



# INDRASHIL UNIVERSITY

(Established by an Act under the Gujarat Private Universities Act, 2009)

*A Life Sciences University*

*Sustained Excellence with Relevance*



योग: कर्मसु कौशलम्

## INDRASHIL UNIVERSITY

**INDRASHIL UNIVERSITY**

**DEPARTMENT OF CHEMISTRY (CHE)**

**PROGRAM STRUCTURE**

**B. Sc CHEMISTRY (Hons) 2019-2022**



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<b>SEMESTER - I</b>			
<b>Subject code</b>	<b>Subject Name</b>	<b>L-T-P</b>	<b>Credits</b>
CH1 101	Foundation Course for Biology (Group A) / Foundation Course for Mathematics (Group B)	2-0-0	2
CH1 102	Basic Physics I	3-1-0	4
CH1 103	Basic Chemistry I	3-1-0	4
CH1 104	Basic Life Sciences I	3-0-0	3
CH1 105	Environmental Science	3-1-0	4
CH1 106	Lab 1 Volumetric Analysis	0-0-4	2
CH1 107	Lab 2 Physics I	0-0-4	2
CH1 108	Lab 3 Life Sciences I	0-0-2	1
IU1 001	Soft Skills-I	1-0-0	0
	<b>Total</b>	15L+3T+10P	<b>22</b>
<b>SEMESTER - II</b>			
<b>Subject code</b>	<b>Subject Name</b>	<b>L-T-P</b>	<b>Credits</b>
<b>CH1 201</b>	Basic Physics II	3-1-0	4
<b>CH1 202</b>	Basic Chemistry II	3-1-0	4
<b>CH1 203</b>	Basic Life Sciences II	3-1-0	4
<b>CH1 204</b>	Mathematics and Statistics	3-1-0	4
<b>CH1 205</b>	Communication Skills I	1-1-0	2
<b>CH1 206</b>	Lab 4 Organic and Physical Chemistry	0-0-4	2
<b>CH1 207</b>	Lab 5 Physics II	0-0-4	2
<b>CH1 208</b>	Lab 6 Life Sciences II	0-0-4	2
	<b>Total</b>	13L+5T+12P	<b>24</b>



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<b>SEMESTER – III</b>			
<b>Subject code</b>	<b>Subject Name</b>	<b>L-T-P</b>	<b>Credits</b>
CH2 101	Physics III	3-0-0	3
CH2 102	Stereochemistry of Cycloalkanes, Conformational Analysis and Aromaticity	3-0-0	3
CH2 103	Chemical Thermodynamics	3-0-0	3
CH2 104	Life Sciences III	3-0-0	3
CH2 105	Industrial Chemistry	2-0-0	2
CH2 106	Seminar & Soft Skills II	1-0-0	1
CH2 107	Lab 7 Organic Qualitative Analysis	0-0-8	4
CH2 108	Lab 8 Physics III	0-0-4	2
CH2 109	Lab 9 Life Sciences III	0-0-4	2
IU 2 000	Community Connect Project	1-0-0	1
	<b>Total</b>	<b>16L+16P</b>	<b>24</b>
<b>SEMESTER – IV</b>			
<b>Subject code</b>	<b>Subject Name</b>	<b>L-T-P</b>	<b>Credits</b>
CH2 201	Physics IV	3-0-0	3
CH2 202	Periodicity of Elements, Chemistry of s and p Block Elements, Noble gases	3-0-0	3
CH2 203	Chemical Kinetics, Catalysis and Chemical Equilibrium	3-0-0	3
CH2 204	Life Sciences IV	3-0-0	3
CH2 205	Organic Chemistry	3-0-0	3
CH2 206	Communication Skills II	1-1-0	0
CH2 207	Seminar	1-0-0	1
CH2 208	Lab 10 Inorganic Qualitative Analysis and Gravimetric Analysis	0-0-6	3
CH2 209	Lab 11 Physical Chemistry	0-0-6	3
CH2 210	Lab 12 Life Sciences IV	0-0-4	2
CH2 211	Lab 13 Physics	0-0-4	2
	<b>Total</b>	<b>17L+1T+20P</b>	<b>26</b>



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SEMESTER - V			
Subject code	Subject Name	L-T-P	Credits
CH3 101	Organic Reactions of Carbonyl Compounds, Sulphur Containing Compounds	3-1-0	4
CH3 102	Chemistry of d and f Block Elements	3-1-0	4
CH3 103	Electrochemistry and Surface Chemistry	3-1-0	4
CH3 104	Molecular Spectroscopy and Structure Elucidation	3-1-0	4
CH3 105	Lab 14 Organic Chemistry	0-0-6	3
CH3 106	Lab 15 Physical and Inorganic	0-0-6	3
CH3 107	Lab 16 Analytical Tools	0-0-6	3
	<b>Total</b>	12L+4T+18L	<b>25</b>
SEMESTER - VI			
Subject code	Subject Name	L-T-P	Credits
CH3 201	Hetreocycles, alkaloids, terpenes, drugs and pharmaceuticals	3-1-0	4
CH3 202	Organometallic and Catalysis	3-1-0	4
CH3 203	Quantum Chemistry	3-1-0	4
CH3 204	Bioorganic and Bioinorganic Chemistry	3-1-0	4
CH3 205	Chemistry Project/ Industrial visit/Comprehensive viva (6 sems)	0-0-12	6
IU -CCID	Innovative project (concept, conceive, implement and deliver)		2 *
	<b>Total</b>	12L+4T+12P	<b>24</b>

**\*Student can take up this innovative project in-between Semesters III & IV.**

**Credit to hours calculation:**

Lecture: 1h = 1C

Practicals: 2h = 1C

**Total Credits: 145**



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## **B. Sc. Chemistry (Hons) SEMESTER I**

### **CH1 101 Foundation Course for Biology (Group A) (L-T-P-C: 2-0-0-2)**

#### **Unit 1:**

Origin and evolution of life on earth; Theory of special creation, Cosmogonic theory, Continental Drifting theory; Theory of biogenesis and abiogenesis, Evolution theories (Darwin and Lamarck), Haldane theory of chemical evolution; Theories on structural complementarity of biomolecules and its role evolution. Urey-miller theory –Ribozyme as evidence of life; RNA Vs DNA Vs Protein world; Evidence of DNA; Avery–MacLeod–McCarty experiments Hershey–Chase Exp.; one gene - one enzyme/one polypeptide/one peptide theory. Colonization of microorganisms, Endosymbiotic theory. Taxonomy; Five kingdom classification; Cavalier-Smith’s classification. Scope of biology in research and industry.

#### **Unit 2:**

Buffer Systems in living organisms, biological applications of pH, Some breakthrough discoveries in the field of Biology and Chemistry: Louis Pasteur (Fermentation & microbiology); Vaccination-Edward Jenner, penicillin-Alexander Fleming (1920s to 1930s), Tetracycline-Benjamin Minge Duggar (1945), The Human Retrovirus HIV (1980s)-Robert Gallo and Luc Montagnier, DNA Structure and function-James Watson and Francis Crick (1950s); Bragg's x-ray crystallography, Magic bullet of Paul Ehrlich (Salvarsan) and Aspirin-1899 Bayer, Insulin-1922, Global warming and emergence of diseases. Concepts of Multi drug resistance. Role of chemists in drug discovery and biological research.

