THE NEW COLLEGE (AUTONOMOUS) CHENNAI 600014

B.Sc. DEGREE BRANCH – IV CHEMISTRY

CBCS Pattern SYLLABUS (Effective from 2017-2018)

GENERAL CHEMISTRY- I (SEMESTER- I)

Core: 1 **TEACHING HOURS: 75**

Code: 17BEM101 **CREDITS : 5**

OBJECTIVES OF THE COURSE:

- To acquit the students with concepts of atomic structure and periodicity.
- To provide them knowledge of basic concept of organic chemistry and to learn about alkanes and alkenes.
- To enable them sound in science of thermodynamics.

UNIT – I Atomic structure and Periodicity (15 hours)

1.1 **Atomic structure**

Bohr Theory, Sommerfield theory, Quantum numbers and their significance. Aufbau principle, Hund's rule, Pauli's exclusion principle and electronic configuration of elements. Stability of half-filled and completely filled orbitals.

1.2 **Periodicity of properties**

Definition, periodicity and factors affecting the following properties – atomic radii, ionic radii, ionization energy, electron affinity and electronegativity. Diagonal relationship with example.

UNIT – II Basic concepts of bonding in organic chemistry (15 hours)

2.1 ***Hybridization and geometry of molecules***: methane, ethylene, acetylene and benzene. ***Electron displacement effects***: definition of inductive, mesomeric and hyper conjugation – with examples.

2.2 ***Cleavage of bonds****:* homolytic fission and heterolytic fission of carbon-carbon bond.

2.3 ***Reaction intermediates****:* carbocations, carboanions and free radicals – their relative stabilities

UNIT – III Alkanes and alkenes (15 hours)

3.1 **Alkanes:** Nomenclature, isomerism and preparation (with special reference to Grignard, Wurtz, and Kolbe's reaction). Halogenation, of alkanes- reaction and mechanism.

3.2 **Alkenes**: Nomenclature, isomerism (*cis* and *trans*), preparation (includes dehydrohalogenation, dehydration), Hoffmann and Saytzeff rules. Properties - ***Electrophilic addition*** - addition of hydrogen, halogens, hydrogen halides (Markownikoff's rule). ***Oxidation***-ozonolysis, hydroxylation. ***Free radical addition*** - Anti- Markownikoff's rule (peroxide effect).

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UNIT –IV Thermodynamics (15 Hours)

4.1 **Thermodynamics**: Intensive and extensive properties. Types of systems: open, closed & isolated system.

Thermodynamics processes: cyclic, reversible, irreversible, isothermal, isobaric, isochoric and adiabatic processes.

4.2 **Thermodynamic functions:** state and path functions–Zeroth law of thermodynamics – concept of heat and work.

4.3 ***First Law of thermodynamics***: statement and equation. Definition and relation between internal energy and enthalpy.

Heat capacity: Relationship between $\mathbf{C_p}$ and $\mathbf{C_v}$. **C**alculation of W, E and H for the expansion of ideal gases under reversible, isothermal and adiabatic conditions.

UNIT – V (15 Hours)

5.1 **Gaseous state** Statement of Gaseous laws: Boyle's law, Charles law, Avogadro's law, Graham's law of Diffusion, Dalton's law of partial pressures – Ideal gas equation –Kinetic theory of gases- derivation of kinetic gas equation - deviation from ideal behaviour – Boyle's temperature - Van der Waal's equation – volume and pressure corrections – Van der Waal's constant and significance –Critical phenomena –P-V isotherms of CO_2 – derivation of Critical constants from Van der Waal's constants.

5.2 **Liquefaction of gases:**

Joule's law, Joule-Thompson effect; Joule-Thompson coefficient–inversion temperature and its significance. Most probable, average and root mean square velocity, collision diameter, collision frequency, collision number- mean free path (definition only).

ALLIED PAPER – I

Subject	Code
Allied: Mathematics – I *(for B.Sc. Physics, Chemistry, Computer science)*	

YEAR	SEMESTER	CREDITS	LECTURE HOURS
I	I	4	135

Objective:

- ✓ *To introduce basics in mathematics and to improve analytical skills*

Unit I : Algebra

Partial fractions(only rules), binomial, exponential and logarithmic series (without proof) Summation – simple problems.

Unit II : Theory of equations

Polynomial equations with real coefficients, irrational roots, complex roots transformation of equation by increasing or decreasing roots by constants, reciprocal equations – simple problems.

Unit III : Matrices

Symmetric, skew-symmetric orthogonal and unitary matrices, rank of a matrix, Eigen roots and Eigen vectors Cayley Hamilton theorem (without proof) verification and computation of inverse of the matrix.

Unit IV : Finite Difference

Operators definitions only difference tables, Newton's forward and backward interpolation formulae Lagrange's interpolation formulae.

Trigonometry

Expansions of $\sin n\theta$, $\cos n\theta$ in terms of powers of sine and cosine. –
Expansions of $\sin^n\theta$, $\cos^n\theta$ in terms of multiple angles of sine and cosines.

Unit V : Differential Calculus

n^{th} derivatives, Lebnitz theorem (without proof) and applications - Curvature and radius of curvature in Cartesian co-ordinates - maxima and minima of functions of two variables.

Recommended Text book for Study:-

1. Allied mathematics, A. Abdul Rasheesd (2006), Vijay Nicole Pvt.Ltd,Chennai.
2. Allied Mathematics, P. R.Vittal (2003), Margham Publications, Chennai.

THE NEW COLLEGE (AUTONOMOUS) CHENNAI 600014

B.Sc. DEGREE BRANCH – IV CHEMISTRY

CBCS Pattern SYLLABUS (Effective from 2017-2018)

GENERAL CHEMISTRY- II (SEMESTER- II)

Core: 2 **TEACHING HOURS: 75**

Code: 17BEM202 **CREDITS: 5**

OBJECTIVES OF THE COURSE:

- To acquit the students with concepts of chemical bonding and applications of VSEPR and MO theories.
- To know about hydrogen and theories of acid and bases.
- To provide them knowledge on chemistry of alkynes, polymerization and aromatic compounds.
- To enable them sound in science of thermodynamics.

UNIT: I Covalent and ionic bond **(15 hours)**

1.1 *Valence bond theory*. ***VSEPR theory***: Geometries of H_2O, NH_3, CIF_3, PCI_5 BF_3 and SF_6 molecules. – Electronegativity and percentage ionic character.

1.3 ***Molecular orbital theory*:** LCAO method- Bonding and anti-bonding orbitals - bond order, MO diagrams. MO treatment for H_2, He_2, N_2, O_2 and CO. Comparison of VB and MO theories.

1.4 **Ionic bond:**

Formation, Factors influencing the formation of ionic bond - Radius-ratio rule – ***lattice energy***: definition and applications. Born-Haber cycle and Fajan's rule.

UNIT: II **(15 hours)**

2.1 **Intermolecular forces:** Kesom forces, Debye forces, London forces and hydrogen bonding – definition and application.

2.2 **Theories of acids and bases:** Arrhenius theory, Bronsted-Lowry theory and Lewis theory. Pauling rules.

2.3 **Hydrogen:** preparation and properties of hydrogen. **Hydrides:** Preparation and properties of ionic, covalent, and metallic hydrides.

UNIT: III **(15 hours)**

3.1 **Alkynes:** Nomenclature, preparation, and physical properties of alkynes.

Chemical properties: acidity of alkynes, formation of acetylides, addition of water with $HgSO_4$ catalyst, addition of hydrogen halides, halogens, oxidation, ozonolysis.

3.2 **Dienes:** Classification – conjugated, isolated and cumulative dienes - Nomenclature, isomerism and stability.

Preparation and properties of dienes: 1, 3–butadiene, isoprene & chloroprene, 1, 2 and 1, 4 additions - Diels - Alder reaction

3.3 **Polymerization:** monomer, oligomer, copolymer, and polymer - types of polymers: natural and synthetic polymers – thermosetting and thermoplastics - polythene, PVC, nylon 66.

UNIT IV **(15 hours)**

4.1 **Aromatic hydrocarbons and aromaticity:** Resonance in benzene. Aromaticity- Huckel's rule - (4n+2) system and its simple applications.

4.2 Electrophilic substitution reactions in aromatic compounds. General mechanisms – nitration, halogenation, sulphonation, Friedal-Craft's alkylation and acylation.

Effect of substituent – Activation, deactivation, ortho- para- directors and meta-directors. Ortho effect.

4.3 **Polynuclear hydrocarbons:** Napthalene and anthracene –isolation, synthesis, properties, structure and uses.

UNIT – V **(15 Hours)**

5.1 **Second law of thermodynamics**: Limitations of first law and need for the second law. Statements of second law- Spontaneous & non-spontaneous process - Carnot's cycle and Carnot's theorem.

5.2 **Concept of entropy:** Definition - entropy of an ideal gas - entropy changes in cyclic, reversible and irreversible processes and in physical transformations. Derivation of entropy changes with changes in temperature, pressure and volume – entropy of mixing of ideal gases. Significance of entropy.

5.3 **Gibbs free energy** - Helmholtz free energy-their variations with temperature, pressure and volume. Gibbs- Helmholtz equations - derivation and applications. Criteria for spontaneity. Maxwell equations – Thermodynamic equation of state.

ALLIED PAPER – II

Subject	Code
Allied: Mathematics – II *(for B.Sc. Physics, Chemistry, and Computer science)*	

YEAR	SEMESTER	CREDITS	LECTURE HOURS
I	II	4	135

Objective:

- ✓ *To introduce basics in mathematics and to improve analytical skills*

Unit I : Integral Calculus

Bernoulli's formula for integration by parts - reduction formulae - properties of definite integral and simple problems. Fourier series for functions in interval $(0,2\pi)$

Unit II : Ordinary Differential Equations

First order and higher degree equations: solvable for p, y, x -
Second order Differential equation with constant coefficient and $F(x) = e^{ax}$, $\sin ax$, $\cos ax$, $e^{ax}\sin bx$, $e^{ax}\cos bx$ - Differential equation with variable coefficient.

Unit III : Partial Differential Equations

Formation - complete integrals and general integrals - four standard types - Lagrange's equations.

Unit IV : Laplace Transforms

Laplace transformations of standard functions and simple properties - inverse Laplace transforms - Application to solution of ordinary second order differential equations with constant coefficients.

Unit V : Vector differentiation and integration

Scalar point functions - vector point functions - gradient, divergence, curl, directional derivative, unit normal to a surface.
Gauss divergence, Stokes's and Green's theorem (without proofs and verification with simple application).

***Recommended Text book for Study*:**

Allied mathematics, A. Abdul Rasheed (2006) Vijay Nicole Pvt.Ltd,Chennai.

***Reference book*:**

Allied Mathematics, P. R.Vittal (2003), Margham Publications, Chennai.

THE NEW COLLEGE (AUTONOMOUS) CHENNAI 600014

B.Sc. DEGREE BRANCH – IV CHEMISTRY

CBCS Pattern SYLLABUS (Effective from 2017-2018)

GENERAL CHEMISTRY- III (SEMESTER- III)

Core: 4 **TEACHING HOURS: 75**

Code: 17BEM303 **CREDITS: 5**

OBJECTIVES OF THE COURSE:

- To provide them knowledge on chemistry of s – block elements, boron family.
- To provide them knowledge on chemistry of Aliphatic and aromatic halides, S_N1 & S_N2 and neighbouring group participation and their mechanisms and Elimination Reactions.
- To enable them to have sound knowledge in science of Liquid State**,** Surface Tension and Viscosity.

UNIT-I 's' block elements (15 Hours)

1.1 **Alkali metals**: General characteristics and gradation in properties of alkali metals. Exceptional properties of Lithium.

1.2 Structure and reactivity of halides, oxides and hydroxides, carbonates and bicarbonates of alkali metals.

1.3 **Alkaline Earth metals**: General characteristics and gradation in properties of alkaline earth metals. Exceptional properties of Beryllium.

1.4 Structure and reactivity of halides, oxides, hydroxides, carbonates and bicarbonates of alkaline earth metals. Structure of $BeCl_2$.

UNIT: II p- block family (15 hours)

2.1 **Boron family:** General characteristics and gradation in properties of Boron family.

2.2 Structure and properties of hydrides, halides, oxides and hydroxides of Boron family.

2.3 Structure of $AlCl_3$, diborane, Borazine, Boron nitride, $LiAlH_4$ and trimethyl aluminium.

2.4 Preparation and structure of borax and boric acid.

UNIT – III Organic halogen compounds (15 Hours)

1.1 **Preparation and reactions of alkyl halides: Nucleophilic Substitution reactions:** S_N1 & S_N2 – reaction – mechanism - differences between S_N1 & S_N2

1.2 **Elimination Reactions:** mechanisms of E_1 and E_2 reactions. Elimination Vs substitution. E_i – Cope reaction.

3.2 **Preparation and Chemical properties**: chlorobenzene (Aryl halides), benzyl chloride (arylalkyl halides), dichloromethane (Dihalogen derivative), vinyl chloride and allyl chloride (Halogen derivatives of unsaturated hydrocarbons).

UNIT-IV **(15 Hours)**

4.1 **Liquid State:** Mesomorphic state (Liquid crystal) – classification of liquid crystals: smectic, nematic and cholestic, disc-shaped and polymer crystals - molecular arrangements. Application of liquid crystals.

4.2 **Surface Tension:** Definition and determination of Surface tension by drop weight method and capillary rise method – Surface active agents. Effect of temperature, pressure on Surface tension.

4.3 **Viscosity:** Viscosity and coefficient of viscosity **–** definition - determination of viscosity by viscometric method. Effect of temperature, pressure on viscosity.

UNIT – V **(15 Hours)**

5.1 **Solid state:** Crystal Lattice- Unit cells- primitive, face-centred, body- centred and end-centred unit cells- crystal systems - Miller indices- Bravais lattices.

5.2 **Close Packing in Crystals**- hexagonal close packing and cubic close packing- holes- octahedral and tetrahedral holes- non-close packing- body centred packing- co-ordination number and radius ratio in crystals.

5.3 **Defects-** point defects- Schottky and Frenkel defects- Metal excess, metal deficiency.

5.4 **X-ray diffraction:** Bragg's equation, derivation and application – for determination of NaCl crystal structure.

Paper- I – 17BUA301 - ALLIED PHYSICS - I

(Offered to students other than Physics major)

CREDITS: 4 TEACHING HOURS: 90 hours
Total Marks: 100 External: 75 + Internal: 25

OBJECTIVE OF THE COURSE:

- *This paper gives concise ideas about various fields available in Physics and their applications in day to day life.*
- *A thorough knowledge of this paper will help the student to enjoy the relation of Physics with other major fields of Science.*

Unit I: WAVES AND OSCILLATIONS

Simple Harmonic Motion - Compositions of two simple harmonic motions in a straight line - Compositions of two simple harmonic motions of equal periods at right angles – Lissajous figures – Uses of Lissajous figures.

