# HIMALAYAN GARHWAL UNIVERSITY
# UTTARAKHAND

# STUDY AND EVALUATION SCHEME
# OF
# BACHELOR OF SCIENCE
# (PCM)

## Academic Session 2017-18

# Syllabus
# B.Sc. (PCM) Semester – I

| S.No. | Subject Code | Subject Name | Effetive Teaching | | | Credits | Evaluation Scheme | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | Internal Assessment | End Term | Total Marks |
| | | | Hours/Week | | | | | | |
| 1 | PCM 101 | English Communication | 2 | - | - | 2 | 30 | 70 | 100 |
| 2 | PCM 102 | Mechanics | 3 | 1 | - | 4 | 30 | 70 | 100 |
| 3 | PCM 103 | Organic Chemistry & Inorganic Chemistry | 3 | 1 | - | 4 | 30 | 70 | 100 |
| 4 | PCM 104 | Differential Calculus | 5 | 1 | - | 6 | 50 | 100 | 150 |
| 5 | PCM 152 | Mechanics–Lab | - | - | 4 | - | 20 | 30 | 50 |
| 6 | PCM 153 | Organic Chemistry & Inorganic Chemistry-Lab | - | - | 4 | - | 20 | 30 | 50 |
| **Total** | | | **13** | **3** | **8** | **20** | **180** | **370** | **550** |

# B.Sc. (PCM) Semester – II

| S.No. | Subject Code | Subject Name | Effetive Teaching | | | Credits | Evaluation Scheme | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | Internal Assessment | End Term | Total Marks |
| | | | Hours/Week | | | | | | |
| 1 | PCM 201 | Environmental Science | 2 | - | - | 2 | 30 | 70 | 100 |
| 2 | PCM 202 | Electricity, Magnetism and EMT | 3 | 1 | - | 4 | 30 | 70 | 100 |
| 3 | PCM 203 | Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I | 3 | 1 | - | 4 | 30 | 70 | 100 |
| 4 | PCM 204 | Differential Equations | 5 | 1 | - | 6 | 50 | 100 | 150 |
| 5 | PCM 252 | Electricity, Magnetism and EMT-Lab | - | - | 4 | - | 20 | 30 | 50 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6 | PCM 253 | Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I-Lab | - | - | 4 | - | 20 | 30 | 50 |
| **Total** | | | **13** | **3** | **8** | **20** | **180** | **370** | **550** |

# B.Sc. (PCM) Semester – III

| S.No. | Subject Code | Subject Name | Effetive Teaching | | | Credits | Evaluation Scheme | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | Internal Assessment | End Term | Total Marks |
| | | | Hours/Week | | | | | | |
| 1 | Elective | (Skill Enhancement Course-I) SEC-I | 2 | - | - | 2 | 30 | 70 | 100 |
| 2 | PCM 302 | Thermal Physics and Statistical Mechanics | 3 | 1 | - | 4 | 30 | 70 | 100 |
| 3 | PCM 303 | Solutions, Phase Equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-II | 3 | 1 | - | 4 | 30 | 70 | 100 |
| 4 | PCM 304 | Real Analysis | 5 | 1 | - | 6 | 50 | 100 | 150 |
| 5 | PCM 352 | Thermal Physics and Statistical Mechanics-Lab | - | - | 4 | - | 20 | 30 | 50 |
| 6 | PCM 353 | Solutions, Phase Equilibria, Conductance, Electrochemistry & Biomolecules-Lab | - | - | 4 | - | 20 | 30 | 50 |
| **Total** | | | **13** | **3** | **8** | **20** | **180** | **370** | **550** |

# B.Sc. (PCM) Semester – IV

| S.No. | Subject Code | Subject Name | Effetive Teaching | | | Credits | Evaluation Scheme | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | Internal Assessment | End Term | Total Marks |
| | | | Hours/Week | | | | | | |
| 1 | Elective | (Skill Enhancement Course-2) SEC-2 | 2 | - | - | 2 | 30 | 70 | 100 |
| 2 | PCM 402 | Waves and Optics | 3 | 1 | - | 4 | 30 | 70 | 100 |
| 3 | PCM 403 | Chemistry of s- and p- block elements, States of matter & Chemical Kinetics | 3 | 1 | - | 4 | 30 | 70 | 100 |
| 4 | PCM 404 | Algebra | 5 | 1 | - | 6 | 50 | 100 | 150 |
| 5 | PCM 452 | Waves and Optics-Lab | - | - | 4 | - | 20 | 30 | 50 |
| 6 | PCM 453 | Chemistry of s- and p- block elements, States of matter & Chemical Kinetics-Lab | - | - | 4 | - | 20 | 30 | 50 |
| **Total** | | | **13** | **3** | **8** | **20** | **180** | **370** | **550** |

# B.Sc. (PCM) Semester – V

| S.No. | Subject Code | Subject Name | Effetive Teaching | | | Credits | Evaluation Scheme | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | Internal Assessment | End Term | Total Marks |
| | | | Hours/Week | | | | | | |
| 1 | Elective | (Skill Enhancement Course-3) SEC-3 | 2 | - | - | 2 | 30 | 70 | 100 |
| 2 | Elective-1 (DSE) | Discipline Specific Elective-1 (DSE-1) | 3 | 1 | - | 4 | 30 | 70 | 100 |
| 3 | Elective-2 (DSE) | Discipline Specific Elective-2 (DSE-2) | 3 | 1 | - | 4 | 30 | 70 | 100 |
| 4 | Elective-3 (DSE) | Discipline Specific Elective-3 (DSE-3) | 5 | 1 | - | 6 | 50 | 100 | 150 |
| 5 | Elective (Lab) | Discipline Specific Elective-1 (DSE-1) Lab | - | - | 4 | - | 20 | 30 | 50 |
| 6 | Elective (Lab) | Discipline Specific Elective-2 (DSE-2) Lab | - | - | 4 | - | 20 | 30 | 50 |
| **Total** | | | **13** | **3** | **8** | **20** | **180** | **370** | **550** |