#### **Text Books:**

1. No Text book is preferred, suggested to take Lecturer’s Notes.

#### **Reference Books:**

1. DNA: The Secret Life by James D. Watson, Andrew Berry, Publisher: Alfred A Knopf, 2003.
2. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA
3. Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C., Gelbart, W. M. An “Introduction to Genetic Analysis”, W. H. Freeman & Company, New York.
4. Lehninger Principles of Biochemistry by Albert L. Lehninger, David L. Nelson, Michael M. Cox, University Michael M Cox, W. H. Freeman, 2005
5. Autobiographies of Scientists (Articles published in annual reviews)
6. Brock’s biology



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## **CH1 101 Foundation Course for Mathematics (Group B) (L-T-P-C: 2-0-0-2)**

### **Unit 1: Basic Mathematics**

Basic algebraic rules, Function, Exponential and logarithmic function, Solving quadratic equation, Basic geometry, Trigonometry

### **Unit 2: Differential Calculus**

Basic concepts of a limit, Continuity and differentiability of function of one and several variables, Rules of differentiation (Without proof), Derivative of implicit functions, Derivative of parametric functions, Indeterminate forms, Applications of Derivatives: Increasing & decreasing functions, maxima and minima, concavity & convexity of a function

### **Unit 3: Integral Calculus**

Standard integration formulae, integration by the method of substitution, Integration by parts, Integration by the method of partial fractions, properties of definite integrals (Without proof), Evaluation of definite integrals, Area under a curve as a definite integral

### **Unit 4: Differential Equations**

Formulation of ordinary differential equations, Degree and order of ODE, First order ODE, Variable separation method, Homogeneous and linear first order ODE, Applications: Growth and Decay problem, Chemical reactions

### **Reference Books:**

1. The calculus with Analytical Geometry by Louis Leithold, 1981.
2. Differential calculus by shanty narayan, 1996.
3. Thomas' Calculus, 13th Edition, George B. Thomas, Jr., Maurice D. Weir, Joel R. Hass.
4. Introduction to calculus by V. M. Shah, 1980.
5. Calculus and Analytical geometry by G. B. Thomas Jr and Finney F. L.



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## **CH1 102 Basic Physics I (L-T-P-C: 3-1-0-4)**

### **Unit 1: Vector Physics**

Introduction to Scalar and Vectors, Dot and Cross Products, Triple Products and Its Physical Interpretation,  $\nabla$  Operator, Vector Operations: Gradient, Divergence and Curl, Their Physical Interpretation, Gauss' Divergence Theorem, Stokes Theorem, Problems.

### **Unit 2: Motion and Central Force**

Motion under a central force, Conservation of angular momentum, Kepler's laws, Gravitational Field and potential due to spherical bodies, Gauss and Poisson equations, Gravitational self-energy, Two-body problem; Reduced mass, scattering by hard spheres, Centre of mass and laboratory reference frames, Collisions in 2D & 3D, Illustrative problems from text books

### **Unit 3: Solid State Physics**

Crystal Lattice and Translation Vectors, Unit Cell, Basis, Symmetry Operations, Point Groups and Space Groups, Types of Lattices, Simple Crystal Structures, X-ray Diffraction, Bragg's Law, X-ray Diffraction methods: Laue method, Rotating Crystal Method, Powder Method, Reciprocal Lattice, Illustrative examples.

### **Unit 4: Mechanics and Continuous Media**

Elastic constants of an isotropic solid, Poisson's ratio, Relations connecting the elastic Constants, Determination of Young's Modulus of a Material, Determination of Poisson's ratio ( $\sigma$ ) of rubber, Dynamical method (Maxwell's needle) of determination of the coefficient of rigidity ( $\eta$ ) of a wire. Bending of beam, Bending Moment, The cantilever, Determination of 'Y' of the material of a cantilever – case study.

### **Text Books:**

1. Introduction to Classical Mechanics by R. G. Takwale and P. S. Pauranik (Tata McGraw-Hill Pub. Com. Ltd.)
2. Engineering physics by R. K. Gaur and S. L. Gupta.

### **Reference Books:**

1. Mechanics by D.S. Mathur (S. Chand & Co. Ltd.)
2. Mathematical Methods in Physical Sciences by M. L. Boas



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## CH1 103 Basic Chemistry I (L-T-P-C: 3-1-0-4)

### Unit 1: Atomic Structure

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of  $\psi$  and  $\psi^2$ . Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

### Unit 2: Principles of Volumetric Analysis

Acids and bases: Modern theory of acids and bases – Bronsted –Lowry concept and Lewis concept, factors that influence the strength of acids and bases. Definition of pH and pKa. Buffers – mechanism of buffer action – Henderson – Hasselbach equations. (problems also)- Hydrolysis of salts – neutralization. Hydrolysis of salts of strong acid and weak base and salt of weak acid and strong base- derivation of  $K_a$ ,  $K_b$  and  $K_w$  and problems.

Redox Reactions: Oxidation and reduction reactions – oxidation number concept, balancing redox equations by oxidation number method and ion electron method – equivalent weight of oxidizing and reducing agents.

Mole concept, Equivalent weight, atomic weight, molecular weight, concentration terms - ppm, mole fraction, normality, molarity, molality. Principles of titrations – standard solutions – primary and secondary standards – types of titrimetric analysis– neutralization, redox, precipitation titrations. Indicators - neutralization –redox indicator, universal indicators.

### Unit 3: Gaseous State

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of  $\sigma$  from  $\eta$ ; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. Vander Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.





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## **Unit 4: Basics of Organic Chemistry**

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.

Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis-trans and, syn-anti isomerism E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

## **References Books:**

1. Principles of physical chemistry by Prutton and Marron.
2. Text Book of Physical Chemistry by Soni and Dharmahara.
3. Text Book of Physical Chemistry by Puri and Sharma.
4. Text Book of Physical Chemistry by K. L. Kapoor.
5. Organic Chemistry by J. Clayden.
6. Stereochemistry of Organic Compounds by D. Nasipuri
7. Stereochemistry of Organic compounds by E L Eliel.



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## **CH1 104 Basic Life Sciences I (L-T-P-C: 3-0-0-3)**

### **Unit 1:**

Basics of living organism's classification. Five kingdom classification.

Introduction and classification of organisms by cell structure (Prokaryote and Eukaryote), cytosol, compartmentalization of eukaryotic cells, cell fractionation.

Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model.

### **Unit 2:**

Cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure, function including role in protein segregation.

Golgi complex: Structure, biogenesis and functions including role in protein secretion.

### **Unit 3:**

Lysosomes: Vacuoles and micro bodies: Structure and functions

Ribosomes: Structures and function including role in protein synthesis.

Mitochondria: Structure and function, Genomes, biogenesis.

Chloroplasts: Structure and function, genomes, biogenesis

Nucleus: Structure and function, chromosomes and their structure.

### **Unit 4:**

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. Concepts of cell division and cell death.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

### **Suggested Readings:**

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8<sup>th</sup> edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7<sup>th</sup> edition. Pearson Benjamin Cummings Publishing, San Francisco.



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## **CH1 105 Environmental Science (L-T-P-C: 3-1-0-4)**

### **Unit 1: Ecosystems and Biodiversity**

- a. Concept of an ecosystem
- b. Structure and functions of an ecosystem
- c. Producers, consumers and decomposers
- d. Food chain, food webs and ecological pyramids
- e. Characteristic features of the following ecosystems: Forest ecosystems, Desert ecosystem, Aquatic ecosystems.
- f. Value of biodiversity: Consumptive use and productive use.

### **Unit 2: Natural Resources**

Definition, scope and importance. Need for public awareness:

- a. Forest resources: Uses and over-exploitation. Deforestation, mining and construction of dams.
- b. Water resources: Uses and over-utilization. Effects of over utilization of surface and ground (sub- surface) water.
- c. Mineral resources: Uses and exploitation, environmental effects of extraction and use of mineral resources.
- d. Food resources: World food problems, Effects of modern agriculture: by using fertilizers and pesticides.
- e. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.