Sound: Transverse vibrations of stretched string – laws of transverse vibrations – a.c. frequency measurement using Sonometer – Ultrasonics – Piezoelectric effect – production and uses of Ultrasonics.

Unit II: PROPERTIES OF MATTER

Elasticity: Elastic constants – Poisson's ratio - energy stored in a stretched wire –bending of beams – expression for the bending moment –Theory of non-uniform bending - Young's modulus by non-uniform bending – torsion of a wire – Torsion Pendulum: Period of oscillation – rigidity modulus.

Viscosity: Coefficient of viscosity – Poissuelle's formula – comparison of viscosities of two liquidsby burette method.
Surface Tension – Determination of surface tension by Jaegar's method.

Unit III: HEAT AND THERMODYNAMICS

Kinetic theory of gases – Van der Waals equation of state – derivation of critical constants – Joule-Kelvin effect – Porous Plug experiment – Theory of Porous Plug experiment - liquefaction of gases – Linde's process – laws of thermodynamics.

Unit IV: ELECTRICITY AND MAGNETISM

Capacitance of a conductor – energy of a charged Capacitors – loss of energy on sharing of charges between two capacitors – Biot-Savart's law – magnetic induction at apoint on the axis of a circular coil.

Switches – Types of Switches – Electric circuit – Open, Closed and Short Circuits - Fuses - Types of Fuses - Relay.

Unit V: ATOMIC PHYSICS

Vector atom model – Quantum numbers associated with the Vector atom model – Coupling schemes – Pauli's exclusion principle – magnetic dipole moment due to spin – Stern and Gerlach experiment

Books for Study:

1. Allied Physics Paper I and II by R. Murugeshan (S. Chand & Company Pvt. Ltd.)
2. Heat & Thermodynamics by J.B.Rajam

UNIT	BOOK	SECTION
I	1	1.1, 1.2, 1.3, 1.4, 1.5, 1.7, 1.10, 1.11, 1.12, 1.13, 1.14.
II	1	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.12, 2.13, 2.14, 2.15, 2.17, 2.19, 2.24, 2.29.
III	1	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.8, 3.9, 3.15, 3.16, 3.17, 3.18.
IV	1	4.1, 4.2, 4.3, 4.5, 4.6, 4.17, 4.16, 4.18, 4.20.
V	1	7.1, 7.2, 7.3, 7.4, 7.7, 7.8.

Books for Reference:

1. Allied Physics by Dr. Dhanalakshmi, Dr.Sabesan
2. Allied Physics by Kamalakannan, Jayaraman
3. Mechanics by Narayanamoorthy and others
4. Elements of properties of matter by Brijlal and Subramanium

THE NEW COLLEGE (AUTONOMOUS) CHENNAI 600014

B.Sc. DEGREE BRANCH – IV CHEMISTRY

CBCS Pattern SYLLABUS (Effective from 2017-2018)

GENERAL CHEMISTRY- IV (SEMESTER- IV)

Core: 5 **TEACHING HOURS: 75**

Code: 17BEM404 **CREDITS: 5**

OBJECTIVES OF THE COURSE:

- To provide them knowledge on chemistry of Carbon & Nitrogen family.
- To provide them knowledge of chemistry on Ethers, Alcohols and Phenols.
- To enable them to have sound knowledge in science of Third law of Thermodynamics**,** Thermo chemistry and Quantum Chemistry.

UNIT – I Carbon family **(15 hours)**

1.1 General characteristics and gradation in properties of Carbon family. Unique properties of carbon.

1.2 Structure and reactivity of hydrides, halides, oxides and hydroxides of Carbon family.

1.3 Structure, bonding and uses of diamond and graphite. Intercalation compounds of graphite. Fullerenes – reactivity only.

1.4 Synthesis and properties of carbides. Structure of silicones and silicates.

1.5 Uses of carbon family. Pb poisioning - TEL.

UNIT-II: Nitrogen family **(15 hours)**

2.1 General characteristics and gradation in properties of nitrogen family - anomalous behaviour of nitrogen.

2.2 Structure and reactivity of halides, oxides and oxoacids of nitrogen family.

2.3 Synthesis, reactivity, structure of nitrides, azides, hydrazine, hydroxyl amine and hydrazoic acids.

2.4 Allotropes – structure of white, red, black phosphorous.

2.5 Polyphosphorous - $P_3O_{10}^{3-}$ (uses only). Arsenic poisoning.

UNIT – III **(15 hours)**

3.1 **Alcohols** Nomenclature, classification and methods of preparation: Grignard method, hydrolysis of alkyl halides, hydration of alkenes, hydroboration-oxidation of alkenes, reduction of aldehydes and ketones and addition of Grignard reagent to aldehydes and ketones. ***Chemical properties of alcohols***: *cleavage of O-H bond*: action with metals,

esterification; *cleavage of C-O bond*: action of halogen acids, action of PCl_3. Oxidation of alcohol. Victor Meyer's test and Lucas test.

3.3 **Unsaturated alcohols:**

Preparation; Reactions of allyl alcohol- with Hydrogen, halogens and sodium. Oxidation of allyl alcohol.

3.2 **Ethers:** Nomenclature, classification and preparation of ethers. Reaction of ether involving *cleavage of alkyl group*: halogentaion, peroxy formation and formation of oxonium salt; *cleavage of C-O bond*: Action of H_2O, H_2SO_4, HI and PCl_5.

UNIT – IV **(15 hours)**

4.1 **Polyhydric alcohols:** Preparation of glycol and glycerol-reactions with Na, HX, HCl, PX_3, acids and dehydration. Oxidation of glycol and glycerol.

4.2 **Phenols**: Types – monohydric, dihydric and trihydric phenols. Synthesis of phenols. Acidic character of phenol on the basis of resonance stabilization.

4.3 *Reactions of the hydroxyl group* –Action of acids, alkyl halides, isocyanide and amines. *Electrophilic substitution reactions*: alkylation, acylation (Fries rearrangement), nitration, sulphonation, halogenation and coupling with diazonium salts. Mechanism of Kolbe's reaction, Reimer-Tiemann reaction and Schotten Baumann reaction.

UNIT – V **(15 hours)**

5.1 **Third law of Thermodynamics:** Nernst heat theorem. Planck and Lewis Randall formulation of third law. Evaluation of absolute entropy of solids. Exception to Third law of thermodynamics.

5.2 **Thermochemistry**

Hess's law of heat summation-bond energy, bond dissociation energy- Variation of heat of reaction with temperature (Kirchhoff's equation)

5.3 **Quantum Chemistry**

Black body radiation**:** Planck's theory-photoelectric effect-Compton effect-de –Broglie relationship - Heisenberg's uncertainty principle, Schrodinger wave equation (no derivation)-significance of Ψ and Ψ^2.

B. Sc. DEGREE BRANCH: PHYSICS

(Effective for students admitted from the academic year 2017 - 18)

Semester-IV (II Year)

Paper-II- 17BUA402 - ALLIED PHYSICS - II

CREDITS: 4 TEACHING HOURS: 90 hours
Total Marks: 100 External: 75 + Internal: 25

OBJECTIVE OF THE COURSE:

- *This paper gives brief ideas about various fields available in Physics and their applications in day to day life.*
- *A thorough knowledge of this paper will help the student to understand the relation of Physics with other major fields of Science.*

Unit I: GEOMETRICAL OPTICS

Refraction – critical angle – Total Internal Reflection - Dispersion through a prism – dispersive power of the material of thin prism - combination of two prisms to produce dispersion without deviation – direct vision spectroscope – combination of two prism to produce deviation without dispersion.

Unit II: PHYSICAL OPTICS

Interference: Interference in thin films – Colours in thin films – Air wedge – Diffraction: Theory of Plane Transmission Grating – wavelength of light using grating by normal incidence – Polarization: double refraction – Nicol prism – Optical activity – Specific Rotatory power– Lauret's Half-shade Polarimeter.

Unit III: NUCLEAR PHYSICS

Binding energy – Mass defect – Liquid drop model – Shell model – Nuclear fission – Energy released in fission – Bohr and Wheeler's theory of nuclear fission – Chain reaction – Nuclear reactor – Nuclear fusion - Thermo nuclear reactions.

Unit IV: RELATIVITY AND QUANTUM MECHANICS

Frames of Reference - Postulates of special theory of relativity – Lorentz transformation equations – derivation – length contraction – time dilation –mass energy equivalence – postulates of wave mechanics - Heisenberg's Uncertainty principle – wave nature of matter.

Unit V: ELECTRONICS

Basic Electronics -Zener diode – Characteristics of the Zener diode – LED - RC coupled amplifier.

Digital electronics: Logic gates - AND, OR, NOT and Exclusive OR gates– construction using diodes and transistors – NAND and NOR gates as Universal gates – Boolean algebra – De Morgan's theorem – Statements and proof.

Books for Study:

1. Allied Physics Paper I and II by R. Murugeshan (S.Chand & Company Pvt. Ltd.)

UNIT	BOOK	SECTION
I	1	5.1, 5.4, 5.11, 5.12, 5.13, 5.14, 5.15.
II	1	6.2, 6.3, 6.4, 6.5, 6.8, 6.10, 6.11, 6.12, 6.14, 6.16, 6.17, 6.19,6.20.
III	1	8.4, 8.3, 8.2, 8.5, 8.8, 8.9, 8.10, 8.11, 8.13, 8.14, 8.15.
IV	1	9.3, 9.5, 9.6, 9.7, 9.9, 9.13, 9.10, 9.12.
V	1	10.2, 10.3, 10.1, 10.6, 10.11, 10.12,10.13, 10.14, 10.23, 10.15, 10.16, 10.17, 10.18, 10.19, 10.20, 10.21.

Books for Reference:

1. Allied Physics by Dr. Dhanalakshmi, Dr.Sabesan
2. Allied Physics by Kamalakannan, Jayaraman
3. Text book of Optics by Brijlal and Subramanium
4. Digital principles and applications by Malvino & Leach.
5. Modern Physics by R.Murugesan

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B.Sc. DEGREE BRANCH – IV CHEMISTRY

CBCS Pattern SYLLABUS (Effective from 2017-2018)

INORGANIC CHEMISTRY -I (SEMESTER –V)

Core: 8 **TEACHING HOURS: 75**

Code: 17BEM505 **CREDITS: 5**

OBJECTIVES OF THE COURSE:

- To provide basic understanding in oxygen, halogens families and noble gases.
- To provide thorough knowledge in fundamentals of Coordination chemistry, Crystal field theory.
- To provide the significance of chemistry of d-block elements.

UNIT-I: Oxygen family **(15 hours)**

1.1 General characteristics and gradation in properties of oxygen family - anomalous behavior of oxygen.

1.2 Structure and reactivity of halides, oxides, oxoacids and peroxyacids of oxygen family.

1.3 Allotropes –sulphur (rhombic, monoclinic, S_n) structures only.

1.4 Preparation and structure of tetra sulphurtetra nitride.

1.5 Role of selenium in xerography- acid rain.

UNIT – II **(15 hours)**

1.1 **Halogens:** General characteristics and gradation in properties. Exceptional properties of Fluorine.

1.2 Structure and reactivity of hydrogen halides and oxides of halogen family

1.3 Structure and reactivity of Interhalogen compounds of types XY, XY_3, XY_5 and XY_7, pseudo halogens, polyhalogen ions and oxoanions of halogen family.

1.4 Fluoridation of water and dental health. CFC – depletion of Ozone layer.

1.5 **Noble Gases:** Hybridization and geometries of XeF_2, XeF_4, XeF_6, XeO_3, $XeOF_2$ and $XeOF_4$.

UNIT-III: Chemistry of `d' block elements (15 Hours)

3.1 Characteristics of `d' block elements. Comparative study of Ti, V, Cr, Mn and Fe group metals- occurrence, oxidation states, magnetic properties, catalytic properties and color.

3.2 Theory of bonding, Valence bond theory – hybridization, geometry and magnetic properties. Failure of VBT.

UNIT-IV: Co-ordination Chemistry-I (15 Hours)

4.1 Nomenclature, Sidwick's theory, Werner's theory, EAN rule, Coordination number and geometry. Chelation and effect of chelation. Application of EDTA-water treatment, metal complex and detergents in industries.

4.2 ***Isomerism***: Ionization isomerism, Hydrate isomerism, Linkage isomerism, Ligand isomerism, coordinated isomerism, Polymerization isomerism. Geometrical and Optical isomerism in 4 and 6 coordinated complexes.

UNIT-V: Crystal Field Theory (15 Hours)

5.1. Crystal field theory- Spectrochemical series, splitting of `d' orbital in Octahedral, Tetrahedral and square planar complexes- low spin and high spin complexes. Explanation of magnetic properties, Colour and geometry using CFT. .

5.2. Comparison of VBT and CFT

5.3. Pi acceptor Ligands- bonding, hybridization and structures of carbonyls of Ni, Cr, Fe, Co, Mn, W and V

THE NEW COLLEGE (AUTONOMOUS) CHENNAI 600014

B.Sc. DEGREE BRANCH – IV CHEMISTRY

CBCS Pattern SYLLABUS (Effective from 2017-2018)

ORGANIC CHEMISTRY- I (SEMESTER –V)

Core: 9 **TEACHING HOURS: 75**

Code: 17BEM506 **CREDITS : 5**

OBJECTIVES OF THE COURSE:

- To enable the students to think and appreciate in a scientific a scientific manner through a comprehensive study of mechanisms of the various types of organic reactions.
- To enable the students to understand and appreciate the concepts of stereochemistry.

UNIT – I Carbonyl Compounds (15 hours)

1.1 **Carbonyl group properties:** Carbonyl polarization, reactivity of carbonyl group – acidity of α–hydrogen.

1.2 **Mechanisms:** Aldol, Cannizzaro, Claisen, Perkin, Knoevenagel, Reformatsky, Haloform and Benzoin reactions.

1.3 **Photochemistry of carbonyl compounds:** Norrish type I and type II reactions

1.4 **Reduction of carbonyl compounds:** Clemmensen, Wolf-Kishner and Rosenmund reductions (Mechanism of Wolf-Kishner only)

1.5 **Oxidation of carbonyl compounds:** Baeyer Villiger oxidation.

UNIT – II Carboxylic acids (15 hours)

2.1 **Structure, acidity and strength:** Ionization of carboxylic acids - acidity constants - comparison of acid strengths of mono carboxylic acids - acid strengths of substituted benzoic acids.

2.2 **Monocarboxylic acids:** Preparation and properties of monocarboxylic acids - HVZ, esterification and decarboxylation reactions; Kolbe electrolysis, Hunsdieker reaction, and Arndt - Eistert homologation.

2.3 **Dicarboxylic acids:** Preparation and properties of dicarboxylic acids: oxalic, malonic, succinic, glutaric, adipic and phthalic acids. Action of heat on dicarboxylic acids.