# B.Sc. (PCM) Semester – VI

| S.No. | Subject Code | Subject Name | Effetive Teaching | | | Credits | Evaluation Scheme | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | Internal Assessment | End Term | Total Marks |
| | | | Hours/Week | | | | | | |
| 1 | Elective | (Skill Enhancement Course-4) SEC-4 | 2 | - | - | 2 | 30 | 70 | 100 |
| 2 | Elective-1 (DSE) | Discipline Specific Elective-1 (DSE-1) | 3 | 1 | - | 4 | 30 | 70 | 100 |
| 3 | Elective-2 (DSE) | Discipline Specific Elective-2 (DSE-2) | 3 | 1 | - | 4 | 30 | 70 | 100 |
| 4 | Elective-3 (DSE) | Discipline Specific Elective-3 (DSE-3) | 5 | 1 | - | 6 | 50 | 100 | 150 |
| 5 | Elective (Lab) | Discipline Specific Elective-1 (DSE-1) Lab | - | - | 4 | - | 20 | 30 | 50 |
| 6 | Elective (Lab) | Discipline Specific Elective-2 (DSE-2) Lab | - | - | 4 | - | 20 | 30 | 50 |
| **Total** | | | **13** | **3** | **8** | **20** | **180** | **370** | **550** |

**Skill Enhancement Course (any four) (Credit: 02 each) - SEC 1 to SEC 4**

**<u>SEMESTER-III</u> (SEC-1: Opt any one)**

SEC 301- Physics Workshop Skills
SEC 302- Fuel
SEC 303- Integral Calculus

**<u>SEMESTER-IV</u> (SEC-2: Opt any one)**

SEC 401- Applied Optics
SEC 402- Basic Analytical Chemistry
SEC 403- Theory of Equations

**<u>SEMESTER-V</u> (SEC-3: Opt any one)**

SEC 501 — Electrical circuit network Skills
SEC 502 — Pharmaceutical Chemistry
SEC 503 — Probability and Statistics

**<u>SEMESTER-VI</u> (SEC-4: Opt any one)**

SEC 601- Basic Instrumentation Skills
SEC 602- Chemistry of Cosmetics & Perfumes
SEC 603- Graph Theory

**Discipline Specific Elective papers (Credit: 06 each) opt any three subject from Vth sem & VIth Sem :**

**SEMESTER-V**

DSE 501: Digital and Analog circuits and Instrumentation
DSE 502: Polymer Chemistry
DSE 503: Matrices
DSE 504: Solid State Physics
DSE 505: Applications of Computer in Chemistry

**SEMESTER-VI**

DSE 601: Elements of Modern Physics
DSE 602: Instrumental Methods of Chemical Analysis
DSE 603: Complex Analysis
DSE 604: Numerical Methods
DSE 605: Green Chemistry

**SEMESTER-I**

**PCM 101: English Communication (Credits 2)**

**Unit 1: Theory of communication, types and modes of communication**
Introduction. Definitions and function of communication, Need for effective communication, Process of communication, Barrier to communication, Kinds of communication: intrapersonal, personal, group and mass verbal and non—verbal communication.

**Unit 2: Listening and speaking skills**
Types of listening, developing effective listening skills, Academic listening (Lectures), Listening to talks and presentation, Monologue, dialogue, group discussion, miscommunication, interview, public speech, Pronunciation, accent and intonation and rhythm.

**Unit 3: Reading skills**
Skimming, scanning, summary, paraphrasing, comprehension.
**Introductory English Grammar**
Parts of Speech, Tenses, punctuation, Common errors in English.

**Unit 4: Writing Skills: Social and Official Correspondence**
Enquiries complaints and replies, Letters to the editor, Social appeals in the form of letter/pamphlets, Standard business Letter, Email drafting and etiquettes, preparing agenda and writing minutes for meetings

**Unit 5: Career skills**
Job application, Cover letters, Bio-data, CV and Resume and effective profiling, Mock interviews Group discussions.

**Suggested Readings:**

I. Prasad, P. The functional Aspects of Communication Skills, Delhi.
2. Scn, Ieena. Communication Skills, Prentice Hall of India, New Delhi.
3. McCarthy, MichaeL English Vocabulary in Use, Cambridge University Press.
4.Rajinder Pal and Prem Lata. English Grammar and Composition, Sultan Chand Publication

**PCM 102: Mechanics (Credits 4)**

**Unit 1: Vectors**

Vector algebra. Scalar and Vector products. Derivatives of a vector with respect to a parameter.

**Ordinary Differential Equations**: 1st order homogeneous — differential equations order homogeneous differential equations with constant coefficients.

**Unit 2: Laws of Motion**

Frames of reference Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.

**Momentum and Energy**: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

**Rotational Motion**: Angular velocity and angular momentum. Torque. Conservation of angular momentum.

**Unit 3: Gravitation**

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). Satellite in orbit and applications. Geosynchronous orbits. Weightlessness Basic idea of global positioning system (GPS)

**Unit 4: Fluids**

Surface tension: Synclastic and anticlastic surface — Excess of pressure — Application of spherical and cylindrical drops and bubbles — variation of surface tension with temperature Jaegar's method. Viscosity: Viscosity — Rate flow of liquid in a capillary tube Poiscuille's formula — Determination of coefficient of viscosity of a liquid — Variations of viscosity of a liquid with temperature lubrication.

