1. Syllabus UG (Programme Course):

Department of Chemistry:

Odd SEM:

SEMESTER-1

GE -1 and DSC -1 :

ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Section A: Inorganic Chemistry (30 Periods)

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3pand 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, Shapes of s, p and d atomic orbitals.

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations**.** **(14 Lectures)**

Chemical Bonding and Molecular Structure:

Ionic Bonding:

General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fagan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent Bonding:

VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures invarious inorganic and organic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+ . Comparison of VB and MO approaches . **(16 Lectures)**

Section B: Organic Chemistry (30 Periods)

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. ReactiveIntermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pKa values. Aromaticity: Benzenoids and Hückel's rule. **(8 Lectures)**

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems). **(10 Lectures)**

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation)

and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$. **(12 Lectures)**

Reference Books:

- Lee, J.D. Concise Inorganic Chemistry ELBS, 1991
- Cotton, F.A., Wilkinson, G & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
- Huheey, J.E., Keiter, E.A., Keiter, R.L & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
- Graham Solomon, T.W., Fryhle, C.B & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014). McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
- Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000
- Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
- Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

PRACTICAL: GE-I and DSC-I

ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

60 Lectures

Section A: Inorganic Chemistry - Volumetric Analysis (ANY THREE)

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 (ANY THREE)

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)

2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination oftwo compounds to be given)

(a) Identify and separate the components of a given mixture of two amino acids (glycine, asparticacid, 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.

Reference Books:

- Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012
- Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J & Smith, P.W.G.,
- Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
- Mann, F.G & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

SEMESTER -3 GE-

3 and DSC-3

SOLUTIONS, PHASE EQUILIBRIA, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY-II

(Credits: Theory-04, Practicals-02)

Theory:

60 Lectures

Section A: Physical Chemistry (30 Lectures)

Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law, non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. Nernst distribution law and its applications. **(8 Lectures)**

Phase Equilibria

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. GibbsPhase Rule. Derivation of Clausius-Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component system (water). **(6 Lectures)**

Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak andstrong electrolytes. Kohlrausch law of independent migration of ions. 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). **(8 Lectures)**

Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Calculation ofthermodynamic properties (of a reversible cell): ΔG, ΔH and ΔS and equilibrium constant from EMF data. Potentiometric titrations-qualitative treatment (acid-base and oxidation-reduction only).

(8 Lectures)

Section B: Organic Chemistry (30 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Carboxylic acids and their derivatives:

Carboxylic acids (aliphatic and aromatic) Preparation: Acidic and Alkaline hydrolysis of esters. Reactions: Hell - Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (Upto 5 carbons) Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their inter conversion. Reactions: Reformatsky Reaction, Perkin condensation. **(6 Lectures)**

Amines and Diazonium Salts

Amines (Aliphatic and Aromatic): (Upto 5 carbons) Preparation: Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2

Diazonium salts: Preparation: from aromatic amines. Reactions: conversion to benzene, phenol.

(6 Lectures)

Amino Acids, Peptides and Proteins

Preparation of Amino Acids: Strecker synthesis, Gabriel's phthalimide synthesis. 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 terminaland C–terminal) (thiohydantoin and with carboxypeptidase enzyme). **(10 Lectures)**

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain andcyclic structure), Determination of absolute configuration of Glucose. Structure of disacharrides(sucrose) and polysaccharides' (starch and cellulose) excluding their structure elucidation.

(8 Lectures)

PRACTICAL: GE -3 and DSC-3 LAB

SOLUTIONS, PHASE EQUILIBRIA, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL ORGANIC CHEMISTRY

Section A: Physical Chemistry

Conductance

Perform the following conductometric titrations (Including theoretical background):

(a) Strong acid vs. strong base

(b) Weak acid vs. strong base

Potentiometry (ANY ONE)

1. Perform the following potentiometric titrations (Including theoretical background):

(i) Strong acid vs. strong base

(ii) Weak acid vs. strong base

(iii) Potassium dichromate vs. Mohr's salt

Section B: Organic Chemistry

Systematic Qualitative Organic Analysis of Organic Compounds possessing mono functionalGroups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines)

and preparation of one derivative.

(Including the study of chemical reactions involved in the detection of functional groups and preparation of their derivatives).

