Curriculum Framework and Credit System for the Four Year Undergraduate Programme (FYUGP)

CHEMISTRY

Academic Session:

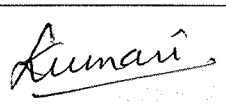
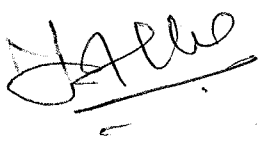
w.e.f. 2022

for

All Constituent/Affiliated Colleges Under

Binod Bihari Mahto Koyalanchal University, Dhanbad

Members of Board of Studies for Under Graduate Syllabus of the Department of Chemistry of Binod Bihari Mahto Koyalanchal University, Dhanbad, Jharkhand.

1	Dr. Leelawati Kumari, Head, University Department of Chemistry, BBMKU	CHAIRPERSON	
2	Dr. Y. JHA, Retired Head, Department of Chemistry, P.K.R.M. College, Dhanbad	EXTERNAL EXPERT	
3	Sri Rajendra Prasad Singh, UNIVERSITY DEPARTMENT of CHEMISTRY, BBMKU	MEMBER	
4	Dr. Dharmendra Kumar Singh, University Department of Chemistry, BBMKU	MEMBER	
5	Dr. Rajeev Pradhan, Head Department of Chemistry, P.K.R.M. College, Dhanbad	MEMBER	

SEM-I

INTRODUCTORY REGULAR COURSE (IRC)-01

CHEMISTRY

LECTURE -45 **CREDIT -03**

FULL MARKS- 100 **PASS MARKS- 40**

UNIT: 1 Atomic Structure — 07 Lectures

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Quantum numbers and their significance. 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: Periodicity of Elements: — 07 Lectures

Basic ideas of the following periodic properties-

(a) Effective nuclear charge, shielding or screening effect, Slater rules,

(b) Atomic radii

(c) Ionic and crystal radii.

(d) Covalent radii

(e) Ionization enthalpy.

(f) Electron gain enthalpy

(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales.

UNIT 3: Chemical Bonding: — 12 Lectures

Ionic bond: Defination, General characteristics, Factors favouring formation of ionic bond.

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 N2, O2, C2, B2, F2, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π 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.

Weak Chemical Forces: Hydrogen bonding: definition, types of hydrogen bond, Effect of hydrogen bonding on physical and chemical properties.

UNIT 4: Basics of Organic Chemistry-I — 05 Lectures

Organic Compounds: Classification and Nomenclature.

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

UNIT 5: Basics of Organic Chemistry-II — 05 Lectures

Reaction mechanism, Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges;

Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.

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

UNIT 6: Ionic equilibria — 09 Lectures

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).

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.

Solubility and solubility product of sparingly soluble salts –applications of solubility product principle.

References Books-

1. Inorganic Chemistry by J. D. Lee
2. Inorganic Chemistry by Puri Sharma Kalia
3. Organic Chemistry by A Bahl and B. S. Bahl
4. Organic Chemistry Volume-1 by I. L. FINAR
5. Physical Chemistry by Puri Sharma Pathania

SEM-01

CHEMISTRY MAJOR - 0I

INORGANIC CHEMISTRY – I

Theory - 60 Lectures **Credit - 04**

Full Mark - 75 **Pass Mark - 30**

Atomic Structure (14 Lectures)

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainity Principleand its significance, Schrodinger's wave equation, significance of Ψ and Ψ^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 diagram.

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, aufbau's principle and its limitations, Variation of orbital energy with atomic number.

Periodicity of Elements (16 Lectures)

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

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

Chemical Bonding (30 Lectures)

Chemical Bonding: Section A

i. Ionic bond : General characteristics, types of ions, size effects, radius ration rule and its limitations. Packing of ions in crytals. Born-Lande equations with derivation and importance of Kaustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its applications, Solvation energy.

ii. 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 osf simple molecules and ions containing lone pairs and σ bond and π approach) irsf electrons and multiple bonding lengths.

Chemical Bonding: Section – B

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rule and consequences of polarization.

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

Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, instantaneous dipole-induced dipole interactions. Hydrogen bonding (theories of hydrogen bonding, valence bond treatment)

Reference Books:

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970.
- Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
- Day,M.C. and Selbin, J. Theoritical Inorganic Chemistry, ACS Publications 1962.

(Chemistry Practical)

PAPER: MJ-01

Credits: 02 **60 Lectures**

Marks: 25 **Pass Marks: 10**

GROUP- A

30 LECTURES

(A) Titrimetric Analysis

(i) Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(iii) Estimation of free alkali present in different soaps/detergents.