2.4 **Unsaturated carboxylic acids:** Preparation and properties of unsaturated acids: Acrylic, crotonic and cinnamic acids.

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UNIT – III Stereochemistry (15 hours)

3.1 **Stereoisomerism:** Definition & classification. **Optical isomerism:** optical activity – conditions for optical activity – asymmetric center – chirality – optical activity of tartaric acid - methods of racemisation and resolution – asymmetric synthesis – (partial and absolute) – Walden inversion. **Absolute configuration:** Cahn – Ingold – Prelog sequence rules, R-S notations for compounds with one chiral carbon.

3.4 **Geometrical isomerism:** Cis, trans and E,Z notations – geometrical isomerism in maleic and fumaric acids – physical and chemical methods of distinguishing geometrical isomers.

3.5 **Conformational analysis:** Conformers – dihedral angle – conformational analysis of ethane and n-butane – energy diagram – conformers of cyclohexane – boat and chair forms.

UNIT – IV Heterocyclic compounds (15 Hours)

4.1 Aromaticity of heterocyclic compounds. Preparation, properties and uses of furan, pyrrole and thiophene.

4.3 Synthesis and reactions of pyridine – comparative study of basicity of pyrrole, pyridine and piperidine.

4.4 Synthesis and reactions of quinoline and isoquinoline with special reference to Skraup and Bischler-Napieralski syntheses.

UNIT – V (15 Hours)

5.1 **Nitro compounds:** Preparation and properties of nitromethane and nitrobenzene; nitro – aci-nitro tautomerism. Reduction of nitrobenzene in neutral, acidic and alkaline media. Preparation and uses of TNT.

5.2 **Amines:** Preparation and properties of primary amines. Distinction between primary, secondary and tertiary amines – separation of a mixture of primary, secondary and tertiary amines by Hofmann's and Hinsberg's methods. Relative basic strengths of aliphatic and aromatic amines.

5.3 **Diazotisation and its mechanism**: Synthetic applications of diazonium salts. Synthesis of benzene, phenol, chlorobenzene (Sandmeyer and Gattermann reactions), iodobenzene, benzoic acid and azo dyes – diazo coupling.

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B.Sc. DEGREE BRANCH – IV CHEMISTRY

CBCS Pattern SYLLABUS (Effective from 2017-2018)

PHYSICAL CHEMISTRY – I (SEMESTER V)

Core: 10 **TEACHING HOURS: 75**

Code: 17BEM507 **CREDITS : 5**

OBJECTIVES OF THE COURSE:

- To understand the basics of Photochemistry, Conductors, Conductance, Buffer, Electrolytes, Electrodes, Cells and applications.
- Able to find conductance, able to prepare buffers of different pHs'
- Learns to find potential of an unknown Single Electrode, EMF of an unknown cell and pH of solutions. Learns to construct a battery and fuel cells.

UNIT – I Thermodynamics (15 Hours)

1.1 **Partial Molar Properties**

Chemical potential – Derivation of Gibbs-Duhem equation – Effect of temperature and pressure on chemical potential – Chemical potential in a system of ideal gases –Derivation of Gibbs-Duhem-Margules equation.

1.2 **Chemical Equilibrium**

Derivation of Law of Chemical equilibrium – Reaction isotherm – Relationship between Equilibrium constant and Free energy (Van't Hoff isotherm) – Variation of equilibrium constant with temperature (Van't Hoff isochore).

UNIT – II Electrochemistry (15 hours)

1.1 Introduction of Electrochemistry – Interconversion of Electrical & Chemical energy – Electrolytic and Galvanic cells. Definition and Comparison of Metallic and Electrolytic conductors.

1.2 **Electrolytic Conductance**: Definition of Specific conductance, Equivalent conductance and Molar conductance – Measurement of Conductance –Variation of Specific, Equivalent and Molar conductance with dilution for strong & weak electrolytes (qualitative explanation) – Definition for ***Transport number*** and its determination by Hittorff's and moving boundary methods – ***Ionic Mobility*** – Effect of temperature and concentration on ionic mobility and ionic conductance.

2.3 Ionic strength, activity, activity coefficients and mean ionic activity coefficients of strong electrolytes (Definition and simple numerical problems only).

2.4 ***Theory of strong electrolytes***: Debye-Huckel theory – Debye-Huckel Limiting Law (No derivation) – Experimental verification of Debye-Huckel Limiting law – Debye-Huckel-Onsager equation – Verification of Debye-Huckel-Onsager equation – Wien Effect and Debye-Falkenhagen effect.

UNIT – III **(15 hours)**

3.1 ***Ostwald's Dilution Law*** – Experimental verification of Ostwald's Dilution Law.

3.2 ***Kohlrausch's law*** and its applications: Calculation of Equivalent conductance of a weak electrolyte at infinite dilution, Degree of dissociation of weak electrolytes, Solubility of sparingly soluble salt.

3.3 ***Applications of Conductance Measurements***: Determination of Solubility Product of sparingly soluble salt - Conductometric titrations - Types of conductometric titration – acid-base, redox and precipitation titrations.

3.4 ***Buffer solution*** and types, Buffer action and Derivation of Henderson-Hasselbalch equation.

UNIT - IV **(15 Hours)**

4.1 ***Galvanic Cells*** – Construction of Cells –Electrode and Cell reactions. EMF of a Cell Origin of EMF in a Cell – Types of Electrodes – Metal-Metal ion Electrodes, Amalgam Electrodes, Gas electrodes (Hydrogen, Chlorine and Oxygen Electrode), Metal-Insoluble metal salt Electrodes – Oxidation-reduction electrodes – Reference electrodes (Standard Hydrogen Electrode and Saturated Calomel Electrode) – Single & Standard Electrode Potentials – Electrochemical Series and its applications.

4.2 Derivation of ***Nernst equation*** for electrode potential and cell.
EMF – Relationship between EMF and ΔG, ΔH, ΔS and equilibrium constants.

4.3 Chemical cells and Concentration cells with and without transference – application of Nernst equation for chemical and concentration cells (no derivation).

4.4 ***Liquid Junction Potential*** – Determination of Liquid Junction Potential - Elimination of Liquid Junction Potential.

4.5 ***Applications of EMF***: Determination of Valency of ions, Transport number, Equilibrium constant, Solubility product and Activity coefficients of Electrolytes – Determination of pH using Quinhydrone and Glass electrodes.

UNIT – V **(15 hours)**

5.1 **Photochemistry:** Basic laws of Photochemistry – Grotthus-Draper law, Beer-Lambert's law, Stark-Einstein's law. Definition for Quantum yield – High and Low Quantum yield reactions – Determination of Quantum yield.

5.2 **Photophysical process:** Jablonski diagram - non-radiative process - Internal conversion, Intersystem crossing, Radiative process - Fluorescence, Phosphorescence.

5.3 **Photochemical process:** Chemilumiescence, Bioluminesence, Photosensitization (definition and examples only).

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ANALYTICAL CHEMISTRY – I (SEMESTER –V)

Core: 11 **TEACHING HOURS: 75**

Code: 17BEM508 **CREDITS : 5**

OBJECTIVES OF THE COURSE:

- To give an insight to the key concepts of analytical chemistry with special reference to practical courses.
- To enable the students to grasp the basics of thermo analytical methods & chromatographic techniques and to gain a clear picture of the principles and processes involved.
- To provide fundamental knowledge on principles, instrumentation & applications of UV – Visible, Infrared and Raman spectroscopy.

UNIT – I **(15 Hours)**

1.1 **Data Analysis**: Idea of significant figures and its importance with examples- Precision and accuracy – method of expressing accuracy.

1.2 Error analysis- determinate and indeterminate errors – methods of minimizing errors – method of expressing precision – standard Deviation and confidence limit.

1.3 **Gravimetric analysis**: Principle - characteristics of precipitating agents – choice of Precipitants and conditions of precipitation.

1.4 Specific and selective precipitants – DMG, cupferron, salicyloldoxime – use of sequestering agents – Co-precipitation – Post- precipitation – reduction of error – Precipitation from homogeneous solutions.

UNIT – II **(15 Hours)**

2.1 **Thermo Analytical Methods**: Principle involved in thermo gravimetric analysis and differential thermal analysis

2.2 Discussion of various components with block diagram of DTA instrumentation – characteristics of TGA and DTA – factors affecting TGA and DTA curves – Discussion of TGA and DTA curves of $CaC_2O_4.H_2O$ and $CuSO_4.5H_2O$ only – thermometric titrations.

UNIT – III Chromatography Techniques **(15 hours)**

3.1. Principles of adsorption, partition and ion exchange chromatography.

3.2 **Column chromatography** – adsorbents – preparation of column – elution and applications.

3.3 **TLC** – choice of adsorbent and solvent – preparation of chromatogram and applications – R_f value. Paper chromatography – principle, R_f value, separation of amino acid mixtures.

3.4 **Ion exchange chromatography** – resins – action of resins – experimental technique – applications

3.5 **Gas chromatography** – principles, carrier gas requisites and applications only.

3.6. **High performance liquid chromatography**- Principles and application only.

UNIT – IV Absorption Spectroscopy (15 Hours)

4.1 Electromagnetic spectrum – quantization of energy – Line and Band spectra.

4.2 UV – Visible spectroscopy – instrumentation – spectrophotometer – block diagrams with description of components

4.3 Theory – types of electronic transitions – Chromophore and auxochromes. Shift of absorption bands (Blue and red shift, Hyperchromic and Hypochromic effects.).

4.4 Absorption maximum (λ max) – calculation of λ max for a few aromatic compounds. (ArCOX; X=H, R, OH, OR)

UNIT - V (15 Hours)

5.1 **Infrared Spectroscopy**: Principle – Fundamental modes of vibrations – vibrational frequencies

5.2 Instrumentation of single beam spectrometer only – block diagram – source – monochromator – cell sampling techniques (KBr pellet making only) – detector and recorders

5.3 Identification of organic molecules from characteristic absorption bands (***Benzaldehyde, Allyl alcohol, Simple phenol, Cresol, Nitrobenzene only***)

5.4 **Raman Spectroscopy**: Raman effect – Theory (Classical concepts only) – Rayleigh and Raman scattering – Stoke's and anti-stokes lines

5.5 Instrumentation – block diagram –mutual exclusion principle, applications.

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B.Sc. DEGREE BRANCH – IV CHEMISTRY

CBCS Pattern SYLLABUS (Effective from 2017-2018)

INORGANIC CHEMISTRY -II (SEMESTER –VI)

Core: 12 **TEACHING HOURS: 75**

Code: 17BEM609 **CREDITS: 5**

OBJECTIVES OF THE COURSE:

- To provide the significance of nuclear chemistry.
- To provide the significance of chemistry of f-block elements.
- To provide basic understanding in chemistry of metallurgy and industrial applications

UNIT-1: Substitution reactions in coordination compounds (**15 Hours)**

1.1 Substitution in square planar complexes, reactivity of platinum complexes, influence of entering, leaving and other groups, trans effect.

1.2 Substitution of octahedral complexes of cobalt and chromium.

UNIT-II: Nuclear Chemistry-I (**15 Hours)**

2.1 Fundamental particles of the nucleus- modern concept-brief introduction, nuclides, isotopes, isobars, isotones, mirror nuclei.

2.2 Nuclear radius, nuclear mass and nuclear forces operating between the nucleons. N/P ratio, curves, stability belts. Nuclear binding energy, mass defect, simple calculations involving mass defect and B.E per nucleon and magic numbers.

UNIT-III: Nuclear Chemistry-II (**15 Hours)**

3.1 **Radioactivity**– Types of radioactive rays and their properties. Laws of radioactive disintegration. Radioactive series including Neptunium series - group displacement law.

3.2 **Artificial Radioactivity**: Definition – induced radioactivity-uses of radio isotopes. Types of nuclear reaction -Nuclear fission - nuclear fusion– thermonuclear reactions-energy source of the sun and stars. Models of nucleus - liquid drop model- shell model.

3.3 Nuclear reactor-breeder reactor. Nuclear plants in India – Nuclear hazards.

UNIT-IV: (**15 Hours)**

4.1 **`f' block elements**: Comparative account of – Lanthanides and actinides- occurrence, elements, oxidation states, magnetic properties, colour and spectra.

4.2 Separation of lanthanide ions by ion-exchange and solvent extraction methods.

4.2 **Metallurgy:** Metallurgical processes – Froth floatation – magnetic separation – Zone refining - Van arkel process - electrolytic refining extraction.

4.4 Steel alloys – heat treatment of steel.

UNIT-V: Industrial chemistry (15 Hours)

5.1. **Fuel gases**, calorific value. Composition and uses of water gas, producer gas, LPG and bio-gas.

5.2. **Water**: hard and soft water. Type of hard water. Methods of softening of hard water using boiling method, reverse osmosis, washing soda and ion exchange methods.

5.3. **Paints, pigments and adhesives**: composition, examples and their role.

5.4 **Portland cement**-manufacturing and setting of cement.

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B.Sc. DEGREE BRANCH – IV CHEMISTRY

CBCS Pattern SYLLABUS (Effective from 2017-2018)

ORGANIC CHEMISTRY – II (SEMESTER VI)

Core: 13 **TEACHING HOURS: 75**

Code: 17BEM610 **CREDITS : 5**

OBJECTIVES OF THE COURSE:

- To study about various organic compounds of industrial importance.
- To study and appreciate the nature of basic building blocks, chemistry of carbohydrates and natural products.
- To provide an understanding of mechanisms involved in various organic rearrangements.

UNIT – I **(15 hours)**

1.1 **Molecular rearrangements:** Mechanisms of molecular rearrangements: Pinacol – Pinacolone, Wagner – Meerwein, Beckmann, Hofmann, Lossen, Curtius, Benzidine, Favorskii, Fries, Benzilic acid, Cope, Wolf and Claisen rearrangements.

UNIT – II **(15 hours)**

2.1 **Carbohydrates:** Classification. Reactions of glucose and fructose – osazone formation. Mutarotation. Structures of D-glucose and D-fructose. Cyclic structure- pyranose and furanose forms. Haworth projection formula. D and L configurations of monosaccharides – epimerisation - chain lengthening (Killiani synthesis) and chain shortening (Ruff's degradation) of aldoses. Inter conversion of aldoses and ketoses.

2.2 **Disaccharides:** Structures of maltose, sucrose & inversion of cane sugar.

2.3 **Polysaccharides:** Elementary treatment only- uses of cellulose derivatives.

UNIT – III **(15 hours)**

3.1 Natural Products: Terpenes - Isoprene rule - Classification of terpenes. Structural elucidations of citral, menthol and α – terpineol.

3.2 **Alkaloids:** General methods of isolation and general methods of structure determination –Zeisel's method, Herzig Meyer's method and Hofmann's exhaustive methylation - structural elucidations of coniine, piperine and nicotine.