DSE - 1 (DSC) [Program]

INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Silicate Industries

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses).Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and

carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and thesetting process, quick setting cements. **(18 Lectures)**

Fertilizers:

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate,calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate. **(8 Lectures)**

Surface Coatings:

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying an anodizing. **(12 Lectures)**

Batteries:

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solarcell and polymer cell. **(6 Lectures)**

Alloys:

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels. **(10 Lectures)**

Catalysis:

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.

Phase transfer catalysts, application of zeolites as catalysts. **(6 Lectures)**

Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics,* Wiley Publishers, New Delhi.

- A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- P. C. Jain, M. Jain: *Engineering Chemistry,* Dhanpat Rai & Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry,* Vikas Publications, New Delhi.

SEC - 3 [DSC]

PESTICIDE CHEMISTRY

CREDIT – 2

Number of Lectures – 30

THEORY

1. General introduction to pesticides (natural and synthetic)
2. Benefits and adverse effects of pesticides
3. Changing concepts of pesticides
4. Structure activity relationship
5. Synthesis and technical manufacture and uses of representative pesticides in the followingclasses:

(a) Organochlorines (DDT, Gammaxene)

(b) Organophosphates (Malathion, Parathion)

(c) Carbamates (Carbofuran and carbaryl)

(d) Quinones (Chloranil)

(e) Anilides (Alachlor and Butachlor)

PRACTICAL (Any ONE)

2. To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
3. Preparation of simple organophosphates, phosphonates and thiophosphates
4. Any other practical deemed relevant.

Reference Book:

- Cremlyn, R. Pesticides. Preparation and Modes of Action, John Wiley & Sons, New York, 1978.

Even SEM:

GENERIC ELECTIVE& DISCIPLINE SPECIFIC CORE COURSES

GE-2 & DSC-2: SEMESTER: 2

CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL GROUP ORGANIC CHEMISTRY-I

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

SECTION-A: PHYSICAL CHEMISTRY (30 Lectures)

Chemical Energetics:

1. Review of thermodynamics and the Laws of Thermodynamics: Basic Definitions and mathematical background. First Law, Enthalpy Functions, Relation between Cp and Cv, Joule-Thomson Experiment, Inversion of Temperature, Adiabatic Changes in State, Enthalpies of Chemical Changes, Important principles and definitions of thermochemistry. Hess's Law. The Second Law, Carnot Cycle and its efficiency. Variation of enthalpy of a reaction with temperature - Kirchhoff's equation. Statement of Third Law of thermodynamics. Entropy. **(10 Lectures)**

2. Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases. **(8 Lectures)**

3. **Ionic Equilibria:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts.

Buffer solutions. Solubility and solubility product of sparingly soluble salts - applications of solubility product principle. **(12 Lectures)**

SECTION-B: ORGANIC CHEMISTRY (30 Lectures)

1. Functional group approach for the following reactions: Aromatic hydrocarbons (benzene): Preparation from phenol, by decarboxylation, from acetylene. Reactions: (benzene): Electrophilic substitution: Nitration, halogenation and sulphonation. Friedel Craft's reaction (alkylation and acylation) (Up to 4 Carbons on benzene). Side chain oxidation of alkyl benzenes (Up to 4 Carbons on benzene). **(6 Lectures)**

2. Alkyl and Aryl Halides: Alkyl Halides (Up to 5 Carbons). Types of Nucleophilic Substitution (SN1 and SN2) reactions. Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation. Williamson's ether synthesis: Elimination vs Substitution. Aryl Halides Preparation: (Chloro, bromo and iodo-benzene): from phenol, Sandmeyer & Gattermann reactions. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$). **(8 Lectures)**

3. Alcohols and Phenols and Ethers (Up to 5 Carbons): Alcohols: Preparation: Preparation of 1^o, 2^o and 3^o alcohols: using Grignard reagent, Reduction of aldehydes, ketones, carboxylic acid and esters. Reactions: HX (Lucas test), esterification, oxidation (with alk. $KMnO_4$, acidic dichromate). Oppeneaur oxidation. Diols: (Up to 6 Carbons) oxidation of diols. Pinacol Pinacolone rearrangement.

