2)

Course Objectives: The purpose of this course is to help using **R**, a powerful free software program for doing statistical computing and graphics. It can be used for exploring and plotting data, as well as performing statistical tests.

Course Learning Outcomes: This course will enable the students to:
i) Become familiar with **R** syntax and to use **R** as a calculator.
ii) Understand the concepts of objects, vectors and data types.
iii) Know about summary commands and summary table in **R**.
iv) Visualize distribution of data in **R** and learn about normality test.
v) Plot various graphs and charts using **R**.

Unit 1: **Getting Started with R - The Statistical Programming Language**
Introducing **R**, using **R** as a calculator; Explore data and relationships in **R**; Reading and getting data into **R:** combine and scan commands, viewing named objects and removing objects from **R**, Types and structures of data items with their properties, Working with history commands, Saving work in **R**; Manipulating vectors, Data frames, Matrices and lists; Viewing objects within objects, Constructing data objects and their conversions.
[1] Chapter 14 (Sections 14.1 to 14.4), [2] Chapter 2, Chapter 3

Unit 2: **Descriptive Statistics and Tabulation**
Summary commands**:** Summary statistics for vectors, Data frames, Matrices and lists; Summary tables.
[2] Chapter 4

Unit 3: **Distribution of Data**
Stem and leaf plot, Histograms, Density function and its plotting, The Shapiro-Wilk test for normality, The Kolmogorov-Smirnov test.
[2] Chapter 5

Unit 4: **Graphical Analysis with R**
Plotting in **R:** Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts, Bar charts; Copy and save graphics to other applications.
[1] Chapter 14 (Section 14.7)[2] Chapter 7

Practical to be done in the Computer Lab using Statistical Software R:
[1] Chapter 14 (Exercises 1 to 3)
[2] Relevant exercises of Chapters 2 to 5, and 7
Note: The practical may be done on the database to be downloaded from https://data.gov.in/

Textbooks:

1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.
2. Gardener, M. (2012). *Beginning* **R:** *The Statistical Programming Language*, Wiley Publications.

MAT-SE-4024: LaTeX and HTML (practical)
Total marks: 100 (Theory 60, Internal assessment 20, Practical 20)
Per week: 2 Lectures 2 Practical, Credits 4(2+2)

Course Objectives: The purpose of this course is to acquaint students with the latest typesetting skills, which shall enable them to prepare high quality typesetting, beamer presentation and webpages

Course Learning Outcomes: After studying this course the student will be able to:
i) Create and typeset a LaTeX document.
ii) Typeset a mathematical document using LaTex.
iii) Learn about pictures and graphics in LaTex.
iv) Create beamer presentations.
v) Create web page using HTML.

Unit 1: Elements of LaTeX; Hands-on-training of LaTex; graphics in LaTeX; PSTricks; Beamer presentation
[1] Chapters 9,10, 11.

Unit 2: HTML, creating simple web pages, images and links, design of web pages.
[1] Chapter 9-11, 15

Practical: Six practical should be done by each student. The teacher can assign practical from the exercises from [1].

Text Book:

1. Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011.

Reference Book:

1. L. Lamport, LATEX: A Document Preparation System, User's Guide and Reference Manual. Addison-Wesley, New York, second edition, 1994.

GENERIC ELECTIVE PAPERS

MAT-HG-4016/ MAT-RC-4016: Real Analysis

Total Marks: 100(Theory: 80 Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial, Credits:6,*Each unit carry equal credit*

Course Objectives: The course will develop a deep and rigorous understanding of real line R and of defining terms to prove the results about convergence and divergence of sequences and series of real numbers. **Course**

Course Learning Outcomes: This course will enable the students to:
i) Understand many properties of the real line R, including completeness and Archimedean properties.
ii) Learn to define sequences in terms of functions from R to a subset of R.
iii) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
iv) Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

Unit 1: Order completeness of Real numbers, Open and closed sets, Limit of functions, Sequentialcriterion for limits, Algebra of limits, Properties of continuous functions, Uniform continuity.
[1] Chapter 2 (Sections 2.1, and 2.2, Sections 2.3, and 2.4)Chapter 11 (Section 11.1, Definition and Examples only)

Unit 2: Sequences, Convergent and Cauchy sequences, Subsequences, Limit superior and limit inferiorof a bounded sequence, Monotonically increasing and decreasing sequences, Infinite series andtheir convergences, Positive term series, Comparison tests, Cauchy's nth root test,D'Alembert's ratio test, Raabe's test, Alternating series, Leibnitz test, Absolute and conditionalconvergence.
[1] Chapter 3, (Sections 3.1, 3.2,3.3,3.4,3.5,3.7), Chapter 9 [Section 9.1(excluding grouping of series)]Sections 9.2 (Statements of tests only), and 9.3 (9.3.1, 9.3.2), Chapter 4 (Sections 4.1 to 4.3).Chapter 5 (Sections 5.1, 5.3, 5.4 excluding continuous extension and approximation)

Text Book:

1. Bartle, Robert G., &Sherbert, Donald R. (2015). *Introduction to Real Analysis* (4th ed.) Wiley India Edition.

Reference Book:

1. Ross, Kenneth A. (2013). *Elementary Analysis*: *The Theory of Calculus* (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian Reprint
2. Bilodeau, Gerald G., Thie, Paul R., &Keough, G. E. (2010). *An Introduction to Analysis* (2nd ed.). Jones & Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.

MAT-HG-4026: Numerical Analysis

Total Marks:100 (Theory: 80 Internal Assessment: 20)

Per week: 5 Lectures, 1 Tutorial,Credits:6, *Each unit carry equal credit*

Course Objectives: To comprehend various computational techniques to find approximate value for possible root(s) of non-algebraic equations, to find the approximate solutions of system of linear equations and Quadratic equations.

Course Learning Outcomes: The course will enable the students to:
i) Learn some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.
ii) Know about iterative and non-iterative methods to solve system of linear equations
iii) Know interpolation techniques to compute the values for a tabulated function at points not in the table.
iv) Integrate a definite integral that cannot be done analytically
v) Find numerical differentiation of functional values
vi) Solve differential equations that cannot be solved by analytical methods

Unit 1: Gaussian elimination method (with row pivoting), Gauss-Jordan method; Iterative methods**:**Jacobi method, Gauss-Seidel method; Interpolation**:** Lagrange form, Newton form, Finite difference operators, Gregory-Newton forward and backward difference interpolations, Piecewise polynomial interpolation (Linear and Quadratic).
[2] Chapter 3 (Sections 3.1, and 3.2), Chapter 6 (Sections 6.1, and 6.2) Chapter 8 (Section 8.1, Section 8.3 (8.3.1, and 8.3.2)
[3] Chapter 3 (Sections 3.2, and 3.4) Chapter 4 (Section 4.2)Chapter 4 (Sections 4.3, and 4.4)
[1] Chapter 18 (Sections 18.1 to 18.3)

Unit 2: Numerical differentiation**:** First and second order derivatives; Numerical integration**:** Trapezoid rule, Simpson's rule; Extrapolation methods**:** Richardson extrapolation, Romberg integration;Ordinary differential equation**:** Euler's method, Modified Euler's methods (Heun and Mid-point).
[2] Chapter 11 [Sections 11.1 (11.1.1, 11.1.2, 11.1.4), and 11.2 (11.2.1, 11.2.2, 11.2.4)]
[1] Chapter 22 (Sections 22.1, 22.2, 22.3)

Text Books:

1. Chapra, Steven C. (2018). *Applied Numerical Methods with* MATLAB *for Engineers and* Scientists (4th ed.). McGraw-Hill Education.

2. Fausett, Laurene V. (2009). *Applied Numerical Analysis Using* MATLAB. Pearson. India
3. Jain, M. K., Iyengar, S. R. K., & Jain R. K. (2012). *Numerical Methods for Scientific andEngineering Computation* (6th ed.). New Age International Publishers. Delhi.

SEMESTER-V

MAT-HC-5016: Riemann Integration and Metric spaces

Total Marks: 100: (Theory 80, Internal assessment 20)

Per week: 5 Lectures 1 Tutorial, Credits 6,*Each unit carry equal credit*

Course Objectives: To understand the integration of bounded functions on a closed and bounded interval and its extension to the cases where either the interval of integration is infinite, or the integrand has infinite limits at a finite number of points on the interval of integration. Up to this stage, students do study the concepts of analysis which evidently rely on the notion of distance. In this course, the objective is to develop the usual idea of distance into an abstract form on any set of objects, maintaining its inherent characteristics, and the resulting consequences.

Course Learning Outcomes: The course will enable the students to:
i) Learn about some of the classes and properties of Riemann integrable functions, and the applications of the Fundamental theorems of integration.
ii) Know about improper integrals including, beta and gamma functions.
iii) Learn various natural and abstract formulations of distance on the sets of usual or unusual entities. Become aware one such formulations leading to metric spaces.
iv) Analyse how a theory advances from a particular frame to a general frame.
v) Appreciate the mathematical understanding of various geometrical concepts, viz. Balls or connected sets etc. in an abstract setting.
vi) Know about Banach fixed point theorem, whose far-reaching consequences have resulted into an independent branch of study in analysis, known as fixed point theory.
vii) Learn about the two important topological properties, namely connectedness and compactness of metric spaces.

UNIT 1: Riemann integration: upper and lower sums; Darbouxintegrability, properties of integral, Fundamental theorem of calculus, mean value theorems for integrals, Riemann sum and Riemann integrability, Riemann integrability of monotone and continuous functions on intervals, sum of infinite series as Riemann integrals, logarithm and exponential functions through Riemann integrals, improper integrals, Gamma functions.
[1] Chapter 6

UNIT 2: Metric spaces: definition and examples, sequences in metric spaces, Cauchy sequences, complete metric spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantor's theorem. Subspaces, dense sets, separable spaces.
[2] Chapter 1 Sections 1.1-4, Chapter 2 Sections 2.1, 2.2

UNIT 3: Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, Banach contraction mapping principle. Connectedness, connected subsets of **R,** connectedness and continuous mappings.
[2] Chapter 3, Sections 3.1, 3.4, 3.5, 3.7 (up to 3.7.7), Chapter 4 Sections 4.1.

Text Books:

1. Ajit Kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, Indian Edn. 2014.
2. SatishShirali&Harikishan L. Vasudeva, Metric Spaces, Springer Verlag London (2006) (First Indian Reprint 2009)

Reference Books:

1. R.G. Bartle D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Charles G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.
3. S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011.
4. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.

MAT-HC-5026: Linear Algebra

Total Marks: 100: (Theory 80 Internal Assessment: 20)

Per week: 5 Lectures 1 Tutorial. Credits 6,*Each unit carry equal credit*

Course Objectives: The objective of this course is to introduce the fundamental theory of vector spaces, also emphasizes the application of techniques using the adjoint of a linear operator and their properties to least squares approximation and minimal solutions to systems of linear equations.

Course Learning Outcomes: The course will enable the students to:
i) Learn about the concept of linear independence of vectors over a field, and the dimension of a vector space.
ii) Basic concepts of linear transformations, dimension theorem, matrix representation of a linear transformation, and the change of coordinate matrix.
iii) Compute the characteristic polynomial, eigenvalues, eigenvectors, and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result.
iv) Compute inner products and determine orthogonality on vector spaces, including Gram−Schmidt orthogonalization to obtain orthonormal basis.
v) Find the adjoint, normal, unitary and orthogonal operators.

Unit 1: Vector spaces and subspaces, null space and column space of a matrix, linear transformations, kernel and range, linearly independent sets, bases, coordinate systems, dimension of a vector space, rank, change of basis.
[1]: Chapter 4 (Sections 4.1 – 4.7)

Unit 2: Eigenvectors and eigenvalues of a matrix, the characteristic equation, diagonalization, eigenvectors of a linear transformation, complex eigenvalues,
[1]: Chapter 4 (Sections 5.1 – 5.5)
Invariant subspaces and Cayley-Hamilton theorem.
[2]: Chapter 5 (Section 5.4)

Unit 3: Inner product, length, and orthogonality, orthogonal sets, orthogonal projections, the Gram–Schmidt process, inner product spaces; Diagonalization of symmetric matrices,the Spectral Theorem.
[1]: Chapter 6 (Sections 6.1 – 6.4, 6.7); Chapter 7 (Section 7.1)

Text Books:
1. David C. Lay, Linear Algebra and its Applications (3rd Edition), Pearson Education Asia, Indian Reprint, 2007.
2. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra* (4th Edition), Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.

Reference Books:
1. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India,1999.
2. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
3. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
4. G. Schay, Introduction to Linear Algebra, Narosa, 1997.

DISCIPLINE SPECIFIC ELECTIVE PAPERS

DSE-1

MAT-HE-5016: Number Theory

Total Marks: 100 (Theory 80 Internal assessment 20)
Per week: 5 lectures 1 Tutorial Credits 6,*Each unit carry equal credit*

Course Objectives: In number theory there are challenging open problems which are comprehensible at undergraduate level, this course is intended to build a micro aptitude of understanding aesthetic aspect of mathematical instructions and gear young minds to ponder upon such problems.

Course Learning Outcomes: This course will enable the students to:
i) Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc.
ii) Know about number theoretic functions and modular arithmetic.
iii) Solve linear, quadratic and system of linear congruence equations.

Unit 1: Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem.
[1] Chapter 2 (Section 2.5), [2] Chapter 2 (Section 2.2, 2.3), [1] Chapter 4 (Sections 4.2, 4.4), Chapter 5:Section 5.2

Unit 2: Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phifunction, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.
[1] Chapter 6 (Sections 6.1 to 6.2, 7.2, 7.3, and 7.4)

Text Books:

1. David M. Burton, *Elementary Number Theory,* 6th Ed., Tata McGrawHill, Indian reprint,2007.
2. G. A. JonesandJ. Mary Jones,*Elementary Number Theo*ry. Undergraduate Mathematics Series (SUMS). First Indian Print. 2005

Reference Books:

1. Neville Robinns, *Beginning Number Theory,* 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.
2. K. C. Chowdhury, A First Course in Number Theory, Asian Books Publications 2012

MAT-HE-5026: Mechanics

Total Marks: 100: (Theory 80, Internal assessment 20)
Per week: 5 Lectures 1 Tutorial, Credits 6(5+1) *Each unit carry equal credit*

Course Objectives: The course aims at understanding the various concepts of physical quantities and the related effects on different bodies using mathematical techniques. It emphasizes knowledge building for applying mathematics in physical world.

Course Learning Outcomes: The course will enable the students to:
i) Know about the concepts in statics such as moments, couples, equilibrium in both two and three dimensions.
ii) Understand the theory behind friction and center of gravity.
iii) Know about conservation of mechanical energy and work-energy equations.
iv) Learn about translational and rotational motion of rigid bodies.

UNIT 1: Composition and resolution of forces, Parallelogram of forces, Triangle of forces, Converse of triangle of forces, Lami's Theorem, Parallel forces, Moment of a force about a point and an axis. Couple, Resultant of a system of forces. Equilibrium of coplanar forces. Friction, C.G of an arc, plane area, surface of revolution, solid of revolution, Catenary.
[1] Chapter 1-9 related sections only

UNIT 2: Velocities and acceleration along radial and transverse directions and along tangential and normal directions, motion in a straight line under variable acceleration, simple harmonic motion and elastic string. Newton's law of motion. Work, Energy and momentum,Conservative forces-Potential energy, Impulsive forces, Motion in resisting medium.
[1] Vol-II Chapter I Sections 1.1, 1.2,1.3, Chapter –2 Sections 2.1,2.2, Chapter 3 Sections 3.1.3.2, Chapter 4 Sections 4.1, Chapter 5 Sections 5.1,5.3, Chapter 6 Sections 6.1,6.3.
[2] Chapter 3 (Sections: 3.1, 3.2, 3.3,3.4).

Text Book:

1. S. L. Loney, The elements of Statics and Dynamics (Vol I & II) PublisherArihant, 4th Edition 2014.
2. F. Chorlton, Textbook of Dynamics, CBS, Publications 2nd Edition, 1985

Reference books:

1. A.S. Ramsay, Statics, Cambridge University Press, publication year:2009
2. A.S. Ramsay, Dynamics, Cambridge University Press,publication year:2009
3. M. R. Spiegel, Theoretical Mechanics, SchaumSeries 2010.

MAT-HE-5036: Probability and Statistics

Total Marks: 100 (Theory: 80, Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial,**Credits**6,*Each unit carry equal credit*

Course Objectives: To make the students familiar with the basic statistical concepts and tools which are needed to study situations involving uncertainty or randomness. The course intends to render the students to several examples and exercises that blend their everyday experiences with their scientific interests.

Course Learning Outcomes: This course will enable the students to:
i) Learn about probability density and moment generating functions.
ii) Know about various univariate distributions such as Bernoulli, Binomial, Poisson, gamma and exponential distributions.
iii) Learn about distributions to study the joint behavior of two random variables.
iv) Measure the scale of association between two variables, and to establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.
v) Understand central limit theorem, which helps to understand the remarkable fact that**:** the empirical frequencies of so many natural populations, exhibit a bell-shaped curve, i.e., a normal distribution

UNIT-1: Sample space, Probability set function, Real random variables - Discrete and continuous,Cumulative distribution function, Probability mass/density functions, Transformations,Mathematical expectation, Moments, Moment generating function, Characteristic function.
[1] Chapter 1 (Sections 1.1, 1.3, 1.5,1.6 to 1.9)

UNIT-2: Discrete distributions**:** Uniform, Bernoulli, Binomial, Negative binomial, Geometric andPoisson; Continuous distributions**:** Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.
[2] Chapter 5 (Sections 5.2 to 5.4, Sections 5.5, and 5.7)
[2] Chapter 6 (Sections 6.2 to 6.4, Sections 6.5, and 6.6)

UNIT-3: Joint cumulative distribution function and its properties, Joint probability density function,Marginal

distributions, Expectation of function of two random variables, Joint momentgenerating function, Conditional distributions and expectations.
[1] Chapter 2 (Sections 2.1, and 2.3)

UNIT-4: The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers.
[1] Chapter 2 (Section 2.4, and Section 2.5), [2] Chapter 14 (Sections 14.1 to 14.3)
[2] Chapter 6 (Section 6.7), and Chapter 4 (Section 4.4), [3] Chapter 2 (Section 2.8, and Exercise 76, page 89)

Text Books:

1. Hogg, Robert V., McKean, Joseph W., & Craig, Allen T. (2013). *Introduction toMathematical Statistics* (7th ed.). Pearson Education, Inc.
2. Miller, Irwin & Miller, Marylees. (2014). John E. Freund's *Mathematical Statistics withApplications*(8th ed.). Pearson. Dorling Kindersley (India).
3. Ross, Sheldon M. (2014). *Introduction to Probability Models* (11th ed.). Elsevier Inc.

Reference Books:

1. Mood, A. M., Graybill, F. A. &Boes, D. C. (1974). *Introduction to the Theory ofStatistics*(3rd ed.). McGraw-Hill Education Pvt. Ltd. Indian Edition (2017)

DSE-2

MAT-HE-5046: Linear Programming

Total Marks: 100 (Theory: 80 Internal Assessment: 20)
Per week: 5 Lectures, 1 TutorialCredits: 6,*Each unit carry equal credit*

Course Objectives: This course develops the ideas underlying the Simplex Method for Linear Programming Problem, as an important branch of Operations Research. The course covers Linear rogramming with applications to transportation, assignment and game problem. Such problems arise in manufacturing resource planning and financial sectors.

Course Learning Outcomes: This course will enable the students to:
i) Learn about the graphical solution of linear programming problem with two variables.
ii) Learn about the relation between basic feasible solutions and extreme points.
iii) Understand the theory of the simplex method used to solve linear programming problems.
iv) Learn about two-phase and big-M methods to deal with problems involving artificial variables.
v) Learn about the relationships between the primal and dual problems.
vi) Solve transportation and assignment problems.
vii) Apply linear programming method to solve two-person zero-sum game problems.

Unit 1: The Linear Programming Problem**:** Standard, Canonical and matrix forms, Graphical solution. Hyperplanes, Extreme points, Convex and polyhedral sets. Basic solutions; Basic Feasible Solutions; Reduction of any feasible solution to a basic feasible solution; Correspondence between basic feasible solutions and extreme points.
[1] Chapter 1 (Section 1.1, 1.4, and 1.6)
[2] Chapter 2 (Sections 2.16, 2.19, and 2.20), and Chapter 3 (Sections 3,2, 3.4, and 3.10)

Unit 2: Simplex Method**:** Optimal solution, Termination criteria for optimal solution of the Linear Programming Problem, Unique and alternate optimal solutions, Unboundedness; Simplex Algorithm and its Tableau Format; Artificial variables, Two-phase method, Big-M method.
[1] Chapter 3 (Sections 3.3, and 3.6, 3.7, and 3.8)

Unit 3: Motivation and Formulation of Dual problem; Primal-Dual relationships; Fundamental Theorem of Duality; Complimentary Slackness.
[1] Chapter 4 (Sections 4.1 to 4.3)
[1] Chapter 6 (Section 6.1, and 6.2, up to Example 6.4)

Unit 4: Applications
*Transportation Problem***:** Definition and formulation; Methods of finding initial basic feasible solutions; North West corner rule. Least cost method; Vogel's Approximation method; Algorithm for solving Transportation Problem.
*Assignment Problem***:** Mathematical formulation and Hungarian method of solving.
*Game Theory***:** Basic concept, Formulation and solution of two-person zero-sum games, Games with mixed strategies, Linear Programming method of solving a game.
[3] Chapter 5 (Sections 5.1, 5.3, and 5.4)
[2] Chapter 11 (Sections 11.12, and 11.13)

Text Books:

1. Bazaraa, Mokhtar S., Jarvis, John J. and Sherali, HanifD. (2010). *Linear Programmingand Network Flows* (4th ed.). John Wiley and Sons.
2. Hadley, G. (1997). *Linear Programming*. Narosa Publishing House. New Delhi.
3. Taha, Hamdy A. (2010). *Operations Research*: *An Introduction* (9th ed.). Pearson.

Reference Books:

1. Hillier, Frederick S. & Lieberman, Gerald J. (2015). *Introduction to Operations Research* (10th ed.). McGraw-Hill Education (India) Pvt. Ltd.
2. Thie, Paul R., &Keough, G. E. (2014). *An Introduction to Linear Programming andGame Theory*. (3rd ed.). Wiley India Pvt. Ltd.

MAT-HE-5056: Spherical Trigonometry and Astronomy

TotalMarks: 100 (Theory 80, Internal Assessment 20)
Per week: 5 Lecture Tutorial 1, Credits 6,*Each unit carry equal credit*

Course Objectives: This main objective of this course is to provide the spherical triangles, Napier's rule of circular parts and Planetary motion

Course Learning Outcomes: This course will enable the students to:
i) Learn about the properties of spherical and polar triangles
ii) know about fundamental formulae of spherical triangles
iii) learn about the celestial sphere, circumpolar star, rate of change of zenith distance and azimuth
iv) learn about Keplar's law of planetary motion, Cassini's hypothesis, differential equation for fraction

Unit1:Section of a sphere by a plane, spherical triangles, properties of spherical and polar triangles, fundamental formulae of spherical triangles, sine formula, cosine formula, sine-cosine formula, cot formula, Napier's rule of circular parts.
[1] Chapter 1: Sections: 1-8, 16

Unit2: The standard (or geometric) celestial sphere, system of coordinates, conversion of one coordinate system to the another system, diurnal motion of heavenly bodies, sidereal time, solar time(mean), rising and setting of stars, circumpolar star, dip of the horizon, rate of change of zenith distance and azimuth, examples.
[1] Chapter 2 Sections 18,19,22,27

Unit3: Planetary motion: annual motion of the sun, planetary motion, synodic period, orbital period, Keplar's law of planetary motion, deduction of Keplar's law from Newton's law of gravitation, the equation of the orbit, velocity of a planet in its orbit,components of linear velocity perpendicular to the radius vector and to the major axis, direct and retrograde motion in a plane, laws of refraction: refraction for small zenith distance, general

formula for refraction, Cassini's hypothesis, differential equation for fraction, effect of refraction on sunrise, sunset, right ascension and declination, shape of the disc of the sun.
[1] Chapter 5 Sections 57-59,64-69, 74, 81-83

Text Book:

1. W.M. Smart and R. M. Green Spherical Astronomy.Cambridge University Press; 6 edition, 1977.

Reference Books:

1. Sir Robert Ball, Spherical Astronomy, Publisher: Forgotten Books 2018
2. Br Nnow Franz, Brunnow Franz, Spherical Astronomy Publisher: BiblioLife, Aug 2009.

MAT-HE-5066: Programming in C (including practical)

Total Marks: 100 (Theory 60, Practical 20, Internal Assessment 20)
Per week: 4 Lectures 2 Tutorial, Credits 6(4+2) *Each unit carry equal credit*

Course Objectives: This course introduces C programming in the idiom and context of mathematics and imparts a starting orientation using available mathematical libraries, and their applications.

Course Learning Outcomes: After completion of this paper, student will be able to:
i) Understand and apply the programming concepts of C which is important to mathematical investigation and problem solving.
ii) Learn about structured data-types in C and learn about applications in factorization of an integer and understanding Cartesian geometry and Pythagorean triples.
iii) Use of containers and templates in various applications in algebra.
iv) Use mathematical libraries for computational objectives.
v) Represent the outputs of programs visually in terms of well formatted text and plots.

Unit 1: Variables, constants, reserved words, variable declaration, initialization, basic data types, operators and expression (arithmetic, relational, logical, assignment, conditional, increment and decrement), hierarchy of operations for arithmetic operators, size of and comma operator, mixed mode operation and automatic (implicit) conversion, cast (explicit) conversion, library functions, structure of a C program, input/output functions and statements.

Unit 2:Control Statements: if-else statement (including nested if-else statement), switch statement.
Loop control Structures (for and nested for, while and do-while). Break, continue, go to statements, exit function.

Unit 3: Arrays and subscripted variables: One and Two dimensional array declaration, accessing values in an array, initializing values in an array, sorting of numbers in an array, addition and multiplication of matrices with the help of array.
Functions: function declaration, actual and formal arguments, function prototype, calling a function by value, recursive function.

Programmes for practical:
To find roots of a quadratic equation, value of a piecewise defined function (single variable), factorial of a given positive integer, Fibonacci numbers, square root of a number, cube root of a number, sum of different algebraic and trigonometric series, a given number to be prime or not, sum of the digits of any given positive integer, solution of an equation using N-R algorithm, reversing digits of an integer. Sorting of numbers in an array, to find addition, subtraction and multiplication of matrices. To find sin(x), cos(x) with the help of functions.
[1] Chapters 3, 4, 5, 6, 7 and 9

Text Book:

1. T. Jeyapoovan, A First Course in Programming with C T. Jeyapoovan, Vikash Publishing House Pvt.Ltd.

Reference books:

1. E. Balaguruswamy, Programming with C, Schaum Series.
2. Y. Kanetkar, *Let us C*, B.P. Publication.

SEMESTER-VI

MAT-HC-6016: Complex Analysis (including practical)

Total marks: 100: (Theory: 60, Practical 20, Internal Assessment: 20)

Per week: 4 Lectures, Practical 2, Credits 6(4+2)*Each unit carry equal credit*

Course Objectives: This course aims to introduce the basic ideas of analysis for complex functions with visualization through relevant practicals. Emphasis has been given on Cauchy's theorems, series expansions and calculation of residues.

Course Learning Outcomes: Completion of the course will enable the students to:

i) Learn the significance of differentiability of complex functions leading to the understanding of Cauchy−Riemann equations.

ii) Learn some elementary functions and can evaluate the contour integrals.

iii) Understand the role of Cauchy−Goursat theorem and the Cauchy integral formula.

iv) Expand some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.

UNIT 1: Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. Limits, Limits involving the point at infinity, continuity.

[1]: Chapter 1 (Section 11), Chapter 2 (Section 12, 13) Chapter 2 (Sections 15, 16, 17, 18, 19, 20, 21, 22)

UNIT 2: Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions.

[1]: Chapter 2 (Sections 24, 25), Chapter 3 (Sections 29, 30, 34),Chapter 4 (Section 37, 38)

UNIT 3: Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals.

[1]: Chapter 4 (Section 39, 40, 41, 43)

UNIT 4: Antiderivatives, proof of antiderivative theorem, Cauchy-Goursat theorem, Cauchy integral formula. Liouville's theorem and the fundamental theorem of algebra.

[1]: Chapter 4 (Sections 44, 45, 46, 50), Chapter 4 (Sections 51, 52, 53)

Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series.

[1]: Chapter 5 (Sections 55, 56, 57, 58, 59, 60, 62, 63, 66)

LAB WORK TO BE PERFORMED ON A COMPUTER

(MODELING OF THE FOLLOWING PROBLEMS USING MATLAB/ MATHEMATICA/ MAPLE ETC.)

1. Declaring a complex number and graphical representation. e.g. $Z_1 = 3 + 4i$, $Z_2 = 4 - 7i$
2. Program to discuss the algebra of complex numbers, e.g.,
   $Z_1 = 3 + 4i$, $Z_2 = 4 - 7i$, then find $Z_1 + Z_2$, $Z_1 - Z_2$, $Z_1 * Z_2$ and Z_1 / Z_2
3. To find conjugate, modulus and phase angle of an array of complex numbers. e.g.
   Z = [2+ 3i, 4-2i, 6+11i, 2-5i]
4. To compute the integral over a straight line path between the two specified end points.

e. g.,$\oint$ Sin$z\ dz$, along the contour C which is a straight line path from -1+ i to 2 - i.

5. To perform contour integration., e.g.,
   (i) $\oint(z^2 - 2z + 1)dz$along the Contour C given by x = y^2 +1; − 2 ≤ y ≤ 2 .
   (ii) $\oint(z^3 + 2z^2 + 1)dz$ along the contour C given by $x^2 + y^2 = 1$, which can be
   (iii) parameterized by x = cos (t), y = sin (t) for 0 ≤ y ≤ 2π.
6. To plot the complex functions and analyze the graph. e.g.,
   (i) f(z) = z, iz, z^2, z^3, e^z and $(z^4-1)^{1/4}$, etc.
7. To perform the Taylor series expansion of a given function f(z) around a given point z. The number of terms that should be used in the Taylor series expansion is given for each function. Hence plot the magnitude of the function and magnitude of its Taylors series expansion, e.g.,
   (i) f(z) = exp(z) around z = 0, n =40 and
   (i) f(z) = exp(z^2) around z = 0, n = 160.
8. To determines how many terms should be used in the Taylor series expansion of a given function f(z) around z = 0 for a specific value of z to get a percentage error of less than 5%. e.g., for f(z) = exp(z) around z =0, execute and determine the number of necessary terms to get a percentage error of less than 5 % for the following values of z:
   (i) z = 30 + 30i (ii) z = 10 +103 i
9. To perform Laurents series expansion of a given function f(z) around a given point z. e.g., (i) f(z)= (sin z -1)/z^4 around z = 0 (ii) f(z) = cot (z)/z^4 around z = 0.

Text Book:

1. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications (Eighth Edition), McGraw – Hill International Edition, 2009.

Reference Book:

1. Joseph Bak and Donald J. Newman, *Complex analysis* (2nd Edition), Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

MAT-HC-6026: Partial Differential Equations (including practical)

Total marks: 100: (Theory: 60, Practical 20, Internal Assessment: 20)

Per week: 4 Lectures, 2 Practical, Credits 6(4+2), *Each unit carry equal credit*

Course Objectives: The main objectives of this course are to teach students to form and solve partial differential equations and use them in solving some physical problems.

Course Learning Outcomes: The course will enable the students to:
i) Formulate, classify and transform first order PDEs into canonical form.
ii) Learn about method of characteristics and separation of variables to solve first order PDE's.
iii) Classify and solve second order linear PDEs.
iv) Learn about Cauchy problem for second order PDE and homogeneous as well as nonhomogeneous wave equations.
v) Apply the method of separation of variables for solving second order PDEs.

Unit 1: Introduction, Classification, Construction of first order partial differential equations (PDE). Cauchy's problem for first order equations, linear equations of the first order, Integral surfaces passing through a given curve, Nonlinear partial differential equations of the first order, Cauchy's method of characteristics, Charpit's method. Solutions satisfying given conditions, Jocobi's method.
[1] Chapter 2 (Sections 2.1 to 2.3), [2] Chapter 2 (Section 3, 4,5, 7,8,10,12, 13)

Unit 2: Canonical form of first order PDE, Method of separation of variables for first order PDE.
[1] Chapter 2 (Sections 2.6 and 2.7)

Unit 3: Reduction to canonical forms, Equations with constant coefficients, General solution.
[1] Chapter 4 (Sections 4.1 to 4.5), [2] Chapter 3 (Sections 4, 5)

Practical /Lab work to be performed in a Computer Lab:
Modelling of the following similar problems using Mathematica /MATLAB/ Maple/ Maxima/ Scilab etc.

1. Solution of Cauchy problem for first order PDE.
2. Plotting the characteristics for the first order PDE.
3. Plot the integral surfaces of a given first order PDE with initial data.
4. Solution of wave equation $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$ for any two of the following associated conditions:

(a) $u(x,0) = \phi(x);\ u(x,0) = \psi(x), x \in R; t > 0$

(b) $u(x,0) = \phi(x);\ u_t(x,0) = \psi(x);\ \ u(0,t) = 0, x > 0; t > 0$

(c) $u(x,0) = \phi(x);\ u_t(x,0) = \psi(x);\ \ u_x(0,t) = 0, x > 0; t > 0$

(d) $u(x,0) = \phi(x);\ u_t(x,0) = \psi(x);\ \ u(0,t) = 0, u(l,t) = 0; x > 0; t > 0$

5. Solving systems of ordinary differential equations.
6. Solution of one-Dimensional heat equation $u_t = k\, u_{xx}$, for a homogeneous rod of length l.
   That is - solve the IBVP:

$$\begin{gathered} u_t = k\, u_{xx}, \qquad 0 < x < l, \qquad t > 0 \\ u(0,t) = 0, \qquad u(l,t) = 0, \qquad t \geq 0 \\ u(0,t) = f(x), \quad 0 \leq x \leq l \end{gathered}$$

Text Book:

1. TynMyint-U and LokenathDebnath**,** *Linear Partial Differential Equation for Scientists and Engineers*, Springer, Indian reprint, 2006.
2. Sneddon, I. N. (2006). *Elements of Partial Differential Equations*, Dover Publications. Indian Reprint.

Reference Book:

1. Stavroulakis, Ioannis P &Tersian, Stepan A. (2004). *Partial Differential Equations*: *An Introduction with Mathematica and* MAPLE (2nd ed.). World Scientific.

DISCIPLIN ESPECIFIC PAPERS

DSE-3

MAT-HE-6016: Boolean Algebra and Automata Theory

Total Marks: 100 (Theory 80 Internal Assessment 20)
Per week 5 Lectures, Tutorial 1, Credits 6,*Each unit carry equal credit*

Course Objectives: This course aims to introduce the basic ideas and properties of ordered sets, Lattices, Boolean algebra and automata theory.

Course Learning Outcomes: The course will enable the students to:
i) Learn about the order isomorphism, Hasse diagrams, building new ordered set.
ii) Learn about the algebraic structure lattices, properties of modular and distributive lattices.
iii) Get ideas about the Boolean algebra, Switching circuits and applications of switching circuits.
iv) Appreciate the theory of automata and its applications

Unit 1: Ordered Sets
Definitions, Examples and basic properties of ordered sets, Order isomorphism, Hasse diagrams, Dual of an ordered set, Duality principle, Maximal and minimal elements, Building new ordered sets, Maps between ordered sets.
[1] Chapter 1 (Sections 1.1 to 1.5 and 1.14 to 1.26, and 1.34 to 1.36), [3] Chapter 1 [Section 1 (1.1 to 1.3)]

Unit 2: Lattices
Lattices as ordered sets, Lattices as algebraic structures, Sublattices, Products and homomorphisms; Definitions, Examples and properties of modular and distributive lattices, The M3 – N5 Theorem with applications, Complemented lattice, Relatively complemented lattice, Sectionally complemented lattice homomorphisms.
[1] Chapter 2 (Sections 2.1 to 2.19) Chapter 4 (Sections 4.1 to 4.9) (Sections 4.10, and 4.11)
[3] Chapter 1 [Section 1 (1.5 to 1.20)] Chapter 1 [Section 2 (2.1 to 2.6) Chapter 1 [Section 2 (2.7 to 2.14)]

Unit 3: Boolean Algebras and Switching Circuits
Boolean Algebras, De Morgan's laws, Boolean homomorphism, Representation theorem; Boolean polynomials, Boolean polynomial functions, Disjunctive normal form and conjunctive normal form, Minimal forms of Boolean polynomial, Quinn-McCluskey method, Karnaugh diagrams, Switching circuits and applications of switching circuits.
[3] Chapter 1 (Sections 3, and 4) Chapter 1 (Section 6) Chapter 2 (Sections 7, and 8).

Unit 4: Introduction: Alphabets, strings, and languages. Finite Automata and Regular Languages: deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages.
[4] Chapter 1, 2,3,4
Context Free Grammars and Pushdown Automata: Context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA, Non- deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties.
[4] Chapter 5

Text Books:

1. Davey, B. A., & Priestley, H. A. (2002). *Introduction to Lattices and Order* (2nd ed.). Cambridge University press, Cambridge
2. Goodaire, Edgar G. andParmenter, Michael M. (2011). *Discrete Mathematics with Graph Theory* (3rd ed.). Pearson Education (Singapore) Pvt. Ltd. Indian Reprint.
3. Lidl, Rudolf and Pilz, Gunter. (2004). *Applied Abstract Algebra* (2nd ed.), Undergraduate Texts in Mathematics. Springer (SIE). Indian Reprint.
4. J.E. Hopcroft, R. Motwani and J. D. Ullman, *Introduction to Automata Theory, Languages, and Computation,* 2nd Ed., Addison-Wesley, 2001.

Reference Books:

1. H.R. Lewis, C.H. Papadimitriou, C. Papadimitriou, *Elements of the Theory of Computation*, 2nd Ed., Prentice-Hall, NJ, 1997.
2. J.A. Anderson, *Automata Theory with Modern Applications*, Cambridge University Press, 2006.

MAT-HE-6026: Bio-Mathematics

Total Marks: 100 (Theory: 80, Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial Credits: 6,*Each unit carry equal credit*

Course Objectives: The focus of the course is on scientific study of normal functions related to living systems. The emphasis is on exposure to nonlinear differential equations with examples such as heartbeat, chemical reactions and nerve impulse transmission. The basic concepts of the probability to understand molecular evolution and genetics have also been applied.

Course Learning outcomes: Apropos conclusion of the course will empower the student to:
i) Learn the development, analysis and interpretation of bio mathematical models such as population growth, cell division, and predator-prey models.
ii) Learn about the mathematics behind heartbeat model and nerve impulse transmission model.
iii) Appreciate the theory of bifurcation and chaos.
iv) Learn to apply the basic concepts of probability to molecular evolution and genetics.

Unit 1: Basic concepts and definitions, Mathematical model, properly posed mathematical problems, System of differential equation, Existence theorems, Homogeneous linear systems, Non-homogeneous linear systems, Linear systems with constant coefficients, Eigenvalues and eigenvectors, Linear equation with periodic coefficients. Population growth model, administration of drug and epidemics, Cell division Predator Prey Model, Chemical reactions and enzymatic catalysis.
[4] Chapter 1 and Chapter 5 [2] Chapter 1 (Sections 1.1 to 1.3), Chapter 4 (Sections 4.4 to 4.5)

Unit 2: Stability and Modeling of Biological phenomenon
The Phase Plane, Local Stability, Autonomous Systems, Stability of Linear Autonomous Systems with Constant Coefficients, Linear Plane Autonomous Systems, Method of Lyapunov for Non–Linear Systems, Limit Cycles, Forced Oscillations. Mathematics of Heart Physiology**:** The local model, The Threshold effect, The phase plane analysis and the Heart beat model, Physiological considerations of the Heart beat model, A model of the Cardiac pace-maker. Mathematics of Nerve impulse transmission**:** Excitability & repetitive firing, Travelling waves.
[4] Chapter 8 (Sections 8.1 to 8.6)
[2] Chapter 4 (Sections 4.1 to 4.3), Chapter 5 (Sections 5.1 and 5.7), Chapter 6 (Sections 6.4 and 6.5), Chapter 7 (Sections 7.1 and 7.3)

Unit 3: Bifurcation and Chaos
Bifurcation and chaos**:** Bifurcation, Bifurcation of a limit cycle, Discrete bifurcation, Chaos, Stability, The Poincare plane.
[2] Chapter 13 (Sections 13.1 to 13.4)

Unit 4: Modelling Molecular Evolution and Genetics
ModellingMolecularEvolution**:** Matrixmodels of base substitutionsfor DNAsequences, The Jukes-Cantor Model, the Kimura Models, Phylogeneticdistances.
Constructing Phylogenetictrees**:**Unweightedpair-groupmethodwitharithmeticmeans (UPGMA), Neighbour-Joining Method, Maximum Likelihood approaches.
Genetics**:**Mendelian Genetics, Probability distributions in Genetics, Linked genes and Genetic Mapping, Statistical Methods and Prediction techniques.
[1] Chapter 4 (Sections 4.4 and 4.5), Chapter 5 (Section 5.1 to 5.3), Chapter 6 (Sections 6.1 and 6.2)

Text Books:

1. Allman, Elizabeth S., & Rhodes, John A . (2004). *Mathematical Models in Biology*. Cambridge University Press.
2. Jones, D. S., & Sleeman B. D. (2003). *Differential Equations and Mathematical Biology,* Chapman & Hall, CRC Press, London, UK.
3. Murray, J. D.(2002). *An Introduction to Mathematical Biology*. Springer.
4. Myint, Tyn– I. (1977). *Ordinary Differential Equation*. Elsevier Science Ltd.

5. Simmons, G. F.,& Krant, S. G. (2015). *Differential Equations*. McGraw Hill Education.
6. Strogatz, Steven H. (1994). *Nonlinear Dynamics and Chaos*. Perseus Book Publishing. LLC.

MAT-HE-6036: Mathematical Modelling (including practical)

Total Marks: 100 (Theory: 60, Practical 20, Internal Assessment: 20)

Per week: 4 Lectures, 2 practical Credits: 6 (4+2)*Each unit carry equal credit*

Course Objectives: The main objective of this course is to teach students how to model physical problems using differential equations and solve them. Also, the use of Computer Algebra Systems (CAS) by which the listed problems can be solved both numerically and analytically.

Course Learning Outcomes: The course will enable the students to:
i) Know about power series solution of a differential equation and learn about Legendre's and Bessel's equations.
ii) Use of Laplace transform and inverse transform for solving initial value problems.
iii) Learn about various models such as Monte Carlo simulation models, queuing models, and linear programming models.

Unit 1: Power series solution of a differential equation about an ordinary point, Solution about a regular singular point, The method of Frobenius; Legendre's and Bessel's equation.
[1] Chapter 8 (Sections 8.1 to 8.3, Section 8.5 up to Equation (19), page 551)

Unit 2: Laplace transform and inverse transform, application to initial value problem up to second order.
[1] Chapter 7 (Sections 7.1 to 7.3)

Unit 3: Monte Carlo Simulation Modelling**:** Simulating deterministic behaviour (area under a curve, volume under a surface); Generating Random Numbers**:** Middle square method, Linear congruence; Queuing Models**:** Harbor system, Morning rush hour.
[2] Chapter 5 (Sections 5.1 to 5.2, and 5.5), Chapter 7

Practical / Lab work to be performed in Computer Lab:
Modelling of the following problems using Mathematica/MATLAB/Maple /Maxima/Scilab etc.

(i) Plotting of Legendre polynomial for $n = 1$ to 5 in the interval [0, 1]. Verifying graphically that all the roots of $P_n(x)$ lie in the interval [0, 1].
(ii) Automatic computation of coefficients in the series solution near ordinary points.
(iii) Plotting of the Bessel's function of first kind of order 0 to 3.
(iv) Automating the Frobenius Series Method.
(v) Random number generation and then use it for one of the following: (a) Simulate area under a curve. (b) Simulate volume under a surface.
(vi) Programming of either one of the queuing model:
(a) Single server queue (e.g. Harbor system). (b) Multiple server queue (e.g. Rush hour).
(vii) Programming of the Simplex method for 2 / 3 variables

Text Books:
1. Edwards, C. Henry, Penney, David E., & Calvis, David T. (2015). *Differential Equation and Boundary Value Problems*: *Computing and Modeling* (5th ed.). Pearson.
2. Giordano, Frank R., Fox, William P., & Horton, Steven B. (2014). *A First Course in Mathematical Modeling* (5th ed.). Brooks/Cole, Cengage Learning.

MAT-HE-6046: Hydromechanics

Total Marks: 100: (Theory 80 Internal assessment: 20)

Per week: 5 Lectures, 1 Tutorial, Credits 6, *Each unit carry equal credit*

Course Objectives: The main objectives of this course are to teach students about fluid pressure on plane surfaces, curved surfaces and Gas law. Also, introduces velocity of a fluid at a point, Eulerian and Lagrangian method, velocity potential and acceleration of a fluid at a point.

Course Learning Outcomes: The course will enable the students to:

i) Know about Pressure equation, rotating fluids.

ii) Learn about Fluid pressure on plane surfaces, resultant pressure on curved surfaces, Gas law, mixture of gases

iii) Learn about the Eulerian and Lagrangian method.

iv) Learn about equation of continuity, examples, acceleration of a fluid at a point

Unit 1: Hydrostatics

Pressure equation, condition of equilibrium, lines of force, homogeneous and heterogeneous fluids, elastic fluids, surface of equal pressure, fluid at rest under action of gravity, rotating fluids. Fluid pressure on plane surfaces, centre of pressure, resultant pressure on curved surfaces. Gas law, mixture of gases, internal energy, adiabatic expansion.

[1] Voll-I Chapter 1-4(related sections only)

Unit 2 Hydrodynamics

Real and ideal fluid, velocity of a fluid at a point, Eulerian and Lagrangian method, stream lines and path lines, steady and unsteady flows, velocity potential, rotational and irrotational motions, material local, convective derivatives, local and particle rate of change, equation of continuity, examples, acceleration of a fluid at a point.

[1] Vol-II Chapter 1

Text Book:

1. Besant, W. H., Ramsey, A. S., *A Treatise on Hydromechanics*. (part I & part II), G.Bell And Sons Limited. CBS Publication 1988(Indian print).

Reference Books:

1. H. Lamb, Hydrodynamics, University Press
2. F.Chorlton, Fluid dynamics, CBS Publisher First Edition 1985

DSE-4

MAT-HE-6056: Rigid Dynamics

Total Marks 100(Theory80 Internal assessment20)

Per week: 5 Lectures1 Tutorial, Credits 6, *Each unit carry equal credit*

Course Objectives: The main objectives of this course is to introduce moments and products of inertia, theorem of six constants, D'Alembert's principle, Motion of a body in two dimension and Lagrange's equations.

Course Learning Outcomes: The course will enable the students to:

i) Know how to find the moments and products of inertia.

ii) Learn about the motion of the centre of inertia

iii) Learn about the D'Alembert's principle and Lagrange's equations

iv) Learn about motion of a body in two dimension

Unit1: Moments and products of inertia, parallel axes theorem, theorem of six constants, the momental ellipsoid, equimomental systems, principle axes.
Unit2: D'Alembert's principle, the general equation of motion of a rigid body, motion of the centre of inertia and motion relative to the centre of inertia.
Unit3: Motion about a fixed axis, the compound pendulum, centre of percussion. Motion of a body in two dimension under finite and impulsive forces.
Unit4: Conservation of momentum and energy, generalized coordinates, Lagrange's equations, initial motions.
[1] Chapter -11-18 (related sections only)

Text Book:

1. S.L. Loney, An elementary treatise on the Dynamics of a particle and of Rigid bodies, Cambridge University Press Kindle Edition August 2018.

Reference Book:

1. A.S. Ramsey, Dynamics PartI, Cambridge University Press; 1 edition, 1952.

MAT-HE-6066: Group Theory II

Total Marks: 100 (Theory: 80, Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial, Credits: 6,*Each unit carry equal credit*

Course Objectives: The course will develop an indepth understanding of one of the most important branch of the abstract algebra with applications to practical real-world problems. Classification of all finite abelian groups (up to isomorphism) can be done.

Course Learning Outcomes: The course shall enable students to:
i) Learn about automorphisms for constructing new groups from the given group.
ii) Learn about the fact that external direct product applies to data security and electric circuits.
iii) Understand fundamental theorem of finite abelian groups.
iv) Be familiar with group actions and conjugacy in S_n.
v) Understand Sylow theorems and their applications in checking non-simplicity.

Unit 1: Isomorphismsm, automorphisms, inner automorphisms, Automorphisms groups; External direct products of groups and their properties; the group of units modulo *n* as an external direct product
[1] Chapter 6 Chapter 8

Unit 2: Normal subgroups, factor groups and their applications, Internal direct products, of subgroups, Fundamental theorem of finite Abelian groups, isomorphism classes of finite abelian groups.
[1] Chapter 9 Chapter 11 (with proof of Fundamental theorem)

Unit 3: Conjugacy classes, The class equation, Conjugacy classes in the symmetric group S_n, *p*-groups, The Sylow theorems and their applications.
[1] Chapter 24, [2] Chapter 4 [Section 4.3(Pages 125-126,Ex 2-12)]

Unit 4: Finite simple groups, nonsimplicity tests; Generalized Cayley's theorem, Index theorem, Embedding theorem and applications. Simplicity of $A_{5.}$
[1] Chapter 25

Text Books:

1. Gallian, Joseph. A. (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited. Delhi. Fourth impression, 2015.
2. Dummit, David S., & Foote, Richard M. (2016). *Abstract Algebra* (3rd ed.). Student Edition. Wiley India.

Reference Book:

1. Joseph J. Rotman, (1995). *An Introduction to The Theory of Groups* (4th ed.). Springer Verlag, New York.
2. John B. Fraleigh (2002), A First Course in Abstract Algebra, 7th Ed., Pearson.
3. G. Santhanam (2017), Algebra, Narosa Publishing House.

MAT-HE-6076: Mathematical Finance

Total Marks: 100 (Theory: 80, Internal Assessment: 20)

Per week: 5 Lectures, 1 Tutorial Credits: 6,*Each unit carry equal credit*

Course Objectives: This course is an introduction to the application of mathematics in financial world, that enables the student to understand some computational and quantitative techniques required for working in the financial markets and actuarial mathematics.

Course Learning outcomes: On completion of this course, the student will be able to:
i) Know the basics of financial markets and derivatives including options and futures.
ii) Learn about pricing and hedging of options, as well as interest rate swaps.
iii) Learn about no-arbitrage pricing concept and types of options.
iv) Learn stochastic analysis (Ito formula, Ito integration) and the Black−Scholes model.
v) Understand the concepts of trading strategies and valuation of currency swaps.