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UNIT – IV **(15 hours)**

4.1 **Amino acids and peptides:** Classification of amino acids. Essential and non-essential amino acids. Preparation and properties of α-amino acids - Zwitter ion, isoelectric point. Peptide: Synthesis of dipeptides.

4.2 **Proteins:** Classification based on physical and chemical properties. Tests for proteins (ninhydric and Xanthoprotic tests) - Primary structure of proteins - N-terminal and C-terminal analysis (Sanger's and Edman's method) and secondary structure of Proteins – α - helical structure. Denaturation of proteins**.**

4.3 **Nucleic acids:** Types of nucleic acids – Distinction between RNA and DNA –types of RNA and their biological functions.

UNIT – V Synthetic organic chemistry: **(15 Hours)**

5.1 **Azo Compounds:** Preparation and synthetic applications of diazomethane and diazoacetic ester.

5.2 **Synthetic applications:** Malonic ester and acetoacetic ester.

5.3 Preparation of phenylene diamines, saccharin and chloramine-T.

5.4 **Sulphadrugs and their mode of action:** Sulphanilamide, Sulphafurazole and Sulphathiozole.

5.5 **Dyes:** Preparation and uses of 1. Azo dyes – methyl orange and Bismark brown 2. Triphenylmethane dye - malachite green 3. Phthalein dyes – phenolphthalein and fluorescein 4. Anthraquinone dye – alizarin.

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B.Sc. DEGREE BRANCH – IV CHEMISTRY

CBCS Pattern SYLLABUS (Effective from 2017-2018)

PHYSICAL CHEMISTRY- II (SEMESTER VI)

Core: 14 **TEACHING HOURS: 75**

Code: 17BEM611 **CREDITS : 5**

OBJECTIVES OF THE COURSE:

- To understand the behaviour of Solutions, Phase equilibria.
- To understand adsorption phenomena, catalysis and theories.
- Caters to perform purification separation techniques.
- Helps to learn rate of exothermic and endothermic reaction and theories of reaction rate.

UNIT – I **(15 hours)**

1.1 **Solutions:** Definition – Factors influencing solubility – Effect of Temperature, Nature of solvent and solute – Types of Solutions of gases in liquids – Henry's law – Solutions of Liquids in Liquids – Raoult's law – Binary liquid mixtures – Ideal solutions – Deviations from Ideal behaviour; Vapour pressure – Composition and Vapour pressure – Temperature curves, Azeotropic distillation. Clapeyron and Clapeyron-Clausius Equation: Derivation and uses.

1.2 **Dilute solutions:** Definition – Colligative properties – Relative lowering of Vapour pressure, Depression of Freezing point, Elevation of Boiling point and Osmotic pressure (no derivations) – Calculation of molecular weights by Rast method – Abnormal colligative properties – Van't-Hoff factor.

1.3 **Nernst Distribution law**: Definitions, limitations and applications (no derivation).

UNIT – II **(15 hours)**

2.1 **Phase equilibria:** Definition of phase, component and Gibb's phase rule – Degree of Freedom – One-component systems – Water and Sulphur systems – Reduced phase rule.

2.2 ***Two component systems***: Simple eutectic system (lead-silver system), Freezing mixtures, Pattinson's process of desilverisation of lead.

Compound formation with Congruent melting point (zinc-magnesium system, Ferric chloride-Water system), Incongruent melting point (Sodium-Potassium system).

2.3 ***Partially miscible liquids***: Phenol-water system, Critical Solution Temperature and Effect of Impurities on CST.

UNIT – III Chemical Kinetics I (15 hours)

3.1 Definition for Order and Molecularity of a reaction – Significance of order of reaction - Experimental methods to determine the rate of decomposition of H_2O_2 and hydrolysis of Ester – Derivation of rate constants for First and Second order reactions with its half-life period.

Definition and examples for Third order and Zero order reactions. (No rate constant derivation required).

3.2 Methods to determine the order of reactions: Graphical, differential and half-life period methods. Effect of temperature on rate of reaction - Arrhenius equation and Concept of energy of activation.

UNIT – IV Chemical Kinetics II (15 Hours)

4.1 **Collision & ARR theories:** Collision theory and Derivation of rate constant for bimolecular reactions – Theory of absolute reaction rates – Thermodynamic derivation for the rate constant of a bimolecular reaction – Absolute Reaction Rate Theory (ARRT). Comparison of collision and ARR theories.

4.2 Significance of entropy and free energy of activation. Consecutive, Parallel and reversible reactions. (No derivations, only examples)

UNIT – V (15 Hours)

5.1 **Adsorption:** Definition – Cause for adsorption – Factors influencing adsorption – Physisorption and Chemisorption –Adsorption Isotherm – Derivaiton for Freundlich Adsorption Isotherm and Langmuir Adsorption Isotherm – BET equation (no derivation) – Determination of surface area.

5.2 **Catalysis**: Definition – characteristics of catalysts – Types of catalyst - positive catalysts, negative catalyst, induced catalyst, auto catalyst and enzyme catalyst with examples – Definition for Homogeneous and Heterogeneous catalysis with examples – Theories of catalysis: Intermediate compound formation theory and adsorption theories.

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B.Sc. DEGREE BRANCH – IV CHEMISTRY

CBCS Pattern SYLLABUS (Effective from 2017-2018)

ANALYTICAL CHEMISTRY – II (SEMESTER –VI)

Core: 15 **TEACHING HOURS: 75**

Code: 17BEM612 **CREDITS : 5**

OBJECTIVES OF THE COURSE:

- To provide basic knowledge about principles, instrumentation and applications of polarography and amperometry.
- To provide basic knowledge of Radio chemical analysis and viscometry.
- To give a wider knowledge of NMR spectroscopy, Mass spectrometry and their interpretation in structural elucidation.
- To provide fundamental computer literacy and its applications in chemistry.

UNIT – I **(15 hours)**

1.1 **Polarography** – principle – dropping mercury electrode – advantages and disadvantages – Residual, migration and diffusion currents – Ilkovic equation (derivation not required) and significance – electrodes – current voltage curve – polarography as an analytical tool in quantitative and qualitative analysis.

1.2 **Amperometry-** Basic principle –Titration Apparatus – Advantages over Titrimetry – Amperometric titration curves.

UNIT – II **(15 hours)**

2.1 **Analytical methods based on physical properties** – Viscosity – Coefficient of viscosity –significance of Poiseulle equation [no derivation] – Measurement of relative viscosity – Ostwald Viscometer.

2.2 **Polarimetry**: principle – instrumentation – comparison of strengths of acids – Estimation of Glucose.

UNIT – III NMR spectroscopy **(15 hours)**

3.1 Principle of nuclear magnetic resonance – Standard used (TMS)

3.2 Basic instrumentation – shielding mechanism – chemical shift – relaxation methods – number of signals – spin coupling and coupling constants – splitting of signals

3.3 NMR spectrum of simple organic compounds (Ethanol/H_2O, Ethanol/CCl_4, Acetaldehyde, Acetone, Acetic acid, Cyclohexane, Benzene, Toluene) (prediction of NMR signals and peaks only).

UNIT – IV Mass spectrometry (15 hours)

4.1 Basic principles – Instrumentation and calibration (single focusing mass spectrometer) – molecular ion peak, base peak, isotopic peak, metastable peak. Nitrogen rule.

4.2 Structural investigation based on m/e – Mass spectrum of simple organic compounds – identification – Allyl alcohol, Acetaldehyde, Acetone, Toluene, Phenol, Benzaldehyde only – McLafferty rearrangement.

UNIT – V Magnetic properties (15 Hours)

5.1 Origin - Magnetic Susceptibility - Types of magnetic properties -Magnetic moment –

5.2 Determination of magnetic Susceptibility and dipole moment (Concept only) – Guoy Balance method.

5.3 Application of magnetic moment - spin only formula - finding the magnetic moment for Ni and Co - ($K_2[Ni(Cl)_4]$) and $[Co(NH_3)_6]Cl_3$.

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PG & RESEARCH DEPARTMENT OF CHEMISTRY
M.Sc., Degree, Branch-IV, Chemistry Syllabus
(Applicable to the candidates admitted from the academic year 2017-2018 onwards)

INORGANIC CHEMISTRY-I (SEMESTER-I)

Core: **Teaching hours: 75**
Code: 17MEM101 **Credits:**

Objectives

The student can gain full knowledge and understanding of all aspects of main group chemistry, theories about bonding and structure of various inorganic compounds, coordination and supramolecular chemistry.

Unit-I: Inorganic cluster compounds (15 Hours)

1.1 ***Silicates***: Introduction, classification of silicates- orthosilicates, disilicates, pyroxene and amphibole minerals, sheet like structures, three dimensional network silicates, ultramines, zeolites, feldspar. Explanation of the properties of the silicates with respect to their structures.

1.2 ***Phosphazene*** and its polymer – S_4N_4, polymeric sulphr nitride (polythiazyl).- preparation, bonding and structure.

1.3 ***Poly acids***: Preparation and structures of polyacids, classification of isopoly acids likepolymolybdate, polyvanadate, polytungstate and heteropoly acids like 12, 9 and 6 heteropolyacids.

Unit-II: Theories of metal–ligand bonding in complexes (15 Hours)

2.1 ***Crystal field theory*** - splitting of d-orbital under various geometry (O_h, T_d, and square planar fields). *Factors affecting splitting* - CFSE and evidences for CFSE. (Structural and thermodynamic effects). Spectrochemical series - Jahn-Teller distortion and consequences. Variation of lattice energy - Heats of hydration - spinels and inverse spinels - site preferences. *Molecular orbital theory*-σ and π bonding in complexes.

Unit-III: Electronic spectra of complexes (15 Hours)

3.1 ***Electronic spectra*** of transition metal complexes - selection rules, d-d and CT transitions, spectral characteristics of transition metal complexes.

3.2 Term states for d^n ions, energy diagram - Orgel and Tanabe -Sugano diagrams for $d^{2,}$ $d^{3,}$ d^8 & d^9 ions, spin orbit coupling, nephelauxetic series, Racah parameters, Hole formalism techniques.

Unit-IV: Stability of coordination complexes (15 Hours)

4.1 ***Stability constants***, Factors affecting stability of complexes -statistical and chelate affects.Thermodynamic and kinetic stability. Stepwise and overall stability constants.

4.2 ***Determination of stability constants*** by UV-Vis spectrophotometric, polarographic and potentiometric methods.

4.3 ***Macrocyclic ligands***: Types- porphyrins, corrins, Schiff bases and template effect.

Unit-V: Supramolecular chemistry (15 Hours)

5.1 Lehn's idea - ***Host-Guest chemistry*** - Cation-binding hosts - crown ethers, cryptands, podands, lariat ethers, spherands, anionic recognition hosts - azacrowns, hydride sponge and neutral molecules recognition hosts - cyclophane, cyclodextrins.

5.2 ***Self-assembly concept***-Basic concepts, Self-assembly using metal templates-monotopicandpolytopicligands, Racks, grids, ladders and helicates. Dendrimers.

5.3 ***Applications*** of supramolecular chemistry in catalysis and molecular devices.

Prescribed books:

1. P.W. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong; Shriver & Atkins: Inorganic Chemistry, 4th ed. Oxford University Press, 2006
2. J. E. Huheey, E. A. Keiter and R. L. Keiter; Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education, 2006.
3. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann; Advanced Inorganic Chemistry, 6th ed. Wiley, 1999.
4. K. F. Purcell and J. C. Kotz; An Introduction to Inorganic Chemistry, Saunders College Publishing, Philadelphia, 1980.
5. B. Douglas, D. McDaniel and J. Alexander. Concepts and Models of Inorganic Chemistry (3rd edn.),John Wiley & Sons (1994).
6. J. M. Lehn, Supramolecular Chemistry, Concepts and Perspectives, VCH, 1995.
7. H. Dodziuk, Introduction to Supramolecular Chemistry, Kluwer Academic, 2002.
8. F. Vogtle, Supramolecular Chemistry, An Introduction, JohnWiley& Sons, 1991.
9. J. W. Steed & J. L. Atwood. Supramolecular Chemistry, John Wiley (2002).

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ORGANIC CHEMISTRY-I (SEMESTER-I)

Core: **Teaching hours: 75**
Code: 17MEM102 **Credits:**

Objectives:

This paper explains the basic concepts of addition reactions of carbon-carbon double bond and elimination reactions. The last part of the course brings forth the salient features of reactive intermediates, oxidation and reduction reactions in organic synthesis.

UNIT-I: Addition to carbon-carbon and carbon-hetero atom multiple bonds (15 hours)

1.1 Electrophilic, Nucleophilic and neighbouring group participation mechanisms-Addition of halogens, nitrosyl chloride to olefins, Hydroboration, hydroxylation.

1.2 Michael addition, Diels-Alder reaction, 1, 3 - dipolar addition, carbenes, Simmon Smith reaction, Mannich reaction, Darzen, Wittig reaction, Wittig- Horner and benzoin condensation.

UNIT-II: Aliphatic Nucleophilic Substitution reactions (15hours)

2.1 Mechanisms of aliphatic nucleophilic substitution reactions: S_N1, S_N2, S_Ni and neighbouring group participation mechanisms by double bond, OMe, halogens and NH_2; reactivity, structural and solvent effects – substitution in norbornyl and bridgehead systems.

2.2 Substitution at allylic and vinylic carbons and Substitution by ambident nucleophiles. 2.3 Nucleophilic substitution at carbon doubly bonded to oxygen and nitrogen; alkylation and acylation of amines, halogen exchange and Von Braun reaction.

UNIT-III: Elimination Reactions and C–C Bond formation reactions (15hours)

3.1 Mechanisms: E_1, E_2, E_1CB and E_i.Orientation of double bonds – Hoffmann and Saytzeff rules – Elimination vs Substitution – Stereochemistry of E_2 elimination in cyclohexane derivatives – Chugaev reaction and Cope elimination.

3.2 Direct arylation- Heck and Suzuki Coupling

UNIT-IV:Reactive intermediates (15 hours)

4.1 A detailed study about carbocations, carboanions, free radicals.

4.2 A detailed study about carbenes, nitrenes, and benzyne – their generation, detection, stability and reactivity.

UNIT-V: (15 hours)

5.1 Oxidation:Reactions and Mechanism –oxidations of alcohols usingDMSO in combination with DCC (Moffatt oxidation) and oxalyl chloride (Swernoxidation), Jones reagent, Sarrett& Collins reagents, Etard reaction, SeO_2 (allylic oxidation and methylene to carbonyl),Oppenaur oxidation.

5.2 Reduction: Selectivity in reduction of 4 – tert- butyl cyclohexanone using $LiAlH_4$ and selectrides, Birch reduction, MPV reduction and McMurry coupling.