**Elasticity**: Hooke' s law — Stress-strain diagram — Elastic moduli—Relation between classic 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, n and o by Searles method

**Unit 5:—Special Theory of Relativity**:

Constancy of speed of light. Postulates of Special theory of Relativity. Length contraction. dilation. Relativistic addition of velocities.

**Suggested Readings:**

1.University Physics. FW Sears, MW Zemansky and HD Young 13/c, 1986. Addison— Wesley
2.Mechanics Berkeley
Physics coursc,v.1 :Charles kittel, et. A1. 2007, Tata McGraw- Hill.
3. Physics Resnick, Halliday & Walker 9/e, 2010, Wiley
4. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

**PCM 103: Atomic Structure, Bonding, Gcncral Organic Chemistry & Aliphatic . Hydrocarbons (Credits 4)**

**Unit I : inorganic Chcmistry-I**

**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 $\Psi$ and $\Psi^2$ Schrodinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for I s 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 Is and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers $m_1$ 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 atornic orbitals Anomalous electronic configurations.

**Unit 2 : 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—Lande êquation for, calculation of lattice energy. Born—Haber cycle arid 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 same inorganic molecules and, ions on the basis of VSEPK and hybridization with suitable examples of linear, trigonal planar square planar. tetrahedral, trigonal bipyrarnidal 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 diatornic 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.

**Unit 3 :Organic Chemistry-I**
**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. Intermediates: Carbocations, Carbanions and free radicals.

strength of organic acids and bases: Comparalive study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Huckel's rule.

**Unit 4 : 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, Diastereomerisrn and Meso compounds). Threo and erythro; D and L; cis irons nomenclature; CIP Rules: R/S (for upto 2 chiral carbon atoms) and E/Z Nomenclature (For upto two C C systems).

**Unit 5: Aliphatic Hydrocarbons**
Functional group approach for the following reactions (preparations & reactions) to the student in context to their structure.

**Alkanes**: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolb''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) arid 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 afid dehydrohalogenation of vicinaIdihàlides. Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$. ozonolysis and oxidation with hot alk. $KMnO_4$.

**Suggested Readings**:
I . 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: Concept and Models in Inorganic Chemistry, John Wiley.
4. James S. 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 Longrnan.
7. E.L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.
8. L.L. Finar: Organic Chemistry (Vol. I & II) E. L: B. S

**PCM 104: Differential Calculus (Credits 6)**

**Unit—1**

Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz' s theorem, Partial differentiation, Euler's theorem on homogeneous functions.

**Unit-2**

Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of' curves. Parametric representation of' curves and tracing of' parametric curves, Polar coordinates and tracing of curves in polar coordinates.

**Unit-3**

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder Taylor's series, Maclaurin's series of sinx, cosx, eX, log(1+x), $(1+x)^m$, Maxima and Minima, Indeterminate forms.

**Books Recommended**

1. I. Anton, I, Bivens and S. Davis, Calculus, John Wiley and Sons, Inc., 2011.
2. G.B. Thornas and R.L.. Finney, Calculus, Pearson Education, 2007.

**PCM 152: Mechanics-Lab (Credits 2)**

1 . Measurements of length (or diameter') using vernier caliper, screw gauge and Travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity ofa Wire by Maxwell's needle.
6. To determine the Elastic Constants of a Wire by Searle's method
7. To determine g by Bar Pendulum.
8. To determine g by Kater's Pendulum.
9. To determine g and velocity for a freely falling body using Digital Timing Technique
1 0. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g

**Suggested Readings:**

1. Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1 971, Asia Publishing Hlouse.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1 985, Heinemann Educational Publishers
3. A Text Book of Practical Physics Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

**PCM 153: Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons Lab (Credits 2)**

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**

I. Detection of extra elements (N, S, Cl, Br, 1) 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.

**Suggested Readings:**

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.

## SEMESTER - II

**PCM 201: Environmental Science (Credits 2)**

**Unit - I : Introduction to Environmental Science**

Multidiscipiinary nature of Environniental Sciences; Scope and importance; Concept of sustainability and sustainable development. Ecosystems: What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains., food webs and ecological succession. Case studies of the following ecosystems: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

**Unit - 2: Natural Resources**

Renewable and Non-renewable Resources ‘ Land resources and land use change: Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, darn building on environment, forests, biodiversity and tribal populations. Water: Use and Over exploitation of surface and grounds water, flood, droughts, conflicts over water (international and interstate).Energy resources, renewable and non renewable energy resources, use of alternate energy sources, growing energy needs, case studies.

**Uuit-3 : Environmental Pollution**

Environmental pollution : types, causes, effects and controls; air; water; soil and noise pollution. Nuclear hazards and human health risks. Solid waste management. Control measures of urban and industrial waste. Pollution case studies.

**Unit-4: Environmental Policies & Practices**

Climate change, global warming, ozone Layer depletion, acid rain and impacts on human communities and agriculture Environment Laws: Environment Protection Act 1986; Air (Prevention & Control of Pollution) Act 1981; Water (Prevention and control of Pollution) Act 1974; Wildlife Protection Act 1972; Forest Conservation Act 1980. International agreements: Montreal protocol, Kyoto protocol and Convention on Biological Diversity (CBD). Nature reserves, tribal populations and tights, and human wildlife conflicts in Indian context.

**Uuit-5: Human Communities and the Environment**

Human population growth: Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies. Disaster management: floods, earthquake, cyclones and landslides. Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

**Unit-6: Field work**

Visit to an area to document environmental assets: river / Forest / flora / fauna, etc.Visit to a local polluted site-
Urban/Rural/Industrial/Agricutural. Study of common plants, insects, birds and basic principles of Identification. Study of simple ecosystems-pond, river, lake, forest patch, grassland, Delhi Ridge, etc.

