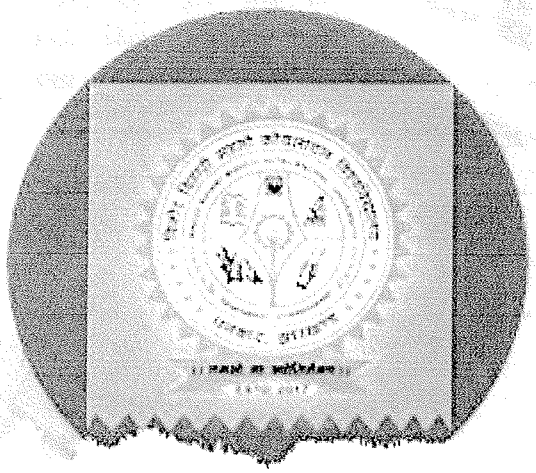
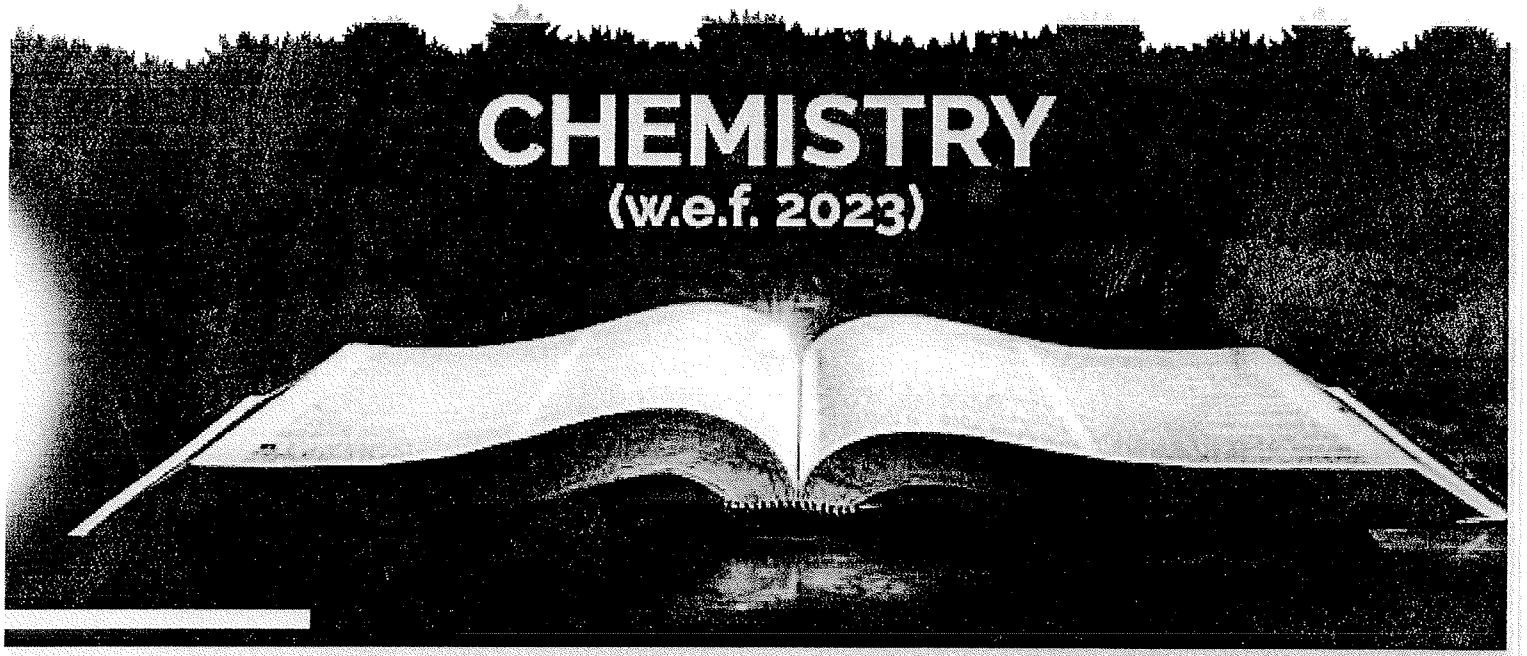
# Curriculum Framework and Credit System for the Four Year Undergraduate Programme (FYUGP)



# CHEMISTRY

(w.e.f. 2023)



## BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY, DHANBAD

# DEPARTMENT OF CHEMISTRY

## BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY, DHANBAD

## Members of Board of Studies for Undergraduate Syllabus

| | | | |
|---|---|---|---|
| 1 | Dr. Leelawati Kumari,<br>Head, University Department of Chemistry,<br>BBMKU | CHAIRPERSON | |
| 2 | Dr. Y. JHA,<br>Retired Head, Department of Chemistry,<br>P.K.R.M. College, Dhanbad | EXTERNAL EXPERT | |
| 3 | Sri Rajendra Prasad Singh,<br>UNIVERSITY DEPARTMENT of CHEMISTRY,<br>BBMKU | MEMBER | |
| 4 | Dr. Dharmendra Kumar Singh,<br>University Department of Chemistry,<br>BBMKU | MEMBER | |
| 5 | Dr. Rajeev Pradhan,<br>Head Department of Chemistry,<br>P.K.R.M. College, Dhanbad | MEMBER | |
| 6 | | | |

# SEMESTER-WISE TITLE OF THE PAPERS IN CHEMISTRY MAJOR

| Year | Semester | Course Code | Paper Title | Credits | Page No. |
|---|---|---|---|---|---|
| I | I | MJ-01 Theory | Inorganic Chemistry – 1 | 04 | 6-8 |
| | II | MJ-02 Theory | Physical Chemistry – 1 | 04 | 9-11 |
| | | MJ-03 Practical | Practical (Physical Chemistry) - 1 | 04 | 12-13 |
| EXIT POINT: UNDERGRADUATE CERTIFICATE | | | | | |
| II | III | MJ-04 Theory | Organic Chemistry – 1 | 04 | 14-16 |
| | | MJ-05 Practical | Practical (Organic Chemistry) - 2 | 04 | 17-18 |
| | IV | MJ-06 Theory | Inorganic Chemistry – 2 | 04 | 19-21 |
| | | MJ-07 Theory | Organic Chemistry – 2 | 04 | 22-24 |
| | | MJ-08 Practical | Practical (Inorganic Chemistry) – 3 | 04 | 25-26 |
| EXIT POINT: UNDERGRADUATE DIPLOMA | | | | | |
| III | V | MJ-09 Theory | Physical Chemistry – 2 | 04 | 27-29 |
| | | MJ-10 Theory | Inorganic Chemistry – 3 | 04 | 30-32 |
| | | MJ-11 Practical | Practical (Organic + Inorganic) | 04 | 33-34 |
| | VI | MJ-12 Theory | Organic Chemistry – 3 | 04 | 35-37 |
| | | MJ-13 Theory | Physical Chemistry – 3 | 04 | 38-40 |
| | | MJ-14 Theory | Analytical Chemistry | 04 | 41-42 |
| | | MJ-15 Practical | Practical (Analytical Chemistry) - 4 | 04 | 43-44 |
| EXIT POINT: BACHELOR'S DEGREE | | | | | |
| IV | VII | AMJ-01 Theory | | 04 | |
| | | AMJ-02 Theory | | 04 | |
| | | AMJ-03 Theory | | 04 | |
| | | AMJ-04 practical | | 04 | |
| | VIII | AMJ-05 Theory | | 04 | |
| EXIT POINT: BACHELOR'S DEGREE WITH Hons./ Hons. With Research | | | | | |

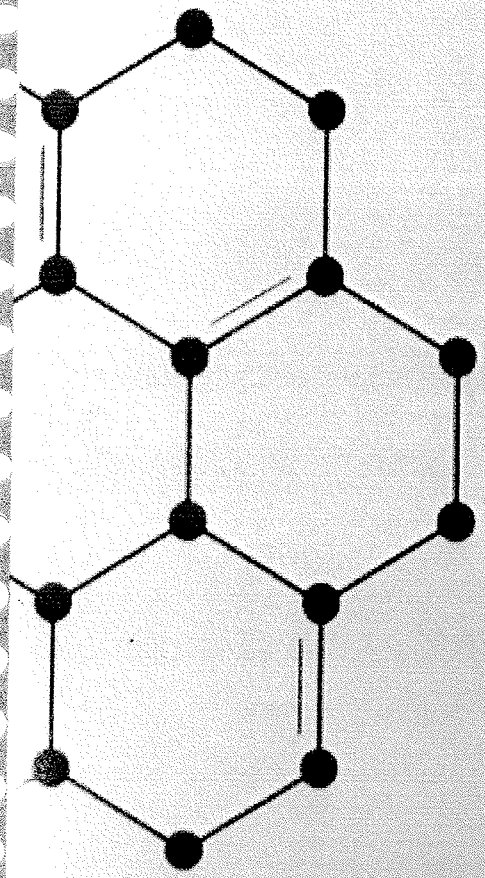
## SEMESTER-WISE TITLE OF THE PAPERS IN CHEMISTRY MINOR

| Year | Semester | Course Code | Paper Title | Credits | Page No. |
|---|---|---|---|---|---|
| I | I | MN-1A Theory | Inorganic 1 + Organic 1 | 03 | 46-48 |
| | | MN-1A Practical | Practical (Inorganic + Organic) | 01 | 49 |
| II | III | MN-1B Theory | Physical 1 + Organic 2 | 03 | 50-52 |
| | | MN-1B Practical | Practical (Physical + Organic) | 01 | 53 |
| III | V | MN-1C Theory | Physical 2 + Organic 3 | 03 | 54-56 |
| | | MN-1C Practical | Practical (Physical + Organic) | 01 | 57 |
| IV | VII | MN-1D Theory | Inorganic 2 + Physical 3 | 03 | 58-60 |
| | | MN-1D Practical | Practical (Inorganic + Physical) | 01 | 61 |

## SEMESTER-WISE TITLE OF THE PAPERS IN CHEMISTRY MULTIDISCIPLINARY COURSE (MDC)

| Year | Semester | Course Code | Paper Title | Credits | Page No. |
|---|---|---|---|---|---|
| I / II | I / II / III | MDC | MULTIDISCIPLINARY COURSE – CHEMISTRY | 03 | 63-65 |

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



# CHEMISTRY MAJOR

## BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY, DHANBAD

# SEMESTER -I

## PAPER: MJ-01 (Inorganic Chemistry – 01)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 25 | 75 | 100 |
| Pass Marks | 10 | 30 | 40 |
| Time | 1 hours | 3 hours | |

**Credits: 04**

**Duration of Course: 60 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 20 Marks.

There will be three questions of 10 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type six (Q. No. 4 to 9)** questions of 15 marks each, out of which any four are to be answered.

## UNIT I: Atomic Structure: 18 hours

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

## UNIT II: Periodicity of Elements: 18 hours

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

1 Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.

2 Atomic radii (van'der Waals)

3 Ionic and crystal radii.

4 Covalent radii (octahedral and tetrahedral)

5 Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.

6 Electron gain enthalpy, trends of electron gain enthalpy.

7 Electronegativity, Pauling, Mullikan, Allred Rachow scales, electronegativity and bond order, partial charge, hybridization, group electronegativity.