Prescribed Books:

1. F. A. Carey and R. J. Sundberg, 2001, Advanced Organic Chemistry, Part A and Part B, 4th edition, Plenum Press, NewYork.
2. J. March, 1992, Advanced Organic Chemistry, 4th edition, John Wiley & Sons, Singapore.
3. Niel Isaacs, 1987, Physical Organic Chemistry, ELBS Publications.
4. W.Currethers, 1993, Some Modern Methods of Organic Synthesis, 3rd edition, Cambridge University Press.
5. H. O. House, 1972, Modern Synthetic Reactions, TheBenjamin Cummings Publishing Company, London.

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PHYSICAL CHEMISTRY-I (SEMESTER-I)

Core: **Teaching hours: 75**
Code: 17MEM103 **Credits: 4**

Objectives:

To learn the basic concepts of quantum chemistry; to understand the concepts of spectroscopy and group theory; to understand their mathematical foundations, significance and applications.

UNIT-I: Group theory-I (15 Hours)

1.1 Symmetry elements and symmetry operations - Product of symmetry operations.
1.2 Concept of groups, similarity transformations, group multiplication tables, classes, subgroups and abelian groups.
1.3 Point group - classification of molecules, systematic procedure for point group assignment of molecules and ions.
1.4 Matrix representation of symmetry operations, reducible and irreducible representations.
1.5 Great orthogonality theorem and its consequences.
1.6 Construction of character tables for C_2, C_3 and C_{2h} point groups.

UNIT-II: Quantum Chemistry–I (15 Hours)

2.1 *Limitations of classical theory and quantum mechanical approach*: Black body radiation-Planck's equation, Photoelectric and Compton effects.
2.2 Functions: Well behaved wave function – normalization and orthogonalization of wave function – Eigen functions and Eigen values.
2.3 Wave particle duality -de Broglie's concept,Heisenberg's uncertainty principle.
2.4 Schrodinger's wave equation- derivation. Postulates of quantum mechanics.
2.5 Operator algebra: Linearmomentum, angular momentum, Hermitian, Laplacian and Hamiltonian operators.

UNIT-III: Quantum chemistry–II (15 Hours)

3.1 Elementary applications of Schrodinger's equation - Particle in a box (one and three dimensional cases) - setting up and solving the Schrodinger equation; analysis of energy equations and wave functions. Application of particle in one dimensional box to butadiene system.
3.2 Setting up and solving the Schrodinger equation to harmonic oscillator and rigid rotor - analysis of energy equations and wave functions.

3.3 Schrodinger equation of Hydrogen atom (no derivation is required) analysis of radial and angular wave equations, probability density and probability function plots, orbital shapes and interpretation.

UNIT-IV:Spectroscopy-I (15 Hours)

4.1 Interaction of electromagnetic radiation with matter – basis for selection rules – factors affecting width and intensity of spectral lines

4.2 Rotational Spectroscopy- Rigid and non-rigid rotor - diatomic and triatomic molecules - effect of isotopic substitution.Rotational energy in terms of molecular parameters - line spacing in terms of Rotational constant 'B' - Calculation of bond length.

4.3 Vibrational spectroscopy-Harmonic and anharmonic oscillator - vibrational frequency, force constant.

4.4 Condition for IR activity - vibrational and rotational spectra of diatomic molecules - effect of isotopic substitution - origin of P,Q and R branches.

4.5 Vibrational spectra of polyatomic molecules-vibrational coupling overtones, combination bonds and Fermi resonance.

UNIT-V: Spectroscopy-II (15 Hours)

5.1 Raman spectroscopy: criteria for a molecule to be Raman active - Rayleigh and Raman scattering - anisotropic polarizability, Stokes and anti-stokes lines.

5.2 Rotational Raman spectra – linear molecules, symmetric top and spherical top molecules-origin of P,Q, R and S branches.

5.3 Vibrational Raman spectra: mutual exclusion principle - rotation vibration Raman spectra of diatomic molecules.

5.4 Electronic spectroscopy: Types of Electronic transitions - Frank condon principle – intensity of electronic transition, vibronic coupling - dissociation, pre-dissociation and continuum of the spectrum - Electronic spectrum of poly atomic molecules.

Prescribed Books:

1. F. A. Cotton, Chemical applications of Group theory, John Wiley & Sons, 1990.
2. K.V. Raman, Group theory and its applications to Chemistry, Tata McGraw Hill, 1990.
3. V. Ramakrishnan and M.S. Gopinathan, Group theory in Chemistry VishalPublications, 1998.
4. D.A.McQuarrie, Quantum Chemistry, University Science Books, Mill Valley,California, 1983.
5. R.K.Prasad, Quantum Chemistry, New Age Publication, India, 1992
6. T.N. Levine, Quantum chemistry, Allyn and Bacon, Boston, 1983.

7. R.Anantharaman Fundamentals of Quantum chemistry, McMillan India Ltd., 2001.
8. C.N.Banwell, Fundamendals of Molecular Spectroscopy, Tata McGraw Hill, 2003.
9. G. M. Barrow, Introduction to Molecular Spectroscopy, McGraw-Hill 1962.
10. Raymond Chang, Basic principles of spectroscopy. McGraw-Hill, 2002.
11. G. Aruldas, Molecular Structure and Spectroscopy, Prentice Hall, 2002.
12. P.W.Atkins, PhysicalChemistry, Oxford University Press.
13. K. L. Kapoor, A Text Book of Physical Chemistry, Macmillan India Ltd, 2008.

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ANALYTICAL CHEMISTRY (SEMESTER-II)

Elective: **Teaching hours: 60**
Code: 17MEM104 **Credits:**

Objectives:

1. *To master the basic principles of analytical techniques to apply for Structural elucidation.*
2. *To learn the various instrumental methods of characterizing a given compound.*
3. *To learn the separation techniques for organic and inorganic compounds.*
4. *To learn about industrial analytical processes.*

Unit-I: Data analysis **(15 Hours)**

1.1 **Errors:** Collection of data by replicated analysis- Need for replications- Precision and Accuracy – Classification of errors- identificationof errors using statistical analysis of data.

1.2 **Statistical Anaysis of Data:**Sampling distribution of data about the mean and central limit theorem - Confidence interval. Significance Testing: Comparison of results- comparison of an experimental mean with a standard value (student's t-test) – Comparison of means of two samples – one– and two – tailed t-tests, paired t-test, F-test for comparison of standard deviations. Regression Analysis: Calibration- principle of least square fit line- the line of Regression of Y and X –parameters of a regression line and their significance.

Unit-II: Chromatographic methods **(15 Hours)**

2.1 **Introduction:**Basic principle of chromatographic techniques – Process of elution – Chromatogram – Resolution of a chromatogram – Migration rates of solutes – Significance of Partition Ratios in chromatography (K_d)& Retention Time (t_R) and relation between them (no derivation) – Definition and significance of Retention Factor R_f (Capacity Factor) and selectivity factor – Definition of Column Efficiency – factors affecting column efficiency.

2.2 **Gas-liquid Chromatography:** Principles, Instrumentation (Carrier Gas, Inlet System- Types of Columns, Pre-packed columns, Pre-conditioning of columns, Stationary Phase, Detectors–Thermal Conductivity, Flame Ionization) and applications of GLC.

2.3 **High Performance Liquid chromatography:** Basic principle, instrumentation (Pumping Systems, Columns, Column packing, Detector) and applications.

Unit-III: Colorimetric analysis and UV-Visible spectroscopy **(15 Hours)**

3.1 **Atomic absorption spectroscopy:** Basic principle of AAS, Instrumentation (Atomizers, Burners and Furnace, properties of Flame, Resonance line source, Hallow Cathode lamp and electrochemical radiation sources, detectors -Single and Double beam flame photometer and spectrophotometer) – Spectral and Chemical Interferences, applications of AAS.

3.2 **UV-Visible spectrophotometric analysis:** Basic principles, Instrumentation (single and double beam instruments), Colorimetric determination of Fe, Co andMn.

3.3 Spectrophotometric Titration: Titration of Fe(III) with EDTA. Titration of Fe(III) in the presence of Aluminium.

Unit-IV: Electroanalyticalmethods-I (8 Hours)

4.1 Polarography: Theory and basics of instrumentation of Classical polarography – DME and its advantages and disadvantages – Definition and origin of Residual, Migration, Diffusion, Kinetic and catalytic currents; Elimination of migration current, factors affecting diffusion current – Ilkovic equation – need for micro electrode – outline of qualitative and quantitative applications.

4.2 Pulse polarography – Square wave polarography – Cyclic voltammetry – theory, Instrumentation and applications to Inorganic systems.

Unit-V: Electroanalytical methods -II (7 Hours)

5.1 Amperometric titrations- theory, indicator electrodes- instrumentation, types of Titrationswith examples.

5.2 Coulometry: Basic Principle of Coulometry – Types of Coulometric analysis – Potentiostatic&Amperostatic methods – Instrumentation of Potentiostaticcoulometry and its application – Coulometric Titrations – its types with examples – KarlFisher Coulometer.

Prescribed Books:

1. D.A.Skoog, 1985, **Principles of Instrumental Methods of Analysis.** 3rd Edition, Saunders college publication.
2. Skoog and West, **Analytical Chemistry**, Saunders college publication.
3. Willard Merrit, Dean and Settle, 1986, **Instrumental Methods of Analysis,** 6th Edition, CBS Publication
4. G.D. Christian & J.E.O. Reilly, 1986.**Instrumental Analysis.**2nd Edition, Allen Becon.
5. H.A. Storbital, 1976, **Chemical Instrumentation**, Addition – Wesley Publication Co.
6. R.C. Kapoor And B.S. Agarwal, Ms.1991, **Principles of Polarography**, Wiley Eastern Limited
7. Miller J.C., and Miller J.N.., 1988, **Statistics for Analytical Chemistry**, 2nd Edition, Ellis Horwood, Chichestor.

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INORGANIC CHEMISTRY-II (SEMESTER-II)

Core: **Teaching hours: 75**
Code: 17MEM205 **Credits:**

Objectives

The student can gain full knowledge and understanding of basics of solid state chemistry, reaction mechanisms in coordination chemistry and nuclear chemistry.

Unit-I: Solid state chemistry-I (15 Hours)

1.1 Structure of solids; Unit cell, crystal lattices, radius ratio and close packed structures. Structure of Wurtzite, Zinc blende, Rutile, Perovskite, Cadmium iodide and Nickel arsenide. Imperfections in crystals (point defects, F centers).

1.2 X-Ray diffraction, powder method, principle and uses - X-ray powder diffraction data in identifying inorganic crystalline solids. Neutron Diffraction-principle, instrumentation and application-determination of magnetic properties.

Unit-II: Solid state chemistry-II (15 Hours)

2.1 Electronic properties and Band theory of metals - Semiconductors, insulators, superconductors - BCS theory, Solid State Electrolytes – Diffusion mechanism - β-alumina.

2.2 Classification of solids with magnetic properties - Dia, para, ferro, antiferro and ferrimagnetism, Hysterisis, Ferrites and Garnets.

2.3 Solid state lasers – Nd-YAG and ruby laser, Inorganic phosphorus.

Unit-III: Substitution reactions in coordination compounds (15 Hours)

3.1 Substitution reactions-types-A, D and interchange mechanisms. Inert and labile complexes-Substitution reaction in octahedral complexes of cobalt.

3.2 Dissociative, associative, anation, aquation, conjugate base mechanism.

3.3 Substitution reaction in square planar complexes, *trans* effect, influence of entering, leaving and other groups, trans effect series, Theories of Trans effect – polarisation, π– bonding theories.

Unit-IV: Electron transfer reactions in coordination compounds (15 Hours)

4.1 Electron transfer reactions: Inner sphere and outer sphere mechanisms, atom transfer reactions, Complementary and non-Complementary reactions.

4.2 Formation and rearrangement of precursor complexes, the bridging ligands. Successor complexes, Marcus-Husch theory.

UNIT-V: Stereoisomerism of coordination compounds: (15 Hours)

5.1 Configuration of mononuclear complexes - polyhedral symbol, configuration index, chirality symbol.

5.2 Geometrical and optical isomerism in square planar, tetrahedral and octahedral complexes.

5.3 Absolute configuration of optically active coordination compounds, Ligand Conformation of individual chelate rings – [M(en)], $[M(en)_2]$and $[M(en)_3]$ systems.

5.4 ORD and CD: Principle- cotton effects. Applications of optical rotatory dispersion and circular dichroism in determining absolute configuration of coordination compounds like $[Co(S\text{-}ala)_3]$ and $[Co(S\text{-}pn)_3]^{3+}$.

Prescribed Books:

1. A. R. West. Solid State Chemistry and its Applications, John Wiley (1998).
2. R.C. Ropp, Solid State Chemistry, Elsevier (2003)
3. L.E. Smart, E.A. Moore, Solid State Chemistry: An Introduction, 3rd Edition, CRC Press (2005).
4. H.Schmalzried, Solid State Reactions,VerlagChemie International Inc., (1981)
5. S. F.A. Kettle, Physical Inorganic Chemistry, Spectrum (1996).
6. S.F.A. Kettle, 1973, Coordination Chemistry, ELBS.
7. F. Basolo& R. G. Pearson, Mechanism of Inorganic Reactions, Wiley Eastern (1967).
8. P.W. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong; Shriver & Atkins: Inorganic Chemistry, 4th ed. Oxford University Press, 2006
9. K.F. Purcell and J.C. Kotz; An Introduction to Inorganic Chemistry, Saunders College Publishing, Philadelphia, 1980.
10. B. Douglas, D. McDaniel and J. Alexander,Concepts and Models of Inorganic Chemistry (3rd edn.),John Wiley & Sons (1994).
11. Sharpe, A.G; Inorganic Chemistry, 3rd Edition, Pearson, 2010.
12. C.R. Choppin and J. Ryd Berg: Nuclear Chemistry - Theory and Applications, Pergamon Press, First Edition edition (December 17, 1980)
13. B.G. Harvey, Introduction to Nuclear Physics and Chemistry Prentice Hall, 1962.
14. H.J. Arnikar, Nuclear Chemistry, Wiley Eastern Co., II Edition, 1987.

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ORGANIC CHEMISTRY–II (SEMESTER-II)

Core: **Teaching hours: 75**
Code: 17MEM206 **Credits:**

Objectives:

This course aims to explain basic concepts in stereochemistry and conformational analysis of organic molecules. In addition, aromaticity, the reaction mechanisms and synthetic applications of aromatic substitution reactions in organic synthesis will be discussed in detail.

Unit-I: Stereochemistry-I (15 hours)

1.1 Optical activity and Chirality: Classification of chiral molecules as asymmetric and dissymmetric – a brief study of dissymmetry of allenes, biphenyls, spiro compounds, *trans*cyclooctene, cyclononene and molecules with helical structure.

1.2 Absolute configuration: R,S notation of biphenyls and allenes - Fischer projections: Interconversion of Sawhorse, Newmann and Fischer projections.