Unit 1: Interest Rates: Types of rates, Measuring interest rates, Zero rates, Bond pricing, Forward rate,Duration, Convexity, Exchange traded markets and OTC markets, Derivatives--Forward contracts, Futures contract, Options, Types of traders, Hedging, Speculation, Arbitrage.
[1] Chapter 4 (Section 4.1 to 4.4, 4.6, 4.8, and 4.9) Chapter 1 (Sections 1.1 to 1.9)

Unit 2: Mechanics and Properties of Options: No Arbitrage principle, Short selling, Forward price for an investment asset, Types of Options,Option positions, Underlying assets, Factors affecting option prices, Bounds on option prices,Put-call parity, Early exercise, Effect of dividends.
[1] Chapter 5 (Sections 5.2 to 5.4), Chapter 8 (Sections 8.1 to 8.3), Chapter 9 (Section 9.1,Sections 9.2 to 9.7)

Unit 3: Stochastic Analysis of Stock Prices and Black-Scholes Model
Binomial option pricing model, Risk neutral valuation (for European and American options on assets following binomial tree model), Lognormal property of stock prices, Distribution of rate of return, expected return, Volatility, estimating volatility from historical data, Extension of risk neutral valuation to assets following GBM, Black-Scholes formula for European options.
[1] Chapter 11 (Sections 11.1 to 11.5) Chapter 13 (Sections 13.1 to 13.4, 13.7, and 13.8)

Unit 4: Hedging Parameters, Trading Strategies and Swaps
Hedging parameters (the Greeks: Delta, Gamma, Theta, Rho and Vega), Trading strategies involving options, Swaps, Mechanics of interest rate swaps, Comparative advantage argument, Valuation of interest rate swaps, Currency swaps, Valuation of currency swaps.
[1] Chapter 17 (Sections 17.1 to 17.9) Chapter 10 (except box spreads, calendar spreads and diagonal spreads) Chapter 7 (Sections 7.1 to 7.4, and 7.7 to 7.9)

Text Book:

1. Hull, J. C., &Basu, S. (2010). *Options, Futures and Other Derivatives* (7th ed.). Pearson Education. New Delhi.

Reference Books:

1. Luenberger, David G. (1998). *Investment Science*, Oxford University Press. Delhi.
2. Ross, Sheldon M. (2011). *An elementary Introduction to Mathematical Finance* (3rd ed.). Cambridge University Press. USA.

Syllabus

Mathematics (Regular)

Version 2

submitted to

Gauhati University

under the

Choice Based Credit System

By

Department of Mathematics

Gauhati University

“This is approved in the Academic Council held on 08/11/2019”

Credits allocation for the Regular courses:

Course	***Credits**	***Credits**
Theory + Practical	**Theory + Tutorial**	**Theory + Practical**
I. Core Course (6 Credits)		
(12 Papers)	12×4= 48	12×5=60
04 Courses from each of the 03 disciplines of choice		
Core Course Practical / Tutorial*		
(**12** Practical/Tutorials*)	12×2=24	12×1=12
04 Courses from each of the 03 disciplines of choice		
II. Elective Course (6 Credits)		
(6 Papers)	6×4=24	6×5=30
Two papers from each discipline of choice including paper of interdisciplinary nature		
Elective Course Practical / Tutorial*	6 × 2=12	6×1=6
Two papers from each discipline of choice including paper of interdisciplinary nature		
Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester		
III. Ability Enhancement Courses		
1. **Ability Enhancement Compulsory Courses (AECC) (2 Papers of 4 credit each)**	2 × 4=8	2 × 4=8
Environmental Science		
English Communication		
2. **Skill Enhancement Courses (SEC) (4 Papers of 4 credit each)**	4 × 4=16	4× 4=16
Total credit	**132**	**132**

* wherever there is a practical there will be no tutorial and vice-versa

CBCS Course Structure for Under -Graduate BA, BSc, BCom Programme (Regular)
SEMESTER WISE PLACEMENT OF THE COURSES

Semester	**Core Course (12)**	**Ability Enhancement Compulsory Course (AECC)(2)**	**SkillEnhancement Course (SEC)(4)**	**Discipline Specific Elective (DSE)(6)**
I	**MAT-RC-1016: Calculus**	**ENG-AE-1014**		
II	**MAT-RC-2016: Algebra**	**ENV-AE-2014**		
III	**MAT-RC-3016: Differential Equations**		**SEC-1** **MAT-SE-3014:** Computer Algebra Systems and Related Software	
IV	**MAT-RC-4016: Real Analysis**		**SEC-2** **MAT-SE-4014:** R Programming	
V			**SEC-3** **MAT-SE-5014:** Combinatorics and Graph Theory	**DSE-1** **MAT-RE-5016:** Number Theory **MAT-RE-5026:** Discrete Mathematics
VI			**SEC-4** **MAT-SE-6014:** LaTeX and HTML	**DSE-2** **MAT-RE-6016:** Numerical Analysis **MAT-RE-6026:** Programming in C

Legends:

RC: Regular Core
RE: Regular Discipline Specific Elective
SE: Skill Enhancement Course

Core papers (Mathematics):

1. MAT-RC-1016: Calculus
2. MAT-RC-2016: Algebra
3. MAT-RC-3016: Differential Equations
4. MAT-RC-4016: Real Analysis

Skill Enhancement Course (SEC) papers

SEC-1
MAT-SE-3014:Computer Algebra Systems and Related Software

SEC-2
MAT-SE-4014: R Programming

SEC-3
MAT-SE-5014:Combinatorics and Graph Theory

SEC-4
MAT-SE-6014: LaTeX and HTML

Discipline Specific Elective (DSE) papers

DSE-1 (Choose one)
MAT-RE-5016: Number Theory
MAT-RE-5026**:** Discrete Mathematics

DSE-2 (Choose one)
MAT-RE-6016: Numerical Analysis
MAT-RE-6026:Programming in C

Details syllabus for B.Sc. / B. A. / B. Com
(Regular Course)
SEMESTER-I
MAT-RC-1016:Calculus

Total Marks: 100(Theory: 80, Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial Credits**:** 6,*Each unit carry equal credit*

Course Objectives: The primary objective of this course is to introduce the graphs of functions and basic tools of calculus and geometric properties which are helpful in understanding their applications in real world problems.

Course Learning Outcomes: This course will enable the students to:
i) Learn differentiability, limit and continuity tests for functions.
ii) Learn different theorems alongwith their geometric properties.
iii) Learn partial differentiation of functions

Unit 1: Graphs of simple concrete functions such as polynomial, Trigonometric, Inverse trigonometric, Exponential and logarithmic functions
[1] Chapter 1 (Sections 1.1 to 1.3), and Chapter 7 (Sections 7.2, 7.3, and 7.6)

Unit 2: Limits and continuity of a function including approach, Properties of continuous functions including Intermediate value theorem.
[2] Chapter 1

Unit 3: Differentiability, Successive differentiation, Leibnitz theorem, Recursion formulae for higher derivatives.
[2] Chapter 3 (Sections 3.2, 3.3, and 3.6), and Exercise 26, page 184.

Unit 4: Rolle's theorem, Lagrange's mean value theorem with geometrical interpretations and simple applications, Taylor's theorem, Taylor's series and Maclaurin's series, Maclaurin's series expansion of functions such as heir use in polynomial approximation and error estimation.
[1] Chapter 4 (Sections 4.2, and 4.3), [2] Chapter 9 (Sections 9.8, and 9.9)

Unit 5: Functions of two or more variables, Graphs and level curves of functions of two variables, Partial differentiation up to second order.
[2] Chapter 13 (Sections 13.1, and 13.3)

Text books:

1. Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). *Thomas*' *Calculus* (13^{th}ed). Pearson Education, Delhi. Indian Reprint 2017.
2. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). John Wiley & Sons Singapore Pte. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi

SEMESTER-II
MAT-RC-2016: Algebra

Total Marks: 100(Theory: 80, Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial Credits:6, *Each unit carry equal credit*

Course Objectives: The primary objective of this course is to introduce the basic theory of equations and trigonometric function, matrices and determinant as well as algebra of vector spaces

Course Learning Outcomes: This course will enable the students to:
i) Employ De Moivre's theorem to solve problems.
ii) Learn about matrices, determinant and application in solving system of euations
iii) Learn about vector space algebra and their application

Unit 1: Theory of Equations and Expansions of Trigonometric Functions:
Fundamental Theorem of Algebra, Relation between roots and coefficients of *n*th degree equation, Remainder and Factor Theorem, Solutions of cubic and biquadratic equations, when some conditions on roots of the equation are given, Symmetric functions of the roots for cubicand biquadratic; De Moivre's theorem (both integral and rational index), Solutions of equations using trigonometry and De Moivre's theorem, Expansion for in terms of powers of in terms of cosine and sine of multiples of x.
[2] Chapter 3, 4 [3] Chapter 7 (Sections 7.6 and 7.7)

Unit 2: Matrices:
Types of matrices, Rank of a matrix, Invariance of rank under elementarytransformations, Reduction to normal form, Solutions of linear homogeneous and nonhomogeneous equations with number of equations and unknowns up to four; Cayley-Hamilton theorem, Characteristic roots and vectors.

[4] Chapter 3 (Sections 3.2, 3.5, and 3.7,Section 3.9)Chapter 2 (Sections 2.1 to 2.5)Chapter 7 (Section 7.1, and Example 7.2.2)

Unit 3: Groups, Rings and Vector Spaces:
Integers modulo *n*, Permutations, Groups, Subgroups, Lagrange's theorem, Euler's theorem, Symmetry Groups of a segment of a line, and regular *n*-gons for $n = 3, 4, 5$, and 6; Rings and subrings in the context of C[0,1] and Definition and examples of a vector space, Subspace and its properties, Linear independence, Basis and dimension of a vector space.

[1] Chapter 1 (Section 1.4), and Chapter 2 (Section 2.3)Chapter 3 (Sections 3.1, and 3.2)(Sections 3.2, 3.3, and 3.6) and Chapter 5 (Section 5.1)
[4] Chapter 4 (Sections 4.1, 4.3, and 4.4)

Text Books:

1. Beachy, John A., & Blair, William D. (2006). *Abstract Algebra* (3rd ed.). Waveland Press, Inc.
2. Burnside, William Snow (1979). *The Theory of Equations*, Vol. 1 (11th ed.) S. Chand & Co. Delhi. Fourth Indian Reprint.
3. Gilbert, William J., & Vanstone, Scott A. (1993). *Classical Algebra* (3rd ed.). Waterloo Mathematics Foundation, Canada.
4. Meyer, Carl D. (2000). *Matrix Analysis and Applied Linear Algebra*. Society for Industrial and Applied Mathematics (Siam).

Reference Books:

1. Dickson, Leonard Eugene (2009). *First Course in The Theory of Equations*. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785)
2. Gilbert, William J. (2004). *Modern Algebra with Applications* (2nd ed.). John Wiley & Sons.

SEMESTER-III

MAT-RC-3016: Differential Equations

Total Marks: 100(Theory: 80, Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial, Credits: 6,*Each unit carry equal credit*

Course Objectives: The main objective of this course is to introduce the students to the exciting world of differential equations and their solutions methods.

Course Learning Outcomes: The course will enable the students to:
i) Learn basics of differential equations and mathods for solving.

Unit 1: First Order Ordinary Differential Equations
First order exact differential equations, Integrating factors, Rules to find an integrating factor
[1] Chapter 1 (Section 1.1,1.2 1.4)
[2] Chapter 1 (Sections 1.1, and 1.2)Chapter 2 (Sections 2.1, and 2.2)

Linear equations and Bernoulli equations, Orthogonal trajectories and oblique trajectories; Basictheory of higher order linear differential equations, Wronskian, and its properties; Solving differential equation by reducing its order.
[2] Chapter 2 (Sections 2.3, and 2.4), Chapter 3 (Section 3.1), and Chapter 4 (Section 4.1)

Unit 2: Second Order Linear Differential Equations

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, Themethod of variation of parameters, The Cauchy-Euler equation; Simultaneous differentialequations.
[1] Chapter 2 (Section 2.2)
[2] Chapter 4 (Sections 4.2, 4.3, 4.4, 4.5,4.6) Chapter 7 (Sections 7.1, 7.3)

Text Books:

1. Kreyszig, Erwin (2011). *Advanced Engineering Mathematics* (10th ed.). John Wiley &Sons, Inc. Wiley India Edition 2015.
2. Ross, Shepley L. (1984). *Differential Equations* (3rd ed.). John Wiley & Sons, Inc

SKILL ENHANCEMENT COURSE
SEC-1
MAT-SE-3014: Computer Algebra Systems and Related Software

Total marks: 100 (Theory 60, Internal assessment 20, Practical 20)
Per week: 2 Lectures, 2 Practical, Credits 4(2+2)
Each unit carry equal credit.

Course Objectives: This course aims at familiarizing students with the usage of mathematical softwares (/Mathematica/MATLAB/Maxima/Maple) and the statistical software **R**. The basic emphasis is on plotting and working with matrices using CAS. Data entry and summary commands will be studied in **R**. Graphical representation of data shall also be explored.

Course Learning Outcomes: This course will enable the students to:
i) Use of softwares; Mathematica/MATLAB/Maxima/Maple etc. as a calculator, for plotting functions and animations
ii) Use of CAS for various applications of matrices such as solving system of equations and finding eigenvalues and eigenvectors.
iii) Understand the use of the statistical software **R** as calculator and learn to read and get data into **R.**
iv) Learn the use of **R** in summary calculation, pictorial representation of data and exploring relationship between data.
v) Analyze, test, and interpret technical arguments on the basis of geometry

Unit 1: Introduction to CAS and Applications:
Computer Algebra System (CAS), Use of a CAS as a calculator, Computing and plotting functions in 2D, Plotting functions of two variables using Plot3D and Contour Plot, Plotting parametric curves surfaces, Customizing plots, Animating plots, Producing tables of values, working with piecewise defined functions, Combining graphics.
[1] Chapter 12 (Sections 12.1 to 12.5)
[2] Chapter 1, and Chapter 3 (Sections 3.1 to 3.6, and 3.8) Chapter 6 (Sections 6.2, and 6.3)

Unit 2: Working with Matrices:
Simple programming in a CAS, Working with matrices, Performing Gauss elimination, operations (transpose, determinant, inverse), Minors and cofactors, Working with large matrices, Solving system of linear equations, Rank and nullity of a matrix, Eigenvalue, eigenvector and diagonalization.
[2] Chapter 7 (Sections 7.1 to 7.8)

Practical:
List of the practical to be done using Matlab / Mathematica / Maple / Scilab / Maxima etc.
Six practicals should be done by each student. The teacher can assign practical from the exercises from [1].

Text Book:

1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.

Reference Book:

1. Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011.

SEMESTER-IV
MAT-RC-4016: Real Analysis

Total Marks: 100(Theory: 80 Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial, Credits:6,*Each unit carry equal credit*

Course Objectives: The course will develop a deep and rigorous understanding of real line R and of defining terms to prove the results about convergence and divergence of sequences and series of real numbers.

Course Learning Outcomes: This course will enable the students to:
i) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit, algebra of limit and uniform continuity of functions.
ii) Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

Unit 1: Order completeness of Real numbers, Open and closed sets, Limit of functions, Sequential criterion for limits, Algebra of limits, Properties of continuous functions, Uniform continuity.
[1] Chapter 2 (Sections 2.1, and 2.2, Sections 2.3, and 2.4)Chapter 11 (Section 11.1, Definition and Examples only)

Unit 2: Sequences, Convergent and Cauchy sequences, Subsequences, Limit superior and limit inferiorof a bounded sequence, Monotonically increasing and decreasing sequences, Infinite series andtheir convergences, Positive term series, Comparison tests, Cauchy's nth root test, D'Alembert's ratio test, Raabe's test, Alternating series, Leibnitz test, Absolute and conditionalconvergence.
[1] Chapter 3, (Sections 3.1, 3.2,3.3,3.4,3.5,3.7), Chapter 9 [Section 9.1(excluding grouping of series)]Sections 9.2 (Statements of tests only), and 9.3 (9.3.1, 9.3.2)Chapter 4 (Sections 4.1 to 4.3).Chapter 5 (Sections 5.1, 5.3, 5.4 excluding continuous extension and approximation)

Text Book:

1. Bartle, Robert G., &Sherbert, Donald R. (2015). *Introduction to Real Analysis* (4th ed.) Wiley India Edition.

Reference Book:

1. Ross, Kenneth A. (2013). *Elementary Analysis*: *The Theory of Calculus* (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian Reprint
2. Bilodeau, Gerald G., Thie, Paul R., &Keough, G. E. (2010). *An Introduction to Analysis* (2nd ed.). Jones & Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.

SKILL ENHANCEMENT COURSE
SEC-2

MAT-SE-4014: R Programming

Total marks: 100 (Theory 60, Internal assessment 20, Practical 20)
Per week: 2 Lectures, 2 Practical, Credits 4(2+2)
Each unit carry equal credit.

Course Objectives: The purpose of this course is to help using **R**, a powerful free software program for doing statistical computing and graphics. It can be used for exploring and plotting data, as well as performing statistical tests.

Course Learning Outcomes: This course will enable the students to:
i) Become familiar with **R** syntax and to use **R** as a calculator.
ii) Understand the concepts of objects, vectors and data types.
iii) Know about summary commands and summary table in **R**.
iv) Visualize distribution of data in **R** and learn about normality test.
v) Plot various graphs and charts using **R**.

Unit 1: **Getting Started with R - The Statistical Programming Language**
Introducing **R**, using **R** as a calculator; Explore data and relationships in **R**; Reading and getting data into **R:** combine and scan commands, viewing named objects and removing objects from **R**, Types and structures of data items with their properties, Working with history commands, Saving work in **R**; Manipulating vectors, Data frames, Matrices and lists; Viewing objects within objects, Constructing data objects and their conversions.
[1] Chapter 14 (Sections 14.1 to 14.4)
[2] Chapter 2, Chapter 3

Unit 2: **Descriptive Statistics and Tabulation**
Summary commands**:** Summary statistics for vectors, Data frames, Matrices and lists; Summary tables.
[2] Chapter 4

Unit 3: **Distribution of Data**
Stem and leaf plot, Histograms, Density function and its plotting, The Shapiro-Wilk test for normality, The Kolmogorov-Smirnov test.
[2] Chapter 5

Unit 4: Graphical Analysis with R
Plotting in **R:** Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts, Bar charts; Copy and save graphics to other applications.
[1] Chapter 14 (Section 14.7)
[2] Chapter 7

Practical to be done in the Computer Lab using Statistical Software R:
[1] Chapter 14 (Exercises 1 to 3)
[2] Relevant exercises of Chapters 2 to 5, and 7

Note: The practical may be done on the database to be downloaded from https://data.gov.in/

Text books:

1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.
2. Gardener, M. (2012). *Beginning* **R:** *The Statistical Programming Language*, Wiley Publications.

SEMESTER-V
SKILL ENHANCEMENT COURSE

SEC-3
MAT-SE-5014: Combinatorics and Graph Theory

Total marks: 100 (Theory 80, Internal Assessment 20)
Per week: 4 Lectures, Credits 4
Each unit carry equal credit

Course Objectives: This course aims to provide the basic tools of conuting principles, pigeonhole principle. Also introduce the basic concepts of graphs, Eulerian and Hamiltonian graphs, and applications to dominoes, Diagram tracing puzzles, Knight's tour problem and Gray codes.

Course Learning Outcomes: This course will enable the students to:
i) Learn about the counting principles, permutations and combinations, Pigeonhole principle
ii) Understand the basics of graph theory and learn about social networks, Eulerian and Hamiltonian graphs, diagram tracing puzzles and Knight's tour problem.

Unit 1: Elementary combinatorics, Rules of sum and product, two models of counting, sample and distribution model of counting. Examples and solution. Integer solution of an equilateral problem.
[1] Chapter 3

Unit 2: Graphs, Diagraphs, Networks and subgraphs, Vertex degree, Paths and cycles, Regular and bipartite graphs, Four cube problem, Social networks, Exploring and traveling, Eulerian and Hamiltonian graphs, Applications to dominoes, Diagram tracing puzzles, Knight's tour problem, Gray codes.
[2] Chapter 1 (Section 1.1) and Chapter 2

Text Books:
1. C.L. Liu and D. Mohapatra Elements of discrete mathematics, Mc Graw Hill, Computer Science Series. 2017
2. Aldous, Joan M., & Wilson, Robin J. (2007). *Graphs and Applications*: *An Introductory Approach*. Springer. Indian Reprint.

Reference Books:
1. Michael Towusend, Discrete Mathematics; Applied Combinatorics and Graph Theory, Benjamin-Cummings Pub Co (March 1, 1987)
2. K.R. Parthasarathi, Basic Graph Theory, Tata McGraw-Hill, 1994.

DISCIPLINE SPECIFIC ELECTIVE

MAT-RE-5016: Number Theory

Total Marks: 100 (Theory 80, Internal assessment 20)
Per week: 5 lectures 1 Tutorial, Credits 6
Each unit carry equal credit

Course Objectives: In number theory there are challenging open problems which are comprehensible at undergraduate level, this course is intended to build a micro aptitude of understanding aesthetic aspect of mathematical instructions and gear young minds to ponder upon such problems.

Course Learning Outcomes: This course will enable the students to:

i) Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc.
ii) Know about number theoretic functions and modular arithmetic.
iii) Solve linear, quadratic and system of linear congruence equations.

Unit 1: Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem.
[1] Chapter 2 (Section 2.5), [2] Chapter 2 (Section 2.2, 2.3), Chapter 4 (Sections 4.2, 4.4) Chapter 5:Section 5.2

Unit 2: Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phifunction, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.
[1] Chapter 6 (Sections 6.1 to 6.2, 7.2M 7.3, and 7.4)

Text Books:

1. David M. Burton, *Elementary Number Theory,* 6th Ed., Tata McGraw Hill, Indian reprint, 2007.
2. Jones, G. A., & Jones, J. Mary. (2005). *Elementary Number Theo*ry. Undergraduate Mathematics Series (SUMS). First Indian Print.

Reference Book:
1. Neville Robinns, *Beginning Number Theory,* 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.

MAT-RE-5026: Discrete Mathematics

Total Marks: 100 (Theory 80, Internal Assessment 20)
Per week 5 Lectures, 1 Tutorial, Credits 6
Each unit carry equal credit

Course Objectives: The course aims at introducing the concepts of ordered sets, lattices, sublattices and homomorphisms between lattices. It also includes introduction to modular and distributive lattices along with complemented lattices and Boolean algebra. Then some important applications of Boolean algebra are discussed in switching circuits.

Course Learning outcomes: After the course, the student will be able to:
i) Understand the notion of ordered sets and maps between ordered sets.
ii) Learn about lattices, modular and distributive lattices, sublattices and homomorphisms between lattices.
iii) Become familiar with Boolean algebra, Boolean homomorphism, Karnaugh diagrams, switching circuits and their applications.

Unit 1: Ordered Sets
Definitions, Examples and basic properties of ordered sets, Order isomorphism, Hasse diagrams, Dual of an ordered set, Duality principle, Maximal and minimal elements, Building new ordered sets, Maps between ordered sets.
[1] Chapter 1 (Sections 1.1 to 1.5 and 1.14 to 1.26, and 1.34 to 1.36)
[3] Chapter 1 [Section 1 (1.1 to 1.3)]

Unit 2: Lattices
Lattices as ordered sets, Lattices as algebraic structures, Sublattices, Products and homomorphisms; Definitions, Examples and properties of modular and distributive lattices, The M3 – N5 Theorem with applications, Complemented lattice, Relatively complemented lattice, Sectionally complemented lattice. homomorphisms.

[1] Chapter 2 (Sections 2.1 to 2.19)Chapter 4 (Sections 4.1 to 4.9)(Sections 4.10, and 4.11)
[3] Chapter 1 [Section 1 (1.5 to 1.20)]Chapter 1 [Section 2 (2.1 to 2.6) Chapter 1 [Section 2 (2.7 to 2.14)]

Unit 3: Boolean Algebras and Switching Circuits
Boolean Algebras, De Morgan's laws, Boolean homomorphism, Representation theorem; Boolean polynomials, Boolean polynomial functions, Disjunctive normal form and conjunctive normal form, Minimal forms of Boolean polynomial, Quinn-McCluskey method, Karnaugh diagrams, Switching circuits and applications of switching circuits.
[3] Chapter 1 (Sections 3, and 4) Chapter 1 (Section 6)Chapter 2 (Sections 7, and 8).

Text Books:
1. Davey, B. A., & Priestley, H. A. (2002). *Introduction to Lattices and Order* (2nd ed.). Cambridge University press, Cambridge
2. Goodaire, Edgar G., & Parmenter, Michael M. (2011). *Discrete Mathematics with Graph Theory* (3rd ed.). Pearson Education (Singapore) Pvt. Ltd. Indian Reprint.
3. Lidl, Rudolf & Pilz, Gunter. (2004). *Applied Abstract Algebra* (2nd ed.), Undergraduate Texts in Mathematics. Springer (SIE). Indian Reprint.

SEMESTER-VI

SKILL ENHANCEMENT COURSE

SEC-4
MAT-SE-6014: LaTeX and HTML(P)

Total marks: 100 (Theory 60, Internal assessment 20, Practical 20)
Per week: 2 Lectures, 2 Practicals, Credits 4(2+2)
Each unit carry equal credit

Course Objectives: The purpose of this course is to acquaint students with the latest typesetting skills, which shall enable them to prepare high quality typesetting, beamer presentation and webpages

Course Learning Outcomes: After studying this course the student will be able to:
i) Create and typeset a LaTeX document.
ii) Typeset a mathematical document using LaTex.
iii) Learn about pictures and graphics in LaTex.
iv) Create beamer presentations.
v) Create web page using HTML.

Unit 1: Elements of LaTeX; Hands-on-training of LaTex; graphics in LaTeX; PSTricks; Beamer presentation
[1] Chapters 9,10, 11.

Unit 2: HTML, creating simple web pages, images and links, design of web pages.
[1] Chapter 9-11, 15

Practical: Six practical should be done by each student. The teacher can assign practical from the exercises from [1].

Text Book:
1. Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011.

Reference Book:
1. L. Lamport, LATEX: A Document Preparation System, User's Guide and Reference Manual. Addison-Wesley, New York, second edition, 1994

DISCIPLINE SPECIFIC ELECTIVE

MAT-RE-6016: Numerical Analysis

Total Marks: 100 (Theory 80, Internal Assessment 20)
Per week 5 Lecture, 1 Tutorial, Credits 6
Each unit carry equal credit

Course Objectives: To comprehend various computational techniques to find approximate value for possible root(s) of non-algebraic equations, to find the approximate solutions of system of linear equations and Quadratic equations.

Course Learning Outcomes: The course will enable the students to:
i) Learn some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.
ii) Know about iterative and non-iterative methods to solve system of linear equations
iii) Know interpolation techniques to compute the values for a tabulated function at points not in the table.
iv) Integrate a definite integral that cannot be done analytically
v) Find numerical differentiation of functional values
vi) Solve differential equations that cannot be solved by analytical methods

Unit 1: Gaussian elimination method (with row pivoting), Gauss-Jordan method; Iterative methods**:** Jacobi method, Gauss-Seidel method; Interpolation**:** Lagrange form, Newton form, Finite difference operators, Gregory-Newton forward and backward difference interpolations, Piecewise polynomial interpolation (Linear and Quadratic).
[2] Chapter 3 (Sections 3.1, and 3.2), Chapter 6 (Sections 6.1, and 6.2) Chapter 8 (Section 8.1, Section 8.3 (8.3.1, and 8.3.2)
[3] Chapter 3 (Sections 3.2, and 3.4) Chapter 4 (Section 4.2)Chapter 4 (Sections 4.3, and 4.4)
[1] Chapter 18 (Sections 18.1 to 18.3)

Unit 2: Numerical differentiation**:** First and second order derivatives; Numerical integration**:** Trapezoid rule, Simpson's rule; Extrapolation methods**:** Richardson extrapolation, Romberg integration; Ordinary differential equation**:** Euler's method, Modified Euler's methods (Heun and Mid-point).
[2] Chapter 11 [Sections 11.1 (11.1.1, 11.1.2, 11.1.4), and 11.2 (11.2.1, 11.2.2, 11.2.4)]
[1] Chapter 22 (Sections 22.1, and 22.2, 22.3)

Text Books:

1. Chapra, Steven C. (2018). *Applied Numerical Methods with* MATLAB *for Engineers and* Scientists (4th ed.). McGraw-Hill Education.
2. Fausett, Laurene V. (2009). *Applied Numerical Analysis Using* MATLAB. Pearson. India
3. Jain, M. K., Iyengar, S. R. K., & Jain R. K. (2012). *Numerical Methods for Scientific and Engineering Computation* (6th ed.). New Age International Publishers. Delhi.

MAT-RE-6026: Programming in C

Total Marks: 100 (Theory 60, Internal 20, Practical 20)
Per week: 4 Lectures, 2 Tutorials, Credits 6(4+2)
Each unit carry equal credit

Course Objectives: This course introduces C programming in the idiom and context of mathematics and imparts a starting orientation using available mathematical libraries, and their applications.

Course Learning Outcomes: After completion of this paper, student will be able to:
i) Understand and apply the programming concepts of C which is important to mathematical investigation and problem solving.

ii) Learn about structured data-types in C and learn about applications in factorization of an integer and understanding Cartesian geometry and Pythagorean triples.
iii) Use of containers and templates in various applications in algebra.
iv) Use mathematical libraries for computational objectives.
v) Represent the outputs of programs visually in terms of well formatted text and plots.

Unit 1: Variables, constants, reserved words, variable declaration, initialization, basic data types, operators and expression (arithmetic, relational, logical, assignment, conditional, increment and decrement), hierarchy of operations for arithmetic operators, size of and comma operator, mixed mode operation and automatic (implicit) conversion, cast (explicit) conversion, library functions, structure of a C program, input/output functions and statements.

Unit 2 : Control Statements : if-else statement (including nested if-else statement), switch statement. Loop control Structures (for and nested for, while and do-while). Break, continue, go to statements, exit function.

Unit 3 : Arrays and subscripted variables : One and Two dimensional array declaration, accessing values in an array, initializing values in an array, sorting of numbers in an array, addition and multiplication of matrices with the help of array.
Functions : function declaration, actual and formal arguments, function prototype, calling a function by value, recursive function.
[1] Chapters 3, 4, 5, 6, 7 and 9

Programmes for practical:
To find roots of a quadratic equation, value of a piecewise defined function (single variable), factorial of a given positive integer, Fibonacci numbers, square root of a number, cube root of a number, sum of different algebraic and trigonometric series, a given number to be prime or not, sum of the digits of any given positive integer, solution of an equation using N-R algorithm, reversing digits of an integer. Sorting of numbers in an array, to find addition, subtraction and multiplication of matrices. To find sin(x), cos(x) with the help of functions.
[1] Chapters 3, 4, 5, 6, 7 and 9

Text Book:
1. T. Jeyapoovan, A First Course in Programming with C T. Jeyapoovan, Vikash Publishing House Pvt. Ltd.

Reference books:
1. E. Balaguruswamy-Programming with C, Schaum Series.
2. Y. Kanetkar, *Let us C*, B.P. Publication.

GENERIC ELECTIVE (GE) COURSES
OFFERED TO B.A./B.Com. Programme
(Students who are not having Mathematics as a discipline Subject can opted for such courses)

Semester	Core Course (12)	Ability Enhancement Compulsory Course (AECC)(2)	Skill Enhancement Course (SEC) (4)	Discipline Specific Elective (DSE)(4)	Generic Elective (GE) (2) Credits: 6 each
I					
II					
III					
IV					
V					**GE-1: MAT-RG-5016 General Mathematics-I**
VI					**GE-2: MAT-RG-6016 General Mathematics-II**

SEMESTER-V
MAT-RG-5016: General Mathematics-I

Total Marks: 100(Theory: 80, Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial,Credits6
Each unit carry equal credit

Course Objectives: In number theory there are challenging open problems which are comprehensible at undergraduate level, this course is intended to build a micro aptitude of understanding aesthetic aspect of mathematical instructions and gear young minds to ponder upon such problems. Encient mathematics are the foundations of present mathematics and so a brief introduction of the same is included. Matrix method is introduced to solve equations.

Course Learning Outcomes: This course will enable the students to:
i) Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc.
ii) Know about number theoretic functions and modular arithmetic.
iii) Solve linear, quadratic and system of linear congruence equations.
iv) Know solve simultaneous algebraic equations with matrix theory.

Unit 1: Biographies of Ancient Indian Mathematicians: A brief introduction to the lives and information on the works of the following Mathematicians**:** Aryabhata, Varahamihira, Brahmagupta, Bhaskara I & II, Mahavira, Madhava, and Paramesvara.
[3] Chapters 5, 6, 7, 9, 11 and 13 for brief statements and examples on the works of the above Mathematicians.
[4] Sections 30, 31, 35, 41 to 44, 54 to 56, 59 to 61, 67 and 68 for brief introduction of the Mathematicians.

Unit 2: Number Systems: An overview of number systems, Algebraic and transcedental numbers with some historical background, Fundamental arithmetic operations, Rules of divisibility, Hierarchy of operations and Modular arithmetic, Euclidean algorithm, Prime numbers, The sieve of Eratosthenes, Fundamental theorem of arithmetic, Euclid's lemma, Fermat numbers, Mersenne numbers and Mersenne primes, prime testing method of Fermat, Statement and significance of the prime number theorem, Goldbach conjuctures, Twin primes, Uses of prime numbers, Perfect and amicable numbers, Pythagoreans triplets and its properties, Statement and historic background of Fermat's Last Theorem, Multiplication principle, Permutation and combinations, Latin squares and magic squares.

[2] Chapter 3 (Sections 3.0, 3.1, and 3.4), and Chapter 4 (Section 4.2 up to page 128) Chapter 3 (Section 3.2) Chapter 3 (Section 3.3), and Chapter 9 (Section 9.9, pages 332 to 334).Chapter 5 (Sections 5.1 to 5.4, and 5.6 up to page 212)

Unit 3: Matrices and Determinants: Matrices, Basic concepts and algebraic operations, Types of matrices, Transpose of a matrix, Symmetric and skew-symmetric matrices, Matrix multiplication and its properties, Powers of square matrices, Inverse square matrix and its properties, Determinant and its properties, Expansion by rows and columns, Cofactors, Matrix singularity, Adjoint matrix and calculation of inverse, Cramer's rule.
[1] Chapter 1 (Sections 1.4, and 1.5)Chapter 2 (Section 2.4 up to Example 3, page 138), and Chapter 3 (Sections 3.1 to 3.3)

Text Books:

1. Andrilli, S., & Hecker, D. (2016). *Elementary Linear Algebr*a (5th ed.). Academic Press, Elsevier India Private Limited.
2. Gulberg, Jan. (1997). *Mathematics from the Birth of Numbers*. W. W. Norton & Company.
3. Puttaswamy, T.K. (2012). Mathematical Achievements of Pre-modern Indian Mathematicians Elsevier Inc. USA.
4. Srinivasiengar, C. N. (1988). *The History of Ancient Indian Mathematics*. The World Press Private Ltd. Calcutta. Digitized Book (2009).

Reference Book:

1. Divakaran, P. P. (2018). The Mathematics of India: Concepts, Methods, Connections. Springer Singapore. Indian Print by Hindustan Book Agency, New Delhi.

SEMESTER-VI
MAT-RG-6016: General Mathematics – II

Total Marks: 100 (Theory 80, Internal Assessment 20)
Per week: 5 Lectures, 1 Tutorial,Credits6
Each unit carry equal credit

Course Objectives: History and biographies of renowned ancient scientists in mathematical science are included to inspire the students and therby develop love mathematics. Basics of graph theory and number theory are included as well. Matrix method is introduced to solve equations and a brief introduction functions are included.

Course Learning Outcomes: This course will enable the students to:
i) Learn about some fascinating problems concerning numbers
ii) Learn about life and works of ancient Indian and Foreign scientists in mathematical scienc.
iii) Learn the symmetrical behaviour of numbers.
iv) Know solve simultaneous algebraic equations with matrix theory.

Unit 1: Biographies of Remarkable Mathematicians:
A brief introduction to the lives and information on the works of the following Mathematicians: Euler, Lagrange, Gauss, Cauchy, Abel, Galois, Riemann, Hardy, Noether, Ramanujan, Neumann, Wiles, and Bhargava.
[2] Pages 41, 126, 161, 207, 280, 346, and 579-580.
[4] Chapter 1 (pages 1–7), Chapter 5 (pages 182 – 189), Chapter 8 (pages 299 – 306), Chapter 9 (pages 357 – 362),and Chapter 10 (pages 412 – 416).

Unit 2: Functions, Perspective Geometry, Symmetry and Fractals
Basics of Graph Theory, The Königsberg Bridge problem, The four-color map problem, The Möbius strip and the Klein bottle.

Introduction of functions, Graphs of functions, Increasing and decreasing functions, Even and odd functions, Location of points of extrema, Inflection, Periodic functions – all via graphs.

Perspective and Projection, Perspective geometry**:** Lines and points in 2D and 3D, Fundamental trigonometric functions, Use of perspective in drawing, Historic background, Common tools adopted by artists for such representations, Analysis of some paintings to spot use of perspective and techniques. Types of symmetry, Concrete examples of symmetry groups, Study of symmetry and patterns by looking at monuments/buildings/ornamental art, Fibonacci sequences in nature, Golden Ratio, Golden triangle. Shapes and solids, Basic tiling, The regular polyhedron, Importance of Platonic solids and mystical significance to the ancient Greeks; Fractals in nature, Snowflake curves, and Sierpinski triangle.
[3] Chapter 5 (Section 5.5), and Chapter 11 (Section 11.5) Chapter 10 (Sections 10.0, and 10.1 up to page 344) Chapter 11 (Section 11.2), Chapter 13 (Section 13.1), and Chapter 15 (Section 15.1)
[2] Chapter 1. [3] Chapter 8 (Section 8.5), and Chapter 12 (Pages 418 and 419).
[3] Chapter 12 (Sections 12.0, and 12.1 up to page 399), and Chapter 17 (Sections 17.0 to 17.4)

Unit 3: Solving Systems of Linear Equations using Matrix
Solving systems of linear equations, Gaussian elimination method and row operations, Consistent and inconsistent system, Gauss-Jordon row reduction and reduced row echelon form, Homogenous system, Equivalent systems and row equivalence of matrices, Rank of a matrix, Relation between homogenous system and rank.
[1] Chapter 2 (Sections 2.1 to 2.3).

Text Books:
1.Andrilli, S., & Hecker, D. (2016). *Elementary Linear Algebr*a (5th ed.). Academic Press, Elsevier India Private Limited.
2. Gallian, Joseph. A. (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited. Delhi. Fourth impression, 2015.
3. Gulberg, Jan. (1997). *Mathematics from the Birth of Numbers*. W. W. Norton & Company.
4. James, Ioan. (2002). *Remarkable Mathematicians*: *From Euler to von Neumann*. The Mathematical Association of America. Cambridge University Press.

B.Sc. Physics (Honours) Syllabus (CBCS)

*The syllabus is approved in the Academic Council meeting held on XXXX**

September, 2020

Physics Department, Gauhati University
WEB : https://gauhati.ac.in
GUWEB : http://web.gauhati.ac.in/syllabus

The syllabus is subject to modifications as deem fit by the Gauhati University

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Course Structure for B.Sc. in Physics (Honours) under CBCS

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<tr><th>Type→</th><th>Core</th><th>AECC</th><th>SEC</th><th>DSE</th><th>GE</th></tr>
<tr><th>Credits→</th><th>14 × 6 = 84</th><th>2 × 4 = 8</th><th>2 × 4 = 8</th><th>4 × 6 = 24</th><th>4 × 6 = 24</th></tr>
<tr><td rowspan="2">Semester I</td><td>PHY-HC-1016</td><td rowspan="2">ENG-AE-1014</td><td rowspan="4" colspan="2"></td><td rowspan="2">AAA-HG-1016</td></tr>
<tr><td>PHY-HC-1026</td></tr>
<tr><td rowspan="2">Semester II</td><td>PHY-HC-2016</td><td rowspan="2">ENV-AE-2014</td><td rowspan="2">BBB-HG-2016</td></tr>
<tr><td>PHY-HC-2026</td></tr>
<tr><td rowspan="3">Semester III</td><td>PHY-HC-3016</td><td rowspan="6"></td><td rowspan="3">PHY-SE-3XX4</td><td rowspan="6"></td><td rowspan="3">CCC-HG-3016</td></tr>
<tr><td>PHY-HC-3026</td></tr>
<tr><td>PHY-HC-3036</td></tr>
<tr><td rowspan="3">Semester IV</td><td>PHY-HC-4016</td><td rowspan="3">PHY-SE-4XX4</td><td rowspan="3">DDD-HG-4016</td></tr>
<tr><td>PHY-HC-4026</td></tr>
<tr><td>PHY-HC-4036</td></tr>
<tr><td rowspan="2">Semester V</td><td>PHY-HC-5016</td><td rowspan="4" colspan="2"></td><td>PHY-HE-5XX6</td><td rowspan="4"></td></tr>
<tr><td>PHY-HC-5026</td><td>PHY-HE-5YY6</td></tr>
<tr><td rowspan="2">Semester VI</td><td>PHY-HC-6016</td><td>PHY-HE-6XX6</td></tr>
<tr><td>PHY-HC-6026</td><td>PHY-HE-6YY6</td></tr>
</table>

Legends

HC : Core Papers
SE : Skill Enhancement Papers
HE : Discipline Specific Elective Papers
HG : Generic Elective Papers

Directives & Advisory

(a) A student majoring (honours) in Physics MAY take GE papers from any available discipline in the college, except Physics.

(b) It is advisable that a student majoring (honours) in Physics take at least one GE paper from Mathematics

B.Sc. Honours Physics
Semester Wise Credit Distribution

Semester	Core Papers	AECC	SEC	DSE	Generic Elective	Total Credit
First	2×6	1×4			1×6	22
Second	2×6	1×4			1×6	22
Third	3×6		1×4		1×6	28
Fourth	3×6		1×4		1×6	28
Fifth	2×6			2×6		24
Sixth	2×6			2×6		24
Total	**84**	**8**	**8**	**24**	**24**	**148**

List of Papers

Honours Core Papers

1. PHY-HC-1016 : Mathematical Physics I
2. PHY-HC-1026 : Mechanics
3. PHY-HC-2016 : Electricity & Magnetism
4. PHY-HC-2026 : Waves & Optics
5. PHY-HC-3016 : Mathematical Physics II
6. PHY-HC-3026 : Thermal Physics
7. PHY-HC-3036 : Digital Systems & Applications
8. PHY-HC-4016 : Mathematical Physics III
9. PHY-HC-4026 : Elements of Modern Physics
10. PHY-HC-4036 : Analog Systems & Applications
11. PHY-HC-5016 : Quantum Mechanics & Applications
12. PHY-HC-5026 : Solid State Physics
13. PHY-HC-6016 : Electromagnetic Theory
14. PHY-HC-6026 : Statistical Mechanics

Discipline Specific Elective (DSE) Papers

1. PHY-HE-5016 : Experimental Techniques (PHY-RE-5016)
2. PHY-HE-5026 : Embedded Sys: Introduction to Microcontrollers (PHY-RE-5026)
3. PHY-HE-5036 : Advanced Mathematical Physics I (PHY-RE-5036)
4. PHY-HE-5046 : Physics of Devices and Instruments (PHY-RE-5046)
5. PHY-HE-5056 : Particle and Nuclear Physics (PHY-RE-5056)
6. PHY-HE-6016 : Communication Electronics (PHY-RE-6016)
7. PHY-HE-6026 : Digital Signal Processing (PHY-RE-6026)
8. PHY-HE-6036 : Advanced Mathematical Physics II (PHY-RE-6036)
9. PHY-HE-6046 : Astronomy and Astrophysics (PHY-RE-6046)
10. PHY-HE-6056 : Classical Dynamics (PHY-RE-6056)

Generic Elective (GE) Papers for other Disciplines

1. PHY-HG-1016 : Mechanics (PHY-RC-1016)
2. PHY-HG-2016 : Electricity & Magnetism (PHY-RC-2016)
3. PHY-HG-3016 : Thermal Physics & Statistical Mechanics (PHY-RC-3016)
4. PHY-HG-4016 : Waves & Optics (PHY-RC-4016)

Skill Enhancement (SE) Papers

1. PHY-SE-3014 : Physics Workshop Skills
2. PHY-SE-3024 : Computational Physics Skills
3. PHY-SE-3034 : Computer Assembling and Networking
4. PHY-SE-3044 : Digital Photography and editing
5. PHY-SE-3054 : Video editing for social media

6. PHY-SE-3064 : Weather Forecast
7. PHY-SE-3074 : Applied Optics
8. PHY-SE-3084 : Technical Drawing
9. PHY-SE-3094 : PageMaker

10. PHY-SE-4014 : Basic Instruments Skills
11. PHY-SE-4024 : Research & Technical Writing
12. PHY-SE-4034 : Domestic and industrial wiring
13. PHY-SE-4044 : Photoshop
14. PHY-SE-4054 : Motion graphics for advertising and films
15. PHY-SE-4064 : Radiation Safety
16. PHY-SE-4074 : Renewable energy
17. PHY-SE-4084 : Introduction to CorelDraw
18. PHY-SE-4094 : Graphic design for digital advertising

Note:

(a) The courses given in Red colour are equivalent in content to the corresponding courses given alongside.

(b) In the Lab classes, wherever applicable, students and instructors can use either of C, C++, FORTRAN 90/95, Matlab, Scilab, or Python environment.

(c) Marks in questions papers must appear approximately, if not exactly, in the proportion of number of lectures assigned to various modules of a particular paper. However, marks in the question paper should not exceed 1.25 times the number of assigned lectures of a module under any circumstances.

Course Pre-Requisites

1. Physics Honours Course : Physics and Mathematics in Class XII (or equivalent)

Paper Pre-Requisites

1. PHY-HG-1016 2. PHY-HG-2016 3. PHY-HG-3016 4. PHY-HG-4016	Physics in Class XII (or equivalent)
5. PHY-HE-5016 / PHY-RE-5016 6. PHY-HE-5026 / PHY-RE-5026 7. PHY-HE-5036 / PHY-RE-5036 8. PHY-HE-5046 / PHY-RE-5046	PHY-HG-1016, 2016, 3016, 4016 or PHY-RC-1016, 2016, 3016, 4016
9. PHY-HE-6016 / PHY-RE-6016 10. PHY-HE-6026 / PHY-RE-6026 11. PHY-HE-6036 / PHY-RE-6036 12. PHY-HE-6046 / PHY-RE-6046	All earlier Pre-Requisites & PHY-HE-5016, 5016, 5016, 5016 or PHY-RE-5016, 5016, 5016, 5016

First Semester

Honours Core Papers

PHY-HC-1016
Mathematical Physics I
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *Successful students should be able to understand vector and its applications in various fields, differential equations and its applications, different coordinate systems, concept of probability and error.*

Theory

Unit I: Vector Calculus (Lectures 25)

Revision: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities.

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).

Unit II: First and Second order Differential Equations (Lectures 17)

First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution.

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration.

Unit III: Orthogonal Curvilinear Coordinates (Lectures 06)

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

Unit IV: Dirac Delta function and its Properties (Lectures 02)

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

Unit V: Introduction to Probability (Lectures 04)

Independent random variables: Probability distribution functions; binomial, Gaussian and Poisson, with examples. Mean and variance.

Unit VI: Theory of Errors (Lectures 06)

Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least-squares fit.

Lab

Aim

The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Highlights the use of computational methods to solve physical problems
- The course will consist of lectures (both theory and practical) in the Lab
- Evaluation done not on the programming but on the basis of formulating the problem
- Aim at teaching students to construct the computational problem to be solved
- Students can use any one operating system Linux or Microsoft Windows

Introduction and Overview Computer architecture and organization, memory and Input/output devices

Basics of scientific computing Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow- emphasize the importance of making equations in terms of dimensionless variables, Iterative methods

Review of C & C++/Python/ Matlab/ Mathematica Programming fundamentals Introduction to Programming, constants, variables and data types, operators and Expressions I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (if statement. if-else Statement. Nested if Structure. else-if Statement. Ternary Operator. goto Statement. switch Statement. Uncondi- tional and Conditional Looping. while Loop. do-while Loop. for Loop. breakand continueStatements. Nested Loops), Arrays (1D & 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects.

Programs Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search

Random number generation Area of circle, area of square, volume of sphere, value of pi (π)

Solution of Algebraic and Transcendental equations by Newton Raphson methods Solution of linear and quadratic equation, solving $\alpha = tan\alpha$, $I = I_O(sin\alpha/\alpha)^2$ in optics

Interpolation by Newton Gregory Forward and Backward difference formula Evaluation of trigonometric functions e.g. $\sin\theta$, $\cos\theta$, $\tan\theta$ etc.

Numerical Integration (Trapezoidal and Simpson rules), Monte Carlo method Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop

Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, modifted Euler and Runge-Kutta (RK) second and fourth order methods First order differential equation

(a) Radioactive decay (b) Newton's law of cooling.

Reference Books

[1] Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, and F. E.. Harris, 2013, 7th Edn., Elsevier.

[2] An introduction to ordinary differential equations, E. A. Coddington, 2009, PHI

[3] Learning Differential Equations, George F. Simmons, 2007, McGraw Hill.

[4] Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.

[5] Mathematical Methods for Scientists and Engineers, D. A. McQuarrie, 2003, Viva Book

[6] Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5 Ed., 2012, Jones and Bartlett Learning

[7] Mathematical Physics, Goswami, 1st edition, Cengage Learning

[8] Engineering Mathematics, S. Pal and S. C. Bhunia, 2015, Oxford University Press

[9] Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India

[10] Essential Mathematical Methods, K. F. Riley and M. P. Hobson, 2011, Cambridge University Press

PHY-HC-1026
Mechanics
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *On successful completion of the course students should be able understand Inertial and non inertial reference frames, Newtonian motion, Galilean transformations, projectile motion, work and energy, Elastic and inelastic collisions, motion under central force, simple harmonic oscillations, special theory of relativity.*

Theory

Unit I: Fundamentals of Dynamics (Lectures 06)

Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.

Unit II: Work and Energy (Lectures 04)

Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy.

Unit III: Collisions (Lectures 03)

Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Unit IV: Rotational Dynamics (Lectures 12)

Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.

Unit V: Elasticity (Lectures 03)

Relation between Elastic constants. Twisting torque on a Cylinder or Wire. Cantilever.