### **Unit 3: Environmental Pollution**

- a. Definition
- b. Causes, effects and control measures for i. Air pollution ii. Water pollution iii. Soil pollution iv. Noise pollution. Global warming and Ozone layer depletion. Environmental protection Act.
- c. Role of individual in prevention of pollution

### **Unit 4: Social Issues and the Environment**

1. Water conservation, rain water harvesting and watershed management.
2. Population explosion and its impact on environment.
3. Environmental and human health
4. Role of Information Technology in Environmental and human health.

### **Unit-V: Environment toxicology**

- a. Introduction to Ecotoxicology
- b. Routes of entry and movement of toxic substances in environment
- c. Fate of contaminants in environment and individual organisms – Effect of Mercury and Lead
- d. Ecotoxicological testing
- e. Revision classes

### **Reference Books:**

1. Environmental Studies by Dr. M. Satyanarayana, Dr. M.V.R.K. Narasimhacharyulu, Dr. G. Rambabu and Dr. V. Viveka Vardhani Published by Telugu Academy, Hyderabad.
2. Environmental Studies by R.C. Sharma, Gurbir Sangha published by Kalyani Publishers.
3. Environmental Studies by Purnima Smarath published by Kalyani Publishers.



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## **CH1 106 Lab 1 Volumetric Analysis (L-T-P-C: 0-0-4-2)**

### **1. Titrimetric Analysis**

- Calibration and use of apparatus
- Preparation of solutions of different Molarity/Normality of titrants

### **2. Acid-Base Titrations**

- Estimation of carbonate and hydroxide present together in mixture.
- Estimation of carbonate and bicarbonate present together in a mixture.
- Estimation of free alkali present in different soaps/detergents

### **3. Oxidation-Reduction Titrimetry**

- Estimation of Fe(II) and oxalic acid using standardized  $\text{KMnO}_4$  solution.
- Estimation of oxalic acid and sodium oxalate in a given mixture.
- Estimation of Fe(II) with  $\text{K}_2\text{Cr}_2\text{O}_7$  using internal (diphenylamine, anthranilic acid) and external indicator.

### **Reference:**

- A Text-Book of Volumetric Analysis by H W. Schimpf.

## **CH1 107 Lab 2 Physics I (L-T-P-C: 0-0-4-2)**

- Basic measurement techniques (Vernier calliper, Screw gauge)
- Newton's rings
- Full wave, Half wave Rectifier
- Melde's Experiment
- The Diffraction Grating Spectrometer
- Series and Parallel Resonance Circuit
- Refractive index of liquid
- Measurement of surface tension of a liquid by capillary rise method

## **CH1 108 Lab 3 Life Sciences I (L-T-P-C: 0-0-2-1)**

- Microscopy
- Mitosis and the Cell Cycle in Onion Root-Tip Cells
- Cell Counting and viability
- Blood Smear Preparation and Staining (Horizontal staining procedure)
- Permanent slide preparation
- Staining of Cell Organelle (mitochondria).



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## **IU1001 Soft Skills I (L-T-P-C: 1-0-0-0)**

### **Unit 1: Self Analysis and Attitude**

- SWOT Analysis
- Who am I?
- Factors influencing Self Perception
- Self Esteem
- Understanding positive and negative attitudes

### **Unit 2: Goal Setting**

- Types of Goals: Immediate, Short term, Long term
- Strategies to Achieve Goals

### **Unit 3: Creativity**

- Out of box thinking
- Lateral Thinking
- Innovative Thinking

### **Unit 4: Corporate Etiquettes**

- E-mail etiquette, Telephone etiquette,
- Dining etiquette, Office meeting etiquettes, Dress etiquette

### **Text Books:**

1. Soft Skills for Everyone by Jeff Butterfield, Cengage publications

### **Reference Books:**

1. Personality Development and Soft Skills by Barun K Mitra
2. Lateral Thinking: Creativity Step by Step by Edward de Bono



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**SEMESTER - II**

## **CH1 201 Basic Physics II (L-T-P-C: 3-1-0-4)**

### **Unit 1: Thermodynamics**

Heat, Heat Engine, Zeroth Law of Thermodynamics, First Law of Thermodynamics and Its Limitations, Second Law of Thermodynamics, Adiabatic, Isobaric, Isotonic Reactions, Entropy, Reversible and Irreversible Process, Increase of Entropy Concept, Enthalpy.

### **Unit 2: Properties Gas**

Postulates of Kinetic Theory of Gas, Derivation of Pressure and R.M.S. Velocity, Degrees of Freedom, Degrees of Freedom for Mono, Di and Tri Atomic Molecules, Law of Equipartition Energy Expression of Mean Free Path, Transport Phenomena, Derivations: Expression of Viscosity Coefficient, Expression of Thermal Conductivity, Expression of Diffusion Coefficient.

### **Unit 3: Liquefaction of Gas**

Real Gas Correction Terms in Ideal Gas Equation, Van Der Waals Model for Real Gas, Critical Constants, Joule-Thomson Porous Plug Experiment, Cascade Cooling, Linde's Method of Air Cooling, Adiabatic Demagnetization Method and Derivation, Measurement Techniques for Low Temperatures, Refrigerator.

### **Unit 4: Materials Science and Nanotechnology**

Band theory of solids: Introduction, Metals, Insulators and Semiconductors, Energy band gap, Fermi Level and Fermi energy, Types of magnetic material, Superconductivity, Properties of superconductors, Types of superconductors (Type I and Type II), London's Penetration depth, Applications of Superconductors.

Nanotechnology: Introduction to Nano Science and Nano technology, Method of Producing, Properties, Physics of nonmaterial, Quantum Confinement, Synthesis of Nano Materials, Shape Memory Alloys and Metallic Glasses.

### **Text Books:**

1. Brijlal, Subramaniam N. Heat and Thermodynamics, S Chand & Co. Ltd, New Delhi.
2. Gupta, A. B. and Roy, H. P. Heat and Thermodynamics. New Central Book Agency Pvt. Ltd., Kolkata 1999.

### **Reference Books:**

1. Kittel, C. Introduction to Solid State Physics, 8th Ed. John Wiley & Sons.
2. Pradeep, T. A. Textbook of Nano science and Nano technology Textbook. Tata McGraw Hill Education Private Limited.



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## CH1 202 Basic Chemistry II (L-T-P-C: 3-1-0-4)

### Unit 1: Chemical Bonding

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules  $N_2$ ,  $O_2$ ,  $C_2$ ,  $B_2$ ,  $F_2$ ,  $CO$ ,  $NO$ , and their ions;  $HCl$ ,  $BeF_2$ ,  $CO_2$ , (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding ( $\sigma$  and  $\pi$  bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.

Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

### Unit 2: Liquid and Solid State

Physical properties of liquids: Vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Defects in crystals and liquid crystals.

### Unit 3: Ionic Equilibrium

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di- and triprotic acids (exact treatment).

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.



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Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.

Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

## **Unit 4: Basics of Organic Chemistry**

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Chemistry of Aliphatic Hydrocarbons, Carbon-Carbon sigma bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

Carbon-Carbon pi bonds: Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes

## **Reference Books:**

1. Physical chemistry by Gurudeep Chatwal.
2. Text Book of Physical Chemistry by Soni and Dharmahara.
3. Text Book of Physical Chemistry by Puri and Sharma.
4. Text book of organic chemistry by Morrison and Boyd.
5. A Text Book of Organic Chemistry by Bahl and Arun Bahl.