## UNIT III: Chemical Bonding: 16 hours

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

(ii) *Covalent bond:* Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone-and bond-pairs of electrons multiple bonding, sigma and pi-bond approach, Valence Bond theory, (Heitler-London approach). Hybridization containing s, p and s, p, d atomic orbitals, shapes of hybrid orbitals, Bents rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules, MO diagrams of simple tri and tetra-atomic molecules, e.g., $N_2$, $O_2$, $C_2$, $B_2$, $F_2$, CO, NO, and their ions; HCl, $BeF_2$, $CO_2$, HCHO, (idea of s-p mixing and orbital interaction to be given). Covalent character in ionic compounds, polarizing power and polarizability. Fajan rules, polarization. Ionic character in covalent compounds: Bond moment and dipole moment. ionic character from dipole moment and electronegativities.

## UNIT IV: Metallic bonding and Weak chemical forces: 8 hours

(iii) *Metallic Bond:* Qualitative idea of free electron model, Semiconductors, Insulators.

(iv) *Weak Chemical Forces:* van'der Waals, ion-dipole, dipole-dipole, induced dipole dipole-induced dipole interactions, Lenard-Jones 6-12 formula, hydrogen bond, effects of hydrogen bonding on melting and boiling points, solubility, dissolution.

## Recommended Books/References:

1. Lee, J. D. *Concise Inorganic Chemistry,* Wiley, 5th Edn.

2. Douglas, B.E., McDaniel, D.H., Alexander J.J., *Concepts & Models of Inorganic Chemistry, (Third Edition)* John Wiley & Sons,1999.

3. Atkins, P. W. and DePaula, J. *Physical Chemistry*, Tenth Edition, Oxford University Press, 2014.

4. Rodger, G. E. *Inorganic and Solid State Chemistry*, Cengage Learning, 2002.

# SEMESTER -II

## PAPER: MJ-02 (Physical Chemistry – 01)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 25 | 75 | 100 |
| Pass Marks | 10 | 30 | 40 |
| Time | 1 hours | 3 hours | |

**Credits: 04**

**Duration of Course: 60 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 20 Marks.

There will be three questions of 10 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type six (Q. No. 4 to 9)** questions of 15 marks each, out of which any four are to be answered.

## UNIT I: Gaseous State: 16 hours

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.

Behavior of real gases: Deviations from ideal gas behavior, compressibility factor, and its variation with pressure for different gases. Causes of deviation from ideal behavior. van der Waals equation of state, its derivation and application in explaining real gas behaviour; van der Waals equation expressed in virial form, Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, critical and van der

Waals constants, law of corresponding states.

## UNIT II: Liquid State: 08 hours

Structure and physical properties of liquids; vapour pressure, surface tension, viscosity, and their dependence on temperature, Effect of addition of various solutes on surface tension, cleansing action of detergents. Structure of water.

## UNIT III: Introduction to thermodynamics: 10 hours

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. *First law:* Concept of heat, $q$, work, $w$, internal energy, $U$, and statement of first law; enthalpy, $H$, relation between heat capacities, calculations of $q$, $w$, $U$ and $H$ for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

## UNIT IV: Chemical Equilibria: 14 hours

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 pure condensed phase.

## UNIT V: Ionic Equilibria: 12 hours

Arrhenius Theory, Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle. 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 tri-protic acids. Salt hydrolysis, hydrolysis constants, degree of hydrolysis and pH for different salts. Buffer solutions; Henderson

equation, buffer capacity, buffer range, buffer action, applications of buffers in analytical chemistry, Solubility and solubility product.

Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolytes.

**Recommended Text books/references:**

1. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press (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).
5. G. M. Barrow, Tata McGraw Hill (Fifth Edition) (2007)

# SEMESTER -II

## PAPER: MJ-03 (Practical Physical Chemistry – 01)

| | Mid Semester Practical | End Semester Practical | Total |
|---|---|---|---|
| Full Marks | | 100 | 100 |
| Pass Marks | | 40 | 40 |
| Time | | 3 hours | |

**Credits: 04**

**Duration of Course: 120 hours**

## UNIT I: Surface tension measurements: 12 hours

1. Determine the surface tension by (i) drop number (ii) drop weight method.
2. Study the variation of surface tension of detergent solutions with concentration.

## UNIT II: Viscosity measurements using Ostwald's viscometer: 12 hours

1. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
2. Viscosity of sucrose solution with the concentration of solute.

## UNIT III: pHmetry: 12 hours

1. Effect on pH of addition of HCl/NaOH to solutions of acetic acid sodium acetate and their mixtures.
2. Preparation of buffer solutions of different pH
   i. Sodium acetate-acetic acid
   ii. Ammonium chloride-ammonium hydroxide
3. pH metric titration of
   i. strong acid vs. strong base
   ii. weak acid vs. strong base.
4. Determination of dissociation constant of a weak acid.

## UNIT IV: Conductometry: 12 hours

1 Determination of cell constant

2 Equivalent conductance, degree of dissociation and dissociation constant of a weak acid.

3 Conductometric titrations of: (i) Strong acid Vs. strong base (ii) Weak acid vs. strong base, (iii) Mixture of strong acid and (iv)weak acid vs. strong base, Strong acid vs. weak base.

## UNIT V: Potentiometry: 12 hours

Potentiometric titrations of:

1 Strong acid vs. strong base

2 Weak acid vs. strong base

3 Dibasic acid vs. strong base

4 Potassium dichromate vs. Mohr's salt.

**Recommended text books/references:**

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

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

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

4 Athawale V. D. amd Mathur P. Experimental Physical Chemistry,, New Age Intenational (2001)

# SEMESTER -III

## PAPER: MJ-04 (Organic Chemistry – 01)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 25 | 75 | 100 |
| Pass Marks | 10 | 30 | 40 |
| Time | 1 hours | 3 hours | |

**Credits: 04**

**Duration of Course: 60 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 20 Marks.

There will be three questions of 10 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type six (Q. No. 4 to 9)** questions of 15 marks each, out of which any four are to be answered.

## UNIT I: Basics of Organic Chemistry: 06 hours

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 II: Stereohemistry: 12 hours

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 III: Chemistry of Aliphatic Hydrocarbons: 22 hours

### 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, DielsAlder 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 IV: Aromatic Hydrocarbons: 08 hours

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 V: Chemistry of Halogenated Hydrocarbons: 12 hours

**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.

# SEMESTER -III

## PAPER: MJ-05 (Practical Organic Chemistry – 02)

| | Mid Semester Practical | End Semester Practical | Total |
|---|---|---|---|
| Full Marks | | 100 | 100 |
| Pass Marks | | 40 | 40 |
| Time | | 3 hours | |

**Credits: 04**

**Duration of Course: 120 hours**

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. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
7. Organic preparations:
   (i) Acetylation of one of the following compounds: amines (aniline, o-, m-, p- toluidines and o-, m-, panisidine) 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)

8. Nitration of any one of the following:
   (a) Acetanilide/nitrobenzene by conventional method
   (b) Salicylic acid by green approach (using ceric ammonium nitrate).
9. Selective reduction of meta dinitrobenzene to m-nitroaniline.
10. Reduction of p-nitrobenzaldehyde by sodium borohydride.
11. Hydrolysis of amides and esters.
12. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
13. S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
14. Aldol condensation using either conventional or green method.

***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 -IV

## PAPER: MJ-06 (Inorganic Chemistry – 02)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 25 | 75 | 100 |
| Pass Marks | 10 | 30 | 40 |
| Time | 1 hours | 3 hours | |

**Credits: 04**

**Duration of Course: 60 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 20 Marks.

There will be three questions of 10 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type six (Q. No. 4 to 9)** questions of 15 marks each, out of which any four are to be answered.

## UNIT I: Oxidation Reduction and General Principal of Metallurgy: 08 hours

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon or carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel- de Boer process and Mond's process, Zone refining.

## UNIT II: Chemistry of *s* and *p* Block Elements: 16 hours

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behavior 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.

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. Per-oxo acids of Sulphur inter-halogen compounds, poly- halide ions, pseudo-halogens, properties of halogens.

## UNIT III: Transition Elements: 10 hours

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and 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 IV: Lanthanoid and Actinides: 10 hours

Electronic configuration, oxidation states, color, spectra and magnetic behavior, lanthanide contraction, separation of lanthanides (ion-exchange method only).

## UNIT V: Noble Gases: 08 hours

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

## UNIT VI: Inorganic Polymers: 08 hours

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

## Recommended books/references:

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.

5) Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.

6) Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* Fourth Ed., Pearson, 2010

7) Atkins, P. W and Shriver D. N. *Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).

# SEMESTER -IV

## PAPER: MJ-07 (Organic Chemistry – 02)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 25 | 75 | 100 |
| Pass Marks | 10 | 30 | 40 |
| Time | 1 hours | 3 hours | |

**Credits: 04**

**Duration of Course: 60 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 20 Marks.

There will be three questions of 10 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type six (Q. No. 4 to 9)** questions of 15 marks each, out of which any four are to be answered.

## UNIT I: Alcohols, Phenols, Ethers and Epoxides: 14 hours

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 $LiAlH_4$.

Sulphur containing compounds: Preparation and reactions of thiols and thioethers

## UNIT II: Carbonyl Compounds: 12 hours

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 III: Carboxylic Acids and their derivatives: 10 hours

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 IV: Polynuclear Hydrocarbons: 06 hours

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

## UNIT V: Carbohydrates: 10 hours

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.

## UNIT VI: Enzymes: 08 hours

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition)

***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 -IV

## PAPER: MJ-08 (Practical Inorganic Chemistry – 03)

| | Mid Semester Practical | End Semester Practical | Total |
|---|---|---|---|
| Full Marks | | 100 | 100 |
| Pass Marks | | 40 | 40 |
| Time | | 3 hours | |

**Credits: 04**

**Duration of Course: 120 hours**

## UNIT I: Titrimetric Analysis: 10 hours

(i) Calibration and use of apparatus.

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

(iii) Use of primary and secondary standard solutions.

## UNIT II: Acid-Base Titrations: 10 hours

(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

## UNIT III: Oxidation-Reduction Titrimetry: 10 hours

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.

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

(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

## UNIT IV: Qualitative analysis of Salt Mixture: 30 hours

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 $Br^-$, $NO_3^-$ and $I^-$.

Spot tests should be done whenever possible.

**Recommended Books/References:**

1. Vogel's *Qualitative Inorganic Analysis,* Revised by G. Svehla. Pearson Education, 2002.
2. Marr & Rockett *Practical Inorganic Chemistry.* John Wiley & Sons 1972.

# SEMESTER -V

## PAPER: MJ-09 (Physical Chemistry – 02)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 25 | 75 | 100 |
| Pass Marks | 10 | 30 | 40 |
| Time | 1 hours | 3 hours | |

**Credits: 04**

**Duration of Course: 60 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 20 Marks.

There will be three questions of 10 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type six (Q. No. 4 to 9)** questions of 15 marks each, out of which any four are to be answered.

## UNIT I: Thermochemistry: 06 hours

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), pressure on enthalpy of reactions.

## UNIT II: Second Law of thermodynamics: 06 hours

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.

## UNIT III: Third law of thermodynamics: 04 hours

Third Law of thermodynamics, residual entropy, calculation of absolute entropy of molecules.

## UNIT IV: Free Energy Functions: 06 hours

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 V: Partial molar quantities: 06 hours

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

## UNIT VI: Dilute solutions: 06 hours

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties: [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

## UNIT VII: Solid State: 10 hours

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

## UNIT VIII: Catalysis: 08 hours

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

## UNIT IX: Surface chemistry: 08 hours

Physical adsorption, chemisorption, adsorption isotherms (Freundlich, Temkin, Derivation of Langmuir adsorption isotherms, surface area determination), BET theory of multilayer adsorption (no derivation), Adsorption in solution.

**Recommended Books/References**

1) Atkins P. and De Paula, J. *Physical Chemistry* Tenth Ed., OUP, 2014.

2) Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa, 2004.

3) Engel, T. and Reid, P. *Physical Chemistry 3rd Ed.,* Prentice Hall, 2012.

4) McQuarrie, D. A. and Simon, J. D. *Molecular Thermodynamics* Viva Books, 2004.

5) Roy, B. N. Fundamentals of Classical and Statistical Thermodynamics Wiley, 2001

6) *Commonly Asked Questions in Thermodynamics.* CRC Press, 2011.

7) Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill, 2010. 8 Metz, C.R. *2000 solved problems in chemistry,* Schaum Series, 2006.

# SEMESTER -V

## PAPER: MJ-10 (Inorganic Chemistry – 03)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 25 | 75 | 100 |
| Pass Marks | 10 | 30 | 40 |
| Time | 1 hours | 3 hours | |

**Credits: 04**

**Duration of Course: 60 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 20 Marks.

There will be three questions of 10 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type six (Q. No. 4 to 9)** questions of 15 marks each, out of which any four are to be answered.

## UNIT I: Coordination Chemistry: 12 hours

Werner's theory, EAN rule, piano-stool compounds, valence bond theory (inner and outer orbital complexes), Crystal field theory, d-orbital splitting, , weak and strong fields, pairing energies, factors affecting the magnitude of (Δ). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar complexes, d orbital splitting in trigonal bipyramidal, square pyramidal and cubic ligand field environments, CFSE, Variation of lattice energies, enthalpies of hydration and crystal radii variations in halides of first and second row transition metal series, Qualitative aspect of Ligand field theory, MO diagrams of representative coronation complexes, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with the coordination number 4 and 6, Chelate effect.

## UNIT II: Organometallic Compounds: 22 hours

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 III: Catalysis by Organometallic Compounds: 06 hours

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

## UNIT IV: Reaction Kinetics and Mechanism: 10 hours

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 V: Bioinorganic Chemistry: 10 hours

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.

**Recommended Books/References**

1) Purcell, K.F & Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977.

2) Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.

3) Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company 1994.

4) Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999

5) Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.

6) Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.

# SEMESTER -V

## PAPER: MJ-11 (Practical Organic + Inorganic Chemistry – 04)

| | Mid Semester Practical | End Semester Practical | Total |
|---|---|---|---|
| Full Marks | | 100 | 100 |
| Pass Marks | | 40 | 40 |
| Time | | 3 hours | |

**Credits: 04**

**Duration of Course: 120 hours**

## Group A (Organic Chemistry)

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 urea formaldehyde.
7. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.
8. 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.
9. Preparation of methyl orange.
10. Estimation of glycine by Sorenson's formalin method.
11. Study of the titration curve of glycine. .
12. Study of the action of salivary amylase on starch at optimum conditions.
13. Effect of temperature on the action of salivary amylase.
14. Saponification value of an oil or a fat.
15. Determination of Iodine number of an oil/ fat.

## Group B (Inorganic Chemistry)

### 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)

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

# SEMESTER -VI

## PAPER: MJ-12 (Organic Chemistry – 03)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 25 | 75 | 100 |
| Pass Marks | 10 | 30 | 40 |
| Time | 1 hours | 3 hours | |

**Credits: 04**

**Duration of Course: 60 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 20 Marks.

There will be three questions of 10 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type six (Q. No. 4 to 9)** questions of 15 marks each, out of which any four are to be answered.

## UNIT I: Nitrogen Containing Functional Groups: 10 hours

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 II: Amino Acids, Peptides and Proteins: 10 hours

Amino acids, Peptides and their classification.

Alpha 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 III: Nucleic Acids: 10 hours**

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

**UNIT IV: Heterocyclic Compounds: 16 hours**

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 (PaalKnorr 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 V: Lipids: 08 hours**

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

**UNIT VI: Pharmaceutical Compounds: Structure and Importance: 06 hours**

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarial: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

## ***Reference Books:***

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.
2. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.
3. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
7. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
8. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Pragati Prakashan (2010).

# SEMESTER -VI

## PAPER: MJ-13 (Physical Chemistry – 03)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 25 | 75 | 100 |
| Pass Marks | 10 | 30 | 40 |
| Time | 1 hours | 3 hours | |

**Credits: 04**

**Duration of Course: 60 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 20 Marks.

There will be three questions of 10 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type six (Q. No. 4 to 9)** questions of 15 marks each, out of which any four are to be answered.

## UNIT I: Chemical Kinetics: 10 hours

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated rate laws for first, second and fractional order reactions, pseudounimolecular reactions, determination of the order, kinetics of complex reactions (limited to first order): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

## UNIT II: Phase Equilibria: 10 hours

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 III: Conductance: 06 hours

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 IV: Electrochemistry: 12 hours

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 V: Introduction to Quantum Chemistry I: 12 hours

Introduction to black-body radiation and distribution of energy, photo-electic effect, concept of quantization, wave particle duality (de-Broglie's hypothesis), The uncertainty principle, The wave function: wave function and its interpretation, conditions of normalization and Orthogonality and its significance. Basic idea about operators, eigen function and values, Schrodinger equation and application to free-particle and particle in a box, boundary conditions, wave functions and energies, degeneracy, hydrogen atom, Schrodinger equation in polar coordinates, radial and angular parts of the hydrogenic orbitals, degeneracies, spherical harmonics, representations of hydrogenic orbitals.

## UNIT VI: Introduction to Quantum Chemistry II: 10 hours

Quantitative treatment of simple harmonic osciallator model, setting up of Schodinger equation and discussion of solution of wave functions. Rigid rotator model and discussion of application of Schrodinger equation. idea about transformation to spherical polar coordinate, discussion on solution,

**Recommended books/References:**

1. Atkins P. W. and De Paula J., *Physical Chemistry, (*tenth edition) Oxford University Press, 2014.

2 Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa , 2004.

3 4 Engel, T. & Reid, P. *Physical Chemistry* Third Edition, Prentice-Hall,2012.

5 Zundhal, S.S. *Chemistry concepts and applications* Cengage India, 2011

6 Ball, D. W. *Physical Chemistry* Cengage India, 2012.

7 Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP, 2009.

8.Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill, 2011.

9.Metz, C. R. *Physical Chemistry 2nd Ed.,* Tata McGraw-Hill, 2009.

10. Laideler K. J. and Meiser J. M. *Physical Chemistry* Third Edition (International)1999

# SEMESTER -VI

## PAPER: MJ-14 (Analytical Chemistry)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 25 | 75 | 100 |
| Pass Marks | 10 | 30 | 40 |
| Time | 1 hours | 3 hours | |

**Credits: 04**

**Duration of Course: 60 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 20 Marks.

There will be three questions of 10 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type six (Q. No. 4 to 9)** questions of 15 marks each, out of which any four are to be answered.

## UNIT I: Qualitative and quantitative aspects of analysis: 08 hours

Tools in analytical chemistry and their applications, Sampling, evaluation of analytical data, errors, accuracy and precision, statistical test of data; F, Q and t-test, rejection of data, and confidence intervals.

## UNIT II: Spectroscopy: 12 hours

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

**Vibration spectroscopy:** Basic principles of instrumentation, sampling techniques. Application of IR spectroscopy for characterization through interpretation of data, Effect and importance of isotope substitution. Introduction to Raman spectra

**UV-Visible Spectrometry:** Basic principles of instrumentation, principles of quantitative

analysis using estimation of metal ions from aqueous solution, Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

**UNIT III: Thermal analysis: 08 hours**

Theory of thermogravimetry (TG and DTG), instrumentation, estimation of Ca and Mg from their mixture.

**UNIT IV: Electroanalytical methods: 12 hours**

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. determination of pKa values.

**UNIT V: Separation techniques: 20 hours**

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.

Chromatography techniques: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis using LC, GLC, TLC and HPLC.

## Recommended Books/Reference Books:

1) Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.

2) Christian, G.D, *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.

3) Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.

4) Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis, Saunder College Publications, (1998).*

5) Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood John Wiley 1979.

6) Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.

7) Khopkar, S. M., Basic Concepts of Analytical Chemistry, New Age (Second edition)1998 9

8) Skoog D.A., Holler F.J., Nieman T.A., Principles of instrumental analysis, 5th Edn., Brooks & Cole (1997).

# SEMESTER -VI

## PAPER: MJ-15 (Practical Analytical Chemistry – 05)

| | Mid Semester Practical | End Semester Practical | Total |
|---|---|---|---|
| Full Marks | | 100 | 100 |
| Pass Marks | | 40 | 40 |
| Time | | 3 hours | |

**Credits: 04**

**Duration of Course: 120 hours**

## UNIT I: Chromatography: 16 hours

(i) Paper chromatographic separation of $Fe^{3+}$, $Al^{3+}$, and $Cr^{3+}$.

(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values.

iii. Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.

(iv) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

## UNIT II: Solvent Extractions: 12 hours

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

ii. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

iii. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.

## UNIT III: Analysis of soil: 12 hours

(i) Determination of pH of soil.

(ii) Total soluble salt

(iii) Estimation of calcium, magnesium, phosphate, nitrate

## UNIT IV: Ion exchange: 10 hours

(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.

(ii) Separation of metal ions from their binary mixture.

(iii) Separation of amino acids from organic acids by ion exchange chromatography.

## UNIT V: Spectrophotometry: 10 hours

(i). Determination of pKa values of indicator using spectrophotometry.

(ii) Structural characterization of compounds by infrared spectroscopy.

(iii) Determination of dissolved oxygen in water.

(iv) Determination of chemical oxygen demand (COD).

(v) Determination of Biological oxygen demand (BOD).

(vi) Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

**Recommended text books/references:**

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.

2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.

3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.

4. Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.

5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.

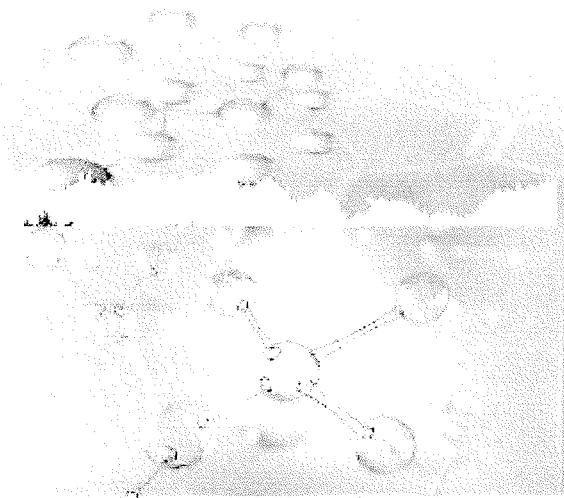
6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.

7. Mikes, O. & Chalmes, R.A. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles Harwood Ltd. London.

8. Ditts, R.V. *Analytical Chemistry: Methods of separation.* Van Nostrand, New York, 1974.

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

# CHEMISTRY
# MINOR



## BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY, DHANBAD

# SEMESTER - I

## PAPER: MN-1A Theory (Inorganic Chemistry 1 + Organic Chemistry 1)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 15 | 60 | 75 |
| Pass Marks | (Mid Sem + End Sem) | | 30 |
| Time | 1 hours | 3 hours | |

**Credits: 03**

**Duration of Course: 45 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 10 Marks.

There will be three questions of 05 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type Five (Q. No. 4 to 8)** questions of 15 marks each, out of which any Three are to be answered.

## *Section A: Inorganic Chemistry-1*

### UNIT I: Atomic Structure: 10 hours

Review of: Bohr's theory and its limitations, Sommerfeld's model, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals .

## UNIT II: Chemical Bonding and Molecular Structure: 15 hours

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance .

## ***Section A: Organic Chemistry-1***

## UNIT III: Fundamentals of Organic Chemistry: 06 hours

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

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Aromaticity: Benzenoids and Hückel's rule.

## UNIT IV: Stereochemistry: 07 hours

Conformations with respect to butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis* - *trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

## UNIT V: Aliphatic Hydrocarbons: 07 hours

**Aliphatic Hydrocarbons**

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

**Alkanes:**

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

**Alkenes:**

(Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Satyzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) and trans -addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition),

**Alkynes**:

(Upto 5 Carbons) *Preparation:* Acetylene from $CaC_2$ and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* formation of metal acetylides, addition of bromine and alkaline KMnO4.

**Reference Books:**

1. J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.
2. F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
3. Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley.
4. James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
5. T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
6. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
7. E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.
8. I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
9. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
10. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.

# SEMESTER -I

## PAPER: MN-1A Practical (Inorganic + Organic Chemistry)

| | Mid Semester Practical | End Semester Practical | Total |
|---|---|---|---|
| Full Marks | | 25 | 25 |
| Pass Marks | | 10 | 10 |
| Time | | 3 hours | |

**Credits: 01**

**Duration of Course: 30 hours**

## *Section A: Inorganic Chemistry*

### *Volumetric Analysis*

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.

## *Section B: Organic Chemistry*

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Determination of M.P./B.P.

***Reference Books:***

1. Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
3. Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
4. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

# SEMESTER - III

## PAPER: MN-1B Theory (Physical Chemistry 1 + Organic Chemistry 2)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 15 | 60 | 75 |
| Pass Marks | (Mid Sem + End Sem) | | 30 |
| Time | 1 hours | 3 hours | |

**Credits: 03**

**Duration of Course: 45 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 10 Marks.

There will be three questions of 05 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type Five (Q. No. 4 to 8)** questions of 15 marks each, out of which any Three are to be answered.

## *Section A: Physical Chemistry-1*

### UNIT I: Chemical Energetics: 08 hours

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. effect of pressure on enthalpy, Adiabatic flame temperature.

## UNIT II: Chemical Equilibrium: 06 hours

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between $\Delta G$ and $\Delta G^0$, Le Chatelier's principle. Definitions of $K_P$, $K_C$ and $K_X$. Relationships between *Kp, Kc* and *Kx* for reactions involving ideal gases.

## UNIT III: Ionic Equilibria: 06 hours

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. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. . .

## ***Section B: Organic Chemistry-2***

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

## UNIT IV: Aromatic hydrocarbons: 07 hours

Structure and aromatic character of benzene.

*Preparation* (Case benzene): from phenol, by decarboxylation, from acetylene.

*Reactions*: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene).

## UNIT V: Alkyl and Aryl Halides: 08 hours

**Alkyl Halides** (Upto 5 Carbons) Types of Nucleophilic Substitution ($S_N1$, $S_N2$ and $S_Ni$) reactions. *Preparation:* from alkenes *and* alcohols.

*Reactions:* hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis.

**Aryl Halides** *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituents.

**UNIT VI: Alcohols and Phenols (Upto 5 Carbons): 10 hours**

**Alcohols:** *Preparation:* Preparation of 1°, 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. *Reactions:* With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. $HNO_3$). Oppeneauer oxidation

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

**Reference Books:**

1. T. W. Graham Solomons: Organic Chemistry, John Wiley and Sons.
2. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
3. I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
4. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
5. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
6. G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
7. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
8. J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage □ Lening India Pvt. Ltd., New Delhi (2009).
9. B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
10. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

# SEMESTER - III

## PAPER: MN-1B Practical (Physical + Organic Chemistry)

| | Mid Semester Practical | End Semester Practical | Total |
|---|---|---|---|
| Full Marks | | 25 | 25 |
| Pass Marks | | 10 | 10 |
| Time | | 3 hours | |

**Credits: 01**

**Duration of Course: 30 hours**

## *Section A: Physical Chemistry*

**Thermochemistry**

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. Ionic equilibria pH measurements
   a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pHmeter.
   b) Preparation of buffer solutions: (i) Sodium acetate-acetic acid. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.
   c) Study of the solubility of benzoic acid in water.

## *Section B: Organic Chemistry*

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
   (a) Bromination of Phenol/Aniline
   (b) Benzoylation of amines/phenols
   (c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone.

**Reference Books:**

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

# SEMESTER - V

## PAPER: MN-1C Theory (Physical Chemistry 2 + Organic Chemistry 3)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 15 | 60 | 75 |
| Pass Marks | (Mid Sem + End Sem) | | 30 |
| Time | 1 hours | 3 hours | |

**Credits: 03**

**Duration of Course: 45 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 10 Marks.

There will be three questions of 05 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type Five (Q. No. 4 to 8)** questions of 15 marks each, out of which any Three are to be answered.

## *Section A: Physical Chemistry-2*

### UNIT I: Solutions: 07 hours

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

**UNIT II: Phase Equilibrium:** **05 hours**

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur)

**UNIT III: Conductance:** **04 hours**

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Conductometric titrations (only acid-base).

**UNIT IV: Electrochemistry:** **04 hours**

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical Series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data.

## ***Section B: Organic Chemistry-3***

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

**UNIT V: Carboxylic acids and their derivative:** **05 hours**

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

Carboxylic acid derivatives (aliphatic): (Upto 5 carbons)

Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion. Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

## UNIT VI: Amines and Diazonium Salts: 05 hours

Amines (Aliphatic and Aromatic): (Upto 5 carbons) Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

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

## UNIT VII: Amino Acids, Peptides and Proteins: 10 hours

Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis. Reactions of Amino acids: ester of –COOH group, acetylation of –NH2 group, complexation with Cu2+ ions, ninhydrin test. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.

## UNIT VIII: Carbohydrates: 05 hours

Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disaccharides (sucrose, cellobiose, maltose, lactose).

***Reference Books:***

1. G. W. Castellan: Physical Chemistry 4th Ed. Narosa (2004).
2. J. C. Kotz, P. M. Treichel, J. R. Townsend, General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
3. B. H. Mahan: University Chemistry, 3rd Edn. Narosa (1998).
4. R. H. Petrucci, General Chemistry, 5th Edn., Macmillan Publishing Co.: New York (1985). (Pearson Education).
5. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7 th Ed., W. H. Freeman.

# SEMESTER - V

## PAPER: MN-1C Practical (Physical + Organic Chemistry)

| | Mid Semester Practical | End Semester Practical | Total |
|---|---|---|---|
| Full Marks | | 25 | 25 |
| Pass Marks | | 10 | 10 |
| Time | | 3 hours | |

**Credits: 01**

**Duration of Course: 30 hours**

## *Section A: Physical Chemistry*

### Conductance

1. Determination of cell constant
2. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
3. Perform the following conductometric titrations: i) Strong acid vs. strong base ii) Weak acid vs. strong base iii) Weak acid vs. strong base.

### Potentiometry

Perform the potentiometric titrations of (i) Strong acid vs strong base and (ii) Weak acid vs strong base.

## *Section B: Organic Chemistry*

Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

## *Reference Books:*

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960). 3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

# SEMESTER - VII

## PAPER: MN-1D Theory (Inorganic Chemistry 2 + Physical Chemistry 3)

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | 15 | 60 | 75 |
| Pass Marks | (Mid Sem + End Sem) | | 30 |
| Time | 1 hours | 3 hours | |

**Credits: 03**

**Duration of Course: 45 hours**

**Instructions for Question Setter**

**Mid Semester Examination (MSE): 1 Hrs.**

The Mid Semester Examination shall have two components.

(a) One Semester Internal Assessment Test (SIA): 10 Marks.

There will be three questions of 05 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): 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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type Five (Q. No. 4 to 8)** questions of 15 marks each, out of which any Three are to be answered.

## *Section A: Inorganic Chemistry-2*

### UNIT I: General Principles of Metallurgy: 04 hours

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent.

### UNIT II: s- and p-Block Elements: 16 hours

Periodicity in s- and p-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred- Rochow scales). Allotropy in C, S, and P. Oxidation states with reference to elements in unusual and rare oxidation

states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

Compounds of s- and p-Block Elements Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of p- block elements. Concept of multicentre bonding (diborane). Structure, bonding and their important properties like oxidation/reduction, acidic/basic nature of the following compounds and their applications in industrial, organic and environmental chemistry. Hydrides of nitrogen (NH3, N2H4, N3H, NH2OH)

## ***Section B: Physical Chemistry-3***

### UNIT III: Kinetic Theory of Gases: 08 hours

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. Van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from Van der Waals equation.

### UNIT IV: Solids: 07 hours

Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography – Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

### UNIT V: Chemical Kinetics: 10 hours

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

***Reference Books:***

1. G. W. Castellan: Physical Chemistry 4th Ed. Narosa (2004).
2. J. C. Kotz, P. M. Treichel, J. R. Townsend, General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
3. B. H. Mahan: University Chemistry, 3rd Edn. Narosa (1998).
4. R. H. Petrucci, General Chemistry, 5th Edn., Macmillan Publishing Co.: New York (1985). (Pearson Education).
5. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7 th Ed., W. H. Freeman.

# SEMESTER - VII

## PAPER: MN-1D Practical (Physical + Organic Chemistry)

| | Mid Semester Practical | End Semester Practical | Total |
|---|---|---|---|
| Full Marks | | 25 | 25 |
| Pass Marks | | 10 | 10 |
| Time | | 3 hours | |

**Credits: 01**

**Duration of Course: 30 hours**

## *Section A: Inorganic Chemistry*

Semi-micro qualitative analysis of mixtures using H2S or any other scheme- not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations: $NH_4^+$, $Pb^{2+}$, $Bi^{3+}$, $Cu^{2+}$, $Cd^{2+}$, $Fe^{3+}$, $Al^{3+}$, $Co^{2+}$, $Ni^{2+}$, $Mn^{2+}$, $Zn^{2+}$, $Ba^{2+}$, $Sr^{2+}$, $Ca^{2+}$, $K^+$

Anions: $CO_3^{2-}$, $S^{2-}$, $SO_3^-$, $NO_2^-$, $CH_3COO^-$, $Cl^-$, $Br^-$, $I^-$, $NO_3^-$,$SO_4^{2-}$, $PO_4^{3-}$, $BO_3^{3-}$, $C_2O_4^{2-}$, $F^-$.

(Spot tests should be carried out wherever feasible).

## *Section B: Physical Chemistry*

1. Surface tension measurement (use of organic solvents excluded).
   (a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
   (b) Study of the variation of surface tension of a detergent solution with concentration.
2. Viscosity measurement (use of organic solvents excluded):
   (a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald viscometer.
   (b) Study of the variation of viscosity of an aqueous solution with concentration of solute.

***Reference Books:***

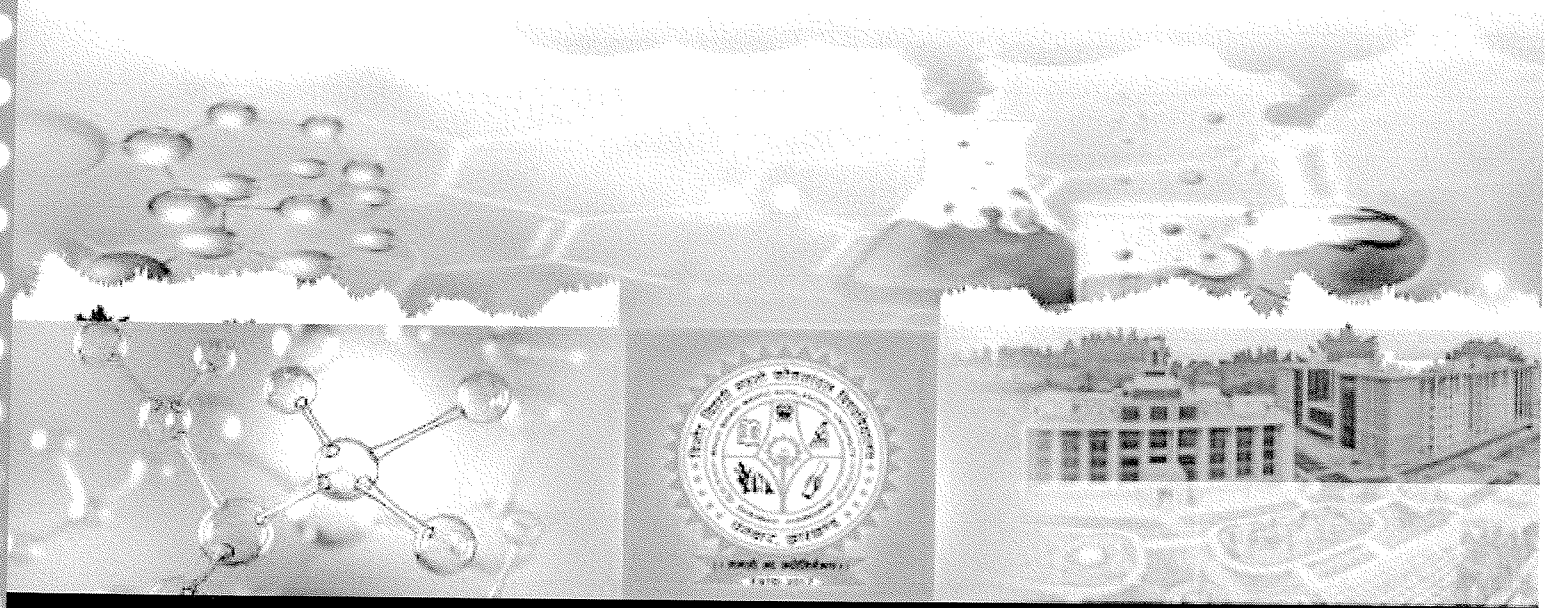
1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960). 3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

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

# CHEMISTRY

## MULTIDISCIPLINARY COURSE

## (MDC)



**BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY, DHANBAD**

# MULTIDISCIPLINARY COURSE (MDC) - CHEMISTRY

| | Mid Semester Exam | End Semester Exam | Total |
|---|---|---|---|
| Full Marks | | 75 | 75 |
| Pass Marks | | 30 | 30 |
| Time | | 3 hours | |

**Credits: 03**

**Duration of Course: 45 hours**

**Instructions for Question Setter**

**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 will be multiple/fill in the blank/very short type five questions of 1 mark each. Q. No. 2 & 3 will contain two short answer type questions each of 5 marks.
**Group B will contain descriptive type six (Q. No. 4 to 9)** questions of 15 marks each, out of which any four are to be answered.

## UNIT I: Atomic Structure: 07 hours

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 II: Periodicity of Elements: 07 hours

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 III: Chemical Bonding: 12 hours

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 $N_2$, $O_2$, $C_2$, $B_2$, $F_2$, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding ($\sigma$ and $\pi$ bond approach) and bond lengths.

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

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

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

## UNIT IV: Basics of Organic Chemistry-I: 05 hours

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 V: Basics of Organic Chemistry-II: 05 hours

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 VI: Ionic equilibria: 09 hours

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

# Members of Board of Studies of FYUGP Syllabus as per Guidelines of the Binod Bihari Mahto Koyalanchal University, Dhanbad

1. Dr. Leelawati Kumari
   Head, University Department of Chemistry, BBMKU -Chairperson

2. Sri Rajendra Prasad Singh
   University Department of Chemistry, BBMKU -Member

3. Dr. Dharmendra Kumar Singh
   University Department of Chemistry, BBMKU. -Member

**Two Experts for UG**

4. Dr. Rajeev Pradhan
   Assistant Professor, Department of Chemistry,
   P.K.R.M. College, Dhanbad -Member

5. Sri Gopal Prajapati
   Assistant Professor, Department of Chemistry,
   K.B. College, Bermo -Member

# Binod Bihari Mahto Koyalanchal University, Dhanbad
## Subject: Chemistry
## FYUGP NEP 2020 (From session 2023 onwards)
## UG Syllabus
## Minor from Vocational
## Semester II

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**Minor – 2A (MN-2A) Chemistry of food, nutrition and preservation**

**Credits – 4** **Lectures – 60 Hours**

**FM = 75** (No Internal Exam) + **25** (Practical/Viva-Voce/Demonstration/Skill-Test) = **100**

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**Instructions to External Examiner:**

- In all **Nine** questions to be set there shall be two groups, i.e., **A** and **B**.
- **Group A** is compulsory which will contain three questions.
- Question no. **1** will be very short answer type/Objective type consisting of five questions of **1 mark** each.
- Question no. **2** & **3** will be of short answer type of **5 marks** each.
- **Group B** will contain descriptive type, six questions* of **Fifteen marks** each, out of which any four are to be answered.

  *Question no.**9** will be short-answer type. There will be four options of which any two are to be answered carrying equal marks covering the whole syllabus.

**Learning Outcomes:**

After successfully completing this course, the students will be able:

1.To know about the basic of human physiological system and food science

2. To learn about the nutrition and its importance

3. To learn about the food preservation and its utility.

| Unit | Topic | Lectures |
|---|---|---|
| **Unit 1:** | **Basics of human physiological system and food science:** | |
| 1.1 | Digestive System: Structure and functions of G.I. tract, Process of digestion and absorption of food, Structure and functions of liver, gall bladder and pancreas. | 5 |
| 1.2 | Basic concept on Food, Nutrition and Nutrients (Nutrition, Malnutrition and Health: Scope of Nutrition.) | 3 |
| 1.3 | Classification of Food | 3 |
| 1.4 | Classification of Nutrients. | 3 |
| **Unit 2:** | **Nutrition:** | |
| 2.1 | Dietary fibers (composition, properties and Minerals and trace elements (biochemical and physiological role, bioavailability and requirement with examples) | 5 |

| | | |
|---|---|---|
| 2.2 | Vitamins (examples, biochemical and physiological requirements, deficiency and excesses) | 5 |
| 2.3 | Water (requirement, water balance) | 3 |
| 2.4 | Basic idea about community nutrition (objective, importance of various programmes) | 3 |
| **Unit 3:** | **Food preservation:** | |
| 3.1 | Food preservation: definition, objectives and principles of food preservation. | 3 |
| 3.2 | Different methods of food preservation | 3 |
| 3.3 | Preserved Products: Jam, Jelly, Marmalade, Sauces, Pickles, Squashes, Syrups-types, composition and manufacture, selection, cost, storage, uses and nutritional aspects. | 5 |
| 3.4 | Food Standards : ISI, Agmark, FPO, MPO, PFA, FSSAI. | 4 |
| | **Total Lectures** | **45** |

**Reference/suggested books**


1. Srilakshmi B( 2017): Nutrition Science,6th Multicolour Ed. New Age International (P) Ltd.
2. Roday S(2012): Food Science and Nutrition, 2nd Ed. Oxford University Press.
3. Mann J and Truswell S(2017) : Essentials of Human Nutrition, 5th Ed. Oxford University Press.
4. Wilson K and Walker J(2000): Principles and Techniques of Practical Biochemistry, 5th Ed. Oxford University Press.
5. Sadasivan S and Manikam K(2007): Biochemical Methods, 3rd Ed. New Age International (P) Ltd.
6. Oser B L(1965). Hawk's Physiological Chemistry, 14th Ed. McGraw-Hill Book
7. Gopalan C , Rama Sastri BV and Balasubramanian SC(2016): Nutritive value of Indian Foods, Indian Council of Medical Research.
8. Subalakshmi G and Udipi, SA(2006):Food processing and preservation, 1st Ed. New Age International (P)Ltd.
9. Potter NN and Hotchkiss JH(1999): Food science,5th Ed , Springer.

**Binod Bihari Mahto Koyalanchal University, Dhanbad**
**Subject: Chemistry**
**FYUGP NEP 2020 (From session 2023 onwards)**
**UG Syllabus**
**Minor from Vocational Paper**
**Semester II**

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**Minor – 2A (Practical) (MN-2A-P) Food, Pharmaceutical & Clinical Analysis**
**Practical/Viva-Voce/Demonstration/Skill-Test based on the above theory content.**
**FM = 25** [End Semester = 25] No Internal Examination. **Duration of Course=15×2=30 hrs**

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**Instruction to Question Setter for**
**End Semester Examination (ESE):**

*There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:*

*Experiment =15 marks*
*Practical record notebook = 05 marks*
*Viva-voce = 05 marks*

1. Estimation of blood Glucose
2. Determination of Vitamin-C in Food Sample.
3. Identification of Mono, Di and Polysaccharides.
4. Identification of Proteins.

# Binod Bihari Mahto Koyalanchal University, Dhanbad
## Subject: Chemistry
## FYUGP NEP 2020 (From session 2023 onwards)
## UG Syllabus
## Minor from Vocational
## Semester IV

**Minor – 2B (MN-2B) Fermentation Science and Technology**

**Credits – 4** **Lectures – 60 Hours**

**FM = 75** (No Internal Exam) + **25** (Practical/Viva-Voce/Demonstration/Skill-Test) = **100**

**Instructions to External Examiner:**

- In all **Nine** questions to be set, there shall be two groups, i.e., **A** and **B**.
- **Group A** is compulsory which will contain **three** questions.
- Question no. **1** will be very short answer type/Objective type consisting of five questions of **1 mark** each.
- Question no. **2** & **3** will be of short answer type of **5 marks** each.
- **Group B** will contain descriptive type, six questions* of **Fifteen marks** each, out of which any four are to be answered.

  *Question No.**9** will be short-answer type. There will be four options of which any two are to be answered carrying equal marks covering the whole syllabus.

**Learning outcomes:**

After completing this course the learner will be able to:

1. Employ the process for maintenance and preservation of microorganisms.
2. Analyze the various aspects of the fermentation technology and apply for Fermentative production.
3. Demonstrate proficiency in the experimental techniques for microbial production of enzymes: amylase and protease, bioproduct recovery.

| Unit | Topic | Lectures |
|---|---|---|
| **Unit 1** | **Microbial culture** | |
| 1.1 | Preparation of microbial culture. | 3 |
| 1.2 | Preparation and sterilization of fermentation media. | 3 |
| 1.3 | Isolation and improvement of industrially important microorganisms. | 3 |
| **Unit 2** | **Fermentation** | |
| 2.1 | Maintenance and preservation of microorganisms. | 3 |
| 2.2 | Metabolic regulations and overproduction of metabolites. | 3 |
| 2.3 | Kinetics of microbial growth and product formation. | 3 |

| | | |
|---|---|---|
| **Unit 3** | **Metabolites, Fermented products** | |
| 3.1 | Scope and opportunities of fermentation technology. | 5 |
| 3.2 | Principles of fermentation: Submerged, solid state, batch, fed-batch and continuous culture. | 5 |
| 3.3 | Fermentative production of vinegar, alcohol (ethanol, wine, beer), acids (citric acid and gluconic acid), amino acids (lysine and glutamic acid) and antibiotics (penicillin and streptomycin). | 7 |
| **Unit 4** | **Enzyme production, Bioproduct recovery** | |
| 4.1 | Microbial production of enzymes: Amylase and Protease. | 5 |
| 4.2 | Bioproduct recovery. | 5 |
| | **Total Lectures** | **45** |

**Suggested readings**


1. Waites M.J. (2008). Industrial Microbiology: An Introduction, 7th Edition, Blackwell Science, London, UK.
2. Prescott S.C., Dunn C.G., Reed G. (1982). Prescott & Dunn's Industrial Microbiology, 4th Edition, AVI Pub. Co., USA.
3. Reed G. (2004). Prescott & Dunn's industrial microbiology, 4th Edition, AVI Pub. Co., USA.
4. JR Casida L.E. (2015). Industrial Microbiology, 3rd Edition, New Age International (P) Limited Publishers, New Delhi, India.
5. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001) Industrial Microbiology: An Introduction. 1st Edition, Blackwell Science, London, UK.
6. Pelczar M.J., Chan E.C.S. and Krieg N.R. (2003) Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

**Binod Bihari Mahto Koyalanchal University, Dhanbad**
**Subject: Chemistry**
**FYUGP NEP 2020 (From session 2023 onwards)**
**UG Syllabus**
**Minor from Vocational Paper**
**Semester IV**

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**Minor – 2B (Practical) (MN-2B-P) Fermentative Production**
**Practical/Viva-Voce/Demonstration/Skill-Test based on the above theory content.**
**FM = 25** [End Semester = 25] No Internal Examination. **Duration of Course=15×2=30 hrs**

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**Instruction to Question Setter for**
**End Semester Examination (ESE):**

*There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:*

*Experiment* *=15 marks*
*Practical record notebook* *= 05 marks*
*Viva-voce* *= 05 marks*

1. Microbial Culture on Agar Plates
2. Fermentative Production of Vinegar
3. Microbial Production of Amylase Enzyme

**Binod Bihari Mahto Koyalanchal University, Dhanbad**
**Subject: Chemistry**
**FYUGP NEP 2020 (From session 2023 onwards)**
**UG Syllabus**
**Minor from Vocational**
**Semester VI**

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**Minor – 2C (MN-2C) Chemistry in Everyday Life**

**Credits – 4** **Lectures – 60 Hours**

**FM= 75**(No Internal Exam)+**25**(Viva-Voce/Demonstration/Practical/Skill-Test) =**100**

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**Instructions to External Examiner:**

- In all **Nine** questions to be set there shall be two groups, i.e., **A** and **B**.
- **Group A** is compulsory which will contain **three** questions.
- Question No. **1** will be Very Short Answer type/Objective type consisting of five questions of **1 mark** each.
- Question no. **2** & **3** will be of Short answer type of **5 marks** each.
- **Group B** will contain descriptive type, six questions* of **Fifteen marks** each, out of which any **four** are to be answered.

  *Question no.**9** will be short-answer type. There will be four options of which any **two** are to be answered carrying equal marks covering the whole syllabus.

**Learning Outcomes:**

After successfully completing this course, the students will be able:

1. Develop their understanding on Human Physiology.
2. Define and describe the principle of some common health hazards.
3. Evaluate the radicals and their destroying enzyme.
4. Understand the chemistry of everyday use Chemicals.

| Unit | Topic | Lectures |
|---|---|---|
| **Unit 1:** | **Respiration and energy production in human body** | |
| 1.1 | Respiration, Respiratory enzymes, brief outline of hemoglobin and myoglobin, oxygen transport mechanism in body, co-operativity | 2 |
| 1.2 | Respiration in lower animals, hemocyanin, hemerythrin. | 2 |
| 1.3 | Energy production in body, ATP; enzyme responsible for food digestion, mechanism of food digestion, active site of cytochrome c-oxidase. | 5 |
| **Unit 2:** | **Chemical aspects of some common health hazards** | |
| 2.1 | Anemia, sickle cell anemia, leukemia, blood pressure irregulation, blood sugar, arthritis, carbon monoxide poisoning in mines, cyanide poisoning, fluorosis etc. | 9 |
| **Unit 3:** | **Significance of Radical chemistry in living system** | |

| | | |
|---|---|---|
| 3.1 | Radical production in environment, superoxide and peroxide, health impact, action of radicals, cell mutation, diseases caused by free radical, cancer, radical quencher, anti-oxidants, natural anti-oxidants like vegetables, beverages like tea and coffee, fruits. | 8 |
| 3.2 | Radical destroying enzymes: superoxide dismutase, catalase, peroxidase, mechanism of action. | 5 |
| **Unit 4:** | **Chemistry of Materials** | |
| 4.1 | Soaps and Detergents – their action, Biofuels – production of biofuels and its utility as alternative fuel source, Fibers: natural fibers, cotton, wool, silk, rayon, artificial fibers, polyamides, acrylic acid, PVC, PVA | 8 |
| 4.2 | Examples of natural biodegradable polymers, cellulose, cellulose acetate, cellophane, soy protein, corn, zein protein, wheat gluten protein, synthetic biodegradable polymers. Use of polymeric materials in daily life. | 6 |
| | **Total Lectures** | **45** |

**Reference/suggested books**


1. Kaim W, Bioinorganic Chemistry, Vol 4, Brigitte Scwederski, Wiley, 1994.
2. Crichton R. H. Biological Inorganic Chemistry – An Introduction, Elsevier, 2008.
3. Berg J. M., Tymoczeko J. L., Stryer l. Biochemistry, W. H. Freeman, 2008.
4. Bertini, I., Gray, H. B., Lippard, S. J. and Valentine, J. S. (1994) Bioinorganic Chemistry. University Science Books (1994).
5. Lippard S., Berg J. M. Principles of Bioinorganic Chemistry; University Science Books 1994.
6. Polymer science, V. R. Gowariker, N. V.Viswanathan, J. Sreedhar, New Age International.

**Binod Bihari Mahto Koyalanchal University, Dhanbad**
**Subject: Chemistry**
**FYUGP NEP 2020 (From session 2023 onwards)**
**UG Syllabus**
**Minor from Vocational Paper**
**Semester VI**

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**Minor – 2C (Practical) (MN-2C-P) Chemistry in Everyday Life**
**Practical/Viva-Voce/Demonstration/Skill-Test based on the above theory content.**
**FM = 25** [End Semester = 25] No Internal Examination. **Duration of Course=15×2=30 hrs**

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**Instruction to Question Setter for**
**End Semester Examination (ESE):**

*There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:*

*Experiment* =*15 marks*
*Practical record notebook* = *05 marks*
*Viva-voce* = *05 marks*

1. Analysis of soaps and detergents.
2. Analysis of Biofuels - flash point, pour point, cloud point
3. Testing of adulterant in food, oil and vegetable.

Kumari

**Binod Bihari Mahto Koyalanchal University, Dhanbad**
**Subject: Chemistry**
**FYUGP NEP 2020 (From session 2023 onwards)**
**UG Syllabus**
**Minor from Vocational**
**Semester VIII**

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**Minor – 2D (MN-2D) Electrochemistry and Corrosion in Polymer-based Paint Technology**

**Credits – 4** **Lectures – 60 Hours**

**FM = 75** (No Internal Exam) + **25** (Practical/Viva-Voce/Demonstration/Skill-Test) = **100**

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**Instructions:**

- In all **Nine** questions to be set, there shall be two groups, i.e., **A** and **B**.
- **Group A** is compulsory which will contain **three** questions.
- Question No. **1** will be Very Short Answer Type/Objective type consisting of five questions of **1 mark** each.
- Question no. **2** & **3** will be of Short answer type of **5 marks** each.
- **Group B** will contain descriptive type, six questions* of **Fifteen marks** each, out of which any four are to be answered.
  *Question No.**9** will be short-answer type. There will be four options of which any **two** are to be answered carrying equal marks covering the whole syllabus.

**Learning outcomes:**

After completing this course the learner will be able to:

1. Understand the fundamentals of electrochemistry and its applications in corrosion science.
2. Analyze the mechanisms of corrosion and degradation of metallic substrates.
3. Explore the role of polymer-based paints in corrosion prevention and mitigation.
4. Examine the synthesis, properties, and applications of polymer-based paints.
5. Develop practical skills in paint formulation, application, and testing techniques.
6. Evaluate the environmental impact and sustainability considerations of paint technology.

| Unit | Topic | Lectures |
|---|---|---|
| **Unit 1** | **Introduction to Electrochemistry** | |
| 1.1 | Basic principles of electrochemistry | 2 |
| 1.2 | Electrochemical cells and electrodes | 2 |

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| | | |
|---|---|---|
| 1.3 | Electrochemical reactions and thermodynamics | 2 |
| **Unit 2** | **Corrosion Fundamentals** | |
| 2.1 | Types and forms of corrosion | 2 |
| 2.2 | Corrosion mechanisms: chemical, electrochemical, and metallurgical | 3 |
| 2.3 | Factors influencing corrosion processes | 2 |
| **Unit 3** | **Corrosion Protection Methods** | |
| 3.1 | Cathodic protection, Anodic protection, Inhibitors and passivation, Coatings and barriers | 3 |
| **Unit 4** | **Polymer Chemistry and Paint Technology** | |
| 4.1 | Introduction to polymers and polymerization techniques | 3 |
| 4.2 | Properties of polymers relevant to paint technology | 3 |
| 4.3 | Formulation of polymer-based paints | 3 |
| **Unit 5** | **Paint Formulation and Application** | |
| 5.1 | Pigments and additives | 3 |
| 5.2 | Solvents and resin systems | 3 |
| 5.3 | Application techniques: spraying, brushing, dipping | 3 |
| 5.4 | Curing and film formation | 3 |
| **Unit 6** | **Environmental and Sustainability Considerations** | |
| 6.1 | Environmental impact of paint technology | 3 |
| 6.2 | Sustainable practices in paint formulation and application | 3 |
| 6.3 | Regulatory compliance and green initiatives | 2 |
| | **Total Lectures** | **45** |

**Suggested readings**

1. "Corrosion Engineering: Principles and Practice" by Pierre R. Roberge .
2. "Polymer Chemistry: An Introduction" by Malcolm P. Stevens .
3. "Paint and Coating Testing Manual: Fourteenth Edition of the Gardner-Sward Handbook" by Joseph V. Koleske .

**Additional Resources:**

- Journal articles from reputable sources (e.g., Journal of Coatings Technology and Research, Progress in Organic Coatings).
- Industry standards and specifications from organizations like ASTM International and NACE International.

**Binod Bihari Mahto Koyalanchal University, Dhanbad**
**Subject: Chemistry**
**FYUGP NEP 2020 (From session 2023 onwards)**
**UG Syllabus**
**Minor from Vocational Paper**
**Semester VIII**

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**Minor – 2D (Practical) (MN-2D-P) Electrochemistry and Corrosion in Polymer-based Paint Technology**

**Practical/Viva-Voce/Demonstration/Skill-Test based on the above theory content.**

**FM = 25** [End Semester = 25] No Internal Examination. **Duration of Course=15×2=30 hrs**

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**Instruction to Question Setter for**
**End Semester Examination (ESE):**

*There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:*

*Experiment =15 marks*
*Practical record notebook = 05 marks*
*Viva-voce = 05 marks*

1. Examine the effect of different electrolyte concentrations on the rate of electrolysis of a copper sulfate solution using copper electrodes.
2. Investigate the effect of primer application on the adhesion and durability of different types of paint coatings applied to metal substrates subjected to accelerated weathering conditions.



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## COURSE STUCTURE FOR FYUGP 'HONOURS/ RESEARCH'

Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits =160]

| | Semester | **MJ:** Discipline specific courses-Core or Major (80) | **MN:** Minor from discipline (16) | **MN:** Minor from vocational (16) | **MDC:** Multidisciplinary Courses [Life Sciences, Physical Sciences, Mathematical and Computer Sciences, Data Analysis, Social Sciences, Humanities, etc.] (9) | **AEC:** Ability Enhancement Courses (Modern Indian Language and English (8) | **SEC:** Ability Enhancement Courses (9) | **VAC:** Value added Courses (6) | **IAP:** Internship / Dissertation (4) | **RC:** Research Courses (12) | **AMJ:** Advanced Courses in lie of Research (12) | Credits | Double Major (DMJ) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100-199: Foundation or Introductory courses | I | 4 | 4 | | 3 | 2 | 3 | | | | | **20** | 4+4 |
| | II | 4+4 | | 4 | 3 | 2 | 3 | | | | | **20** | 4+4 |
| | **Exit Point: Undergraduate Certificate provided with Summer Internship/Project (4 credits)** | | | | | | | | | | | | |
| 200-299: Intermediate-level courses | III | 4+4 | 4 | | 3 | 2 | 3 | | | | | **20** | |
| | IV | 4+4+4 | | 4 | | 2 | | 2 | | | | **20** | 4+4 |
| | **Exit Point: Undergraduate Diploma Certificate provided with Summer Internship in 1st or 2nd year /Project (4 credits)** | | | | | | | | | | | | |
| 300-399: Higher-level courses | V | 4+4+4 | 4 | | | | | | 4 | | | **20** | 4+4 |
| | VI | 4+4+4+4 | | 4 | | | | | | | | **20** | 4+4 |
| | **Exit Point: Bachelor's Degree** | | | | | | | | | | | | |
| 400-499: Advanced courses | VII | 4+4+4+4 | 4 | | | | | | | | | **20** | 4+4 |
| | VIII | 4 | | 4 | | | | | | 12 | 4+4+4 | **20** | 4+4 |
| | **Exit Point: Bachelor's Degree with Hons. /Research** | | | | | | | | | | | **160** | **224** |

**Note:** Honours students not undertaking research will do 3 courses for 12 credits in lieu of a Research project / Dissertation

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SEMESTER WISE COURSES OF STUDY FOR FOUR YEAR UNDERGRADUATE PROGRAMME (2023 onwards)

**Table 2: Semester wise Course Code and Credit Points**

| Semester | Common, Introductory, Major, Minor, Vocational & Internship Courses | | Credits |
|---|---|---|---|
| | Code | Papers | |
| I | AEC-1 | Language and Communication Skills (Modern Indian language including TRL) | 2 |
| | VAC-1 | Value Added Course-1 | 4 |
| | SEC-1 | Skill Enhancement Course-1 | 3 |
| | MDC-1 | Multi-disciplinary Course-1 | 3 |
| | MN-1A | Minor from Discipline-1 | 4 |
| | MJ-1 | Major paper 1 (Disciplinary/Interdisciplinary Major) | 4 |
| II | AEC-2 | Language and Communication Skills (English) | 2 |
| | SEC-2 | Skill Enhancement Course-2 | 3 |
| | MDC-2 | Multi-disciplinary Course-2 | 3 |
| | MN-2A | Minor from Vocational Studies/Discipline-2 | 4 |
| | MJ-2 | Major paper 2 (Disciplinary/Interdisciplinary Major) | 4 |
| | MJ-3 | Major paper 3 (Disciplinary/Interdisciplinary Major) | 4 |
| III | AEC-3 | Language and Communication Skills (Modern Indian language including TRL) | 2 |
| | SEC-3 | Skill Enhancement Course-3 | 3 |
| | MDC-3 | Multi-disciplinary Course-3 | 3 |
| | MN-1B | Minor from Discipline-1 | 4 |
| | MJ-4 | Major paper 4 (Disciplinary/Interdisciplinary Major) | 4 |
| | MJ-5 | Major paper 5 (Disciplinary/Interdisciplinary Major) | 4 |
| IV | AEC-3 | Language and Communication Skills (MIL-2/English-2) | 2 |
| | VAC-2 | Value Added Course-2 | 2 |
| | MN-2B | Minor from Vocational Studies/Discipline-2 | 4 |
| | MJ-6 | Major paper 6 (Disciplinary/Interdisciplinary Major) | 4 |
| | MJ-7 | Major paper 7 (Disciplinary/Interdisciplinary Major) | 4 |
| | MJ-8 | Major paper 8 (Disciplinary/Interdisciplinary Major) | 4 |
| V | MN-1C | Minor from Discipline-1 | 4 |
| | MJ-9 | Major paper 9 (Disciplinary/Interdisciplinary Major) | 4 |
| | MJ-10 | Major paper 10 (Disciplinary/Interdisciplinary Major) | 4 |
| | MJ-11 | Major Paper 11 (Disciplinary/Interdisciplinary Major) | 4 |
| | IAP | Internship/Apprenticeship/ Field work / Dissertation/ Project | 4 |
| VI | MN-2C | Minor from Vocational Studies/Discipline-2 | 4 |
| | MJ-12 | Major paper 12 (Disciplinary/Interdisciplinary Major) | 4 |
| | MJ-13 | Major paper 13 (Disciplinary/Interdisciplinary Major) | 4 |
| | MJ-14 | Major Paper 14 (Disciplinary/Interdisciplinary Major) | 4 |
| | MJ-15 | Major Paper 15 (Disciplinary/Interdisciplinary Major) | 4 |
| VII | MN-1D | Minor from Discipline-1 | 4 |
| | MJ-16 | Major paper 16 (Disciplinary/Interdisciplinary Major) | 4 |
| | MJ-17 | Major paper 17 (Disciplinary/Interdisciplinary Major) | 4 |
| | MJ-18 | Major Paper 18 (Disciplinary/Interdisciplinary Major) | 4 |
| | MJ-19 | Major Paper 19 (Disciplinary/Interdisciplinary Major) | 4 |
| VIII | MN-2D | Minor from Vocational Studies/Discipline-2 | 4 |
| | MJ-20 | Major paper 20 (Disciplinary/Interdisciplinary Major) | 4 |
| | RC/ | Research Internship/ Field work/ Dissertation | 12/ |
| | AMJ-1 | Advanced Major paper-1 (Disciplinary/Interdisciplinary Major) | 4 |
| | AMJ-2 | Advanced Major Paper-2 (Disciplinary/Interdisciplinary Major) | 4 |
| | AMJ-3 | Advanced Major Paper-3 (Disciplinary/Interdisciplinary Major) | 4 |

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**Abbreviations:**

| | |
|---|---|
| AEC | Ability Enhancement Courses |
| SEC | Skill Enhancement Courses |
| IAP | Internship/Apprenticeship/ Project |
| MDC | Multidisciplinary Courses |
| MJ | Major Disciplinary/Interdisciplinary Courses |
| DMJ | Double Major Disciplinary/Interdisciplinary Courses |
| AMJ | Advanced Major Disciplinary/Interdisciplinary Courses |
| MN | Minor Disciplinary/Interdisciplinary Courses |
| RC | Research Courses |

***AEC (Ability enhancements courses)- 2 Credits***

- *Full marks – 50, Pass Marks – 20*
- *In AEC the students of all faculties will have to select either Hindi or English in Semester -1 and those students who have opted Hindi will have to select English as AEC in Semester -2 and vice versa. For 3rd and 4th semester student can opt Sanskrit, Urdu, Bengali, English, Hindi or TRL.*
- *In 4th semester there will be AEC-3 will include Language and Communication Skill in Hindi and English.*
- *No internal examination will be conducted.*

***VAC (Value added Courses)- 2 Credits***

- *Full marks – 50, Pass Marks – 20*
- *For 1st semester – "Understanding India"*
- *For 4th Semester – "Environmental Studies"*
- *No internal examination will be conducted.*

***SEC (Skill Enhancement Courses) – 3 Credits***

- *Full Marks – 75, Pass Marks – 30*
- *Digital Education or Mathematical & Computational Thinking Analysis is selected as SEC. Student will have to select or opt either of the two subjects for semester – I, II and III in no case both subjects will be allowed to opt.*
- *No internal examination will be conducted.*

***MDC (Multidisciplinary Courses) – 3 credits***

- *Full Marks – 75, Pass Marks – 30*
- *A student will study three different subjects in the multidisciplinary courses during first three semesters.*
- *No internal examination will be conducted.*

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Table 3: Semester wise Course Code and Credit Points and Marks distribution of Minor Papers from Discipline-1

| S.No | Semester | Paper | Credits | Full Marks | | Pass Marks | |
|---|---|---|---|---|---|---|---|
| | | | | Theory (Internal+ End Sem) | Practical End Sem. | Theory (Internal+ End Sem | Practical |
| 1. | I | MN-1A | 3+1 | 15+60 | 25 | 30 | 10 |
| 2. | III | MN-1B | 3+1 | 15+60 | 25 | 30 | 10 |
| 3. | V | MN-1C | 3+1 | 15+60 | 25 | 30 | 10 |
| 4. | VII | MN-1D | 3+1 | 15+60 | 25 | 30 | 10 |

*Note: No internal or mid semester examination will be conducted for practical papers.*

Table 4: Semester wise Course Code and Credit Points and Marks distribution of Minor Papers from Discipline-2

| S.No | Semester | Paper | Credits | Full Marks | | Pass Marks | |
|---|---|---|---|---|---|---|---|
| | | | | Theory (Internal+ End Sem) | Practical End Sem. | Theory (Internal+ End Sem | Practical |
| 1. | II | MN-2A | 3+1 | 15+60 | 25 | 30 | 10 |
| 2. | IV | MN-2B | 3+1 | 15+60 | 25 | 30 | 10 |
| 3. | VI | MN-1C | 3+1 | 15+60 | 25 | 30 | 10 |
| 4. | VIII | MN-1D | 3+1 | 15+60 | 25 | 30 | 10 |

*Note: No internal or mid semester examination will be conducted for practical papers.*

Table 5: Semester wise Course Code and Credit Points and Marks distribution of Minor Papers from Vocational Studies

| S.N. | Semester | Paper | Credits | Full Marks | | Pass Marks | |
|---|---|---|---|---|---|---|---|
| | | | | Theory (Written test) | Practical/ Demonstration/ Skill test & Viva voce | Theory | Practical/ Demonstration/ Skill test & Viva voce |
| 1. | II | MN-2A | 4 | 75 | 25 | 30 | 10 |
| 2. | IV | MN-2B | 4 | 75 | 25 | 30 | 10 |
| 3. | VI | MN-2C | 4 | 75 | 25 | 30 | 10 |
| 4. | VIII | MN-2D | 4 | 75 | 25 | 30 | 10 |

*Note: No internal or mid semester examination will be conducted*

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## SEMESTER 7

### MJ 16 THEORY: GREEN CHEMISTRY

**Credits: 04** **Lectures: 60**

***Marks: 100 (End Semester Examination=75, Pass Marks = 30***
***Semester Internal Examination=20, Class Performance & Attendance = 05, Pass Marks=10)***

***Instruction to Question Setter for***

*Semester Internal Examination (SIE 25 marks) (20+05):*

*There will be **two** groups of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

*End Semester Examination (ESE 75 marks):*

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

**UNIT 1: Introduction to Green Chemistry** **(04 Lectures)**

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

**UNIT 2: Principles of Green Chemistry and Designing a Chemical synthesis** **(24 Lectures)**

Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ by-products; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

**UNIT 3: Examples of Green Synthesis/ Reactions** **(24 Lectures)**

Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to Strecker synthesis), citral, ibuprofen, paracetamol, furfural.

Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis of benzyl chloride, benzamide, n-phenyl benzamide, methyl benzoate to benzoic acid, Oxidation of toluene to alcohols).

Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Ortho ester Claisen Rearrangement, Diels-Alder Reaction and Decarboxylation.

Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2- dihydrotriazine derivatives; benzimidazoles.

Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.
Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clay", a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.

**UNIT 4: Future Trends in Green Chemistry** **(08 Lectures)**

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; Non-covalent derivatization; Green chemistry in sustainable development.

**Reference Books:**


1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
2. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
3. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
4. M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
5. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).


## MJ 17 THEORY: POLYMER CHEMISTRY

**Credits: 04** **Lectures: 60**

***Marks: 100 (End Semester Examination=75, Pass Marks = 30***
***Semester Internal Examination=20, Class Performance & Attendance =05, Pass Marks=10)***

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***Instruction to Question Setter for***

*Semester Internal Examination (SIE 25 marks) (20+05):*

*There will be **two** groups of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

*End Semester Examination (ESE 75 marks):*

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

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**UNIT 1: Introduction and history of polymeric materials** **(04 Lectures)**

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

**UNIT 2: Functionality and its importance** (08 Lectures)

Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi- functional systems, Poly-functional systems.

**UNIT 3: Kinetics of Polymerization:** (08 Lectures)

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

**UNIT 4: Crystallization and crystallinity** (04 Lectures)

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

**UNIT 5: Nature and structure of polymers** (10 Lectures)

Structure Property relationships. Determination of molecular weight of polymers ($M_n$, $M_w$, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

**UNIT 6: Glass transition temperature (Tg) and determination of Tg** (08 Lectures)

Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

**UNIT 7: Polymer Solution** (08 Lectures)

Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

**UNIT 8: Properties of Polymer (Physical, thermal, Flow & Mechanical Properties)** (10 Lectures)

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,
Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

**Reference Books:**


1. Seymour's Polymer Chemistry, Marcel Dekker, Inc.
2. G. Odian: Principles of Polymerization, John Wiley.
3. F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
4. P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
5. R.W. Lenz: Organic Chemistry of Synthetic High Polymers.


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## MJ 18 THEORY: INDUSTRIAL CHEMICALS AND ENVIRONMENT

Credits: 04 Lectures: 60

*Marks: 100 (End Semester Examination=75, Pass Marks = 30*
*Semester Internal Examination=20, Class Performance & Attendance =05, Pass Marks=10)*

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*Instruction to Question Setter for*

*Semester Internal Examination (SIE 25 marks) (20+05):*

*There will be **two** groups of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

*End Semester Examination (ESE 75 marks):*

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

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### UNIT 1: Industrial Gases and Inorganic Chemicals (10 Lectures)

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

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

### UNIT 2: Industrial Metallurgy (04 Lectures)

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

### UNIT 3: Environment and its segments (30 Lectures)

*Ecosystems*: Biogeochemical cycles of carbon, nitrogen and Sulphur.

*Air Pollution*: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.
Pollution by $SO_2$, $CO_2$, CO, $NO_x$, $H_2S$ and other foul-smelling gases. Methods of estimation of CO, $NO_x$, $SO_x$ and control procedures.
Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

*Water Pollution*: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

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Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, Argo fertilizer, etc. Sludge disposal.
Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

**UNIT 4: Energy & Environment** **(10 Lectures)**

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.
Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

**UNIT 5: Bio-catalysis** **(06 Lectures)**

Introduction to bio-catalysis: Importance in "Green Chemistry" and Chemical Industry.

**Reference Books:**


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


## MJ 19: Practical-VI

**Credits: 04 Lectures: 120 (60X2)**

***Instruction to Question Setter for***

*End Semester Examination (ESE):*

*There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines*

| | |
|---|---|
| *Experiment* | *= 60 marks* |
| *Practical record notebook* | *= 20 marks* |
| *Viva-voce* | *= 20 marks* |

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples ($CO_3^{2-}$, $HCO_3^-$) using double titration method.

7. Measurement of dissolved $CO_2$.
8. Preparation of borax/ boric acid.
9. Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide
10. Preparation of biodiesel from vegetable oil.
11. Preparation of urea-formaldehyde resin
12. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
13. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
14. Testing of mechanical properties of polymers.

**Reference Books:**


1. Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003)
2. Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)
3. Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)
4. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice,* Oxford University Press (1998).
5. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
6. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
7. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi.* Bangalore CISBN 978-9381141-55-7 (2013).
8. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
9. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
10. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
11. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
12. A.K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
13. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.


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## SEMESTER 8

## MJ 20 THEORY: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

**Credits: 04 Lectures: 60**

***Marks: 100 (End Semester Examination=75, Pass Marks = 30***
***Semester Internal Examination=20, Class Performance & Attendance =05, Pass Marks=10)***

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***Instruction to Question Setter for***

*Semester Internal Examination (SIE 25 marks) (20+05):*

*There will be **two** groups of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

*End Semester Examination (ESE 75 marks):*

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

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**UNIT 1: Introduction to spectroscopic methods of analysis** **(04 Lectures)**

Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.

**UNIT 2: Molecular spectroscopy** **(16 Lecture)**

**Infrared spectroscopy:** Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.

**UV-Visible/ Near IR** – emission, absorption, fluorescence and photo-accoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoaccoustic, fluorescent tags).

**UNIT 3: Separation techniques** **(08 Lectures)**

**Chromatography:** Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.

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**UNIT 4: Immunoassays and DNA techniques** **(08 Lectures)**

**Mass spectroscopy:** Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).

**Elemental analysis** **(08 Lectures)**

Mass spectrometry (electrical discharges).

Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence

Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

**UNT 5: NMR spectroscopy** **(04 Lectures)**

Principle, Instrumentation, Factors affecting chemical shift, Spin- coupling, Applications.

**UNIT 6: Electroanalytical Methods:** **(04 Lectures)**

Potentiometry & Voltammetry

**UNIT 7: Radiochemical Methods** **(04 Lectures)**

**UNIT 8: X-ray analysis and electron spectroscopy (surface analysis)** **(04 Lectures)**

Reference books:


1. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).
2. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.
3. P.W. Atkins: Physical Chemistry.
4. G.W. Castellan: Physical Chemistry.
5. C.N. Banwell: Fundamentals of Molecular Spectroscopy.
6. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
7. W.J. Moore: Physical Chemistry


## AMJ 01 THEORY: NUCLEAR & RADIATION CHEMISTRY

**Credits: 04 Lectures: 60**

***Marks: 100 (End Semester Examination=75, Pass Marks = 30***
***Semester Internal Examination=20, Class Performance & Attendance =05, Pass Marks=10)***

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***Instruction to Question Setter for***

*Semester Internal Examination (SIE 25 marks) (20+05):*

*There will be **two** groups of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

*End Semester Examination (ESE 75 marks):*

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

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**Unit 1** **(08 Lectures)**

Nucleus and its classification, nuclear forces, nuclear stability, binding energy, nuclear models. Radioactive decay (Radioactive elements, general characteristics of radioactive decay, decay kinetics - decay constant, half life, mean life period), units of radioactivity, Transient and secular equilibria, Carbon dating and its usefulness.

**Unit 2** **(10 Lectures)**

**Nuclear reactions**: Bethe notation, types of nuclear reactions (n, p, α, d and γ), conservation of quantities (mass-energy and linear momentum) in nuclear reactions, reaction cross-section, compound nucleus theory and nuclear reactions. Nuclear fission: the process, fragments, mass distribution, and fission energy.

**Unit 3** **(12 Lectures)**

Measurement of radioactivity, idea about accelerator and detectors, Van de Graaf and linear accelators, synchrontrons, Geiger-Muller detector, Scintillaton detectors, Type of nuclear reactions, Nuclear fission, Nuclear fusion, Nuclear reactor: classification of reactors, the natural uranium reactor, breeder reactor. Nuclear fusion and stellar energy.

**Unit 4** **(12 Lectures)**

Radiation chemistry: Elementary ideas of radiation chemistry, radiolysis of water and aqueous solutions, unit of radiation chemical yield (G-value), radiation dosimetry (Fricke's dosimeter), units of radiation energy (Rad, Gray, Rontgen, RBE, Rcm, Sievert)

**Unit 5** **(18 Lectures)**

Nuclear pollution and Radiological safety: Interaction of radiation with matter, Radiolysis of water, Radiation dosimetry. Radioactive isotopes and their applications, Isotopic dilution analysis, Neutron activation analysis, disposal of nuclear waste, nuclear disaster and its management (nuclear accidents and holocaust – discussion about case studies).

**Recommended Books/references:**


1. Friendlander G, Kennedy G and Miller J. M. Nuclear and Radiochemistry, Wiley Interscience
2. Harvey, B. G. Introduction to Nuclear Physics & Chemistry, Prentice – Hall,
3. Overman R. T, Basic concept of Nuclear Chemistry, Chapman & Hall.
4. A. N. Nesmeyanov, Radiochemistry, MIR Publication, Moscow.
5. Spinks J. W. T. and Woods R. J. An Introduction to Radiation Chemistry, Wiley
6. Arnikar H. J., Essentials of Nuclear Chemistry, Wiley Eastern, Second Edition


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## AMJ 02 THEORY: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

**Credits: 04 Lectures: 60**

***Marks: 100 (End Semester Examination=75, Pass Marks = 30***
***Semester Internal Examination=20, Class Performance & Attendance =05,***
***Pass Marks=10)***

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***Instruction to Question Setter for***

*Semester Internal Examination (SIE 25 marks) (20+05):*

*There will be **two** groups of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

*End Semester Examination (ESE 75 marks):*

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

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**UNIT 1: Silicate Industries** **(16 Lectures)**

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armored glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass. Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre. Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

**UNIT 2: Fertilizers** **(08 Lectures)**

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

**UNIT 3: Surface Coatings** **(10 Lectures)**

Objectives of coatings surfaces, preliminary treatment of surface, classification of coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-

friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

**UNIT 4: Batteries** **(06 Lectures)**

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

**UNIT 5: Alloys** **(10 Lectures)**

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

**UNIT 6: Catalysis** **(06 Lectures)**

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

**UNIT 7: Chemical explosives** **(04 Lectures)**

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

**Reference Books:**

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

## AMJ 03: PRACTICAL

**Credits: 04 Lectures: 120 (60X2)**

***Instruction to Question Setter for***

*End Semester Examination (ESE):*

*There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines*

| | |
|---|---|
| *Experiment* | *= 60 marks* |
| *Practical record notebook* | *= 20 marks* |
| *Viva-voce* | *= 20 marks* |

1. Determination of free acidity in ammonium sulphate fertilizer.

2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Determination of composition of dolomite (by complexometric titration).
5. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
6. Analysis of Cement.
7. Safety Practices in the Chemistry Laboratory
8. Determination of the isoelectric pH of a protein.
9. Titration curve of an amino acid.
10. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
11. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
12. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)
13. Separation of Carbohydrates by HPLC
14. Determination of Caffeine in Beverages by HPLC
15. Potentiometric Titration of a Chloride-Iodide Mixture

**Reference Books**:


1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
7. B.K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut
8. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).
9. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle


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