**Suggested Readings:**

1. Carson, R. 2002, Silent Spring. Houghton Mifflin Harcourt.
2. Gadgil, M. & Guha, R. 1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
3, Gleeson, B. and Low, N. (eds.) 1999. Global Ethics arid Environment, London, Routledge.
4. Gleick, P. H. 1993. Water in Crisis. Pacific Institute For Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha .J,, Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.

## PCM 202: Electricity, Magnetism and EMT (Credits 4)

**Unit-1: Vector Analysis:**
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.

**Unit-2: Electrostatics:**
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 withdielectric.

**Unit-3: Magnetism:**
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 4: Electromagnetic Induction:**
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 5: Maxwell's equations and Electromagnetic wave propagation:**
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.

**Suggested Readings:**


1. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education..
2. Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
3. Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
4. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
5. D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.


*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.

## PCM 203: Chemical Energetics, Equilibria & Functional Organic Chemistry (Credits

### Physical Chemistry-I

**Unit 1: 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.

**Unit 2: Chemical Equilibrium:**

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between $\Delta G$ and $\Delta G^{o}$, Le Chatelier's principle. Relationships between $K_p$, $K_c$ and $K_x$ for reactions involving ideal gases.

**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.

### Organic Chemistry-2

**Unit 3: 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).

**Unit 4: 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.

**Unit 5**
**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.

**Suggested Readings:**


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).

## PCM 204: Differential Equations (Credits 6)

### Unit-1

First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher-degree equations solvable for x, y, p. Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order.

### Unit-2

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters. The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations.

### Unit-3

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method.

### Suggested Readings:


1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

## PCM 252: Electricity and Magnetism-Lab (Credits 2)

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:
   (i) Measurement of charge and current sensitivity
   (ii) Measurement of CDR
   (iii) Determine a high resistance by Leakage Method
   (iv) 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

### Suggested Readings:


1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

## PCM 253: Chemical Energetics, Equilibria & Functional Organic Chemistry-Lab

(Credits 2)

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 $\Delta H$.

**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.

*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

## SEMESTER-III

### PCM 302: Thermal Physics and Statistical Mechanics (Credits 4)

**Unit1:-Laws of Thermodynamics:**
Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between $C_P$ & $C_V$, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

**Unit2:-Thermodynamic Potentials:** Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for $(C_P - C_V)$, $C_P/C_V$, TdS equations.

**Unit3:-Kinetic Theory of Gases:** 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.

**Unit4:-Theory of Radiation:** 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.

**Unit5:-Statistical Mechanics:** Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Phase space - Fermi-Dirac distribution law – electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.

**Reference Books:**


- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L.Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Colle.

## PCM 303: Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II (Credits 4)

*Section A: Physical Chemistry-2*

### Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature- composition 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 acid-base).

### 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: $\Delta G$, $\Delta H$ and $\Delta S$ 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*

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.

**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.

**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 (N-terminal) and C-terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

**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.

**Reference 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 Biochemistry 7th Ed., W.H. Freeman.
10. Berg. J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman

## PCM 304: Real Analysis (Credits 6)

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test (Tests of Convergence without proof). Definition and examples of absolute and conditional convergence. Sequences and series of functions, Pointwise and uniform convergence. Mn-test, M-test.

**Books Recommended**

1. T. M. Apostol, *Calculus* (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
2. R.G. Bartle and D. R Sherbert, *Introduction to Real Analysis*, John Wiley and Sons (Asia) P. Ltd., 2000.
3. K.A. Ross, *Elementary Analysis- The Theory of Calculus Series*- Undergraduate Texts in Mathematics, Springer Verlag, 2003.

## PCM 352: Thermal Physics and Statistical Mechanics-Lab (Credits 2)

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:**


- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal, 1985, Vani Publication.

## PCM 353: Solutions, Phase Equilibrium, Conductance, Electrochemistry & Biomolecules-Lab (Credits 2)

*Section A: Physical Chemistry*

**Distribution**

Study of the equilibrium of one of the following reactions by the distribution method:

$I_2(aq) + I^-(aq) \rightleftharpoons I_3^-(aq)$

$Cu^{2+}(aq) + xNH_2(aq) \rightleftharpoons [Cu(NH_3)_x]^{2+}$

**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**

I. Determination of cell constant
II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
III. Perform the following conductometric titrations:
   i. Strong acid vs. strong base
   ii. Weak acid vs. strong base

**Potentiometry**

Perform the following potentiometric titrations:

i. Strong acid vs. strong base
ii. Weak acid vs. strong base
iii. 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. Differentiation between a reducing/nonreducing sugar.

**Reference 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.

## SEMESTER-VI

PCM 402: Waves and Optics (Credits 4)

**Unit1:-Superposition of Two Collinear Harmonic oscillations:** Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).
**Superposition of Two Perpendicular Harmonic Oscillations:** Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.

**Unit2:-Waves Motion- 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.

**Oscillations:** Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations.

**Unit3:-Sound:** 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.

**Unit4:-Wave Optics:** Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

**Interference:** Interference: 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 (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index.

**Unit5:-Michelson's Interferometer:** (1) Idea of form of fringes (no theory needed), (2) Determination of wavelength,(3) Wavelength difference,(4) Refractive index, (5) Visibility of fringes.

**Diffraction:** Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.

**Polarization:** Transverse nature of light waves. Plane polarized light - production and analysis. Circular and elliptical polarization.

**Reference Books:**


- Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill
- Principles of Optics, B.K. Mathur, ,1995, Gopal Printing .
- Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication
- UniversityPhysics.FWSears,MWZemanskyandHDYoung13/e, 1986.Addison- Wesley

## PCM 403: Chemistry of S- and P-Block Elements, States of Matter & Chemical Kinetics (Credits 4)

### General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent.

Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process.

### *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.

### Compounds of *s*- and *p*-Block Elements

Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of p- block elements.