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## **CH1 203 Basic Life Sciences II (L-T-P-C: 3-1-0-4)**

### **Unit 1:**

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa, Archaea and Unique features of viruses.

### **Unit 2: Basic Techniques of Microbiology**

Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

### **Unit 3: Microbial growth**

Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Gene transfer: Transformation, Transduction and Conjugation. Bacterial differentiation-Endospore and sporulation.

### **Unit 4: Control of Microorganisms**

By physical, chemical and chemotherapeutic Agents Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

### **Suggested Readings:**

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education



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## **CH1 204 Mathematics and Statistics (L-T-P-C: 3-1-0-4)**

### **Unit 1: Introduction to Matrices**

Addition and multiplication of Matrices, special types of matrices and their properties. Determinant of matrices of order 2, 3 and 4, inverse of a matrix, Cayley- Hamilton theorem (Without proof) & Characteristic values.

### **Unit 2: Elementary operations of Matrices**

Elementary operations and Elementary matrices, Rank of a matrix, Invariance of rank under elementary operations, Row reduced echelon form of a matrix, homogenous and Non-homogeneous system of linear equations, Cramer's rule.

### **Unit 3: Reorientation**

Definition of probability, Exhaustive events, Pair wise independent events, Multiplicative law of probability, Conditional probability, Baye's theorem

Probability Distributions: Random variable, Mathematical Expectation, Binomial, Poisson and Normal distributions.

### **Unit 4: Statistics**

Descriptive Statistics: Mean, Median, Mode, Standard deviation, Skewness

Curve Fitting: Fitting of Linear, Quadratic, Exponential and Logarithmic curves, Least squares method

Correlation and Regression: Bivariate distribution, Correlation coefficients, Regression lines, Formulas for Regression coefficients, Rank correlation

### **Suggested books:**

1. E. Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley (1999)
2. Matrices by J.N. Kapur and M.K. Singal.
3. An introduction to linear algebra by V. Krishnamurthy, V.P. Mainra and J. L. Arora.
4. A text book of matrices by Shantinarayan and R. K. Mittal.
5. Probability and Statistics by Johnson Richard A., Miller and Freund's - (8th Edition).
6. Gupta, S.P., Statistical Methods, Sultan Chand and Sons, New Delhi



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## **CH 1 205 Communication Skills I (L-T-P-C: 1-1-0-2)**

### **Unit 1: Communication Skills**

Importance of Communication Skills, Communication Cycle, Types, Flows, Barriers, Non-verbal communication

### **Unit 2: Listening skills**

Types of Listening, Barriers to Effective Listening, Tips to improve Listening Skills

### **Unit 3: Grammar**

Articles, Prepositions, Tenses, Concord, Adjectives & degrees of Comparison, Adverbs

### **Unit 4: Speaking Skills**

Impromptu, Short situational dialogues/conversation, Short speeches, Presentations

### **Unit 5: Reading Skills**

Difference between Skimming & Scanning, identifying main idea and topic, guessing the meanings of words

### **Text Books:**

1. "Communication Skills", - Dr. Sanjay Kumar and Dr. Pushp Lata, Oxford University Press
2. "Technical Communication; Principles and Practice" – Meenakshi Raman & Sangita Sharma (Oxford University Press).

### **Reference Books:**

1. "Effective Technical Communication" -M Ashraf Rizvi
2. "Text Book of Communication Skills" – Vitthal Patel & Unnat Patel, Ria Publishing House
3. "High School English Grammar" –Wren & Martin
4. "Communication Skills" –Asha Kaul, Tata McGraw Hill, 2<sup>nd</sup> Ed.

**Note: Tutorials via Language Lab sessions will be based on the above course.**



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## **CH1 206 Lab 4 Organic and Physical Chemistry (L-T-P-C: 0-0-4-2)**

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization, distillation and sublimation.
3. Determination of the melting points of above compounds and unknown organic compounds (electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Surface tension measurements.  
Determine the surface tension by (i) drop number (ii) drop weight method.  
Study the variation of surface tension of detergent solutions with concentration.
6. Viscosity measurement using Ostwald's viscometer.  
Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.  
Study the variation of viscosity of sucrose solution with the concentration of solute.

### **Reference Books:**

1. B.D.Khosla, Senior Practical Physical Chemistry, R. Chand & Co.
2. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice Hall.
3. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (2001).

## **CH1 207 Lab 5 Physics II (L-T-P-C: 0-0-4-2)**

1. p-n Junction Characteristics
2. Logic Gates
3. e/m ratio by Thomson's Method
4. specific rotation of sugar solution
5. Hall Effect and its measurement
6. Numerical aperture of Fiber optics
7. Study of a Transformer
8. Study of magnetic field of Solenoid

## **CH1 208 Lab 6 Life Sciences II (L-T-P-C: 0-0-4-2)**

1. Preparation of media.
2. Isolation of coliform bacteria from waste water and their identification.
3. Isolation of *Bacillus* spp. from soil sample.
4. Staining methods: Monochrome staining, Gram's staining, Capsule staining.
5. Effect of UV radiation on pigment production of *Serratia marcescens*.



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**SEMESTER - III**

## **CH2 101 Basic Physics III (L-T-P-C: 3-0-0-3)**

### **Unit 1: Optics**

Interference, Types of Interference, Fresnel's biprism, White Light Fringes, Determination of the thickness of a thin sheet of transparent material, interference in thin films, Newton's rings, Michelson interferometer, Feby-Perot interferometer, Diffraction and its types, Fraunhofer diffraction at a circular aperture, Plane diffraction grating, dispersive power of grating, Resolving power of grating, Prism, Telescope and Microscope

### **Unit 2: Waves**

Types of waves, Wave equation development: String case, Ideal string constraints, Solution of String wave, Travelling wave solution for string, Energy in wave motion, Wave speed, speed of sound in air: Newton's formula, Laplace correction.

### **Unit 3: Resolving Power**

Rayleigh's criterion, Resolving power of optical instrument : Telescope and Microscope, Relation between resolving power and magnifying power, Resolving power of a plane diffraction grating, Huygen's and Ramsden's eye-piece. Polarization: Polarization by scattering and by selective Absorption Double refraction, Huygen's theory of double refraction, Nicol's prism, Production and detection of plane, elliptically and circularly polarized lights.

### **Unit 4: Lasers**

Attenuation of light in an optical medium, Thermal equilibrium, Interaction of light with matter, Absorption, Spontaneous emission, Einstein's prediction, Stimulated emission, Einstein relations, Light amplification, condition for stimulated emission to dominate spontaneous emission and absorption, population inversion, active medium, pumping methods, meta-stable states, principle of pumping schemes-three and four level scheme, optical resonant cavity, lasing action, He-Ne Laser, P-N Junction Laser.

### **Reference Books:**

1. A Textbook of Optics, N. Subrahmanyam Brijlal, M. N. Avadhanulu (S. Chand & Co. Ltd.)
2. Optics – Ajay Ghatak, TMH Edition
3. A text book on oscillations, waves & Acoustics by M. Ghosh, D. Bhattacharya (S. Chand)
4. Mechanics, Wave motion & Heat by Francis Weston Sears (Addison Wesley Publication)



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## **CH2 102 Stereochemistry of Cycloalkanes, Conformational Analysis and Aromaticity (L-T-P-C: 3-0-0-3)**

### **Unit 1: Introduction to Stereochemistry**

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis-trans and, syn-anti isomerism E/Z notations with C.I.P rules.