Unit VI: Fluid Motion (Lectures 02)

Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

Unit VII: Gravitation and Central Force Motion (Lectures 08)

Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws.

Unit VIII: Oscillations (Lectures 08)

SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. Compound Pendulum.

Unit IX: Non-Inertial Systems (Lectures 04)

Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications.

Unit X: Special Theory of Relativity (Lectures 10)

Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum.

Lab

A minimum of seven experiments to be done.

1. Measurements of length (or diameter) using vernier caliper, screw gauge, Spherometer and travelling micro- scope.
2. To study the Motion of Spring and calculate (a) Spring constant and (b) Rigidity modulus.
3. To determine the Moment of Inertia of a cylinder about two different axes of symmetry by torsional oscillation method.
4. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
5. To determine the Young's Modulus of the material of a wire by Searle's apparatus.
6. To determine the Modulus of Rigidity of a Wire Static method.
7. To determine the value of g using Bar Pendulum.
8. To determine the value of g using Kater's Pendulum.
9. To determine the height of a building using a Sextant.
10. To determine g and velocity for a freely falling body using Digital Timing Technique.

Reference Books

[1] An Introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.

[2] Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill.

[3] Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.

[4] Analytical Mechanics, G. R. Fowles and G. L. Cassiday. 2005, Cengage Learning.

[5] Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

[6] Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

[7] University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

[8] Mechanics, D. S. Mathur, S. Chand and Company Limited, 2000

[9] University Physics, F. W. Sears, M. W. Zemansky, H.D Young 13/e, 1986, Addison Wesley

[10] Physics for Scientists and Engineers with Modern Phys., J. W. Jewett, R. A. Serway, 2010, Cengage Learning

[11] Theoretical Mechanics, M. R. Spiegel, 2006, Tata McGraw Hill.

Honours Generic Paper

PHY-HG-1016 (PHY-RC-1016)
Mechanics
Total Lectures: 60 Credits : 6 (Theory : 04, Lab : 02)

Course outcome: *Upon completion of this course, students are expected to understand the role of vectors and coordinate systems in Physics, solve Ordinary Differential Equations, laws of motion and their application to various dynamical situations, Inertial reference frames their transformations, concept of conservation of energy, momentum, angular momentum and apply them to basic problems, phenomenon of simple harmonic motion, motion under central force, concept of time dilation, Length contraction using special teory of relativity. In the laboratory course, after acquiring knowledge of how to handle measuring instruments (like screw gauge, Vernier calipers, travelling microscope) student shall embark on verifying various principles and associated measurable parameters.*

Theory

Unit I : Vectors (Lectures 06)

Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coeffcients.

Unit II : Laws of Motion (Lectures 10)

Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.

Unit III : Momentum and Energy (Lectures 06)

Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

Unit IV : Rotational Motion (Lectures 05)

Angular velocity and angular momentum. Torque. Conservation of angular momentum.

Unit V : Gravitation (Lectures 07)

Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only).

Unit VI : Oscillations (Lectures 07)

Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. Compound pendulum.

Unit VII : Elasticity (Lectures 08)

Hooke's law - Stress-strain diagram – Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants – Work done in stretching and work done in twisting a wire – Twisting couple on a cylinder – Determination of Rigidity modulus by static torsion - Torsional pendulum-Determination of Rigidity modulus and moment of inertia – q, η and σ by Searles method.

Unit VII : Special Theory of Relativity (Lectures 07)

Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

Lab

A minimum of five experiments to be done.

1. Measurements of length (or diameter) using vernier caliper, screw gauge and Spherometer.
2. To determine the Moment of Inertia of a Symmetrical body about an axis by torsional oscillation method.
3. To determine the Young's Modulus of the material of a wire by Searle's apparatus.
4. To determine the Modulus of Rigidity of a Wire Static method.
5. To determine the elastic Constants of a wire by Searle's method.
6. To determine the value of g using Bar Pendulum.
7. To determine the value of g using Kater's Pendulum.
8. To study the Motion of Spring and calculate (a) Spring constant and (b) value of g.

Reference Books

[1] An Introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.

[2] Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill.

[3] Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.

[4] Analytical Mechanics, G. R. Fowles and G. L. Cassiday. 2005, Cengage Learning.

[5] Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

[6] Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

[7] University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

[8] Mechanics, D. S. Mathur, S. Chand and Company Limited, 2000

[9] University Physics, F. W. Sears, M. W. Zemansky, H.D Young 13/e, 1986, Addison Wesley

[10] Physics for Scientists and Engineers with Modern Phys., J. W. Jewett, R. A. Serway, 2010, Cengage Learning

[11] Theoretical Mechanics, M. R. Spiegel, 2006, Tata McGraw Hill.

Second Semester

Honours Core Papers

PHY-HC-2016
Electricity & Magnetism
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *After successful completion of this course, students will be able to Understand electric and magnetic fields in matter, Dilectric properties of matter magnetic properties of matter, electromagnetic induction, applications of Kirchhofff's law in different circuits, applications of network theorem in circuits.*

Theory

Unit I: Electric Field and Electric Potential (Lectures 26)

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Unique- ness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Unit II: Dielectric Properties of Matter (Lectures 08)

Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector $\vec{D}$. Relations between $\vec{E}$, $\vec{P}$ and $\vec{D}$ Gauss' Law in dielectrics.

Unit III: Magnetic Field (Lectures 09)

Magnetic Force on a point charge, definition and properties of magnetic field $\vec{B}$. Curl and Divergence. Vector potential $\vec{A}$. Magnetic Force on (1) a current carrying wire (2) between current elements. Torque on a current loop in a uniform magnetic field. Biot-Savart's law and its simple application : straight wire and circular loop. Current loop as a magnetic dipole and its dipole moment (analogy with electric dipole) Ampere's circuital law and its application to (1) Solenoid (2) Torus.

Unit IV: Magnetic Properties of Matter (Lectures 04)

Magnetization vector ($\vec{M}$). Magnetic Intensity ($\vec{H}$). Magnetic Susceptibility and permeability. Relation between $\vec{B}$, $\vec{H}$, $\vec{M}$. Ferromagnetism. B-H curve and hysteresis.

Unit V: Electromagnetic Induction (Lectures 06)

Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.

Unit VI: Electrical Circuits (Lectures 04)

AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) 13 Quality Factor, and (4) Band Width. Parallel LCR Circuit.

Unit VII: Network Theorems (Lectures 03)

Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.

Unit VIII: Ballistic Galvanometer (Lectures 03)

Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.

Lab

A minimum of seven experiments to be done.

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De' Sauty's bridge.
6. Measurement of field strength $\vec{B}$ and its variation in a solenoid (determine $\frac{dB}{dx}$).
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
10. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
11. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonant frequency and (b) Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer.
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.

Reference Books

[1] Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw

[2] Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education

[3] Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.

[4] Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

[5] Elements of Electromagnetics, M. N. O. Sadiku, 2010, Oxford University Press.

[6] Electricity and Magnetism, J. H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

PHY-HC-2026
Waves & Optics
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *After successful completion of this course, students will be able to Understand superposition of harmonic oscillations, different types of wave motions, superposition of harmonic waves, interference and interferometer, diffraction, holography.*

Theory

Unit I: Superposition of Collinear Harmonic Oscillations (Lectures 05)

Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.

Unit II: Superposition of Two Perpendicular Harmonic Oscillations (Lectures 02)

Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

Unit III: Wave Motion (Lectures 04)

Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.

Unit IV: Velocity of Waves (Lectures 06)

Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

Unit V: Superposition of Two Harmonic Waves (Lectures 07)

Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves.

Unit VI: Wave Optics (Lectures 03)

Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

Unit VII: Interference (Lectures 09)

Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index.

Unit VIII: Interferometer (Lectures 04)

Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, (5) Visibility of fringes. Fabry-Perot interferometer.

Unit IX: Diffraction (Lectures 09)

Fresnel and Fraunhofer diffraction. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel diffraction pattern of a straight edge and at a circular aperture . Resolving Power of a telescope.

Unit X: Fraunhofer Diffraction (Lectures 08)

Single slit. Double slit. Multiple slits. Diffraction grating . Resolving power of grating.

Unit XI: Holography (Lectures 03)

Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

Lab

A minimum of seven experiments to be done.

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda^2 - T$ law.
2. To study Lissajous Figures.
3. Familiarization with: Schuster's focusing, determination of angle of prism.
4. To determine refractive index of the Material of a prism using sodium source.
5. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
6. To determine wavelength of sodium light using Fresnel Biprism.
7. To determine wavelength of sodium light using Newton's Rings.
8. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
9. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
10. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

[1] Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.

[2] Fundamentals of Optics, F. A. Jenkins and H.E. White, 1981, McGraw-Hill

[3] Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.

[4] Optics, Ajoy Ghatak, 2008, Tata McGraw Hill

[5] The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.

[6] The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

[7] Fundamental of Optics, A. Kumar, H. R. Gulati and D. R. Khanna, 2011, R. Chand Publications.

Honours Generic Paper

PHY-HG-2016 (PHY-RC-2016)
Electricity & Magnetism
Total Lectures: 60 Credits : 6 (Theory : 04, Lab : 02)

Course outcome: *Upon completion of this course, students are expected to apply Gauss's law of electrostatics to solve a variety of problems, calculate the magnetic forces that act on moving charges and the magnetic fields due to currents, have brief idea of magnetic materials, understand the concepts of induction, and apply them to solve variety of problems. In the Lab course, students will be able to measure resistance (high and low), Voltage, Current, self and mutual inductance, capacitor, strength of magnetic field and its variation, study different circuits RC, LCR etc.*

Theory

Unit I : Vector Analysis (Lectures 12)
Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

Unit II : Electrostatics (Lectures 22)
Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem – Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

Unit III : Magnetism (Lectures 10)
Magnetostatics: Biot-Savart's law & its applications – straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia, para, and ferro-magnetic materials.

Unit IV : Electromagnetic Induction (Lectures 06)
Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

Unit V : Maxwell's Equations and EM Wave (Lectures 10)
Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

Lab

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer
   (a) Measurement of charge and current sensitivity
   (b) Measurement of CDR
   (c) Determine a high resistance by Leakage Method
   (d) To determine Self Inductance of a Coil by Rayleigh's Method.
3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
5. To study the Characteristics of a Series RC Circuit.
6. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q .
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorem.
10. To verify the Superposition, and Maximum Power Transfer Theorem.

Reference Books

[1] Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw

[2] Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education

[3] Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.

[4] Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

[5] Elements of Electromagnetics, M. N. O. Sadiku, 2010, Oxford University Press.

[6] Electricity and Magnetism, J. H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

Third Semester

Honours Core Papers

PHY-HC-3016
Mathematical Physics II
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *After successful completion of the course, students will be able to solve differential equation using power series solution method, solve differential equation using separation of variables method, special integrals, different properties of matrix, Fourier series.*

Theory

Unit I: Frobenius Method and Special Functions (Lectures 18)

Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials.

Unit II: Partial Differential Equations (Lectures 14)

Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation.

Unit III: Some Special Integrals (Lectures 04)

Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions.

Unit IV: Matrix (Lectures 15)

Matrix algebra using index notation, Properties of matrices, Special matrix with their properties: Transpose matrix, complex conjugate matrix, Hermitian matrix, Anti-Hermitian matrix, special square matrix, unit matrix, diagonal matrix, co-factor matrix, adjoint of a matrix, self- adjoint matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix. Determinant, Rank, Eigen value, Eigen vector and diagonalisation of matrix.

Unit V: Fourier Series (Lectures 09)

Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coeffcients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Application to square and triangular waves.

Lab

Aim

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Introduction to Numerical computation softwares Introduction to Scilab/Mathematica/Matlab/Python, Advantages and disadvantages, Scilab / Mathematica / Matlab/ Python environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab / Mathematica / Matlab/ Python, Multidimensional ar- rays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab / Mathematica / Matlab/Python functions, Introduction to plotting, 2D and 3D plotting.

Curve fttting, Least square fit, Goodness of fit, standard deviation Ohms law to calculate R, Hooke's law to calculate spring constant.

Solution of Linear system of equations Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalisation of matrices, Inverse of a matrix, Eigen vectors, eigenvalues prob- lems. Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses).

Generation of Special functions Generation of Special functions using User defined functions in Scilab / Math- ematica / Matlab. Generating and plotting Legendre Polynomials Generating and plotting Hermite function.

First order ODE Solution of first order Differential equation Euler, modified Euler and Runge-Kutta second order methods. First order differential equation (a) Current in RC, LC circuits with DC source (b) Classical equations of motion.

Second order ODE Second order differential equation. Fixed difference method. Second order Differential Equation (a) Harmonic oscillator (no friction) (b) Damped Harmonic oscillator (c) Over damped (d) Critical damped.

Partial Differential Equation (PDE) Solution of Partial Differential Equation: (a) Wave equation (b) Heat equation.

Reference Books

[1] Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, and F. E. Harris, 2013, 7th Edn., Elsevier.

[2] An introduction to ordinary differential equations, E. A. Coddington, 2009, PHI

[3] Learning Differential Equations, George F. Simmons, 2007, McGraw Hill.

[4] Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.

[5] Mathematical Methods for Scientists and Engineers, D. A. McQuarrie, 2003, Viva Book

[6] Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5 Ed., 2012, Jones and Bartlett Learning

[7] Mathematical Physics, Goswami, 1st edition, Cengage Learning

[8] Engineering Mathematics, S. Pal and S. C. Bhunia, 2015, Oxford University Press

[9] Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India

[10] Essential Mathematical Methods, K. F. Riley and M. P. Hobson, 2011, Cambridge University Press

PHY-HC-3026
Thermal Physics
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *Upon successful completion, students will have the knowledge and skills to identify and describe the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, Thermodynamics potentials, Free energies, Maxwell's relations in thermodynamics, behaviour of real gases.*

Theory

Introduction to Thermodynamics

Unit I: *Zeroth and First Law of Thermodynamics* (Lectures 08)

Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient.

Unit II: *Second Law of Thermodynamics* (Lectures 10)

Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & effciency. Refrigerator & coeffcient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Unit III: *Entropy* (Lectures 07)

Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

Unit IV: *Thermodynamic Potentials* (Lectures 07)

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.

Unit V: *Maxwell's Thermodynamic Relations* (Lectures 07)

Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of C_p-C_v, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.

Kinetic Theory of Gases

Unit VI: *Distribution of Velocities* (Lectures 07)

Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.

Unit VII: *Molecular Collisions* (Lectures 04)

Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

Unit VIII: *Real Gases* (Lectures 10)

Behaviour of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule- Thomson Cooling.

Lab

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

Reference Books

[1] Heat and Thermodynamics, M. W. Zemansky, Richard Dittman, 1981, McGraw-Hill.

[2] A Treatise on Heat, Meghnad Saha, and B. N.Srivastava, 1958, Indian Press

[3] Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill

[4] Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.

[5] Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.

[6] Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press

[7] Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

PHY-HC-3036
Digital Systems & Applications
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *After successful completion of the course student will be able to understand the working principle of CRO, develop a digital logic and apply it to solve real life problems, Analyze, design and implement combinational logic circuits, Classify different semiconductor memories, Analyze, design and implement sequential logic circuits, Analyze digital system design using PLD, Simulate and implement combinational and sequential circuits.*

Theory

Unit I: Introduction to CRO (Lectures 03)

Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

Unit II: Integrated Circuits (qualitative treatment only) (Lectures 03)

Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital lCs.

Unit III: Digital Circuits (Lectures 06)

Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates.

Unit IV: Boolean Algebra (Lectures 06)

De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

Unit V: Data Processing Circuits (Lectures 04)

Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.

Unit VI: Arithmetic Circuits (Lectures 05)

Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

Unit VII: Sequential Circuits (Lectures 06)

SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race- around conditions in JK Flip-Flop. M/S JK Flip-Flop.

Unit VIII: Timers: IC 555 (Lectures 03)

Block diagram and applications: Astable multivibrator and Monostable multivibrator.

Unit IX: Shift Registers (Lectures 02)

Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).

Unit X: Counters (4 bits) (Lectures 04)

Ring Counter, Asynchronous counters, Decade Counter. Synchronous Counter.

Unit XI: Computer Organization (Lectures 06)

Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing.

Unit XII: Intel 8085 Microprocessor Architecture (Lectures 08)

Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry.

Unit XIII: Introduction to Assembly Language (Lectures 04)

1 byte, 2 byte, & 3 byte instructions.

Lab

A minimum of eight experiments to be done.

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. Half Adder, Full Adder and 4-bit binary Adder.
8. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder IC.
9. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
10. To build JK Master-slave flip-flop using Flip-Flop ICs .
11. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
12. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
13. To design an astable multivibrator of given specifications using 555 Timer.
14. To design a monostable multivibrator of given specifications using 555 Timer.
15. Write the following programs using 8085 Microprocessor
    (a) Addition and subtraction of numbers using direct addressingmode
    (b) Addition and subtraction of numbers using indirect addressin gmode
    (c) Multiplication by repeated addition
    (d) Division by repeated subtraction
    (e) Handling of 16-bit Numbers
    (f) Use of CALL and RETURN Instruction (g) Block data handling

Reference Books

[1] Digital Principles and Applications, A. P. Malvino, D. P. Leach and Saha, 7th Ed., 2011, Tata McGraw

[2] Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.

[3] Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.

[4] Digital Electronics G. K. Kharate ,2010, Oxford University Press

[5] Digital Systems: Principles & Applications, R. J. Tocci, N. S. Widmer, 2001, PHI Learning

[6] Logic circuit design, Shimon P. Vingron, 2012, Springer.

[7] Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.

[8] Digital Electronics, S. K. Mandal, 2010, 1st edition, McGraw Hill

[9] Microprocessor Architecture Programming & applications with 8085, 2002, R. S. Goankar, Prentice Hall.

Honours Generic Paper

PHY-HG-3016 (PHY-RC-3016)
Thermal Physics & Statistical Mechanics
Total Lectures: 60 Credits: 6 (Theory: 04, Lab : 02)

Course outcome: *Upon completion of this course, students are expected learn the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations, Maxwell's thermodynamic relations, fundamentals of the kinetic theory of gases, Maxwell-Boltzman distribution law, equipartition of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion, black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances, quantum statistical distributions, viz., the Bose-Einstein statistics and the Fermi-Dirac statistics. In the laboratory course, the students will be able to Measure of Planck's constant using black body radiation, determine Stefan's Constant, coefficient of thermal conductivity of a bad conductor and a good conductor, determine the temperature coefficient of resistance, study variation of thermo emf across two junctions of a thermocouple with temperature etc.*

Theory

Unit I : Laws of Thermodynamics (Lectures 22)

Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between C_P & C_V , Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

Unit II : Thermodynamic Potentials (Lectures 10)

Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for ($C_P - C_V$), C_P/C_V , $T\,dS$ equations.

Unit III : Kinetic Theory of Gases (Lectures 10)

Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

Unit IV : Theory of Radiation (Lectures 06)

Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

Unit V : Statistical Mechanics (Lectures 12)

Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity – Quantum statistics – Fermi-Dirac distribution law – electron gas – Bose-Einstein distribution law – photon gas – comparison of three statistics.

Lab

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system.
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.

Reference Books

[1] Heat and Thermodynamics, M. W. Zemansky, Richard Dittman, 1981, McGraw-Hill.

[2] A Treatise on Heat, Meghnad Saha, and B. N.Srivastava, 1958, Indian Press

[3] Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill

[4] Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.

[5] Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.

[6] Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press

[7] Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

[8] Statistical Mechanics, R. K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.

[9] Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill

[10] Statistical and Thermal Physics, S. Lokanathan and R. S. Gambhir. 1991, Prentice Hall

Skill Enhancement Papers
[Choose One]

PHY-SE-3014
Physics Workshop Skills
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics or a B.E/B.Tech in Mechanical Engineering

The aim of this course is to enable the students to familiar and experience with various mechanical and electrical tools through hands-on mode

Unit I: Introduction (4 Lectures)
Measuring units. conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc.

Unit II: Mechanical Skill (10 Lectures)
Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood. Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothening of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. Make funnel using metal sheet.

Unit III : Electrical and Electronic Skill (10 Lectures)
Use of Multimeter. Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. Making regulated power supply. Timer circuit, Electronic switch using transistor and relay.

Unit III : Introduction to prime movers: (6 Lectures)
Mechanism, gear system, wheel, Fixing of gears with motor axel. Lever mechanism, Lifting of heavy weight using lever. braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment.

Lab

1. Study the use of meter scale, Vernier caliper, Screw Gauge.
2. To measure dimension of solid block, volume of cylindrical beaker/ glass, diameter of thin wire, thickness of metal sheet.
3. To measure height of building, mountain using Sextant
4. To join metals using welding.
5. To prepare nut, bolts etc. using lathe machine and other tools.
6. To Cut a metal sheet and smoothening of the cutting edge using file.
7. Study the use of multimeter and Oscilloscope.
8. To use soldering of electrical circuit having discrete components on PCB.
9. To construct a regulated power supply
10. Demonstration of lifting of heavy weight using lever

Reference Books:

[1] A text book in Electrical Technology-B L Theraja – S. Chand and Company.
[2] Performance and design of AC machines – M.G. Say, ELBS Edn.
[3] Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.
[4] Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edn., Editor Newnes [ISBN: 0750660732]
[5] New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of Ireland [ISBN: 0861674480]

PHY-SE-3024
COMPUTATIONAL PHYSICS SKILLS
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with adequate knowledge on computer programming/An MCA/M.Sc. with DCA.

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- *Highlights the use of computational methods to solve physical problems*
- *Use of computer language as a tool in solving physics problems (applications)*
- *Course will consist of hands on training on the Problem solving on Computers.*

Theory

Unit I: Introduction (Lectures 3)

Importance of computers in Physics, paradigm for solving physics problems for solution. Introduction to various OS, Linux OS such as RedHat, Ubuntu, Scientific Linux, Usage of Basic linux commands. Text editors such as vi and Emacs.

Unit II: Basics of Scientific Programming (Lectures 4)

Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

Unit III: Scientific Programming (Lectures 18)

Variables and Formatting: Introduction to HLL, Concepts of a Compiler. Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of a Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.

Control Statements, Functions, and Subroutines: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file.

Unit V: Visualization (Lectures 5)

Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, curve fitting – straight line, polynomials, user defined function. Physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

Hands on exercises:

1. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor.
2. To print out all natural even/ odd numbers between given limits.
3. To find maximum, minimum and range of a given set of numbers.
4. Calculating Euler number using exp(x) series evaluated at x=1
5. To compile a frequency distribution and evaluate mean, standard deviation etc.
6. To evaluate sum of finite series and the area under a curve.
7. To find the product of two matrices
8. To find a set of prime numbers and Fibonacci series.
9. To write program to open a file and generate data for plotting using Gnuplot.
10. Plotting trajectory of a projectile projected horizontally.
11. Plotting trajectory of a projectile projected making an angle with the horizontally.
12. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
13. To find the roots of a quadratic equation.
14. Motion of a projectile using simulation and plot the output for visualization.
15. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
16. Motion of particle in a central force field and plot the output for visualization.

Reference Books:

[1] Introduction to Numerical Analysis, S.S. Sastry, 5^{th} Edn., 2012, PHI Learning Pvt. Ltd.

[2] Computer Programming in Fortran 77". V. Rajaraman (Publisher: PHI).

[3] LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).

[4] Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)

[5] Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.

[6] Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)

[7] A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning Elementary Numerical Analysis, K.E. Atkinson, 3^{rd} Edn., 2007, Wiley India Edition.

PHY-SE-3034
Computer Assembling and Networking
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate course on Computer Assembling and Networking, B.E./B.Tech. in Computer Science/ MCA/First class or Second class govt registered contractor with a Bachelor Degree in Science/ B.Sc. with DCA.

The aim of the course is give overview of the different components in a computer and their assembling and dissembling and handling of installation of operating system in computer. It will also give overview of the networking, different hardware and components of networking.

Course Outcome: *After successfully completing the course students will be able to Identify Computer Hardware Components, Network Components and Peripherals, assemble and dissemble a computer, Identify the different types of network topologies and protocols. Enumerate the layers of the OSI model and TCP/IP. Explain the function(s) of each layer, Identify the different types of network devices and their functions within a network, Understand and building the skills of subnetting and routing mechanisms., Familiarity with the basic protocols of computer networks, and how they can be used to assist in network design and implementation.*

Unit I: Components of Computer (Lectures 10)
Specifications of processors (Intel Celeron, P4family, Xeon dual core, quad core, core2 duo, i3, i5, i7 and AMD).
Memory devices, types, principle of storing. Data organization 4bit, 8-bit, word. Semiconductor memories, RAM, ROM, PROM, EMPROM, EEPROM, Static and dynamic. Example of memory chips, pin diagram, pin function.
Concept of track, sector, cylinder. FD Drive components read write head, head actuator, spindle motor, sensors, PCB.
Precaution and care to be taken while dismantling Drives. Drive bay, sizes, types of drives that can be fitted. Precautions to be taken while removing rive bay from PC.
HDD, advantages, Principle of working of Hard disk drive, cylinder and cluster, types, capacity, popular brands, standards, interface, jumper setting. Drive components- hard disk platens, and recording media, air filter, read write head, head actuator, spindle motor, circuit board, sensor, features like head parking, head positioning, reliability, performances, shock mounting capacity. HDD interface IDE, SCSI-I/2/3 comparative study. Latest trends in interface technology in PC and server HDD interface. Concept of SATA and SACH.
Precautions to be taken while fitting drives into bays and bay inside PC cabinet. CMOS setting. (restrict to drive settings only). Meaning and need for Using Scan disk and defrag. Basic blocks of SMPS, description of sample circuit. Vendor/sources of PC hardware components.

Unit II: Operating System Basics & Installation (Lectures 4)
Introduction to OS, Types of Operating systems, System files FAT and NTFS DOS, Windows XP, Windows Vista, Windows 7 and Windows 8, Windows 10 and RedHat Linux and Multi Boot Operating System

Unit III: Overview of Networking (Lectures 2)
Introduction to networks and networking, LAN, VLAN, CAN, MAN, WAN, Internet and Intranet etc. Uses and benefits of Network, Server-client based network, peer to peer networks.

Unit IV: Network Hardware and Components (Lectures 4)
Concept of Server, client, node, segment, backbone, host etc. Analog and Digital transmission, Network Interface Card, Crimping tools and Color standards for Straight crimping and Cross crimping Functions of NIC, Repeaters, Hub, Switches, Routers, Bridges, Router etc.

Unit V: Transmission Media and Topologies (Lectures 4)
Media types: STP cable, UTP cable, Coaxial cable, Fiber cable, Base band and Broadband transmission, Cables and

Connectors, Physical and logical topologies, Bus, Star, Ring and Mesh topologies

Unit VI: Protocols and Services (Lectures 3)

HTTP, FTP and other Different types of protocols, OSI Model, Media Access Method, DNS services, DHCP services, WINS services and RAS services, Web services, Proxy Services etc.

Unit VII: TCP/IP and Sub-netting (Lectures 3)

Introduction about TCP/IP and Sub-nettings, configuring IP address and subnettings with different Routers and Network, TCP/IP Errors and Solutions,

Lab

(i) Computer Assembling and Operating System Installations

1. Installation of different Operating Systems Windows XP, Windows 7, Windows 10, RedHat, Linux,
2. Installation Dual Operating System like: Windows XP and Windows 7, Ubuntu, Linux
3. Troubleshooting and Repair Operating System : Windows XP, Windows 7, Windows 10, RedHat, Linux
4. Tacking Data Backup and System Formatting and OS Installation
5. Check various front panel connections on motherboard (power switch, reset switch and HDD Led). Check power and reset switch connection. Replace faulty power switch from cabinet and assemble a new one.
6. Check DDR3 and DDR4 RAM's FSB. Insert it on memory slot. Test and understand various beep sounds in case of trouble.
7. Find the CMOS/ROM BIOS chip on mother board.
8. Install a Hard Drive. Identify and check data and power cable and SATA and SACH ports in motherboards.
9. Install internal and external DVD ROM Drive.
10. Troubleshoot defects related to SMPS, its cable, connector and servicing procedure. Removing a Power Supply. Installing a Power Supply. Use SMPS tester.
11. Install a Graphic and sound cards. Remove them safely.
12. Install and removing cooling Fans on pc cabinet.
13. Removing the Motherboard carefully and Install it again.
14. Removing the Processor, Installing the Processor. Understand and identify various different processor sockets.
15. Installing different type of CPU Cooler.
16. Find the CMOS Battery. Test it with multimeter. Replace it.

(ii) Networking

1. Installing and Configuring Windows 2003 and 2008 Server or latest server
2. Cable Crimping using Different Color Codes (Straight and Cross Cable)
3. Installation and configuring Peer to Peer and Server-Client Network
4. Installation and Configuring Active Directory Services
5. Installation and Configuring DNS & DHCP Services
6. Installation and Configuring FTP, HTTP Services
7. Backup and Restoration for ADS, DHCP and User Data
8. FAT and NTFS Sharing Permission
9. Configuring & Implementing Unmanageable Network Switch
10. Configuring & Implementing Manageable Network Switch
11. Configuring a Local Security Policies & Domain Security Policies
12. Installing Printer in Windows XP, Windows 7, Windows 2003 & 2008 Server
13. Configuring Gateway Service for Internet Connectivity
14. Configuring ADSL+2 Router for BSNL/other Internet Connectivity
15. Configuring Wireless Access Point
16. Installation and Configuring Wire Network
17. Installation and Configuring Wireless Network
18. Installation of AD-hoc Wireless Network
19. Installation and Configure Different Antivirus Software and Admin Console
20. Remote Desktop, Remote Assistance, Telnet, HyperTerminal, TeamViewer

Reference Books:

[1] Fundamentals of Computer by V Rajaraman; Prentice Hall of India Pvt. Ltd., New Delhi

[2] Information Technology for Management by Henery Lucas, Tata McGraw Hills, New Delhi

[3] Computers Fundamentals Architecture and Organisation by B Ram, revised Edition, New Age International Publishers, New Delhi

[4] Computer Networking A Top-Down Approach, Kurose James F., Ross Keith W., Sixth Edition By Pearon

PHY-SE-3044
Digital Photography & Editing
Credits: 4 (Theory: 02, Lab: 02)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with a certificate on digital photography/Professional Photographer with degree or diploma in photography with adequate knowledge on digital editing and a Bachelor degree in Science.

This course will give you the basic understanding of photography, Physics behind working of camera, various composition techniques that will help you to take superior photos. Various composition techniques those will help the students to improve the photos. This course will give the students an overview and explanation of what good overflow in photography look like.

Course Outcome: *On successful completion of the course students will be able to indentify cameras according to formats and view finder systems, identify types of lenses and state what type of lenses to be used for different purposes, apply settings of shutter speed, control depth of field via aperture settings, apply suitable focal length, Use the light metering mechanism of the camera to take photographs.*

Theory

Unit I: Theory of Basic Photography (Lectures 2)

History of Photography, Introduction to Digital Photography, Digital Camera, dSLR, Advantages and Disadvantages of Digital Photography

Unit II: The Camera- Components and Concepts (Lectures 2)

Lens, Focal Length, Lens type, Aperture, Depth of Field, Shutter, Shutter Speed, Image sensor, Memory cards, External Flash, File types

Unit III: Capturing an Image, Hands-on Basics (Lectures 3)

Elements of Composition: Pattern, Symmetry, Texture, Depth of Field, Lines; Law of Thirds, Camera Shake, Red eye, Lighting, Digital Noise

Unit IV: Exposure Modes (Lectures 5)

Automatic mode, Manual mode, aperture mode, shutter mode, Scene mode, Portrait mode, landscape mode, close up mode, sports mode, Twilight mode, Night Mode, Black and white, sepia, Panoramic **mode**.

Unit V: Conditions in Digital Photography (Lectures 7)

Lighting, Importance of Natural Light, Best Time of Day to Take Photos, Disable Flash Indoors, Disable Flash in Low Light, Use Flash to Balance Bright Light, Get Closer to the Subject, Crop Your Photo, Choose Better Backgrounds, Pick Proper Orientation, Use Point of View, Frame your Subject, Experiment with Abstract Photography, Holding your DSLR

Unit VI: Digital Videography (Lectures 4)

Various Parts, Contrl and Features of Video Camera, Types of daylight applications, Three points lighting- (a) The key light, (b) The fill light and the back light, (c) Bounce and diffuse light, Framing and shots, Camera angle and camera movements

Unit VII: Post Production (Lectures 7)

The Digital Workflow: Capturing the Image, Storing the Photo, Cataloging the Image Files, Editing the Photo,

Reference Books

[1] Beginner's Guide to Digital Photography
[2] Complete Idiot's Guide to Digital Photography – Steve Greenberg
[3] Complete Digital Photography Third Edition – Ben Long
[4] The Textbook of Digital Photography Second Edition – Dennis P. Curtin

PHY-SE-3054
VIDEO EDITING FOR SOCIAL MEDIA
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on video editing/ B.E./B.Tech. in Computer Science/ MCA/B.Sc with DCA.

This course will give you the skills to edit innovative videos for news, events, food, travel or blogging to be promoted on Social Media platforms. You will learn to create & edit these videos on the most popular and industry relevant video editing software, Adobe Premiere Pro.

Course Outcome: *On successful completion of the course students will be able to learn to Edit impactful video content which appeals to target audience, Add or Edit Music, Soundtrack or Audio to your videos, Learn to customize your videos by using Text (fonts), Learn to use transitions and effects to create impactful videos.*

Tools: Adobe Premiere CC

Unit I: What's New in Premiere Pro CC 7.0 (Lectures 2)
New Features: Summary, Workspace

Unit II: Workflow and Project Setup (Lectures 2)
Basic Workflow, Preferences

Unit III: Importing Footage (Lectures 2)
Transferring and Importing Files, Supported File Format, Importing Sequences, Clip Lists, Compositions, Still Images, and Digital Videos

Unit IV: Working Sequences (Lectures 3)
Creating and Changing Sequences, Adding, Rearranging, and Working with Clips in a Sequences, Rendering and Previewing Sequences

Unit V: Editing Audio (Lectures 4)
Overview of Audio and Audio Track Mixer, Working with Clips, Channels, and Tracks, Editing Audio in a Timeline Panel, Adjusting Volume Levels

Unit VI: Titling and the Titler (Lectures 4)
Creating and Editing Titles, Creating and Formatting Text in Titles, Working with Text and Objects in Titles

Unit VII: Effects (Lectures 5)
About Effects - Applying, Removing, Finding, and Organizing Effects, Viewing and Adjusting Effects, Keyframes, and Effects Presets, Masking and Tracking, Applying Transitions, Adjustment Layers, Color Correction and Adjustments, Three-way Color Corrector Effect, Audio Effects and Transitions

Unit VIII: Compositing and Exporting (Lectures 4)
Compositing, Alpha Channels, and Adjusting Clip Opacity, Blending Modes, Workflow and Overview for Exporting, Exporting Projects for Other Applications, Exporting Still Images

Unit IX: Patching of Rough Cuts (Lectures 4)
Working with Rough Cut, Editing Rough Cuts, The Prelude Workspace, Exporting Still Images

PHY-SE-3064
WEATHER FORECASTING
Credits: 4 (Theory: 02, Lab: 02)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with PhD in Atmospheric Physics.

The aim of this course is not just to impart theoretical knowledge to the students but to enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques

Theory

Unit I: Introduction to atmosphere (Lectures 9)

Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; atmospheric pressure: its measurement; atmospheric boundary layer and its characteristics; atmospheric convection and inversion; introduction to numerical weather prediction systems.

Unit II: Measuring the weather (Lectures 4)

Wind; forces acting to produce wind; measurement of wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

Unit III: Weather systems (Lectures 3)

Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes, Indian summer monsoon.

Unit IV: Climate and Climate Change (Lectures 6)

Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.

Unit V: Basics of weather forecasting (Lectures 8)

Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

Lab

1. Study of synoptic charts & weather reports, working principle of weather station.
2. Processing and analysis of weather data
   (a) To calculate the sunniest time of the year.
   (b) To study the variation of rainfall amount and intensity by wind direction.
   (c) To observe the sunniest/driest day of the week.
   (d) To examine the maximum and minimum temperature throughout the year.
   (e) To evaluate the relative humidity of the day.
   (f) To examine the rainfall amount month wise.
3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis.
4. Formats and elements in different types of weather forecasts/ warning (both aviation and non aviation)

Reference books

[1] Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
[2] The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.
[3] Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
[4] Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur.
[5] Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.
[6] Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

PHY-SE-3074
APPLIED OPTICS
Credits: 4 (Theory: 2, Lab: 2)
THEORY: 30 Lectures

Preferred minimum qualification of the teacher/instructor: Asst. Professor of Physics with PhD in Experimental Spectroscopy/Optics.

Theory includes only qualitative explanation. Minimum five experiments should be performed covering minimum three sections.

Theory

Unit I: Sources and Detectors (Lectures 10)

Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers.

Experiments on Lasers:

(b) Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.
(c) To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
(d) To find the polarization angle of laser light using polarizer and analyzer

Experiments on Semiconductor Sources and Detectors:

(a) V-I characteristics of LED
(b) Study the characteristics of solid state laser
(c) Study the characteristics of LDR
(d) Photovoltaic Cell

Unit II: Holography (Lectures 8)

Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition.

Experiments on Holography and interferometry:

(a) Recording and reconstructing holograms
(b) Constructing a Michelson interferometer or a Fabry Perot interferometer
(c) Measuring the refractive index of air
(d) White light Hologram

Unit III: Photonics: Fibre Optics (Lectures 12)

Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating

Experiments on Photonics: Fibre Optics

(a) To measure the numerical aperture of an optical fibre
(b) To study the variation of the bending loss in a multimode fibre

Reference Books:

[1] Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.
[2] LASERS: Fundamentals & applications, K.Thyagrajan & A.K.Ghatak, 2010, Tata McGraw Hill
[3] Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
[4] Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
[5] Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.
[6] Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.
[7] Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.
[8] Optical Physics, A.Lipson, S.G.Lipson, H.Lipson, 4th Edn., 1996, Cambridge Univ. Press

PHY-SE-3084
TECHNICAL DRAWING
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with a certificate on Technical Drawing/B.E./B.Tech. in Mechanical Engineering.

The subject is aimed at developing basic graphic skills in the students so as to enable them to use these skills in preparation of engineering drawings, their reading and interpretation. The emphasis, while imparting instructions, should be to develop conceptual skills in the students.

Course Outcome: *After successfully completing the course students will be able to draw free hand sketches of various kinds of objects, apply different dimensioning methods on drawing of objects, different types of scales and their utilization in reading and reproducing drawings of objects and maps, Draw 2 - dimensional view of different objects viewed from different angles, Generate isometric (3D) drawing from different 2D (orthographic) views/sketches, use basic commands of Auto CAD.*

Theory

Unit I: Introduction (Lectures 4)

Drafting Instruments and their uses. lettering: construction and uses of various scales: dimensioning as per I.S.I. 696-1972. Engineering Curves: Parabola: hyperbola: ellipse: cycloids, involute: spiral: helix and loci of points of simple moving mechanism. 2D geometrical construction. Representation of 3D objects. Principles of projections.

Unit II: Projections (Lectures 6)

Straight lines, planes and solids. Development of surfaces of right and oblique solids. Section of solids.

Unit III: Object Projections (Lectures 4)

Orthographic projection. Interpenetration and intersection of solids. Isometric and oblique parallel projection of solids.

Unit IV: CAD Drawing (Lectures 16)

Introduction to CAD and Auto CAD, precision drawing and drawing aids, Geometric shapes, Demonstrating CAD-specific skills (graphical user interface. Create, retrieve, edit, and use symbol libraries. Use inquiry commands to extract drawing data). Control entity properties. Demonstrating basic skills to produce 2-D and 3-Ddrawings. 3D modeling with Auto CAD (surfaces and solids), 3D modeling with sketch up, annotating in Auto CAD with text and hatching, layers, templates & design center, advanced plotting (layouts, viewports), office standards, dimensioning, internet and collaboration, Blocks, Drafting symbols, attributes, extracting data. basic printing, editing tools, Plot/Print drawing to appropriate scale.

Reference Books

[1] K. Venugopal, and V. Raja Prabhu. Engineering Graphic, New Age International

[2] AutoCAD 2014 & AutoCAD 2014/Donnie Gladfelter/Sybex/ISBN:978-1-118-57510-9

[3] Architectural Design with Sketchup/Alexander Schreyer/John Wiley & Sons/ISBN: 978-1-118-12309-6

PHY-SE-3094
PAGEMAKER
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on PageMaker/B.E./B.Tech. in Computer Science / MCA/ B.Sc. with DCA.

This course prepares students for proficiency in electronic publishing with the Adobe PageMaker publishing and graphics software application. The course topics include: skills using the PageMaker software; creating simple single-page publications; creating multiple page publications; working with text; working with graphics; formatting; and publishing publications electronically.

Course Outcome: *On successful completion of the course students will be able to Create Documents and Templates, add text into documents using various methods, and apply different formatting styles to characters and paragraphs, Import graphics, create objects using various tools, add effects to objects, Create a book and export it into PDF, Multipage Layout Design.*

Theory

Unit I: Pagemaker Basics (4 Lectures)

Starting PageMaker, PageMaker Window Elements, Viewing the Page, Floating Palettes, Toolbox, Using the Zoom Tool, Using the Rulers, Displaying the Rulers, Using the Revert Feature. Opening a Publication, Creating a New Document, Setting the Margins, Setting the Page Size, Setting the Page Orientation, The Page Icons, Displaying Master Pages and Master Page Items, Inserting and Removing Pages, Inserting a Page, Removing a Page, Setting Page Numbers, Saving a New Document, Saving an Existing Document, Saving a Document as Another Document, Closing a Document.

Unit II: The text and drawing tool (4 Lectures)

Introduction, Using the Text Tool, Creating Text From Scratch, The Manual Text Icon, The Autoflow Text Icon, Text Blocks, Sizing and Positioning Text Blocks, Editing and Manipulating Text, Threading and Unthreading Text, Threading Additional Text, Threading Text to a Different Page, Unthreading Text Blocks, Rethreading Text Blocks.
The Line Tool, The Oval Tool, Rectangle Tool, Polygon Tool, Changing the Shape of Rectangle, Changing Strokes and Fills, Deleting an Object, Duplicating an Object.

Unit III: Importing Graphics (2 Lectures)

Introduction, Placing Graphics, Placing in-Line Graphics, Converting an Independent Graphic to an In-Line Graphic, Aligning In-Line Graphics, Sizing Graphics, Cropping Graphics, Object Linking and Embedding (OLE), Setting Up an OLE Liked Object, Embedding an OLE Object, Text Wrap.

Unit IV: Transformations (3 Lectures)

Introduction, Using the Control Palette, Control Palette Basics, Modifying Objects by Adjusting Values, Using the Reference-Point Proxy, Setting Measurement and Nudge Preferences, Moving Objects, Rotating an Object, Reflecting an Object, Skewing an Object, Removing Transformation, Aligning and Distributing Objects, Grouping and Ungrouping, Rules for Grouping Objects, Changing the Staking Order of Objects, Locking Objects.

Unit V: Utilities (3 Lectures)

Creating PDF Files with Acrobat, Creating an Adobe Acrobat File, Font Issues, Managing Automatic Hypertext Links, Using the Tables Editor, Setting Adobe Table Defaults, Adobe Table Preferences, Typing, Editing and Formatting Text in Adobe Table, Formatting Text in a Table, Exporting and Saving Adobe Tables, Exporting Tables from Adobe Table, Exporting a Table as Text, Exporting a Table as a Graphic, Saving Adobe Tables, Importing and Updating Table, Sorting Pages, Balancing Columns, Create Keyline, Bullets and Numbering, Add

Continued Line.

Unit VI: Master Pages (3 Lectures)

Creating Master Pages, Setting Up Pages, Numbering Pages, Adding Page Numbers, Adding a Prefix to Page Numbers, Numbering pages within a book, Setting Margins, Setting Print-related Document Setup Options, Resizing 1-bit Bitmap Images, Column Guides, Setting Up Ruler Guides, Revising, Deleting and Renaming Masters, Removing Master Page Formatting, Displaying Master Pages and Master Page Items, Showing Master Pages, About the Adjust Layout Option.

Unit VII: Working with large amount of texts (2 Lectures)

Introduction, Character Specifications, Paragraph Specifications, Changing Indents, Paragraph Spaces, Alignment, Adding Lines Above or Below Your Paragraphs, Indent/Tabs, Hyphenation, Grid Manager.

Unit VIII: The story editor (3 Lectures)

Introduction, Using the Story Editor, Starting at a Particular Spot in a Story, Placing the Story, Returning to an Open Story Window, Creating and Editing Text in Story Editor, Managing Story Editor Windows, Story Editor Preferences, Navigating through Text, Using the Key Board, Selecting Text, Cutting, Copying, Deleting and Pasting Text, Using the Spelling Checker, Starting the Speller, Adding Words to Dictionaries, Using Find and Change, The Find Feature, Searching with Wildcard Characters, Searching for Phrases, Searching for Special Attributes, Positioning the Find Dialog Box, Using the Change Feature, Replacing Text, Replacing Special Attributes, Story Editor and Layout Views.

Unit IX: Pagemaker style Sheets (3 Lectures)

Introduction, Defining Styles, Creating New Styles, Editing Styles, Removing Styles, Copying Styles, Applying Styles to Text, Changing Styles, Modifying Styles Text.

Unit X: Long documents features (3 Lectures)

Compiling Chapters into a Book, Preparing the Book, Combing the Chapters, Numbering Pages, Restarting Page Numbering, Creating a Table of Contents.

Practical / Lab work to be performed

1. Letter Head Design
2. Business Card Design
3. Sign Board Design
4. Cash Memo Design
5. Logo Design
6. Certificate Design
7. Newspaper Advertisement Design
8. Build Booklet, Page Numbering
9. Type a Doc Using Story Editor
10. Newsletter Design (Page Layout Design)

Fourth Semester

Honours Core Papers

PHY-HC-4016
Mathematical Physics III
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: On successful completion of the course students will able to solve complex integrals using residue theorem, apply Fourier and Laplace transforms in solving differential equations, understand properties of Tensor like Transformation of coordinates, contravariant and co-variant tensors, indices rules for combining tensors.

Theory

Unit I: Complex Analysis (Lectures 10)

Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity.

Unit II: Complex Integration (Lectures 10)

Integration of a function of a complex variable. Cauchys Integral formula. Simply and multiply connected region. Laurent and Taylors expansion. Residues and Residue Theorem with numerical application.

Unit III: Fourier Transforms (Lectures 15)

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier trans- form of trigonometric, Gaussian functions Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem (Statement only). Properties of Fourier transforms (translation, change of scale, complex conjugation).

Unit IV: Laplace Transforms (Lectures 15)

Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem (Statement only). Inverse LT. Application of Laplace Transforms to 2nd order Differential Equations: Damped Harmonic Oscillator.

Unit V: Tensor Algebra (Lectures 10)

Introduction to tensor, Transformation of co-ordinates, Einsteins summation convention. contravariant and co- variant tensor, tensorial character of physical quantities, symmetric and antisymmetric tensors, kronecker delta, Levi-Civita tensor. Quotient law of tensors, Raising and lowering of indices Rules for combination of tensors- addition, subtraction, outer multiplication, contraction and inner multiplications.

Lab

1. Solve differential equations

   $\frac{dy}{dx} = e^x$ with $y = 0$ for $x = 0$

   $$\frac{dy}{dx} + e^{-x}y = x^2$$

   $\frac{d^2y}{dt^2} + 2\frac{dy}{dt} = -y$

   $\frac{d^2y}{dt^2} + e^{-t}\frac{dy}{dt} = -y$
2. Dirac Delta Function

Evaluate the integral I

$I = \frac{1}{\sqrt{2\pi\sigma^2}} \int exp\left[-\frac{(x-2)^2}{2\sigma^2}\right](x+3)dx$ for $\sigma = 1.0, 0.1, 0.01$ and show the $I \rightarrow 5$

3. Fourier Series

   Make a program to evaluate

$$\sum_{n=1}^{\infty} (0.2)^n$$

   Evaluate the Fourier coefficients of a given periodic function (square wave)

4. Frobenius method and Special Functions

   Evaluate

$$\int_{-1}^{1} P_n(x)\, P_m(x) dx = \delta_{n,m}$$

   Plot $P_n(x)$, $j_\vartheta(x)$ and show the recursion relation.

5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two)

6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.

7. Evaluation of trigonometric functions e.g. $sin\theta$, ,given Bessel'sfunctionat *N* points find its value at an intermediate point.

8. Integrate

$$\frac{1}{(x^2+2)}$$

   Numerically in a given interval.

9. Compute the nth roots of unity for n=2, 3, and 4.

10. Find the two square roots of 5+12*j*.

11. Integral transform

    Evaluate FFT of e^{-x^2}

12. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace's transform.

Reference Books

[1] Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, and F. E.. Harris, 2013, 7th Edn., Elsevier.

[2] An introduction to ordinary differential equations, E. A. Coddington, 2009, PHI

[3] Learning Differential Equations, George F. Simmons, 2007, McGraw Hill.

[4] Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.

[5] Mathematical Methods for Scientists and Engineers, D. A. McQuarrie, 2003, Viva Book

[6] Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5 Ed., 2012, Jones and Bartlett Learning

[7] Mathematical Physics, Goswami, 1st edition, Cengage Learning

[8] Engineering Mathematics, S. Pal and S. C. Bhunia, 2015, Oxford University Press

[9] Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India

[10] Essential Mathematical Methods, K. F. Riley and M. P. Hobson, 2011, Cambridge University Press

PHY-HC-4026
Elements of Modern Physics
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *On completion of the course students will be able to understand modern development in Physics, Starting from Planck's law, it development of the idea of probability interpretation and the formulation of Schrodinger equation. Students will also get preliminary idea of structure of nucleus, radioactivity Fission and Fusion and Laser*

Theory

Unit I: Quantum Theory and Blackbody Radiation (Lecture 12)

Quantum theory of light; photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. group and phase velocities and relation between them. Two-slit experiment with electrons. Probability. wave amplitude and wave functions.

Unit II: Uncertainty and Wave-Particle Duality (Lecture 05)

Position measurement : gamma ray microscope thought experiment; wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from wave packets, impossibility of a particle following a trajectory; estimating minimum energy of a confined particle using uncertainty principle; energy-time uncertainty principle- application to virtual particles and range of an interaction.

Unit III: Schrödinger Equation (Lecture 8)

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrödinger equation for non- relativistic particles; expectation value, momentum and energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; probability and probability current densities in one dimension.

Unit IV: One-dimensional Box and Step Barrier (Lecture 9)

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; quantum dot as example; quantum mechanical scattering and tunnelling in one dimension-across a step potential and rectangular potential barrier.

Unit V: Structure of the Atomic Nucleus (Lecture 06)

Size and structure of atomic nucleus and its relation with atomic weight; impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Atomic Mass Unit. Nature of nuclear force, $N - Z$ graph, liquid drop model: semi-empirical mass formula and binding energy, nuclear shell model (qualitative discussions) and magic numbers.