Phenols: (Phenol) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI. **(10 Lectures)**

4. Aldehydes and ketones: (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde) Preparation: from acid chlorides and nitriles. Reactions - Reaction with HCN, ROH. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Benzoin condensation, Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

(6 Lectures)

Reference Books:

- Graham Solomon, T.W., Fryhle, C.B & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
- McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
- Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
- Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
- Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
- Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
- Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
- Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

GE-2 & DSC-2 [PRACTICAL]

SECTION A: PHYSICAL CHEMISTRY

(ANY TWO)

1. Determination of heat capacity of calorimeter for different volumes.

2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

3. Measurement of pH of different solutions like aerated drinks/ fruit juices/shampoos/ soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

4. (a) Preparation of buffer solutions: (ANY ONE)

(i) Sodium acetate-acetic acid

(ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: ORGANIC CHEMISTRY

(ANY TWO)

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.

(ANY ONE)

(a) Bromination of Phenol/Aniline

(b) Benzoylation of amines/phenols

(c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

Reference Books:

- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

GE-4 & DSC-4 [SEMESTER-4]

TRANSITION METAL & COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

SECTION-A: INORGANIC CHEMISTRY (30 Lectures)

1. Transition Elements (3d series)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic properties, and ability to form complexes. stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. **(8 Lectures)**

2. Lanthanoids and actinoids:

Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only). **(4 Lectures)**

3. Coordination Chemistry

Valence Bond Theory (VBT): Inner and outer orbital complexes of Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature.

(8 Lectures)

4. Crystal Field Theory

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of Δ_o. Spectrochemical series. Comparison of CFSE for O_h and T_d complexes, Tetragonal distortion of octahedral geometry, Jahn-Teller distortion, Square planar coordination. **(10 Lectures)**

SECTION - B: PHYSICAL CHEMISTRY (30 Lectures)

1. 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). 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). **(10 Lectures)**

2. 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).

(4 Lectures)

3. 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 (qualitative treatment only). **(8 Lectures)**

3. 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 . 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. **(8 Lectures)**

Reference Books:

- Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007)
- Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
- Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998)
- Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
- Cotton, F.A. & Wilkinson, G. Basic Inorganic Chemistry, Wiley
- Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, Oxford University Press.
- Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd
- Rodgers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008

GE-4 & DSC-4: PRACTICAL

Section A: Inorganic Chemistry

(a) Semi-micro qualitative analysis (using H_2S or other methods) of mixtures - not more than **THREE ionic species** (two anions and two cations, excluding insoluble salts) out of the following:

Cations : NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, 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^-, Cl^-, Br^-, I^- , NO_3^- , SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, F^- (Spot tests should be carried out wherever feasible)

Section B: Physical Chemistry

(ANY TWO)

1. Determination of Density of a liquid.

2. (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 solution with concentration

3. (a) Determination of the coefficient of 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.

4. Chemical Kinetics

Study the kinetics of the following reactions. (ANY ONE)

(a) Acid hydrolysis of methyl acetate with hydrochloric acid

(b) Saponification of ethyl acetate.

Reference Books:

- Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
- Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand

CHEMISTRY-DSE- 4 (H) & DSE-2 (DSC): SEMESTER-6

INDUSTRIAL CHEMICALS AND ENVIRONMENT

(Credits: Theory-04, Practicals-02)

1. Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

2. Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by SO_2 , CO_2, CO, NO_x, H_2S and other foul smelling gases.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources andnature of water pollutants, Techniques for measuring water pollution,

Water purification methods. Effluent treatment plants (primary, secondary and tertiarytreatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

3. Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
- K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
- S.E. Manahan, *Environmental Chemistry*, CRC Press (2005).
- G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
- Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).

DSE-4 INDUSTRIAL CHEMICALS & ENVIRONMENT PRACTICAL or INDUSTRY/LABORATORY VISIT

(A) PRACTICAL (Any Three)

1. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).

2. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method.

3. Measurement of dissolved CO_2.

4. Study of some of the common bio-indicators of pollution.

5. Estimation of SPM in air samples.

6. Preparation of borax/ boric acid.

OR

(B) INDUSTRY/LABORATORY VISIT

(Note: Submission of Detailed Report after the Visit. Certificate of Participation to be provided to the Students.

Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
- K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

SEC- 4 (DSC): SEMESTER-6

CHEMISTRY OF COSMETICS & PERFUMES

(Credits: 2)

Theory and Hand-on Experiments

THEORY

A general study including preparation and uses of the following:

Hair dye, hair spray, shampoo, face powder, 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 sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone.

COSMETICS and PERFUMES PRACTICAL or PROJECT WORK or INDUSTRY/LABORATORY VISIT

(A) PRACTICAL (ANY TWO)

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of face cream
4. Preparation of nail polish and nail polish remover.