Concept of multicentre bonding (diborane).

Structure, bonding and their important properties like oxidation/reduction, acidic/basic nature of the following compounds and their applications in industrial, organic and environmental chemistry.

Hydrides of nitrogen ($NH_3$, $N_2H_4$, $N_3H$, $NH_2OH$)Oxoacids of P, S and Cl.

Halides and oxohalides: $PCl_3$, $PCl_5$, $SOCl_2$ and $SO_2Cl_2$

***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).

**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)

**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.

**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).

**Reference Books:**


1. G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
2. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
3. J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
4. B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
5. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
6. J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
7. F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
8. D. F. Shriver and P. W. Atkins: Inorganic Chemistry, Oxford University Press.

## PCM 404: Algebra (Credits 6)

Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers under addition modulo n and the group U(n) of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity, circle group, the general linear group GLn (n,R), groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle,(iii) a rectangle, and (iv) a square, the permutation group Sym (n), Group of quaternions.

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Zn the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Zp, Q, R, and C.

**Books Recommended**


1. John B. Fralcigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa, 1999.
4. George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984.

## PCM 452: Waves and Optics-Lab (Credits 2)

1. To investigate the motion of coupled oscillators
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify $\lambda^2 - T$ Law.
3. To study Lissajous Figures
4. Familiarization with Schuster's focussing; determination of angle of prism.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
6. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a given Prism using Mercury Light
8. To determine the value of Cauchy Constants of a material of a prism.
9. To determine the Resolving Power of a Prism.
10. To determine wavelength of sodium light using Fresnel Biprism.
11. To determine wavelength of sodium light using Newton's Rings.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.
13. To determine wavelength of (1) Sodium & (2) Mercury light using plane diffraction Grating
14. To determine the Resolving Power of a Plane Diffraction Grating.
15. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.

**Reference Books:**


- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011. Kitab Mahal, New Delhi.

**PCM 453: Chemistry of S- and P-Block Elements, States of Matter & Chemical Kinetics- Lab** **(Credits 2)**

***Section A: Inorganic Chemistry***

Semi-micro qualitative analysis using H2S of mixtures- not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations : $NH^{4+}$, $Pb^{2+}$, $Ag^{+}$, $Bi^{3+}$, $Cu^{2+}$, $Cd^{2+}$, $Sn^{2+}$, $Fe^{3+}$, $Al^{3+}$, $Co^{2+}$, $Cr^{3+}$, $Ni^{2+}$, $Mn^{2+}$, $Zn^{2+}$, $Ba^{2+}$, $Sr^{2+}$, $Ca^{2+}$, $K^{+}$

Anions : $CO_3^{2-}$ , $S^{2-}$, $SO^{2-}$, $S_2O_3^{2-}$, $NO_3^{-}$, $CH_3COO^{-}$, $Cl^{-}$, $Br^{-}$, $I^{-}$, $NO_3^{-}$,$SO_4^{2-}$, $PO_4^{3-}$, $BO_3^{3-}$, $C_2O_4^{2-}$, $F^{-}$

***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:**


- A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
- A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

## Skill Enhancement Course (any four) (Credit: 02 each) - SEC 1 to SEC 4

SEMESTER-III (Opt. any one) (SEC-1)

**(Elective paper)** **SEC 301: Physics Workshop Skills** **(Credits 2)**

*The aim of this course is to enable the students to familiar and experience with various mechanical and electrical tools through hands-on mode*

**Introduction:** 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.

**Mechanical Skill:** 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.

**Electrical and Electronic Skill:** 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.

**Introduction to prime movers:** 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.

**Reference Books:**


- A text book in Electrical Technology - B L Theraja - S. Chand and Company.
- Performance and design of AC machines – M.G. Say, ELBS Edn.
- Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.
- Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edn., Editor Newnes [ISBN: 0750660732]
- New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of Ireland [ISBN: 0861674480]

**(Elective paper)** **SEC 302: Fuel** **(Credits 2)**

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.

**Reference Books:**


- E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
- P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
- B.K. Sharma: *Industrial Chemistry*. Goel Publishing House, Meerut.


**(Elective paper)** **SEC 303: Integral Calculus** **(Credits 2)**

Integration by Partial fractions, integration of rational and irrational functions. Properties of definite integrals. Reduction formulae for integrals of rational, trigonometric, exponential and logarithmic functions and of their combinations.

Areas and lengths of curves in the plane, volumes and surfaces of solids of revolution. Double and Triple integrals.

**Books Recommended**


1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd., 2002.

SEMESTER- IV (Opt. any one) (SEC-2)

**(Elective paper) SEC 401: Applied Optics** (Credits 2)

*Theory includes only qualitative explanation. Minimum five experiments should be performed covering minimum three sections.*

**(i) Sources and Detectors**

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:**

a. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.
b. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
c. To find the polarization angle of laser light using polarizer and analyzer
d. Thermal expansion of quartz using laser

**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
e. Characteristics of IR sensor

**(ii) Fourier Optics**

Concept of Spatial frequency filtering, Fourier transforming property of a thin lens

**Experiments on Fourier Optics:**

**a. Fourier optic and image processing**

1. Optical image addition/subtraction
2. Optical image differentiation
3. Fourier optical filtering
4. Construction of an optical 4f system

**b. Fourier Transform Spectroscopy**

Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science.

Experiment:

To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters. Computer simulation can also be done.