Unit VI: Radioactivity (Lecture 08)

Stability curve and stability of nuclei, Law of radioactive decay, disintegration constant, half life and mean life. Activity unit. Alpha decay – Range energy relation, Fine structure of alpha energy spectrum. Beta decay energy released, continuous beta spectrum and Pauli's prediction of neutrino. Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

Unit VII : Detection of nuclear radiation (Lecture 04)

Method of energy loss by charged particles and gamma photons. Photoelectric, Compton and Pair-production processes Gas filled detectors – principle and construction of a gas filled detector, Ionization, proportional, GM and spark region.

Unit VIII: Fission and Fusion (Lecture 04)

Energy consideration in Nuclear Reaction, Q-value of nuclear reaction, Mass deficit, Einstein's mass-energy equivalence principle and generation of nuclear energy. Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235. Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

Unit IX: Lasers (Lecture 04)

Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing.

Lab

A minimum of six experiments to be done.

1. Measurement of Planck's constant using black body radiation and photo-detector.
2. Photo-electric effect
   Photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of $H - \alpha$ emission line of hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of iodine vapour.
8. To determine the value of e/m by (a) magnetic focusing or (b) bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using $I - V$ characteristics.
11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating.

Reference Books

[1] Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.

[2] Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill

[3] Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.

[4] Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.

[5] Modern Physics, G. Kaur and G. R. Pickrell, 2014, McGraw Hill

[6] Quantum Mechanics: Theory & Applications, A. K. Ghatak & S. Lokanathan, 2004, Macmillan

PHY-HC-4036
Analog Systems & Applications
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *On successful completion of the course students will be able to understand about the physics of semiconductor p-n junction and devices such as rectifier diodes, zener diode, photodiode etc. and bipolar junction transistors, transistor biasing and stabilization circuits, the concept of feedback in amplifiers and the oscillator circuits, students will also have an understanding of operational amplifiers and their applications.*

Theory

Unit I: Semiconductor Diodes (Lectures 10)

P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current flow mechanism in Forward and Reverse Biased Diode.

Unit II: Two-terminal Devices and their Applications (Lectures 06)

(1) Rectifier Diode: Half- wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell.

Unit III: Bipolar Junction Transistors (Lectures 06)

$n-p-n$ and $p-n-p$ Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.

Unit IV: Amplifiers (Lectures 10)

Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class *A, B* & *C* Amplifiers.

Unit V: Coupled Amplifier (Lectures 04)

Two stage RC-coupled amplifier and its frequency response.

Unit VI: Feedback in Amplifiers (Lectures 04)

Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

Unit VII: Sinusoidal Oscillators (Lectures 04)

Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

Unit VIII: Operational Amplifiers (Black Box approach) (Lectures 04)

Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.

Unit IX: Applications of Op-Amps (Lectures 09)

(1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.

Unit X: Convversion (Lectures 03)

Resistive network (Weighted and $R - 2R$ Ladder). Accuracy and Resolution. A/D Conversion (successive approximation).

Lab

A minimum of eight experiments to be done.

1. To study $V - I$ characteristics of PN junction diode, and Light emitting diode.
2. To study the $V - I$ characteristics of a Zener diode and its use as voltage regulator.
3. Study of $V - I$ & power curves of solar cells, and find maximum power point & effciency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To study the various biasing configurations of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt's oscillator.
11. To design a digital to analog converter (DAC) of given specifications.
12. To study the analog to digital convertor (ADC) IC.
13. To design an inverting amplifier using Op-amp (741/351) for dc voltage of given gain .
14. To design inverting amplifier using Op-amp (741/351) and study its frequency response.
15. To design non-inverting amplifier using Op-amp (741/351) & study its frequency response.
16. To study the zero-crossing detector and comparator.
17. To add two dc voltages using Op-amp in inverting and non-inverting mode.
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an Integrator.
20. To investigate the use of an op-amp as a Differentiator.

Reference Books

[1] Integrated Electronics, J. Millman and C. C. Halkias, 1991, Tata Mc-Graw Hill.

[2] Electronics: Fundamentals and Applications, J. D. Ryder, 2004, Prentice Hall.

[3] Solid State Electronic Devices, B. G. Streetman & S. K. Banerjee, 6th Edn.,2009, PHI Learning

[4] Electronic Devices & circuits, S. Salivahanan & N. S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

[5] OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall

[6] Microelectronic circuits, A. S. Sedra, K.C. Smith, A. N. Chandorkar, 2014, 6th Edn., Oxford University Press.

[7] Electronic circuits: Handbook of design & applications, U. Tietze, C. Schenk,2008, Springer

[8] Semiconductor Devices: Physics and Technology, S. M. Sze, 2nd Ed., 2002, Wiley India

[9] Microelectronic Circuits, M. H. Rashid, 2nd Edition, Cengage Learning

[10] Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Honours Generic Paper

PHY-HG-4016 (PHY-RC-4016)
Waves & Optics
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course outcome: *Upon completion of this course, students are expected to understand Simple harmonic oscillation and superposition principle, importance of classical wave equation in transverse and longitudinal waves and solving a range of physical systems on its basis, concept of normal modes in transverse and longitudinal waves: their frequencies and configurations, interference as superposition of waves from coherent sources derived from same parent source, Demonstrate understanding of Interference and diffraction experiments, Polarization. In the laboratory course, student will gain hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc. Resolving power of optical equipment, the motion of coupled oscillators, study of Lissajous figures and behaviour of transverse, longitudinal waves.*

Theory

Unit I: Superposition of Two Collinear Harmonic Oscillations (Lectures 04)
Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).

Unit II: Superposition of Two Perpendicular Harmonic Oscillations (Lectures 02)
Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

Unit III: Waves Motion (Lectures 07)
General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.

Unit IV: Fluids (Lectures 06)
Surface Tension: Synclastic and anticlastic surface – Excess of pressure – Application to spherical and cylindrical drops and bubbles – variation of surface tension with temperature – Jaegar's method. Viscosity – Rate flow of liquid in a capillary tube – Poiseuille's formula – Determination of coefficient of viscosity of a liquid – Variations of viscosity of liquid with temperature – lubrication.

Unit V : Sound (Lectures 06)
Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.

Unit VI : Wave Optics (Lectures 03)
Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

Unit VII : Interference (Lectures 10)
Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination and Fringes of equal thickness . Newton's Rings: measurement of wavelength . Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index Visibility of fringes.

Unit VIII : Michelson Interferometer (Lectures 03)

(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Refractive Index. (4) Visibility of fringes.

Unit IX : Diffraction (Lectures 14)

Fresnel and Fraunhofer diffraction . Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel diffraction pattern of a straight edge and at a circular aperture . Resolving Power of a telescope. Fraunhofer diffraction due to a Single slit , Diffraction grating . Resolving power of grating.

Unit X : Polarization (Lectures 05)

Transverse nature of light waves. Double Refraction, Plane, circular and elliptically polarized light , Production and analysis of polarized light. Retarding plates.

Lab

A minimum of five experiments to be done.

1. To study the variation in liquid column height with diameter of capillary tube and determine the surface tension of the liquid.
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify Z^2 — T Law.
3. To determine the coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method)
4. To determine the focal length of a convex mirror with the help of convex lens .
5. To determine the refractive index of a liquid by using plane mirror and convex lens.
6. To determine the focal length of two lenses and their combination by displacement method .
7. Familiarization with Schuster's focussing; determination of angle of prism.
8. To determine the Refractive Index of the Material of a Prism using Sodium Light.
9. To determine wavelength of sodium light using Newton's Rings.

Reference Books

[1] Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.

[2] Fundamentals of Optics, F. A. Jenkins and H.E. White, 1981, McGraw-Hill

[3] Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.

[4] Optics, Ajoy Ghatak, 2008, Tata McGraw Hill

[5] The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.

[6] The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

[7] Fundamental of Optics, A. Kumar, H. R. Gulati and D. R. Khanna, 2011, R. Chand Publications.

Skill Enhancement Papers
[Choose One]

PHY-SE-4014
BASIC INSTRUMENTATION SKILLS
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics/B.E./B.Tech in Instrumentation/Mechanical Engineering.

This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.

Theory

Unit I: Basic of Measurement (Lectures 4)

Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Unit II: Electronic Voltmeter (Lectures 4)

Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance.

Unit III: Cathode Ray Oscilloscope (Lectures 6)

Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.

Unit IV: (Lectures 3)

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

Unit V: Signal Generators and Analysis Instruments (Lectures 4)

Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

Unit VI: Impedance Bridges & Q-Meters (Lectures 3)

Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges.

Unit VII: Digital Instruments (Lectures 3)

Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

Unit VIII: Digital Multimeter (Lectures 3)

Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Lab

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R, L and C using a LCR bridge/ universal bridge.

Open Ended Experiments:

2. Using a Dual Trace Oscilloscope
3. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books

[1] Electronic Measurements and Instrumentation, K. Lal Kishore, Pearson India
[2] Electrical and Electronics Measurements and Instrumentation, Prithwiraj Purkait, Budhaditya Biswas, Santanu Das, Chiranjib Koley, McGraw Hill India.
[3] A text book in Electrical Technology - B L Theraja - S Chand and Co.
[4] Performance and design of AC machines - M G Say ELBS Edn.
[5] Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
[6] Logic circuit design, Shimon P. Vingron, 2012, Springer.
[7] Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
[8] Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
[9] Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
[10] Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

PHY-SE-4024
Research & Technical Writing
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with adequate knowledge on Latex/ B.E./B.Tech. in Computer Science/ MCA.

This aim of the course is to make the students aware about importance of research and technical writing. This course provides students with an introduction to technical writing, graphing and data analysis, and computer presentation with LaTex, Origin and Microsoft excel.

Course Outcome: *On successful completion of the course students will be able to identify and write different parts of technical reports, write article, thesis, and presentation in latex, create chart in Microsoft excel, use different format of chart based on need, plot data from different sources using Origin plot.*

Theory

Introduction (Lectures 4)

Structure and components of scientific reports - Types of report – Technical reports and thesis– Different steps in the preparation – Layout – Illustrations and tables - Bibliography, referencing and footnotes. Need of scientific word processor, examples of scientific word processors.

Unit II: Technical Writing in LaTex (Lectures 12)

Introduction to LaTeX, advantages of using LaTex, TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors. Applications of LaTex in article, thesis, slide preparation.

Unit III: Scientific graphing and data analysis (Lectures 14)

Creating chart in Microsoft excel, Types of chart- Column chart, line chart, Pie chart, Doughnut chart, bar chart, area chart, scatter chart, surface chart; Chart elements- Chart style, Chart filter, fine tune of chart; Chart design tools- Design and format.

The Origin Workspace, Multi-sheet Workbooks, Managing Data and Metadata, Importing Data from different sources, Working with Excel and Origin, Basic Data Manipulation, Creating and Customizing Graphs, Custom Graph Templates and Themes, Publishing Graphs, Basic Data Analysis, Customizing Data Import, Post Processing of Imported Data, Creating and Customizing Multi-layer Graphs, Data Exploration and Pre-selection, Advanced Nonlinear Fitting, including Creating Custom Fitting Functions, Analysis Themes, Customizing Reports and Creating Custom Tables in Graphs, Recalculating/Updating Results, Analysis Templates and Custom Reports, Peaks and Baseline.

PHY-SE-4034
Domestic and Industrial Electrical Wiring
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: B.E./B.Tech. in electrical engineering/First class or Second class govt. registered contractor with a Bachelor Degree in Science.

The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode. This course will enable the students to read, understand and interpret engineering drawing and communicate through sketches and drawings. Students will be able to prepare working drawings of panels, transmission and distribution and install and commission electrical wiring in domestic as well as industrial buildings.

Course Outcome: *After successfully completion of the course students will be able to r*ecognize various electrical devices and their symbols, Recognize various electrical devices placed on the panels/distribution boards and to design the panels, Read schematic and wiring diagrams of electrical devices, Read and interpret electrical installation plan, Practice and execute any type of wiring , Estimate and determine the cost of wiring installation

Theory
Unit I: Understanding Electrical Circuits (Lectures 3)
Main electric circuit elements and their combination; Rules to analyze DC sourced electrical circuits; Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources; Rules to analyze AC sourced electrical circuits.

Unit II: Electrical Drawing and Symbols (Lectures 10)
Various electrical symbols used in domestic and industrial installation and power system as per BIS code. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. Wiring diagram of light, fan, bell and alarm circuit, staircase and godown wiring, schematic diagram of lighting system of conference room, theatre, sports stadium etc. Design and drawing of panels, distribution board using MCB, ELCB, main switches and change over switches for domestic, industrial and commercial installations.

Unit III: Types of wiring (Lectures 5)
Basics of wiring- star and delta wiring; Cleat, Batten, casing-capping and conduit wiring, comparison of different types of wiring systems; selection and design of wiring schemes for particular situation (domestic and industrial), selection of wire, cables, wiring accessories and use of protective devices i.e., MCB, ELCB etc.; rating and current carrying capacity of wires, cables, fuse, switches, socket, MCBs, ELCBs and other electrical accessories.

Unit IV: Earthing (Lectures 2)
Concept and purpose of earthing, different types and procedure of earthing, drawing of plate and pipe earthing, test material and costing and estimating.

Unit V: Estimating and costing (Lectures 10)
(i) Domestic Installations: Standard practices as per IS and IE rules. Planning of circuits, sub circuits and position of different accessories, electrical layouts, preparing estimates including costs as per schedule rate pattern and actual market rate (single storey and multi storey buildings having similar electrical load)
(ii) Industrial Installations: Standard practices as per IS and IE rules; planning, designing and estimation of installation of single phase motors of different ratings, electrical circuit diagram, starters, preparation of list of materials,

estimating and costing on workshop with single phase , 3-phase motor laod and the light load
(iii) Service line connections: Estimate for domestic and industrial load from pole to energy meter.

Lab

1. Safety use in electricity, shock treatment methods, safety precautions.
2. To study & find the specifications of various types of wires and cables.
3. To measure the gauge of a given wire with the help of wire gauge.
4. To connect the wires with different electrical accessories.
5. Skinning the cable and joint practice on single and multi strand wire.
6. To measure the power of an electric motor by wattmeter.
7. To make a main switch board for house wiring
8. Installation of common electrical accessories such as switch, holder, plug on board.
9. Installation and wiring connection of ceiling fan, exhaust fan, geyser, water purifier.
10. Preparation of extension board.
11. Demonstrate electrical circuit diagrams related to electrical equipment
12. Calculate/ interpret electrical power rating of electrical circuits installed in the equipments
13. Carry out the earthing of the installed electrical circuit as per standard practice
14. Practice on different types of House Wiring installation and testing
15. Designing of light and fan scheme for a institutional or commercial building
16. House wiring circuits using fuse, switches, sockets, ceiling fan etc. in batten or P.V.C. casing-caping.
17. Prepare one estimate of materials required for CTS wiring for small domestic installation of one room and one verandah within 25 m^2 with given light, fan & plug points.
18. Prepare one estimate of materials required for conduit wiring for small domestic installation of one room and one verandha within 25 m^2 with given light, fan & plug points.
19. Prepare one estimate of materials required for concealed wiring for domestic installation of two rooms and one latrine, bath, kitchen & verandah within $80m^2$ with given light, fan & plug points.
20. Prepare one estimate of materials required for erection of conduct wiring to a small workshop installation about $30m^2$

Reference Books:

[1] Electrical Installation and Estimating- Surjit Singh, Dhanpatrai and sons
[2] A course in Electrical Installation, Estimating and costing- J B Gupta, S K Kataria and Sons
[3] A text book in Electrical Technology - B L Theraja - S Chand & Co.
[4] A text book of Electrical Technology - A K Theraja
[5] Performance and design of AC machines - M G Say ELBS Edn.

PHY-SE-4044
Photoshop
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on Photoshop/B.E./B.Tech. in Computer Science/MCA/ B.Sc. with DCA.

This course will give you skill to prepare creative effect to design stunning text style, design icons, business cards, illustrations and characters. You will learn to remove people or objects from photos, cut away a person from their background. In this course you will learn how to properly use Photoshop's tools, discover how to retouch and color correct photographic images.

Course Outcome: *On successful completion of the course students will be able to work with the tools in Adobe Photoshop CC, crop image in Adobe Photoshop CC, to resize an image for print and digital media in Adobe Photoshop CC, apply Photoshop filters in print and digital media, apply filters to sharpen the images, different types of brushes used for digital painting.*

Tools: Adobe Photoshop CC

Unit I: Getting Started with Adobe Photoshop CC (Lectures 3)
Overview of Adobe Photoshop CC, Features of Adobe Photoshop CC

Unit II: Importance of Adobe Photoshop CC (Lectures 5)
Overview of Tools Used in Adobe Photoshop CC, Importance of Adobe Photoshop CC

Unit III: Working with Typography (Lectures 4)
Typography, Creating Typographies, Choosing the Right Font and Color

Unit IV: Working with Layers and Images (Lectures 6)
Cropping a Photo, Resizing Images, Basics of Layers, Creating Layers for Print and Digital Media, Aligning Images within Multiple Layers, Merging Layer Techniques

Unit V: Working with Filters (Lectures 4)
Photoshop Filters, Smart Filters, Common Features of Photoshop Filter

Unit VI: Digital Painting in Adobe Photoshop CC (Lectures 4)
Working with Brush Tool, Importance of Using Colors

Unit VII: Masking and File Formats in Adobe Photoshop CC (Lectures 4)
Introduction to Mask, Creating Vector and Layer Masks, Essential File Formats, Choosing the Right Format for Print and Digital Media

PHY-SE-4054
MOTION GRAPHICS FOR ADVERTISING & FILMS
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on Photoshop/B.E./B.Tech. in Computer Science/MCA/ B.Sc. with DCA.

This course will give you the skills to design and create motion graphics for Ad Commercials and Films. You will learn to create & edit these motion graphics on the most popular and industry relevant Compositing software, Adobe After Effects.

Course Outcome: *On successful completion of the course students will be able to create Motion Graphic Design for Ads, Commercials, Promos & Film / Show Titles, use After Effects templates to create your own customized 2D or 3D Motion Graphics, Understand Working with Layers, create Shape morphing animation and build transitions, utilize After Effects' Motion Graphics Techniques.*

Tools: Adobe After Effects CC

Unit I: Getting started with Adobe After Effects CS6 (Lectures 3)
Introduction to Adobe After Effects CS6, Importing Files, Creating a Composition

Unit II: Basic Effects and Composition Animation (Lectures 5)
Adding Effects, Adding Animation, Expressions, Creating animation and Effects Presets

Unit III: Creating Video Composites with Green Screen Footage (Lectures 5)
Masks, Blending Modes, Tracking Mattes

Unit IV: Advanced Compositing Techniques (Lectures 6)
Motion Stabilization, Motion Tracking, Time Remapping Techniques

Unit V: 3D in After Effects (Lectures 6)
Introduction, Text Animation, Particle Preset

Unit VI: Previewing and Rendering Output (Lectures 5)
Previewing the Work, Rendering Process, Exporting to Different Output

PHY-SE-4064
Radiation Safety
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with PhD in Nuclear Physics/ Radiation Physics (preferably with a RSO degree from BRIT/BARC).

To ensure safety of the public, occupational workers and the environment, this course on the basic knowledge of radiation safety is introduced. The course is designed in such a way to acquaint the students with the sources of various natural and man-made radiation sources, risks involved in working in relatively high radiation zone, and safety measures to be taken to protect individual's health.

The students will acquire a basic knowledge of types and sources of radiations, interactions of radiations with matter, risks involved and safety measures to be taken.

Theory

Unit I: Structure of Matter (Lectures 6)

Constituents of atoms and nuclei, atomic and mass numbers, Isotopes, energy units, electron shells, atomic energy levels, Nuclear energy levels. Transitions between atomic energy levels (resulting optical photons) and nuclear energy levels (resulting gamma photons), -Ionization and excitation, Electromagnetic spectrum, Relationship between wavelengths, Frequency, Energy.

Units and Measurements of Physical Quantities: Force, Work, Power, energy temperature and heat. SI units of above parameters. (6L)

Unit II: Radioactivity (Lectures 6)

Natural and artificial radioactivity, types of nuclear radiations: alpha, beta, and gamma rays – concepts of Half life, activity, units of activity, -specific activity. Interactions of gamma ray and charged particles with matter. Absorbed Dose, Units of Dose. Radiation hazard, Safety measurements: Time, distance and shielding. Occupational dose limit.

Unit III: Radiation Quantities and Units (Lectures 7)

Particle flux and fluence, Radiation flux and fluence, cross section, energy, linear energy transfer (LET), linear and mass attenuation coefficients, mass stopping power, inverse square law, W-value, exposure (rate), Kerma (rate), Terma, absorbed dose (rate), rate constants, radiation weighting factors, tissue weighting factors, equivalent dose, effective dose, collective effective dose, Annual Limit of Intake {ALI}, Derived Air Concentration {DAC}, personnel dose equivalent, committed dose.

Unit IV: X-Ray (Lectures 5)

Electromagnetic waves, X-Rays –Production of X-rays: The X-ray tube, Physics of X-ray production, continuous spectrum, characteristic spectrum,–Basics of X-ray Circuits, measurement of high voltage –control of KV circuit –MA circuit. Loading, processing and storing of X-ray plates. Distribution of X-rays in space, Interaction of X-rays with matter, Attenuation of x-rays. Radiation effect of X-rays, safety measurements to be followed.

Unit V: Computed Tomography (Lectures 3)

Theory of tomography – multi section radiography, tomographic equipment, Computer tomography. Radiation hazard of Tomographic machine, Safety measurement to be followed.

Unit VI: MRI (Lectures 3)

Magnetic Resonance imaging – Basic principle– Imaging methods– Slice section, Image contrast, Bio-effects of MRI. Safety measurements. Counting statistics, errors in counting.

Lab

1. Measurement of alpha track density due to environmental (air) Radon (and its daughter) using SSNTD
2. Taking X-ray of a pen/pencil
3. Visit to a CT scan and MRI laboratory.
4. Study the background radiation levels using Radiation meter

Characteristics of Geiger Muller (GM) Counter:

5. Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).
6. Study of counting statistics using background radiation using GM counter.
7. Study of radiation in various materials (e.g. KSO_4 etc.). Investigation of possible radiation in different routine materials by operating GM at operating voltage.
8. Study of absorption of beta particles in Aluminum using GM counter.
9. Detection of α particles using reference source & determining its half life using spark counter
10. Gamma spectrum of Gas Light mantle (Source of Thorium)
11. Studying α particles in air using SSNTDs technique

Reference Books

[1] Radiation Safety: J S Ballard (https://openoregon.pressbooks.pub/radsafety130/)
[2] Atomic and Nuclear Physics Vol. II: S N Ghosal
[3] An introduction to Radiation Physics: Vivek Mandot (ISBN: 9788179067635, 8179067637)
[4] W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)
[5] G.F.Knoll, Radiation detection and measurements
[6] Thermoluninescense Dosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook 5)
[7] W.J. Meredith and J.B. Massey, "Fundamental Physics of Radiology". John Wright and Sons, UK, 1989.
[8] J.R. Greening, "Fundamentals of Radiation Dosimetry", Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981.
[9] Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
[10] A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981. NCRP, ICRP, ICRU, IAEA, AERB Publications.

W.R. Hendee, "Medical Radiation Physics", Year Book – Medical Publishers Inc. London, 1981

PHY-SE-4074
RENEWABLE ENERGY AND ENERGY HARVESTING
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with PhD in Condensed Matter Physics.

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

Theory
Unit I: Fossil fuels and Alternate Sources of energy (Lectures 3)
Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

Unit II: Solar energy (Lectures 6)
Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Unit III: Wind Energy harvesting (Lectures 3)
Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Unit IV: Ocean Energy (Lectures 3)
Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.
Unit V: (Lectures 2)
Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

Unit VI: Geothermal Energy (Lectures 2)
Geothermal Resources, Geothermal Technologies.

Unit VII: Hydro Energy (Lectures 2)
Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Unit VIII: Piezoelectric Energy harvesting (Lectures 4)
Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modelling piezoelectric generators, Piezoelectric energy harvesting applications, Human power.

Unit IX: Electromagnetic Energy Harvesting (Lectures 2)
Linear generators, physics mathematical models, recent applications

Unit X: (Lectures 2)

Carbon captured technologies, cell, batteries, power consumption

Unit XI: (Lectures 1)

Environmental issues and Renewable sources of energy, sustainability.

Demonstrations and Experiments

1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

Reference Books

[1] Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi

[2] Solar energy - M P Agarwal - S Chand and Co. Ltd.

[3] Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.

[4] Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.

[5] Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009 • J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

[6] http://en.wikipedia.org/wiki/Renewable_energy

PHY-SE-4084
Introduction to CorelDraw
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on CorelDraw/B.E./B.Tech. in Computer Science/ MCA/B.Sc. with DCA.

This course will give you how to use CorelDraw to present objects, layers, and pages in an effective and presentable form. This course will enables you to create logos, brochures, website graphics, illustrations and other artwork. The trained candidates can develop the designs to meet the computer graphics need of various applications.

Course Outcome: *On successful completion of the course students will be able to work with layers and symbols in CorelDRAW, Apply fills and outlines to illustrations in CorelDRAW, Use, edit, and create artistic and paragraph text in CorelDRAW, Create boundaries to objects and copy and clone the effect of one object to another in CorelDRAW, Import and export projects, Print objects/documents created on CorelDRAW.*

Unit I: Getting Started with CorelDRAW (Lectures 6)
CorelDRAW Interface, Moving from Adobe Illustrator to CorelDRAW, Drawing Basic Shapes, Selecting Objects, Changing Order of Objects, Transforming Objects, Duplicating Objects, Organizing Objects, Zooming, Panning, and Scrolling, Hiding and Displaying Objects, Using Guides and Grids, Saving the Document

Unit II: Drawing and Coloring (Lectures 6)
Drawing Lines in CorelDRAW, Calligraphy, Shape Edit Tool, Applying Fills and Outlines, Pages and Layout Tools, Viewing Modes, Working with Layers, Working with Symbols, Creating Styles

Unit III: Working with Text (Lectures 6)
Artistic Text, Fitting Text to Curve, Reshaping Tools, Paragraph Text, Entering and Editing, Paragraph Text, Wrapping Text around Other Shapes, Linking Text to Objects, Finding and Replacing
Working with Text Styles, Working with Tables, Inserting Formatting Codes, Font Identification

Unit IV: Applying Effects (Lectures 6)
Envelopes and Distortion Effects, Blends and Contours, Transparency and Drop Shadow, Extrude
Lens, Perspective, Bevel, Powerclip, Create Boundary, Copying and Cloning Effects, Inserting Bar Codes, Inserting and Editing QR Codes

Unit V: Working with Bitmaps and Web Resources (Lectures 6)
Importing and Exporting Bitmaps, Working with Bitmaps, Internet Toolbar, Setting Web pages
Creating Buttons with Rollover Effects, Publishing to PDF, Printing

PHY-SE-4094
GRAPHIC DESIGN FOR DIGITAL ADVERTISING
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on digital advertising /B.E./B. Tech. in Computer Science/ MCA/B.Sc. with DCA.

This course will give you the skills to come up with innovative concepts and visualization and further create Graphic Designs using the principles of Design, Composition & Colour theory. You will learn to create Graphic Design on the most popular and industry relevant design software, Adobe Photoshop.

Course Outcome: *On successful completion of the course students will be able to Understand aesthetics & visual appeal in design, Using impactful visual content which appeals to target audience, Conceptualize, Visualize and Create Graphic Designs for:Digital Ads, Posters, Banners and Flyers, Social Media Ads & Banners, Websites and Blogs*

Tools: Adobe Photoshop Extended CC

Unit I: Getting Started with Adobe Photoshop CC (Lectures 3)
Overview of Adobe Photoshop CC, Features of Adobe Photoshop CC

Unit II: Importance of Adobe Photoshop CC (Lectures 3)
Overview of Tools Used in Adobe Photoshop CC, Importance of Adobe Photoshop CC

Unit III: Working with Typography (Lectures 4)
Typography, Creating Typographies, Choosing the Right Font and Color

Unit IV: Working with Layers and Images (Lectures 5)
Cropping a Photo, Resizing Images, Basics of Layers, Creating Layers for Print and Digital Media, Aligning Images within Multiple Layers, Merging Layer Techniques

Unit V: Working with Filters (Lectures 5)
Photoshop Filters, Smart Filters, Common Features of Photoshop Filter

Unit VI: Digital Painting in Adobe Photoshop CC (Lectures 5)
Working with Brush Tool, Importance of Using Colors

Unit VII: Masking and File Formats in Adobe Photoshop CC (Lectures 5)
Introduction to Mask, Creating Vector and Layer Masks, Essential File Formats, Choosing the Right Format for Print and Digital Media

Fifth Semester

Honours Core Papers

PHY-HC-5016
Quantum Mechanics & Applications
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *On successful completion of the course students will be able to understand the principles in quantum mechanics, such as the Schrödinger equation, the wave function, the uncertainty principle, stationary and non-stationary states, time evolution of solutions, as well as the relation between quantum mechanics and linear algebra. Students will be able to solve the Schrödinger equation for hydrogen atom. Students will have the concepts of angular momentum and spin, as well as the rules for quantization and addition of these, spin-orbit coupling and Zeeman Effect.*

Theory

Unit I: Time Dependent Schrödinger Equation (Lectures 06)

Time dependent Schrödinger equation and dynamical evolution of a quantum state, properties of wave function. Interpretation of wave function. Probability and probability current densities in three dimensions. Conditions for physical acceptability of wave functions. Normalization. Linearity and Superposition Principles. Eigenvalues and eigenfunctions. Position, momentum and energy operators; commutator of position and momentum operators. Expectation values of position and momentum. wave function of a free particle.

Unit II: Time Independent Schrödinger Equation (Lectures 10)

Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wave function as a linear combination of energy eigenfunctions; General solution of the time dependent Schrödinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle.

Unit III: Bound States (Lectures 12)

Continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle.

Unit IV: Hydrogen-like Atoms (Lectures 10)

Time independent Schrödinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wave functions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; $s, p, d, ...$ shells.

Unit V: Atoms in Electric & Magnetic Fields (Lectures 12)

Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. Zeeman Effect: Normal and Anomalous Zeeman Effect. Paschen-Back Effect and Stark Effect (Qualitative Discussion only).

Unit VI: Many Electron Atoms (Lectures 10)

Pauli's Exclusion Principle. Symmetric & Antisymmetric W ave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms: $L-S$ and $j-j$ couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).

Lab

Use C/C++/Scilab/FORTRAN/Mathematica/ Python for solving the following problems based on Quantum Mechanics.

1. Solve the s-wave Schrödinger equation for the ground state and the first excited state of the hydrogen atom

$$\frac{d^2y}{dr^2} = A(r)u(r),\ \ A(r) = \frac{2m}{\hbar^2}[V(r) - E] \text{ where } V(r) = -\frac{e^2}{r},$$

were, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is ≈-13.6 eV. Take e=3.795 (eVÅ), $\hbar c$= 1973(eVÅ) and m=0.511×10^6 eV/c^2.

2. Solve the s-wave radial Schrödinger equation for an atom

$$\frac{d^2y}{dr^2} = A(r)u(r),\ \ A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

Where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened Coulomb potential

$$V(r) = -\frac{e^2}{r}e^{-r/a}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wave function. Take e=3.795 (eVÅ), and a=3 Å, 5 Å, and 7 Å in the units of $\hbar c$ = 1973(eVÅ) and m=0.511×10^6 eV/c^2. The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrödinger equation for a particle of mass m

$$\frac{d^2y}{dr^2} = A(r)u(r),\ \ A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

The anharmonic potential

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m=940 MeV/c^2, k=100 MeV fm^{-2}, b=0, 10, 30 MeV fm^{-3}. In these units, cħ=197.3 MeV fm. The ground state energy *I* is expected to lie in between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrödinger equation for the vibration of hydrogen molecule

$$\frac{d^2y}{dr^2} = A(r)u(r),\ \ A(r) = \frac{2\mu}{\hbar^2}[V(r) - E]$$

where μ is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D\left(e^{-2\alpha r'} - e^{-\alpha r'}\right), r' = \frac{r - r_0}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of thee significant digits. Also plot the corresponding wave function. Take m=940×10^6 eV/c^2, D= 0.755501 eV, α=1.44, and r_0=0.131349 Å.

Laboratory based experiments (Optional)

5. Study of electron spin resonance – determine magnetic field as a function of the resonance frequency.
6. Study of Zeeman Effect – with external magnetic field; hyperfine splitting.
7. To show the tunneling effect in tunnel diode using $I - V$ characteristics.
8. Quantum efficiency of CCDs.

Reference Books

[1] A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill

[2] Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.

[3] Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.

[4] Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.

[5] Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.

[6] Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer

[7] Quantum Mechanics for Scientists & Engineers, D. A. B. Miller, 2008, Cambridge University Press

PHY-HC-5026
Solid State Physics
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *On successful completion of the course students should be able to explain the main features of crystal lattices and phonons, understand the elementary lattice dynamics and its influence on the properties of materials, describe the main features of the physics of electrons in solids; explain the dielectric ferroelectric and magnetic properties of solids and understand the basic concept in superconductivity.*

Theory

Unit I: Crystal Structure (Lectures 10)

Amorphous and Crystalline Materials. Lattice Translation Vectors. Symmetry operations, Lattice with a Basis - Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

Unit II: Elementary Lattice Dynamics (Lectures 10)

Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law.

Unit III: Magnetic Properties of Matter (Lectures 08)

Dia, Para, Ferri, and Ferromagnetic Materials. Classical Langevin Theory of Dia and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of $B - H$ Curve. Hysteresis and Energy Loss.

Unit IV: Dielectric Properties of Materials (Lectures 08)

Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, T_0 modes.

Unit V: Ferroelectric Properties of Materials (Lectures 06)

Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.

Unit VI: Free Electron Theory of Metals (Lectures 12)

Electrical and thermal conductivity of metals, Wiedemann-Franz law. Elementary band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (4-probe method) & Hall coefficient.

Unit VII: Superconductivity (Lectures 06)

Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation).

Lab

A minimum of five experiments to be done.

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method).
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coeffcient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency.
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR).
6. To determine the refractive index of a dielectric layer using SPR.
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the $B - H$ curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 $^{\circ}$C) and to determine its band gap.
10. To determine the Hall coeffcient of a semiconductor sample.

Reference Books

[1] Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.

[2] Elements of Solid State Physics, J. P. Srivastava, 4th Edition, 2015, Prentice-Hall of India

[3] Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill

[4] Solid State Physics, N. W. Ashcroft and N. D. Mermin, 1976, Cengage Learning

[5] Solid-state Physics, H. Ibach and H. Luth, 2009, Springer

[6] Solid State Physics, Rita John, 2014, McGraw Hill

[7] Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India

[8] Solid State Physics, M. A. Wahab, 2011, Narosa Publications

Discipline Specific Elective Papers
[Choose Two]

PHY-HE-5016
Experimental Techniques
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *Upon completion of this course, students will be able to describe the errors in measurement and statistical analysis of data required while performing an experiment. Also, students will learn the working principle, efficiency and applications of transducers & industrial instruments like digital multimeter, RTD, Thermistor, Thermocouples and Semiconductor type temperature sensors.*

Theory

Unit I: Measurements (Lectures 7)

Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting.

Unit II: Signals and Systems (Lectures 7)

Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise.

Unit III: Shielding and Grounding (Lectures 4)

Methods of safety grounding. Energy coupling. Grounding. Shielding:Electrostatic shielding. Electromagnetic Interference Shielding.

Unit IV: Transducers & industrial instrumentation (working principle, efficiency, applications) (Lectures 21)

Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers.

Unit V: Digital Multimeter (Lectures 5):

Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement.

Unit VI: Impedance Bridges and Q-meter (Lectures 4):

Block diagram and working principles of RLC bridge. Qmeter and its working operation. Digital LCR bridge.

Unit VII: Vacuum Systems (Lectures 12):

Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization).

Lab

(Minimum number of experiments to be completed is seven)

1. Determine output characteristics of a LVDT & measure displacement using LVDT
2. Measurement of Strain using Strain Gauge.
3. Measurement of level using capacitive transducer.
4. To study the characteristics of a Thermostat and determine its parameters.
5. Study of distance measurement using ultrasonic transducer.
6. Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75)
7. To measure the change in temperature of ambient using Resistance Temperature Device (RTD).
8. Create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge.
9. Comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of 2m length, understanding of importance of grounding using function generator of mV level & an oscilloscope.
10. To design and study the Sample and Hold Circuit.
11. Design and analyze the Clippers and Clampers circuits using junction diode
12. To plot the frequency response of a microphone.
13. To measure Q of a coil and influence of frequency, using a Q-meter

Reference Books:

[1] Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.

[2] Experimental Methods for Engineers, J.P. Holman, McGraw Hill

[3] Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.

[4] Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.

[5] Instrumentation Devices and Systems, C.S. Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill

[6] Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.

[7] Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008, Springer

[8] Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Graw Hill

PHY-HE-5026
Embedded System: Introduction to microcontroller
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *Upon completion of this course, students will be able to understand microprocessor and microcontroller 8051. Students will also learn about the 8051 I/O port programming, various addressing modes, Timer and counter programming, Serial port programming with and without interrupt and interfacing 8051 microcontroller to peripherals.*

Theory

Unit I: Embedded System (Lectures 6)

Introduction to embedded systems and general purpose computer systems, architecture of embedded system, classifications, applications and purpose of embedded systems, challenges & design issues in embedded systems,

Unit II: Review of microprocessors (Lectures 6)

Organization of Microprocessor based system, 8085μp pin diagram and architecture, concept of data bus and address bus, 8085 programming model, instruction classification, subroutines, stacks and its implementation, delay subroutines, hardware and software interrupts.

Unit III: 8051 microcontroller (Lectures 13)

Introduction and block diagram of 8051 microcontroller, architecture of 8051, overview of 8051 family, 8051 assembly language programming, Program Counter and ROM memory map, Data types and directives, Flag bits and Program Status Word (PSW) register, Jump, loop and call instructions.

Unit IV: 8051 I/O port programming (Lectures 4)

Introduction of I/O port programming, pin out diagram of 8051 microcontroller, I/O port pins description & their functions Bit manipulation.

Unit V: Programming of 8051 (Lectures 13)

8051 addressing modes and examples using assembly language, arithmetic and logic instructions 8051 programming in C: for time delay & I/O operations and manipulation, for arithmetic and logic operations.

Unit VI: Timer and counter programming (Lectures 3)

Programming 8051 timers, counter programming.

Unit VII: Serial port programming with and without interrupt (Lectures 6)

Introduction to 8051 interrupts, programming timer interrupts, programming external hardware interrupts and serial communication interrupt, interrupt priority in the 8051.

Unit VIII: Interfacing 8051 microcontroller to peripherals (Lectures 2)

ADC, DAC interfacing, LCD interfacing.

Unit IX: Programming Embedded Systems (Lectures 3)

Basic Structure of embedded program,compiling, linking and locating, downloading and debugging.

Unit X: Embedded system design and development (Lectures 2)

trends in embedded industry

Unit XI: Introduction to Arduino (Lectures 2)

Pin diagram and description of Arduino UNO. Basic programming.

Lab

(Minimum number of experiments to be completed is seven)

A.8051 microcontroller based Programs and experiments

1. To find that the given numbers is prime or not.

2. To find the factorial of a number.

3. Write a program to make the two numbers equal by increasing the smallest number and decreasing the largest number.

4. Use one of the four ports of 8051 for O/P interfaced to eight LED‟s. Simulate binary counter (8 bit) on LED‟s .

5. Program to glow the first four LEDs then next four using TIMER application.

6. Program to rotate the contents of the accumulator first right and then left.

7. Program to run a countdown from 9-0 in the seven segment LED display.

8. To interface seven segment LED display with 8051 microcontroller and display „HELP‟ in the seven segment LED display.

9. To toggle "1234" as "1324" in the seven segment LED display.

10. Interface stepper motor with 8051 and write a program to move the motor through a given angle in clock wise or counter clockwise direction

11. Application of embedded systems: Temperature measurement, some information on LCD display, interfacing a keyboard.

B. Arduino based programs and experiments:

12. Make a LED flash at different time intervals.

13. To vary the intensity of LED connected to Arduino

14. To control speed of a stepper motor using a potential meter connected to Arduino

15. To display "PHYSICS" on LCD/CRO.

Reference Books

[1] Embedded Systems: Architecture, Programming & Design, R.Kamal, 2008,Tata McGraw Hill

[2] The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India.

[3] Embedded microcomputor system: Real time interfacing, J.W.Valvano, 2000, Brooks/Cole

[4] Microcontrollers in practice, I. Susnea and M. Mitescu, 2005, Springer.

[5] Embedded Systems: Design & applications, S.F. Barrett, 2008, Pearson Education India

[6] Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning Embedded Systems: Architecture, Programming& Design, R.Kamal,]2008,Tata McGraw Hill

[7] Embedded System, B.K. Rao, 2011, PHI Learning Pvt. Ltd.

[8] Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning

PHY-HE-5036
Advanced Mathematical Physics I
Total Lectures: 60Credits: 6 (Theory: 04, Lab: 02)

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Course Outcome: *Upon completion of this course, students will be able to solve problems in Physics related to Linear Vector space, Matrix algebra, Tensor.*

Theory

Unit I: Linear Vector Spaces (Lectures 20)

Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Change of basis. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations. Non-singular Transfor- mations. Representation of Linear Transformations by Matrices.

Unit II: Matrix (Lectures 10)

Eigen-values and Eigenvectors. Cayley- Hamiliton Theorem. Diagonalization of Matrices. Co- ordinate transformations, rotation in two dimensions, rotation in three dimensions. Solutions of Coupled Linear Ordinary Differential Equations. Functions of a Matrix.

Unit III: Cartesian Tensors (Lectures 20)

Transformation of Co-ordinates. Einstein's Summation Convention. Relation between Direc- tion Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti- symmetric Tensors. Invariant Tensors : Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. Vector Algebra and Calculus using Cartesian Tensors : Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Vector Identities. Tensorial Formulation of Analytical Solid Geometry : Equa- tion of a Line. Angle Between Lines. Projection of a Line on another Line. Condition for Two Lines to be Coplanar. Foot of the Perpendicular from a Point on a Line. Rotation Tensor (No Derivation). Isotropic Tensors. Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors.

Unit IV :General Tensors (Lectures 10)

Transformation of Co-ordinates. Minkowski Space. Contravariant & Covariant Vectors. Con- travariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference & Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor.

Lab

Scilab/Mathematica/C ++ or others based simulations experiments based on Mathematical Physics problems like

1. Linear algebra:
   - Multiplication of two 3× 3 matrices
   - Eigenvalue and eigenvectors of

$$\begin{pmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 3 & 1 & 4 \end{pmatrix};\ \begin{pmatrix} 1 & -i & 3+4i \\ i & 2 & 4 \\ 3-4i & 4 & 3 \end{pmatrix};\ \begin{pmatrix} 2 & -i & 2i \\ i & 4 & 3 \\ -2i & 3 & 5 \end{pmatrix}$$

2. Orthogonal polynomials as eigenfunctions of Hermitian differential operators.
3. Determination of the principal axes of moment of inertia through diagonalization.
4. Lagrangian formulation in Classical Mechanics with constraints.
5. Study of geodesics in Euclidean and other spaces (surface of a sphere, etc).

Reference Books

[1] Mathematical Tools for Physics, James Nearing, 2010, Dover Publications

[2] Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier.

[3] Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge University Press

[4] Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.

[5] Linear Algebra, W. Cheney, E.W.Cheney & D.R.Kincaid, 2012, Jones & Bartlett Learning

[6] Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole

[7] Mathematical Methods for Physicis & Engineers, K.F.Riley, M.P.Hobson, S.J.Bence, 3rd Ed., 2006, Cambridge University Press

[8] Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896

[9] Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444

[10] Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

PHY-HE-5046
Physics of Devices and Instruments
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *Upon completion of this course, students will be able to gain knowledge on advanced electronics devices such as UJT, JFET, MOSFET, CMOS etc., detailed process of IC fabrication, Digital Data serial and parallel Communication Standards along with the understanding of communication systems.*

Theory

Unit I: Devices (Lectures 14)

Characteristic and small signal equivalent circuits of UJT and JFET. Metal- semiconductor Junction. Metal oxide semiconductor (MOS)device. Ideal MOS and Flat Band voltage. SiO2-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode.

Unit II: Power supply and Filters (Lectures 3)

Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation**,** Short circuit protection

Unit III: Active and Passive Filters (Lectures 3)

Low Pass, High Pass, Band Pass and band Reject Filters.

Unit IV: Multivibrators (Lectures 3)

Astable and Monostable Multivibrators using transistors.

Unit V: Phase Locked Loop(PLL) (Lectures 5)

Basic Principles, Phase detector(XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter–Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046).

Unit VI: Processing of Devices (Lectures 12)

Basic process flow for IC fabrication, Electronic grade silicon. Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. Optical lithography. Electron lithography. Feature size control and wet anisotropic etching. Lift off Technique. Diffusion and implantation**.**

Unit VII: Digital Data Communication Standards (Lectures 5)

Serial Communications: RS232, Handshaking, Implementation of RS232 on PC. Universal Serial Bus (USB): USB standards, Types and elements of USB transfers. Devices (Basic idea of UART). Parallel Communications: General Purpose Interface Bus (GPIB), GPIB signals and lines, Handshaking and interface management, Implementation of a GPIB on a PC. Basic idea of sending data through a COM port.

Unit VIII: Introduction to communication systems (Lectures 15)

Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK.

Lab

Minimum number of experiments to be completed is seven
(4 from Section A,3 from Section B)
Experiments should be done from both Section A and Section B:

Section-A

1. To design a power supply using bridge rectifier and study effect of C-filter.
2. To design the active Low pass and High pass filters of given specification.
3. To design the active filter (wide band pass and band reject) of given specification.
4. To study the output and transfer characteristics of a JFET.
5. To design a common source JFET Amplifier and study its frequency response.
6. To study the output characteristics of a MOSFET.
7. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
8. To design an Amplitude Modulator using Transistor.
9. To design PWM, PPM, PAM and Pulse code modulation using ICs.
10. To design an Astable multivibrator of given specifications using transistor.
11. To study a PLL IC (Lock and capture range).
12. To study envelope detector for demodulation of AM signal.
13. Study of ASK and FSK modulator.
14. Glow an LED via USB port of PC.
15. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

Section-B:

SPICE/MULTISIM simulations for electrical networks and electronic circuits

1. To verify the Thevenin and Norton Theorems.
2. Design and analyze the series and parallel LCR circuits
3. Design the inverting and non-inverting amplifier using an Op-Amp of given gain
4. Design and Verification of op-amp as integrator and differentiator
5. Design the 1st order active low pass and high pass filters of given cutoff frequency
6. Design a Wein`s Bridge oscillator of given frequency.
7. Design clocked SR and JK Flip-Flop`s using NAND Gates
8. Design 4-bit asynchronous counter using Flip-Flop ICs
9. Design the CE amplifier of a given gain and its frequency response.
10. Design an Astable multivibrator using IC555 of given duty cycle.

Reference Books

[1] Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons

[2] Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.

[3] Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd

[4] Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.

[5] Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.

[6] Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.

[7] Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill

[8] PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

PHY-HE-5056
Nuclear and Particle Physics
Total Lectures: 75 Credits: 6 (Theory: 05, Tutorial: 01)

Course Outcome: *Upon completion of this course, students will have the understanding of the sub atomic particles and their properties. They will gain knowledge about the different nuclear techniques and their applications in different branches of Physics and societal application. The course will develop problem based skills and the acquire knowledge can be applied in the areas of nuclear, medical, archeology, geology and other interdisciplinary fields of Physics and Chemistry.*

Theory

Unit I: General Properties of Nuclei (Lectures 10)

Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

Unit II: Nuclear Models (Lectures 12)

Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.

Unit III: Radioactivity decay (Lectures 10)

(a) Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) -decay: energy kinematics for -decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion.

Unit IV: Nuclear Reactions (Lectures 8)

Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

Unit V: Interaction of Nuclear Radiation with matter (Lectures 8)

Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.

Unit VI: Detector for Nuclear Radiations (Lectures 8)

Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

Unit VII: Particle Accelerators (Lectures 5)

Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

Unit VIII: Particle physics (Lectures 14)

Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons.

Reference Books

[1] Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).

[2] Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).

[3] Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).

[4] Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press

[5] Introduction to Elementary Particles, D. Griffith, John Wiley & Sons

[6] Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi

[7] Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).

[8] Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).

[9] Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).

[10] Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991)

Sixth Semester

Honours Core Papers

PHY-HC-6016
Electromagnetic Theory
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *On successful completion of the course students will acquire the concepts of Maxwell's equations, propagation of electromagnetic (EM) waves in different homogeneous-isotropic as well as anisotropic unbounded and bounded media, production and detection of different types of polarized EM waves, general information as waveguides and fibre optics.*

Theory

Unit I: Maxwell Equations (Lecture 12)

Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physi- cal Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.

Unit II: EM Wave Propagation in Unbounded Media (Lecture 10)

Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.

Unit III: EM Wave in Bounded Media (Lecture 10)

Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence).

Unit IV: Polarization of Electromagnetic Waves (Lecture 12)

Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light.

Unit V: Rotatory Polarization (Lecture 08)

Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter. (5 Lectures) Wave Guides: Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission.

Unit VI: Optical Fibres (Lecture 03)

Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).

Lab

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves.
7. To study Polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.
9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To verify the Stefan's law of radiation and to determine Stefan's constant.
12. To determine the Boltzmann constant using $V - I$ characteristics of PN junction diode.

Reference Books

[1] Introduction to Electrodynamics, D. J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.

[2] Elements of Electromagnetics, M. N. O. Sadiku, 2001, Oxford University Press.

[3] Introduction to Electromagnetic Theory, T. L. Chow, 2006, Jones & Bartlett Learning

[4] Fundamentals of Electromagnetics, M. A. W. Miah, 1982, Tata McGraw Hill

[5] Electromagnetic field Theory, R. S. Kshetrimayun, 2012, Cengage Learning

[6] Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill.

[7] Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

PHY-HC-6026
Statistical Mechanics
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course outcome: *On successful completion of the course students will be learn the techniques of Statistical Mechanics to apply in various fields including Astrophysics, Semiconductors, Plasma Physics, Bio-Physics, Chemistry and in many other directions.*

Theory

Unit I: Classical Statistics (Lectures 18)

Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.

Unit II: Classical Theory of Radiation (Lectures 09)

Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff’s law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien’s Displacement law. Wien’s Distribution Law. Saha’s Ionization Formula. Rayleigh-Jean’s Law. Ultraviolet Catastrophe.