UNIT-II: Stereochemistry-II (15 hours)

2.1 Molecules with more than one asymmetric center (restricted to five carbons) Erthyro and Threo compounds-Asymmetric synthesis, Cram's rule and optical purity. Geometrical and Optical isomerism of disubstituted cyclopropane,cyclobutane and cyclopentanes.

2.2 Identification of homotopic, enantiotopic, diastereotopic hydrogens and prochiral carbons - stereospecific and stereo selective reactions.

UNIT-III: Conformational Analysis (15 hours)

3.1 Conformational analysis of some simple 1, 2disubstituted ethane derivatives. Conformational analysis of disubstitutedcyclohexanes and their stereo chemical features [Geometrical and optical isomerism (if shown) by these derivatives].

3.2 Conformation and reactivity of substituted cyclohexanols: Oxidation, acylation, esterification and hydrolysis. Conformation and stereochemistry of *cis* and *trans* decalins and 9-methyl decalin.

Unit-IV: Aromaticity (15 hours)

4.1 Benzenoid and non benzenoid compounds, Huckel and Craig rules. Alternant andnon - alternant hydrocarbons, aromatic, homo aromatic, non – aromatic and anti-aromatic compounds.

4.2 Study of Cyclopropenium cation, Cyclopentadineyl anion, Cycloheptatrienylcation, ferrocene, pyrene, annulenes [10], [14], [16], [18], Tropolone,azulene and Fulvenes.

Unit-V: Aromatic Electrophilic & Nucleophilic Substitution reactions (15 hours)

5.1 Kinetic and non-kinetic methods of determining organic reaction mechanisms. Hammet and Taft equation and their significance.

5.2 Aromatic electrophilic substitution reactions: Arenium ion mechanism, orientation and reactivity.

5.3 Aromatic nucleophilic substitution reactions mechanisms: S_NAr, Aryne $S_N1$mechanisms; Zeigler alkylation and Chichibabin reaction.

Prescribed Books:

1. J.March, 1992, Advanced Organic Chemistry, 4th edition, John Wiley & Sons, Singapore.
2. E.Eliel, S.H.Wilen and L.N.Mander, 1994, Stereochemistry of Carbon Compounds, 2nd Edition, John Wiley & Sons, New York.
3. D.Nasipuri, 1984, Stereochemistry of Organic Compounds, 2nd Edition, Wiley Eastern Ltd., New Delhi.
4. P.S.Kalsi, 1994, Stereochemistry, Conformational Analysis and Mechanism, 2nd Edition, Wiley Eastern Ltd., Chennai.
5. Niel Isaacs, 1987, Physical Organic Chemistry, ELBS Publications
6. Organic chemistry by Clayden, Greeves, Warren and Wothers, Oxford University Press-2001.

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PHYSICAL CHEMISTRY-II (SEMESTER-II)

Core: **Teaching hours: 75**
Code: 17MEM207 **Credits:**

Objectives:

To enable the students to learn i) Basic concepts of classical thermodynamics ii) the approximation methods in quantum chemistry to solve many electron system, iii) the basic principle and application of NMR spectroscopy, iv) the applications of group theory and v) the basic principles of photochemistry.

UNIT-I: Group Theory-II (15 Hours)

1.1 Direct product representations, determining the number of irreducible representations in a reducible representation using the reduction formula.
1.2 Construction of hybrid orbitals of non-linear molecules (NH_3, BF_3, CH_4 and XeF_4).
1.3 Determination of representations of vibrational modes in non-linear molecules (H_2O, NH_3, BF_3, CH_4 and XeF_4) and their activities in IR and Raman spectra.
1.4 Symmetry selection rules for IR, Raman and electronic spectra.
1.5 Electronic spectra of formaldehyde and ethylene.

UNIT-II: Quantum Chemistry -III (15 Hours)

2.1 Approximation methods: Perturbation method- application to hydrogen and helium atoms, Variation method; application to hydrogen and helium atoms.
2.2 Born-Oppenheimer approximation.
2.3 Valence bond theory for hydrogen molecule.
2.4 LCAO-MO theory to hydrogen molecular ion.
2.5 Huckel's molecular orbital theory (HMO theory) –ethylene and butadiene.

UNIT-III: Spectroscopy -III (15 Hours)

3.1 Nuclear Magnetic Resonance spectroscopy: Angular and magnetic motions of nucleus – Larmor frequency – population of nuclear spin levels.
3.2 Relaxation processes - relaxation time and its effect on line width.
3.3 Chemical shift; Factors affecting 'g' and 'δ' values.
3.4 Spin-spin coupling-coupling constant.
3.5 NMR spectrum of simple A-X and AMX type molecules.
3.6 FT NMR and C^{13} NMR spectroscopy - double resonance spectroscopy.

UNIT-IV: Thermodynamics (15 Hours)

4.1 Partial molar quantities – partial molar volume, partial molar heat content.

4.2 Chemical Potential - Physical significance of chemical potential - variation of chemical potential with temperature and pressure.

4.3 Thermodynamics of real gases - fugacity - variation of fugacity with temperature and pressure – determination of fugacity by graphical method.

4.4 Activity and activity coefficient of non-electrolytes and electrolytes. Determination of activity co-efficient by emf method.

UNIT-V: Photochemistry (15 Hours)

5.1 Absorption and emission of radiation - decay of electronically excited states.

5.2 Jablonski diagram - radiative and non-radiative processes.

5.3 Fluorescence – Structural dependence on fluorescence

5.4 Phosphorescence –triplet state and phosphorescence emission – heavy atom effect

5.5 Energy transfer process - excimers and exciplexes - static and dynamic quenching – Stern-Volmer analysis.

Prescribed Books:

1. F. A. Cotton, Chemical applications of Group theory, John Wiley & Sons, 1990.
2. K.V. Raman, Group theory and its applications to Chemistry, Tata McGraw Hill, 1990.
3. V. Ramakrishnan and M.S. Gopinathan, Group theory in Chemistry VishalPublications, 1998.
4. D.A.McQuarrie, Quantum Chemistry, University Science Books, Mill Valley,California, 1983.
5. R.K.Prasad, Quantum Chemistry, New Age Publication, India, 1992
6. T. N. Levine, Quantum chemistry, Allyn and Bacon, Boston, 1983.
7. R. Anantharaman Fundamentals of Quantum chemistry, McMillan India Ltd., 2001.
8. C.N.Banwell, Fundamendals of Molecular Spectroscopy, Tata McGraw Hill, 2003.
9. G. M. Barrow, Introduction to Molecular Spectroscopy, McGraw-Hill 1962.
10. Raymond Chang, Basic principles of spectroscopy. McGraw-Hill, 2002.
11. G. Aruldas, Molecular Structure and Spectroscopy, Prentice Hall, 2002.
12. S.Glasstone**,** Thermodynamics for Chemists, Affiliated East West Press, New Delhi, 1960.
13. J. Rajaram and J.C. Kuriacose, Thermodynamics for Students of Chemistry, LalNagin Chand, New Delhi, 1986.
14. N.J.Turro, Modern Molecular Photochemistry, Benjamin, Cummings, Menlo Park, California, 1978.
15. K. K. Rohatgi Mukherjee, Fundamentals of Photochemistry, Wiley Eastern Ltd., 1978.
16. P. W. Atkins, Physical Chemistry, Oxford University Press.

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SYNTHETIC ORGANIC AND GREEN CHEMISTRY (SEMESTER-II)

Core: **Teaching hours: 60**
Code: 17MEM208 **Credits:**

Objectives:

This paper introduces the basic methodologies for the synthesis of organic compounds. The second part consists of study of inter conversions of functional groups. Certain organic name reactions and reagents used in organic synthesis are also discussed. Principle and applications of few techniques of green chemistry are also illustrated.

Unit-I: Modern Synthetic Methodology-I (15 hours)

1.1 Reterosynthetic analysis – disconnection approach – Basic principle: FGI, Disconnections, synthons, target molecule – guidelines for order of events – one group C-X and two group C-X disconnections.

1.2. Chemo selectivity, Stereo selectivity and regio-selectivity in organic synthesis. One group C-C disconnections alcohols and carbonyl compounds.

Unit-II: Modern Synthetic Methodology-II (15 hours)

2.1 Reversal of polarity (Umpolung) – amine synthesis – alkene synthesis Introduction to carbonyl condensation – Two group C-C disconnections – Diels- Alder reaction, 1,2 - difuntionalised compound and 1,3 – difuntionalised compound

2.2 Protection and deprotection of functional groups like carbonyls, hydroxy, amine, carboxylic acids and olefins.

2.3 Retrosynthetic analysis of ferruginol, vivalan and α and β sinensols.

Unit-III:Uses of Reagents in Organic Synthesis (15 hours)

3.1 Uses of following reagents in organic synthesis – DIBAL, Gilman's reagent, Lithium diisopropylamide,trimethylsilyl chloride, n-Bu_3SnH, DDQ, Wilkinson's catalyst, n – butyl lithium, PDC and Corey's reagent.

3.2 Phase transfer catalysis: Types of PTC, preparation, mechanism and advantages.

Unit-IV: Green Chemistry (8 hours)

4.1 Principles of green chemistry

4.2 Designing of green synthesis: concept of atom economy, role of protecting and deprotecting group, role of green solvent and role of catalyst.

Unit-V: Modern Techniques in Synthetic Organic Chemistry (7 hours)

5.1 Microwave induced organic synthesis – Principle, advantages and applications (any two).

5.2 Sonochemistry in organic synthesis - Principle, advantages and applications (any two).

Prescribed Books:

1. B. I. Smith, 1980, Organic synthesis, Chapman and Hall, New York.
2. A. Francis Carey, Richard. J. Sundberg, 2001, Advanced Organic Chemistry, 4th edition, Plenum Press, New York.
3. R. K. Mackie and D. M. Smith, 1998, Guide Book to Organic Synthesis, ELBS Publications.
4. V. K. Ahluwalia, 2011, Green Chemistry: Greener Alternatives to Synthetic Organic Transformations, Alpha Science International Ltd.,
5. I. L. Finar, 1986, Organic Chemistry, 5th edition, Volume II, ELBS Publications.
6. Bradford .P.Mundy, Michael.G.Ellerd&Frank.G.Favalaro, 2005, Name Reactions & Reagents in Organic Synthesis, 2nd edition, Wiley – Interscience.

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INORGANIC CHEMISTRY–III (SEMESTER-III)

Core: **Teaching hours: 75**
Code: 17MEM309 **Credits :**

Objectives:

This paper exposes the student to understand theory, bonding and applications of organometallic compounds. This paper deals about spectroscopy and their applications to inorganic compounds.

Unit-I: Organometallic chemistry (15 Hours)

1.1 **Carbon donors**: Alkyl donors and aryl donors, Metallation, Bonding in carbonyls and nitrosyls, chain and cyclic donors, Olefin (Zeise's salt), acetylene and allyl (mono hapto, tri hapto, pentahapto complexes) systems. Synthesis, structure and bonding of ferrocene.

1.2 **Reactions**: Association, substitution, addition and elimination, ligand protonation, electrophilic and nucleophilic attack on ligands, carbonylation and decarbonylation, oxidative addition, fluxionality.

Unit-II: Catalysis (Industrial applications of organometallic compounds) (15 Hours)

2.1 Hydrogenation of olefins (Wilkinson catalyst), Hydroformylation of olefins, Cobalt - rhodium catalyst (Oxo process), Oxidation of olefins to aldehydes and ketones (Wacker process).

2.2 Polymerization (Ziegler-Natta catalyst), Cyclo oligomerisation of acetylene using Nickel catalyst (Reppe's catalyst), Polymer bound catalysts.

Unit-III: Inorganic Spectroscopy-I (15 Hours)

3.1 **IR spectroscopy** : Introduction – applications of IR spectroscopy -Linkage of sulphato and perchlorato ligands as monodendate and bidendate ligands, distinction between ionic and coordinate anions such as NO_3^- , SO_4^{2-} and SCN^-, Lattice and coordinated water. Effect of coordination on ligand bands- Urea, carboxylate, cyano, carbonyls, olefin and sandwich complexes.

3.2 **Raman spectroscopy**: Resonance Raman effect - Applications - study of solution equilibrium - detection of dimeric species like Hg_2^{2+}, N_2O_2 and mixed halide formation - structural changes with phase changes - PCl_5-study of reactions.

3.3 **Photo electron spectroscopy (UV and X-ray)**: photoelectron spectra - Koopman's theorem, fine structure in PES, chemical shift and correlation with electronic charges.

Unit-IV: Inorganic Spectroscopy-II (15 Hours)

4.1 **Nuclear magnetic resonance spectroscopy**: Introduction to Nuclear Magnetic Resonance, Chemical shift, Application of chemical shifts, signal intensities and spin-spin coupling to structure determination of inorganic compounds carrying NMR active nuclei like ^{1}H, ^{19}F and ^{31}P. Lanthanide shift reagents.

4.2 **ESRspectroscopy**:ESR introduction – Zeeman equation, g-value, nuclear hyper fine splitting, and interpretation of spectra of simple carbon cantered free radicals. Anisotropy – g value and hyper fine splitting constant. Mc Connel's equation, Kramers theorem, ESR of transition metal complexes (manganese and copper complexes).

Unit-V:Inorganic Spectroscopy-III (15 Hours)

5.1 **Nuclear Quadrupolar Resonance (NQR) Spectroscopy:** Quadrupole nuclei and quadrupole nuclear moment.Energy levels of a quadrupole nuclei with I = 3/2 & 5/2 (axially symmetric field gradient) and I = 1, 3/2 (non-symmetric field gradient). Effect of asymmetry parameters. Effect of an external magnetic field. Effect of 'q' on nature of chemical bond, partial ionic character, type of hybridization. Structural information from NQR spectral data (nitrosyl compounds, K_2SeBr_6, BrCN, PCl_5, $TeCl_4$).

5.2 **Mossbauer Spectroscopy**: Principle and experimental MB spectroscopy. Isomer shift, quadrupole interactions and magnetic interactions on the MB spectrum.Applications–High spin and low spin Fe(II) and Fe(III) octahedral complexes, structure of sodium nitroprusside and characterization of the oxidation state of Sn in different compounds.'

Prescribed books:

1. K.F. Purcell and J.C. Kotz, 1977, Inorganic Chemistry - WB Saunders Co., USA.
2. F.A. Cotton and G. Wilkinson, 1988, Advanced Inorganic Chemistry - A Comprehensive Text, V. Edition, John Wiley & Sons, New York.
3. R. Drago, 1968, Physical methods in Inorganic Chemistry, Reinhold, New York.
4. E.A.V. Ebesworth, D. WH. Rankin and S. Crackdock, 1987, Structural Methods in Inorganic Chemistry, Blackwell Scientific Publishers.
5. Dickensen, Mösbauer spectroscopy.
6. G. Coates, M.L. Green and K. Wade, 1988, Principles of Organo Metallic Chemistry, Methven Co., London.
7. R.B. Jordon, 1991, Reaction Mechanisms of Inorganic and Organo Metallic Systems, Oxford University Press.
8. P. Powell, 1988, Principles of Organo Metallic Chemistry, Chapman and Hall.
9. R. C. Mehothra, A. Singh, 1992, Organo Metallic Chemistry, Wiley Eastern Co.
10. C.N.R. Rao, J.R. Ferraro, 1970, Spectroscopy in Inorganic Chemistry, Vol. I and Vol. II, Academic Press.
11. G. Aruldas, Molecular Structure and Spectroscopy, Prentice Hall.