**(iii) Holography**

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:**

1. Recording and reconstructing holograms
2. Constructing a Michelson interferometer or a Fabry Perot interferometer
3. Measuring the refractive index of air
4. Constructing a Sagnac interferometer
5. Constructing a Mach-Zehnder interferometer
6. White light Hologram

**(iv) Photonics: Fibre Optics**

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
c. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern
d. To measure the near field intensity profile of a fibre and study its refractive index profile
e. To determine the power loss at a splice between two multimode fibre

**Reference Books:**


- Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.
- LASERS: Fundamentals & applications, K.Thyagrajan & A.K.Ghatak, 2010, Tata McGraw Hill
- Fibre optics through experiments,M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
- Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
- Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.
- Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.
- Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.
- Optical Physics, A.Lipson, S.G.Lipson, H.Lipson, 4th Edn., 1996, Cambridge Univ. Press


## (Elective paper) SEC 402: Basic Analytical Chemistry (Credits 2)

**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.

**Reference 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).

**(Elective paper) SEC 403: Theory of Equations (Credits 2)**

General properties of polynomials, Graphical representation of a polynomials, maximum and minimum values of a polynomials, General properties of equations, Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.

Symmetric functions, Applications symmetric function of the roots, Transformation of equations. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.

**Books Recommended**

1. W.S. Burnside and A.W. Panton, *The Theory of Equations*, Dublin University Press, 1954.
2. C. C. MacDuffee, *Theory of Equations*, John Wiley & Sons Inc., 1954.

SEMESTER-V (Opt. any one) (SEC-3)

(Elective paper) SEC 501: Electrical circuit network Skills (Credits 2)

*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*

**Basic Electricity Principles**: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter.

**Understanding Electrical Circuits**: 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. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.

**Electrical Drawing and Symbols**: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.

**Generators and Transformers**: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.

**Electric Motors**: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.

**Solid-State Devices**: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources

**Electrical Protection**: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)

**Electrical Wiring**: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.

**Reference Books:**


- A text book in Electrical Technology - B L Theraja - S Chand & Co.
- A text book of Electrical Technology - A K Theraja
- Performance and design of AC machines - M G Say ELBS Edn.

**(Elective paper) SEC 502: Pharmaceutical Chemistry (Credits 2)**

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

**Fermentation**

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol 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).

**Reference Books:**


1. G.L. Patrick: Introduction to *Medicinal Chemistry, Oxford University* Press, UK.
2. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry,* Vallabh Prakashan, Pitampura, New Delhi.
3. William O. Foye, Thomas L., Lemke , David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt. Ltd. New Delhi.


**(Elective paper) SEC 503: Probability and Statistics (Credits 2)**

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, continuous distributions: uniform, normal, exponential.

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables.

**Books Recommended:**


1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Application*, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, *Introduction to Probability Model*, 9th Ed., Academic Press, Indian Reprint, 2007.

SEMESTER-VI (Opt. any one) (SEC-4)

(Elective paper) SEC 601: Basic Instrumentation Skills (Credits 2)

**Basic of Measurement:** 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.

**Electronic Voltmeter:** 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.

**Cathode** Ray **Oscilloscope:** 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.

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.

**Signal Generators and Analysis Instruments:** 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.

**Impedance Bridges & Q-Meters:** 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.

**Digital Instruments:** Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

**Digital Multimeter:** 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

Laboratory Exercises:

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:**


- A text book in Electrical Technology - B L Theraja - S Chand and Co.
- Performance and design of AC machines - M G Say ELBS Edn.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer


## (Elective paper) SEC 602: Chemistry of Cosmetics & Perfumes (Credits 2)

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.

**Reference Books:**

- E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
- P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
- B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.

**(Elective paper) SEC 603: Graph Theory** **(Credits 2)**

Definition, examples and basic properties of graphs, pseudographs, complete graphs, bi - partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd - Warshall algorithm.

**Books Recommended:**

1. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory* 2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2003.
2. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian Sreprint, 2004.

**Discipline Specific Elective papers (Credit: 06 each) opt any three subject from Vth sem & VIth Sem :**

## SEMESTER-V

**(Elective paper) DSE 501: Digital and Analog Circuits and Instruments (Credits 4)**

**Unit-1: Digital Circuits**

Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates.

De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Minterms and Maxterms. Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

Binary Addition. Binary Subtraction using 2's Complement Method).Half Adders and Full Adders and Subtractors, 4-bit binary Adder-Subtractor.

**Unit-2: Semiconductor Devices and Amplifiers:**

Semiconductor Diodes: p and n type semiconductors. Barrier Formation in PN Junction Diode. Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode. PN junction and its characteristics. Static and Dynamic Resistance. Principle and structure of (1) LEDs (2) Photodiode (3) Solar Cell.

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains $\alpha$ and $\beta$. Relations between $\alpha$ and $\beta$. Load Line analysis of Transistors. DC Load line and Q-point. Active, Cutoff, and Saturation Regions. Voltage-Divider Bias Circuit for CE Amplifier. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Class A, B, and C Amplifiers.

**Unit-3: Operational Amplifiers (Black Box approach):**

Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop& Closed-loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and Non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Zero Crossing Detector. **(13 Lectures) Sinusoidal Oscillators:** Barkhausen's Criterion for Self-sustained Oscillations. Determination of Frequency of RC Oscillator

**Unit-4: Instrumentations:**

Introduction to CRO: Block Diagram of CRO. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. Power Supply: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency, Basic idea about capacitor filter, Zener Diode and Voltage Regulation

Timer IC: IC 555 Pin diagram and its application as Astable & Monostable Multivibrator

**Reference Books:**


- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronic devices and circuits; S. Salivahanan and N.Suresh Kumar, 2012, Tata

Mc-Graw Hill.
- Microelectronic Circuits, M.H. Rashid, 2nd Edn.,2011, Cengage Learning.
- Modern Electronic Instrumentation & Measurement Tech.,Helfrick&Cooper,1990, PHI Learning
- Digital Principles & Applications, A.P.Malvino, D.P.Leach & Saha, 7th Ed.,2011, Tata McGraw Hill
- Fundamentals of Digital Circuits, A. Anand Kumar, 2nd Edition, 2009, PHI Learning Pvt. Ltd.
- OP-AMP and Linear Digital Circuits, R.A. Gayakwad, 2000, PHI Learning Pvt. Ltd.