OR

(B) PROJECT WORK on relevant topics of COSMETICS & PERFUMES

(Note: Preparation and Submission of Project File)

OR

(C) INDUSTRY/LABORATORY VISIT

(Note: Submission of Detailed Report after the Visit. Certificate of Participation to be provided to the Students.

Reference Books:

- Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990). Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996)

Department of Physics:

Semester I

PHYSICS-DSC 1 A: MECHANICS
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. **(4 Lectures)**

Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. **(6 Lectures)**

Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. **(10 Lectures)**

Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. **(6 Lectures)**

Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum. **(5 Lectures)**

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 circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). **(8 Lectures)**

Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. **(6 Lectures)**

Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion - Torsional pendulum-Determination of Rigidity modulus and moment of inertia - q, η and $\sigma$by Searles method **(8 Lectures)**

Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities. **(7 Lectures)**

PHYSICS LAB: DSC 1A LAB: MECHANICS

60 Lectures

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 of a 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
10. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g

semester- II

PHYSICS-DSC 2A: ELECTRICITY AND MAGNETISM

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Vector Analysis: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only). **(12 Lectures)**

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 with dielectric.

(22 Lectures)

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.

(10 Lectures)

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. **(6 Lectures)**

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. **(10 Lectures)**

PHYSICS LAB- DSC 2A LAB: ELECTRICITY AND MAGNETISM

60 Lectures

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

Semester III

PHYSICS-DSC 3A: THERMAL PHYSICS AND STATISTICAL MECHANICS

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

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. **(22 Lectures)**

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. **(10 Lectures)**

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. **(10 Lectures)**

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. **(6 Lectures)**

Statistical Mechanics: Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics. **(12 Lectures)**

PHYSICS LAB-DSC 3A LAB: THERMAL PHYSICS AND STATISTICAL MECHANICS

60 Lectures

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

semester- IV

PHYSICS-DSC 4A: WAVES AND OPTICS
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

Superposition of Two Collinear Harmonic oscillations: Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). **(4 Lectures)**

Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. **(2 Lectures)**

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. **(7 Lectures)**

Fluids: Surface Tension: Synclastic and anticlastic surface - Excess of pressure - Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature - Jaegar's method. Viscosity: Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of a liquid with temperature lubrication. Physics of low pressure - production and measurement of low pressure - Rotary pump - Diffusion pump - Molecular pump - Knudsen absolute gauge - penning and pirani gauge – Detection of leakage. **(6 Lectures)**

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. **(6 Lectures)**

Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. **(3 Lectures)**

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. **(10 Lectures)**

Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index and Visibility of fringes. **(3 Lectures)**

14

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. **(14 Lectures)**

Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization. **(5 Lectures)**

PHYSICS LAB-DSC 4A LAB: WAVES AND OPTICS

60 Lectures

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 λ^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) spectrum of 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.

semester-v

PHYSICS-DSE: Nuclear & Particle Physics

(Credits: Theory-05, Tutorials-01)
Theory: 75 Lectures

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about size, mass, charge density (matter energy), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states. **(10 Lectures)**

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of various terms, condition of nuclear stability. Two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force. **(12 Lectures)**

Radioactivity decay:(a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. **(10 Lectures)**

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, resonance reaction, Coulomb scattering (Rutherford scattering). **(8 Lectures)**

Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation, Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter. **(8 Lectures)**

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation

Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si & Ge) for charge particle and photon detection (concept of charge carrier and mobility). **(8 Lectures)**

Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons. **(5 Lectures)**

Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons. **(14 Lectures)**

semester- VI

PHYSICS-DSE: QUANTUM MECHANICS
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and

Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.

(6 Lectures)

Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to the spread of Gaussian wavepacket for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle.

(10 Lectures)

General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method.

(12 Lectures)

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for the second order partial differential equation; angular momentum operator and quantum numbers; Radial wavefunctions from Frobenius method; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells (idea only) **(10 Lectures)**

Atoms in Electric and Magnetic Fields:- Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

(8 Lectures)

Atoms in External Magnetic Fields:- Normal and Anomalous Zeeman Effect.

(4 Lectures)

Many electron atoms:- Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. Spin-orbit coupling in atoms-L-S and J-J couplings.