### **Unit 2: Optical Isomerism**

Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

### **Unit 3: Stereochemistry of Cycloalkanes and Conformational Analysis**

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

### **Unit 4: Stereochemistry of Aromatic Hydrocarbons**

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

### **Reference Books:**

1. Stereochemistry of organic compounds E.L. Eliel.
2. Introduction to stereochemistry By Kurt Mislow
3. Stereochemistry of organic compounds D. Nasipuri.
4. Stereochemistry: Conformation and mechanism P. S. Kalsi.



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## **CH2 103 Chemical Thermodynamics (L-T-P-C: 3-0-0-3)**

### **Unit 1: Introduction to Chemical Thermodynamics**

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law: Concept of heat,  $q$ , work,  $w$ , internal energy,  $U$ , and statement of first law; enthalpy,  $H$ , relation between heat capacities, calculations of  $q$ ,  $w$ ,  $U$  and  $H$  for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

### **Unit 2: Thermochemistry**

Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

### **Unit 3: Free Energy Functions**

Gibbs and Helmholtz energy; variation of  $S$ ,  $G$ ,  $A$  with  $T$ ,  $V$ ,  $P$ ; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

### **Reference Books:**

1. Chemical engineering Thermodynamics by M.J. Smith.
2. A textbook of Chemical engineering Thermodynamics By K V Narayanan.
3. Engineering Thermodynamics By P.K. Nag.
4. Fundamentals of Engineering Thermodynamics By Moran M. J and Shapiro.



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## **CH2 104 Life sciences III (L-T-P-C: 3-0-0-3)**

### **Unit 1: DNA Replication**

DNA Replication in prokaryotes and eukaryotes. Stages in DNA replication- initiation, elongation and termination. Enzymes and proteins involved in DNA replication. DNA repair mechanism. Drugs that inhibit DNA replication.

Mutagenesis, Mutations, and Mutants- Terminology, Types of Mutations, Biochemical Basis of Mutants and mutagenesis

### **Unit 2: Transcription**

Introduction to transcription, RNA polymerases, Promoter, terminator and other regulatory elements. Process of transcription; Initiation, elongation and termination, Transcription inhibitors (Rifampicin, Actinomycin D and  $\alpha$ -Amanitin). Types of RNA; mRNA, rRNA and tRNA. Post transcriptional modifications of RNA.

### **Unit 3: Translation**

Genetic codon, Structure and assembly of eukaryotic and prokaryotic ribosomes, peptidyl transferase and aminoacyl tRNA synthetases. Process of translation; Initiation, elongation and termination, Post translational modification. Translation inhibitors (Chloramphenicol, Tetracyclin, Ricin, Neomycin and Puromycin etc.)

### **Unit 4: Recombinant DNA Technology**

Extraction and Purification of nucleic acids, Detection and Quantitation of Nucleic acids, Gel Electrophoresis. Vectors for Gene Cloning- plasmids, ColEI bacteriophages, cosmids, BAC and YAC. Restriction Endonucleases, Ligases, End modification enzymes etc., Selection of recombinants. PCR : basic features and application. Application of recombinant DNA technology, Basic steps involved in RDT, Basic PCR and its applications.

### **Suggested Readings:**

1. Alberts B, Bray D, Lewis J, Raff M, Roberts K, and Watson J.D. "Molecular Biology of the Cell". Garland Science.
2. Watson J.D, Baker T.A, Bell S.P, Gann A, Levine M and Losick R. "Molecular Biology of the Gene" . Benjamin-Cummings Publishing Co.,
3. T.A. Brown, Gene Cloning and DNA Analysis: An Introduction, 7<sup>th</sup> Ed., Wiley Blakwell publication
4. Lewin B. "Genes". Jones & Bartlett Publishers





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## **CH2 105 Industrial Chemistry (L-T-P-C: 2-0-0-2)**

### **Unit 1: Silicate Industries**

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

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

### **Unit 2: Fertilizers**

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate.

### **Unit 3: Batteries**

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

### **Unit 4: Alloys**

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

### **Reference Books:**

1. E. Stocchi: Industrial Chemistry, Vol-I, , Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel s Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
7. B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut



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## **CH2 106 Seminar & Soft skills II (L-T-P-C: 1-0-0-1)**

### **Unit 1: Interpersonal Skills**

- Understanding Professional Relationship
- Respecting Social Protocols
- Handling Social Media
- Showing Basics Office Courtesies
- Image Building

### **Unit 2: Personal Skills**

- Body Language
- Time Management
- Negotiation Skills
- Persuasion Skill

### **Unit 3: Making Effective Presentations**

- Patterns & Methods of Presentation, Oral Presentation: Planning & Preparation
- To learn the skill of presentation, How to prepare the presentation,
- Knowing the audience and their requirements
- Effective ways to deliver presentation
- How to prepare multi-media presentation

### **Unit 4: Group Discussions**

- Purpose (Intellectual Ability, Creativity, Approach to a Problem, Solving, Tolerance)
- Group Behavior
- Analyzing Performance

### **Text Books:**

1. Soft Skills for Everyone by Jeff Butterfield, Cengage publications

### **Reference Books:**

1. Personality Development and Soft Skills by Barun K Mitra
2. Lateral Thinking: Creativity Step by Step by Edward de Bono
3. Teach Yourself to Think by Edward de Bono
4. Six Thinking Hats by Edward de Bono



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## **CH2 107 Lab 7 Organic Qualitative Analysis (L-T-P-C: 0-0-8-4)**

1. Qualitative analysis of Single Organic Compound at least one belonging from each type
2. Type, Preliminary tests, elements, functional group. Physical constants.
  - a. Benzoic Acid, Salicylic Acid, Cinnamic Acid, Phthalic Acid and Oxalic acid
  - b. Beta-Naphthol, Alpha-Naphthol
  - c. Aniline, N-methyl aniline, N, N-Demethyl aniline
  - d. Naphtalene, thiourea, Urea, m-Dinitrobenzene, chloroform, ethyl methyl ketone, ethyl acetate, chlorobenzene
3. Thin Layer chromatography, column chromatography

### **Reference Books:**

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice Hall.
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (2001)

## **CH2 108 Lab 8 Physics III (L-T-P-C: 0-0-4-2)**

1. Diffraction grating
2. Cauchy's constants
3. Fresnel's bi-prism
4. Thermal conductivity of glass
5. Thermal conductivity by Lee's disc method
6. Stefan's constant using filament lamp
7. Magnetic field along solenoid axis
8. Magnetic hysteresis
9. Rigidity by Maxwell's needle method
10. Rigidity by statistical method

## **CH2 109 Lab 9 Life Sciences III (L-T-P-C: 0-0-4-2)**

1. Estimation of DNA by DPA method
2. Estimation of RNA by orcinol method
3. Estimation of protein by Folin Lowry and Bradford's method
4. Isolation and extraction of DNA from bacterial culture using chloroform: isoamyl alcohol method
5. Qualitative analysis of DNA
6. Isolation and extraction of plasmid DNA

## **IU2 000 Community Connect Project (L-T-P-C: 1-0-0-1)**



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**SEMESTER-IV**

## **CH2 201 Physics IV (L-T-P-C: 3-0-0-3)**

### **Unit 1: Nuclear Chemistry**

Structure of atomic nucleus, Segre Chart, Instability of nucleus, Radioactivity, Decay constant and half-life, isotopes, isotones, simple nuclear reactions, “ideal, transient and secular equilibrium”, Q value of nuclear reactions, Threshold energy of nuclear reactions, Energy difference in Chemical and nuclear reaction, Nuclear fission, Nuclear reactor, Nuclear fusion, Energy production in stars, Illustrative examples.