## DSE 551: Digital and Analog Circuits and Instruments Lab (Credits 2)

1. To measure (a) Voltage, and (b) Frequency of a periodic waveform using a CRO
2. To verify and design AND, OR, NOT and XOR gates using NAND gates.
3. To minimize a given logic circuit.
4. Half adder, Full adder and 4-bit Binary Adder.
5. Adder-Subtractor using Full Adder I.C.
6. To design an astable multivibrator of given specifications using 555 Timer.
7. To design a monostable multivibrator of given specifications using 555 Timer.
8. To study IV characteristics of PN diode, Zener and Light emitting diode
9. To study the characteristics of a Transistor in CE configuration.
10. To design a CE amplifier of a given gain (mid-gain) using voltage divider bias.
11. To design an inverting amplifier of given gain using Op-amp 741 and study its frequency response.
12. To design a non-inverting amplifier of given gain using Op-amp 741 and study its Frequency Response.
13. To study a precision Differential Amplifier of given I/O specification using Op- amp.
14. To investigate the use of an op-amp as a Differentiator
15. To design a Wien Bridge Oscillator using an op-amp.

**Reference Books:**

- Basic Electronics: A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1994, Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.

**(Elective paper) DSE 502: Polymer Chemistry (Credits 4)**

**Introduction and history of polymeric materials:**

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

**Functionality and its importance:**

Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.

**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.

**Crystallization and crystallinity:**

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

**Nature and structure of polymers**-Structure Property relationships.

**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.

**Glass transition temperature (Tg) and determination of Tg,** Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

**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.

**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)].

**Reference Books:**

- *Seymour's Polymer Chemistry,* Marcel Dekker, Inc.
- G. Odian: Principles of Polymerization, John Wiley.
- F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
- P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.

**DSE 552: Polymer Chemistry-Lab** **(Credits 2)**

**I. 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.

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.

**Reference Books:**


- Malcohm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.
- Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003)
- Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)
- Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)• Petr Munk and Tejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002)
- L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005)
- Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005)
- Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

**(Elective paper)** **DSE 503: Matrices** **(Credits 6)**

R, R2, R3 as vector spaces over R. Standard basis for each of them. Concept of Linear Independence and examples of different bases. Subspaces of R2, R3.

Translation, Dilation, Rotation, Reflection in a point, line and plane. Matrix form of basic geometric transformations. Interpretation of eigen values and eigen vectors for such transformations and eigen spaces as invariant subspaces.

Types of matrices. Rank of a matrix. Invariance of rank under elementary transformations. Reduction to normal form, Solutions of linear homogeneous and non-homogeneous equations with number of equations and unknowns upto four.

Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3. Computation of matrix inverses using elementary row operations. Rank of matrix. Solutions of a system of linear equations using matrices.

**Books Recommended**


1. A.I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.
2. S. H. Friedberg, A. L. Insel and L. E. Spence, *Linear Algebra*, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989.

**(Elective paper) DSE 504: Solid State Physics**

**Unit1:-Crystal Structure:** Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

**Unit2:-Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. $T^3$ law

**Unit3:-Magnetic Properties of Matter:** Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

**Unit4:-Dielectric Properties of Materials:** Polarization. Local Electric Field at an Atom. Depolarization Field, Electric Susceptibility, Polarizability, Clausius Mosotti Equation, Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons.

**Unit5:-Elementary band theory:** Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient.

**Superconductivity:** Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect.

**Reference Books:**


- Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, Neil W. Ashcroft and N. David Mermin, 1976, Cengage Learning
- Solid-state Physics, H.Ibach and H Luth, 2009, Springer
- Elementary Solid State Physics, I/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publication

## DSE 554: Solid State Physics-Lab (Credits 2)

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of iron using a Solenoid and determine the energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four- probe method (from room temperature to 150 $^{o}$C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

**Reference Books**


- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4$^{th}$ Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11$^{th}$ Ed., 2011, Kitab Mahal, New Delhi
- Elements of Solid State Physics, J.P. Srivastava, 2$^{nd}$ Ed., 2006, Prentice-Hall of India

**(Elective paper) DSE 505: Applications of Computers in Chemistry (Credits 4)**

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.

**Reference 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).

## DSE 555: Applications of Computers in Chemistry-Lab (Credits 2)

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.

**Reference Books:**


- McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).
- Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005).
- Steiner, E. The Chemical Maths Book Oxford University Press (1996).
- Yates, P. Chemical Calculations. 2nd Ed. CRC Press (2007).
- Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
- Noggle, J. H. *Physical Chemistry on a Microcomputer*. Little Brown & Co. (1985).
- Venit, S.M. *Programming in BASIC: Problem solving with structure and style*. Jaico Publishing House: Delhi (1996).

## SEMESTER-VI

**(Elective paper) DSE 601: Elements of Modern Physics (Credits 4)**

**Unit1**:-Planck's quantum, Planck's constant and light as a collection of photons; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson- Germer experiment. Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra.

**Unit2**:-Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.

**Unit3**:-Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wavefunction, probabilities and normalization; Probability and probability current densities in one dimension.

**Unit4**:-One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier.
Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy.

**Unit5**:-Radioactivity: stability of nucleus; Law of radioactive decay; Mean life & half-life; $\alpha$ decay; $\beta$ decay - energy released, spectrum and Pauli's prediction of neutrino; $\gamma$- ray emission.

Fission and fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions.