(10 Lectures)

PRACTICAL-DSE LAB: QUANTUM MECHANICS

60 Lectures

Use C/C^{++}/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

   $$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E] \text{ where } V(r) = -\frac{e^2}{r}$$

   Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m = $0.511x10^6 eV/c^2$.

2. Solve the s-wave radial Schrodinger equation for an atom:

   $$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

   Where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

   $$V(r) = -\frac{e^2}{r}e^{-r/a}$$

   Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 $(eVÅ)^{1/2}$, m = $0.511x10^6 eV/c^2$, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

   $$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

   For the anharmonic oscillator potential

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$$

for the ground state energy (in MeV) of the particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3} In these units, ch = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2\mu}{\hbar^2}[V(r) - E]$$

where μ is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D\left(e^{-2\alpha r'} - e^{-\alpha r'}\right), \qquad r' = \frac{r - r_o}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.
Take: m = 940x10^6eV/C^2, D = 0.755501 eV, α = 1.44, r_o = 0.131349 Å

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
7. To study the quantum tunnelling effect with solid state device, e.g. tunnelling current in backward diode or tunnel diode.

Department of Mathematics:

Semester 1					
Course Name	Calculus and Geometry			**Total Credit**	5+1=6
Subject Course No.	MATP 11 DSC	**Discipline Specific Core**	DSC Paper 1	**Total Marks**	60+10+5=75

CALCULUS AND GEOMETRY

Unit 1 : Calculus

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to the problems of the type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n \sin x$, $(ax+b)^n \cos x$. L'Hospital's rule and it's applications. Concept of plane, simple and closed curves, parameterizing a curve. Pedal equation, envelopes, evolute, asymptotes, radius of curvature, curve tracing in Cartesian and polar coordinates of standard curves. Concavity, convexity, cusps and inflection points.

Unit 2

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int sin^n x\, dx, \int \cos^n x\, dx, \int \sec^n x\, dx, \int \tan^n x\, dx, \int (logx)^n\, dx, \int \sin nx\ cos\, mx\, dx$ etc. Arc length of a curve, arc length of parametric curves, area enclosed by a curve, area between two curves, area and volume of revolution.

Unit 3 : Geometry

2D: Reflection properties of conics, rotation of axes and second degree equations, classification of conics using the discriminant, polar equations of conics.

Unit 4

3D: Spheres, cylindrical surfaces, central conicoids, paraboloids, hyperboloids, plane sections of conicoids, generating lines, classification of quadrics.

Semester 2					
Course Name	Real Analysis			**Total Credit**	5+1=6
Subject Course No.	MATP 21 DSC	**Discipline Specific Core**	DSC Paper 2	**Total Marks**	60+10+5=75

REAL ANALYSIS

Unit 1

Review of Algebraic and order properties of $\mathbb{R}$, ε-neighborhood of a point in $\mathbb{R}$. Idea of countable sets, uncountable sets and uncountability of $\mathbb{R}$. Bounded above sets, bounded below sets, bounded sets, unbounded sets. Suprema and infima. Completeness property of $\mathbb{R}$ and its equivalent properties. Archimedean property, density of rational (and irrational) numbers in $\mathbb{R}$, intervals. Limit points of a set, isolated points, open set, closed set, derived set, illustrations of Bolzano-Weierstrass theorem for sets, compact sets in $\mathbb{R}$, Heine-Boreal Theorem.

Unit 2

Sequences: Sequence, bounded sequence, convergent sequence, limit of a sequence, lim inf, lim sup. Limit theorems. Monotone sequences, monotone convergence theorem. Subsequences, divergence criteria. Monotone subsequence theorem (statement only), Bolzano Weierstrass theorem for sequences. Cauchy sequence, Cauchy's convergence criterion.

Unit 3

Series: Infinite series, convergence and divergence of infinite series, Cauchy criterion. Tests for convergence: Comparison test, limit comparison test, ratio test, Cauchy's nth root test, integral test. Alternating series, Leibniz test. Absolute and conditional convergence.

Semester 3					
Course Name	Algebra			**Total Credit**	5+1=6
Subject Course No.	MATP 31 DSC	**Discipline Specific Core**	DSC Paper 3	**Total Marks**	60+10+5=75

ALGEBRA

Unit 1

Complex numbers: Polar representation, De Moivre's theorem for rational indices and its applications. Trigonometric, logarithm, exponential and hyperbolic functions of complex variable.

