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

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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

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 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:

$$x(n) = \overset{\{1,1,1,1\}}{\uparrow} = \begin{cases} 1\ 0 \leq n \leq 3 \\ 0\ Otherwise \end{cases}$$

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,

$$x(n) = \overset{\{1,2,2,1\}}{\uparrow}$$

$$h(n) = \overset{\{1,-1,-1,1\}}{\uparrow}$$

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*

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

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* (13thed). 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.

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.

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 , Ø (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.

7

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)

9

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.(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	ENG-AE-1014			XXX-HG-1XX6 ZOO-HG-1XX6 XXX-HG-1XX6 . . . . . .
	ZOO-HC-1026				

Regular

Type	Core	AECC	SEC	DSE
Credits	12 × 6 = 72	2 × 4 = 8	4 × 4 = 16	6 × 6 = 36
Sem I	ZOO-RC-1016	ENG-AE-1014		
	YYY-RC-1016			
	ZZZ-RC-1016			

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	ENV-AE-2014			XXX-HG-2XX6 ZOO-HG-2XX6 XXX-HG-2XX6 . . . . . .
	ZOO-HC-2026				

Regular

Type	Core	AECC	SEC	DSE
Credits	12 × 6 = 72	2 × 4 = 8	4 × 4 = 16	6 × 6 = 36
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-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 3rd Edition
- **Goldman** : Limnology, 2nd Edition
- **Odum and Barrett** : Fundamentals of Ecology, 5th Edition
- **Pawlowski**: Physicochemical Methods for Water and Wastewater Treatment, 1st Edition
- **Wetzel** : Limnology, 3rd edition
- **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

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

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

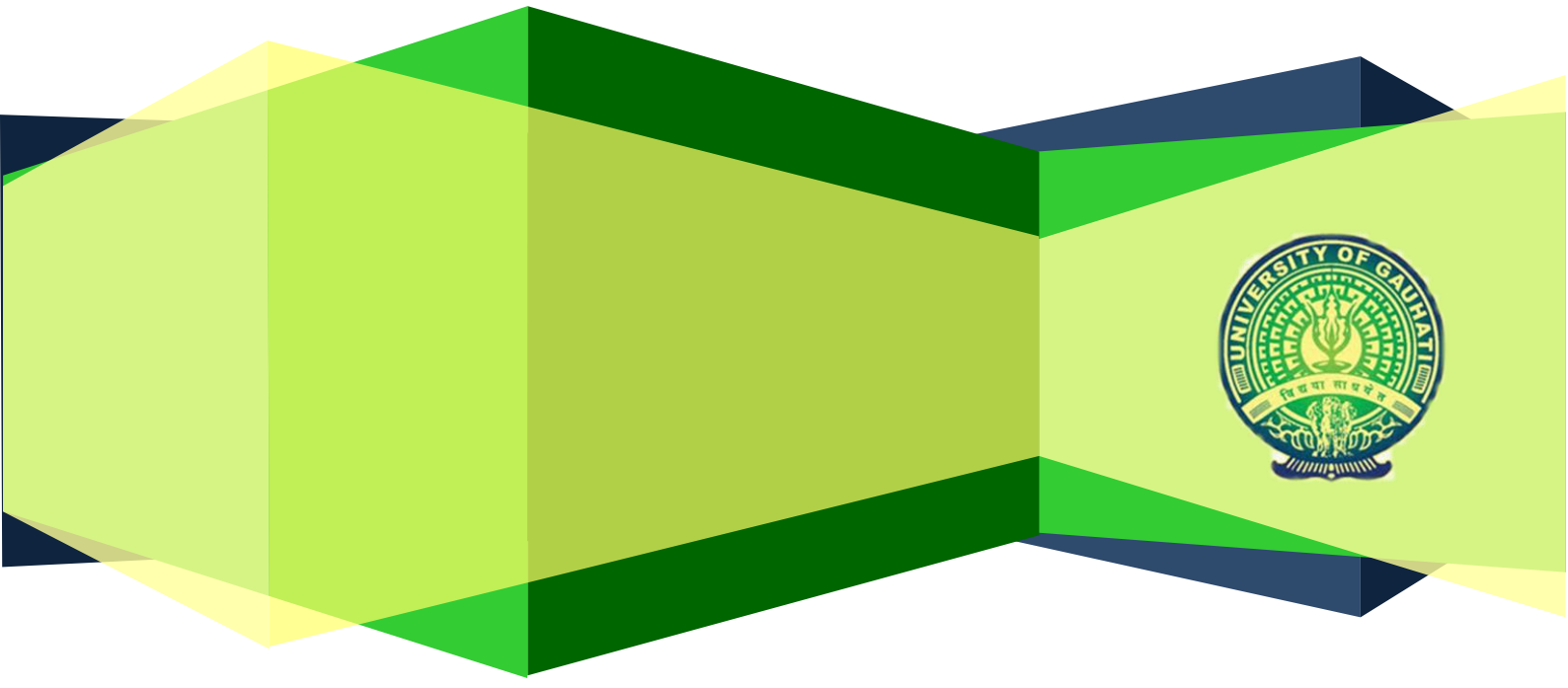
Gauhati University

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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&
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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 **Core Course Practical/ Tutorial* (12 Papers)** 04 Courses from each of the 03 disciplines of choice	12×4= 48 12×2= 24	14×5=60 12×1= 12
II. Elective Course (6 Papers) Two papers from each discipline of choice including paper of interdisciplinary nature.**)** **Elective Course Practical / Tutorials* (6 Practical / Tutorials*)** Two papers from each discipline of choice including paper of interdisciplinary nature.**)**	6×4=24 6×2=12	6×5=30 6×1=6
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) **(4 Papers of 2 credit each)**	2×4=8 4×4=16	2×4=8 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 × 6 = 72**	**2 × 4 = 8**	**4 × 4 = 16**	**6 × 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^{o}, 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.