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ORGANIC CHEMISTRY-III (SEMESTER-III)

Core: **Teaching hours: 75**
Code: 17MEM310 **Credits :**

Objectives:

This paper explains the physical methods of determination of organic structure and their applications. Organic name reaction and mechanism is the work horse of any organic industry. The last part of the subject deals with the significance of bio-organic chemistry.

Unit-I: Spectroscopy–I (15 Hours)

1.1 **UV and visible spectroscopy:** Principles and application - Woodward Fischer rule to calculate λ_{max} (conjugated dienes, α, β unsaturated ketones, benzene derivatives -ArCOR, ArCHO, ArCOOH and ArCOOR).

1.2 **IR spectroscopy:**Significance of Hooke's law, Factors affecting stretching frequency, Functional group region and applications.

1.3 **NMR spectroscopy:** Proton chemical shift, spin-spin coupling constants and application to organic molecules. Elementary treatment of FT NMR - ^{13}C NMR-Coupled and decoupled spectra. Introduction to 2D NMR-Cosy-1H-1H; HSQC. (Instrumentation is not required for UV, IR and NMR)

Unit-II: Spectroscopy–II (15 Hours)

2.1 **Mass spectrometry:** Basic principle- Nitrogen rule, metastable peak -McLafferty rearrangement - Fragmentation pattern of organic molecules - alcohols, phenols, amines, carbonyl compounds and carboxylic acids-High Resolution Mass Spectroscopy (HRMS). (Instrumentation is not required)

2.2 Structural elucidation oforganic compounds using UV-Vis, IR, NMR and Mass spectral data (with a minimum of 10 problems including cyclic compounds)

Unit-III: Organic Name Reactions (15 Hours)

3.1 Carbon-carbon bond formation reaction like Robinson's annulation reaction, Shapiro reaction, Ene reaction, Hoffmann - Loffler - Freytag reaction, Stork enamine reaction.

3.2 Sharplessasymmetric epoxidation, Passerini Reaction, Pechmann Condensation, Stille coupling reaction, Glaser oxidative coupling reaction, Baylis- Hillman Reaction and Biginelli reaction.

Unit-IV: Heterocyclic compounds (15 Hours)

4.1 Synthesis and reactions: Imidazole, Oxazole &Thiazole.

4.2 Synthesis:Cyanidin chloride, Hirsutidin chloride, Quercetin and Daidzein.

4.3 Synthesis of purines (adenine, guanine) & pyrimidines (cytocine and uracil only)

Unit-V: Proteins and nucleic acids (15 Hours)

5.1 Proteins: Primary structure - end group analysis - N-terminal analysis - Edman's method, Dansyl chloride method; C-terminal analysis -hydrazinolysis and Bio-Chemical Methods, Biological functions of proteins. Secondary and tertiary structure of proteins.

5.2 Structure and role of DNA and RNA, Genetic code. Solid phase peptide synthesis.

Prescribed books:

1. R. M. Silverstien, G. C. Bassler&Morril, 1991, Spectrometric Identification of OrganicCompounds, 5th Edition, John Wiley & Sons, NewYork.
2. Organic Spectroscopy. William Kemp.
3. Jag Mohan, 2005, Organic Spectroscopy, II edition, Narosa publishing house Pvt. Ltd, New Delhi.
4. P.S Kalsi, 2002, Spectroscopy of Organic Compounds, Wiley Eastern Ltd.,Chennai. Cole. Thomson Learning. Ed. III, 2001, Singapore.
5. Y.R. Sharma, 2002, Elementary Organic Spectroscopy. Principles and Chemical Applications, S. Chand & Co. Ltd, New Delhi.
6. D.L. Pavia, G.M. Lampman and G. S. Kriz, Introduction to Spectroscopy, Brookes
7. J.March, 1992, Advanced Organic Chemistry, 4th edition, John Wiley & Sons,Singapore.
8. Organic Chemistry by Clayden, Greeves, Warren and Wothers, Oxford University Press-2001.
9. Name reactions by Jie Jack Li. Springer. Ed. IV.
10. Principles of Modern Heterocyclic Chemistry, L.A. Pacquette, Benjamin Cummings Pub. Co. London, 1978.
11. I. L. Finar, 1986, Organic Chemistry, Vol. II, 5th edition, ELBS Publications.

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PHYSICAL CHEMISTRY-III (SEMESTER-III)

Core: **Teaching hours: 75**
Code: 17MEM311 **Credits:4**

Objectives:

To learn the basic concepts of chemical kinetics, statistical thermodynamics, and electrochemistry.

UNIT-I: Chemical Kinetics-I (15 Hours)

1.1 Effect of temperature on reaction rates.
1.2 Probability of activation -Activation energies for forward and backward reactions.
1.3 Collision theory of bimolecular and unimolecular reactions,Lindemann's mechanism-Steric factor in collisions.
1.4 Activation energies from Arrhenius equation and collision theory.
1.5 Reaction Rate theory (ARRT) -Eyring's equation.
1.6 Evaluation of thermodynamic parameters of activation- Physical significance of entropy, enthalpy and free energy of activation.
1.7 Kinetic isotope effect and Molecular beams.

UNIT-II: Chemical Kinetics-II (15 Hours)

2.1 Reactions in solutions -Solvation of ions and Electrostriction
2.2 Factors influencing reaction rates in solution -Effect of dielectric constant and ionic strength on reaction rates.
2.3 Primary and secondary salt effects.
2.4 Diffusion controlled reactions in solution (cage effect).
2.5 Acid-base catalysis- Mechanism of acid-base catalysed reactions. - Acidity functions - Bronsted catalysis law.
2.6 Potential energy surfaces.

UNIT-III: Electrochemistry-I (15 Hours)

3.1 Ion-Ion interactions: Debye-Huckel ionic atmosphere model of the strong electrolytes.
3.2 Derivation of Debye - Huckel limiting law - Validity of the equation- extension of Debye-Huckel equation - Significance of activity co-efficient of electrolytes.
3.3 Ion-transport in solutions: Derivation of Debye-Huckel-Onsager equation - validity of the equation - modification of the Onsager equation.
3.4 Ion association:Bjerrum treatment of association - Bjerrum ion association constant-factors influencing ion association- effect of ion association on conductivity.

UNIT-IV: Electrochemistry-II (15 Hours)

4.1 Electrified interfaces -Electrical double layer– Inner Helmholtz Plane, OuterHelmholtz Plane, contact adsorption - Surface excess and its importance.

4.2 Structure of electrical interfaces: Discussion of various models -Helmholtz-perrin,Guoy-chapmann and Stern models.

4.3 Electrocapillarity measurements - Lipmann potential - Lippman equation-polarisable and non-polarisable interfaces.

4.4 Electro kinetic effects:Zeta potential and its application to the determination of charge of the colloidal particle - Origin of electro osmosis, Streaming and sedimentation potentials - Electrophoresis.

UNIT-V: Statistical Thermodynamics-I (15 Hours)

5.1 Comparison between classical and statistical thermodynamics.

5.2 Laws of probability -Concept of thermodynamics and mathematical probabilities.

5.3 Distribution laws - Guassian distribution -distribution of distinguishable and non-distinguishable particles - micro and macro states-velocity space and phase space.

5.4 Maxwell-Boltzmann distribution for molecular velocities –

5.5 Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics- comparison and applications.

5.6 Modes of contribution to energy -Fermi energy, negative absolute temperature -ortho and para hydrogen.

Prescribed books:

1. J. Rajaram and J. C. Kuriacose, Kinetics and Mechanism of Chemical Transformations, McMillan India Ltd., 1993.
2. K.J.Laidler, Chemical Kinetics, Harper and Row, New York.
3. J.O.M.Bokris& A.K.N. Reddy, Electrochemistry, Vols 1 and 2 Plenum, NewYork, 1997
4. D. R. Crow, Principles and Applications to Electrochemistry, Chapman and Hall, 1991.
5. S.Glasstone, Introduction to Electrochemistry, Affiliated East West Press, New Delhi, 1960
6. B. Viswanathan et al., Electrochemistry principles and applications.
7. J. Rajaram and J. C. Kuriacose, Thermodynamics for Students of Chemistry, LalNagin Chand, New Delhi, 1986
8. M.C.Gupta, Statistical Thermodynamics, Wiley Eastern, New Delhi, 1990.
9. S.Glasstone, Thermodynamics for Chemists. Affiliated East West Press, New Delhi, 1960.
10. P.W.Atkins, Physical Chemistry, Oxford University Press.
11. K.L.Kapoor, A Text Book of Physical Chemistry, Macmillan India Ltd, 2001

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BIO-INORGANIC CHEMISTRY (SEMESTER-III)

Elective: **Teaching hours: 60**
Code: 17MEM312 **Credits:**

Objectives of the course

Bioinorganic chemical knowledge grows more interesting and more complex with each passing year. As more details about the usage and utility of metals in biological species and more mechanistic and structural information about bioinorganic molecules becomes available, scientists and students continue to turn their attention to this blossoming discipline. Hence, this paper enables the student to understand the role of inorganic substances in biological systems.

Unit-I: (15Hours)

1.1 Essential and trace elements: Selective transport and storage of metal ions: Ferritin, Transferrin and sidorphores; Sodium and potassium transport, Calcium signalling proteins.

1.2 Metalloenzymes: Zinc enzymes–carboxypeptidase and carbonic anhydrase. Ironenzymes–catalase, peroxidase. Copperenzymes – superoxide dismutase, Plastocyanin, Ceruloplasmin, Tyrosinase. Coenzymes - Vitamin-B_{12} coenzymes.

Unit-II: (15Hours)

2.1 Transport Proteins: Oxygen carriers-Hemoglobin and myoglobin - Structure and oxygenation - Bohr Effect. Binding of CO, NO, CN^- to Myoglobin and Hemoglobin.

2.2 Biological redox system: Cytochromes-Classification, cytochrome a, b and c. Cytochrome P-450.

2.3 Non-heme oxygen carriers-Hemerythrin and hemocyanin.
Iron-sulphur proteins- Rubredoxin and Ferredoxin- Structure and classification

Unit-III: (15Hours)

3.1 Nitrogen fixation-Introduction, types of nitrogen fixing microorganisms. Nitrogenase enzyme - Metal clusters in nitrogenase- redox property - Dinitrogen complexes-transition metal complexes of dinitrogen - nitrogen fixation *via* nitride formation and reduction of dinitrogen to ammonia.

3.2 Photosynthesis:photosystem-I and photosystem-II-chlorophylls structure and function.

Unit-IV: (8Hours)

4.1 Metals in medicine: Metal Toxicity of Hg, Cd, Zn, Pb, As, Sb.

4.2 Therapeutic Compounds: Vanadium-Based Diabetes Drugs; Platinum-Containing Anticancer Agents.Chelation therapy; Cancer treatment.

4.3 Diagnostic Agents: Technetium Imaging Agents; Gadolinium MRI Imaging Agents.

Unit-V: (7Hours)

5.1 Enzymes -General introduction and properties -nomenclature and classification. Enzyme kinetics, free energy of activation and the effects of catalysis.

5.2 Michelis - Menton equation - Effect of pH, temperature on enzyme reactions. Factors contributing to the efficiency of enzyme study.

Prescribed books:

1. Williams,D.R. –Introdution to Bioinorganic chemistry.
2. F.M. Fiabre and D.R. Williams– The Principles of Bioinorganic Chemistry,RoyolSoceity of Chemistry, Monograph for Teachers-31
3. K.F. Purcell and Kotz., Inorganic chemistry, WB Saunders Co., USA.
4. G.N. Mugherjea and Arabinda Das, Elements of Bioinorganic Chemistry - 1993.
5. M.Satake and Y.Mido, Bioinorganic Chemistry- Discovery Publishing House, New Delhi (1996)
6. M.N. Hughes, 1982, The Inorganic Chemistry of Biological processes, II Edition, Wiley London.
7. R. W. Hay, Bio Inorganic Chemistry, Ellis Horwood, 1987.
8. R. M. Roat-Malone, Bio Inorganic Chemistry, John Wiley, 2002.
9. T. M. Loehr, Iron carriers and Iron proteins, VCH, 1989.
10. S. J. Lippord, Progress in Inorganic Chemistry, John Wiley, Vol. 30, 1983.

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INORGANIC CHEMISTRY–IV (SEMESTER-IV)

Core: **Teaching hours: 75**
Code: 17MEM413 **Credits:**

Objectives:

This paper exposes student to the stereo chemical aspects of the co-ordination compounds. This paper also deals about the chemistry of transition elements, environmental chemistry and photochemistry.

Unit-I: Nuclear chemistry (15 Hours)

1.1 ***Nuclear properties***-nuclear spin and moments, origin of nuclear forces, salient features of liquid drop and shell models of the nucleus.

1.2 ***Nuclear reactions*** – Bethe's notation, classification of nuclear reactions, nuclear cross section, Q-value, compound nucleus theory.Nuclear fission and fusion reactions as energy sources. Photonuclear and thermal nuclear reactions. Stellar energy. Elementary particles-concept of Boson, types of quarks and mass energy relationship.

Unit-II: Radioactivity (15 Hours)

2.1 Modes of ***Radioactive decay***- orbital electron capture, nuclear isomerism, internal conversion.***Detection and determination of radioactivity***- by cloud chamber, bubble chamber, proportional counter and G.M. Counter.

2.2 ***Application of radioisotopes***: radioactive tracers in the study of reaction mechanism and field of medicine -diagnosis and treatment. Neutron activation analysis, isotope dilution analysis, rock dating and radiocarbon dating method.

Unit-III: Photochemistry (15 Hours)

3.1 Introduction - Mechanism - Photoredox, Photoisomerisation, photodissociation and photosubstitution reactions in coordination chemistry - Photochemistry of Cr^{3+} and $[Ru(bpy)_3]^{2+}$ complexes-Photosensitized reactions.

3.2 Photoelectrochemistry - Aspects of solar energy conversion - photovoltaic and photogalvanic cells, Photo assisted electrolysis of water - Photomoleculardivices and machines - Fluorescent switches - light harvesting antennae.

Unit-IV: Acid-base and donor-acceptor chemistry (15 Hours)

4.1 ***Bronsted-Lowry concept*** - Brønsted–Lowry Strength of Oxyacids- Pauling's rules.

4.2 ***Lewis Acid–Base Concept***-Group characteristics of Lewis acids,Factors affecting Lewis Acidity and Basicity.