Theory of equations: Fundamental theorem of Classical Algebra (statement only), relation between roots and coefficients, symmetric functions of roots, transformation of equation, Descartes' rule of signs, Sturms' theorem, cubic equation (Cardan's method), biquadratic equation (Ferrari's method), graphical representation of a polynomial.

Inequality: $AM \geq GM \geq HM$, theorem of weighted means and m-th power theorem (statement only), Cauchy-Schwartz inequality (statements only) and its application.

Unit 2

Equivalence relations, partition, partially ordered relation, functions, composition of functions, permutations, even and odd permutations, invertible functions.

Well-ordering property of positive integers, principles of mathematical induction, division algorithm, divisibility and Euclidean algorithm, congruence relation between integers, Fundamental Theorem of

Arithmetic (statement only), solution of linear congruence equations.

Unit 3

Matrices: Inverse of a matrix, characterizations of invertible matrices, elementary operations and matrices, echelon matrix, row/column reduced echelon matrix, rank of matrix, normal forms, equivalency and congruency of matrices. Eigen values and eigen vectors of a square matrix, characteristic equation of a matrix, Cayley-Hamilton theorem and its use in finding the inverse of a matrix.

Unit 4

Systems of linear equations: Consistency, the matrix equation $AX = B$ of a system of linear equations, solution sets of linear systems, solution of linear systems using row reduced form.

Semester 3					
Course Name	Logic and Sets			**Total Credit**	2
Subject Course No.	MATP 33 SEC	**Skill Enhancement Courses**	SEC SEM 3 Paper 1	**Total Marks**	60+10+5=75

LOGIC AND SETS

Unit 1 : Logic

Introduction, propositions, truth table, logical connectives: Negation, conjunction, disjunction, implications. Biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, quantifiers, binding variables and negations.

Unit 2 : Sets

The natural number sequence, Proof and definition by induction, cardinal numbers, countable sets, cardinal arithmetic, order types, well-ordered sets and ordinal numbers, the axiom of choice, the well-ordering theorem, and Zorn's lemma, further properties of cardinal numbers, Some theorems equivalent to the axiom of choice.

OR

Semester 3					
Course Name	Graph Theory			**Total Credit**	2
Subject Course No.	MATP 33 SEC	**Skill Enhancement Courses**	SEC SEM 3 Paper 1	**Total Marks**	60+10+5=75

GRAPH THEORY

Unit 1

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bipartite graphs, isomorphism of graphs. Trees and forests, paths and cycles.

Unit 2

Eulerian circuits, Eulerian graph, semi-Eulerian graph, theorems, Hamiltonian cycles, theorems Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph.

Unit 3

Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm.

Semester 4					
Course Name	Differential Equation and Vector Calculus			**Total Credit**	5+1=6
Subject Course No.	MATP 41 DSC	**Skill Enhancement Courses**	DSC Paper 4	**Total Marks**	60+10+5=75

DIFFERENTIAL EQUATION AND VECTOR CALCULUS

Unit 1 : Differential Equation

Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.

General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.

Unit 2

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients. Basic theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.

Unit 3

Lipschitz condition and Picard's Theorem (Statement only). Equilibrium points, Interpretation of the phase plane.

Unit 4 : Vector Calculus

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions.

Semester 4					
Course Name	Theory of Equations			**Total Credit**	2
Subject Course No.	MATP 43 SEC	**Skill Enhancement Courses**	SEC SEM 4 Paper 2	**Total Marks**	60+10+5=75

THEORY OF EQUATIONS

Unit 1

General properties of polynomials, Graphical representation of a polynomial, 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.

Unit 2

Symmetric functions. Applications of 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, Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations.

Unit 3

Separation of the roots of equations, Strums theorem. Applications of Strum's theorem, conditions for reality of the roots of an equation. Solution of numerical equations.

OR

Semester 4					
Course Name	C Programming Language			**Total Credit**	2
Subject Course No.	MATP 43 SEC	**Skill Enhancement Courses**	SEC SEM 4 Paper 2	**Total Marks**	60+10+5=75

C PROGRAMMING LANGUAGE

Unit 1

An overview of history of computers and architecture of computer. Concept of compiler, assembler, machine language, high level language, object-oriented language, programming language and importance of C programming.

Unit 2

Characters, Constants and variables data types. Expression, statements, declaration. Operators: Arithmetic operators, increment and decrement operators, relational operators, logical operators, assignment operators, conditional operators.