Unit III: Quantum Theory of Radiation (Lectures 05)

Spectral Distribution of Black Body Radiation. Planck’s Quantum Postulates. Planck’s Law of Blackbody Radi- ation: Experimental Verification. Deduction of (1) Wien’s Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan- Boltzmann Law, (4) Wien’s Displacement law from Planck’s law.

Unit IV: Bose-Einstein Statistics (Lectures 13)

B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck’s law.

Unit V: Fermi-Dirac Statistics (Lectures 15)

Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.

Lab

Use C/C++/Scilab/other numerical simulations for solving the problems based on Statistical Mechanics.

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
   (a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations.
   (b) Study of transient behaviour of the system (approach to equilibrium).
   (c) Relationship of large N and the arrow of time.
   (d) Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution.
   (e) Computation and study of mean molecular speed and its dependence on particle mass.
   (f) Computation of fraction of molecules in an ideal gas having speed near the most probable speed
2. Computation of the partition function $Z(\beta)$ for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics:
   (a) Study of how $Z(\beta)$, average energy $\langle E\rangle$, energy fluctuation ΔE, specific heat at constant volumeC_{ϑ}, depend upon the temperature, total number of particles N and the spectrum of single particle states.
   (b) Ratios of occupation numbers of various states for the systems considered above.
   (c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.
3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.
4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.
5. Plot the following functions with energy at different temperatures
   (a) Maxwell-Boltzmann distribution
   (b) Fermi-Dirac distribution
   (c) Bose-Einstein distribution

Reference Books

[1] Statistical Mechanics, R. K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.

[2] Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill

[3] Statistical and Thermal Physics, S. Lokanathan and R. S. Gambhir. 1991, Prentice Hall

[4] Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.

[5] Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer

[6] An Introduction to Statistical Mechanics & Thermodynamics, R. H. Swendsen, 2012, Oxford Univ. Press

Discipline Specific Elective Papers
[Choose Two]

PHY-HE-6016
Communication Electronics
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *Upon completion of this course, students will have the concepts of electronics in communication, details of communication techniques based on Analog Modulation, Analog and digital Pulse Modulation including PAM, PWM, PPM, ASK, PSK, FSK, overview of communication and Navigation systems such as GPS and mobile telephony system.*

Theory

Unit I: Electronic communication (Lectures 8)

Introduction to communication – means and modes. Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio.

Unit II: Analog Modulation (Lectures 12)

Amplitude Modulation, modulation index and frequency spectrum. Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Qualitative idea of Super heterodyne receiver

Unit III: Analog Pulse Modulation (Lectures 9)

Channel capacity, Sampling theorem, Basic Principles- PAM, PWM, PPM, Basic concept of Multiplexing. (time and frequency division.

Unit IV: Digital Pulse Modulation (Lectures 10)

Need for digital transmission, Pulse Code Modulation, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK).

Introduction to Communication and Navigation systems

Unit V: Satellite Communication (Lectures 10)

Introduction, need, Geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites., path loss, ground station, simplified block diagram of earth station. Uplink and downlink.

Unit VI: Mobile Telephony System (Lectures 10)

Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only).

Unit I: GPS navigation system (Lectures 1)

Qualitative idea only

Lab

(Minimum number of experiments to be completed is seven)

1. To design an Amplitude Modulator using Transistor
2. To study envelope detector for demodulation of AM signal
3. To study FM - Generator and Detector circuit
4. To study AM Transmitter and Receiver
5. To study FM Transmitter and Receiver
6. To study Time Division Multiplexing (TDM)
7. To study Pulse Amplitude Modulation (PAM)
8. To study Pulse Width Modulation (PWM)
9. To study Pulse Position Modulation (PPM)
10. To study ASK, PSK and FSK modulator

Reference Books

[1] Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.

[2] Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.

[3] Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGraw Hill.

[4] Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill

[5] Communication Systems, S. Haykin, 2006, Wiley India

[6] Electronic Communication system, Blake, Cengage, 5th edition.

[7] Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press

PHY-HE-6026
Digital Signal Processing
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *Upon completion of this course, students will be able This paper describes the discrete-time signals and systems, Fourier Transform Representation of Aperiodic Discrete-Time Signals. This paper also highlights the concept of filters and realization of Digital Filters. At the end of the syllabus, students will develop the understanding of Discrete and fast Fourier Transform.*

Theory
Unit I: Discrete-Time Signals and Systems (Lectures 10)
Classification of Signals, Periodic and Aperiodic Signals, Energy and Power Signals, Even and Odd Signals, Discrete-Time Systems, System Properties. Impulse Response, Convolution Sum; Properties of Convolution; Commutative; Associative; Distributive; Shift; Sum Property, Relationship Between LTI System Properties and the Impulse Response; Causality; Stability**.**

Unit II: Discrete-Time Fourier Transform (Lectures 15)
Fourier Transform Representation of Aperiodic Discrete-Time Signals, Periodicity of DTFT, Properties; Linearity; Time Shifting; Frequency Shifting**, The *z*-Transform:** Bilateral (Two-Sided) Transform, Inverse *z*-Transform, Relationship Between *z*-Transform and Discrete-Time Fourier Transform, *z*-plane, Region-of-Convergence; Properties of ROC, Properties; Analysis and Characterization of LTI Systems; Transfer Function and Difference-Equation System**.**

Unit III: Filter Concepts (Lectures 5)
Phase Delay and Group delay, Zero-Phase Filter, Linear-Phase Filter, Simple FIR Digital Filters, Simple IIR Digital Filters.

Unit IV: Discrete Fourier Transform (Lectures 10)
Frequency Domain Sampling (Sampling of DTFT), The Discrete Fourier Transform (DFT) and its Inverse, DFT as a Linear transformation, Properties; Periodicity; Linearity; Circular Time Shifting; Circular Frequency Shifting; Circular Time Reversal; Multiplication Property.

Unit V: Fast Fourier Transform (Lectures 5)
Direct Computation of the DFT, Symmetry and Periodicity Properties of the Twiddle factor (*WN*), Radix-2 FFT Algorithms; Decimation-In-Time (DIT) FFT Algorithm; Decimation-In-Frequency (DIF) FFT Algorithm, Inverse DFT Using FFT Algorithms.

Unit VI: Realization of Digital Filters (Lectures 15)
Non Recursive and Recursive Structures, Canonic and Non Canonic Structures, Equivalent Structures (Transposed Structure), FIR Filter structures; Direct-Form; Cascade-Form; Basic structures for IIR systems; Direct-Form I.

Finite Impulse Response Digital Filter: Advantages and Disadvantages of Digital Filters, Types of Digital Filters: FIR and IIR Filters; Difference Between FIR and IIR Filters, Desirability of Linear-Phase Filters, Frequency Response of Linear-Phase FIR Filters, Impulse Responses of Ideal Filters, Windowing Method.

Infinite Impulse Response Digital Filter: Design of IIR Filters from Analog Filters, IIR Filter Design by Approximation of Derivatives, Impulse Invariance Method**.**

Lab

(Minimum number of experiments to be completed is seven)

Scilab based simulations experiments based problems like

1. Write a program to generate and plot the following sequences: (a) Unit sample sequence ð(n) , (b) unit step sequence $u(n)$, (c) ramp sequence *r(n)* , (d) real valued exponential sequence $x(n) = (0.8)^n u(n)$ for $0 \leq n \leq 50$.
2. Write a program to compute the convolution sum of a rectangle signal (or gate function) with itself for $N = 5$

$$x(n) = rect\left(\frac{n}{2N}\right) = \Pi\left(\frac{n}{2N}\right) = \begin{cases} 1 - N \leq n \leq N \\ 0\ Otherwise \end{cases}$$

3. An LTI system is specified by the difference equation

$$y(n) = 0.8y(n-1) + x(n)$$

(a) Determine $H(e^{jw})$

(b) Calculate and plot the steady state response $y_{ss}(n)$ to

$$x(n) = \cos(0.5\pi n)\, u(n)$$

4. Given a casual system

$$y(n) = 0.9y(n - 1) + x(n)$$

(a) Find *H(z)* and sketch its pole-zero plot

(b) Plot the frequency response $|H(e^{jw})|$and $\angle H(e^{jw})$

5. Design a digital filter to eliminate the lower frequency sinusoid of *x(t)= sin 7t + sin 200t.* The sampling frequency is f_s= 500 *Hz*. Plot its pole zero diagram, magnitude response, input and output of the filter.

6. Let *x(n)* be a 4-point sequence:

$$x(n) = \underset{\uparrow}{\{1,1,1,1\}} = \begin{cases} 1\ 0 \leq n \leq 3 \\ 0\ Otherwise \end{cases}$$

Compute the DTFT $X(e^{jw})$ and plot its magnitude

(a) Compute and plot the 4 point DFT of *x(n)*

(b) Compute and plot the 8 point DFT of *x(n)* (by appending 4 zeros)

(c) Compute and plot the 16 point DFT of *x(n)* (by appending 12 zeros)

7. Let *x(n)* and *h(n)* be the two 4-point sequences,

$$x(n) = \underset{\uparrow}{\{1,2,2,1\}}$$

$$h(n) = \underset{\uparrow}{\{1,-1,-1,1\}}$$

Write a program to compute their linear convolution using circular convolution.

8. Using a rectangular window, design a FIR low-pass filter with a pass-band gain of unity, cut off frequency of 1000 Hz and working at a sampling frequency of 5 KHz. Take the length of the impulse response as 17.
9. Design an FIR filter to meet the following specifications:
   Passband edge F_p= 2 KHz
   stopband edge F_s=5 KHz
   Passband attenuation A_p = 2 dB
   Stopband attenuation A_s = 42 dB
   Sampling frequency F_s = 20 KHz
10. The frequency response of a linear phase digital differentiator is given by

$$H_d(e^{jw}) = jwe^{jw} \quad |w| \leq \pi$$

Using a Hamming window of length M = 21, design a digital FIR differentiator. Plot the amplitude response.

Reference Books

[1] Digital Signal Processing, Tarun Kumar Rawat, 2015, Oxford University Press, India

[2] Digital Signal Processing, S. K. Mitra, McGraw Hill, India.

[3] Modern Digital and Analog Communication Systems, B.P. Lathi, 1998, 3rd Edn. Oxford University Press.

[4] Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L. Harris, 2005, Cengage Learning.

[5] A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press

[6] Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press.

[7] Simulation of ODE/PDE Models with MATLAB®, OCTAVE andSCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896

[8] Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444

[9] Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978- 6133459274

PHY-HE-6036

Advanced Mathematical Physics II

Total Lectures: 60 Credits: 6 (Theory: 05, Tutorial: 01)

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Course Outcome: *Upon completion of this course, students will be able to apply the concepts of Calculus of Variations, Group Theory and Probability Theory to solve numerical problems in Physics.*

Theory

Unit I: Calculus of Variations (Lectures 25)

Variable Calculus: Variational Principle, Euler's Equation and its Application to Simple Problems. Geodesics. Concept of Lagrangian. Generalized co-ordinates. Definition of canonical moment, Euler-Lagrange's Equations of Motion and its Applications to Simple Problems (e.g., Simple Pendulum and One dimensional harmonic oscillator). Definition of Canonical Momenta. Canonical Pair of Variables. Definition of Generalized Force: Definition of Hamiltonian (Leg- endre Transformation). Hamilton's Principle. Poisson Brackets and their properties. Lagrange Brackets and their properties.

Unit II: Group Theory (Lectures 25)

Review of sets, Mapping and Binary Operations, Relation, Types of Relations. Groups: Ele- mentary properties of groups, uniqueness of solution, Subgroup, Centre of a group, Co-sets of a subgroup, cyclic group, Permutation/Transformation. Homomorphism and Isomorphism of group.

Unit III: Advanced Probability Theory (Lectures 25)

Fundamental Probability Theorems. Conditional Probability, Bayes' Theorem, Repeated Tri- als, Binomial and Multinomial expansions. Random Variables and probability distributions, Expectation and Variance, Special Probability distributions: The binomial distribution, The poisson distribution, Continuous distribution: The Gaussian (or normal) distribution, The principle of least squares.

Reference Books

[1] Mathematical Methods for Physicists: Weber and Arfken, 2005, Academic Press.
[2] Mathematical Methods for Physicists: A Concise Introduction: Tai L. Chow, 2000, Cambridge Univ. Press.
[3] Elements of Group Theory for Physicists by A. W. Joshi, 1997, John Wiley.
[4] Group Theory and its Applications to Physical Problems by Morton Hamermesh, 1989, Dover
[5] Introduction to Mathematical Physics: Methods & Concepts: Chun Wa Wong, 2012, Oxford University Press
[6] Introduction to Mathematical Probability, J. V. Uspensky, 1937, Mc Graw-Hill.

PHY-HE-6046
Astronomy and Astrophysics
Total Lectures: 75 Credits: 6 (Theory: 05, Tutorial: 01)

Course Outcome: *Upon completion of this course, students will be able to understanding the origin and evolution of the Universe. The course will give a comprehensive introduction on the measurement of basic astronomical parameters such as astronomical scales, luminosity and astronomical quantities. It will give an overview on key developments in observational astrophysics. Students will have the idea of the instruments implemented for astronomical observation, the formation of planetary system and its evolution with time, the physical properties of Sun and the components of the solar system; and stellar and interstellar components of our Milky Way galaxy. Students will have the understanding of the origin and evolution of galaxies, presence of dark matter and large scale structures of the Universe.*

Theory

Unit I: Stellar properties (Lectures 15)

Radiant flux and Luminosity, Magnitude scale. Measurement of astronomical quantities: Stellar distances(parallax), Radii, Mass and Effective Temperature. Equilibrium of stars, Gravity and thermodynamics, virial theorem. Stellar spectral classification – Hertzsprung-Russell (HR) diagram. Introductory idea of stellar evolution: white dwarf, neutron stars and black holes.

Unit II: The Sun and the solar system (Lectures 15)

The Sun; properties of photosphere, chromosphere and corona. Solar system's objects: Theory of formation of the solar system (introductory idea only); physical properties of the planets- their distances, atmospheres, asteroid belt, meteorites and the comets – Kuiper belt and the Oort cloud; Introduction to Extra-Solar Planets.

Unit III: Positional Astronomy (Lecture 10)

Celestial sphere, spherical geometry and celestial coordinates. Concept of time: universal time, solar time, mean solar time, local sidereal time and Julian day. Introduction to constellations (hands on practice in evening sky with small telescopes or laser pointer), ecliptic and diurnal motion of stars. Solar system's objects : rotation, revolution and coordinates in the sky.

Unit IV: Astronomical Techniques (Lecture 10)

Introduction to telescopes – telescope size and light gathering power, resolving power, f-number. Different types of optical telescopes (reflecting and refracting). Space telescopes. Concept of virtual observatory, on-line tools in astronomy: SDSS, SkyView, SIMBAD, Aladin, AAVSO database etc. Introduction to photometry, spectroscopy and polarimetry.

Unit V: Galaxies (Lecture - 10)

The Milky Way, properties of the galactic centre. Classification of galaxies, Hubble's tuning fork diagram, normal (spiral, elliptical and lenticular) and active galaxies. Black holes in galaxies.

Unit VI: Large Scale Structure and Cosmology (Lecture - 15)

Distance ladder in cosmology, Cepheid variables. Cosmic expansion of the universe and Hubble(- Lemaitre) law. Clusters of galaxies and dark matter - virial theorem. Concept of the Hot Big Bang, Oscillating Universe, Cosmic Microwave Background (CMB).

Reference Books

[1] Astrophysics-Stars and Galaxies; K D Abhyankar

[2] Astrophysics-A modern perspective, K. S. Krishnaswamy

[3] Astrophysics for Physicists; A Rai Choudhuri

[4] Textbook of Astronomy and Astrophysics with elements of Cosmology; V B Bhatia

[5] An Introduction to Astrophysics by Baidyanath Basu

[6] Introduction to Astrophysics by H. L. Duorah and Kalpana Duorah

[7] The Physical Universe: An Introduction to Astronomy, Frank H. Shu

PHY-HE-6056

PHYSICS-DSE: CLASSICAL DYNAMICS

Total Lectures: 75 Credits: 6 (Theory: 05, Tutorial: 01)

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Course Outcome: *Upon completion of this course, students will have the overview of Newton's Laws of Motion, Special Theory of Relativity by 4-vectoer approach and fluids. Students will also have the understanding of the Lagrangian and Hamiltonian of a system.. By the end of this course, students will be able to solve the seen or unseen problems/numericals in classical mechanics.*

Theory

Unit I: Classical Mechanics of Point Particles (Lectures 22)

Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyroradius and gyrofrequency, motion in crossed electric and magnetic fields.constraints, Generalized coordinates and velocities, principle of virtual work, D,Alembert's principle,Hamilton'sprinciple, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field- conservation of angular momentum and energy.

Unit II: Small Amplitude Oscillations (Lectures 10)

Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.

Unit III: Special Theory of Relativity (Lectures 33)

Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and
alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.

Unit IV: Fluid Dynamics (Lectures 10)

Density ρ and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number.

Reference Books

[1] Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
[2] Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
[3] Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
[4] The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
[5] Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
[6] Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
[7] Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
[8] Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
[9] Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

B.Sc. Physics (Regular) Syllabus (CBCS)

*The syllabus is approved in the Academic Council meeting held on XXXX**

September, 2020

Physics Department, Gauhati University
WEB : https://gauhati.ac.in
GUWEB : http://web.gauhati.ac.in/syllabus

The syllabus is subject to modifications as deem fit by the Gauhati University

Index

Course Structure for B.Sc. in Physics (Regular) under CBCS

Type→	Core	AECC	SEC	DSE
Credits→	12 × 6 = 72	2 × 4 = 8	4 × 4 = 16	6 × 6 = 36
Semester I	PHY-RC-1016	ENG-AE-1014		
	XXX-RC-1016			
	YYY-RC-1016			
Semester II	PHY-RC-2016	ENV-AE-1014		
	XXX-RC-2016			
	YYY-RC-2016			
Semester III	PHY-RC-3016		PHY-SE-3XX4	
	XXX-RC-3016			
	YYY-RC-3016			
Semester IV	PHY-RC-4016		PHY-SE-4XX4	
	XXX-RC-4016			
	YYY-RC-4016			
Semester V			PHY-SE-5XX4	PHY-RE-5XX6
				XXX-RE-5XX6
				YYY-RE-5XX6
Semester VI			PHY-SE-6XX4	PHY-RE-6XX6
				XXX-RE-6XX6
				YYY-RE-6XX6

Legends

HC: Core Papers

SE: Skill Enhancement Papers

HE: Discipline Specific Elective Papers

HG: Generic Elective Papers

Directives & Advisory

(a) *A student majoring (honours) in Physics MAY take GE papers from any available discipline in the college, except Physics.*

(b) *It is advisable that a student majoring (honours) in Physics take at least one GE paper from Mathematics*

B.Sc. Regular Physics

Semester Wise Credit Distribution

Semester	Core Papers	AECC	SEC	DSE	Total Credit
First	3×6	1×4			22
Second	3×6	1×4			22
Third	3×6		1×4		22
Fourth	3×6		1×4		22
Fifth			1×4	3×6	22
Sixth			1×4	3×6	22
Total	**72**	**8**	**16**	**36**	**132**

List of Papers

Core Papers

1. PHY-RC-1016 : Mechanics (PHY-HG-1016)
2. PHY-RC-2016 : Electricity & Magnetism (PHY-HG-2016)
3. PHY-RC-3016 : Thermal Physics & Statistical Mechanics (PHY-HG-3016)
4. PHY-RC-4016 : Waves & Optics (PHY-HG-4016)

Discipline Specific Elective (DSE) Papers

1. PHY-HE-5016 : Experimental Techniques (PHY-RE-5016)
2. PHY-HE-5026 : Embedded Sys : Introduction to Microcontrollers (PHY-RE-5026)
3. PHY-HE-5036 : Advanced Mathematical Physics I (PHY-RE-5036)
4. PHY-HE-5046 : Physics of Devices and Instruments (PHY-RE-5046)
5. PHY-HE-5056 : Nuclear and Particle Physics (PHY-RE-5056)
6. PHY-HE-6016 : Communication Electronics (PHY-RE-6016)
7. PHY-HE-6026 : Digital Signal Processing (PHY-RE-6026)
8. PHY-HE-6036 : Advanced Mathematical Physics II (PHY-RE-6036)
9. PHY-HE-6046 : Astronomy and Astrophysics (PHY-RE-6046)
10. PHY-HE-6056 : Classical Dynamics (PHY-RE-6056)

Generic Elective (GE) Papers

1. PHY-HG-1016 : Mechanics (PHY-RC-1016)
2. PHY-HG-2016 : Electricity & Magnetism (PHY-RC-2016)
3. PHY-HG-3016 : Thermal Physics & Statistical Mechanics (PHY-RC-3016)
4. PHY-HG-4016 : Waves & Optics (PHY-RC-4016)

Skill Enhancement (SE) Papers

1. PHY-SE-3014 : Physics Workshop Skills
2. PHY-SE-3024 : Computational Physics Skills
3. PHY-SE-3034 : Computer Assembling and Networking
4. PHY-SE-3044 : Digital Photography and editing
5. PHY-SE-3054 : Video editing for social media
6. PHY-SE-4014 : Basic Instruments Skills
7. PHY-SE-4024 : Research & Technical Writing
8. PHY-SE-4034 : Domestic and industrial wiring
9. PHY-SE-4044 : Photoshop
10. PHY-SE-4054 : Motion graphics for advertising and films

11. PHY-SE-5014 : Weather Forecast
12. PHY-SE-5024 : Applied Optics
13. PHY-SE-5034 : Technical Drawing
14. PHY-SE-5044 : PageMaker

15. PHY-SE-6014 : Radiation Safety
16. PHY-SE-6024 : Renewable energy
17. PHY-SE-6034 : Introduction to CorelDraw
18. PHY-SE-6044 : Graphic design for digital advertising

Note :

(a) ***The courses given in Red colour are equivalent in content to the corresponding courses given alongside.***

(b) ***In the Lab classes, wherever applicable, students and instructors can use either of C, C++, FORTRAN 90/95, Matlab, Scilab, or Python environment.***

(c) ***Marks in questions papers must appear approximately, if not exactly, in the proportion of number of lectures assigned to various modules of a particular paper. However, marks in the question paper should not exceed 1.25 times the number of assigned lectures of a module under any circumstances.***

Course Pre-Requisites

1. Physics Honours Course : Physics and Mathematics in Class XII (or equivalent)

Paper Pre-Requisites

Papers	Pre-Requisites
1. PHY-RC-1016 2. PHY-RC-2016 3. PHY-RC-3016 4. PHY-RC-4016	Physics in Class XII (or equivalent)
5. PHY-HE-5016 / PHY-RE-5016 6. PHY-HE-5026 / PHY-RE-5026 7. PHY-HE-5036 / PHY-RE-5036 8. PHY-HE-5046 / PHY-RE-5046	PHY-HG-1016, 2016, 3016, 4016 or PHY-RC-1016, 2016, 3016, 4016
9. PHY-HE-6016 / PHY-RE-6016 10. PHY-HE-6026 / PHY-RE-6026 11. PHY-HE-6036 / PHY-RE-6036 12. PHY-HE-6046 / PHY-RE-6046	All earlier Pre-Requisites & PHY-HE-5016, 5016, 5016, 5016 or PHY-RE-5016, 5016, 5016, 5016

First Semester

Regular Core Paper

PHY-RC-1016 (PHY-HG-1016)
Mechanics
Total Lectures: 60   Credits : 6 (Theory : 04, Lab : 02)

Course outcome: *Upon completion of this course, students are expected to understand the role of vectors and coordinate systems in Physics, solve Ordinary Differential Equations, laws of motion and their application to various dynamical situations, Inertial reference frames their transformations, concept of conservation of energy, momentum, angular momentum and apply them to basic problems, phenomenon of simple harmonic motion, motion under central force, concept of time dilation, Length contraction using special teory of relativity. In the laboratory course, after acquiring knowledge of how to handle measuring instruments (like screw gauge, Vernier calipers, travelling microscope) student shall embark on verifying various principles and associated measurable parameters.*

Theory

Unit I : Vectors (Lectures 06)

Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coeffcients.

Unit II : Laws of Motion (Lectures 10)

Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.

Unit III : Momentum and Energy (Lectures 06)

Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

Unit IV : Rotational Motion (Lectures 05)

Angular velocity and angular momentum. Torque. Conservation of angular momentum.

Unit V : Gravitation (Lectures 07)

Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only).

Unit VI : Oscillations (Lectures 07)

Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. Compound pendulum.

Unit VII : Elasticity (Lectures 08)

Hooke's law - Stress-strain diagram – Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants – Work done in stretching and work done in twisting a wire – Twisting couple on a cylinder – Determination of Rigidity modulus by static torsion - Torsional pendulum-Determination of Rigidity modulus and moment of inertia – q, η and $\sigma$by Searles method.

Unit VII : Special Theory of Relativity (Lectures 07)

Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

Lab

A minimum of five experiments to be done.

1. Measurements of length (or diameter) using vernier caliper, screw gauge and Spherometer.
2. To determine the Moment of Inertia of a Symmetrical body about an axis by torsional oscillation method.
3. To determine the Young's Modulus of the material of a wire by Searle's apparatus.
4. To determine the Modulus of Rigidity of a Wire Static method.
5. To determine the elastic Constants of a wire by Searle's method.
6. To determine the value of g using Bar Pendulum.
7. To determine the value of g using Kater's Pendulum.
8. To study the Motion of Spring and calculate (a) Spring constant and (b) value of g.

Reference Books

[1] An Introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.

[2] Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill.

[3] Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.

[4] Analytical Mechanics, G. R. Fowles and G. L. Cassiday. 2005, Cengage Learning.

[5] Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

[6] Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

[7] University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

[8] Mechanics, D. S. Mathur, S. Chand and Company Limited, 2000

[9] University Physics, F. W. Sears, M. W. Zemansky, H.D Young 13/e, 1986, Addison Wesley

[10] Physics for Scientists and Engineers with Modern Phys., J. W. Jewett, R. A. Serway, 2010, Cengage Learning

[11] Theoretical Mechanics, M. R. Spiegel, 2006, Tata McGraw Hill.

Second Semester

Regular Core Paper

PHY-RC-2016 (PHY-HG-2016)
Electricity & Magnetism
Total Lectures: 60 Credits : 6 (Theory : 04, Lab : 02)

Course outcome: *Upon completion of this course, students are expected to apply Gauss's law of electrostatics to solve a variety of problems, calculate the magnetic forces that act on moving charges and the magnetic fields due to currents, have brief idea of magnetic materials, understand the concepts of induction, and apply them to solve variety of problems. In the Lab course, students will be able to measure resistance (high and low), Voltage, Current, self and mutual inductance, capacitor, strength of magnetic field and its variation, study different circuits RC, LCR etc.*

Theory

Unit I : Vector Analysis (Lectures 12)
Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

Unit II : Electrostatics (Lectures 22)
Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem – Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

Unit III : Magnetism (Lectures 10)
Magnetostatics: Biot-Savart's law & its applications – straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia, para, and ferro-magnetic materials.

Unit IV : Electromagnetic Induction (Lectures 06)
Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

Unit V : Maxwell's Equations and EM Wave (Lectures 10)
Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

Lab

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer
   (a) Measurement of charge and current sensitivity
   (b) Measurement of CDR
   (c) Determine a high resistance by Leakage Method
   (d) To determine Self Inductance of a Coil by Rayleigh's Method.
3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
5. To study the Characteristics of a Series RC Circuit.
6. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q .
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorem.
10. To verify the Superposition, and Maximum Power Transfer Theorem.

Reference Books

[1] Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw

[2] Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education

[3] Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.

[4] Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

[5] Elements of Electromagnetics, M. N. O. Sadiku, 2010, Oxford University Press.

[6] Electricity and Magnetism, J. H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

Third Semester

Regular Core Paper

PHY-RC-3016 (PHY-HG-3016)

Thermal Physics & Statistical Mechanics

Total Lectures: 60 Credits: 6 (Theory: 04, Lab:02)

Course outcome: *Upon completion of this course, students are expected learn the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations, Maxwell's thermodynamic relations, fundamentals of the kinetic theory of gases, Maxwell-Boltzman distribution law, equipartition of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion, black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances, quantum statistical distributions, viz., the Bose-Einstein statistics and the Fermi-Dirac statistics. In the laboratory course, the students will be able to Measure of Planck's constant using black body radiation, determine Stefan's Constant, coefficient of thermal conductivity of a bad conductor and a good conductor, determine the temperature coefficient of resistance, study variation of thermo emf across two junctions of a thermocouple with temperature etc.*

Theory

Unit I : Laws of Thermodynamics (Lectures 22)

Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP & CV , Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

Unit II : Thermodynamic Potentials (Lectures 10)

Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for (CP — CV), CP/CV , T dS equations.

Unit III : Kinetic Theory of Gases (Lectures 10)

Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

Unit IV : Theory of Radiation (Lectures 06)

Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

Unit V : Statistical Mechanics (Lectures 12)

Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity – Quantum statistics – Fermi-Dirac distribution law – electron gas – Bose-Einstein distribution law – photon gas – comparison of three statistics.

Lab

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system.
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.

Reference Books

[1] Heat and Thermodynamics, M. W. Zemansky, Richard Dittman, 1981, McGraw-Hill.

[2] A Treatise on Heat, Meghnad Saha, and B. N.Srivastava, 1958, Indian Press

[3] Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill

[4] Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.

[5] Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.

[6] Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press

[7] Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

[8] Statistical Mechanics, R. K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.

[9] Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill

[10] Statistical and Thermal Physics, S. Lokanathan and R. S. Gambhir. 1991, Prentice Hall

Skill Enhancement Paper
[Choose One]

PHY-SE-3014
Physics Workshop Skills

Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics or a B.E/B.Tech in Mechanical Engineering

The aim of this course is to enable the students to familiar and experience with various mechanical and electrical tools through hands-on mode

Unit I: Introduction (4 Lectures)

Measuring units. conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc.

Unit II: Mechanical Skill (10 Lectures)

Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood. Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothening of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. Make funnel using metal sheet.

Unit III : Electrical and Electronic Skill (10 Lectures)

Use of Multimeter. Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. Making regulated power supply. Timer circuit, Electronic switch using transistor and relay.

Unit III : Introduction to prime movers: (6 Lectures)

Mechanism, gear system, wheel, Fixing of gears with motor axel. Lever mechanism, Lifting of heavy weight using lever. braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment.

Lab

1. Study the use of meter scale, Vernier caliper, Screw Gauge.
2. To measure dimension of solid block, volume of cylindrical beaker/ glass, diameter of thin wire, thickness of metal sheet.
3. To measure height of building, mountain using Sextant
4. To join metals using welding.

5. To prepare nut, bolts etc. using lathe machine and other tools.
6. To Cut a metal sheet and smoothening of the cutting edge using file.
7. Study the use of multimeter and Oscilloscope.
8. To use soldering of electrical circuit having discrete components on PCB.
9. To construct a regulated power supply
10. Demonstration of lifting of heavy weight using lever

Reference Books:

[1] A text book in Electrical Technology-B L Theraja – S. Chand and Company.
[2] Performance and design of AC machines – M.G. Say, ELBS Edn.
[3] Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.
[4] Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edn., Editor Newnes [ISBN: 0750660732]
[5] New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of Ireland [ISBN: 0861674480]

PHY-SE-3024
COMPUTATIONAL PHYSICS SKILLS
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with adequate knowledge on computer programming/An MCA/M.Sc. with DCA.

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- *Highlights the use of computational methods to solve physical problems*
- *Use of computer language as a tool in solving physics problems (applications)*
- *Course will consist of hands on training on the Problem solving on Computers.*

Theory

Unit I: Introduction (Lectures 3)

Importance of computers in Physics, paradigm for solving physics problems for solution. Introduction to various OS, Linux OS such as RedHat, Ubuntu, Scientific Linux, Usage of Basic linux commands. Text editors such as vi and Emacs.

Unit II: Basics of Scientific Programming (Lectures 4)

Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

Unit III: Scientific Programming (Lectures 18)

Variables and Formatting: Introduction to HLL, Concepts of a Compiler. Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of a Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems. (6L)

Control Statements, Functions, and Subroutines: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file.

Unit V: Visualization (Lectures 5)

Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, curve fitting – straight line, polynomials, user defined function. Physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

Hands on exercises:

1. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor.
2. To print out all natural even/ odd numbers between given limits.
3. To find maximum, minimum and range of a given set of numbers.
4. Calculating Euler number using exp(x) series evaluated at x=1
5. To compile a frequency distribution and evaluate mean, standard deviation etc.
6. To evaluate sum of finite series and the area under a curve.
7. To find the product of two matrices
8. To find a set of prime numbers and Fibonacci series.
9. To write program to open a file and generate data for plotting using Gnuplot.
10. Plotting trajectory of a projectile projected horizontally.
11. Plotting trajectory of a projectile projected making an angle with the horizontally.
12. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
13. To find the roots of a quadratic equation.
14. Motion of a projectile using simulation and plot the output for visualization.
15. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
16. Motion of particle in a central force field and plot the output for visualization.

Reference Books:

[1] Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.

[2] Computer Programming in Fortran 77”. V. Rajaraman (Publisher: PHI).

[3] LaTeX–A Document Preparation System”, Leslie Lamport (Second Edition, Addison-Wesley, 1994).

[4] Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)

[5] Schaum’s Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.

[6] Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)

[7] A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.

PHY-SE-3034
Computer Assembling and Networking
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate course on Computer Assembling and Networking, B.E./B.Tech. in Computer Science/ MCA/First class or Second class govt registered contractor with a Bachelor Degree in Science/ B.Sc. with DCA.

The aim of the course is give overview of the different components in a computer and their assembling and dissembling and handling of installation of operating system in computer. It will also give overview of the networking, different hardware and components of networking.

Course Outcome: *After successfully completing the course students will be able to Identify Computer Hardware Components, Network Components and Peripherals, assemble and dissemble a computer, Identify the different types of network topologies and protocols. Enumerate the layers of the OSI model and TCP/IP. Explain the function(s) of each layer, Identify the different types of network devices and their functions within a network, Understand and building the skills of subnetting and routing mechanisms., Familiarity with the basic protocols of computer networks, and how they can be used to assist in network design and implementation.*

Unit I: Components of Computer (Lectures 10)

Specifications of processors (Intel Celeron, P4family, Xeon dual core, quad core, core2 duo, i3, i5, i7 and AMD).

Memory devices, types, principle of storing. Data organization 4bit, 8-bit, word. Semiconductor memories, RAM, ROM, PROM, EMPROM, EEPROM, Static and dynamic. Example of memory chips, pin diagram, pin function.

Concept of track, sector, cylinder. FD Drive components read write head, head actuator, spindle motor, sensors, PCB.

Precaution and care to be taken while dismantling Drives. Drive bay, sizes, types of drives that can be fitted. Precautions to be taken while removing rive bay from PC.

HDD, advantages, Principle of working of Hard disk drive, cylinder and cluster, types, capacity, popular brands, standards, interface, jumper setting. Drive components- hard disk platens, and recording media, air filter, read write head, head actuator, spindle motor, circuit board, sensor, features like head parking, head positioning, reliability, performances, shock mounting capacity. HDD interface IDE, SCSI-I/2/3 comparative study. Latest trends in interface technology in PC and server HDD interface. Concept of SATA and SACH.

Precautions to be taken while fitting drives into bays and bay inside PC cabinet. CMOS setting. (restrict to drive settings only). Meaning and need for Using Scan disk and defrag. Basic blocks of SMPS, description of sample circuit. Vendor/sources of PC hardware components.

Unit II: Operating System Basics & Installation (Lectures 4)
Introduction to OS, Types of Operating systems, System files FAT and NTFS DOS, Windows XP, Windows Vista, Windows 7 and Windows 8, Windows 10 and RedHat Linux and Multi Boot Operating System

Unit III: Overview of Networking (Lectures 2)

Introduction to networks and networking, LAN, VLAN, CAN, MAN, WAN, Internet and Intranet etc. Uses and benefits of Network, Server-client based network, peer to peer networks.

Unit IV: Network Hardware and Components (Lectures 4)

Concept of Server, client, node, segment, backbone, host etc. Analog and Digital transmission, Network Interface Card, Crimping tools and Color standards for Straight crimping and Cross crimping Functions of NIC, Repeaters, Hub, Switches, Routers, Bridges, Router etc.

Unit V: Transmission Media and Topologies (Lectures 4)

Media types: STP cable, UTP cable, Coaxial cable, Fiber cable, Base band and Broadband transmission, Cables and Connectors, Physical and logical topologies, Bus, Star, Ring and Mesh topologies

Unit VI: Protocols and Services (Lectures 3)

HTTP, FTP and other Different types of protocols, OSI Model, Media Access Method, DNS services, DHCP services, WINS services and RAS services, Web services, Proxy Services etc.

Unit VII: TCP/IP and Sub-netting (Lectures 3)

Introduction about TCP/IP and Sub-nettings, configuring IP address and subnettings with different Routers and Network, TCP/IP Errors and Solutions,

Lab

(i) Computer Assembling and Operating System Installations

1. Installation of different Operating Systems Windows XP, Windows 7, Windows 10, RedHat, Linux,
2. Installation Dual Operating System like: Windows XP and Windows 7, Ubuntu, Linux
3. Troubleshooting and Repair Operating System : Windows XP, Windows 7, Windows 10, RedHat, Linux
4. Tacking Data Backup and System Formatting and OS Installation
5. Check various front panel connections on motherboard (power switch, reset switch and HDD Led). Check power and reset switch connection. Replace faulty power switch from cabinet and assemble a new one.
6. Check DDR3 and DDR4 RAM's FSB. Insert it on memory slot. Test and understand various beep sounds in case of trouble.
7. Find the CMOS/ROM BIOS chip on mother board.
8. Install a Hard Drive. Identify and check data and power cable and SATA and SACH ports in motherboards.
9. Install internal and external DVD ROM Drive.
10. Troubleshoot defects related to SMPS, its cable, connector and servicing procedure. Removing a Power Supply. Installing a Power Supply. Use SMPS tester.
11. Install a Graphic and sound cards. Remove them safely.
12. Install and removing cooling Fans on pc cabinet.
13. Removing the Motherboard carefully and Install it again.
14. Removing the Processor, Installing the Processor. Understand and identify various different processor sockets.
15. Installing different type of CPU Cooler.
16. Find the CMOS Battery. Test it with multimeter. Replace it.

(ii) Networking

1. Installing and Configuring Windows 2003 and 2008 Server or latest server
2. Cable Crimping using Different Color Codes (Straight and Cross Cable)
3. Installation and configuring Peer to Peer and Server-Client Network
4. Installation and Configuring Active Directory Services
5. Installation and Configuring DNS & DHCP Services
6. Installation and Configuring FTP, HTTP Services
7. Backup and Restoration for ADS, DHCP and User Data
8. FAT and NTFS Sharing Permission
9. Configuring & Implementing Unmanageable Network Switch
10. Configuring & Implementing Manageable Network Switch
11. Configuring a Local Security Policies & Domain Security Policies
12. Installing Printer in Windows XP, Windows 7, Windows 2003 & 2008 Server
13. Configuring Gateway Service for Internet Connectivity
14. Configuring ADSL+2 Router for BSNL/other Internet Connectivity
15. Configuring Wireless Access Point
16. Installation and Configuring Wire Network
17. Installation and Configuring Wireless Network
18. Installation of AD-hoc Wireless Network
19. Installation and Configure Different Antivirus Software and Admin Console
20. Remote Desktop, Remote Assistance, Telnet, HyperTerminal, TeamViewer

Reference Books:

[1] Fundamentals of Computer by V Rajaraman; Prentice Hall of India Pvt. Ltd., New Delhi

[2] Information Technology for Management by Henery Lucas, Tata McGraw Hills, New Delhi

[3] Computers Fundamentals Architecture and Organisation by B Ram, revised Edition, New Age International Publishers, New Delhi

[4] Computer Networking A Top-Down Approach, Kurose James F., Ross Keith W., Sixth Edition By Pearon

PHY-SE-3044
Digital Photography & Editing
Credits: 4 (Theory: 02, Lab: 02)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with a certificate on digital photography/Professional Photographer with degree or diploma in photography with adequate knowledge on digital editing and a Bachelor degree in Science.

This course will give you the basic understanding of photography, Physics behind working of camera, various composition techniques that will help you to take superior photos. Various composition techniques those will help the students to improve the photos. This course will give the students an overview and explanation of what good overflow in photography look like.

Course Outcome: *On successful completion of the course students will be able to indentify cameras according to formats and view finder systems, identify types of lenses and state what type of lenses to be used for different purposes, apply settings of shutter speed, control depth of field via aperture settings, apply suitable focal length, Use the light metering mechanism of the camera to take photographs.*

Theory

Unit I: Theory of Basic Photography (Lectures 2)

History of Photography, Introduction to Digital Photography, Digital Camera, dSLR, Advantages and Disadvantages of Digital Photography

Unit II: The Camera- Components and Concepts (Lectures 2)

Lens, Focal Length, Lens type, Aperture, Depth of Field, Shutter, Shutter Speed, Image sensor, Memory cards, External Flash, File types

Unit III: Capturing an Image, Hands-on Basics (Lectures 3)

Elements of Composition: Pattern, Symmetry, Texture, Depth of Field, Lines; Law of Thirds, Camera Shake, Red eye, Lighting, Digital Noise

Unit IV: Exposure Modes (Lectures 5)

Automatic mode, Manual mode, aperture mode, shutter mode, Scene mode, Portrait mode, landscape mode, close up mode, sports mode, Twilight mode, Night Mode, Black and white, sepia, Panoramic mode.

Unit V: Conditions in Digital Photography (Lectures 7)

Lighting, Importance of Natural Light, Best Time of Day to Take Photos, Disable Flash Indoors, Disable Flash in Low Light, Use Flash to Balance Bright Light, Get Closer to the Subject, Crop Your Photo, Choose Better Backgrounds, Pick Proper Orientation, Use Point of View, Frame your Subject, Experiment with Abstract Photography, Holding your DSLR

Unit VI: Digital Videography (Lectures 4)

Various Parts, Contrl and Features of Video Camera, Types of daylight applications, Three points lighting- (a) The key light, (b) The fill light and the back light, (c) Bounce and diffuse light, Framing and shots, Camera angle and camera movements

Unit VI: Post Production (Lectures 7)

The Digital Workflow: Capturing the Image, Storing the Photo, Cataloging the Image Files, Editing the Photo,

Reference Books

[1] Beginner's Guide to Digital Photography
[2] Complete Idiot's Guide to Digital Photography – Steve Greenberg
[3] Complete Digital Photography Third Edition – Ben Long
[4] The Textbook of Digital Photography Second Edition – Dennis P. Curtin

PHY-SE-3054
VIDEO EDITING FOR SOCIAL MEDIA
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on video editing/ B.E./B.Tech. in Computer Science/ MCA/B.Sc with DCA.

This course will give you the skills to edit innovative videos for news, events, food, travel or blogging to be promoted on Social Media platforms. You will learn to create & edit these videos on the most popular and industry relevant video editing software, Adobe Premiere Pro.

Course Outcome: *On successful completion of the course students will be able to learn to Edit impactful video content which appeals to target audience, Add or Edit Music, Soundtrack or Audio to your videos, Learn to customize your videos by using Text (fonts), Learn to use transitions and effects to create impactful videos.*

Tools: Adobe Premiere CC

Unit I: What's New in Premiere Pro CC 7.0 (Lectures 2)
New Features: Summary, Workspace

Unit II: Workflow and Project Setup (Lectures 2)
Basic Workflow, Preferences

Unit III: Importing Footage (Lectures 2)
Transferring and Importing Files, Supported File Format, Importing Sequences, Clip Lists, Compositions, Still Images, and Digital Videos

Unit IV: Working Sequences (Lectures 3)
Creating and Changing Sequences, Adding, Rearranging, and Working with Clips in a Sequences, Rendering and Previewing Sequences

Unit V: Editing Audio (Lectures 4)
Overview of Audio and Audio Track Mixer, Working with Clips, Channels, and Tracks, Editing Audio in a Timeline Panel, Adjusting Volume Levels

Unit VI: Titling and the Titler (Lectures 4)
Creating and Editing Titles, Creating and Formatting Text in Titles, Working with Text and Objects in Titles

Unit VII: Effects (Lectures 5)
About Effects - Applying, Removing, Finding, and Organizing Effects, Viewing and Adjusting Effects, Keyframes, and Effects Presets, Masking and Tracking, Applying Transitions, Adjustment Layers, Color Correction and Adjustments, Three-way Color Corrector Effect, Audio Effects and Transitions

Unit VIII: Compositing and Exporting (Lectures 4)
Compositing, Alpha Channels, and Adjusting Clip Opacity, Blending Modes, Workflow and Overview for Exporting, Exporting Projects for Other Applications, Exporting Still Images

Unit IX: Patching of Rough Cuts (Lectures 4)
Working with Rough Cut, Editing Rough Cuts, The Prelude Workspace, Exporting Still Images

Fourth Semester

Regular Core Paper

PHY-RC-4016 (PHY-HG-4016)
Waves & Optics
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course outcome: *Upon completion of this course, students are expected to understand Simple harmonic oscillation and superposition principle, importance of classical wave equation in transverse and longitudinal waves and solving a range of physical systems on its basis, concept of normal modes in transverse and longitudinal waves: their frequencies and configurations, interference as superposition of waves from coherent sources derived from same parent source, Demonstrate understanding of Interference and diffraction experiments, Polarization. In the laboratory course, student will gain hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc. Resolving power of optical equipment, the motion of coupled oscillators, study of Lissajous figures and behaviour of transverse, longitudinal waves.*

Theory

Unit I : Superposition of Two Collinear Harmonic Oscillations (Lectures 04)

Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).

Unit II : Superposition of Two Perpendicular Harmonic Oscillations (Lectures 02)

Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

Unit III : Waves Motion (Lectures 07)

General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.

Unit IV : Fluids (Lectures 06)

Surface Tension: Synclastic and anticlastic surface – Excess of pressure – Application to spherical and cylindrical drops and bubbles – variation of surface tension with temperature – Jaegar's method. Viscosity – Rate flow of liquid in a capillary tube – Poiseuille's formula – Determination of coefficient of viscosity of a liquid – Variations of viscosity of liquid with temperature – lubrication.

Unit V : Sound (Lectures 06)

Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.

Unit VI : Wave Optics (Lectures 03)

Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

Unit VII : Interference (Lectures 10)

Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination and Fringes of equal thickness. Newton's Rings: measurement of wavelength .

Michelson’s Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index Visibility of fringes.

Unit VIII : Michelson Interferometer (Lectures 03)

(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Refractive Index. (4) Visibility of fringes.

Unit IX : Diffraction (Lectures 14)

Fresnel and Fraunhofer diffraction . Fresnel’s Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel diffraction pattern of a straight edge and at a circular aperture . Resolving Power of a telescope. Fraunhofer diffraction due to a Single slit , Diffraction grating . Resolving power of grating.

Unit X : Polarization (Lectures 05)

Transverse nature of light waves. Double Refraction, Plane, circular and elliptically polarized light , Production and analysis of polarized light. Retarding plates.

Lab

A minimum of five experiments to be done.

1. To study the variation in liquid column height with diameter of capillary tube and determine the surface tension of the liquid.
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde’s Experiment and to verify Z^2 — T Law.
3. To determine the coefficient of Viscosity of water by Capillary Flow Method (Poiseuille’s method)
4. To determine the focal length of a convex mirror with the help of convex lens .
5. To determine the refractive index of a liquid by using plane mirror and convex lens.
6. To determine the focal length of two lenses and their combination by displacement method .
7. Familiarization with Schuster’s focussing; determination of angle of prism.
8. To determine the Refractive Index of the Material of a Prism using Sodium Light.
9. To determine wavelength of sodium light using Newton’s Rings.

Reference Books

[1] Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.

[2] Fundamentals of Optics, F. A. Jenkins and H.E. White, 1981, McGraw-Hill

[3] Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.

[4] Optics, Ajoy Ghatak, 2008, Tata McGraw Hill

[5] The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.

[6] The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

[7] Fundamental of Optics, A. Kumar, H. R. Gulati and D. R. Khanna, 2011, R. Chand Publications.

Skill Enhancement Papers
[Choose One]

PHY-SE-4014
BASIC INSTRUMENTATION SKILLS
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics/B.E./B.Tech in Instrumentation/Mechanical Engineering.

This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.

Theory

Unit I: Basic of Measurement (Lectures 4)

Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Unit II: Electronic Voltmeter (Lectures 4)

Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance.

Unit III: Cathode Ray Oscilloscope (Lectures 6)

Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.

Unit IV: (Lectures 3)

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

Unit V: Signal Generators and Analysis Instruments (Lectures 4)

Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

Unit VI: Impedance Bridges & Q-Meters (Lectures 3)

Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges.

Unit VII: Digital Instruments (Lectures 3)

Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

Unit VIII: Digital Multimeter (Lectures 3)

Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Lab

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R, L and C using a LCR bridge/ universal bridge.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books

[1] Electronic Measurements and Instrumentation, K. Lal Kishore, Pearson India
[2] Electrical and Electronics Measurements and Instrumentation, Prithwiraj Purkait, Budhaditya Biswas, Santanu Das, Chiranjib Koley, McGraw Hill India.
[3] A text book in Electrical Technology - B L Theraja - S Chand and Co.
[4] Performance and design of AC machines - M G Say ELBS Edn.
[5] Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
[6] Logic circuit design, Shimon P. Vingron, 2012, Springer.
[7] Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
[8] Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
[9] Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
[10] Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

PHY-SE-4024
Research & Technical Writing
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with adequate knowledge on Latex/ B.E./B.Tech. in Computer Science/ MCA.

This aim of the course is to make the students aware about importance of research and technical writing. This course provides students with an introduction to technical writing, graphing and data analysis, and computer presentation with LaTex, Origin and Microsoft excel.

Course Outcome: *On successful completion of the course students will be able to identify and write different parts of technical reports, write article, thesis, and presentation in latex, create chart in Microsoft excel, use different format of chart based on need, plot data from different sources using Origin plot.*

Theory

Introduction (Lectures 4)

Structure and components of scientific reports - Types of report – Technical reports and thesis– Different steps in the preparation – Layout – Illustrations and tables - Bibliography, referencing and footnotes. Need of scientific word processor, examples of scientific word processors.

Unit II: Technical Writing in LaTex (Lectures 12)

Introduction to LaTeX, advantages of using LaTex, TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors. Applications of LaTex in article, thesis, slide preparation.

Unit III: Scientific graphing and data analysis (Lectures 14)

Creating chart in Microsoft excel, Types of chart- Column chart, line chart, Pie chart, Doughnut chart, bar chart, area chart, scatter chart, surface chart; Chart elements- Chart style, Chart filter, fine tune of chart; Chart design tools- Design and format.