**Reference Books:**


- Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
- Modern Physics, John R.Taylor, Chris D.Zafiratos, Michael A.Dubson,2009, PHI Learning
- Six Ideas that Shaped Physics:Particle Behave like Waves, Thomas A. Moore, 2003, McGraw Hill
- Quantum Physics, Berkeley Physics Course Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.
- Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning

## DSE 651: Elements of Modern Physics- Lab (Credits 2)

1. To determine work function of material of filament of directly heated vacuum diode.
2. To determine value of Planck's constant using LEDs of at least 4 different colours.
3. To determine the ionization potential of mercury.
4. To determine the wavelength of H-alpha emission line of Hydrogen atom.
5. To determine the absorption lines in the rotational spectrum of Iodine vapour.
6. To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photosensor and compare with incoherent source - Na light.
7. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
8. To determine the value of e/m by magnetic focusing.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.

**Reference Books:**


- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.


## (Elective paper) DSE 602: Instrumental Methods of Chemical Analysis (Credits 4)

**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.

**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).

**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).

**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).

**NMR spectroscopy**: Principle, Instrumentation, Factors affecting chemical shift, Spin-coupling, Applications.

**Electroanalytical Methods:** Potentiometry & Voltammetry

Radiochemical Methods

**X-ray analysis and electron spectroscopy (surface analysis)**

**Reference books:**

- Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).
- Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.

- P.W. Atkins: Physical Chemistry.
- G.W. Castellan: Physical Chemistry.
- C.N. Banwell: Fundamentals of Molecular Spectroscopy.
- Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
- W.J. Moore: Physical Chemistry.

**DSE 652: Instrumental Methods of Chemical Analysis-Lab** **(Credits 2)**

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 (Y chromosome only or multiple chromosome)
19. Use of sequencing for the analysis of mitochondrial DNA20. 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.*

**Reference Books:**

- Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).
- Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.

**(Elective paper) DSE 603: Complex Analysis (Credits 6)**

Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy- Goursat theorem, Cauchy integral formula.

Liouville's theorem and Taylor and Laurent series, and its examples.

**Books Recommended**


1. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications,* 8th Ed., McGraw – Hill International Edition, 2009.
2. Joseph Bak and Donald J. Newman, *Complex analysis,* 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.


**(Elective paper) DSE 604: Complex Analysis Numerical Methods (Credits 6)**

Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method, LU decomposition, Gauss-Jacobi, Gauss-Siedel and SOR iterative methods.

Lagrange and Newton interpolation: linear and higher order, finite difference operators. Numerical differentiation: forward difference, backward difference and central Difference. Integration: trapezoidal rule, Simpson's rule, Euler's method.

**Recommended Books**


1. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 5th Ed., New age International Publisher, India, 2007.

**(Elective paper) DSE 605: Green Chemistry** (Credits 4)

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.

**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.

**Examples of Green Synthesis/ Reactions**

1. Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to Strecker synthesis), citral, ibuprofen, paracetamol, furfural.
2. Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols).
   Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation.
   Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2-dihydrotriazine derivatives; benzimidazoles.
3. Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.
4. 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.

**Future Trends in Green Chemistry**

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development.

**Reference Books:**


- V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
- P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
- A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
- M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
- M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).


**DSE 655: Green Chemistry-Lab** **(Credits 2)**

**1. Safer starting materials**

The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch.

- Effect of concentration on clock reaction
- Effect of temperature on clock reaction. (if possible)

**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.

**Reference Books:**


- Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press (1998).
- Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
- Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
- Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN 978-93-81141-55-7 (2013).
- Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*. American Chemical Society (2008).
- Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*. American Chemical Society (2008).
- Pavia, D. L. Lamponan, G. H. &Kriz, G.S. *W B Introduction to organic laboratory*

INTELLECTUAL PROPERTY RIGHT **Credits 2**

**Paper Code:-**

**The course shall comprise of the following:-**

(1) **Concept of Property vis- Intellectual Property:-** Concept of Property and Theories of Property- An Overview, Theories of Intellectual Property Rights, Social and Economic Development and Role of Intellectual Property System, Need for Protecting Intellectual Property- Policy Consideration- National Perspectives and International Demands , Types of Intellectual Property- Origin and Development – an overview, Intellectual Property Rights as Human Right.

(2) **Role of International Institutions:-** World Intellectual Property Organization (WIPO), Function of WIPO , Membership of WIPO , Agreement between the WIPO and the WTO, Dispute Settlement –New Treaties.

(3) **Copyright- National Perspective:-** Copyright:- What and Why.? Term of Copyright, Assignments and Licensing , Registration and Regulatory Authority , Procedure, Infringements and Remedies- Contractual, Civil, Criminal and Administrative, An Overview of International Perspective

(4) **Trademarks:-** Need and Emergence of Trade Mark Law, The Register and Conditions for Registration ,Procedure for and Duration of Registration , Effect of Registration, Passing-Off and infringement of Trade Mark, Assignment and Transmission, Use of Trade Mark and Registered Users, Rectification, Correction of the Register and Certification of Trademarks, Appellate Board , Offences, Penalties and Procedure.

(5) **Patent:-** Meaning of Patent –Inventions- Concept of Novelty, Inventive step and Utility- Inventions not Patentable –Process and Product, Patents- TRIPS Agreement ( Article 27) Implications to Indian Patents System, Acquisition of Patent, Right of patents and other- Term, Exclusive Marketing Right , Surrender, Licenses, Revocation, Functionaries Under the Patent Act, Infringement of Patents and Remedies.

**BOOK RECOMMENDED:-**

**Narayanan P, Law of Copy Right and Industrial Designs.**
**Narayanan P, Intellectual Property Law.**
**Copinger, Law of Copy Right. Lyenger,**
**Narayanan P., Patent Law.**
**(Dr.) Faizan Mustfa . Copy Right Law (A Comparative Study)**