(C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) Estimation of Fe(II) with K2Cr2O7 using internal (diphenylamine, anthranilic acid) and external indicator.

GROUP-B

30 LECTUTRES

1. Surface tension measurements.

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension of detergent solutions with concentration.

2. Viscosity measurement using Ostwald's viscometer.

a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) Sugar at room temperature.

b. Study the variation of viscosity of sucrose solution with the concentration of solute.

Reference Books-

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

2. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.:

N.Delhi (2011).

3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8

th Ed.;

McGraw-Hill: New York (2003).

4. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003)

SEM-II

(Physical Chemistry)

PAPER: MJ-02

Credits: Theory-04 **Theory: 60 Lectures**

Marks: 15 (MSE) + 60 (ESE) =75 **Pass Marks: (MSE: 06 +ESE: 24) = 30**

Instruction to Question Setter for

Mid Semester Examination (MSE): 1 Hrs.

The Mid Semester Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks. There will be three questions of 5 marks each, out of which two are to be answered. Each question may be subdividedinto two or more parts (b) Class Attendance Score (CAS) & Day to day activities (DDA) of 5 marks.

(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)

End Semester Examination (ESE): 3 Hrs.

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. Q. No. 1(A) will be multiple type six questions of 1 mark each. Q. No. 1(B) will contain two short answer type questions (max. 50 words) each of 3 marks. **Group B will contain descriptive type eight** questions of twelve marks each, out of which any four are to be answered.*

UNIT 1: Gaseous state 20 Lectures

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. 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 behavior. Vander Waals equation of state, its derivation and application in explaining real gas behaviour. 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.

UNIT 2: Ionic equilibria 24
Lectures

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

UNIT 3: Chemical Equilibria 16
Lectures

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. 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 Kp, *Kc* and *Kx*. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a purecondensed phase.

Reference Books:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

SEM-II

(Chemistry Practical)

PAPER: MJ-02

Credits: 02 **60 Lectures**

Marks: 25 **Pass Marks: 10**

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1. Surface tension measurements.

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension of detergent solutions with concentration.

2. Viscosity measurement using Ostwald's viscometer.

c. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) Sugar at room temperature.

d. Study the variation of viscosity of sucrose solution with the concentration of solute.

3. Thermochemistry

a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).

b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

c) Calculation of the enthalpy of ionization of ethanoic acid.

d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

References Books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
2. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: N.Delhi (2011).
3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.*; McGraw-Hill: New York (2003).
4. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York(2003).
5. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
6. 6.Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

SEM-III

(ORGANIC CHEMISTRY)

PAPER MJ-03

Credits: 04 **Theory: 60 Lectures**

Full Marks: 15 (MSE) + 60 (ESE) =75 **Pass Marks: (MSE: 06 +ESE: 24) = 30**

Instruction to Question Setter for

Mid Semester Examination (MSE): 1 Hr.

The Mid Semester Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks.

There will be three questions of 5 marks each, out of which two are to be answered. Each question may be subdivided into two or more parts. (b) Class Attendance Score (CAS) & Day to day activities (DDA) of 5 marks.

(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)

End Semester Examination (ESE): 3 Hrs.

There will be two groups of questions. Group A is compulsory and will contain two questions. Q. No. 1(A) will be multiple type six questions of 1 mark each. Q. No. 1(B) will contain two short answer type questions (max. 50 words) each of 3 marks. Group B will contain descriptive type eight questions of twelve marks each, out of which any four are to be answered.

UNIT 1: Basics of Organic Chemistry — 06 Lectures

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.

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

UNIT 2: Stereochemistry — 12Lectures

Fischer Projection, Newman 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.

UNIT 3: Chemistry of Aliphatic Hydrocarbons — 22 Lectures

A. Carbon-Carbon sigma bonds

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

B. 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.

C. 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: Aromatic Hydrocarbons — 08 Lectures

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.

UNIT 5: Chemistry of Halogenated Hydrocarbons — 12 Lectures

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. Nucleophilic aromatic substitution; SNAr, 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.

Reference Books:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.

5. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

SEM-III

(Organic Chemistry Practical)

PAPER: MJ-03

Credits: 02 **60 Lectures**

Full Marks: 25 **Pass Marks: 10**

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1. Checking the calibration of the thermometer.

2. Purification of organic compounds by crystallization using the following solvents:

a. Water

b. Alcohol

c. Alcohol-Water

3. Determination of the melting points of above compounds and unknown organic compounds (kjeldahl method and electrically heated melting point apparatus).