The Origin Workspace, Multi-sheet Workbooks, Managing Data and Metadata, Importing Data from different sources, Working with Excel and Origin, Basic Data Manipulation, Creating and Customizing Graphs, Custom Graph Templates and Themes, Publishing Graphs, Basic Data Analysis, Customizing Data Import, Post Processing of Imported Data, Creating and Customizing Multi-layer Graphs, Data Exploration and Pre-selection, Advanced Nonlinear Fitting, including Creating Custom Fitting Functions, Analysis Themes, Customizing Reports and Creating Custom Tables in Graphs, Recalculating/Updating Results, Analysis Templates and Custom Reports, Peaks and Baseline.

PHY-SE-4034
Domestic and Industrial Electrical Wiring
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: B.E./B.Tech. in electrical engineering/First class or Second class govt. registered contractor with a Bachelor Degree in Science.

The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode. This course will enable the students to read, understand and interpret engineering drawing and communicate through sketches and drawings. Students will be able to prepare working drawings of panels, transmission and distribution and install and commission electrical wiring in domestic as well as industrial buildings.

Course Outcome: *After successfully completion of the course students will be able to r*ecognize various electrical devices and their symbols, Recognize various electrical devices placed on the panels/distribution boards and to design the panels, Read schematic and wiring diagrams of electrical devices, Read and interpret electrical installation plan, Practice and execute any type of wiring , Estimate and determine the cost of wiring installation

Theory

Unit I: Understanding Electrical Circuits (Lectures 3)

Main electric circuit elements and their combination; Rules to analyze DC sourced electrical circuits; Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources; Rules to analyze AC sourced electrical circuits.

Unit II: Electrical Drawing and Symbols (Lectures 10)

Various electrical symbols used in domestic and industrial installation and power system as per BIS code. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. Wiring diagram of light, fan, bell and alarm circuit, staircase and godown wiring, schematic diagram of lighting system of conference room, theatre, sports stadium etc. Design and drawing of panels, distribution board using MCB, ELCB, main switches and change over switches for domestic, industrial and commercial installations.

Unit III: Types of wiring (Lectures 5)

Basics of wiring- star and delta wiring; Cleat, Batten, casing-capping and conduit wiring, comparison of different types of wiring systems; selection and design of wiring schemes for particular situation (domestic and industrial), selection of wire, cables, wiring accessories and use of protective devices i.e., MCB, ELCB etc.; rating and current carrying capacity of wires, cables, fuse, switches, socket, MCBs, ELCBs and other electrical accessories.

Unit IV: Earthing (Lectures 2)

Concept and purpose of earthing, different types and procedure of earthing, drawing of plate and pipe earthing, test material and costing and estimating.

Unit V: Estimating and costing (Lectures 10)

(i) Domestic Installations: Standard practices as per IS and IE rules. Planning of circuits, sub circuits and position of different accessories, electrical layouts, preparing estimates including costs as per schedule rate pattern and actual market rate (single storey and multi storey buildings having similar electrical load)
(ii) Industrial Installations: Standard practices as per IS and IE rules; planning, designing and estimation of installation

of single phase motors of different ratings, electrical circuit diagram, starters, preparation of list of materials, estimating and costing on workshop with single phase , 3-phase motor laod and the light load

(iii) Service line connections: Estimate for domestic and industrial load from pole to energy meter.

Lab

1. Safety use in electricity, shock treatment methods, safety precautions.
2. To study & find the specifications of various types of wires and cables.
3. To measure the gauge of a given wire with the help of wire gauge.
4. To connect the wires with different electrical accessories.
5. Skinning the cable and joint practice on single and multi strand wire.
6. To measure the power of an electric motor by wattmeter.
7. To make a main switch board for house wiring
8. Installation of common electrical accessories such as switch, holder, plug on board.
9. Installation and wiring connection of ceiling fan, exhaust fan, geyser, water purifier.
10. Preparation of extension board.
11. Demonstrate electrical circuit diagrams related to electrical equipment
12. Calculate/ interpret electrical power rating of electrical circuits installed in the equipments
13. Carry out the earthing of the installed electrical circuit as per standard practice
14. Practice on different types of House Wiring installation and testing
15. Designing of light and fan scheme for a institutional or commercial building
16. House wiring circuits using fuse, switches, sockets, ceiling fan etc. in batten or P.V.C. casing-caping.
17. Prepare one estimate of materials required for CTS wiring for small domestic installation of one room and one verandah within 25 m^2 with given light, fan & plug points.
18. Prepare one estimate of materials required for conduit wiring for small domestic installation of one room and one verandha within 25 m^2 with given light, fan & plug points.
19. Prepare one estimate of materials required for concealed wiring for domestic installation of two rooms and one latrine, bath, kitchen & verandah within $80m^2$ with given light, fan & plug points.
20. Prepare one estimate of materials required for erection of conduct wiring to a small workshop installation about $30m^2$

Reference Books:

[1] Electrical Installation and Estimating- Surjit Singh, Dhanpatrai and sons

[2] A course in Electrical Installation, Estimating and costing- J B Gupta, S K Kataria and Sons

[3] A text book in Electrical Technology - B L Theraja - S Chand & Co.

[4] A text book of Electrical Technology - A K Theraja

[5] Performance and design of AC machines - M G Say ELBS Edn.

PHY-SE-4044
Photoshop
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on Photoshop/B.E./B.Tech. in Computer Science/MCA/ B.Sc. with DCA.

This course will give you skill to prepare creative effect to design stunning text style, design icons, business cards, illustrations and characters. You will learn to remove people or objects from photos, cut away a person from their background. In this course you will learn how to properly use Photoshop's tools, discover how to retouch and color correct photographic images.

Course Outcome: *On successful completion of the course students will be able to work with the tools in Adobe Photoshop CC, crop image in Adobe Photoshop CC, to resize an image for print and digital media in Adobe Photoshop CC, apply Photoshop filters in print and digital media, apply filters to sharpen the images, different types of brushes used for digital painting.*

Tools: Adobe Photoshop CC

Unit I: Getting Started with Adobe Photoshop CC (Lectures 3)
Overview of Adobe Photoshop CC, Features of Adobe Photoshop CC

Unit II: Importance of Adobe Photoshop CC (Lectures 5)
Overview of Tools Used in Adobe Photoshop CC, Importance of Adobe Photoshop CC

Unit III: Working with Typography (Lectures 4)
Typography, Creating Typographies, Choosing the Right Font and Color

Unit IV: Working with Layers and Images (Lectures 6)
Cropping a Photo, Resizing Images, Basics of Layers, Creating Layers for Print and Digital Media, Aligning Images within Multiple Layers, Merging Layer Techniques

Unit V: Working with Filters (Lectures 4)
Photoshop Filters, Smart Filters, Common Features of Photoshop Filter

Unit VI: Digital Painting in Adobe Photoshop CC (Lectures 4)
Working with Brush Tool, Importance of Using Colors

Unit VII: Masking and File Formats in Adobe Photoshop CC (Lectures 4)
Introduction to Mask, Creating Vector and Layer Masks, Essential File Formats, Choosing the Right Format for Print and Digital Media

PHY-SE-4054
MOTION GRAPHICS FOR ADVERTISING & FILMS
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on Photoshop/B.E./B.Tech. in Computer Science/MCA/ B.Sc. with DCA.

This course will give you the skills to design and create motion graphics for Ad Commercials and Films. You will learn to create & edit these motion graphics on the most popular and industry relevant Compositing software, Adobe After Effects.

Course Outcome: *On successful completion of the course students will be able to create Motion Graphic Design for Ads, Commercials, Promos & Film / Show Titles, use After Effects templates to create your own customized 2D or 3D Motion Graphics, Understand Working with Layers, create Shape morphing animation and build transitions, utilize After Effects' Motion Graphics Techniques.*

Tools: Adobe After Effects CC

Unit I: Getting started with Adobe After Effects CS6 (Lectures 3)
Introduction to Adobe After Effects CS6, Importing Files, Creating a Composition

Unit II: Basic Effects and Composition Animation (Lectures 5)
Adding Effects, Adding Animation, Expressions, Creating animation and Effects Presets

Unit III: Creating Video Composites with Green Screen Footage (Lectures 5)
Masks, Blending Modes, Tracking Mattes

Unit IV: Advanced Compositing Techniques (Lectures 6)
Motion Stabilization, Motion Tracking, Time Remapping Techniques

Unit V: 3D in After Effects (Lectures 6)
Introduction, Text Animation, Particle Preset

Unit VI: Previewing and Rendering Output (Lectures 5)
Previewing the Work, Rendering Process, Exporting to Different Output

Fifth Semester

Discipline Specific Elective Papers
[Choose One]

PHY-HE-5016
Experimental Techniques
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *Upon completion of this course, students will be able to describe the errors in measurement and statistical analysis of data required while performing an experiment. Also, students will learn the working principle, efficiency and applications of transducers & industrial instruments like digital multimeter, RTD, Thermistor, Thermocouples and Semiconductor type temperature sensors.*

Theory

Unit I: Measurements (Lectures 7)

Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting.

Unit II:Signals and Systems (Lectures 7)

Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise.

Unit III:Shielding and Grounding (Lectures 4)

Methods of safety grounding. Energy coupling. Grounding. Shielding:Electrostatic shielding. Electromagnetic Interference Shielding.

Unit IV:Transducers & industrial instrumentation (working principle, efficiency, applications) (Lectures 21)

Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers.

Unit V:Digital Multimeter (Lectures 5):

Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement.

Unit VI:Impedance Bridges and Q-meter (Lectures 4):

Block diagram and working principles of RLC bridge. Qmeter and its working operation. Digital LCR bridge.

Unit VII:Vacuum Systems (Lectures 12):

Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization).

Lab

(Minimum number of experiments to be completed is seven)

1. Determine output characteristics of a LVDT & measure displacement using LVDT
2. Measurement of Strain using Strain Gauge.
3. Measurement of level using capacitive transducer.
4. To study the characteristics of a Thermostat and determine its parameters.
5. Study of distance measurement using ultrasonic transducer.
6. Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75)
7. To measure the change in temperature of ambient using Resistance Temperature Device (RTD).
8. Create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge.
9. Comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of 2m length, understanding of importance of grounding using function generator of mV level & an oscilloscope.
10. To design and study the Sample and Hold Circuit.
11. Design and analyze the Clippers and Clampers circuits using junction diode
12. To plot the frequency response of a microphone.
13. To measure Q of a coil and influence of frequency, using a Q-meter

Reference Books:

[1] Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.

[2] Experimental Methods for Engineers, J.P. Holman, McGraw Hill

[3] Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.

[4] Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.

[5] Instrumentation Devices and Systems, C.S. Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill

[6] Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.

[7] Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008, Springer

[8] Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Graw Hill

PHY-HE-5026
Embedded System: Introduction to microcontroller
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *Upon completion of this course, students will be able to understand microprocessor and microcontroller 8051. Students will also learn about the 8051 I/O port programming, various addressing modes, Timer and counter programming, Serial port programming with and without interrupt and interfacing 8051 microcontroller to peripherals.*

Theory

Unit I: Embedded System (Lectures 6)
Introduction to embedded systems and general purpose computer systems, architecture of embedded system, classifications, applications and purpose of embedded systems, challenges & design issues in embedded systems,

Unit II: Review of microprocessors (Lectures 6)
Organization of Microprocessor based system, 8085μp pin diagram and architecture, concept of data bus and address bus, 8085 programming model, instruction classification, subroutines, stacks and its implementation, delay subroutines, hardware
and software interrupts.

Unit III: 8051 microcontroller (Lectures 13)
Introduction and block diagram of 8051 microcontroller, architecture of 8051, overview of 8051 family, 8051 assembly language programming, Program Counter and ROM memory map, Data types and directives, Flag bits and Program Status Word (PSW) register, Jump, loop and call instructions.

Unit IV: 8051 I/O port programming (Lectures 4)
Introduction of I/O port programming, pin out diagram of 8051 microcontroller, I/O port pins description & their functions Bit manipulation.

Unit V: Programming of 8051 (Lectures 13)
8051 addressing modes and examples using assembly language, arithmetic and logic instructions 8051 programming in C: for time delay & I/O operations and manipulation, for arithmetic and logic operations.

Unit VI: Timer and counter programming (Lectures 3)
Programming 8051 timers, counter programming.

Unit VII: Serial port programming with and without interrupt (Lectures 6)
Introduction to 8051 interrupts, programming timer interrupts, programming external hardware interrupts and serial communication interrupt, interrupt priority in the 8051.

Unit VIII: Interfacing 8051 microcontroller to peripherals (Lectures 2)
ADC, DAC interfacing, LCD interfacing.

Unit IX: Programming Embedded Systems (Lectures 3)
Basic Structure of embedded program,compiling, linking and locating, downloading and debugging.

Unit X: Embedded system design and development (Lectures 2)

trends in embedded industry

Unit XI: Introduction to Arduino (Lectures 2)

Pin diagram and description of Arduino UNO. Basic programming.

Lab

(Minimum number of experiments to be completed is seven)

A.8051 microcontroller based Programs and experiments

1. To find that the given numbers is prime or not.

2. To find the factorial of a number.

3. Write a program to make the two numbers equal by increasing the smallest number and decreasing the largest number.

4. Use one of the four ports of 8051 for O/P interfaced to eight LED‟s. Simulate binary counter (8 bit) on LED‟s .

5. Program to glow the first four LEDs then next four using TIMER application.

6. Program to rotate the contents of the accumulator first right and then left.

7. Program to run a countdown from 9-0 in the seven segment LED display.

8. To interface seven segment LED display with 8051 microcontroller and display „HELP‟ in the seven segment LED display.

9. To toggle “1234” as “1324” in the seven segment LED display.

10. Interface stepper motor with 8051 and write a program to move the motor through a given angle in clock wise or counter clockwise direction

11. Application of embedded systems: Temperature measurement, some information on LCD display, interfacing a keyboard.

B. Arduino based programs and experiments:

12. Make a LED flash at different time intervals.

13. To vary the intensity of LED connected to Arduino

14. To control speed of a stepper motor using a potential meter connected to Arduino

15. To display “PHYSICS” on LCD/CRO.

Reference Books

[1] Embedded Systems: Architecture, Programming & Design, R.Kamal, 2008,Tata McGraw Hill

[2] The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India.

[3] Embedded microcomputor system: Real time interfacing, J.W.Valvano, 2000, Brooks/Cole

[4] Microcontrollers in practice, I. Susnea and M. Mitescu, 2005, Springer.

[5] Embedded Systems: Design & applications, S.F. Barrett, 2008, Pearson Education India

[6] Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning Embedded Systems: Architecture, Programming& Design, R.Kamal,]2008,Tata McGraw Hill

[7] Embedded System, B.K. Rao, 2011, PHI Learning Pvt. Ltd.

[8] Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning

PHY-HE-5036
Advanced Mathematical Physics I
Total Lectures: 60Credits: 6 (Theory: 04, Lab:02)

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Course Outcome: *Upon completion of this course, students will be able to solve problems in Physics related to Linear Vector space, Matrix algebra, Tensor.*

Theory

Unit I: Linear Vector Spaces (Lectures 20)

Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Change of basis. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations. Non-singular Transfor- mations. Representation of Linear Transformations by Matrices.

Unit II: Matrix (Lectures 10)

Eigen-values and Eigenvectors. Cayley- Hamiliton Theorem. Diagonalization of Matrices. Co- ordinate transformations, rotation in two dimensions, rotation in three dimensions. Solutions of Coupled Linear Ordinary Differential Equations. Functions of a Matrix.

Unit III: Cartesian Tensors (Lectures 20)

Transformation of Co-ordinates. Einstein's Summation Convention. Relation between Direc- tion Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti- symmetric Tensors. Invariant Tensors : Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. Vector Algebra and Calculus using Cartesian Tensors : Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Vector Identities. Tensorial Formulation of Analytical Solid Geometry : Equa- tion of a Line. Angle Between Lines. Projection of a Line on another Line. Condition for Two Lines to be Coplanar. Foot of the Perpendicular from a Point on a Line. Rotation Tensor (No Derivation). Isotropic Tensors. Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors.

Unit IV :General Tensors (Lectures 10)

Transformation of Co-ordinates. Minkowski Space. Contravariant & Covariant Vectors. Con- travariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference & Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor.

Lab

Scilab/Mathematica/C ++ or others based simulations experiments based on Mathematical Physics problems like

1. Linear algebra:
   - Multiplication of two 3×3 matrices
   - Eigenvalue and eigenvectors of

$$\begin{pmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 3 & 1 & 4 \end{pmatrix}; \begin{pmatrix} 1 & -i & 3+4i \\ i & 2 & 4 \\ 3-4i & 4 & 3 \end{pmatrix}; \begin{pmatrix} 2 & -i & 2i \\ i & 4 & 3 \\ -2i & 3 & 5 \end{pmatrix}$$

2. Orthogonal polynomials as eigenfunctions of Hermitian differential operators.
3. Determination of the principal axes of moment of inertia through diagonalization.
4. Lagrangian formulation in Classical Mechanics with constraints.
5. Study of geodesics in Euclidean and other spaces (surface of a sphere, etc).

Reference Books

[1] Mathematical Tools for Physics, James Nearing, 2010, Dover Publications

[2] Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier.

[3] Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge University Press

[4] Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.

[5] Linear Algebra, W. Cheney, E.W.Cheney & D.R.Kincaid, 2012, Jones & Bartlett Learning

[6] Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole

[7] Mathematical Methods for Physicis & Engineers, K.F.Riley, M.P.Hobson, S.J.Bence, 3rd Ed., 2006, Cambridge University Press

[8] Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896

[9] Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444

[10] Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

PHY-HE-5046
Physics of Devices and Instruments
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *Upon completion of this course, students will be able to gain knowledge on advanced electronics devices such as UJT, JFET, MOSFET, CMOS etc., detailed process of IC fabrication, Digital Data serial and parallel Communication Standards along with the understanding of communication systems.*

Theory

Unit I: Devices (Lectures 14)

Characteristic and small signal equivalent circuits of UJT and JFET. Metal- semiconductor Junction. Metal oxide semiconductor (MOS)device. Ideal MOS and Flat Band voltage. SiO2-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode.

Unit II: Power supply and Filters (Lectures 3)

Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation**,** Short circuit protection

Unit III: Active and Passive Filters (Lectures 3)

Low Pass, High Pass, Band Pass and band Reject Filters.

Unit IV: Multivibrators (Lectures 3)

Astable and Monostable Multivibrators using transistors.

Unit V: Phase Locked Loop(PLL) (Lectures 5)

Basic Principles, Phase detector(XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter–Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046).

Unit VI: Processing of Devices (Lectures 12)

Basic process flow for IC fabrication, Electronic grade silicon. Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. Optical lithography. Electron lithography. Feature size control and wet anisotropic etching. Lift off Technique. Diffusion and implantation**.**

Unit VII: Digital Data Communication Standards (Lectures 5)

Serial Communications: RS232, Handshaking, Implementation of RS232 on PC. Universal Serial Bus (USB): USB standards, Types and elements of USB transfers. Devices (Basic idea of UART). Parallel Communications: General Purpose Interface Bus (GPIB), GPIB signals and lines, Handshaking and interface management, Implementation of a GPIB on a PC. Basic idea of sending data through a COM port.

Unit VIII: Introduction to communication systems (Lectures 15)

Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK.

Lab

Minimum number of experiments to be completed is seven
(4 from Section A,3 from Section B)
Experiments should be done from both Section A and Section B:

Section-A

1. To design a power supply using bridge rectifier and study effect of C-filter.
2. To design the active Low pass and High pass filters of given specification.
3. To design the active filter (wide band pass and band reject) of given specification.
4. To study the output and transfer characteristics of a JFET.
5. To design a common source JFET Amplifier and study its frequency response.
6. To study the output characteristics of a MOSFET.
7. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
8. To design an Amplitude Modulator using Transistor.
9. To design PWM, PPM, PAM and Pulse code modulation using ICs.
10. To design an Astable multivibrator of given specifications using transistor.
11. To study a PLL IC (Lock and capture range).
12. To study envelope detector for demodulation of AM signal.
13. Study of ASK and FSK modulator.
14. Glow an LED via USB port of PC.
15. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

Section-B:

SPICE/MULTISIM simulations for electrical networks and electronic circuits

1. To verify the Thevenin and Norton Theorems.
2. Design and analyze the series and parallel LCR circuits
3. Design the inverting and non-inverting amplifier using an Op-Amp of given gain
4. Design and Verification of op-amp as integrator and differentiator
5. Design the 1st order active low pass and high pass filters of given cutoff frequency
6. Design a Wein`s Bridge oscillator of given frequency.
7. Design clocked SR and JK Flip-Flop`s using NAND Gates
8. Design 4-bit asynchronous counter using Flip-Flop ICs
9. Design the CE amplifier of a given gain and its frequency response.
10. Design an Astable multivibrator using IC555 of given duty cycle.

Reference Books

[1] Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons

[2] Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.

[3] Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd

[4] Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.

[5] Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.

[6] Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.

[7] Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill

[8] PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

PHY-HE-5056
Nuclear and Particle Physics
Total Lectures: 75 Credits: 6 (Theory: 05, Tutorial: 01)

Course Outcome: *Upon completion of this course, students will have the understanding of the sub atomic particles and their properties. They will gain knowledge about the different nuclear techniques and their applications in different branches of Physics and societal application. The course will develop problem based skills and the acquire knowledge can be applied in the areas of nuclear, medical, archeology, geology and other interdisciplinary fields of Physics and Chemistry.*

Theory

Unit I: General Properties of Nuclei (Lectures 10)

Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

Unit II: Nuclear Models (Lectures 12)

Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.

Unit III: Radioactivity decay (Lectures 10)

(a) Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) -decay: energy kinematics for -decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion.

Unit IV: Nuclear Reactions (Lectures 8)

Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

Unit V: Interaction of Nuclear Radiation with matter (Lectures 8)

Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.

Unit VI: Detector for Nuclear Radiations (Lectures 8)

Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

Unit VII: Particle Accelerators (Lectures 5)

Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

Unit VIII: Particle physics (Lectures 14)

Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons.

Reference Books

[1] Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
[2] Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
[3] Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
[4] Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
[5] Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
[6] Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
[7] Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
[8] Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
[9] Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
[10] Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991)

Skill Enhancement Papers
[Choose One]

PHY-SE-5014
WEATHER FORECASTING
Credits: 4 (Theory: 02, Lab: 02)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with PhD in Atmospheric Physics.

The aim of this course is not just to impart theoretical knowledge to the students but to enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques

Theory

Unit I: Introduction to atmosphere (Lectures 9)

Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; atmospheric pressure: its measurement; atmospheric boundary layer and its characteristics; atmospheric convection and inversion; introduction to numerical weather prediction systems.

Unit II: Measuring the weather (Lectures 4)

Wind; forces acting to produce wind; measurement of wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

Unit III: Weather systems (Lectures 3)

Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes, Indian summer monsoon.

Unit IV: Climate and Climate Change (Lectures 6)

Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.

Unit V: Basics of weather forecasting (Lectures 8)

Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

Lab

1. Study of synoptic charts & weather reports, working principle of weather station.
2. Processing and analysis of weather data
   (a) To calculate the sunniest time of the year.
   (b) To study the variation of rainfall amount and intensity by wind direction.
   (c) To observe the sunniest/driest day of the week.
   (d) To examine the maximum and minimum temperature throughout the year.
   (e) To evaluate the relative humidity of the day.
   (f) To examine the rainfall amount month wise.
3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis.
4. Formats and elements in different types of weather forecasts/ warning (both aviation and non aviation)

Reference books

[1] Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
[2] The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.
[3] Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
[4] Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur.
[5] Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.
[6] Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

PHY-SE-5024
APPLIED OPTICS
Credits: 4 (Theory: 2, Lab: 2)
THEORY: 30 Lectures

Preferred minimum qualification of the teacher/instructor: Asst. Professor of Physics with PhD in Experimental Spectroscopy/Optics.

Theory includes only qualitative explanation. Minimum five experiments should be performed covering minimum three sections.

Theory

Unit I: Sources and Detectors (Lectures 10)

Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers.

Experiments on Lasers:

(b) Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.
(c) To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
(d) To find the polarization angle of laser light using polarizer and analyzer

Experiments on Semiconductor Sources and Detectors:

(a) V-I characteristics of LED
(b) Study the characteristics of solid state laser
(c) Study the characteristics of LDR
(d) Photovoltaic Cell

Unit II: Holography (Lectures 8)

Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition.

Experiments on Holography and interferometry:

(a) Recording and reconstructing holograms
(b) Constructing a Michelson interferometer or a Fabry Perot interferometer
(c) Measuring the refractive index of air
(d) White light Hologram

Unit III: Photonics: Fibre Optics (Lectures 12)

Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating

Experiments on Photonics: Fibre Optics

(a) To measure the numerical aperture of an optical fibre
(b) To study the variation of the bending loss in a multimode fibre

Reference Books:

[1] Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.
[2] LASERS: Fundamentals & applications, K.Thyagrajan & A.K.Ghatak, 2010, Tata McGraw Hill
[3] Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
[4] Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
[5] Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.
[6] Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.
[7] Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.
[8] Optical Physics, A.Lipson, S.G.Lipson, H.Lipson, 4th Edn., 1996, Cambridge Univ. Press

PHY-SE-5034
TECHNICAL DRAWING
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with a certificate on Technical Drawing/B.E./B.Tech. in Mechanical Engineering.

The subject is aimed at developing basic graphic skills in the students so as to enable them to use these skills in preparation of engineering drawings, their reading and interpretation. The emphasis, while imparting instructions, should be to develop conceptual skills in the students.

Course Outcome: *After successfully completing the course students will be able to draw free hand sketches of various kinds of objects, apply different dimensioning methods on drawing of objects, different types of scales and their utilization in reading and reproducing drawings of objects and maps, Draw 2 - dimensional view of different objects viewed from different angles, Generate isometric (3D) drawing from different 2D (orthographic) views/sketches, use basic commands of Auto CAD.*

Theory
Unit I: Introduction (Lectures 4)
Drafting Instruments and their uses. lettering: construction and uses of various scales: dimensioning as per I.S.I. 696-1972. Engineering Curves: Parabola: hyperbola: ellipse: cycloids, involute: spiral: helix and loci of points of simple moving mechanism. 2D geometrical construction. Representation of 3D objects. Principles of projections.

Unit II: Projections (Lectures 6)
Straight lines, planes and solids. Development of surfaces of right and oblique solids. Section of solids.

Unit III: Object Projections (Lectures 4)
Orthographic projection. Interpenetration and intersection of solids. Isometric and oblique parallel projection of solids.

Unit IV: CAD Drawing (Lectures 16)
Introduction to CAD and Auto CAD, precision drawing and drawing aids, Geometric shapes, Demonstrating CAD-specific skills (graphical user interface. Create, retrieve, edit, and use symbol libraries. Use inquiry commands to extract drawing data). Control entity properties. Demonstrating basic skills to produce 2-D and 3-Ddrawings. 3D modeling with Auto CAD (surfaces and solids), 3D modeling with sketch up, annotating in Auto CAD with text and hatching, layers, templates & design center, advanced plotting (layouts, viewports), office standards, dimensioning, internet and collaboration, Blocks, Drafting symbols, attributes, extracting data. basic printing, editing tools, Plot/Print drawing to appropriate scale.

Reference Books

[1] K. Venugopal, and V. Raja Prabhu. Engineering Graphic, New Age International

[2] AutoCAD 2014 & AutoCAD 2014/Donnie Gladfelter/Sybex/ISBN:978-1-118-57510-9

[3] Architectural Design with Sketchup/Alexander Schreyer/John Wiley & Sons/ISBN: 978-1-118-12309-6

PHY-SE-5044
PAGEMAKER
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on PageMaker/B.E./B.Tech. in Computer Science / MCA/ B.Sc. with DCA.

This course prepares students for proficiency in electronic publishing with the Adobe PageMaker publishing and graphics software application. The course topics include: skills using the PageMaker software; creating simple single-page publications; creating multiple page publications; working with text; working with graphics; formatting; and publishing publications electronically.

Course Outcome: *On successful completion of the course students will be able to Create Documents and Templates, add text into documents using various methods, and apply different formatting styles to characters and paragraphs, Import graphics, create objects using various tools, add effects to objects, Create a book and export it into PDF, Multipage Layout Design.*

Theory

Unit I: Pagemaker Basics (4 Lectures)

Starting PageMaker, PageMaker Window Elements, Viewing the Page, Floating Palettes, Toolbox, Using the Zoom Tool, Using the Rulers, Displaying the Rulers, Using the Revert Feature. Opening a Publication, Creating a New Document, Setting the Margins, Setting the Page Size, Setting the Page Orientation, The Page Icons, Displaying Master Pages and Master Page Items, Inserting and Removing Pages, Inserting a Page, Removing a Page, Setting Page Numbers, Saving a New Document, Saving an Existing Document, Saving a Document as Another Document, Closing a Document.

Unit II: The text and drawing tool (4 Lectures)

Introduction, Using the Text Tool, Creating Text From Scratch, The Manual Text Icon, The Autoflow Text Icon, Text Blocks, Sizing and Positioning Text Blocks, Editing and Manipulating Text, Threading and Unthreading Text, Threading Additional Text, Threading Text to a Different Page, Unthreading Text Blocks, Rethreading Text Blocks.
The Line Tool, The Oval Tool, Rectangle Tool, Polygon Tool, Changing the Shape of Rectangle, Changing Strokes and Fills, Deleting an Object, Duplicating an Object.

Unit III: Importing Graphics (2 Lectures)

Introduction, Placing Graphics, Placing in-Line Graphics, Converting an Independent Graphic to an In-Line Graphic, Aligning In-Line Graphics, Sizing Graphics, Cropping Graphics, Object Linking and Embedding (OLE), Setting Up an OLE Liked Object, Embedding an OLE Object, Text Wrap.

Unit IV: Transformations (3 Lectures)

Introduction, Using the Control Palette, Control Palette Basics, Modifying Objects by Adjusting Values, Using the Reference-Point Proxy, Setting Measurement and Nudge Preferences, Moving Objects, Rotating an Object, Reflecting an Object, Skewing an Object, Removing Transformation, Aligning and Distributing Objects, Grouping and Ungrouping, Rules for Grouping Objects, Changing the Staking Order of Objects, Locking Objects.

Unit V: Utilities (3 Lectures)

Creating PDF Files with Acrobat, Creating an Adobe Acrobat File, Font Issues, Managing Automatic Hypertext Links, Using the Tables Editor, Setting Adobe Table Defaults, Adobe Table Preferences, Typing, Editing and Formatting Text in Adobe Table, Formatting Text in a Table, Exporting and Saving Adobe Tables, Exporting Tables from Adobe Table, Exporting a Table as Text, Exporting a Table as a Graphic, Saving Adobe Tables, Importing and Updating Table, Sorting Pages, Balancing Columns, Create Keyline, Bullets and Numbering, Add

Continued Line.

Unit VI: Master Pages (3 Lectures)

Creating Master Pages, Setting Up Pages, Numbering Pages, Adding Page Numbers, Adding a Prefix to Page Numbers, Numbering pages within a book, Setting Margins, Setting Print-related Document Setup Options, Resizing 1-bit Bitmap Images, Column Guides, Setting Up Ruler Guides, Revising, Deleting and Renaming Masters, Removing Master Page Formatting, Displaying Master Pages and Master Page Items, Showing Master Pages, About the Adjust Layout Option.

Unit VII: Working with large amount of texts (2 Lectures)

Introduction, Character Specifications, Paragraph Specifications, Changing Indents, Paragraph Spaces, Alignment, Adding Lines Above or Below Your Paragraphs, Indent/Tabs, Hyphenation, Grid Manager.

Unit VIII: The story editor (3 Lectures)

Introduction, Using the Story Editor, Starting at a Particular Spot in a Story, Placing the Story, Returning to an Open Story Window, Creating and Editing Text in Story Editor, Managing Story Editor Windows, Story Editor Preferences, Navigating through Text, Using the Key Board, Selecting Text, Cutting, Copying, Deleting and Pasting Text, Using the Spelling Checker, Starting the Speller, Adding Words to Dictionaries, Using Find and Change, The Find Feature, Searching with Wildcard Characters, Searching for Phrases, Searching for Special Attributes, Positioning the Find Dialog Box, Using the Change Feature, Replacing Text, Replacing Special Attributes, Story Editor and Layout Views.

Unit IX: Pagemaker style Sheets (3 Lectures)

Introduction, Defining Styles, Creating New Styles, Editing Styles, Removing Styles, Copying Styles, Applying Styles to Text, Changing Styles, Modifying Styles Text.

Unit X: Long documents features (3 Lectures)

Compiling Chapters into a Book, Preparing the Book, Combing the Chapters, Numbering Pages, Restarting Page Numbering, Creating a Table of Contents.

Practical / Lab work to be performed

1. Letter Head Design
2. Business Card Design
3. Sign Board Design
4. Cash Memo Design
5. Logo Design
6. Certificate Design
7. Newspaper Advertisement Design
8. Build Booklet, Page Numbering
9. Type a Doc Using Story Editor
10. Newsletter Design (Page Layout Design)

Sixth Semester

Discipline Specific Elective Papers
[Choose One]

PHY-HE-6016
Communication Electronics
Total Lectures: 60 Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *Upon completion of this course, students will have the concepts of electronics in communication, details of communication techniques based on Analog Modulation, Analog and digital Pulse Modulation including PAM, PWM, PPM, ASK, PSK, FSK, overview of communication and Navigation systems such as GPS and mobile telephony system.*

Theory

Unit I: Electronic communication (Lectures 8)

Introduction to communication – means and modes. Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio.

Unit II: Analog Modulation (Lectures 12)

Amplitude Modulation, modulation index and frequency spectrum. Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Qualitative idea of Super heterodyne receiver

Unit III: Analog Pulse Modulation (Lectures 9)

Channel capacity, Sampling theorem, Basic Principles- PAM, PWM, PPM, Basic concept of Multiplexing. (time and frequency division.

Unit IV: Digital Pulse Modulation (Lectures 10)

Need for digital transmission, Pulse Code Modulation, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK).

Introduction to Communication and Navigation systems

Unit V: Satellite Communication (Lectures 10)

Introduction, need, Geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites., path loss, ground station, simplified block diagram of earth station. Uplink and downlink.

Unit VI: Mobile Telephony System (Lectures 10)

Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only).

Unit I: GPS navigation system (Lectures 1)

Qualitative idea only

Lab

(Minimum number of experiments to be completed is seven)

1. To design an Amplitude Modulator using Transistor
2. To study envelope detector for demodulation of AM signal
3. To study FM - Generator and Detector circuit
4. To study AM Transmitter and Receiver
5. To study FM Transmitter and Receiver
6. To study Time Division Multiplexing (TDM)
7. To study Pulse Amplitude Modulation (PAM)
8. To study Pulse Width Modulation (PWM)
9. To study Pulse Position Modulation (PPM)
10. To study ASK, PSK and FSK modulator

Reference Books

[1] Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.

[2] Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.

[3] Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGraw Hill.

[4] Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill

[5] Communication Systems, S. Haykin, 2006, Wiley India

[6] Electronic Communication system, Blake, Cengage, 5th edition.

[7] Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press

PHY-HE-6026
Digital Signal Processing
Total Lecures: 60   Credits: 6 (Theory: 04, Lab: 02)

Course Outcome: *Upon completion of this course, students will be able This paper describes the discrete-time signals and systems, Fourier Transform Representation of Aperiodic Discrete-Time Signals. This paper also highlights the concept of filters and realization of Digital Filters. At the end of the syllabus, students will develop the understanding of Discrete and fast Fourier Transform.*

Theory

Unit I: Discrete-Time Signals and Systems (Lectures 10)

Classification of Signals, Periodic and Aperiodic Signals, Energy and Power Signals, Even and Odd Signals, Discrete-Time Systems, System Properties. Impulse Response, Convolution Sum; Properties of Convolution; Commutative; Associative; Distributive; Shift; Sum Property, Relationship Between LTI System Properties and the Impulse Response; Causality; Stability**.**

Unit II:Discrete-Time Fourier Transform (Lectures 15)

Fourier Transform Representation of Aperiodic Discrete-Time Signals, Periodicity of DTFT, Properties; Linearity; Time Shifting; Frequency Shifting**, The** ***z*****-Transform:** Bilateral (Two-Sided) Transform, Inverse *z*-Transform, Relationship Between *z*-Transform and Discrete-Time Fourier Transform, *z*-plane, Region-of-Convergence; Properties of ROC, Properties; Analysis and Characterization of LTI Systems; Transfer Function and Difference-Equation System**.**

Unit III:Filter Concepts (Lectures 5)

Phase Delay and Group delay, Zero-Phase Filter, Linear-Phase Filter, Simple FIR Digital Filters, Simple IIR Digital Filters.

Unit IV:Discrete Fourier Transform (Lectures 10)

Frequency Domain Sampling (Sampling of DTFT), The Discrete Fourier Transform (DFT) and its Inverse, DFT as a Linear transformation, Properties; Periodicity; Linearity; Circular Time Shifting; Circular Frequency Shifting; Circular Time Reversal; Multiplication Property.

Unit V:Fast Fourier Transform (Lectures 5)

Direct Computation of the DFT, Symmetry and Periodicity Properties of the Twiddle factor (*WN*), Radix-2 FFT Algorithms; Decimation-In-Time (DIT) FFT Algorithm; Decimation-In-Frequency (DIF) FFT Algorithm, Inverse DFT Using FFT Algorithms.

Unit VI:Realization of Digital Filters (Lectures 15)

Non Recursive and Recursive Structures, Canonic and Non Canonic Structures, Equivalent Structures (Transposed Structure), FIR Filter structures; Direct-Form; Cascade-Form; Basic structures for IIR systems; Direct-Form I.

Finite Impulse Response Digital Filter: Advantages and Disadvantages of Digital Filters, Types of Digital Filters: FIR and IIR Filters; Difference Between FIR and IIR Filters, Desirability of Linear-Phase Filters, Frequency Response of Linear-Phase FIR Filters, Impulse Responses of Ideal Filters, Windowing Method.

Infinite Impulse Response Digital Filter: Design of IIR Filters from Analog Filters, IIR Filter Design by Approximation of Derivatives, Impulse Invariance Method**.**

Lab

(Minimum number of experiments to be completed is seven)

Scilab based simulations experiments based problems like

1. Write a program to generate and plot the following sequences: (a) Unit sample sequence ð(n) , (b) unit step sequence $u(n)$, (c) ramp sequence *r(n)* , (d) real valued exponential sequence $x(n) = (0.8)^n u(n)$ for $0 \le n \le 50$.
2. Write a program to compute the convolution sum of a rectangle signal (or gate function) with itself for $N = 5$

$$x(n) = rect\left(\frac{n}{2N}\right) = \Pi\left(\frac{n}{2N}\right) = \begin{cases} 1 - N \le n \le N \\ 0\ Otherwise \end{cases}$$

3. An LTI system is specified by the difference equation

$$y(n) = 0.8y(n-1) + x(n)$$

(a) Determine $H(e^{jw})$

(b) Calculate and plot the steady state response $y_{ss}(n)$ to

$$x(n) = \cos(0.5\pi n)\, u(n)$$

4. Given a casual system

$$y(n) \ = \ 0.9y(n — \ 1) \ + \ x(n)$$

(a) Find *H(z)* and sketch its pole-zero plot

(b) Plot the frequency response $\left|H(e^{jw})\right|$and $\angle H(e^{jw})$

5. Design a digital filter to eliminate the lower frequency sinusoid of *x(t)= sin 7t + sin 200t*. The sampling frequency is f_s= 500 *Hz*. Plot its pole zero diagram, magnitude response, input and output of the filter.

6. Let *x(n)* be a 4-point sequence:

$$x(n) = \underset{\uparrow}{\{1,1,1,1\}} = \begin{cases} 1\ 0 \le n \le 3 \\ 0\ Otherwise \end{cases}$$

Compute the DTFT $X(e^{jw})$ and plot its magnitude

(a) Compute and plot the 4 point DFT of *x(n)*

(b) Compute and plot the 8 point DFT of *x(n)* (by appending 4 zeros)

(c) Compute and plot the 16 point DFT of *x(n)* (by appending 12 zeros)

7. Let *x(n)* and *h(n)* be the two 4-point sequences,

$$x(n) = \underset{\uparrow}{\{1,2,2,1\}}$$

$$h(n) = \underset{\uparrow}{\{1,-1,-1,1\}}$$

Write a program to compute their linear convolution using circular convolution.

8. Using a rectangular window, design a FIR low-pass filter with a pass-band gain of unity, cut off frequency of 1000 Hz and working at a sampling frequency of 5 KHz. Take the length of the impulse response as 17.
9. Design an FIR filter to meet the following specifications:
Passband edge F_p= 2 KHz
stopband edge F_s=5 KHz
Passband attenuation A_p = 2 dB
Stopband attenuation A_s = 42 dB
Sampling frequency F_s = 20 KHz
10. The frequency response of a linear phase digital differentiator is given by

$$H_d(e^{jw}) = jwe^{jw}\ \ |w| \le \pi$$

Using a Hamming window of length $M = 21$, design a digital FIR differentiator. Plot the amplitude response.

Reference Books

[1] Digital Signal Processing, Tarun Kumar Rawat, 2015, Oxford University Press, India

[2] Digital Signal Processing, S. K. Mitra, McGraw Hill, India.

[3] Modern Digital and Analog Communication Systems, B.P. Lathi, 1998, 3rd Edn. Oxford University Press.

[4] Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L. Harris, 2005, Cengage Learning.

[5] A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press

[6] Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press.

[7] Simulation of ODE/PDE Models with MATLAB®, OCTAVE andSCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896

[8] Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444

[9] Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978- 6133459274

PHY-HE-6036

Advanced Mathematical Physics II

Total Lectures: 60 Credits: 6 (Theory: 05, Tutorial: 01)

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Course Outcome: *Upon completion of this course, students will be able*

Theory

Unit I: Calculus of Variations (Lectures 25)

Variable Calculus: Variational Principle, Euler's Equation and its Application to Simple Problems. Geodesics. Concept of Lagrangian. Generalized co-ordinates. Definition of canonical moment, Euler-Lagrange's Equations of Motion and its Applications to Simple Problems (e.g., Simple Pendulum and One dimensional harmonic oscillator). Definition of Canonical Momenta. Canonical Pair of Variables. Definition of Generalized Force: Definition of Hamiltonian (Leg- endre Transformation). Hamilton's Principle. Poisson Brackets and their properties. Lagrange Brackets and their properties.

Unit II: Group Theory (Lectures 25)

Review of sets, Mapping and Binary Operations, Relation, Types of Relations. Groups: Ele- mentary properties of groups, uniqueness of solution, Subgroup, Centre of a group, Co-sets of a subgroup, cyclic group, Permutation/Transformation. Homomorphism and Isomorphism of group.

Unit III: Advanced Probability Theory (Lectures 25)

Fundamental Probability Theorems. Conditional Probability, Bayes' Theorem, Repeated Tri- als, Binomial and Multinomial expansions. Random Variables and probability distributions, Expectation and Variance, Special Probability distributions: The binomial distribution, The poisson distribution, Continuous distribution: The Gaussian (or normal) distribution, The principle of least squares.

Reference Books

[1] Mathematical Methods for Physicists: Weber and Arfken, 2005, Academic Press.

[2] Mathematical Methods for Physicists: A Concise Introduction: Tai L. Chow, 2000, Cambridge Univ. Press.

[3] Elements of Group Theory for Physicists by A. W. Joshi, 1997, John Wiley.

[4] Group Theory and its Applications to Physical Problems by Morton Hamermesh, 1989, Dover

[5] Introduction to Mathematical Physics: Methods & Concepts: Chun Wa Wong, 2012, Oxford University Press

[6] Introduction to Mathematical Probability, J. V. Uspensky, 1937, Mc Graw-Hill.

PHY-HE-6046
Astronomy and Astrophysics
Total Lectures: 75 Credits: 6 (Theory: 05, Tutorial: 01)

Course Outcome: *Upon completion of this course, students will be able to understanding the origin and evolution of the Universe. The course will give a comprehensive introduction on the measurement of basic astronomical parameters such as astronomical scales, luminosity and astronomical quantities. It will give an overview on key developments in observational astrophysics. Students will have the idea of the instruments implemented for astronomical observation, the formation of planetary system and its evolution with time, the physical properties of Sun and the components of the solar system; and stellar and interstellar components of our Milky Way galaxy. Students will have the understanding of the origin and evolution of galaxies, presence of dark matter and large scale structures of the Universe.*

Theory

Unit I: Stellar properties (Lectures 15)

Radiant flux and Luminosity, Magnitude scale. Measurement of astronomical quantities: Stellar distances(parallax), Radii, Mass and Effective Temperature. Equilibrium of stars, Gravity and thermodynamics, virial theorem. Stellar spectral classification – Hertzsprung-Russell (HR) diagram. Introductory idea of stellar evolution: white dwarf, neutron stars and black holes.

Unit II: The Sun and the solar system (Lectures 15)

The Sun; properties of photosphere, chromosphere and corona. Solar system's objects: Theory of formation of the solar system (introductory idea only); physical properties of the planets- their distances, atmospheres, asteroid belt, meteorites and the comets – Kuiper belt and the Oort cloud; Introduction to Extra-Solar Planets.

Unit III: Positional Astronomy (Lecture 10)

Celestial sphere, spherical geometry and celestial coordinates. Concept of time: universal time, solar time, mean solar time, local sidereal time and Julian day. Introduction to constellations (hands on practice in evening sky with small telescopes or laser pointer), ecliptic and diurnal motion of stars. Solar system's objects : rotation, revolution and coordinates in the sky.

Unit IV: Astronomical Techniques (Lecture 10)

Introduction to telescopes – telescope size and light gathering power, resolving power, f-number. Different types of optical telescopes (reflecting and refracting). Space telescopes. Concept of virtual observatory, on-line tools in astronomy: SDSS, SkyView, SIMBAD, Aladin, AAVSO database etc. Introduction to photometry, spectroscopy and polarimetry.

Unit V: Galaxies (Lecture - 10)

The Milky Way, properties of the galactic centre. Classification of galaxies, Hubble's tuning fork diagram, normal (spiral, elliptical and lenticular) and active galaxies. Black holes in galaxies.

Unit VI: Large Scale Structure and Cosmology (Lecture - 15)

Distance ladder in cosmology, Cepheid variables. Cosmic expansion of the universe and Hubble(- Lemaitre) law. Clusters of galaxies and dark matter - virial theorem. Concept of the Hot Big Bang, Oscillating Universe, Cosmic Microwave Background (CMB).

Reference Books

[1] Astrophysics-Stars and Galaxies; K D Abhyankar
[2] Astrophysics-A modern perspective, K. S. Krishnaswamy
[3] Astrophysics for Physicists; A Rai Choudhuri
[4] Textbook of Astronomy and Astrophysics with elements of Cosmology; V B Bhatia
[5] An Introduction to Astrophysics by Baidyanath Basu
[6] Introduction to Astrophysics by H. L. Duorah and Kalpana Duorah
[7] The Physical Universe: An Introduction to Astronomy, Frank H. Shu

PHY-HE-6056
PHYSICS-DSE: CLASSICAL DYNAMICS
Total Lectures: 75 Credits: 6 (Theory: 05, Tutorial: 01)

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Course Outcome: *Upon completion of this course, students will have the overview of Newton's Laws of Motion, Special Theory of Relativity by 4-vectoer approach and fluids. Students will also have the understanding of the Lagrangian and Hamiltonian of a system.. By the end of this course, students will be able to solve the seen or unseen problems/numericals in classical mechanics.*

Theory

Unit I: Classical Mechanics of Point Particles (Lectures 22)

Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyroradius and gyrofrequency, motion in crossed electric and magnetic fields.constraints, Generalized coordinates and velocities, principle of virtual work, D,Alembert's principle,Hamilton'sprinciple, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field- conservation of angular momentum and energy.

Unit II: Small Amplitude Oscillations (Lectures 10)

Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.

Unit III: Special Theory of Relativity (Lectures 33)

Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.

Unit IV: Fluid Dynamics (Lectures 10)

Density ρ and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number.

Reference Books

[1] Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
[2] Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
[3] Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
[4] The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
[5] Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
[6] Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
[7] Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
[8] Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
[9] Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

Skill Enhancement Papers
[Choose One]

PHY-SE-6014
Radiation Safety
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with PhD in Nuclear Physics/ Radiation Physics (preferably with a RSO degree from BRIT/BARC).

To ensure safety of the public, occupational workers and the environment, this course on the basic knowledge of radiation safety is introduced. The course is designed in such a way to acquaint the students with the sources of various natural and man-made radiation sources, risks involved in working in relatively high radiation zone, and safety measures to be taken to protect individual's health.

The students will acquire a basic knowledge of types and sources of radiations, interactions of radiations with matter, risks involved and safety measures to be taken.

Theory

Unit I: Structure of Matter (Lectures 6)

Constituents of atoms and nuclei, atomic and mass numbers, Isotopes, energy units, electron shells, atomic energy levels, Nuclear energy levels. Transitions between atomic energy levels (resulting optical photons) and nuclear energy levels (resulting gamma photons), -Ionization and excitation, Electromagnetic spectrum, Relationship between wavelengths, Frequency, Energy.

Units and Measurements of Physical Quantities: Force, Work, Power, energy temperature and heat. SI units of above parameters. (6L)

Unit II: Radioactivity (Lectures 6)

Natural and artificial radioactivity, types of nuclear radiations: alpha, beta, and gamma rays – concepts of Half life, activity, units of activity, -specific activity. Interactions of gamma ray and charged particles with matter. Absorbed Dose, Units of Dose. Radiation hazard, Safety measurements: Time, distance and shielding. Occupational dose limit.

Unit III: Radiation Quantities and Units (Lectures 7)

Particle flux and fluence, Radiation flux and fluence, cross section, energy, linear energy transfer (LET), linear and mass attenuation coefficients, mass stopping power, inverse square law, W-value, exposure (rate), Kerma (rate), Terma, absorbed dose (rate), rate constants, radiation weighting factors, tissue weighting factors, equivalent dose, effective dose, collective effective dose, Annual Limit of Intake {ALI}, Derived Air Concentration {DAC}, personnel dose equivalent, committed dose.

Unit IV: X-Ray (Lectures 5)

Electromagnetic waves, X-Rays –Production of X-rays: The X-ray tube, Physics of X-ray production, continuous spectrum, characteristic spectrum,–Basics of X-ray Circuits, measurement of high voltage – control of KV circuit –MA circuit. Loading, processing and storing of X-ray plates. Distribution of X-rays in space, Interaction of X-rays with matter, Attenuation of x-rays. Radiation effect of X-rays, safety measurements to be followed.

Unit V: Computed Tomography (Lectures 3)

Theory of tomography – multi section radiography, tomographic equipment, Computer tomography.

Radiation hazard of Tomographic machine, Safety measurement to be followed.

Unit VI: MRI (Lectures 3)

Magnetic Resonance imaging – Basic principle– Imaging methods – Slice section, Image contrast, Bio-effects of MRI. Safety measurements. Counting statistics, errors in counting.