Unit 3

Conditional control statements: If, if-else, nested if-else statements. Switch, break and continue statements. Loop control statements: For, while and do-while statements.

Unit 4

Arrays, One-dimension, two-dimension and multidimensional arrays, declaration and type of arrays. Reading and displaying elements of arrays.

User-defined Functions: Function Prototype, Definition of functions, Type of functions, local and global variables in a function, type of return values, function declaration, nesting of functions, main ( ) function, recurrence of function. Library functions, e.g. stdio.h, math.h, string.h, stdlib.h, etc. No arguments and no return values, arguments but no return values, arguments with return values, no arguments but returns a value.

Semester 5					
Course Name	Numerical Methods			**Total Credit**	4
Subject Course No.	MATP 52 DSE	**Core Course**	DSE Paper 1	**Total Marks**	40+10+5=55

NUMERICAL METHODS

Unit 1

Algorithms. Convergence. Errors: Absolute, relative, percentage, inherent, round off, truncation errors. Significant figures, approximate number. Operators: Δ, ∇, μ, E, δ.

Unit 2

Transcendental and polynomial equations: Bisection method, secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method for simple and multiple roots. Rate of convergence and conditions of convergence of these methods.

Unit 3

System of linear algebraic equations: Gaussian elimination, Gauss Jordan methods, Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

Unit 4

Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation. Numerical differentiation: Methods based on interpolations methods based on finite differences.

Unit 5

Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, Weddle's rule, Composite trapezoidal rule, composite Simpson's 1/3rd rule.

Unit 6

Ordinary differential equations: The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of order 2 (for order 4 statement only).

Semester 5					
Course Name	Numerical Methods LAB			**Total Credit**	2
Subject Course No.	MATP 52 DSE	**Core Course**	DSE Paper 1	**Total Marks**	20

NUMERICAL METHODS LAB
(PRACTICAL)

1. Solution of transcendental and algebraic equations by
   a) Bisection method
   b) Newton Raphson method (for simple root).
   c) Regula-Falsi method.
2. Interpolation
   a) Lagrange Interpolation
   b) Newton Forward Interpolation
   c) Newton Backward Interpolation
3. Numerical Integration by
   a) Trapezoidal Rule

b) Simpson's one third rule

4. Solution of ordinary differential equations by

a) Euler method

b) Runge-Kutta method (4^{th} order only)

OR

Semester 5					
Course Name	Group Theory and Linear Algebra			**Total Credit**	5+1=6
Subject Course No.	MATP 52 DSE	**Discipline Specific Electives**	DSE Paper 1	**Total Marks**	60+10+5=75

GROUP THEORY AND LINEAR ALGEBRA

Unit 1 : **Group Theory**

Groupoid, semigroup, monoid, groups, commutative groups, elementary properties of groups, finite semigroup with cancellation properties is a group, semigroup containing unique solution of $ax = b$ and $xa = b$ is a group. Particularly, $\mathbb{Z}_n$ group, U_n group, Klein's 4 group, symmetric group S_n, alternating group A_n, matrix group $M_n(R)$, multiplicative group of n-th roots of unity, Dihedral group, quaternion group (through matrices) etc.

Unit 2

Subgroups and examples of subgroups, necessary and sufficient conditions for a subset of a group to be a subgroup, union and intersection of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

Unit 3

Order of an element and a group. Generators, cyclic group and its properties, necessary and sufficient condition. Cosets, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

Unit 4 : Linear Algebra

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension of a vector space, dimension of subspaces.

Unit 4

Linear transformations, null space, range space, rank and nullity of a linear transformation, matrix representation of a linear transformation relative to ordered bases, algebra of linear transformations, correspondence between LTs and matrices. Isomorphisms.

Semester 5					
Course Name	Theory of Probability			**Total Credit**	2
Subject Course No.	MATP 53 SEC	**Skill Enhancement Courses**	SEC SEM 5 Paper 1	**Total Marks**	60+10+5=75

THEORY OF PROBABILITY

Unit 1

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 distribution. Continuous distributions: uniform, normal, exponential distribution.

Unit 2

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, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.

Unit 3

Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers. Central limit theorem for independent and identically distributed random variables with finite variance.