4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds

5. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100 °C by distillation and capillary method)

6. Chromatography

a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography

b. Separation of a mixture of two sugars by ascending paper chromatography

c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Reference Books:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

SEMESTER-IV

PAPER: MJ – 4

INORGANIC CHEMISTRY-II

Credits: Theory-04 **Theory: 60 Lectures.**

UNIT 1: Chemistry of s and p Block Elements 20 Lectures

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.

UNIT 2: Noble Gases: 06Lectures

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).

UNIT 3: Inorganic Polymers: 07 Lectures

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes and polysulphates.

UNIT 4: Organometallic Compounds 22 Lectures

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. π-acceptor behavior 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 5: Catalysis by Organometallic Compounds (05 Lectures)

Study of the following industrial processes and their mechanism:

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

Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991
2. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth- Heinemann. 1997.
4. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.

SEM-IV

MJ-V

PHYSICAL CHEMISTRY-II

Credits: Theory-04 **Theory: 60 Lectures.**

Marks: 15 (MSE: 1Hr) + 60 (ESE: 3Hrs) = 75 **Pass Marks: (MSE: 06 +ESE: 24) = 30**

Instruction to Question Setter for

Mid Semester Examination (MSE): 1 Hrs.

The Mid Semester Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks.

There will be three questions of 5 marks each, out of which two are to be answered. Each question may be subdivided intotwo or more parts (b) Class Attendance Score (CAS) & Day to day activities (DDA) of 5 marks.

(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80.-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)

End Semester Examination (ESE): 3 Hrs.

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. Q. No. 1(A) will be multiple type six questions of 1 mark each. Q. No. 1(B) will contain two short answer type questions (max. 50 words) each of 3 marks. **Group B will contain descriptive type eight** questions of twelve marks each, out of which any four are to be answered.*

UNIT 1: Chemical Thermodynamics: **28 Lectures**

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.

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.

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.

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.

UNIT 2: Phase Equilibria — 17 Lectures

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid- liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications.

Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions.

Three component systems, water-chloroform-acetic acid system, triangular plots.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation.

Nernst distribution law: its derivation and applications.

UNIT 3: Chemical Kinetics — 10 Lectures

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

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 4: Catalysis: — 03 Lectures

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces;

effect of particle size. Enzyme catalysis, Michaelis- Menten mechanism, acid-base catalysis.

UNIT 5: Surface chemistry: **02 Lectures**

Physical adsorption, chemisorption, adsorption isotherms. Nature of adsorbed state.

Reference Books:

1. Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
2. Castellan, G. W. Physical Chemistry, 4th Ed., Narosa (2004).
3. McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi (2004).
4. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
6. Zundhal, S.S. Chemistry concepts and applications Cengage India (2011).
7. Ball, D. W. Physical Chemistry Cengage India (2012).
8. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
9. Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill (2011).

SEMESTER – IV

(Inorganic Chemistry Practical)

Credits: 02 **60 Lectures**

Marks: 25 **Pass Marks: 10**

A) Iodo / Iodimetric Titrations

I. Estimation of Cu(II) and K2Cr2O7using sodium thiosulphate solution (Iodometrically).

II. Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodometrically

III. Estimation of available chlorine in bleaching powder iodometrically

B) Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-},$S_2O_3^{2-}$, CH_3COO^-, F^-,Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+},Sr^{2+}, Ca^{2+}, Mg^{2+}

Mixtures should preferably contain one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) or combination of anions e.g. $CO_3^{2-}$and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, $Br^-$and I^-, NO_3^- and Br^-, NO_3^- andI^-.

Spot tests should be done whenever possible.

A. Measurement of 10 Dq by spectrophotometric method

B. Verification of spectrochemical series.

C. Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs thermodynamic factors.

D. Preparation of acetylacetanato complexes of Cu^{2+}/Fe^{3+}. Find the λ_{max} of thecomplex. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

Reference books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS. 1978

(Physical Chemistry Practical)

Credits: 02 **60 Lectures**

Marks: 25 **Pass Marks: 10**

1.Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.

2.Distribution of acetic/ benzoic acid between water and cyclohexane.

3.Study the kinetics of the following reacti

I Initial rate method: Iodide-persulphate reaction

II Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Saponification of ethyl acetate.

III Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate.

4. Adsorption

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

References Books:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press(2000).

4. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

SEM-V

ORGANIC CHEMISTRY

MJ-6

Credits: Theory-04, Practical – 02 **Theory: 60 Lectures.**

Marks: 15 (MSE) + 60 (ESE) = 75 **Pass Marks: (MSE: 06 +ESE: 24) = 30**

Instruction to Question Setter for

Mid Semester Examination (MSE): 1 Hr.

The Mid Semester Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks. There will be three questions of 5 marks each, out of which two are to be answered. Each question may be subdivided into two or more parts (b) Class Attendance Score (CAS) & Day to day activities (DDA) of 5 marks.

(Attendance: Upto75% = 1 mark; 75-80% = 2 marks; 80-85% = 3 marks; 85-90% = 4 marks; >90% = 5 marks)

End Semester Examination (ESE): 3 Hrs.

There will be two groups of questions. Group A is compulsory and will contain two questions. Q. No. 1(A) will be multiple type six questions of 1 mark each. Q. No. 1(B) will contain two short answer type questions (max. 50 words) each of 3 marks. Group B will contain descriptive type eight questions of twelve marks each, out of which any four are to be answered.

UNIT 1: Alcohols, Phenols, Ethers and Epoxides — 16 Lectures

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 acidity, 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 LiAlH4.

Sulphur containing compounds: Preparation and reactions of thiols and thioethers

UNIT 2: Carbonyl Compounds — 14 Lectures

Structure, reactivity and preparation:

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt,

Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH4, NaBH4, 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 3: Carboxylic Acids and their derivatives — 10 Lectures

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 4: Polynuclear Hydrocarbons — 06 Lectures

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

UNIT 5: Carbohydrates — 14 Lectures

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.

Reference Books:

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

4. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.

5. Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry. IV Edition. W.H. Freeman and Co.

SEMESTER-V

INORGANIC CHEMISTRY-III

PAPER: MJ - 7

Credits: Theory-04, Practical – 02 **Theory: 60 Lectures.**

UNIT 1: Transition Elements: (12 Lectures)

General group trends with special reference to electronic configuration, colour, variable valency, magnetic, catalytic properties, and 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: Coordination Chemistry: (20 Lectures)

Werner's theory, valence bond theory (inner and outer orbital complexes), electro neutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). 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 3: Reaction Kinetics and Mechanism (14 Lecture)

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 4: Lanthanoids and Actinoids: (04 Lectures)

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide

contraction, separation of lanthanides (ion-exchange method only).

UNIT 5: Bioinorganic Chemistry: (10 Lectures)

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium/ K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

ORGANIC CHEMISTRY-II LAB

Credits: 02 **60 Lectures**

Marks: 25 **Pass Marks: 10**

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1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.

2. Organic preparations:

(i) Acetylation of one of the following compounds: amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method:

(a) Using conventional method.

(b) Using green approach

(ii) Benzolyation of one of the following amines (aniline, o-, m-, p- toluidines and o-, m-, panisidine) and one of the following phenols (β-naphthol, resorcinol, p- cresol) by Schotten-Baumann reaction.

(iii) Oxidation of ethanol/ isopropanol (Iodoform reaction).

(iv) Bromination of any one of the following:

(a) Acetanilide by conventional methods

(b) Acetanilide using green approach (Bromate-bromide method)

(v) Nitration of any one of the following:

(a) Acetanilide/nitrobenzene by conventional method

(b) Salicylic acid by green approach (using ceric ammonium nitrate).

(vi) Selective reduction of meta dinitrobenzene to m-nitroaniline.

(vii) Reduction of p-nitrobenzaldehyde by sodium borohydride.

(viii) Hydrolysis of amides and esters.

(ix) Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.

(x) S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).

(xi) Aldol condensation using either conventional or green method.

(xii) Benzil-Benzilic acid rearrangement.

Reference Books:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press(2000).

4. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

SEMESTER – V

MJ – 7 CHEMISTRY LAB (PRACTICAL)

(60 Lectures)

Gravimetric Analysis:

i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN
iii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.
iv. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).

Inorganic Preparations:

i. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
ii. *Cis* and *trans* $K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III)
iii. Tetraamminecarbonatocobalt (III) ion
iv. Potassium tris(oxalate)ferrate(III)
v. Cuprous Chloride, Cu2Cl2
vi. Preparation of Manganese(III) phosphate, MnPO4.H2O.
vii. Preparation of Aluminium potassium sulphate KAl(SO4)2.12H2O (Potash alum) or Chrome alum.

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i. Ni (II) and Co (II)
ii. Fe (III) and Al (III)

SEM-VI

PHYSICAL CHEMISTRY

MJ-8

Credits: Theory-04, Practical – 02 **Theory: 60 Lectures.**

Marks: 15 (MSE) + 60 (ESE) = 75 **Pass Marks: (MSE: 06 +ESE: 24) = 30**

Instruction to Question Setter for

Mid Semester Examination (MSE): 1Hr.

The Mid Semester Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks.

There will be three questions of 5 marks each, out of which two are to be answered. Each question may be subdivided into two or more parts (b) Class Attendance Score (CAS) & Day to day activities (DDA) of 05 marks.

(Attendance: Upto75% = 1 mark; 75-80% = 1.5 marks; 80.-85% = 2 marks; 85-90% = 2.5 marks; >90% = 3 marks)

End Semester Examination (ESE): 3 Hrs.

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. Q. No. 1(A) will be multiple type six questions of 1 mark each. Q. No. 1(B) will contain two short answer type questions (max. 50 words) each of 3 marks. **Group B will contain descriptive type eight** questions of twelve marks each, out of which any four are to be*

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answered

UNIT 1: Conductance (12 Lectures)

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 (18 Lectures)

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 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 and SbO/Sb_2O_3 electrodes.

Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

UNIT 3: Quantum Chemistry (11 Lectures)

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; wave functions, probability distribution functions, nodal properties.

UNIT 2: Molecular Spectroscopy (13 Lectures)

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

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, anharmonocity, 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.

UNIT 3: Photochemistry (06Lectures)

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical

significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

Reference Books:

1. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw- Hill: New Delhi (2006).
2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill(2001).
3. House, J. E. Fundamentals of Quantum Chemistry 2ndEd. Elsevier: USA(2004).
4. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
5. Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015
6. Atkins, P.W & Paula, J.D. Physical Chemistry, 9th Ed., Oxford University Press (2011).
7. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
8. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
9. Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
10. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
11. Rogers, D. W. Concise Physical Chemistry Wiley (2010).
12. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons,Inc. (2005).

MJ-9

ORGANIC CHEMISTRY-III

Credits: Theory-04, Practical – 02 **Theory: 60 Lectures.**

Marks: 15 (MSE) + 60 (ESE) = 75 **Pass Marks: (MSE: 06 +ESE: 24) = 30**

Instruction to Question Setter for

Mid Semester Examination (MSE): 1 Hr.

The Mid Semester Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks.

There will be three questions of 5 marks each, out of which two are to be answered. Each question may be subdivided into two or more parts (b) Class Attendance Score (CAS) & Day to day activities (DDA) of 05 marks.

(Attendance: Upto75% = 1 mark; 75-80% = 1.5 marks; 80.-85% = 2 marks; 85-90% = 2.5 marks; >90% = 3 marks)

End Semester Examination (ESE): 3 Hrs.

There will be two groups of questions. Group A is compulsory and will contain two questions. Q. No. 1(A) will be multiple type six questions of 1 mark each. Q. No. 1(B) will contain two short answer type questions (max. 50 words) each of 3 marks. Group B will contain descriptive type eight questions of twelve marks each, out of which any four are to be answered.

UNIT 1: Nitrogen Containing Functional Groups 12 Lectures

Amines: Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid.

Diazonium Salts: Preparation and their synthetic applications.

UNIT 2: Amino Acids, Peptides and Proteins 10 Lectures

Amino acids, Peptides and their classification.

α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa 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 3: Nucleic Acids — 10 Lectures

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

UNIT 4: Heterocyclic Compounds — 22 Lectures

Classification and nomenclature, Structure, aromaticity in 5-membered 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), 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.

UNIT 5: Dyes — 06 Lectures

Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing;

Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet;

Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes –structure elucidation and synthesis of Alizarin and Indigotin.

Reference Books:

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

4. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons(1976).

5. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

6. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.

7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.

8. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Parakashan (2010).

Physical Chemistry Practical)

Credits: 02 **60Lectures**

Marks: 25 **Pass Marks:10**

Conductometry

I. Determination of cell constant

II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.

III. Perform the following conductometric titrations:

a. Strong acid vs. strong base

b. Weak acid vs. strong base

c. Strong acid vs. weak base

Potentiometry

a. Strong acid vs. strong base

b. Weak acid vs. strong base

c. Potassium dichromate vs. Mohr's salt

Reference Books:

1.Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.

2.Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

3.Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).

4.Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

ORGANIC CHEMISTRY-III LAB

(60 Lectures)

1. Detection of extra elements.

2. Functional group test for nitro, amine and amide groups.

3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)

4. Saponification value of an oil or a fat.

5. Determination of Iodine number of an oil/ fat.

6. Preparation of sodium polyacrylate.

7. Preparation of urea formaldehyde.

8. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.

9. 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.

10. 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.

11. Preparation of methyl orange.

Reference Books:

1. Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.

2. Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.

3. Arthur, I. V. Quantitative Organic Analysis, Pearson.

4. Vogel, A.I. Quantitative Organic Analysis, Part 3, Pearson (2012).

5. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).

6. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5thEd., Pearson (2012).

7. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).

8. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).