### **Unit 2: Electronics**

Semiconductors, Intrinsic and extrinsic semiconductor structure, PN Junction diode, FB and RB condition for PN junction and IV characteristics, LED, Half wave-full wave rectifier, Photodiode, Varactor Diode, Filter circuits: L, C and  $\Pi$  type filters, Transistor, IV characteristics of CE mode, Binary-octal-hex decimal number system and mutual conversions, Illustrative examples

### **Unit 3: Electricity & Magnetism**

Gauss' Law integration and differential form, Poisson and Laplace equation, Application of Gauss' Law – charge on sphere all cases; charge in hollow sphere all cases, Charging and discharging of LR and LC circuits

Magnetic field and units, Motion of charge in magnetic field, Magnetic Susceptibility and types of material on the bases of its value. Hysteresis.

### **Unit 4: Modern Physics**

Millikan's oil drop experiment for electronic charge, Determination of  $q/m$  of positive rays, Aston mass spectrograph. X Rays production, origin and properties, diffraction of X rays, Bragg's law, Moseley's law. Wave behaviour of particles; De Broglie wave length wave packets and particles; Heisenberg's uncertainty relation; Wave function; Physical interpretation of trapped particles and Probability densities.

### **Reference Books:**

1. Nuclear Physics – An introduction, S. B. Patel, New Age International Limited.
2. Principles of Electronics, V. K. Mehta (S. Chand & Co. Ltd.).
3. Electricity and Magnetism with Electronics, K. K. Tewari (S. chand & Co. Ltd.).
4. Modern physics by G Aruldas and P Rajgopal
5. Modern physics by D Sehgal, K Chopra and N Sehgal (S Chand and Co, New Delhi)
6. Fundamentals of modern physics by J P Agrawal and A Agrawal Pragati Prakashan (Meerut)
7. Concepts of Modern Physics by Bieser (Tata McGraw-Hill)



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## **CH2 202 Periodicity of Elements, Chemistry of s and p Block Elements, Noble Gases (L-T-P-C: 3-0-0-3)**

### **Unit 1: Periodicity of Elements**

s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s & p-block.

- Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
- Atomic radii (van der Waals)
- Ionic and crystal radii.
- Covalent radii (octahedral and tetrahedral)
- Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
- Electron gain enthalpy, trends of electron gain enthalpy.
- Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

### **Unit 2: Chemistry of s and p Block Elements**

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements.

Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses.

Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

### **Reference Books:**

- Principles of Inorganic Chemistry by Puri, Sharma and Kalia Vishal Publications 1996.
- Concise Inorganic Chemistry by J.D. Lee 3rd Ed.
- Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson and Paul. L. Gaus 3rd Ed. Wiley Publishers 2001. Chem.
- Inorganic Chemistry Principles of structure and reactivity by James E. Huhey
- Selected topics in Inorganic Chemistry by Madan, Malik and Tuli.



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## **CH2 203 Chemical Kinetics, Catalysis and Chemical Equilibrium (L-T-P-C: 3-0-0-3)**

### **Unit 1: Chemical Kinetics**

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

### **Unit 2: Catalysis**

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

### **Unit 2: Chemical Equilibrium**

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exergonic and endergonic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants  $K_p$ ,  $K_c$  and  $K_x$ . Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

### **Reference Books:**

1. Chemical Kinetics by K.J. Laidler
2. Chemical Kinetic Methods–Principles of Relaxation techniques & Applications by C. Kalidas.



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## **CH2 204 Life Sciences IV (L-T-P-C: 3-0-0-3)**

### **Unit 1: Cells and Organs of Immune System**

(a) Lymphocytes as main actors; Types of lymphocytes, B cells, T cells and Null cells. (b) Importance of antigen presenting cells in IR. (c) An introduction to the primary (central) and secondary (peripheral) lymphoid organs. Antigens, Antibodies and their Reaction, Antigens, Concept of antigen, immunogen and hapten, Physico-chemical and biological properties of antigens, Various types of antigens, Antigens occurring in bacterial cell. (b) Antibodies- Concept of antibody, immunoglobulin and myeloma proteins, Basic structure of antibodies, Classes of immunoglobulins; Physicochemical and biological properties, Clonal selection and Antibody diversity.

### **Unit 2: Immunity and its Types**

(a) Immunity - Concept of innate (native) and acquired (adaptive) immunity, Types of immunity, Innate immunity: species, racial and individual, Acquired immunity: active and passive; natural and artificial, Concept of herd immunity. (b) Immune response (IR)- Concept and basic functions of IR, two arms (branches) of IR: Antibody mediated (humoral) and cell mediated immune(CMI), Characteristics of IR: Discrimination, diversity, specificity, memory and transferability. (c) Primary and secondary IR

### **Unit 3: Antigen-Antibody Reactions**

(a) Mechanism of antigen-antibody reactions (zone phenomenon); Concept of lattice formation. (b) Principles and applications antigen-antibody reactions, Precipitation reaction, Agglutination reaction, Complement fixation reaction, Immunofluorescence, Enzyme Linked Immunosorbant Assay (ELISA), Radio Immunoassay (RIA); Radio-Allergo-Sorbent test (RAST), Western blot technique. (C ) Various skin tests

### **Unit 4: Immune Disorders**

(a) Concept of hyper and hypo functioning of immune system. (b) Types immune disorder- Hypersensitivity, Autoimmunity and autoimmune disorders. (c) Immunodeficiency. (d) Transplantation immunity, concept of immune suppression. (e) MHC and its importance

### **Suggested Readings:**

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.





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## CH2 205 Organic Chemistry (L-T-P-C: 3-0-0-3)

### Unit 1: Chemistry of Halogenated Hydrocarbons

Alkyl halides: Methods of preparation, nucleophilic substitution reactions –  $S_N1$ ,  $S_N2$  and  $S_Ni$  mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution;  $S_NAr$ , Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

### Unit 2: Alcohols, Phenols, Ethers and Epoxides

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc

Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer-Tiemann and Kolbe's-Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and  $LiAlH_4$

### Reference Books:

1. Organic Chemistry by J. Clayden.
2. Organic Chemistry by R. N. Boyd and R. T. Morrison
3. Text book of Organic Chemistry by (2019) Arun Bahl and B S Bahl, S chand series.
4. Organic Chemistry by P Y Bruice (Pearson, 2019)





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## **CH2 206 Communication Skills II (L-T-P-C: 1-1-0-0)**

### **Unit 1: Business Communication**

Types of Letters and format, complaint letters and letters of regret and adjustment, E-mail-Dos and Don'ts

### **Unit 2: Resume and job application**

### **Unit 3: Speaking Skills**

Presentations based on case lets, Group Discussion & Personal Interview

### **Unit 4: Report Writing**

### **Reference Books:**

1. Business Communication: Asha Kaul
2. Business Correspondence and Report Writing – R.C. Sharma, Krishna Mohan (Tata McGraw)

## **CH2 207 Seminar (L-T-P-C: 1-0-0-1)**



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## **CH2 208 Lab 10 Inorganic Qualitative and Gravimetric Analysis (L-T-P-C: 0-0-6-3)**

### **Inorganic**

- a. Inorganic Qualitative analysis (four mixtures to be analysed including phosphate and Borate)

### **Gravimetric**

- a. Determination of water of crystallisation of given salt.  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ ,  $\text{Mg} \cdot \text{SO}_4 \cdot 7\text{H}_2\text{O}$
- b. Determination of Percentage Purity of given salt ( $\text{Na}_2\text{CO}_3$ ,  $\text{NaHCO}_3$ )

### **Solvent Extraction**

- a. To separate a mixture of  $\text{Ni}^{2+}$  &  $\text{Fe}^{2+}$  by complexation with DMG and extracting the  $\text{Ni}^{2+}$ -DMG complex in chloroform, and determine its concentration by spectrophotometry

### **Ion exchange**

- a. Determination of exchange capacity of cation exchange resins and anion exchange resins.
- b. Separation of metal ions from their binary mixture.
- c. Separation of amino acids from organic acids by ion exchange chromatography.

## **CH2 209 Lab 11 Physical Chemistry (L-T-P-C: 0-0-6-3)**

1. Preparation of buffer solutions of different pH
  - a. Sodium acetate-acetic acid
  - b. Ammonium chloride-ammonium hydroxide
2. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
3. Determination of dissociation constant of a weak acid.
4. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of  $\Delta H$ .
7. Perform the following conductometric titrations:
  - a. Strong acid vs. strong base
  - b. Weak acid vs. strong base
  - c. Mixture of strong acid and weak acid vs. strong base
  - d. Strong acid vs. weak base
8. Potentiometry: -Perform the following potentiometric titrations:
  - a. Strong acid vs. strong base
  - b. Weak acid vs. strong base
  - c. Dibasic acid vs. strong base
  - d. Potassium dichromate vs. Mohr's salt



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## **CH2 210 Lab 12 Life Sciences (L-T-P-C: 0-0-4-2)**

1. Blood smear preparation
2. RBC and WBC enumeration
3. Total count and differential count
4. Blood grouping and Rh typing
5. Separation of lymphocytes from blood
6. Widal test
7. Immunoelectrophoresis and serum electrophoresis
8. Demonstration of detection of Hbs Ag by ELISA
9. Single immune-diffusion techniqueseg. Radial immune-diffusion
10. Blood-glucose estimation

## **CH2 211 Lab 13 Physics (L-T-P-C: 0-0-4-2)**

1. Filter circuit
2. Kater's pendulum
3. Fly wheel
4. Double refraction
5. Polarimeter
6. Small thickness by optical lever
7. Charging-discharging of a capacitor (RC circuit)
8. Transistor amplifier – current, voltage and power gains
9. Figure of merit of a ballistic galvanometer
10. High resistance by substitution method



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**SEMESTER - V**

## **CH3 101 Organic Reactions of Carbonyl Compounds, Sulphur Containing Compounds (L-T-P-C: 3-1-0-4)**

### **Unit 1: Carbonyl Compounds**

Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation,  $\alpha$  - substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner,  $\text{LiAlH}_4$ ,  $\text{NaBH}_4$ , MPV, PDC and PGC); Addition reactions of unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

### **Unit 2: Carboxylic Acids and their Derivatives**

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids; Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group - Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

### **Unit 3: Sulphur Containing Compounds**

Preparation and reactions of thiols, thioethers and sulphonic acids

### **Unit 4: Nitrogen Containing Functional Groups**

Preparation and important reactions of nitro compounds, nitriles and isonitriles. Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between  $1^\circ$ ,  $2^\circ$  and  $3^\circ$  amines with Hinsberg reagent and nitrous acid. Diazonium Salts: Preparation and their synthetic applications.

### **Unit 5: Polynuclear Hydrocarbons**

Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.

### **Reference Books:**

- A guide book to reaction mechanisms in organic chemistry – Peter Sykes
- Mechanism and structure in organic chemistry - S.M.Mukherji&S.P.Singh
- Organic Chemistry - L. G. Wade Jr
- Advanced Organic Chemistry, Part A: Structure and Mechanisms - Francis A. Carey and Richard J. Sundberg



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5. Advanced Organic Chemistry: Part B: Reaction and Synthesis - Francis A. Carey and Richard J. Sundberg
6. Organic Chemistry - Greeves, Warren, and Wothers Clayden
7. Organic Chemistry - Paula Y. Bruice



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## **CH3 102 Chemistry of d and f Block Elements (L-T-P-C: 3-1-0-4)**

### **Unit 1: Coordination Chemistry**

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of  $10 Dq(o)$ , CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of  $10 Dq(o, t)$ . Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.

### **Unit 2: Transition Elements**

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series.

Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)

### **Unit 2: Lanthanoids and actinoids**

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

### **Reference Books:**

1. Principles of Inorganic Chemistry by Puri, Sharma and Kalia Vishal Publications 1996.
2. Concise Inorganic Chemistry by J.D. Lee 3<sup>rd</sup> Ed.
3. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson and Paul. L. Gaus.
4. Chemistry of the elements by N.N. Greenwood and A. Earnshaw Pergamon Press 1989.
5. Inorganic Chemistry by Shriver and Atkins 3<sup>rd</sup> edn Oxford Press 1999.
6. Inorganic Chemistry Principles of structure and reactivity by James E. Huhey, E.A. Keiter and R.L. Keiter 4<sup>th</sup> Ed.
7. Textbook of inorganic chemistry by R Gopalan.
8. Selected topics in Inorganic Chemistry by Madan, Malik and Tuli.



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## **CH3 103 Electrochemistry and Surface Chemistry (L-T-P-C: 3-1-0-4)**

### **Unit 1: Electrochemistry I**

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules.

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

### **Unit 2: Electrochemistry II**

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.

Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass electrodes. Concentration cells with and without transference, liquid junction potential. Fuel Cell: Principle, types and their functioning.

### **Unit 3: Surface Chemistry**

Reaction on Surfaces-Physisorption and chemisorption, adsorption isotherms, derivations of Langmuir adsorption isotherm, mechanism of surface reactions

### **Reference Books:**

1. An Introduction to Electrochemistry- Samuel Glasstone (10th Ed)
2. Electrochemistry by M.S. Yadav.
3. Text book of physical chemistry -Puri& Sharma.
4. Text book of advanced physical chemistry – Gurudeepraj.



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## **CH3 104 Molecular Spectroscopy and Structure Elucidation (L-T-P-C: 3-1-0-4)**

### **Unit 1: Molecular Spectroscopy**

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

General principles Introduction to absorption and emission spectroscopy.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

### **Unit 2: Organic Spectroscopy**

UV Spectroscopy: Types of electronic transitions,  $\lambda_{\max}$ , Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of  $\lambda_{\max}$  for the following systems:  $\alpha,\beta$  unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin - Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds.

Applications of IR, UV and NMR for identification of simple organic molecules.

### **Reference Books:**

1. Instrumental methods of Analysis- Willard, Dean & Settle.
2. Principles of Instrumental Analysis - Skoog, Holler and Wieman.





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3. Introduction to photoelectron spectroscopy - P. K. Ghosh.
4. Applications of Mössbauer Spectroscopy - Green Wood.
5. Structural inorganic chemistry-Mössbauer spectroscopy – Bhide.
6. Spectroscopic identification of organic compounds- Silverstein, Basseler and Morrill.
7. Application of absorption spectroscopy - John R. Dyer.
8. NMR in chemistry -A multinuclear introduction - Willam Kemp.
9. Organic Spectroscopy - William Kemp.
10. Spectroscopic methods in Organic chemistry - DH Williams and I Fleming.
11. Modern NMR techniques for chemistry research - Andrew B Derome.
12. Introduction to organic spectroscopy – Pavia.
13. Applications of Mössbauer spectroscopy -N.N. Greenwood and T.C. Gibb, Chapman & Hall.
14. Principles of Mössbauer spectroscopy-T.C. Gibb, Chapman & Hall.
15. Physical methods for chemists- R.S. Drago, 2nd Ed.
16. Spectroscopy of organic compounds- P. S. Kalsi.



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## **CH3 105 Lab 14 Organic Chemistry (L-T-P-C: 0-0-6-3)**

1. Two organic component mixture separation (Mixture separation of organic acid, base, phenol, neutral components by chemical method)
2. Extraction of caffeine from tea leaves.
3. Preparation of urea formaldehyde.
4. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.
5. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols etc.
6. Preparation of methyl orange.

## **CH3 106 Lab 15 Physical and Inorganic (L-T-P-C: 0-0-6-3)**

### **Physical**

Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:
  - a. Acid hydrolysis of methyl acetate with hydrochloric acid.
  - b. Saponification of ethyl acetate.
3. Compare the strengths of HCl and H<sub>2</sub>SO<sub>4</sub> by studying kinetics of hydrolysis of methylacetate.
4. Determine the rate constant for the inversion of sucrose using a polarimeter

### **Adsorption**

Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal

### **Inorganic**

1. Measurement of 10 D<sub>q</sub> by spectrophotometric method
2. Verification of spectrochemical series.
3. Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs thermodynamic factors.
4. Preparation of acetylacetonato complexes of Cu<sup>2+</sup>/Fe<sup>3+</sup>. Find the  $\lambda_{\max}$  of the complex.
5. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetonone, DMG, glycine) by substitution method



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## **CH3 107 Lab 16 Analytical Tools (L-T-P-C: 0-0-6-3)**

### **UV/Visible spectroscopy**

1. Study the 200-500 nm absorbance spectra of  $\text{KMnO}_4$  and  $\text{K}_2\text{Cr}_2\text{O}_7$  (in 0.1 M  $\text{H}_2\text{SO}_4$ ) and determine the  $\lambda_{\text{max}}$  values. Calculate the energies of the two transitions in different units ( $\text{J molecule}^{-1}$ ,  $\text{kJ mol}^{-1}$ ,  $\text{cm}^{-1}$ , eV).
2. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of  $\text{K}_2\text{Cr}_2\text{O}_7$ .
3. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.
4. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).

### **Colorimeter**

1. Verify Lambert-Beer's law and determine the concentration of  $\text{CuSO}_4/\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$  in a solution of unknown concentration
2. Determine the concentrations of  $\text{KMnO}_4$  and  $\text{K}_2\text{Cr}_2\text{O}_7$  in a mixture.
3. Study the kinetics of iodination of propanone in acidic medium.
4. Determine the amount of iron present in a sample using 1,10-phenanthroline.
5. Determine the dissociation constant of an indicator (phenolphthalein).
6. Study the kinetics of interaction of crystal violet/phenolphthalein with sodiumhydroxide.
7. Analysis of the given vibration-rotation spectrum of  $\text{HCl}(\text{g})$



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**SEMESTER - VI**

## **CH3 201 Heterocycles, Alkaloids, Terpenes, Drugs and Pharmaceuticals (L-T-P-C: 3-1-0-4)**

### **Unit 1: Heterocyclic Compounds**

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction

Derivatives of furan: Furfural and furoic acid.

### **Unit 2: Alkaloids**

Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine

### **Unit 3: Terpenes**

Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral, Neral and  $\alpha$ -terpineol.

### **Unit 4: Drugs & Pharmaceuticals**

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

### **Reference Books:**

1. Organic Chemistry – Volume-I & II – I.L. Finar
2. Heterocycles – R.K. Bansal
3. An introduction to chemistry of heterocyclic compounds – R.M. Acheson
4. An introduction to chemistry of terpenoids and steroids – William Templeton
5. The alkaloids – Kenneth Walter Bentley



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## **CH3 202 Organometallic and Catalysis (L-T-P-C: 3-1-0-4)**

### **Unit 1: Introduction to Organometallic Compounds & Properties**

Definition and classification of organometallic compounds on the basis of bond type.

Concept of hapticity of organic ligands.

Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT.  $\pi$ -acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

### **Unit 2: Reaction Kinetics and Mechanism**

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

### **Unit 3: Catalysis by Organometallic Compounds**

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinson's Catalyst)
2. Hydroformylation (Co salts)
3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)
5. Synthesis gas by metal carbonyl complexes

### **Unit 4: Organometallic and Organic Synthesis**

Reactions of Mg, Li, Cu, Zn, Pd, Co, Cr

### **Reference Books:**

1. Organometallic Chemistry, R. C. Mehrotra and A. Singh, New age international.
2. Metalorganic Chemistry, A. J. Pearson, Wiley.
3. Organo metallic chemistry by R C Malhotra



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## CH3 203 Quantum Chemistry (L-T-P-C: 3-1-0-4)

### Unit 1: Quantum Chemistry

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and “particle-in-a-box” (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.

Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.

Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

### Unit 2: Chemical bonding:

Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of  $H_2^+$ . Bonding and antibonding orbitals. Qualitative extension to  $H_2$ . Comparison of LCAO-MO and VB treatments of  $H_2$  (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic ( $BeH_2$ ,  $H_2O$ ) molecules. Qualitative MO theory and its application to  $AH_2$  type molecules.

### Reference Books:

1. Quantum Chemistry, Ira N. Levine, Prentice Hall.
2. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
3. Concise Inorganic Chemistry by J.D. Lee 3rd edn.
4. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson and Paul.L. Gaus 3rd edn Wiley Publishers 2001. Chem
5. Analytical chemistry by G. L. David Krupadanam, D. Vijaya Prasad, K. Varaprasada Rao, K.L.N. Reddy and C. Sudhakar.



# INDRASHIL UNIVERSITY

(Established by an Act under the Gujarat Private Universities Act, 2009)

*A Life Sciences University*

*Sustained Excellence with Relevance*

## **CH3 204 Bioorganic and Bioinorganic Chemistry(L-T-P-C: 3-1-0-4)**

### **Unit 1: Amino Acids, Peptides and Proteins**

Amino acids, Peptides and their classification.  $\alpha$ -Amino Acids - Synthesis, ionic properties and reactions. Zwitterions,  $pK_a$  values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis

### **Unit 2: Carbohydrates**

Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Disaccharides – Structure elucidation of maltose, lactose and sucrose. Polysaccharides – Elementary treatment of starch, cellulose and glycogen

### **Unit 3: Lipids**

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

### **Unit 4: Nucleic Acids**

Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides.

### **Unit 5: Bio-Inorganic Chemistry**

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to  $Na^+$ ,  $K^+$  and  $Mg^{2+}$  ions: Na/K pump; Role of  $Mg^{2+}$  ions in energy production and chlorophyll. Role of  $Ca^{2+}$  in blood clotting, stabilization of protein structures and structural role (bones).

Bio-Inorganic Chemistry of Iron, Haem Proteins, Vitamin B-12 -Structure and Applications

### **Reference Books:**

1. Bioinorganic Chemistry, L. Bertini, H.B. Gray, S. J. Lippard and S. J. Valentine, Viva Low-Priced Student edition.
2. Principles of Bioinorganic Chemistry, S. J. Lippard and Berg. 8. Bioinorganic Chemistry, K. Hussain Reddy, New Age international Publishers
3. Bio organic chemistry by H. Dugas.
4. Bio inorganic and Bio organic chemistry by P. S. Kalsi.

## **CH3 205 Chemistry Project/ Industrial Visit / Comprehensive Viva (6 sems) (L-T-P-C: 0-0-12-6)**

## **IU CCID Innovative Project (Concept, Conceive, Implement and Deliver) (L-T-P-C: 0-0-0-2)**