Lab

1. Measurement of alpha track density due to environmental (air) Radon (and its daughter) using SSNTD
2. Taking X-ray of a pen/pencil
3. Visit to a CT scan and MRI laboratory.
4. Study the background radiation levels using Radiation meter

Characteristics of Geiger Muller (GM) Counter:

5. Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).
6. Study of counting statistics using background radiation using GM counter.
7. Study of radiation in various materials (e.g. KSO_4 etc.). Investigation of possible radiation in different routine materials by operating GM at operating voltage.
8. Study of absorption of beta particles in Aluminum using GM counter.
9. Detection of α particles using reference source & determining its half life using spark counter
10. Gamma spectrum of Gas Light mantle (Source of Thorium)
11. Studying α particles in air using SSNTDs technique

Reference Books

[1] Radiation Safety: J S Ballard (https://openoregon.pressbooks.pub/radsafety130/)
[2] Atomic and Nuclear Physics Vol. II: S N Ghosal
[3] An introduction to Radiation Physics: Vivek Mandot (ISBN: 9788179067635, 8179067637)
[4] W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)
[5] G.F.Knoll, Radiation detection and measurements
[6] Thermoluninescense Dosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook 5)
[7] W.J. Meredith and J.B. Massey, "Fundamental Physics of Radiology". John Wright and Sons, UK, 1989.
[8] J.R. Greening, "Fundamentals of Radiation Dosimetry", Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981.
[9] Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
[10] A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981. NCRP, ICRP, ICRU, IAEA, AERB Publications.
W.R. Hendee, "Medical Radiation Physics", Year Book – Medical Publishers Inc. London, 1981

PHY-SE-6024
RENEWABLE ENERGY AND ENERGY HARVESTING
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor of Physics with PhD in Condensed Matter Physics.

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

Theory

Unit I: Fossil fuels and Alternate Sources of energy (Lectures 3)

Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

Unit II: Solar energy (Lectures 6)

Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Unit III: Wind Energy harvesting (Lectures 3)

Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Unit IV: Ocean Energy (Lectures 3)

Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.

Unit V: (Lectures 2)

Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

Unit VI: Geothermal Energy (Lectures 2)

Geothermal Resources, Geothermal Technologies.

Unit VII: Hydro Energy (Lectures 2)

Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Unit VIII: Piezoelectric Energy harvesting (Lectures 4)

Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modelling piezoelectric generators, Piezoelectric energy harvesting applications, Human power.

Unit IX: Electromagnetic Energy Harvesting (Lectures 2)

Linear generators, physics mathematical models, recent applications

Unit X: (Lectures 2)

Carbon captured technologies, cell, batteries, power consumption

Unit XI: (Lectures 1)

Environmental issues and Renewable sources of energy, sustainability.

Demonstrations and Experiments

1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

Reference Books

[1] Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi

[2] Solar energy - M P Agarwal - S Chand and Co. Ltd.

[3] Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.

[4] Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford University Press, in association with The Open University.

[5] Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009 • J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

[6] http://en.wikipedia.org/wiki/Renewable_energy

PHY-SE-6034
Introduction to CorelDraw
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on CorelDraw/B.E./B.Tech. in Computer Science/ MCA/B.Sc. with DCA.

This course will give you how to use CorelDraw to present objects, layers, and pages in an effective and presentable form. This course will enables you to create logos, brochures, website graphics, illustrations and other artwork. The trained candidates can develop the designs to meet the computer graphics need of various applications.

Course Outcome: *On successful completion of the course students will be able to work with layers and symbols in CorelDRAW, Apply fills and outlines to illustrations in CorelDRAW, Use, edit, and create artistic and paragraph text in CorelDRAW, Create boundaries to objects and copy and clone the effect of one object to another in CorelDRAW, Import and export projects, Print objects/documents created on CorelDRAW.*

Unit I: Getting Started with CorelDRAW (Lectures 6)
CorelDRAW Interface, Moving from Adobe Illustrator to CorelDRAW, Drawing Basic Shapes, Selecting Objects, Changing Order of Objects, Transforming Objects, Duplicating Objects, Organizing Objects, Zooming, Panning, and Scrolling, Hiding and Displaying Objects, Using Guides and Grids, Saving the Document

Unit II: Drawing and Coloring (Lectures 6)
Drawing Lines in CorelDRAW, Calligraphy, Shape Edit Tool, Applying Fills and Outlines, Pages and Layout Tools, Viewing Modes, Working with Layers, Working with Symbols, Creating Styles

Unit III: Working with Text (Lectures 6)
Artistic Text, Fitting Text to Curve, Reshaping Tools, Paragraph Text, Entering and Editing, Paragraph Text, Wrapping Text around Other Shapes, Linking Text to Objects, Finding and Replacing
Working with Text Styles, Working with Tables, Inserting Formatting Codes, Font Identification

Unit IV: Applying Effects (Lectures 6)
Envelopes and Distortion Effects, Blends and Contours, Transparency and Drop Shadow, Extrude
Lens, Perspective, Bevel, Powerclip, Create Boundary, Copying and Cloning Effects, Inserting Bar Codes, Inserting and Editing QR Codes

Unit V: Working with Bitmaps and Web Resources (Lectures 6)
Importing and Exporting Bitmaps, Working with Bitmaps, Internet Toolbar, Setting Web pages
Creating Buttons with Rollover Effects, Publishing to PDF, Printing

PHY-SE-6044
GRAPHIC DESIGN FOR DIGITAL ADVERTISING
Credits: 4 (Theory: 2, Lab: 2)
Theory: 30 Lectures

Preferred minimum qualifications of the teacher/instructor: Assistant Professor with a certificate on digital advertising /B.E./B. Tech. in Computer Science/ MCA/B.Sc. with DCA.

This course will give you the skills to come up with innovative concepts and visualization and further create Graphic Designs using the principles of Design, Composition & Colour theory. You will learn to create Graphic Design on the most popular and industry relevant design software, Adobe Photoshop.

Course Outcome: *On successful completion of the course students will be able to Understand aesthetics & visual appeal in design, Using impactful visual content which appeals to target audience, Conceptualize, Visualize and Create Graphic Designs for:Digital Ads, Posters, Banners and Flyers, Social Media Ads & Banners, Websites and Blogs*

Tools: Adobe Photoshop Extended CC

Unit I: Getting Started with Adobe Photoshop CC (Lectures 3)
Overview of Adobe Photoshop CC, Features of Adobe Photoshop CC

Unit II: Importance of Adobe Photoshop CC (Lectures 3)
Overview of Tools Used in Adobe Photoshop CC, Importance of Adobe Photoshop CC

Unit III: Working with Typography (Lectures 4)
Typography, Creating Typographies, Choosing the Right Font and Color

Unit IV: Working with Layers and Images (Lectures 5)
Cropping a Photo, Resizing Images, Basics of Layers, Creating Layers for Print and Digital Media, Aligning Images within Multiple Layers, Merging Layer Techniques

Unit V: Working with Filters (Lectures 5)
Photoshop Filters, Smart Filters, Common Features of Photoshop Filter

Unit VI: Digital Painting in Adobe Photoshop CC (Lectures 5)
Working with Brush Tool, Importance of Using Colors

Unit VII: Masking and File Formats in Adobe Photoshop CC (Lectures 5)
Introduction to Mask, Creating Vector and Layer Masks, Essential File Formats, Choosing the Right Format for Print and Digital Media

Gauhati University

Syllabus for B.Sc. (Honors) ZOOLOGY

Choice Based Credit System (CBCS)

Course effective from academic year 2019-20

Syllabus for B.Sc.(Honors) Zoology

Choice Based Credit System (CBCS)

Course effective from academic year 2019-20

This is approved in the Academic Council on 08//11/2019

Gauhati University

Guwahati::Assam

Mapping of Subjects

1st Semester

	Type	Core	AEC	SEC	DSE	GEN
	Credits	**14 × 6 = 84**	**2 × 4 = 8**	**2 × 4 = 8**	**4 × 6 = 24**	**4 × 6 = 24**
Honours	**Sem I**	ZOO-HC-1016	ENG-AE-1014			XXX-HG-1XX6 ZOO-HG-1XX6 XXX-HG-1XX6 . . . . . .
		ZOO-HC-1026				

	Type	Core	AECC	SEC	DSE
	Credits	**12 × 6 = 72**	**2 × 4 = 8**	**4 × 4 = 16**	**6 × 6 = 36**
Regular	**Sem I**	ZOO-RC-1016	ENG-AE-1014		
		YYY-RC-1016			
		ZZZ-RC-1016			

2nd Semester

	Type	Core	AEC	SEC	DSE	GEN
	Credits	**14 × 6 = 84**	**2 × 4 = 8**	**2 × 4 = 8**	**4 × 6 = 24**	**4 × 6 = 24**
Honours	**Sem II**	ZOO-HC-2016	ENV-AE-2014			XXX-HG-2XX6 ZOO-HG-2XX6 XXX-HG-2XX6 . . . . . .
		ZOO-HC-2026				

	Type	Core	AECC	SEC	DSE
	Credits	**12 × 6 = 72**	**2 × 4 = 8**	**4 × 4 = 16**	**6 × 6 = 36**
Regular	**Sem II**	ZOO-RC-2016	ENV-AE-2014		
		YYY-RC-2016			
		ZZZ-RC-2016			

BSc Courses
3rd - 6th Semesters

Honours

Type	Core	AEC	SEC	DSE	GEN
Credits	14 × 6 = 84	2 × 4 = 8	2 × 4 = 8	4 × 6 = 24	4 × 6 = 24
Sem III	ZOO-HC-		ZOO-SE-3XX4		ZOO-HG-3XX6
	ZOO-HC-				
	ZOO-HC-				
Sem IV	ZOO-HC-		ZOO-SE-4XX4		ZOO-HG-4XX6
	ZOO-HC-				
	ZOO-HC-				
Sem V	ZOO-HC-			ZOO-HE-	
	ZOO-HC-			ZOO-HE-	
Sem VI	ZOO-HC-			ZOO-HE-	
	ZOO-HC-			ZOO-HE-	

Regular

Type	Core	AECC	SEC	DSE
Credits	12 × 6 = 72	2 × 4 = 8	4 × 4 = 16	6 × 6 = 36
Sem III	ZOO-RC-3016		ZOO-SE-3XX4	
	YYY-RC-3016			
	ZZZ-RC-3016			
Sem IV	ZOO-RC-4016		ZOO-SE-4XX4	
	YYY-RC-4016			
	ZZZ-RC-4016			
Sem V			ZOO-SE-5XX4	ZOO-RE-5XX6
				ZOO-RE-5XX6
				ZOO-RE-5XX6
Sem VI			ZOO-SE-6XX4	ZOO-RE-6XX6
				ZOO-RE-6XX6
				ZOO-RE-6XX6

Contents

Preamble

The choice based credit system is naturally the next logical step in a credit based semester system. This makes the system the more learner-centric. A CBCS offers the student a diversity of courses to choose from and the autonomy to decide on the place, pace and the time of learning.

The Gauhati University has decided to introduce the CBCS system at the under graduate level from the session 2019-20. The CBCS syllabus for the B.Sc. (Honours) is prepared in the model of syllabus prepared by theUGC.

A student opting for honors course in ZOOLOGY must have and passed the BIOLOGY as a subject in the Senior Secondary level examination.

Course Structure	
Course	***Credits**
	Theory+ Practical
I. Core Course **(14 Papers)** **Core Course Practical / Tutorial*** **(14 Papers)**	14×4= 56 14×2= 28
II. Elective Course (8 Papers) **A.1.** Discipline Specific Elective **(4Papers)** **A.2.** Discipline Specific Elective Practical/Tutorial***(4Papers)**	4×4=16 4×2=8
B.1. Generic Elective/ Interdisciplinary **(4 Papers)** B.2. Generic Elective Practical/ Tutorial* **(4 Papers)**	4×4=16 4×2=8
III. Ability Enhancement Courses 1. **Ability Enhancement Compulsory (2 Papers of 2 credit each)** Environmental Studies English/MIL Communication **2. Ability Enhancement Elective**(SkillBased) (Minimum2) **(2 Papers of 2 credit each)**	2×4=8 2×4=8
Total	**148**

***Core and DSE courses without practicals will have tutorial and have credit distribution of: 5credits for theory and 1credit for tutorial, total6credits,sameasthe papers with practical**

Structure of BSc Honours(ZOOLOGY) Programme

Semester	Type / Credits	Core	AECC	SEC	DSE	GEN
		14 × 6 = 84	2 × 4 = 8	2 × 4 = 8	4 × 6 = 24	4 × 6 = 24
I		ZOO- HC- 1 016	ENG- AE- 10 14			XXX- HG- 1XX6
		ZOO- HC- 1 026				
II		ZOO- HC- 2 016	ENV- AE- 20 14			XXX- HG- 2XX6
		ZOO- HC- 2 026				
III		ZOO- HC- 3 016		ZOO- SE- 3YY4†		XXX- HG- 3XX6
		ZOO- HC- 3 026				
		ZOO- HC- 3 036				
IV		ZOO- HC- 4 016		ZOO- SE- 4YY4†		XXX- HG- 4XX6
		ZOO- HC- 4 026				
		ZOO- HC- 4 036				
V		ZOO- HC- 5 016			ZOO- HE- 5YY6‡	
		ZOO- HC- 5 026			ZOO- HE- 5YY6‡	
VI		ZOO- HC- 6 016			ZOO- HE- 6YY6‡	
		ZOO- HC- 6 016			ZOO- HE- 6YY6‡	

SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B. Sc. Honours (ZOOLOGY)

SEMESTER	COURSE CODE	COURSE NAME	Credits
I	ENG-AE-1014	English Communications	4
	ZOO-HC-1016	Non Chordates I: Protista to Pseudocoelomates	4+2=6
		NON Chordates-I Lab	
	ZOO-HC-1026	Principles of Ecology	4+2=6
		Principles of Ecology Lab	
	AAA-HG-1YY6	GE-1	4/5
		Generic Elective 1 Practical/Tutorial	2/1
		Total Credits in Semester I	22
II	Ability Enhancement Compulsory Course-II**	Environmental Studies	4
	ZOO-HC-2016	Non Chordates-II: Coelomate	4+2=6
		NON Chordates-II Lab	
	ZOO-HC-2026	Cell Biology	4+2=6
		Cell Biology Lab	
	AAA-HG-2YY6*	GE-2	4/5
		Generic Elective 2 Practical/Tutorial	2/1
		Total Credits in Semester II	22
III	ZOO-HC-3016	Diversity of Chordates	4+2=6
		Diversity of Chordates Lab	
	ZOO-HC-3026	Physiology: Controlling and Coordinating Systems	4+2=6
		Physiology Controlling and Coordinating Systems Lab	
	ZOO-HC-3036	Fundamental of Biochemistry	4+2=6
		Fundamental of Biochemistry Lab	
	ZOO-SE-3YY4†	SEC-1	4
	AAA-HG-3YY6*	GE-3	4/5

		Generic Elective 3 Practical/Tutorial	2/1
Total Credits in Semester III			28
IV	ZOO-HC-4016	Comparative anatomy of Vertebrate	4+2=6
		Comparative Anatomy of Vertebrate Lab	
	ZOO-HC-4026	Physiology Life Sustaining systems	4+2=6
		Physiology Life Sustaining systems Lab	
	ZOO-HC-4036	Biochemistry of Metabolic process	4+2=6
		Biochemistry of Metabolic Process Lab	
	ZOO-SE-4YY4†	SEC -2	4
	AAA-HG-4YY 6*	GE-4	4/5
		Generic Elective Practical/tutorial	2/1
Total Credits in Semester IV			28
V	ZOO-HC-5016	Molecular Biology	4+2=6
		Molecular Biology Lab	
	ZOO-HC-5026	Principles of Genetics	4+2=6
		Principles of genetics Lab	
	ZOO-HE-5YY6‡	DSE-1	4+2=6
		DSE-1 Lab	
	ZOO-HE-5YY6‡	DSE-2	4+2=6
		DSE-2 Lab	
Total Credits in Semester V			24
VI	ZOO-HC-6016	Developmental Biology	4+2=6
		Developmental Biology Lab	
	ZOO-HC-6026	Evolutionary Biology	4+2=6
		Evolutionary Biology Lab	
	ZOO-HE-6YY6‡	DSE-3	4+2=6
		DSE-3 Lab	
	ZOO-HE-6YY6‡	DSE-4	4+2=6

		DSE-4 Lab	
Total Credits in Semester VI			24
Grand Total Credits			148

Generic Electives (Other Discipline) - GE 1 to GE 4

1. Botany (4) + Lab(4)
2. Chemistry (4)+ Lab (4)
3. Anthropology (4)+ Lab (4)
4. Geography (4)+ Lab (4)
5. Geology (4)+ Lab (4)
6. Biotechnology (4)+ Lab (4)
7. Computer Science (4)+Lab (4)
8. STATISTICS (4)+ Lab (2)
9. MATHEMATICS
10. MICROBIOLOGY (4)+ Lab (2)
11. PHYSICS (4)+ Lab (2)

a)Generic Electives(GE) are to be taken preferably from Botany and Chemistry disciplines.
b) Students can choose minimum of two GE papers from different disciplines.

‡ Discipline Specific Elective Papers: (Credit: 06 each) (4 papers to be selected)-
DSE for Semester V DSE-1 (Any One from the following)

1. **ZOO-HE-5016:** Computational Biology and Biostatistics (4) + Lab(2) (Compulsory)

DSE-2(Any One from the following)

2. **ZOO-HE-5026:** Animal biotechnology (4) + Lab(2)
3. **ZOO-HE-5036:** Endocrinology (4) + Lab(2)
4. **ZOO-HE-5046:** Parasitiology (4) + Lab(2)

DSE for Semester VI

DSE-3(Any One from the following)

5. **ZOO-HE-6016:** Biology of Insect (4) + Lab(2)
6. **ZOO-HE-6026:** FISH and Fisheries (4) + Lab(2)

DSE-4 (Any One from the following)

7. **ZOO-HE-6046:** Reproductive Biology (4) + Lab(2)
8. **ZOO-HE-6056:**Wildlife Conservation and Management (4)+ Lab (2)
9. **ZOO-HE-6066**: Dissertation in any Zoology Specific Subject (6)

†Skill Enhancement Courses (04papers)(Credit:04each)

SEC for SemesterIII

Any One from the following

1. **ZOO-SE-3014:** Ornamental fish and Fisheies
2. **ZOO-SE-3024:** Apiculture

SEC for Semester IV

Any One from the following

3. **ZOO-SE-4014:** Non Mulberry sericuture
4. **ZOO-SE-4024:** Wildlife Photography and Ecotourism
5. **ZOO-**SE-4034: Research Methodology

****Ability Enhancement Compulsory Courses (02 papers) (Credit: 04 each)**

AECC for Semester I

1. **ENG-AE-1014: English Communications**

AECC for Semester II

2. **ENV-AE-2014: Environmental Science**

CORE COURSE I

CODE: ZOO-HC-1016

NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES

THEORY **(Credits 4)**

Unit 1: Protista, Parazoa and Metazoa **19**

General characteristics and Classification upto classes Study of *Euglena, Amoeba* and *Paramecium*

Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*

Locomotion and Reproduction in Protista

Evolution of symmetry and segmentation of Metazoa

Unit 2: Porifera **7**

General characteristics and Classification upto classes Canal system and spicules in sponges

Unit 3: Cnidaria **12**

General characteristics and Classification upto classes Metagenesis in *Obelia*

Polymorphism in Cnidaria Corals and coral reefs

Unit 4: Ctenophora **4**

General characteristics and Evolutionary significance

Unit 5: Platyhelminthes **10**

General characteristics and Classification up to classes

Life cycle and pathogenicity of *Fasciola hepatica* and *Taeniasolium*

Unit 6: Nemathelminthes **8**

General characteristics and Classification up to classes

Lifecycle, and pathogenicity of *Ascaris lumbricoides* and *Wuchereri abancrofti*

Parasitic adaptations in helminthes

Note: Classification to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition"

NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES

PRACTICALS **(Credits 2)**

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium*
2. Examinationofpondwatercollectedfromdifferentplacesfordiversityinprotista
3. Study of *Sycon*(T.S. and L.S.), *Hyalonema*, *Euplectella*,*Spongilla*
4. Study of *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina,Madrepora*
5. One specimen/slide of anyctenophore
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/micro- photographs)
7. Study of adult *Ascaris lumbricoides* and its life stages(Slides/micro-photographs)
8. To submit a Project Report on any related topic on life cycles.

Note: Classification to be followed from "Ruppert and Barnes (2006) *Invertebrate Zoology*, 8th edition, Holt Saunders International Edition"

SUGGESTED READINGS

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders InternationalEdition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, BlackwellScience
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. andNelson

CORE COURSE II

CODE: ZOO-HC-1026

PRINCIPLES OF ECOLOGY

THEORY **(Credits 4)**

Unit 1: Introduction to Ecology **6**

History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors

Unit2:Population **24**

Unitary and Modular populations

Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion Exponential and logistic growth, equation and patterns, r and K strategies Population regulation - density-dependent and independent factors

Population interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical responses

Unit3:Community **12**

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one example

Theories pertaining to climax community

Unit4:Ecosystem **14**

Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies

Nutrient and biogeochemical cycle with one example of Nitrogen cycle Human modified ecosystem

Unit 5:Applied Ecology **4**

Ecology in Wildlife Conservation and Management

PRINCIPLES OF ECOLOGY

PRACTICALS **(Credits 2)**

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by quadrate methodandcalculationofShannon-Weinerdiversityindexforthesamecommunity
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler'smethod).
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

SUGGESTED READINGS

- Colinvaux,P.A.(1993).Ecology.IIEdition.Wiley,JohnandSons,Inc.
- Krebs, C. J. (2001). Ecology. VI Edition. BenjaminCummings.
- Odum,E.P.,(2008).FundamentalsofEcology.IndianEdition.Brooks/Cole
- RobertLeoSmithEcologyandfieldbiologyHarperandRowpublisher
- Ricklefs, R.E., (2000). Ecology. V Edition. ChironPres

CORE COURSE III

CODE: ZOO-HC-2016

NON-CHORDATES II: COELOMATES

THEORY	**(Credits 4)**
Unit 1: Introduction to Coelomates	**2**

Evolution of coelom and metamerism

Unit 2: Annelida	**10**

General characteristics and Classification upto classes Excretion in Annelida

Unit 3: Arthropoda	**17**

General characteristics and Classification upto classes Vision and Respiration in Arthropoda

Metamorphosis in Insects

Social life in bees and termites

Unit 4: Onychophora	**4**

General characteristics and Evolutionary significance

Unit 5: Mollusca

General characteristics and Classification upto classes Respiration in Mollusca Torsion and detorsion in Gastropoda Pearl formation in bivalves Evolutionary significance of trochophore larva

Unit 6: Echinodermata	**12**

General characteristics and Classification upto classes Water-vascular system in Asteroidea Larval forms in Echinodermata

Affinities with Chordates

Note: Classification to be followed from "Ruppert and Barnes (2006) *Invertebrate Zoology*, 8th edition, Holt Saunders International Edition"

NON-CHORDATES II: COELOMATES

PRACTICAL **(Credits 2)**

1. Study of followingspecimens:
Annelids-*Aphrodite, Nereis, Heteronereis ,Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria*
Arthropods - *Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta,* termites and honey bees Onychophora - *Peripatus*
Molluscs - *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus*
Echinodermates - *Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria*and *Antedon*
2. Studyofdigestivesystem,septalnephridiaandpharyngealnephridiaofearthworm
3. T.S. through pharynx, gizzard, and typhlosolar intestine ofearthworm
4. Mount of mouth parts and dissection of digestive system and nervous systemof *Periplaneta**
5. To submit a Project Report on any related topic to larval forms (crustacean, mollusc andechinoderm)

Note: Classification to be followed from “Ruppert and Barnes (2006) *Invertebrate Zoology,* 8th edition, Holt Saunders InternationalEdition”

SUGGESTED READINGS

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders InternationalEdition
- Barnes,R.S.K.,Calow,P.,Olive,P.J.W.,Golding,D.W.andSpicer,J.I.(2002). *TheInvertebrates: A New Synthesis*, III Edition, Blackwell Science
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. andNelson

CORE COURSE IV

CODE: ZOO-HC-2026
CELL BIOLOGY

THEORY **(Credits4)**

Unit 1: Over view of Cells **3**

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions

Unit 2:Plasma Membrane **7**

Various models of plasma membrane structure
Transportacrossmembranes:ActiveandPassivetransport,Facilitatedtransport Cell junctions: Tight junctions, Desmosomes, Gapjunctions

Unit 3:Endomembrane System **10**

Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes

Unit 4: Mitochondria and Peroxisomes **8**

Mitochondria:Structure,Semi-autonomousnature,Endosymbiotichypothesis Mitochondrial Respiratory Chain, Chemi-osmotichypothesis
Peroxisomes

Unit5:Cytoskeleton **8**

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments

Unit6:Nucleus **12**

Structure of Nucleus: Nuclearenvelope, Nuclear pore complex, Nucleolus Chromatin: Euchromatin and Hetrochromatin and packaging(nucleosome)

Unit 7:Cell Division **8**

Mitosis, Meiosis, Cell cycle and its regulation

Unit 8:Cell Signaling **4**

GPCR and Role of second messenger (cAMP)

CELL BIOLOGY

PRACTICAL **(Credits 2)**

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
2. Study of various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barrbody in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate: iDNA by Feulgen reaction
   ii Mucopolysaccharides by PAS reaction
   iii Proteins by Mercuro bromophenol blue/FastGreen

SUGGESTED READINGS

- Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons.Inc.

- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins,Philadelphia.

- Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition. ASMPressandSunderland,Washington,D.C.;SinauerAssociates,MA.

- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*.VIIEdition. Pearson Benjamin Cummings Publishing, SanFrancisco.

- Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008).*MolecularBiology of the Cell*,VEdition,GarlandpublishingInc.,NewYorkand London.

CORE COURSE V

DIVERSITY OF

CHORDATA

CODE: ZOO-HC-3016

THEORY **(Credits 4)**

Unit 1: Introduction to Chordates **2**

General characteristics and outline classification

Unit2:Protochordata **8**

General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates*;* Retrogressive metamorphosis in Urochordata

Unit 3: Origin of Chordata **3**

Dipleurula concept and the Echinoderm theory of origin of chordates Advanced features of vertebrates over Protochordata

Unit4:Agnatha **2**

General characteristics and classification of cyclostomes up to class

Unit5:Pisces **8**

GeneralcharacteristicsofChondrichthyesandOsteichthyes,classificationupto order Migration, Osmoregulation and Parental care infishes

Unit6:Amphibia **6**

Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characteristics and classification upto order; Parental care in Amphibians

Unit7:Reptilia **7**

General characteristics and classification up to order; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes

Unit8:Aves **8**

General characteristics and classification up to order *Archaeopteryx*-- a connecting link; Principles and aerodynamics of flight, Flight adaptations and Migration in birds

Unit9:Mammals **8**

General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages

Unit10:Zoogeography **8**

Zoo geographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms

DIVERSITY OF CHORDATA

PRACTICAL **(Credits 2)**

1. **Protochordata**

Balanoglossus, Herdmania, Branchiostoma, Colonial Urochordata Sections of *Balanoglossus* through proboscis and branchio genital regions, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions.Permanent slide of *Herdmania* spicules

2. **Agnatha**

Petromyzon, Myxine

3. **Fishes**

Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas, Flat fish

4. **Amphibia**

Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra

5. **Reptilia**

Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus Key for Identification of poisonous and non-poisonoussnakes

6. **Aves**

Study of six common birds from different orders. Types of beaks and claws

7. **Mammalia**

Sorex, Bat (Insectivorous and Frugivorous), *Funambulus, Loris, Herpestes, Erinaceous.*

Mount of weberian ossicles of *fish*

Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission)

Classification from Young, J. Z. (2004) to be followed

SUGGESTED READINGS

- Young,J.Z.(2004).*TheLifeofVertebrates*.IIIEdition.Oxforduniversitypress.
- Pough H. *Vertebrate life,* VIII Edition, PearsonInternational.

- DarlingtonP.J.*TheGeographicalDistributionofAnimals*,R.E.KriegerPubCo.
- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*.
IV Edition. Jones and Bartlett PublishersInc.

CORE COURSE VI

ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS

CODE: ZOO-HC-3026

THEORY **(Credits 4)**

Unit 1: Tissues **6**

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue

Unit 2: Bone and Cartilage **4**

Structure and types of bones and cartilages, Ossification, bone growth and resorption

Unit 3: Nervous System **10**

Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc; Physiology of hearing and vision.

Unit 4: Muscle **12**

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus

Unit 5: Reproductive System **10**

Histology of testis and ovary; Physiology of male and female reproduction; Puberty, Methods of contraception in male and female

Unit 6: Endocrine System **18**

Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones; Regulation of their secretion; Mode of hormoneaction,Signaltransductionpathwaysforsteroidalandnon-steroidal hormones;Hypothalamus(neuroendocrinegland)-principalnucleiinvolved in neuro endocrine control of anterior pituitary and endocrines system;

Placental hormones

ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS

PRACTICALS **(Credits 2)**

*1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerkreflex)

2. Preparationoftemporarymounts:Squamousepithelium,Striatedm usclefibres and nervecells
3. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nervecell,Pituitary,Pancreas,Testis,Ovary,Adrenal,ThyroidandParathyr oid
4. Microtomy: Preparation of permanent slide of any five mammalian(Goat/ rat/mice)tissues

(*Subject to UGC guidelines)

SUGGESTED BOOKS

 Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.

 Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley &sons

 Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. &Wilkins.

CORE COURSE VII

FUNDAMENTALS OF BIOCHEMISTRY

CODE: ZOO-HC-3036

THEORY **(CREDITS 4)**

Unit1:Carbohydrates **8**

Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates

Unit2:Lipids **8**

Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids

Unit3:Proteins **14**

Amino acids: Structure, Classification and General properties of α-amino acids; Physiological importance of essential and non-essential α-amino acids

Proteins: Bonds stabilizing protein structure; Levels of organization in proteins; Denaturation; Introduction to simple and conjugate proteins

Immunoglobulins: Basic Structure, Classes and Function, Antigenic Determinants

Unit 4:NucleicAcids **12**

Structure:Purines and pyrimidines,Nucleosides,Nucleotides,Nucleicacids CotCurves: Base pairing, Denaturation and Renaturation of DNA
Types of DNA and RNA, Complementarity of DNA, Hpyo- Hyperchromaticity of DNA

Unit5:Enzymes **18**

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action

FUNDAMENTALS OF BIOCHEMISTRY

PRACTICAL **(CREDITS2)**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Paper chromatography of amino acids.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH, temperature on the action of salivary amylase.
5. Demonstration of proteins separation by SDS-PAGE.

SUGGESTED READING

- Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., NewYork.
- Berg,J.M.,Tymoczko,J.L.andStryer,L.(2007).*Biochemistry*,VIEdition, W.H. Freeman and Co., New York.
- Murray,R.K.,Bender,D.A.,Botham,K.M.,Kennelly,P.J.,Rodwell, V.W.and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill CompaniesInc.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd.,U.K.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene*, VI Edition, Cold Spring Harbor Lab. Press, PearsonPub.

CORE COURSEVIII COMPARATIVE ANATOMY OF VERTEBRATES

CODE: ZOO-HC-4016

THEORY	**(CREDITS 4)**
Unit 1:Integumentary System	**8**
Structure, functions and derivatives of integument	
Unit 2:Skeletal System	**8**
Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches	
Unit 3:Digestive System	**8**
Alimentary canal and associated glands, dentition	
Unit 4:Respiratory System	**8**
Skin, gills, lungs and air sacs; Accessory respiratory organs	
Unit 5:Circulatory System	**8**
General plan of circulation, evolution of heart and aortic arches	
Unit 6:Urinogenital System	**6**
Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri	
Unit 7:Nervous System	**8**
Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals	
Unit 8:Sense Organs	**6**
Classification of receptors Brief account of visual and auditory receptors in man	

COMPARATIVE ANATOMY OFVERTEBRATES

PRACTICAL **(CREDITS2)**

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, Fowl, Rabbit
3. Carapace and plastron of turtle/tortoise
4. Mammalian skulls: One herbivorous and one carnivorous animal
5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)
6. Project on skeletal modifications in vertebrates (may be included if dissection not permitted)

SUGGESTED READINGS

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill HigherEducation
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-HillCompanies
- Hilderbrand, M and GaslowG.E. *Analysis of Vertebrate Structure*, John Wileyand Sons
- Walter,H.E.andSayles,L.P;*BiologyofVertebrates*,KhoslaPublishingHouse

CORE COURSE IX

ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS

CODE: ZOO-HC-4026

THEORY **(Credits 4)**

Unit 1: Physiologyof Digestion **14**

Structural organization and functions of gastrointestinal tract andassociated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Hormonal control of secretion of enzymes in Gastrointestinaltract.

Unit 2: PhysiologyofRespiration **12**

Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Carbon monoxide poisoning; Control of respiration

Unit 3:Renal Physiology **8**

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance

Unit4:Blood **14**

Components of blood and their functions; Structure and functions of haemoglobin

Haemostasis: Blood clotting system, Kallikrein-Kinninogen system, Complement system&Fibrinolytic system,Haemopoiesis

Blood groups: Rh factor, ABO and MN

Unit 5: PhysiologyofHeart **12**

Structure of mammalian heart; Coronary circulation; Structure and working of conducting myocardial fibers.Origin and conduction of cardiac impulses Cardiac cycle; Cardiac output and its regulation, Frank-Starling Law of the heart, nervous and chemical regulation of heart rate. Electrocardiogram, Blood pressure and its regulation

ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS

PRACTICALS **(CREDITS 2)**

1. Determination of ABO Blood group
2. Enumeration of red blood cells and white blood cells using haemocytometer
3. Estimation of haemoglobin using Sahli'shaemoglobinometer
4. Preparation of haemin crystals
5. Recording of blood pressure using a sphygmomanometer
6. Examinationofsectionsofmammalianoesophagus,stomach,duodenum,ileum, rectum liver, trachea, lung, kidney

(*Subject to UGC guidelines)

SUGGESTED READINGS

- Guyton,A.C.&Hall,J.E.(2006).TextbookofMedicalPhysiology.XIEdition. Hercourt Asia PTE Ltd. W.B. SaundersCompany.
- Tortora,G.J.&Grabowski,S.(2006).PrinciplesofAnatomy&Physiology.XI Edition John Wiley &sons,
- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. &Wilkins.
- VanderA,ShermanJ.andLucianoD.(2014).Vander'sHumanPhysiology:The Mechanism of Body Function. XIII Edition, McGrawHills

CORE COURSE X BIOCHEMISTRY OF METABOLIC PROCESSES

CODE: ZOO-HC-4036

THEORY **(CREDITS 4)**

Unit 1: Overview of Metabolism **10**

Catabolism *vs* Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms

Unit 2:Carbohydrate Metabolism **16**

Sequence of reactions and regulation of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis

Unit 3:Lipid Metabolism **14**

β-oxidation and omega-oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmiticacid; Ketogenesis

U**nit 4:Protein Metabolism** **10**

Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit 5:OxidativePhosphorylation **10**

Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System

BIOCHEMISTRY OF METABOLIC PROCESS

PRACTICALS **(CREDITS 2)**

1. Estimation of total protein in given solutions by Lowry'smethod.
2. Detection of SGOT and SGPT in serum/tissue
3. To study the enzymatic activity of Trypsin and Lipase.
4. Study of biological oxidation (SDH) [goatliver]
5. To perform the Acid and Alkaline phosphatase assay from serum/tissue.

SUGGESTED READINGS

- Cox, M.M and Nelson, D.L. (2008). *Lehninger Principles of Biochemistry*, V Edition, W.H. Freeman and Co., NewYork.
- Berg,J.M.,Tymoczko,J.L.andStryer,L.(2007).*Biochemistry*,VIEdition, W.H. Freeman and Co., New York.
- Murray, R.K., Bender, *D.A.*, Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw-Hill CompaniesInc.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd.,U.K.

CORE COURSE XI

MOLECULAR BIOLOGY

CODE: ZOO-HC-5016

THEORY **(CREDITS 4)**

Unit 1:NucleicAcids **4**

Salient features of DNA and RNA Watson and Crick model of DNA

Unit 2:DNAReplication **12**

DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear *ds*-DNA, replication of telomeres

Unit3:Transcription **10**

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors

Unit4:Translation **12**

Geneticcode,DegeneracyofthegeneticcodeandWobbleHypothesis;Processof protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptidechain;Inhibitorsofproteinsynthesis;Differencebetweenprokaryotic and eukaryotic translation

Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA **6**

Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA

Unit 6:GeneRegulation **10**

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp*operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprinting

Unit 7: DNA Repair Mechanisms **3**

Pyrimidine dimerization and mismatch repair

Unit 8: Regulatory RNAs **3**

Ribo-switches, RNA interference, miRNA, siRNA

MOLECULAR BIOLOGY

PRACTICAL **(CREDITS 2)**

1. Study of Polytene chromosomes from Chironomous / Drosophilalarvae
2. Preparation of liquid culture medium(LB)andraisecultureof*E.coli*
3. Estimation of the growth kinetics of *E. coli* by turbidity method
4. Quantitative estimation DNA using colorimeter (Diphenylamine reagent)
5. Quantitative estimation of RNA using Orcinolreaction
6. Study and interpretation of electron micrographs/ photographshowing
   (a) DNA replication
   (b) Transcription
   (c) Splitgenes

SUGGESTED READINGS

- Becker,W.M.,Kleinsmith,L.J.,Hardin.J.andBertoni,G.P.(2009).*TheWorld of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IVEdition.
- CooperG.M.andRobertE.HausmanR.E.*TheCell:AMolecularApproach*,V Edition, ASM Press and SinauerAssociates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*.VIIIEdition.LippincottWilliamsandWilkins,Philadelphia.
- Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons.Inc.
- Lewin B. (2008). *Gene XI*, Jones andBartlett
- McLennanA.,BatesA.,Turner,P.andWhiteM.(2015).*MolecularBiology*IV Edition.GS,TaylorandFrancisGroup,NewYorkandLondon.

CORE COURSE XII

PRINCIPLES OF

GENETICS

CODE: ZOO-HC-5026

THEORY **(CREDITS 4)**

Unit 1: Mendelian Genetics and its Extension **8**

Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex- influenced and sex-limited characters inheritance.

Unit 2: Linkage, Crossing Over and Chromosomal Mapping **12**

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.

Unit3:Mutations **10**

Typesofgenemutations(Classification),Typesofchromosomalaberrations (Classification, figures and with one suitable example of each), Molecular basisofmutationsinrelationtoUVlightandchemicalmutagens;Detection of mutations: CLB method, attached *X* method.

Unit 4:SexDetermination **4**

Chromosomal mechanisms of sex determination in Drosophila and Man

Unit 5:Extra-chromosomalInheritance **6**

Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations in *Saccharomyces*, Infective heredity in *Paramecium* and Maternal effects

Unit 6:PolygenicInheritance **3**

Polygenic inheritance with suitable examples; simple numericals based on it.

Unit 7: Recombination in BacteriaandViruses **9**

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

Unit 8: TransposableGeneticElements **8**

Transposons in bacteria, Ac-Ds elements in maize and P elements in *Drosophila*, Transposons in humans

PRINCIPLES OF GENETICS

PRACTICALS **(CREDITS 2)**

1. To study the Mendelian laws and gene interactions.
2. Chi-square analyses using seeds/beads/*Drosophila*.
3. Linkage maps based on data from conjugation ,transformation and transduction.
4. Linkage maps based on data from *Drosophila* crosses.
5. Study of human karyotype (normal and abnormal).
6. Pedigree analysis of some human inherited traits.

SUGGESTED READINGS

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. WileyIndia
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and SonsInc
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. BenjaminCummings
- Russell, P. J. (2009). *Genetics- A Molecular Approach*.III Edition. BenjaminCummings
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll,S.B. *Introduction to Genetic Analysis*.IX Edition. W. H. Freeman and Co
- Fletcher H. and Hickey I. (2015). *Genetics.* IV Edition. GS, Taylor and Francis Group, New York andLondon.

CORE COURSE XIII

DEVELOPMENTAL BIOLOGY

CODE: ZOO-HC-6016

THEORY **(CREDITS 4)**

Unit1:Introduction **4**

Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differentialgene expression, Cytoplasmic determinants and asymmetric cell division

Unit 2: Early Embryonic Development **28**

Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers

Unit 3: Late Embryonic Development **8**

Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure,types and functions of placenta)

Unit 4: PostEmbryonicDevelopment **12**

Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories

Unit 5: Implications ofDevelopmentalBiology **8**

Teratogenesis: Teratogenic agents and their effects on embryonic development; *In vitro* fertilization, Stem cell (ESC), Amniocentesis

DEVELOPMENTAL BIOLOGY

PRACTICALS (CREDITS 2)

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gillstages)
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburgerstages)
3. Study of the developmental stages and life cycle of *Drosophila* from stock culture
4. Study of different sections of placenta (photomicropgraph/slides)
5. Project report on *Drosophila* culture/chick embryodevelopment

SUGGESTED READINGS

- Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts,USA
- Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson ComputerPress
- Carlson, R. F. Patten's Foundations ofEmbryology
- Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
- LewisWolpert(2002).PrinciplesofDevelopment.IIEdition,Oxford University Press

CORE COURSE XIV
EVOLUTIONARY BIOLOGY

CODE: ZOO-HC-6026

THEORY **(CREDITS 4)**

Unit1: **7**
Life'sBeginnings: Chemogeny, RNAworld, Biogeny, Origin of photosynthesis, Evolution of eukaryotes

Unit2: **4**
Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism

Unit3: **10**
Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Molecular (universality of genetic code and protein synthesising machinery, three domains of life, neutral theory of molecular evolution, molecular clock ,example of globin gene family, rRNA/cyt c

Unit4: **8**
Sources of variations: Heritable variations and their role in evolution

Unit5: **13**
Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium;Naturalselection(conceptoffitness,selectioncoefficient,derivationof one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon;RoleofMigrationandMutationinchangingallelefrequencies

Unit6: **7**
Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches

Unit7: **2**
Extinctions,Backgroundandmassextinctions(causesandeffects),detailedexampleof K-Textinction

Unit8: **6**
Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus*leading to *Homo*

sapiens, molecular analysis of human origin

Unit9: 2

Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees

EVOLUTIONARY BIOLOGY

PRACTICALS (CREDITS2)

1. Study of fossils from models/pictures
2. Study of homology and analogy from suitable pecimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Graphicalrepresentationandinterpretationofdataofheight/weighto fasample of 100 humans in relation to their age andsex.
5. Construction of phylogenetic trees with the help of bioinformatics tools(Clustal X, Phylip, NJ) and its interpretation.

SUGGESTED READINGS

- Ridley,M (2004) Evolution III Edition Blackwellpublishing
- Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
- Campbell,N.A.andReeceJ.B(2011).Biology.IXEdition.Pearson, Benjamin, Cummings.
- Douglas, J. Futuyma (1997). Evolutionary Biology. SinauerAssociates.
- Snustad. S Principles ofGenetics.
- Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley- Blackwell

DISCIPLINE CENTRIC ELECTIVE COURSES

CODE: ZOO-HE-5016

COMPUTATIONAL BIOLOGY and BIOSTATICS

THEORY **(Credits 4)**

Unit 1: Introduction to Bioinformatics **5**

Importance, Goal, Scope; Genomics, Transcriptomics, Systems Biology, Functional Genomics, Metabolomics, Molecular Phylogeny; Applications and Limitations of Bioinformatics

Unit 2:BiologicalDatabases **10**

Introduction to biological databases; Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB); Metabolic pathway database (KEGG, EcoCyc, and MetaCyc); Small molecule databases (PubChem, Drug Bank, ZINC, CSD)

Unit 3: Data Generation andDataRetrieval **14**

Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)

Unit 3: Basic Concepts of Sequence Alignment **14**

Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences.

Unit 4: Applications of Bioinformatics **7**

Structural Bioinformatics (3-D protein, PDB), Functional genomics (genome- wide and high throughput approaches to gene and protein function), Drug discovery method (Basic concepts)

Unit5:Biostatistics **10**

Introduction, calculation of standard deviation, standard error, Co-efficient of Variance, Chi-square test, Z test, t-Test

COMPUTATIONAL BIOLOGY

PRACTICAL **(Credits 2)**

1. Accessing biological databases
2. Retrieval of nucleotide and protein sequences from the databases.
3. To perform pair-wise alignment of sequences (BLAST) and interpret the output
4. Predict the structure of protein from its amino acid sequence.
5. To perform a "two-sample t- test" for a given set ofdata
6. Tolearngraphicalrepresentationsofstatisticaldatawiththehel pofcomputers (e.g. MSExcel).

SUGGESTED READINGS

- Ghosh Z and Mallick B. (2008). Bioinformatics: *Principles and Applications*, Oxford UniversityPress.
- Pevsner J. (2009). *Bioinformatics and Functional Genomic*s, II Edition, Wiley Blackwell.
- Zvelebil,MarketaandBaumO.Jeremy(2008).*Understanding Bioinformatics*, Garland Science, Taylor and Francis Group,USA.
- Zar, Jerrold H. (1999). *Biostatistical Analysis*, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc.USA
- Antonisamy, B., Christopher S. and Samuel, P. P. (2010). *Biostatistics: PrinciplesandPractice*.TataMcGrawHillEducationPrivateLimited,India.
- Pagana,M.andGavreau,K.(2000).*PrinciplesofBiostatistics*, DuxberryPress, USA

CODE: ZOO-HC-5026

ANIMAL BIOTECHNOLOGY

THEORY **(Credits 4)**

Unit 1. Introduction **8**

Concept and scope of biotechnology

Unit 2. Molecular Techniques in Gene manipulation **24**

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics).

Restriction enzymes: Nomenclature, detailed study of Type II.

Transformation techniques: Calcium chloride method and electroporation.

Construction of genomic and cDNA libraries and screening by colony and plaque hybridization

Southern, Northern and Western blotting

DNA sequencing: Sanger method

Polymerase Chain Reaction, DNA Finger Printing and DNA micro array

Unit 3. Genetically Modified Organisms **18**

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection

Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock outmice.

Production of transgenic plants: *Agrobacterium* mediated transformation.

Applications of transgenic plants: insect and herbicide resistant plants.

Unit 4. Culture Techniques and Applications **10**

Animalcellculture,Expressingclonedgenesinmammaliancells,Molecular diagnosis of genetic diseases (Cysticfibrosis,Sicklecellanemia)

Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy

ANIMAL BIOTECHNOLOGY

PRACTICAL **(Credits 2)**

1. Genomic DNA isolation from *E.coli*

2. Plasmid DNA isolation (pUC 18/19) from *E.coli*

3. Restriction digestion of plasmid DNA.

4. Construction of circular and linear restriction map from the data provided.

5. Calculation of transformation efficiency from the data provided..

6. To study following techniques through photographs

   a. Southern Blotting

   b. Northern Blotting

   c. Western Blotting

   d. DNA Sequencing (Sanger'sMethod)

   e. PCR

   f. DNA fingerprinting

7. Projectreportonanimalcellculture

10

SUGGESTED READINGS

- Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNA Analysis*. II Edition, Academic Press, California,USA.

- Glick,B.R.andPasternak,J.J.(2009).*MolecularBiotechnology-Principlesand ApplicationsofRecombinantDNA*.IVEdition,ASMpress,Washington,USA.

- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart,W.M. (2009).*AnIntroductiontoGeneticAnalysis*.IXEdition.FreemanandCo.,N.Y., USA.

- Snustad,D.P.andSimmons,M.J.(2009).*PrinciplesofGenetics.*VEdition,John Wiley and SonsInc.
- Watson,J.D.,Myers,R.M.,Caudy,A.andWitkowski,J.K.(2007).*Recombinant DNA- Genes and Genomes- A Short Course*. III Edition, Freeman and Co., N.Y.,USA.

- Beauchamp,T.I.andChildress,J.F.(2008).*PrinciplesofBiomedical Ethics.*VI Edition, Oxford University Press.

CODE: ZOO-HE-5036
ENDOCRINOLOGY

THEORY **(Credits 4)**

Unit 1: **Introduction to Endocrinology** **12**

History of endocrinology, Classification, Characteristic and Transport of Hormones, Neuro secretions and Neuro hormones

Unit 2: Epiphysis, Hypothalamo-hypophysialAxis **15**

Structure of pineal gland, Secretions and their functions in biological rhythm sand reproduction.

Structure of hypothalamus, Hypothalamic nuclei and their functions, Regulation of neuroendocrine glands, Feed back mechanisms

Structure of pituitary gland, Hormones and their functions, Hypothalamo- hypophysial portal system, Disorders of pituitary gland.