OR

Semester 5					
Course Name	Differential Geometry			**Total Credit**	2
Subject Course No.	MATP 53 SEC	**Skill Enhancement Courses**	SEC SEM 5 Paper 1	**Total Marks**	60+10+5=75

DIFFERENTIAL GEOMETRY

Unit 1

Theory of curves: Parametrization and reparametrization of curves, plane curves, space curves, regular curves, curvature, torsion and relation between curvature and torsion, Serret-Frenet formula. Osculating plane, osculating circles and osculating spheres. Evolutes and involutes of curves.

Unit 2

Theory of surfaces: Regular surfaces, tangent plane, First and second Fundamental forms. Principal and Gaussian curvatures. Rodrigue's formula. Conjugate and asymptotic lines.

Unit 3

Developable: Developable associated with space curves and curves on surfaces, minimal surfaces, canonical geodesic equations.

Semester 6					
Course Name	Metric Spaces and Complex Analysis			**Total Credit**	5+1=6
Subject Course No.	MATP 62 DSE	**Discipline Specific Electives**	DSE Paper 2	**Total Marks**	60+10+5=75

METRIC SPACES AND COMPLEX ANALYSIS

Unit 1 : Metric Spaces

Metric spaces: Definition and examples. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, subspaces, dense sets, separable spaces. Sequences in metric spaces, Cauchy sequences. Complete metric spaces, Cantor's theorem.

Unit 2 : Complex Analysis

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.

Unit 3

Analytic functions, examples of analytic functions. Derivatives of functions and definite integrals of functions. Contours, Contour integrals and its examples. Upper bounds for moduli of contour integrals. Cauchy- Goursat theorem, Cauchy integral formula.

Unit 4

Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples.

OR

Semester 6					
Course Name	Linear Programming			**Total Credit**	5+1=6
Subject Course No.	MATP 62 DSE	**Discipline Specific Electives**	DSE Paper 2	**Total Marks**	60+10+5=75

LINEAR PROGRAMMING

Unit 1

Introduction to linear programming problem (LPP), Problem formation, Type of solutions: Basic solution (BS), feasible solution (FS), basic feasible solution (BFS), degenerate and non-degenerate BFS. Matrix notation of LPP, graphical solution of LPP.

Unit 2

Theory of simplex method, convex sets, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables. Two-phase method, Big-M method and their comparison.

Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

Unit 3

Transportation and assignment problems: Mathematical formulation. North-west corner method, least cost method and Vogel approximation method for determination of solution of transportation problem. Algorithm for solving transportation problem. Hungarian method for solving assignment problem.

Unit 4

Game theory: Formulation of two-person zero sum games, solving two-person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

Semester 6					
Course Name	Mechanics			**Total Credit**	2
Subject Course No.	MATP 63 SEC	**Skill Enhancement Courses**	SEC SEM 6 Paper 2	**Total Marks**	60+10+5=75

MECHANICS

Unit 1

Co-planar forces. Astatic equilibrium. Friction. Equilibrium of a particle on a rough curve. Virtual work. Forces in three dimensions. General conditions of equilibrium. Centre of gravity for different bodies. Stable and unstable equilibrium.

Unit 2

Equations of motion referred to a set of rotating axes. Motion of a projectile in a resisting medium. Stability of nearly circular orbits. Motion under the inverse square law. Slightly disturbed orbits. Motion of artificial satellites. Motion of a particle in three dimensions. Motion on a smooth sphere, cone and on any surface of revolution.

Unit 3

Degrees of freedom. Moments and products of inertia. Momental Ellipsoid. Principal axes. D'Alembert's principle. Motion about a fixed axis. Compound pendulum. Motion of a rigid body in two dimensions under finite and impulsive forces. Conservation of momentum and energy.

OR

Semester 6					
Course Name	Boolean Algebra and Automata Theory			**Total Credit**	2
Subject Course No.	MATP 63 SEC	**Skill Enhancement Courses**	SEC SEM 6 Paper 2	**Total Marks**	60+10+5=75

BOOLEAN ALGEBRA AND AUTOMATA THEORY

Unit 1 : Boolean Algebra

Lattice: Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms. Definition, examples and properties of modular and distributive lattices.

Unit 2

Boolean algebra: Definition of Boolean algebra, Boolean polynomials, minimal and maximal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams. Logic gates, switching circuits and applications of switching circuits.

Unit 3 : Automata Theory

Introduction: Alphabets, strings and languages. Finite automata and regular languages: deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages.