Institute for Excellence in Higher Education (IEHE), Bhopal

M.Sc. PREVIOUS Semester: **I**

SUBJECT: CHEMISTRY **PAPER: I**

TITLE: Chemistry of Transition Metal Complexes

Max. Marks: **140**

SYLLABUS

I. (A) ***Metal-Ligand Bonding***

Limitation of crystal field theory, Molecular orbital theory for bonding in octahedral, Tetrahedral & square planar complexes.

(B) ***Metal Ligand Equilibrium in Solution***

Stepwise & overall formation constant & their interaction. Trends in stepwise constant. Factors affecting the stability of metal complexes with reference to the nature of metal ions & ligands, chelate effect, Determination of binary formation constant by potentiometer & spectrophotometer.

II. ***Reaction Mechanism-I***

Reactivity of metal complex, inert & labile complexes, Kinetic application of valence bond & crystal field theory, Kinetics of octahedral substitution reactions, acid hydrolysis, Factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism. Direct and Indirect evidences in favour of conjugate mechanism, Anation reactions, reactions without metal ligand bond cleavage.

III ***Reaction Mechanism-II***

Substitution reactions in square planar complex, Trans effect, mechanism of substitution reaction, Redox reaction, Electron transfer reaction, mechanism of one electron transfer reaction, outer sphere type reaction.

IV. (A) ***Electronic Spectral Studies of Transition metal complexes***

Spectroscopic ground states, correlation Orgel & Tanabe-Sugana diagrams for transition metal complexes (d1-d9 states), selection rule for electronic spectroscopy. Intensity of various type electronic transitions. Calculation of Dq & B parameters, charge transfer spectra.

(B) ***Magnetic properties of transition metal complex***

Magnetic property & determination of magnetic susceptibility, anomalous magnetic moments, quenching of orbital contribution, orbital contribution to magnetic moment, magnetic exchange coupling & spin cross over.

V. ***Transitional metal π complexes***

Structure & bonding in metal carbonyl & nitrosyl compound. Transition metal π complexes with unsaturated organic molecules like alkenes, alkynes, allyl.

Institute for Excellence in Higher Education (IEHE), Bhopal

M.Sc.: **PREVIOUS** Semester: **I**

SUBJECT: **CHEMISTRY** PAPER: **II**

TITLE: **Organic Chemistry- Reaction Mechanism**

Maximum Marks: **140**

SYLLABUS

1. **Nature of bonding in organic compounds**
   - Concept of hybridization, sigma and pi bond, polar and steric effects (i) Types of bond cleavage (ii) Intermediates (iii) Reagents and (iv) Reactions.

2. **Mechanism of chemical reactions involving carbocation intermediates/transition state:**
   - **Nucleophilic substitution at a saturating carbon atom (aliphatic):**

     Types of mechanism –SN^1, SN^2 & SN^i. Effect of (i) solvent (ii) structure (iii) entering and leaving group on proposed mechanism.

     Kinetic and stereochemical studies (i) inversion (ii) racemisation (iii) retention of configuration –neighbouring group participation.

   - **Electrophilic addition to c=c & c=c-c=c system**

     Mechanism of addition with common addendum (X_2, H_2, HX, O_3, Hydration, carbocation, hydroxylation) stereochemistry, orientation, reactivity of substituted substrate (effect of substitution on rate of addition).

     Electrophilic substitution to benzene and it's derivatives with reference to kinetic and theromodynamic control.
     Energy profile diagrams, Directing influence of groups, O/P ratio, partial rate factors and selectivity.

   - **Elimination reactions:**

     α elimination; E-1, E-1cB and E-2 mechanism, Stereoselectivity, Orientation, Saytzeff vs. Hofmann; factors affecting Saytzeff and Hofmann elimination, Elimination vs. Substitution, effect of activating groups. 1, 1 (α) elimination.

   - **Rearrangement at electron deficient atom:**

     Carbocation rearrangement
     - With change in carbon skeleton - Pinacole Pinacolone rearrangement
     - Without change in carbon skeleton - Allylic rearrangement.
     - Rearrangement to electron deficient nitrogen atom - Backmann rearrangement
     - Rearrangement to electron deficient oxygen atom - Baeyer-villiger oxidation

Institute for Excellence in Higher Education (IEHE), Bhopal

M.Sc.: PREVIOUS **Semester: I**

SUBJECT: CHEMISTRY **PAPER: III**

TITLE: Physical Chemistry

Max. Marks: **140**

SYLLABUS

I: Chemical Dynamics

Methods of determining rate laws, collision theory of reaction rates, steric factors, activated complex theory. Arrhenius equation and the activated complex theory, ionic reactions, kinetic salt effect, steady state kinetics, kinetics and thermodynamic control of reaction, treatment of unimolecular reactions. Dynamic chain reaction (Hydrogen-Bromine, Hydrogen Chlorine, Pyrolysis of acetaldehyde, decomposition of ethane and oscillatory reactions). General features of fast reaction, study of fast reactions by flow method relaxation method, flash photolysis and nuclear magnetic resonance method, dynamics of unimolecular reaction (Lindermann Hinshelwood and Rice-Ramasberger-Kassel-Marcus (RRKM) theories for unimolecular reactions).

II: Classical Thermodynamics

Brief resume of the concepts of laws of thermodynamics, free energy, chemical potential and entropies, partial molar properties, Partial molar free energy, partial molar volume and partial molar heat content and their significance. Determination of these quantities, Concept of Fugacity and determination of fugacity, non-ideal behavior.

III: Statistical Thermodynamics

Concepts of distribution, thermodynamic probability and most probable distribution, Ensemble averaging, postulation of ensemble averaging, canonical, grand canonical and micro canonical ensemble, Corresponding distribution laws (using Lagrange's method of undetermined multipliers) Partition function- translation, rotational, vibrational and electronic partition functions.

Institute for Excellence in Higher Education (IEHE), Bhopal

M.Sc.: PREVIOUS **Semester: I**

SUBJECT: CHEMISTRY **PAPER: IV**

TITLE: Chemical Hazard and Management

Max. Marks: **140**

SYLLABUS

I. Understanding of Chemical Hazards:

- Understanding of Basic terms: Hazards, risk, vulnerability, Disasters
- Types and characteristics of Chemical hazard: Fire, Explosion, toxic release
- Hazardous Chemicals: Definitions and Categorization as per regulatory provisions
- Hazardous properties and Safe handling of following Hazardous Chemicals: Chlorine, Sulphuric acid, Propane, Hydrogen Sulphide, Acetone, Liquefied Petroleum Gas.

II. Fire and Explosion Hazards:

Basic understanding of Fire and Explosion incidents, Initiating Factors for Fire and Explosions, Types of fire, Chemistry of fire, Industrial fire, Flash point, Auto ignition temperature, explosive limit, Extinguishing Agents, Water and its extinguishing properties, Carbon dioxide and its extinguishing properties, Dry chemicals and dry powders and its extinguishing properties, Carbon tetrachloride and its extinguishing properties, Foam and its extinguishing properties, halogenated extinguishing agents, Fire protection equipment.

Types of Explosion: Basic understanding of Boiling Liquid Expanding Vapor Explosions and Vapor Cloud Explosions.

Case Study of San Juanico Disaster, sequence of events, the scale of disaster, failure of system, lessons of the disaster.

III. **Chemical Hazard Assessment:**

Basic concept of risk analysis for chemical accident, Methodology and basic Steps for risk assessment, Understanding of Domino effect

IV. **Hazardous waste management :**

Hazard information labeling system, TREM card, emergency information panel, Safety precaution in transportation of hazardous chemicals, Hazardous material emergency management codes. Case studies of accidents during transportation of hazards chemicals. Definition and characterization of Hazardous chemicals as per hazardous waste management rule 1989. Chemical, biological and thermal treatment of hazardous waste.

V. **Chemical disaster management**

Basic features of guidelines, responsibility of different stake-holders in Chemical emergency management

Books Suggested:

1.*Safe Handling of Hazardous Chemicals* – A.K. Rohatgi
2.*Chemical Hazards* – Lee (vol-1 and vol.- 2)

Approved for the session 2019-20

4. MASS Spectroscopy

(A) Introduction, ion production, fragmentation, factors influencing ion abundance, single & multiple bond cleavage, rearrangement, cleavage associated with common functional groups, molecular ion peak, metastable ion peak, Nitrogen rule & interpretation of mass spectra.

(B) Fingerprint application & the interpretation of mass spectra, effect of isotopes on the appearance of mass spectrum, recognition of the molecular ion peak, Ionization techniques (E1 & FAB).

5. Symmetry and Group theory in chemistry

Symmetry elements and symmetry operation, definition of group, subgroup, Conjugacy relation and classes, point symmetry group, Schoonfilies symbols, representation of groups by matrices (representations for the Cn, Cnv, Cnh, Dnh group to be worked out explicitly), character of a representation.

The great orthogonality theorem (without proof) and its importance, character tables and their use, derivation of character table for C_2v and C_3v point group, symmetry aspects of molecular vibrations of H_2O molecule. Symmetry & shapes of simple AB_2, AB_3, AB_4 molecules on the basis of IR spectral data

Books Suggested

1. *Inorganic Electronic spectroscopy* - A.P.B. Lever, Elsevier
2. *Structural Methods in Inorganic Chemistry* - E.A.V., Ebsworth, D.W.H., Rankin and S. Cradock, ELBS.
3. *Infrared and Raman Spectra - Inorganic and Coordination Compounds* - H. Nakamoto, Wiley.
4. *Basic Principle of Spectroscopy* - R. Change, McGraw Hill.
5. *NMR, NOR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry* - R.V. Parish, Ellis Horwood
6. *Chemical Application of Group Theory* - F.A. Cotton, 3rd Edn., John Wiley & Sons, New York.
7. *Inorganic Chemistry* - G.L. Miessler& D.A. Tarr, 2nd Edn., Prentice Hall International Inc., London
8. *Symmetry and Spectroscopy of Molecular* - K. Veera Reddy- New Age International Pvt. Ltd.,New Delhi
9. *Application of Spectroscopy of Organic Compounds* - J.R. Dyers, Prentice Hall
10. *Introduction of NMR Spectroscopy* - R.J. Abrahim, J. Fishes & P. Loftus, Wiley
11. *Spectroscopic Methods in Organic Chemistry* - D.H. Williams, I. Fleming, Tata McGraw.
12. *Spectroscopic Identification of Organic Compounds*, 6th Edition, John Wiley, New York.

Institute for Excellence in Higher Education (IEHE), Bhopal

M.Sc. Previous **Semester: II**

SUBJECT: CHEMISTRY **PAPER: II**

TITLE: Mathematics and Computers for Chemists

Part-**B**: **Computers for Chemists** Max marks: **70**

SYLLABUS

I. Introduction to Computer and Computing

Basic Structure and functioning of Computers with a PC as an illustrative example. Memory, I/O devices, Secondary storage, Computer languages. Operating System with DOS as an example. Introduction to UNIX & WINDOWS. Data processing, Principles of programming. Algorithms & flow charts.

II. Computer Programming in C

Elements of the Computer language, Constants & variables, Operations & Symbols, Expressions, Arithmetic assignment statement, Operators.

Branching Statement – such as *if*, *if .....else*, nested *if-else*, ladder *if-else*.
Looping – *while, do-while* & *for*. Controls statements - *break*, *continue* & *goto*.
Functions – User defined function, returning a value from function, local and global variables, automatic variables, static variables, external variables, declaration of a function, recursion.
Array – Declaration and initialization of 1D & 2D array, String functions (*strcpy, strlen, strcmp* and *strcat*)

III. Programming in Chemistry by C Language

Development of small computer codes involving simple formula in chemistry such as solution of Vander Waal equation, pH titration, kinetics, radioactive decay. Evaluation of lattice energy & ionic radii from experimental data. Determination of normality, molarity, molality of solution Electronegativity of atom. Linear simultaneous equation to solve secular within the Huckle theory.

IV. Use of Application Packages

Introduction to application packages such as MS-WORD, MS-EXCEL, special emphasis on calculation & chart formation and its interpretation (Trendline & Forecasting).

V. INTERNET

Application of INTERNET for Chemistry with search engines, downloading & uploading of files.

Books Suggested

1. *Fundamental of Chemistry* : P.K. Sinha, B.P.B Publication
2. *Programming in ANSI C* : E. Balagurusamy, Tata McGraw Hill
3. *Computation Chemistry* : A.C. Norris
4. *Fundamental of Computer* : V. Rajaraman, Prentice Hill
5. Computer in Chemistry : K.V. Raman, Tata McGraw Hill
6. *MS Office 2000* : Gini Counter, B.P.B. Publication

B- Liquid Chromatography

1. *HPLC*: Principle, Equipment (mobile phase supply system, sample injection system, column, detector). and Applications
2. *Ion exchange*: Cation-anion exchange resin, effect of pH. and their Applications
3. *Gas Chromatography*: Introduction, Types: Gas-Solid (adsorption), Gas-liquid (partition), Types of column. Capillary application.

IV: *STATISTICAL TREATMENT OF ANALYTICAL DATA:*

Limitation of analytical method, Classification system of error, Accuracy, Precision, mean and standard deviation, how to reduce systematic errors, Reliability of result, Confidence interval, Rejection of measurement, Confidence limits test of significance, Significant figure and computation – Statistical evaluation of data, Computation rule - Method for reporting analytical data, Student **t**-test, Paired **t**-test, Chi-square test.

V: *INSTRUMENTATION:*

Basic components of analytical instrument, Principles of instrumentation, Working and Applications of-

1. Refractometer
2. Colorimeter
3. Flame-photometer
4. Nephelometer
5. Turbidometer
6. Flourimeter
7. Spectrophotometer
8. Thermo-gravimeter analysis Instrumental, TG curve
9. Atomic Absorption spectrophotometer

Books Suggested:

1. Vogel's *Textbook of Quantitative Chemical Analysis*: J. Mendham, R.C. Denney, Publisher-Pearson Education
2. *Quantitative Chemical Analysis*: Daniel C. Harries, Publisher: W.H. Freeman.
3. *Analytical Chemistry*: B.K. Sharma, Publisher: Krishna Prakashan Media Pvt. Ltd.
4. *Analytical Chemistry*: Gary D. Christian, Publisher: WSE Wiley
5. *Separation Method*: M.N. Shastri, Publisher: Himalaya Publishing House

Engineering Plastics

Polyamides - Nylons 6, 66, 610, 11, 12 etc.

Polyesters - Polyethylene terephthalate, polybutylene terephthalate, polycarbonate

Polyacetals - Polyoxymethylene

Fluropolymers - Polytetrafluoroethylene

End user applications - case studies on applications in agriculture, building, electrical, electronics, industrial, packaging, medical, sports, transport, water management, telecommunication, toys etc.

IV: Testing and Characterization of Polymers

Importance of testing, physical (special gravity, MVTR), mechanical (tensile, flexural, impact and hardness), thermal (MFI, HDT, VSP, Flammability) and electrical properties (surface and volume resistivity, arc resistance, dielectric strength, CTI) of polymers, identification of polymers by simple techniques.

Polymers characterization techniques like - FTIR. DSC, TGA, TMA and GPC.

V: Thermosetting Materials

Synthesis, properties and applications of Phenol Formaldehyde (PF Resin), Urea Formaldehyde Resin (UF Resin), Melamine Formaldehyde (MF Resin), Unsaturated Polyesters (UP Resin), Alkyd Resin, Epoxies Resin, Polyurethane and Silicon Resin.

An introduction to Composites Materials - Definitions, properties of resins, fibres (Carbon fibre, glass fibre, Kevlar Fibre), Method of preparation of composite materials.

An introduction to Polymer Blends and Alloys - Definitions, advantages of polymers blends and alloys, role of composition, compatibility, properties and applications.

An introduction to Nano Materials - Polymer nanocomposites, nanoclay, carbon nanotubes, fullerenes - their advantages and applications in polymeric materials.

Books Suggested:

1. *Plastic Materials (Ed-7)* : Brdson, J.A.
2. *Hand Book of Plastics Materials & Technology* : Rubin, Irwin, J
3. *Plastics Materials Hand Book* : Athalye, A.S.
4. *Polymer Science* : Gowarikar, V.R. & others
5. *Text Book of Polymer Science* : Billmeyer, F.W.
6. *Introduction to Nanotechnology* : Charles P. Pool Jr. & Frank J. Owens
7. *Plastics Engineering Hand Book (Ed-5)* : SPI, Society of the Plastic Industry Inc
8. *Plastic Materials and Processing* : Schwartz & Goodman
9. *Plastic Materials and Processing Application* : *Birely & Scott*
10. *Modern Plastic Hand Book* : Harper

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4. Pharmacodynamics :

(A) Definition, enzyme stimulation, enzyme inhibition, antidiabetic drugs- Introduction, mode of action of insulin & metformine.

(B) Xenobiotics, detoxication - Definition, site of detoxication, mechanism of detoxication oxidation, reduction, hydroxylation,hydrolysis, conjugation, detoxication of cyanide, general introduction of toxicological study of drugs.

5. Storage & applications :

Factors affecting stability of medication on storage, temperature effect, humidity effect, effect of gases, effect of light, container, Encapsulation. Application of pharmaceutical chemistry

Books Suggested :

1. *Fundamental Concept of Applied Chemistry* - Jayshree Ghosh.
2. *Medicinal Chemistry-Ashutosh*, New Age International Publishers.
3. *A Textbook of Pharmaceutical Chemistry* - Jayshree Ghosh.
4. *Foye's Medicinal Chemistry* - Lemke Williams.
5. *Pharmaceutical Chemistry Inorganic* - G.R. Chatwal, Himalaya Publishing House.
6. *Text Book of Biochemistry* - D.M. Vasudeven, J.P. Publication.
7. *Pharmacology* - H.P. Rang, M.M. Dalp, P.K. Moora, J.M. Ritter.

Institute for Excellence in Higher Education (IEHE), Bhopal

M.Sc. : FINAL **Semester: III**

SUBJECT:CHEMISTRY **PAPER: III**

TITLE: Spectroscopy Diffraction Techniques and Solid State Chemistry

Max. Marks: **140**

SYLLABUS

I. *ELECTRON SPIN RESONANCE*

Basic principles, zero field splitting & kramer's degeneracy, factor affecting the 'g' value isotropic & anisotropic hyper fine coupling constant, spin Hamitonian, spin densities and Mc Connell relationship, measurement techniques, applications. Hyperfine coupling, spin polarization for atoms & transition metal ions, spin-orbit coupling & significance of g-tensors, application to transition metal complexes (having one unpaired electron) including biological systems & to inorganic free radicals such as PH_4 F_2 & BH_3.

II. *MOSSBAUER SPECTROSCOPY*

Basic principles, spectral parameters & spectrum display. Application of technique to the studies of (1) Bonding & structure of Fe^{2+} & Fe^{3+} compounds including those of intermediate spin (2) Sn^{2+} & Sn^{+4} compound-nature of M-L bond, co-ordination number, structure (3) Detection of oxidation state & in equivalent MB atoms

III. *NUCLEAR QUADRUPOLE RESONANCE SPECTROSCOPY*

Quadrupole nuclei, quadrupole moments, electric field gradients, coupling constant, splitting, applications.

IV. (A) *ELECTRON DIFFRACTION*

Scattering intensity V/s scattering angle, Wierl equation, measurement technique, elucidation of structure of simple gas phase molecules, low energy electron diffraction & structure of surfaces.

(B) *NEUTRON DIFFERACTION*

Scattering of neutrons by solid measurement techniques, elucidation of structure of magnetically ordered unit cells.

Institute for Excellence in Higher Education (IEHE), Bhopal

M.Sc. Final **Semester-III**

SUBJECT: CHEMISTRY **PAPER : IV**

TITLE: RESEARCH METHODOLOGY

Max. Marks: 140

SYLLABUS

1. Understanding the Research Process

Types of Research, Fundamental of Pure Research, Applied Research Action Research, Historical Research, Experimental Research, what is Scientific Research, Characteristics of Scientific Methodology, Qualities of Good Researcher, General rule of Academic Research, Types of research, Steps of Scientific Research

2. Problems of Identification and Preparatory Work

Exploratory field work & Identification the research area, narrowing on a specific topic,what is literature survey, role of literature survey and field work, formulating and delaminating a problem, Defining aims and objectives.

Computer Searches of literature

ASAP Alert, CA alerts, SciFinder, ChemPort, Science direct, STN international, Journal Home pages

3. Research Design

What is Research Design, preparing a Research Design, Steps in research design. Hypothesis testing in scientific research, sources of chemical information: primary, secondary & tertiary sources, indexes and abstracts in science and technology, chemical abstract, chemical titles, citation index.

4. Methodology, Method Tools and Techniques

Method of research: Survey research, case studies, qualitative and quantitative method, Ethnographic method.
Tools &Techniques: Observations, analytical instrumentation techniques.

5. Data Processing& Analysis Interpretation

Data processing, classification & categorization of data, data analysis, statistical method and statistical tools. data interpretation using computer and technology for research (chemical software).

Institute for Excellence in Higher Education (IEHE), Bhopal

B.Sc. (HONOURS) PART-I **Semester-I**

SUBJECT: CHEMISTRY **PAPER: HONOURS-I**

TITLE: Analytical Chemistry

Max. Marks: 100

SYLLABUS

1) ***Statistical treatment of analytical data:***

(a) Types of Errors-True, standard & observed value, absolute and relative errors, mean and relative mean deviation. Physical significance of standard deviation, confidence limits and probability, Accuracy and precision. Significant figures, Rejection of observation- Q test, confidence interval test of significance-t test, chi-square test and F test.

(b) Sampling and sample handling- Concept of sampling, Representative sample, storage, pre-treatment and its preparation.

2) ***Methods of analysis:***

(a) Qualitative analysis:- Basic concept of Inorganic analysis- Common ion effect, solubility product, ionic product, effect of pH and buffer in inorganic analysis.

(b) Quantitative analysis

(i) Volumetric analysis – Basic concept and its types, theories of indicator, Law of equivalence, standards and its type.

(ii) Gravimetric analysis- Basic concept

(c) Instrumental method of analysis

(i) Conductivity- TDS meter- Principle, selection of standard solutions, calibration

(ii) pH meter-Principle, selection of standards, calibration

(iii)Potentiometer- Principle, selection of standards, calibration

3) ***Photometric Method of Analysis:***

(a) Electromagnetic radiation, properties of electromagnetic radiation, electromagnetic spectrum, types of spectrum. Spectroscopy-atomic and molecular (rotational, vibrational and electronic spectra).

(b) Spectrometer/Colorimeter- Lambert-Beer's law, Instrumentation and applications.

4) ***Separation Method:***

(a) Solvent Extraction - Introduction, principle - Distribution Law, extraction technique and its types, completeness and selectivity of extraction , factors affecting solvent extraction and analytical applications.

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Institute for Excellence in Higher Education (IEHE), Bhopal

B.Sc. (HONOURS): PART-I **Semester: I**

SUBJECT: CHEMISTRY **PAPER: HONOURS-II / SUBSIDIARY**

TITLE: Inorganic Chemistry – I

Max. Marks: **100**

SYLLABUS

1. ***Atomic Structure & Elementary Quantum Mechanics:***

(A) Quantum Numbers Shapes of *s, p, d, f* orbitals. Aufbau principle and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements, effective nuclear charge. Dual nature of Electron, Photo Electric Effect, Compton effect, Idea of the de-Broglie matter waves, Heisenberg Uncertainty principle, Bohr's Model of Hydrogen atom (no derivation) and its defects.

(B) Molecular orbital theory, basic ideas – criteria for forming M.O, construction M.O's by LCAO-H_2^+ ion calculation of energy levels from wave functions, concept of σ, σ^*, π, π^* & n orbitals and their characteristics. Hybrid orbitals – (sp, sp^2, sp^3), calculation of co-efficient of A.O.'s used in these hybrid orbitals. Schrödinger wave equation, Significance of ψ and ψ^2.

2. ***Periodic Properties:***

Atomic and ionic radii, ionization energy, electron affinity and electro negativity definition, methods of determination, trends in periodic table and applications in predicting and explaining the chemical behaviour.

3. ***Chemical Bonding***:

(A) **Covalent Bond** – Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence Shell Electron Pair Repulsion (VSEPR) theory to NH_3, H_3O^+, SF_4, $C\ell F_3$, $IC\ell_2$ and H_2O. MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electro negativity difference.

(i) **Ionic Solids** – Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, Lattice defects, Semiconductors, Lattice energy and Born-Haber cycle, Solvation energy and Solubility of Ionic solids, polarizing power and polarisability of ions, Fajan's rule. Metallic bond: free electron, valence bond and bond theories.

(ii) **Weak Interactions** – Hydrogen bonding, Vander Waals forces.

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Institute for Excellence in Higher Education (IEHE), Bhopal

B.Sc. (HONOURS): PART-I Semester: II

SUBJECT: CHEMISTRY PAPER-HONOURS -I

TITLE:Environmental Chemistry

Maximum Marks: **100**

SYLLABUS

1. **Atmospheric Chemistry:**
   (a) Evolution of Atmosphere, Major region of Atmosphere, composition of Atmosphere , Temperature inversion, Meteorology and Human activities, Surface temperature of Earth, Earth's Heat balances.
   (b) Photochemistry: Primary photochemical process, Radicals in Atmosphere ($OH^{\cdot}$) and ($HO_2^{\cdot}$). Ions in mesosphere and lower Thermosphere, Reactions of atmospheric Nitrogen, O_2, CO_2 and H_2O.

2. **Air Pollution**:
   Classification and control of air pollutants:
   Inorganic air pollutants: Oxides of C, N, S, Ozone, Carbonyl Sulphidesand Carbon disulphide. Fluorine and its compounds
   Organic Air pollutants: Hydrocarbons, Alkyl Aryl halides, Aldehyde and Ketones. Acid Rain, photochemical Smog, Depletion of ozone layer, Green House Effect and its consequences

3. **Water Pollution:**
   Classification of water pollutants:
   Hardness and Alkalinity, DO, BOD and COD
   Control of water pollution: Water softening , Advanced Techniques of Water treatment :Using liquid-liquid separation, liquid-solid separation, use of coagulants and High intensity aeration process. Removal of Metallic ions, Waste water treatment methods: Nitrogen removal, phosphorus removal, sludge treatment. Sewage treatment: Primary, secondary,tertiary. Water Reuse and Recycle

4. **Soil Pollution:**
   Soil type, Trace metals, Organic matter in soil and micro nutrients in soil, pollution of soil, Agricultural pollution

5. **Biochemical Effect of Toxic Metals on Man:**
   Enzymes inhibited by Toxic metals, Effect of Mercury, Lead, Arsenic, Cadmium and Cobalt.

6. **Thermal Pollution**: Sources and Effect of Thermal pollution and its control.

Approved for the session 2019-20

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Institute for Excellence in Higher Education (IEHE), Bhopal

B.Sc. (HONOURS): **PART-I** Semester: **II**

SUBJECT: CHEMISTRY **PAPER: HONOURS II/SUBSIDIARY**

TITLE:Organic Chemistry-I

Maximum Marks: **100**

SYLLABUS

1. **Structure and Bonding:**

Characteristics of carbon, concept of hybridization(SP^3,SP^2,SP) and their molecular shapes,Vander Waals interactions, Inclusion compounds,Charge transfer complexes, polar effects, hyper conjugation, Resonance, Hydrogen bonding, its types and effect on physical properties .

2. **Mechanism of Organic Reactions:**

Bond cleavage, types of reagents, types of organic reactions, energy considerations, thermodynamic and kinetic control. Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereo chemical studies.)

Reactive intermediates-

Carbonium ions,Carbanoins,Free radicals, Carbenes, Arynes, and Nitrinestheir structure and stability.

3. **Stereochemistry of Organic Compounds:**

Concept of Isomerism, types of isomerism.

Optical Isomerism – Elements of Symmetry, Molecular Chirality, Enantiomers, StereogenicCentres, Diastereomers, Threo and Erythro stereoisomers, meso Compounds, Resolution of Enantiomers, Inversion, Retention and Racemization. Relative and Absolute Configuration, Sequence Rules, D- and L- and R-and S- Systems of Nomenclature.

Geometrical Isomerism – Determination of Configuration of Geometrical Isomers. E and Z System of Nomenclature, Geometrical Isomerism in Oximes and Alicyclic Compounds.

Conformational Isomerism –Conformational Analysis of Ethane and n-butane, Conformation of Cyclohexane, Axial and Equatorial Bonds, Conformation of Mono-substituted Cyclohexane Derivatives. Newman Projection and Sawhorse Difference between configuration and conformation.

4. **Alkanes and Cycloalkanes:**

IUPAC Nomenclature and Isomerism of Alkanes,Physical properties and chemical properties of alkanes, Mechanism of free radical halogenation of methane,energy consideration, orientation , reactivity and selectivity.

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8. **Alcohols**

Classification and nomenclature

Monohydric alcohols-Methods of formation effect of hydrogen bonding on physical properties, acidic nature and chemical properties.

Dihydric alcohols-Methods of formation,chemical reactions of glycols,oxidative cleavage, pinacol-pinacolone rearrangement.

Trihydric alcohols- glycerol- synthesis, physical and chemical properties.

9. **Phenols**

Nomenclature, preparation of phenols,physical properties and acidic character. Comparison of acidic strengths of alcohols andphenols. Electrophilic substitution and other properties with mechanism.

10. **Aldehyde and Ketones**

Nomenclature, structure and reactivity of carbonyl group,synthesis of aldehyde and Ketone, physical and chemical properties, mechanism of nucleophillic addition to carbonyl group with particular emphasis on benzoin,aldol, Perkin and Knoevenagel condensation.Application of acetals as protecting group of carbonyl group. Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Cannizzaro-reaction. Halogenaton and enolisation of aldehyde and ketones. Reductions-Meerwein-PonndorfVerley (MPV) reduction, Clemensen's, Wolf Kishner reductions, reductions with metal hydride ($LiAlH_4$ and $NaBH_4$). Oxidation of aldehydes, Baeyer-villager oxidation of ketones.

References :

1. Finar, I. L.,*Organic Chemistry,Vol-I,edition 6th* ,B S/E L with Longman publication
2. Mukherji, S.M.,*Reaction Mechanism in Organic Chemistry*,Macmillan Publication
3. Morrison, R.T.,*Organic Chemistry*,Prentice Hall Publication
4. Jerry March,*Advanced Organic Chemistry,*WeleyPublication
5. Robert Thornton,*Organic Chemistry*,Pearson Publication
6. Sykes Peter,*A Guidebook to Mechanismin Organic Chemistry*, Pearson Publication
7. Madan,R.L.,*Organic Reaction Conversion*, S.Chand Publication

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Institute for Excellence in Higher Education (IEHE), Bhopal

B.Sc.(HONOURS) : **PART-II** Semester: **III**

SUBJECT: Chemistry **PAPER: Honours-II/Subsidiary**

TITLE: Physical Chemistry - I

SYLLABUS

I. Gaseous state

Postulates of Kinetic Theory of gases, deviation from ideal behaviour, Vander Waal's equation of state.

Critical Phenomena: PV isotherms of real gases, continuity of states, the isotherms of Vander Waal's equation, relationship between critical constants and Vander Waal's constants, the law of corresponding states, reduced equation of state.

Molecular Velocities: Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquification of gases (based on Joule-Thomson effect).

II. Liquid State

Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases.

Liquid crystal: Difference between liquid crystal, solid and liquid. Classification structure of nematic and cholestric phases. Thermography and seven segment cell.

III. Solid State

Definition of space lattice, unit cell.

Laws of crystallography: (i) Law of constancy of interfacial angles (ii) Law of rationality of indices (iii) Law of symmetry. Symmetry elements in crystals.

X-ray diffraction by crystals. Derivation of Bragg's equation. Determination of crystal structure of NaCℓ, KCℓ and CsCℓ (Laue's Method and Powder Method)

IV. Colloidal State

Definition of colloids, classification of colloids.

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VIII. Thermodynamics-II

Second Law of Thermodynamics: Need for the law, different statements of the law, Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature.

Concept of entropy: Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, *Clausius inequality:* entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases.

Statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions; Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P, V and T.
Reaction isotherm and reaction isochore. Clapeyron equation and Clausius–Clapeyron equation, application
Third Law of Thermodynamics: Nernst heat theorem

References:

1. Singh N.B, *Physical Chemistry*, Dominant Publication.
2. Laidler Keith J, *Chemical Kinetics*, Pearson Education publication.
3. Berry R.Stephan, *Physical Chemistry*, Oxford press publication.
4. Yadav J.B, *Physical Chemistry*, Goel publication.
5. Raj Gurdeep, *Advanced Physical Chemistry*, Krishna Prakashan.
6. Laidler J. Keith, *Physical Chemistry*, CBS Publication
7. Castellan Gilbert W, *Physical Chemistry*, Narosa publication

Differentiation (Differential calculus)

Meaning, Differentiation of standard form, Differential of sum, Difference, Product and quotient, Differential coefficient of a function of functions, Second derivatives.

Integral Calculus

Infinite integration by substitution (simple cases), Definite integrals.

Differential Equations

Linear equation, Formation of differential equation, Solution of a differential equation (without variable).

Section-B: Syllabus for Computer Application

In computer application, the students have to learn 'C' language and its application in Chemistry. The topics of chemistry should be within the syllabus of chemistry as prescribed by UGC for B.Sc. classes.

'C' Language will cover the following topics:

1. ***Programming Language:*** Brief description of machine language and assembly languages. Language translators, Algorithm and flow charts. An over view of '**C**' programming
2. ***Data Type, Constants & Variable:*** Character set, '**C**' tokens, Keywords and Identifiers, Constant & variable, Data type, Declaration of variable, assigning values to variables, symbolic constants.
3. ***Operators & Expressions:*** Arithmetic, Relational, Logical, Assignment, Increment and decrement, Conditional, Bit wise & special Operators. Arithmetic expressions, Evaluation of expression, Precedence of arithmetic operators, Mathematical functions.
4. ***Input/Output Operations:*** Reading & writing character, Formatted input and output.
5. ***Control Statements:*** **If, If .... Else,** Nesting of **If ... Else** statement, The **Else ... If** ladder, The **switch** statement, the **?:** operator and **GOTO** statement.
6. ***Looping:*** **While, Do-While, for** loops, Jumps in loops the **break, Continue** and **Exit** statement.
7. ***Arrays:*** One dimensional & Two dimensional arrays.
8. ***Character Strings:*** Declaring & initializing string variables, Reading & writing of strings.
9. ***User Defined Functions:*** The form of '**C**' functions, Return values and their types, calling a function, categories of functions: (i) No argument – no return value (ii) Argument but no return values (iii) Argument with return values. Function with Arrays, The scope and lifetime of variables in function (Local and global variables).
10. ***File Management:*** Opening, Reading and closing a file in '**C**' Input /Output operation on files.

Reference Books:

1. Singh, Bhupendra, *Mathematics for Chemist*, Pragati Prakashan
2. Kumari Ramesh, *Computers and their Application to Chemistry*, Narosa Publication
3. Aggarwal, Naresh, *Computer in Chemistry*, Sonali Publication
4. Rao, Sambasiva R., *Computer Application in Chemistry*, Himalaya Publication
5. Sigh, S.K., *Mathematics and Computer for Chemist*, S. Chand Publication
6. E. Balagurusami, *ANSI C*, S. Chand Publication
7. Yashvant Kanitkar, *Let Us 'C'*, BPB Publication

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7. **Thermodynamics and Kinetic Aspects of Metal Complexes:**

   A Brief Outline of Thermodynamic Stability of Metal Complexes and Factors affecting stability, Substitution Reaction of Square Planar Complexes.

8. **Chemistry of Lanthanide Elements:**

   Electronic Structure, Oxidation State and Ionic Radii and Lanthanide contraction. Complex Formation, Occurrence and Isolation of Lanthanides.

9. **Chemistry of Actinides:**

   General Features and Chemistry of Actinides, Chemistry of Separation of Np, Pu, Am from U, Similarities between later Actinides and later Lanthanides.

10. **Organometallic Chemistry**:

    A Brief Account of Metal-ethylene Complexes and Homogeneous Hydrogenation, Mononuclear Carbonyls and Nature of Bonding in Metal Carbonyls.

Reference Books:

1. Gurdeep Raj, *Inorganic Chemistry*, Krishna Publication
2. Malik Waheed, *Inorganic Chemistry*, S. Chand Publication
3. Madan R.D., *Modern Inorganic Chemistry*, S. Chand Publication
4. Satya Prakash, *Advanced Inorganic Chemistry*, S. Chand Publication
5. Lee J.D., *Concise Inorganic Chemistry*, Blackwell Publication
6. Huheey James, *Inorganic Chemistry*, Addison Wesely Publication
7. Cotton & Wilkenson, *Advanced Inorganic Chemistry*, Wiley John Publication
8. Malik Waheed, *Selected Topic in Inorganic Chemistry*, S. Chand Publication.

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6. *Lubricants:*

Introduction, Mechanism of Lubrication, Classification of Lubricants – Solid, Liquid, Semi-Solid Lubricants: Grease, Properties of Lubricating Oils and Greases, Synthetic Lubricants, Lubricating Emulsions, Cutting Fluids

7. *Fuels:*

Introduction and Classification of Fuels, Characteristics of a good Fuel

Calorific Value: Definition, Units, Gross and Net Calorific Value, Determination of Calorific Value – Bomb Calorimeter [Construction, Working and Calculations (use of Dulong's Formula)].

Coal: Origin, Classification of Coal by Rank, Selection of Coal, Analysis of Coal – Proximate and Ultimate Analysis, Carbonization of Coal, Pulverized Coal, Metallurgical Coke – Requisites of Metallurgical Coke and Manufacture of Metallurgical Coke.

Petroleum: Origin, Classification, Cracking – Thermal and Catalytic Cracking, Synthesis of Synthetic Petrol – By Polymerization and By Fischer-Tropes Method, Refining of Gasoline, Reforming and Knocking.

Gaseous Fuels : Classification, water gas, producer gas, LPG and CNG.

Non-Conventional Sources of Energy: Biomass and Biogas.

References:

1. J. A. Kent: Riegel's, *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
2. S. C. Bhatia: *Chemical Process Industries,* Vol. I & II, CBS Publishers, New Delhi.
3. P. C. Jain, M. Jain: *Engineering Chemistry,* Dhanpat Rai & Sons, Delhi.
4. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry,* Vikas Publications, New Delhi.
5. B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut.
6. E. Stocchi: *Industrial Chemistry,* Vol -I, Ellis Horwood Ltd. UK.
7. B. K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.

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7 **Organic Compounds of Nitrogen:**

Nitroalkanes and Nitroarenes: Preparation and Chemical properties. Mechanism of nucleophilic substitution in Nitroarenes and their reduction in acidic, neutral and alkaline media.

Amines: Aliphatic and Aromatic amines- their nomenclature, preparation and properties. Separation of primary, secondary and tertiary aliphatic amines Structural features affecting the basicity in aliphatic and aromatic amines. Electrophillic aromatic substitution in aryl amines.

Diazonium Salts: Preparation and Properties.

8 **Heterocyclic Compounds:**

Aromatic behaviour of 5 and 6 membered heterocyclics, preparations and chemical properties of Pyrrole, Furan, Thiophene and Pyridine, mechanism of electrophilic substitution and their reactivity at α and β carbon atoms. Mechanism of nucleophilic substitution reactions in Pyridine. Comparison of basicity of Pyridine, Piperidine and Pyrrole.

Preparation and properties of Indole, Quinoline and Isoquinoline. mechanism of substitution reactions.

9 **Carbohydrates:**

Classification of Carbohydrates, Monosaccharides: Nomenclature properties of aldoses and ketoses. Interconversion of glucose, mannose and fructose, chain lengthening and chain shortening. Configuration of monosaccharides. Erythro and Threo diastereomers. Formation of glycosides, ethers and esters. Structure of D (+) Glucose , D(-) Fructose, (open and cyclic), determination of ring size. Mechanism of Mutarotation.

An introduction to Disaccharides (Maltose, Sucrose and Lactose) their conformation and properties, Polysaccharides (Starch and Cellulose) Properties.

10 **Amino Acids, Peptides, Proteins and Nucleic Acids:**

Amino Acids: Classification, structure and stereochemistry of Amino acids. Acid-base behaviour, Isoelectric point and Electrophoresis. Preparation and properties of α Amino acids.

Peptides: synthesis, properties and structure. Sequence determination of amino acid by end group analysis.

Proteins: Classification, nomenclature, properties and tests. Denaturation and Renaturation. Levels of protein structure.

Institute for Excellence in Higher Education (IEHE), Bhopal

B.Sc. (HONOURS): **PART-III** Semester: **VI**

SUBJECT: **CHEMISTRY** PAPER: **HONOURS-I**

TITLE: **Biochemistry**

Maximum Marks: **100**

SYLLABUS

1. **Introduction to Biochemistry &, Bio-Physical Chemistry:**

   (a) water metabolism-Dehydration & its types, Biochemical Functions of Inorganic Ions: Role of Ca^{2+}, K^{+}, Na^{+}, Mg^{2+}, Fe^{2+} in living system & their requirements Fe storage & transport proteins-Ferritin, transferring & hemosiderin, Oxygen transport, Protein, Fe-S proteins.

   (b) **pH scale, buffer** - General introduction of Acid & Base. Buffer-Definition, composition, Henderson equation, Role of different biological buffer system like-Phosphate buffer, Bicarbonate buffer, Protein /Amino acid buffer, Haemoglobin buffer system.

2. (a) **Biological oxidation** - Definition, Types of biological oxidation Reduction oxidation by direct action of oxygen, oxidation by loss of hydrogen.

   (b) Mitochondrial electron transport chain, inhibitors of ETC.

   (c) **Oxidative phosphorylation** - Definition, Theories, Inhibitors of Oxidative-phosphorylation, Un-couplers.

3. (a) **Bioenergetics** - Coupled reaction, law of thermodynamics, Free energy, Relationship between Standard Free energy change & Equilibrium constant. General introduction of high energy compounds.

   (b) **Introduction to ATP** - Structure, ATP as universal currency of free energy in biological systems with example-in muscle contraction, Free energy of ATP Hydrolysis.

4. **Nucleic Acid & Enzymes**:

   (a) **Nucleic Acid** – Introduction, constituents (sugars and bases), nucleosides and nucleotides. Double helical structure of DNA.

   (b) **Enzyme** - Definition, Classification, Nomenclature, Coenzyme, Cofactors, Properties of enzyme, factors affecting enzyme activity, Active site, Mechanism of enzyme action-Lock & Key theory, Koshland theory, strain theory. Enzyme Kinetics – Michaelis-Menton equation, L.B Plot. Medical importance of enzyme.

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Institute for Excellence in Higher Education (IEHE), Bhopal

B.Sc. (Honours): **PART-III** Semester: **VI**

SUBJECT: **Chemistry II/Subsidiary** PAPER: **Honours-**

Title: Physical Chemistry – II

Maximum Marks:**100**

SYLLABUS

I. Chemical Kinetics and Catalysis:

Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction – concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates, Mathematical characteristics of simple chemical reactions – Zero order, first order, second order, pseudo order, half-life and mean life. Determination of the order of reaction-differential method, method of integration, method of half-life period and isolation method.

Radioactive decay as a first order phenomena. Experimental methods of chemical kinetics, conductometric, potentiometric, optical methods, polarimetry and spectrophotometer.

Theories of chemical kinetics: Effect of temperatures on rate of reaction, Arrhenius equation, concept of activation energy, simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and Thermodynamic aspects. Catalysis, characteristics of catalyzed reactions, classification of catalysts miscellaneous examples.

II. Electro Chemistry – I

Electrical transport - conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution.

Debye Huckel - Onsager's equation for strong electrolytes (elementary treatments only). Transport number, Its definition and determination by Hittorf method and moving boundary method.

Application of conductivity measurement, determination of degree of dissociation, determination of K_a of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

III.Electrochemistry-II:

Types of reversible electrodes - gas-metal ion, metal-metal ion, metal-insoluble salt-anion and redox electrodes. Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode – reference electrodes - Standard

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Electronic spectrum: Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck Condon principle.

Qualitative description of σ, π and η M.O., their energy levels and the respective transitions.

VII. Solution, Dilute Solution and Colligative Properties

Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity co-efficient, Dilute solutions, colligative properties, Raoult's Law, relative lowering of vapour pressure, molecular weight determination. Osmosis, Law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point, Experimental methods for determining various colligative properties Abnormal molar mass, degree of dissociation and association of solutes.

Reference Books:

1. Singh N.B., *Physical Chemistry*, Dominant Publication
2. Laidler Keith J., *Chemical Kinetics*, Pearson Education Publication
3. Berry R.Stephan, *Physical Chemistry*, Oxford Press Publication
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