Unit3:Peripheral Endocrine Glands **18**

Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis

Hormones in homeostasis, Disorders of endocrine glands

Unit4: Regulation of Hormone Action **15**

Hormone action at Cellular level: Hormone receptors, transduction and regulation Hormone action at Molecular level: Molecular mediators, Genetic control of hormone action

ENDOCRINOLOGY

PRACTICAL **(Credits 2)**

1. Dissect and display of Endocrine glands in laboratory bred rat* 2.Study of the permanent slides of all the endocrine glands
3. Demonstration of Castration/ovariectomy in laboratory bred rat* 4. Designing of primers of any hormone

SUGGESTED READINGS

- General Endocrinology C. Donnell Turner Pub- SaundersToppan
- Endocrinology: An Integrated Approach; Stephen Nussey andSaffron Whitehead.
- Oxford: BIOS Scientific Publishers;2001.
- Hadley, M.E. and Levine J.E. 2007. Endocrinology, 6th Edition. Pearson Prentice-Hall, Pearson Education Inc., NewJersey.
- Vertebrate Endocrinology by David O.Norris,

CODE: ZOO-HE-5046
PARASITOLOGY

THEORY **(CREDITS 4)**

Unit I: Introduction to Parasitology **3**

Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship

Unit II: Parasitic Protists **15**

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica, Giardia intestinalis, Trypanoso magambiense, Leishmania donovani, Plasmodium vivax*

Unit III: Parasitic Platyhelminthes **15**

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Fasciolopsis buski, Schistosoma haematobium, Taenia solium* and *Hymenolepis nana*

Unit IV: Parasitic Nematodes **15**

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascarislumbricoides*, *Ancylostomaduodenale*,*Wuchereriabancrofti*and*Trichinellaspiralis.*Study ofstructure,life cycle and importance of *Meloidogyne*(root knot nematode), *Pratylencus*(lesion nematode)

Unit IV: Parasitic Arthropoda **10**

Biology, importance and control of ticks, mites, *Pediculushumanus*(head and body louse), *Xenopsyllacheopis*and *Cimexlectularius*

Unit V: Parasitic Vertebrates **2**

A brief account of parasitic vertebrates; Cookicutter Shark, Candiru, Hood Mockingbird and Vampire bat

PARASITOLOGY

PRACTICAL **(Credits 2)**

- Study of life stages of *Entamoeba histolytica, Giardia intestinalis, Trypanosoma gambiense, Leishmania donovani* and *Plasmodium vivax* through permanent slides/microphotographs
- Study of adult and life stages of *Fasciolopsis buski*, *Schistoso mahaematobium, Taenia solium* and *Hymenolepis nana* through permanent slides/microphotographs
- Study of adult and life stages of *Ascarislumbricoides*, *Ancylostomaduodenale,* *Wuchereriabancrofti*and *Trichinellaspiralis*through permanent slides/microphotographs
- Study of plant parasitic root knot nematode, *Meloidogyne*from the soil sample
- Study of *Pediculushumanus*(Head louse and Body louse), *Xenopsyllacheopis*and*Cimexlectularius*throughpermanentslides/photographs
- Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by product of theindustry]
- Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a byproduct]

Submission of a brief report on parasitic

vertebrates SUGGESTEDREADINGS

- Arora, D. R and Arora, B. (2001) *Medical Parasitology*. II Edition. CBS Publications andDistributors
- E.R. Noble and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea &Febiger
- Ahmed,N.,Dawson,M.,Smith,C.andWood,Ed.(2007)*BiologyofDisease.* Taylor and Francis Group
- Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai,Delhi
- RattanLalIchhpujaniandRajeshBhatia.MedicalParasitology ,IIIEdition,Jaypee Brothers Medical Publishers (P) Ltd., NewDelhi

- Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. BrownPublishers

K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS ***Publishers*** & Distributors (P)Lt

CODE: ZOO-HE-6016

BIOLOGY OF INSECTA

THEORY **(Credits 4)**

UnitI: Introduction **4**

General Features of Insects

Distribution and Success of Insects on the Earth

Unit II:Insect Taxonomy **4**

Basis of insect classification; Classification of insects up to orders

Unit III: General Morphology of Insects **8**

External Features; Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits

Thorax:Wings and wing articulation, Types of Legs adapted to

diverse habitat Abdominal appendages and genitalia

Unit IV: Physiology of Insects **28**

Structure and physiology of Insect body systems - Integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive, and nervous system

Sensory receptors

Growth and metamorphosis

Unit IV: Insect Society **6**

Group of social insects and their social life

Social organization and social behaviour (w.r.t. any one example)

Unit V: Insect Plant Interaction **4**

Theory of co-evolution, role of allele chemicals in host plant

mediation Host-

plantselectionbyphytophagousinsects,Insectsasplantpests

Unit VI: InsectsasVectors **6**

Insects as mechanical and Biological vectors, Brief discussion on houseflies and mosquitoes as important insect vectors

BIOLOGY OF INSECTA

PRACTICAL **(CREDITS 2)**

1. Study of one specimen from each insect order
2. Study of different kinds of antennae, legs and mouth parts of insects
3. Study of head and sclerites of any one insect
4. Study of insect wings and theirvenation.
5. Study of insect spiracles
6. Methodology of collection, preservation and identification of insects.
7. Morphological studies of various castes of *Apis, Camponotus* and *Odontotermes*
8. Study of any three insect pests and theirdamages
9. Study of any three beneficial insects and theirproducts

Field study of insects and submission of a project report on the insect diversity

SUGGESTED READINGS

- Ageneraltextbookofentomology,Imms,A.D.,Chapman&Hall,UK
- The Insects: Structure and function, Chapman, R. F., Cambridge University Press,UK
- PrinciplesofInsectMorphology,Snodgrass,R.E.,CornellUniv.Press,USA
- Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders College Publication,USA
- The Insect Societies, Wilson, E. O., Harward Univ. Press,UK
- HostSelectionbyPhytophagousinsects,Bernays,E.A.,andChapman,R.F., Chapman and Hall, New York,USA
- Physiological system in Insects, Klowden, M. J., Academic Press,USA
- The Insects, An outline of Entomology, Gullan, P. J. , and Cranston, P. S., Wiley Blackwell,UK

Insect Physiology and Biochemistry, Nation, J. L., CRC Press,USA

CODE: ZOO-HE-6026

FISH AND FISHERIES

THEORY **(Credits 4)**

UNIT 1: Introduction and Classification: **6**

General description of fish; Account of systematic classification of fishes (upto classes); Classification based on feeding habit, habitat and manner of reproduction.

UNIT 2: Morphology and Physiology: **18**

Types of fins and their modifications; Locomotion in fishes; Hydrodynamics; Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Osmoregulation in Elasmobranchs; Reproductive strategies (special reference to Indian fishes); Electric organs; Bioluminiscience; Mechanoreceptors; Schooling; Parental care; Migration

UNIT3:Fisheries **12**

Inland Fisheries; Marine Fisheries; Environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations

Unit4:Aquaculture **20**

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture offish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparationandmaintenanceoffishaquarium;Preparationofcompounddietsf or fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic;Preservationandprocessingofharvestedfish,Fisheryby-products

UNIT 5: Fish in research **4**

Transgenic fish, Zebra fish as a model organism in research

FISH AND FISHERIES

PRACTICAL **(Credits 2)**

1. Morphometric and meristic characters of fishes
2. Study of *Petromyzon*, *Myxine*, *Pristis*, *Chimaera*, *Exocoetus*, *Hippocampus*, *Gambusia*, *Labeo*, *Heteropneustes* ,*Anabas*
3. Study of different types of scales (through permanent slides/photographs).
4. Study of crafts and gears used in Fisheries
5. WaterqualitycriteriaforAquaculture:AssessmentofpH,cond uctivity,Total solids, Total dissolved solids
6. Study of air breathing organs in *Channa, Heteropneustes, Anabas* and *Clarias*
7. Demonstration of induced breeding in Fishes(video)
8. Demonstration of parental care in fishes(video)
9. ProjectReportonavisittoanyfishfarm/pisciculturеunit/Zebra fishrearing Lab.

SUGGESTED READINGS

- QBone and R Moore, Biology of Fishes, Talyor and Francis Group, CRCPress, U.K.
- D. H. Evans and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group,CRCPress,UKvonderEmde,R.J.MogdansandB.G.Kapoor.TheSensesof Fish:AdaptationsfortheReceptionofNaturalStimuli,Springer,Netherlands
- C.B.L. Srivastava, Fish Biology, Narendra Publishing House
- J.R. Norman, A history of Fishes, Hill and Wang Publishers
- S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House

CODE: ZOO-HE-6036

REPRODUCTIVE BIOLOGY

THEORY **(CREDITS 4)**

Unit 1: Reproductive Endocrinology

Gonadalhormonesandmechanismofhormoneaction,steroids,glycoproteinhormones ,and prostaglandins, hypothalamo – hypophyseal – gonadal axis, regulation of gonado trophin secretion in male and female; Reproductive System: Development and differentiation of gonads, genital ducts, external genitalia, mechanism of sex differentiation.

Unit 2: Functional anatomy of male reproduction

Outline and histological of male reproductive system in rat and human; Testis: Cellular functions, germ cell, system cell renewal; Spermatogenesis: kinetics and hormonal regulation; Androgen synthesis and metabolism; Epididymal function and sperm maturation; Accessory glands functions; Sperm transportation in male tract

Unit 3: Functional anatomy of female reproduction

Outline and histological of female reproductive system in rat and human; Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (rat and human) and their regulation, changes in the female tract; Ovum transport in the fallopian tubes; Sperm transport in the female tract, fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation

Unit 4: Reproductive Health

Infertility in male and female: causes, diagnosis and management; Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET,EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern contraceptive technologies; Demographic terminology used in family planning

REPRODUCTIVE BIOLOGY

PRACTICAL **(CREDITS 2)**

1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.
2. Examination of vaginal smear rats from live animals.
3. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
4. Sperm count and sperm motility in rat
5. Study of modern contraceptive devices

SUGGESTED READINGS

- Austin,C.R.andShort,R.V.reproductioninMammals.CambridgeUniversityPress.
- Degroot,L.J.andJameson,J.L.(eds).Endocrinology.W.B.SaundersandCompany.
- Knobil,E.etal.(eds).ThePhysiologyofReproduction.RavenPressLtd.
- Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.

CODE: ZOO-HE-6046
WILD LIFE CONSERVATION AND MANAGEMENT

THEORY **(CREDITS 4)**

Unit 1: Introduction to Wild Life

Values of wildlife-positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.

Unit 2: Evaluation and management of wild life

Habitat analysis, Physical parameters :Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS.

Unit 3: Management of habitats

Setting back succession; Grazing logging; Mechanical treatment; Advancing the successionalprocess;Coverconstruction;Preservationofgeneralgeneticdi versity; Restoration of degradedhabitats

Unit 4: Population estimation

Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method.

Unit 5: Management planning of wild life in protected areas

Estimationofcarryingcapacity;Ecotourism/wildlifetourisminforests;Conceptofclimax persistence; Ecology of perturbence.

Unit 7: Management of excess population

Bio-telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animal

Unit 8: Protected areas

Nationalparks&sanctuaries,Communityreserve;ImportantfeaturesofprotectedareasinI ndia; Tigerconservation-TigerreservesinIndia;ManagementchallengesinTigerreserve.

WILD LIFE CONSERVATION AND MANAGEMENT

PRACTICALS **(CREDITS 2)**

1. Identification of flora, mammalian fauna, avian fauna, herpeto-fauna
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)
3. Familiarization and study of animal evidences in the field; Identification of animals through pugmarks, hoofmarks, scats, pellet groups, nest, antlers etc.
4. Demonstration of different field techniques for flora and fauna
5. PCQ,Tentree method,Circular,Square&rectangularplots,Parker's2Stepandot her methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment.
6. Trail/transectmonitoringforabundanceanddiversityestimati onofmammalsandbird (direct and indirect evidences)

SUGGESTED READINGS

- Caughley, G., and Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. Blackwell Science.

- WoodroffeR.,Thirgood,S.andRabinowitz,A.(2005).*Peoplea ndWildlife,Conflict or Co-existence*? Cambridge University.

- Bookhout, T.A. (1996). *Research and Management Techniques for Wildlife and Habitats*, 5 th edition. The Wildlife Society, Allen Press.

- Sutherland, W.J. (2000). *The Conservation Handbook: Research, Management and Policy*. Blackwell Sciences

- HunterM.L.,Gibbs,J.B.andSterling,E.J.(2008).*Problem-SolvinginConservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory*. Blackwell Publishing.

ZOO-HE-6056

DISSERTATION

Dissertation of Zoology Specific subject

.

GENERIC ELECTIVE COURSES

CODE: ZOO-HG-1016

ANIMAL DIVERSITY

THEORY **(CREDITS 4)**

Unit 1:Kingdom Protista **4**
General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa

Unit 2: Phylum Porifera **3**
General characters and classification up to classes; Canal System in *Sycon*

Unit 3: Phylum Cnidaria **3**
General characters and classification up to classes; Polymorphism in Hydrozoa

Unit 4:Phylum Platyhelminthes **3**
General characters and classification up to classes; Life history of *Taenia solium*

Unit 5: Phylum Nemathelminthes **5**
General characters and classification up to classes; Life history of *Ascaris lumbricoides* and its parasitic adaptations

Unit 6:Phylum Annelida **3**
General characters and classification up to classes; Metamerism in Annelida

Unit 7:Phylum Arthropoda **5**
General characters and classification up to classes; Vision in Arthropoda, Metamorphosis in Insects

Unit 8: Phylum Mollusca **4**

General characters and classification up to classes; Torsion in gastropods

Unit 9: Phylum Echinodermata **4**

General characters and classification up to classes; Water-vascular system in Asteroidea

Unit 10: Protochordates **2**

General features and Phylogeny of Protochordata

Unit 11: Agnatha **2**

General features of Agnatha and classification of cyclostomes up to classes

Unit 12: Pisces **4**

General features and Classification up to orders; Osmoregulation in Fishes

Unit13: Amphibia **4**

General features and Classification up to orders; Parental care

Unit14: Reptiles **4**

General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in snakes

Unit15: Aves **5**

General features and Classification up to orders; Flight adaptations in birds

Unit17: Mammals **5**

Classification up to orders; Origin of mammals

Note: Classification of Unit 1-9 to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition"

ANIMAL DIVERSITY

PRACTICAL **(CREDITS2)**

1. Study of the followingspecimens:
Amoeba, *Euglena, Plasmodium, Paramecium, Sycon*, *Hyalonema,* and *Euplectella, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taeniasolium,* Male and female *Ascarislumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria*and *Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis*, Any six common birds from different orders, *Sorex*, Bat, *Funambulus,Loris*

2. Study of the following permanent slides:
T.S. and L.S. of *Sycon*, Study of life history stages of *Taenia*, T.S. of Male and female *Ascaris*

3. Key for Identification of poisonous and non-poisonous snakes

An "**animal album**" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for thispurpose.

SUGGESTED READINGS

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, BlackwellScience
- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford universitypress.
- Pough H. *Vertebrate life*, VIII Edition, PearsonInternational.
- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett PublishersInc.

COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

CODE: ZOO-HG-2016

THEORY **(CREDITS 4)**

Unit 1: Integumentary System **4**

Derivatives of integument w.r.t. glands and digital tips

Unit 2: Skeletal System **3**

Evolution of visceral arches

Unit 3:Digestive System **4**

Brief account of alimentary canal and digestive glands

Unit 4:RespiratorySystem **5**

Brief account of Gills, lungs, air sacs and swim bladder

Unit 5: Circulatory System **4**

Evolution of heart and aortic arches

Unit 6:Urinogenital System **4**

Succession of kidney, Evolution of urinogenital ducts

Unit 7:Nervous System **3**

Comparative account of brain

Unit 8: Sense Organs **3**

Types of receptors

Unit 9: Early Embryonic Development **12**

Gametogenesis: Spermatogenesis and oogenesis w.r.t. mammals, vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals), blocks to polyspermy; Early development of frog and humans (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula);types of morphogenetic movements; Fate of germ layers; Neurulation in frog embryo.

Unit 10: Late Embryonic Development **10**

Implantation of embryo in humans, Formation of human placenta and functions, other types of placenta on the basis of histology; Metamorphic events in frog life cycle and its hormonal regulation.

Unit 11: Control of Development **8**

Fundamental processes in development (brief idea) – Gene activation, determination, induction, Differentiation, morphogenesis, intercellular communication, cell movements and cell death

COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

PRACTICAL **(CREDITS 2)**

1. Osteology:
    a) Disarticulated skeleton of fowl and rabbit
    b) Carapace and plastron of turtle/tortoise
    c) Mammalian skulls: One herbivorous and one carnivorous animal.
2. Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
3. Study of the different types of placenta- histological sections through permanent slides or photomicrographs.
4. Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs.

SUGGESTED READINGS

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies.
- Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons.
- Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House.
- Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts,USA.
- Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
- Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.

CORE COURSE III
PHYSIOLOGY AND BIOCHEMISTRY
CODE: ZOO-HG-3016

THEORY **(CREDITS 4)**

Unit 1: Nerveandmuscle **8**

Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction

Unit2: Digestion **5**

Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids

Unit3: Respiration **5**

Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood

Unit 4: Excretion **5**

Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

Unit 5: Cardiovascular system **6**

Composition of blood, Hemostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle

Unit 6: Reproduction andEndocrineGlands **7**

Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrualcycle
Structure and function of pituitary, thyroid, Parathyroid, pancreas and adrenal

Unit 7: Carbohydrate Metabolism **8**

Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain

Unit 8: Lipid Metabolism **5**

Biosynthesis and β oxidation of palmitic acid

Unit 9: Protein metabolism **5**

Transamination, Deamination and Urea Cycle

Unit 10: Enzymes **6**

Introduction, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation

PHYSIOLOGY AND BIOCHEMISTRY

PRACTICAL **(CREDITS2)**

1. Preparation of hemin crystals
2. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland
3. Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage
4. Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose)

2. Estimation of total protein in given solutions by Lowry's method.
3. Study of activity of salivary amylase under optimum conditions

SUGGESTED READINGS

- Tortora, G.J. and Derrickson, B.H. (2009). *Principles of Anatomy and Physiology*, XII Edition, John Wiley & Sons,Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) *Vander's Human Physiology*, XI Edition., McGrawHill
- Guyton, A.C. and Hall, J.E. (2011). T*extbook of Medical Physiology*, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. SaundersCompany
- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). *Biochemistry*. VI Edition. W.H Freeman andCo.
- Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). *Principles of Biochemistry*. IV Edition. W.H. Freeman andCo.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). *Harper's Illustrated Biochemistry*. XXVIII Edition. Lange Medical Books/McGraw3Hill.

GENETICS AND EVOLUTIONARY BIOLOGY

CODE: ZOO-HG-4016

THEORY **(CREDITS 4)**

Unit 1: Introduction to Genetics **3**

Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information

Unit 2: Mendelian Genetics and its Extension **8**

Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance

Unit 3: Linkage, Crossing Over and Chromosomal Mapping **9**

Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics - an alternative approach to gene mapping

Unit4: Mutations **7**

Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations,

Unit 5: Sex Determination **4**

Chromosomal mechanisms, dosage compensation

Unit 6: History of Life **2**

Major Events in History of Life

Unit 7: Introduction to Evolutionary Theories **5**

Lamarckism, Darwinism, Neo-Darwinism

Unit 8: Direct Evidences of Evolution **5**

Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

Unit 9: Processes of Evolutionary Change **9**

Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection

Unit 10:Species Concept **6**

Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)

Unit11:Macro-evolution **5**

Macro-evolutionary Principles (example: Darwin's Finches)

Unit 12: Extinction **6**

Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution

GENETICS AND EVOLUTIONARY BIOLOGY

PRACTICAL **(CREDITS 2)**

1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
3. Study of Human Karyotypes (normal and abnormal).
4. Study of fossil evidences from plaster cast models and pictures
5. Study of homology and analogy from suitable specimens/pictures
6. Charts:
   a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors
   b) Darwin's Finches with diagrams/ cut outs of beaks of different species
7. Visit to Natural History Museum and submission of report

SUGGESTED READINGS

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. WileyIndia.
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and SonsInc.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. BenjaminCummings.
- Russell, P. J. (2009). *Genetics- A Molecular Approach.* III Edition. Benjamin Cummings.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman andCo.
- Ridley, M. (2004). *Evolution*. III Edition. BlackwellPublishing
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H.(2007). *Evolution*. Spring, Harbour Laboratory Press.
- Hall, B. K. and Hall grimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
- Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.
- Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.

SKILL ENHANCEMENT COURSES

CODE: ZOO-SE-3014 **Credit-4**

Ornamental Fish & Fisheries

1. Ornamental Fish Diversity of North East India.
2. Aquarium plant diversity in the wetland of Assam.
3. Construction and management of Home Aquarium.
4. Natural feed of Ornamental Fish
5. Strategies for maintenance of natural colour of Ornamental Fish
6. Natural Breeding of Tricogaster species
7. Health management of Ornamental Fish
8. Feed formulation of Ornamental Fish
9. Development of Biological filtration in Aquarium
10. Pure culture of planktons

Practical's

11. Identification of Ornamental Fish
12. Culture of Indigenous ornamental fish in Aquarium
13. Estimation of Physico-chemical characteristics of Aquarium water
14. Biological filter for removal of Ammonia from Aquarium
15. Culture of Planktons

APICULTURE

CODE: ZOO-SE-3024

(CREDITS4)

Unit 1: Biology of Bees

History, Classification and Biology of Honey
Bees Social Organization of Bee Colony

Unit 2: Rearing of Bees

Artificial Bee rearing(Apiary),Beehives–Newton and
Langstroth Bee Pasturage
Selection of Bee Species for
Apiculture Bee Keeping Equipment
Methods of Extraction of Honey (Indigenous and Modern)

Unit 3: Diseases and Enemies

Bee Diseases and Enemies

Control and Preventive
measures

Unit 4:Bee Economy

Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc

Unit5:EntrepreneurshipinApiculture

Bee Keeping Industry–Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens

SUGGESTED READINGS

- Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
- Bisht D.S., *Apiculture*, ICAR Publication.
- SinghS., *Bee keeping in India*, Indian council of Agricultural Research, NewDelhi.

CODE: ZOO-SE-4014

SEC 2 N0N-

MULBERRY

SERICULTURE

(CREDITS 4)

Unit 1: Introduction

Sericulture: Definition, history and present status of Mulberry and Non-Mulberry Sericulture; Silk route Varieties of Silk; Types and distribution of non-mulberry or wild or vanya sericigenous insects in N-E India

Unit 2: Biology of Non-mulberry Silkworm:

Life cycle of silkworm- Eri and Muga
Structure of silk gland and Nature of Silk

Unit 3: Rearing of Silkworms (Eri and Muga Silkworm):

Food plants of Eri and Muga Silkworm

Rearing Operation:

Rearing house/Site and rearing appliances
Disinfectants: Formalin, bleaching powder
Rearing technology: Early age and Late age rearing
Environmental conditions in rearing-Temperature, Humidity, Light and Air
Types of mountages
Harvesting and storage of cocoons
Spinning and Reeling of silk

Unit 4: Pests and Diseases:

Pests of eri and muga silkworm
Pathogenesis of eri and muga silkworm diseases: Protozoan, viral, fungal and bacterial
Prevention and control measures of pests and diseases

Unit 5: Entrepreneurship in Non-Mulberry Sericulture:

Varieties of Non-Mulberry Silk products and economics in India

Prospectus of Non-Mulberry Sericulture in India: Non-Mulberry Sericulture industry in different states, employment generation and potential

Visit to various sericulture Govt. /Private Farm/ Centers.

SUGGESTED READINGS

- Jolly, M. S., S. K. Sen, T.N. Sonwalkar and G.K. Prashad 1979. ***Non-Mulberry Sericulture.*** *In*: Manual ofSericulture, Rome, **FAO**, 4 (29)
- Chowdhury, S.N. 1981. ***Muga Silk Industry***. Directorate of Sericulture, Govt. of Assam, Guwahati-781005, Assam.
- Chowdhury, S.N. 1982. ***Eri Silk Industry***. Directorate of Sericulture, Govt. of Assam, Guwahati-781005, Assam.
- Chowdhury, S.N. 1992. ***Silk and Sericulture***. Directorate of Sericulture and Weaving, Govt. of Assam, Guwahati-781005, Assam.

CODE: ZOO-SE-4024

Wildlife Photography and

Ecotourism

CREDITS 4

Unit-I Tools and Technique of Photography **Credit-1**

- Introduction to Photography
- Still && Video Photography
- To develop expertise in Photography
- Field trips for photography in different periods (Light and Dark),seasons and places(Wetlands, Wildlife sanctuaries, National parks, Industrial sites)
- Methods of documentation

Practical

- Submission of Photography
- Preparation of Poster and Calendar

Unit-2 Eco-tourism

- Introduction of Eco-tourism
- Scope of Eco-tourism with special reference to North East region of India
- Management of Eco-tourism & hospitality
- Development of Eco-tourism with innovative Eco-restoration ideas.

Practical

- Field visit to Wildlife sanctuaries, Eco-park, Historical and religious places, Cultural museum etc.
- Preparation of report and seminar presentation

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CODE: ZOO-SE-4034
RESEARCH METHODOLOGY
Credit:4

Unit 1:

Foundations of Research:

Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied

Unit 2:

Research Design Need for research design:

Features of good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs

Unit 3:

Data Collection, Analysis and Report Writing

Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology

Unit 4:

Ethical Issues

Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

SUGGESTED READINGS

- Anthony, M, Graziano, A.M. and Raulin, M.L. 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
- Walliman, N. 2011.Research Methods- The Basics.Taylor and Francis, London, New York.
- Wadhera, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, 2002, Universal Law publishing
- C.R.Kothari: Research Methodology, New Age International, 2009 •Coley, S.M. and Scheinberg, C.A. 1990, "Proposal writing".Stage Publications.

Gauhati University

Syllabus for B.Sc.(General)

ZOOLOGY

Choice Based Credit System (CBCS)

Course effective from academic year 2019-20

Syllabus for B.Sc.(General) Zoology

Choice Based Credit System (CBCS)

Course effective from academic year 2019-20

This is approved in the Academic Council held on 08/11/2019

Gauhati University

Guwahati::Assam

Mapping of Subjects

1st Semester

Honours

Type	Core	AEC	SEC	DSE	GEN
Credits	14 × 6 = 84	2 × 4 = 8	2 × 4 = 8	4 × 6 = 24	4 × 6 = 24
Sem I	ZOO-HC-1016 ZOO-HC-1026	ENG-AE-1014			XXX-HG-1XX6 ZOO-HG-1XX6 XXX-HG-1XX6 . . . . . .

Regular

Type	Core	AECC	SEC	DSE
Credits	12 × 6 = 72	2 × 4 = 8	4 × 4 = 16	6 × 6 = 36
Sem I	ZOO-RC-1016 YYY-RC-1016 ZZZ-RC-1016	ENG-AE-1014		

2nd Semester

Honours

Type	Core	AEC	SEC	DSE	GEN
Credits	14 × 6 = 84	2 × 4 = 8	2 × 4 = 8	4 × 6 = 24	4 × 6 = 24
Sem II	ZOO-HC-2016 ZOO-HC-2026	ENV-AE-2014			XXX-HG-2XX6 ZOO-HG-2XX6 XXX-HG-2XX6 . . . . . .

Regular

Type	Core	AECC	SEC	DSE
Credits	12 × 6 = 72	2 × 4 = 8	4 × 4 = 16	6 × 6 = 36
Sem II	ZOO-RC-2016 YYY-RC-2016 ZZZ-RC-2016	ENV-AE-2014		

BSc Courses
3rd - 6th Semesters

Honours

Type	Core	AEC	SEC	DSE	GEN
Credits	**14 × 6 = 84**	**2 × 4 = 8**	**2 × 4 = 8**	**4 × 6 = 24**	**4 × 6 = 24**
Sem III	ZOO-HC-3016		ZOO-SE-3XX4		ZOO-HG-3XX6
	ZOO-HC-3026				
	ZOO-HC-3036				
Sem IV	ZOO-HC-4016		ZOO-SE-4XX4		ZOO-HG-4XX6
	ZOO-HC-4026				
	ZOO-HC-4036				
Sem V	ZOO-HC-5016			ZOO-HE-5XX6	
	ZOO-HC-5026			ZOO-HE-5YY6	
Sem VI	ZOO-HC-6016			ZOO-HE-6XX6	
	ZOO-HC-6026			ZOO-HE-6YY6	

Regular

Type	Core	AECC	SEC	DSE
Credits	**12 × 6 = 72**	**2 × 4 = 8**	**4 × 4 = 16**	**6 × 6 = 36**
Sem III	ZOO-RC-3016		ZOO-SE-3XX4	
	YYY-RC-3016			
	ZZZ-RC-3016			
Sem IV	ZOO-RC-4016		ZOO-SE-4XX4	
	YYY-RC-4016			
	ZZZ-RC-4016			
Sem V			ZOO-SE-5XX4	ZOO-RE-5XX6
				ZOO-RE-5XX6
				ZOO-RE-5XX6
Sem VI			ZOO-SE-6XX4	ZOO-RE-6XX6
				ZOO-RE-6XX6
				ZOO-RE-6XX6

Preamble

The choice based credit system is naturally the next logical step in a credit based semester system. This makes the system the more learner-centric. A CBCS offers the student a diversity of courses to choose from and the autonomy to decide on the place, pace and the time of learning.

The Gauhati University has decided to introduce the CBCS system at the under graduate level from the session 2019-20. The CBCS syllabus for the B.Sc. (General) is prepared in the model of syllabus prepared by the UGC.

A student opting for Zoology General course preferred to have and passed the BIOLOGY as a subject in the Senior Secondary level examination.

	CORE COURSE (12)	**Ability Enhancement Compulsory Courses AEC(2)**	**Skill Enhancement Courses SEC(4)**	**Discipline Specific Elective DSE (4)**
I	AAA- RC-1YY6 ZOO-RC-1016 AAA- RC-1YY6	ENG-AE-1014 English Communication		
II	AAA- RC-2YY6 ZOO-RC-2016 AAA-RC-2YY6	ENV-AE-2014 Environmental Science		
III	AAA-RC-3YY6 ZOO-RC-3016 AAA- RC-3YY6		ZOO-SE-3014 Ornamental Fish & Fisheries	
IV	AAA- RC-4YY6 ZOO-RC-4016 AAA- RC-4YY6		ZOO-SE-4014 Apiculture	
V			Z00-SE-5014 Non mulberry sericulture	AAA-RE- 5YY6 ZOO-RE-5016 (Applied Zoology Or Animal Biotechnology AAA-RE-5YY6
VI			ZOO-SE-6014 Wildlife Photography and Ecotourisim	AAA-RE-6YY6 ZOO-RE-6016 (Aquatic Biology) Or (Insect vectors and Diseases) AAA-RE- 6YY6

Discipline Core Courses: Zoology with Practicals

1. Animal Diversity (ZOO-RC-1016
2. Comparative Anatomy and Developmental Biology of Vertebrates (ZOO-RC-2016)
3. Physiology and Biochemistry (ZOO-RC-3016)
4. Genetics and Evolutionary Biology (ZOO-RC-4016)

Discipline Specific Electives: Zoology (Any two) with Practicals

1. Applied Zoology (ZOO-RE-5016)

OR

2. Aquatic Biology (ZOO-RE- 6016)

OR

Insect, Vector and Diseases

Skill Enhancement Courses: Zoology

1. Apiculture ZOO-SE-3014
2. Ornamental Fish farming ZOO-SE-4014
3. Non Mulberry Sericulture ZOO-SE-5014
4. Wild life Photography and Ecotourism ZOO-SE-6014

CORE COURSE I
ANIMAL DIVERSITY
CODE: ZOO-RC-1016

THEORY **(CREDITS 4)**

Unit 1:Kingdom Protista **4**
General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa

Unit 2: Phylum Porifera **3**
General characters and classification up to classes; Canal System in *Sycon*

Unit 3: Phylum Cnidaria **3**
General characters and classification up to classes; Polymorphism in Hydrozoa

Unit 4:Phylum Platyhelminthes **3**
General characters and classification up to classes; Life history of *Taeniasolium*

Unit 5: Phylum Nemathelminthes **5**
General characters and classification up to classes; Life history of *Ascaris lumbricoides* and its parasitic adaptations

Unit 6:Phylum Annelida **3**
General characters and classification up to classes; Metamerism in Annelida

Unit 7:Phylum Arthropoda **5**
General characters and classification up to classes; Vision in Arthropoda, Metamorphosis in Insects

Unit 8: Phylum Mollusca **4**
General characters and classification up to classes; Torsion in gastropods

Unit 9: Phylum Echinodermata **4**
General characters and classification up to classes; Water-vascular system in Asteroidea

Unit 10: Protochordates **2**
General features and Phylogeny of Protochordata

Unit 11: Agnatha **2**
General features of Agnatha and classification of cyclostomes up to classes

Unit 12: Pisces **4**

General features and Classification up to orders; Osmoregulation in Fishes

Unit13: Amphibia **4**

General features and Classification up to orders; Parental care

Unit14: Reptiles **4**

General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in snakes

Unit15: Aves **5**

General features and Classification up to orders; Flight adaptations in birds

Unit17: Mammals **5**

Classification up to orders; Origin of mammals

Note: Classification of Unit 1-9 to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition"

ANIMAL DIVERSITY

PRACTICAL **(CREDITS2)**

1. Study of the following specimens:
Amoeba, *Euglena, Plasmodium, Paramecium*, *Sycon*, *Hyalonema*, and *Euplectella, Obelia*, *Physalia, Aurelia*, *Tubipora, Metridium*, *Taenia solium*, Male and female *Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer*, *Limulus, Palamnaeus*, *Scolopendra*, *Julus*, *Periplaneta*, *Apis, Chiton, Dentalium, Pila, Unio, Loligo*, *Sepia*, *Octopus, Pentaceros, Ophiura*, *Echinus, Cucumaria* and *Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis,* Any six common birds from different orders, *Sorex*, Bat, *Funambulus,Loris*

2. Study of the following permanent slides:
T.S. and L.S. of *Sycon*, Study of life history stages of *Taenia*, T.S. of Male and female *Ascaris*

3. Key for Identification of poisonous and non-poisonous snakes

An "**animal album**" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.

SUGGESTED READINGS

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
- Pough H. *Vertebrate life*, VIII Edition, Pearson International.
- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

CORE COURSE II

COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

CODE: ZOO-RC-2016

THEORY **(CREDITS 4)**

Unit 1: Integumentary System **4**
Derivatives of integument w.r.t. glands and digital tips

Unit 2: Skeletal System **3**
Evolution of visceral arches

Unit 3: Digestive System **4**
Brief account of alimentary canal and digestive glands

Unit 4: Respiratory System **5**
Brief account of Gills, lungs, air sacs and swim bladder

Unit 5: Circulatory System **4**
Evolution of heart and aortic arches

Unit 6: Urinogenital System **4**
Succession of kidney, Evolution of urinogenital ducts

Unit 7: NervousSystem **3**
Comparative account of brain

Unit 8: Sense Organs **3**
Types of receptors

Unit 9: Early Embryonic Development **12**
Gametogenesis: Spermatogenesis and oogenesis w.r.t. mammals, vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals), blocks to polyspermy; Early development of frog and humans (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula); types of morphogenetic movements; Fate of germ layers; Neurulation in frog embryo.

Unit 10: Late Embryonic Development **10**
Implantation of embryo in humans, Formation of human placenta and functions, other types of placenta on the basis of histology; Metamorphic events in frog life cycle and its hormonal regulation.

Unit 11: Control of Development **8**

Fundamental processes in development (brief idea) – Gene activation, determination, induction, Differentiation, morphogenesis, intercellular communication, cell movements and cell death

COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

PRACTICAL **(CREDITS 2)**

1. Osteology:
   a) Disarticulated skeleton of fowl and rabbit
   b) Carapace and plastron of turtle/tortoise
   c) Mammalian skulls: One herbivorous and one carnivorous animal.
2. Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
3. Study of the different types of placenta- histological sections through permanent slides or photomicrographs.
4. Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs.

SUGGESTED READINGS

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies.
- Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons.
- Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House.
- Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts,USA.
- Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
- Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill,Inc.

CORE COURSE III

PHYSIOLOGY AND BIOCHEMISTRY

CODE: ZOO-RC-3016

THEORY **(CREDITS 4)**

Unit 1: Nerve and muscle **8**

Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction

Unit2: Digestion **5**

Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids

Unit3: Respiration **5**

Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood

Unit 4: Excretion **5**

Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

Unit 5: Cardiovascular system **6**

Composition of blood, Hemostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle

Unit 6: Reproduction and Endocrine Glands **7**

Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle

Structure and function of pituitary, thyroid, Parathyroid, pancreas and adrenal

Unit 7: Carbohydrate Metabolism **8**

Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain

Unit 8: Lipid Metabolism **5**

Biosynthesis and β oxidation of palmitic acid

Unit 9: Protein metabolism **5**

Transamination, Deamination and Urea Cycle

Unit 10: Enzymes **6**

Introduction, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation

PHYSIOLOGY AND BIOCHEMISTRY

PRACTICAL **(CREDITS 2)**

1. Preparation of hemin crystals
2. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland
3. Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage
4. Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose)
2. Estimation of total protein in given solutions by Lowry'smethod.
3. Study of activity of salivary amylase under optimum conditions

SUGGESTED READINGS

- Tortora, G.J. and Derrickson, B.H. (2009). *Principles of Anatomy and Physiology*, XII Edition, John Wiley & Sons,Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) *Vander's Human Physiology*, XI Edition., McGraw Hill
- Guyton, A.C. and Hall, J.E. (2011). T*extbook of Medical Physiology*, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). *Biochemistry*. VI Edition. W.H Freeman and Co.
- Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). *Principles of Biochemistry*. IV Edition. W.H. Freeman and Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). *Harper's Illustrated Biochemistry*. XXVIII Edition. Lange Medical Books/McGraw3Hill.

CORE COURSE IV

GENETICS AND EVOLUTIONARY BIOLOGY

CODE: ZOO-RC-4016

THEORY **(CREDITS4)**

Unit 1: Introduction toGenetics **3**

Mendel’s work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information

Unit 2: Mendelian Genetics and its Extension **8**

Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance

Unit 3: Linkage, Crossing Over and Chromosomal Mapping **9**

Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics - an alternative approach to gene mapping

Unit4: Mutations **7**

Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations,

Unit 5: Sex Determination **4**

Chromosomal mechanisms, dosage compensation

Unit 6: History of Life **2**

Major Events in History of Life

Unit 7: Introduction to Evolutionary Theories **5**

Lamarckism, Darwinism, Neo-Darwinism

Unit 8: Direct Evidences of Evolution **5**

Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

Unit 9: Processes of Evolutionary Change **9**

Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection

Unit 10: Species Concept **6**

Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)

Unit11: Macro-evolution **5**

Macro-evolutionary Principles (example: Darwin's Finches)

Unit 12: Extinction **6**

Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution

GENETICS AND EVOLUTIONARY BIOLOGY

PRACTICAL **(CREDITS2)**

1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
3. Study of Human Karyotypes (normal and abnormal).
4. Study of fossil evidences from plaster cast models and pictures
5. Study of homology and analogy from suitable specimens/pictures
6. Charts:
   a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors
   b) Darwin's Finches with diagrams/ cut outs of beaks of different species
7. Visit to Natural History Museum and submission of report

SUGGESTED READINGS

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India.
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings.
- Russell, P. J. (2009). *Genetics- A Molecular Approach.* III Edition. Benjamin Cummings.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co.
- Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H.(2007). *Evolution*.Cold Spring, Harbour Laboratory Press.
- Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
- Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.
- Douglas, J. Futuyma (1997). *Evolutionary Biology*. SinauerAssociates.

DISCIPLINE CENTRIC ELECTIVE COURSES

DSE 1
ANIMAL BIOTECHNOLOGY
CODE: ZOO-RE-5016

THEORY **(Credits 4)**

Unit 1: Introduction **8**

Concept and scope of biotechnology

Unit 2: Molecular Techniques in Gene manipulation **24**

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics)

Restriction enzymes: Nomenclature, detailed study of Type II.

Transformation techniques: Calcium chloride method and electroporation.

Construction of genomic and cDNA libraries and screening by colony and plaque hybridization

Southern, Northern and Western blotting; DNA sequencing: Sanger method

Polymerase Chain Reaction, DNA Finger Printing and DNA micro array

Unit 3: Genetically Modified Organisms **18**

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection

Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock out mice.

Production of transgenic plants: *Agrobacterium* mediated transformation.

Applications of transgenic plants: insect and herbicide resistant plants.

Unit 4: Culture Techniques and Applications **10**

Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia)

Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy

ANIMAL BIOTECHNOLOGY

PRACTICAL **(Credits 2)**

1. Genomic DNA isolation from *E.coli*

2. Restriction digestion of plasmid DNA.

3. Construction of circular and linear restriction map from the data provided.

4. Calculation of transformation efficiency from the data provided.

5. To study following techniques through photographs

   a) Southern Blotting

   b) Northern Blotting

   c) Western Blotting

   d) DNA Sequencing (Sanger's Method)

   e) PCR

   f) DNAfinger printing

6. Project report on animal cell culture

SUGGESTED READINGS

- Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNA Analysis*. II Edition, Academic Press, California,USA.
- Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.
- Griffiths, A.J.F.,J.H.Miller, Suzuki,D.T.,Lewontin,R.C.andGelbart,W.M.(2009). *An Introduction to Genetic Analysis*.IX Edition. Freeman and Co., N.Y., USA.
- Snustad, D.P. and Simmons, M.J. (2009). *Principles of Genetics.* V Edition, John Wiley and Sons Inc.
- Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). *Recombinant DNA-Genes and Genomes- A Short Course*. III Edition, Freeman and Co., N.Y.,USA.
- Beauchamp, T.I. and Childress, J.F. (2008). *Principles of Biomedical Ethics.* VI Edition, Oxford University Press.

DSE 2

APPLIED ZOOLOGY

CODE: ZOO-RE-5026

THEORY **(CREDITS 4)**

Unit 1: Introduction to Host-parasite Relationship **3**

Host,Definitive host,Intermediate host, Parasitism, Symbiosis,Commensalism, Reservoir, Zoonosis

Unit 2: Epidemiology of Diseases **7**

Transmission, Prevention and control of diseases: Tuberculosis, typhoid

Unit 3: Rickettsiae and Spirochaetes **6**

Brief account of *Rickettsia prowazekii*, *Borreliare currentis*and *Treponema pallidum*

Unit 4: Parasitic Protozoa **8**

Life history and pathogenicity of *Entamoeba histolytica*, *Plasmodium vivax* and *Trypanosoma gambiense*

Unit 5: Parasitic Helminthes **5**

Life history and pathogenicity of *Ancylostoma duodenale* and *Wuchereria bancrofti*

Unit 6: Insects of Economic Importance **8**

Biology, Control and damage caused by *Helicover paarmigera*, *Pyrillaper pusilla* and *Papiliodemoleus, Calloso bruchuschinensis, Sitophilus oryzae* and *Tribolium castaneum*

Unit 7: Insects of Medical Importance **8**

Medical importance and control of *Pediculus humanuscorporis*, *Anopheles, Culex, Aedes, Xenopsyllacheopis*

Unit 8: Animal Husbandry **5**

Preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle

Unit 9: Poultry Farming **5**

Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs

Unit 10: Fish Technology **5**

Genetic improvements in aquaculture industry; Induced breeding and transportation of fish seed

APPLIED ZOOLOGY

PRACTICAL **(CREDITS 2)**

1. Study of *Plasmodium vivax*, *Entamoeba histolytica*, *Trypanosoma gambiense*, *Ancylostoma duodenale* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens.
2. Study of arthropod vectors associated with human diseases: *Pediculus, Culex, Anopheles, Aedes* and *Xenopsylla.*
3. Study of insect damage to different plant parts/stored grains through damaged products/photographs.
4. Identifying feature and economic importance of *Helicoverpa* (*Heliothis*) *armigera*, *Papilio demoleus, Pyrilla perpusilla,Calloso bruchuschinensis, Sitophilus oryzae* and *Tribolium castaneum*
5. Visit to poultry farmor animal breeding centre. Submission of visit report
6. Maintenance of fresh water aquarium

SUGGESTED READINGS

- Park, K. (2007). *Preventive and Social Medicine*. XVI Edition. B.B Publishers.
- Arora, D. Rand Arora,B.(2001).*Medical Parasitology*.II Edition. CBS Publications and Distributors.
- Kumar and Corton. *Pathological Basis of Diseases*.
- Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia*, Kalyani Publishers.
- Dennis, H. (2009). *Agricultural Entomology.* Timber Press (OR).
- Hafez,E.S.E.(1962). *Reproduction in Farm Animals*. Lea & Fabiger Publisher
- Dunham R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approache*s. CABI publications,U.K.
- Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.

DCE 3

AQUATIC BIOLOGY

CODE: ZOO-RE-6016

THEORY **(Credits 4)**

UNIT 1: Aquatic Biomes

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes,wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

UNIT 2: Freshwater Biology

Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry,

Physico–chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.

Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-streamfishes.

UNIT 3: Marine Biology

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

UNIT 4: Management of Aquatic Resources

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills,

Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.

PRACTICAL **(Credits 2)**

1. Determine the area of a lake using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a pond/ Beel water system.
3. Determine the amount of Turbidity/transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ waterbody.
4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grabsampler) and their significance.
5. A Project Report on a visit to a Sewage treatment plant/Marine bio-reserve/Fisheries Institutes.

SUGGESTED READINGS

- **Anathakrishnan**: Bioresources Ecology 3rdEdition
- **Goldman** : Limnology, 2ndEdition
- **Odum and Barrett** : Fundamentals of Ecology, 5thEdition
- **Pawlowski**: Physicochemical Methods for Water and Wastewater Treatment, 1st Edition
- **Wetzel** : Limnology, 3rdedition
- **TrivediandGoyal**: Chemical and biological methods for water pollution studies
- **Welch** : Limnology Vols.I-II

DSE 4

INSECT, VECTORS AND DISEASES

CODE: ZOO-RE-6026

THEORY **(Credits 4)**

Unit I: Introduction to Insects **6**

General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits

Unit II: Concept of Vectors **6**

Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity

Unit III: Insects as Vectors **8**

Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera

Unit IV: Dipteran as Disease Vectors **24**

Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies;

Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes

Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; Control of Sand fly

Study of house fly as important mechanical vector, Myiasis, Control of house fly

Unit IV: Siphonaptera as Disease Vectors **6**

Fleas as important insect vectors;Host-specificity,StudyofFlea-bornediseases– Plague, Typhus fever; Control off leas

Unit V: Siphunculata as Disease Vectors **4**

Humanlouse (Head, Body and Pubiclouse) as important insect vectors; Study of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever, Vagabond’s disease, Phthiriasis; Control of humanlouse

Unit VI: Hempitera as Disease Vectors **6**

Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

INSECT VECTORS AND DISEASES

PRACTICAL **(CREDITS 2)**

1. Study of different kinds of mouth parts of insects
2. Study of following insect vectors through permanent slides/ photographs: *Aedes, Culex, Anopheles, Pediculus humanus capitis, Pediculus humanus corporis, Phithirus pubis, Xenopsyllacheopis, Cimex lectularius, Phlebotomus argentipes, Musca domestica,* through permanent slides/ photographs
3. Study of different diseases transmitted by above insect vectors

Submission of a project report on any one of the insect vectors and disease transmitted

SUGGESTED READINGS

- Imms, A.D. (1977). *A General Text Book of Entomology*. Chapman & Hall, UK
- Chapman, R.F. (1998). *The Insects: Structure and Function.* IV Edition, Cambridge University Press, UK
- PedigoL.P.(2002). *Entomology and Pest Management.*Prentice Hall Publication
- Mathews, G. (2011). *Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases*. Wiley-Blackwell

SKILL ENHANCEMENT COURSES

SEC – 1

Ornamental Fish & Fisheries

CODE: ZOO-SE-3014 **Credit-4**

1. Ornamental Fish Diversity of North East India.
2. Aquarium plant diversity in the wetland of Assam.
3. Construction and management of Home Aquarium.
4. Natural feed of Ornamental Fish
5. Strategies for maintenance of natural colour of Ornamental Fish
6. Natural Breeding of Tricogaster species
7. Health management of Ornamental Fish
8. Feed formulation of Ornamental Fish
9. Development of Biological filtration in Aquarium
10. Pure culture of planktons

<u>Practical's</u>

11. Identification of Ornamental Fish
12. Culture of Indigenous ornamental fish in Aquarium
13. Estimation of Physico-chemical characteristics of Aquarium water
14. Biological filter for removal of Ammonia from Aquarium
15. Culture of Planktons

SEC

2APICULTURE

CODE: ZOO-SE-4014

(CREDITS 4)

Unit 1: Biology of Bees
History, Classification and Biology of Honey Bees
Social Organization of Bee Colony

Unit 2: Rearing of Bees
Artificial Bee rearing (Apiary), Beehives–Newton and Langstroth
Bee Pasturage
Selection of Bee Species for Apiculture

Bee Keeping Equipment
Methods of Extraction of Honey (Indigenous and Modern)

Unit 3: Diseases and Enemies
Bee Diseases and Enemies
Control and Preventive measures

Unit 4: Bee Economy
Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis),Pollen etc

Unit5: Entrepreneurship in Apiculture
Bee Keeping Industry–Recent Efforts, Modern Methods in employing artificial Bee hives for cross pollination in horticultural gardens

SUGGESTED READINGS

- Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
- Bisht D.S., *Apiculture*, ICAR Publication.
- Singh S.,*Bee keeping in India*, Indian council of Agricultural Research, New Delhi.

SEC 3

N0N-MULBERRY SERICULTURE

CODE: ZOO-SE-5014

(CREDITS 4)

Unit 1: Introduction

Sericulture: Definition, history and present status of Mulberry and Non-Mulberry Sericulture; Silk route
Varieties of Silk; Types and distribution of non-mulberry or wild or vanyasericigenous insects in N-E India

Unit 2: Biology of Non-mulberry Silkworm:

Life cycle of silkworm- Eri and Muga
Structure of silk gland and Nature of Silk

Unit 3: Rearing of Silkworms (Eri and Muga Silkworm):

Food plants of Eri and Muga Silkworm

Rearing Operation:

Rearing house/Site and rearing appliances
Disinfectants: Formalin, bleaching powder
Rearing technology: Early age and Late age rearing
Environmental conditions in rearing-Temperature, Humidity, Light and
Air Types of mountages
Harvesting and storage of cocoons
Spinning and Reeling of silk

Unit 4: Pests and Diseases:

Pests of eri and muga silkworm
Pathogenesis oferi and muga silkworm diseases: Protozoan, viral, fungal and
bacterial Prevention and control measures of pests and diseases

Unit 5: Entrepreneurship in Non-Mulberry Sericulture:

Varieties of Non-Mulberry Silk products and economics in India
Prospectus of Non-Mulberry Sericulture in India: Non-Mulberry Sericulture industry in different states, employment generation and potential
Visit to various sericulture Govt. /Private Farm/ Centers.

SUGGESTED READINGS

- Jolly, M. S., S. K. Sen, T.N. Sonwalkar and G.K. Prashad 1979. ***Non-Mulberry Sericulture*.** *In*: Manual ofSericulture, Rome, **FAO**, 4 (29)
- Chowdhury, S.N. 1981. ***Muga Silk Industry***. Directorate of Sericulture, Govt. of Assam, Guwahati-781005, Assam.
- Chowdhury, S.N. 1982. ***Eri Silk Industry***. Directorate of Sericulture, Govt. of Assam, Guwahati-781005, Assam.
- Chowdhury, S.N. 1992. ***Silk and Sericulture***. Directorate of Sericulture and Weaving, Govt. of Assam, Guwahati-781005, Assam.

SEC

CODE: ZOO-SE-6014

Wildlife Photography and Ecotourism

CREDITS 4

Unit-I Tools and Technique of Photography **Credit-1**

- Introduction to Photography
- Still && Video Photography
- To develop expertise in Photography
- Field trips for photography in different periods (Light and Dark),seasons and places (Wetlands, Wildlife sanctuaries, National parks, Industrial sites)
- Methods of documentation

Practical

- Submission of Photography
- Preparation of Poster and Calendar

Unit-2 Eco-tourism

- Introduction of Eco-tourism
- Scope of Eco-tourism with special reference to North East region of India
- Management of Eco-tourism & hospitality
- Development of Eco-tourism with innovative Eco-restoration ideas.

Practical

- Field visit to Wildlife sanctuaries, Eco-park, Historical and religious places, Cultural museum etc.
- Preparation of report and seminar presentation