4.3 ***Hard and soft acids and bases***-Theory of Hard and Soft Acids and Bases, HSAB Quantitative Measures-Drago–Wayland equation. Interpretation of hardness, Chemical consequences of hardness.

Unit-V: Environmental Chemistry (15 Hours)

5.1 Water Quality Standards, BOD, COD. Ambient air quality standards: Photochemical smog, oxides of nitrogen. Toxic Chemicals in environment: LD_{50}, Toxicity of Hg, Pb, Cr.

5.2 Hazardous Wastes: Nature and sources of hazardous wastes - classification, characteristics and constituents - transport and effects - hazardous wastes in Geosphere, Hydrosphere, Biosphere and Atmosphere - reduction, treatment by physical and chemical methods - Thermal treatment methods - Biodegradation of wastes - Disposal of hazardous wastes.

5.3 Waste management and Industrial byproducts - Natural hazards and managements - control of subsurface migration of Hazardous Waste.

Prescribed books:

1. K.F. Purcell and J.C. Kotz, 1977, Inorganic Chemistry – WB Saunders Co., USA.
2. F.A. Cotton and G. Wilkinson, 1988, Advanced Inorganic Chemistry –A Comprehensive Text, V. Edition, John Wiley & Sons.
3. Huheey, 1993, Inorganic Chemistry – Principles, Structure and Reactivity; IV Edition, Harper Collins, NY.
4. U. Malik, G.D Tuli and R.D. Madan 1992 Selected Topics in Inorganic Chemistry.
5. K.K.Rohatgi Mukherjee, 1978, Fundamentals of Photochemistry, Wiley Eastern Ltd.
6. Balgani, Inorganic Photochemistry.
7. A.K.De., Environmental Chemistry, 2nd Ed., Wiley Eastern 1989.
8. S.F.A. Kettle, 1973, Coordination Chemistry, ELBS.
9. M.C. Day and J.Selbin, 1974, Theoretical Inorganic Chemistry, Van No strand Co., NY.
10. N.N. Greenwood, Elementary Inorganic Chemistry.
11. D.F. Shrivers, P.W. Atkins and C.H. Langfor 1990, Inorganic Chemistry, CH Langford, OUP.
12. Sodhi, Environmental Chemisty.
13. M.M. Varma, Hazardous and Industrial Wastes – Ed. HMCRI, 1988.

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ORGANIC CHEMISTRY–IV (SEMESTER-IV)

Core: **Teaching hours: 75**
Code: 17MEM414 **Credits:**

Objectives:

This paper comprises of two parts namely, basic organic chemistry and bio-organic chemistry. Molecular rearrangements are the work horses of any organic industries. The stability of orbital symmetry forms the basis of organic synthesis. Terpenes, steroids, vitamins, alkaloids and antibiotics are inevitable in day to day life of human beings and other living organisms.

Unit-I: Molecular Rearrangements (15 Hours)

1.1 A detailed study with suitable examples of mechanisms of the following rearrangements: Pinacol-Pinacolone (other than tetra methyl ethylene glycol), Wagner Meerwin, Demjanov, Dienone-Phenol rearrangement.

1.2 Favorskii, Bayer-Villiger, Wolf, Stevens, Sommelet-Hauser rearrangement and Von Richter rearrangement.

Unit-II: Organic Photochemistry (15 Hours)

2.1 General principles - Photochemistry of carbonyl compounds - Norrish type I and Norrish type II reactions - Photo oxidation, photo reduction -PaternoBuchi, di - pi methane rearrangement, Barton rearrangement –

2.2 Cheletropic reactions –*cis-trans* isomerisation - Photochemistry of arenes.

Unit-III: Pericyclic reactions (15 Hours)

3.1 Pericyclic reactions: Classification - Orbital symmetry - Woodward-Hoffmanrules. FMO analysis of electrocyclic, cycloaddition and sigmatropic reactions.Correlation diagrams for butadiene $\rightleftharpoons$ cyclobutene and hexatriene tocyclohexadiene inter conversion; ($\pi^{2s} + \pi^{2s}$) and ($\pi^{2s} + \pi^{4s}$) cycloaddition reaction.

3.2 Cope and Claisen rearrangements.

Unit-IV:Terpenes, Steroids and Medicinal chemistry (15 Hours)

4.1 Terpenes: Classification, structural elucidation by chemical degradation and synthesis of α-Pinene andZingiberene.

4.2 Steroids: Cholesterol - functions and physiological importance (no elucidation). Hormones (testosterone and estrone - biological importance only).

4.3 Diabetes and Hypoglycemic Drugs: Types of Diabetes- Control of Diabetes Insulin- Basic skeletal structure- Uses of Insulin- Oral Hypoglycemic Drugs - Biguanides- General Structure- Uses of Phenformin and Metformin.

4.4 Cancer and Antineoplastic agents: Cancer - Causes and Treatment of Cancer-Antineoplastic agents- Chlorambucil, Mustine- Structure (synthesis not required) and their uses.

Unit-V: Alkaloids, Vitamins and Antibiotics (15 Hours)

5.1 Alkaloids: Synthesis and uses of morphine, quinine and cocaine.

5.2 Vitamins: Vitamin A, B_1, B_2 and B_6 (synthesis only).

5.3 Antibiotics: penicillin, streptomycin (elementary ideas and uses only). Chlorampenicol – synthesis and uses.

Prescribed books:

1. J.March, 1992, Advanced Organic Chemistry, 4th edition, John Wiley & Sons,]rSingapore.
2. Organic Chemistry by Clayden, Greeves, Warren and Wothers, Oxford University Press-2001.
3. I. L. Finar, 1986, Organic Chemistry, Vol. II, 5th edition, ELBS Publications.
4. Molecular Rearrangements. Vol. I and Vol II by Paul de Mayo.
5. Molecular reaction and photochemistry, Charles H. Depuy and Orville, L. Chapman, Prantice Hall of India Pvt. Ltd.
6. Molecular photochemistry, N.J. Turro, W.A. Benjamin Inc., New York, 1965.
7. F.A.Carey and R.J.Sundberg, 2001, Advanced Organic Chemistry, Part B: Reactions and Synthesis, 4th edition, Plenum Press, New York.
8. A Guide Book to Organic Synthesis by R.K. Mackie and D.M. Smith, ELBS Publication.
9. Fundamental Concepts of Applied Chemistry. Dr.Jayashree Ghosh. S. Chand & Company Ltd. New Delhi, Edition-I, 2013, p 140, 145
10. Organic Synthesis by Michael Smith.

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PHYSICAL CHEMISTRY-IV (SEMESTER-IV)

Core: **Teaching hours: 75**
Code: 17MEM415 **Credits : 4**

Objectives:

To learn the concepts of Chemical kinetics, statistical thermodynamics, electrochemistry and macromolecules.

UNIT-I: Chemical Kinetics-III (15 Hours)

1.1 Complex reactions: kinetics of consecutive, reversible, parallel and chain reactions - Rice-Herzfeld mechanism -Explosion limits.

1.2 Methods of studying fast reactions - flow methods, relaxation techniques and flash photolysis.

1.3 Heterogeneous catalysis: Langmuir and BET adsorption isotherms- adsorption coefficient and its significance- Surface area measurement.

1.4 Langmuir – Hinshelwood, Hinshelwood - Rideal and Rideal - Eley mechanisms.

UNIT-II: Electrochemistry-III (15Hours)

2.1 Charge transfer across the electrified interface-its chemical and electrical implications.

2.2 Mechanism of single electrode reaction - Polarization and over potential -types of over potentials.

2.3 Derivation and significance of the basic electrodic equation -Butler-Volmer equation for single stepelectron transfer reactions.

2.4 Significance of exchange current density and symmetry factor

2.5 Nernst and Tafel equation- transfer coefficient - oxygen and hydrogen evolution reaction.

2.6 Hydrogen over potential: Factors influencing the hydrogen over potential and the mechanism.

UNIT-III: Electrochemistry-IV (15 Hours)

3.1 Fuel cells - types of fuel cells - Introductory aspects and applications.

3.2 Hydrogen-oxygen, methanol, solid oxide and Bio-fuel cells.

3.3 Corrosion and passivation of metals:Theories- Evan’s and Pourbaix diagrams.

3.4 Techniques for inhibiting corrosion.

UNIT-IV: Statistical Thermodynamics-II (15 Hours)

4.1 Partition function - evaluation of translational, vibrational and rotational partition functions for mono, diatomic and polyatomic ideal gases.

4.2 Relationship between partition function and thermodynamic quantities E,H,G,A,P,Cv and Cp.

4.3 Third law of thermodynamics-Heat capacities of mono atomic gases and solids-Einstein and Debye models-Debye T^3 equation.

4.4 Entropy of monoatomic gases–Sackur Tetrode equation.

UNIT-V: Macromolecules (15 Hours)

5.1 Introduction and classification of polymers – polymerisation in homogeneous and heterogeneous phases.

5.2 Molecular weight of polymers – Mn, Mw determination - light scattering, viscometryand gel permeation chromatography

5.3 Properties of polymers; crystallinity, glass transition temperature – factors influencing transition temperature.

5.4 Polymer Degradation:Physical methods used in the study of degradation process – thermal degradation of polymers, oxidative degradation of polymers, photo degradation of polymers, antioxidants and stabilizers - biodegradation.

Prescribed books:

1. J.Rajaram and J.C.Kuiracose, Kinetics and Mechanism of Chemical Transformations, McMillan India Ltd., 1993.
2. K.J.Laidler, Chemical Kinetics, Harper and Row, New York.
3. J.O.M.Bokris& A.K.N. Reddy, Electrochemistry, Vols 1 and 2 Plenum, New York, 1997
4. D.R..Crow, Principles and Applications to Electrochemistry, Chapman and Hall, 1991.
5. B. Viswanathan et al., Electrochemistry principles and applications.
6. J.Rajaram and J.C.Kuiracose, Thermodynamics for Students of Chemistry, LalNagin Chand, New Delhi, 1986.
7. S.Glasstone, Introduction to Electrochemistry, Affiliated East West Press, New Delhi, 1960.
8. M.C.Gupta, Statistical Thermodynamics, Wiley Eastern, New Delhi, 1990.
9. S.Glasstone, Thermodynamics for Chemists. Affiliated East West Press, New Delhi, 1960.
10. J. M. Gowariker, Text book of Polymer Chemistry.
11. F. W. Billmeyer, Text book of Polymer Science, Wiley Interscience, 1984.
12. P.W.Atkins, Physical Chemistry, Oxford University Press.
13. K.L.Kapoor, A Text Book of Physical Chemistry, Macmillan India Ltd, 2001.

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NANO CHEMISTRY (SEMESTER-IV)

Core: **Teaching hours: 75**
Code: 17MEM416 **Credits : 4**

Objective:

To introduce the basics of classification of nanotechnology.To learn the instrumental techniques used in characterization of nanomaterials.Gain more knowledge in various application of nanomaterials.

UNIT-I Basics and classification of nanomaterials (15 hours)

1.1 **Fundamentals in Nanochemistry:**Introduction – definition for nanoscience & nanotechnology – perspective length scales – Unique properties of nanomaterials – significance of surface to volume ratio in nanotechnology. Advantages and disadvantages of nanomaterials - Toxicity of Nanomaterials - Exposure to Nanomaterials.

1.2 **Classification of nanosystem based on dimension:** Zero Dimension (nanoparticles), one dimension (nanowires, nanorods, nanotubes-SWCNT & MWCNT), two-dimension (nanofilms), three-dimension (bulk).

UNIT-II Synthesis of nanomaterials (15 hours)

2.1 **Physical method:** Inert gas condensation, Arc discharge method and Laser ablation method.

2.2 **Chemical method:** Chemical reduction method, Sol-gel technique, Chemical vapor deposition andhydrothermal method.

2.3 **Biological method:** Using plant extract.

UNIT-III Structural Characterization of nanomaterials (15 hours)

3.1 **Physical characterization:** Crystal morphology by XRD and particle size determination.

3.2 **Surface characterization:** Principle and instrumentation of Scanning electron microscopy (SEM), Tunneling electron microscopy (TEM) and Atomic fluorescence spectroscopy (AFM).

UNIT-IV Properties of Nano-materials (8 hours)

4.1 **Properties of Metal and metal oxide nano-materials in** Electrical, Magnetic and optical and Photocatalytic properties.

4.2 Types of CNTs – Electronic properties of CNTs – Band structure of Graphene – Band structure of SWNT from graphene.

UNIT-V Application of nanomaterials (7 hours)

5.1 Nanomaterials in Solar cells, conversion and storage, hydrogen storage, Fuel cells, Gas sensors, Field emission display, electrochemical system.

5.2 **Environmental application –** Nanotechnology in agriculture, Microbiol fuel.

5.3 **Nano-materials in medicine –** Silver and gold nanoparticles and Iron oxide nanoparticles in cancer therapy – *in vivo* cancer detection and therapy.

5.4 **Biological application** in antibacterial and antimicrobial activities of metal and metal oxide nanoparticles.

Books for Study:

1. Nanotechnology, S.Shanmugam, MJP Publishers, Chennai (2010).
2. A Handbook on Nanochemistry, Patrick Salomon, Dominant Publishers and Distributers, New Delhi.
3. Nanobiotechnology, S. Balaji, MJP Publishers, Chennai (2010).
4. Nano: The Essentials, T. Pradeep, Tata Mc-Graw Hill, New Delhi (2007).

Books for Reference:

1. The Chemistry of Nanomaterial: Synthesis, Properties and Applications, Vol. I and II, CNR Rao, Springer (2006).
2. Nanotechnology: Basic Science and Emerging Technologies, Mick Wilson, KamaliKannangara, Geoff Smith, Michelle Simmons, BurkhardRaguse, Overseas Press (2005).
3. Nanochemistry, G. B. Segreev, Elsevier, Science, New York, (2006).
4. D. Fennell Evans and HåkanWennerström, The Colloidal Domain: Where Physics, Chemistry, Biology, and Technology Meet, Wiley - VCH, 1999.
5. Krister Holmberg, Bo Jönsson, Bengt Kronberg, BjörnLindman Surfactants and Polymers in Aqueous Solution, 2nd Edition, John – Wiley, 2002.
6. C.N.R.Rao, A.Muller, A.K.Cheetham (Eds), The chemistry of nanomaterials Vol I & II: Synthesis, properties and applications, Eds.,Wiley VCH VerlagGmbh&Co, Weinheim, 2006.
7. GlebBorisovichSergeev, Nanochemistry, Elsevier , 2006
8. Gerhard Gompper and Michael Schick (Eds), Soft Matter:Vol 1 & 2, John-Wiley and Sons, Inc., 2006.
9. Hans Kuhn and Horst Forsterling, Principles of Physical chemistry, Understanding molecules, molecular assembles, supramolecular machines, John – Wiley and Sons Ltd, 2002.