UNIVERSITY OF NORTH BENGAL

*Raja Rammohunpur, Dist. Darjeeling, Pin: 734*013

FYUGP syllabus

B.Sc. 4-YEAR UNDER GRADUATE PROGRAM (FYUGP) WITH CHEMISTRY AS **DSC** SUBJECT UNDER THE NEW CURRICULUM AND CREDIT FRAMEWORK, **2024**

WITH EFFECT FROM THE **2024-2025** ACADEMIC SESSION

LAYOUT OF SYLLABUS FOR CHEMISTRY AS DSC SUBJECT

SEMESTER	***COURSE TYPE***	***PAPER DESCRIPTION***	***PAPER CODE***
1	DSC-1	PHYSICAL CHEMISTRY-I	CHEMDSC101
2	DSC-2	INORGANIC CHEMISTRY-I	CHEMDSC202
3	DSC-3	ORGANIC CHEMISTRY-I	CHEMDSC303
4	DSC-4	PHYSICAL CHEMISTRY-II	CHEMDSC404
5	DSC-5	INORGANIC CHEMISTRY-II	CHEMDSC505
5	DSC-6	ORGANIC CHEMISTRY-II	CHEMDSC506
6	DSC-7	GREEN CHEMISTRY	CHEMDSC607
6	DSC-8	BIOCHEMISTRY	CHEMDSC608
7	DSC-9	PHYSICAL CHEMISTRY-III	CHEMDSC709
7	DSC-10	INORGANIC CHEMISTRY-III	CHEMDSC710
8	DSC-11	ORGANIC CHEMISTRY-III	CHEMDSC811
8	DSC-12	INDUSTRIAL CHEMISTRY	CHEMDSC812

Semester-I

COURSE TYPE: DSC-1

PAPER CODE	PAPER DESCRIPTION
CHEMDSC101	PHYSICAL CHEMISTRY-I
Credit	Paper Type
4	L
Paper Levels	Full Marks
100	80

Semester-II

COURSE TYPE: DSC-2

PAPER CODE	PAPER DESCRIPTION
CHEMDSC202	INORGANIC CHEMISTRY-I
Credit	Paper Type
4	L
Paper Levels	Full Marks
100	80

Semester-III

COURSE TYPE: DSC-3

PAPER CODE	PAPER DESCRIPTION
CHEMDSC303	ORGANIC CHEMISTRY-I
Credit	Paper Type
4	L
Paper Levels	Full Marks
200	80

Semester-IV

COURSE TYPE: DSC-4

PAPER CODE	PAPER DESCRIPTION
CHEMDSC404	PHYSICAL CHEMISTRY-II
Credit	Paper Type
4	L
Paper Levels	Full Marks
200	80

Semester-V

COURSE TYPE: DSC-5

PAPER CODE	PAPER DESCRIPTION
CHEMDSC505	INORGANIC CHEMISTRY-II
Credit	Paper Type
4	L
Paper Levels	Full Marks
300	80

Semester-V

COURSE TYPE: DSC-6

PAPER CODE	PAPER DESCRIPTION
CHEMDSC506	ORGANIC CHEMISTRY-II
Credit	Paper Type
4	L
Paper Levels	Full Marks
300	80

Semester-VI

COURSE TYPE: DSC-7

PAPER CODE	PAPER DESCRIPTION
CHEMDSC607	GREEN CHEMISTRY
Credit	Paper Type
4	L
Paper Levels	Full Marks
300	80

Semester-VI

COURSE TYPE: DSC-8

PAPER CODE	PAPER DESCRIPTION
CHEMDSC608	BIOCHEMISTRY
Credit	Paper Type
4	L
Paper Levels	Full Marks
300	80

Semester-VII

COURSE TYPE: DSC-9

PAPER CODE	PAPER DESCRIPTION
CHEMDSC709	PHYSICAL CHEMISTRY-III
Credit	Paper Type
4	L
Paper Levels	Full Marks
400	80

Semester-VII

COURSE TYPE: DSC-10

PAPER CODE	PAPER DESCRIPTION
CHEMDSC710	INORGANIC CHEMISTRY-III
Credit	Paper Type
4	L
Paper Levels	Full Marks
400	80

Semester-VIII

COURSE TYPE: DSC-11

PAPER CODE	PAPER DESCRIPTION
CHEMDSC811	ORGANIC CHEMISTRY-III
Credit	Paper Type
4	L
Paper Levels	Full Marks
400	80

Semester-VIII

COURSE TYPE: DSC-12

PAPER CODE	PAPER DESCRIPTION
CHEMDSC812	INDUSTRIAL CHEMISTRY
Credit	Paper Type
4	L
Paper Levels	Full Marks
400	80

UNIVERSITY OF NORTH BENGAL

CHEMISTRY

Semester-I

DSC-1

Paper Code: CHEMDSC101

Paper Description: PHYSICAL CHEMISTRY-I

Paper Type: L (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

PHYSICAL CHEMISTRY-I

UNIT I: Gaseous State

***Kinetic molecular model of a gas*:** postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, the relation between mean free path and coefficient of viscosity, calculation of σ from η.

***The behavior of real gases*:** Deviations from ideal behavior, compressibility factor, *Z*, 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 behavior and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, and the law of corresponding states. **(15 Lectures)**

UNIT II: Liquid and Solid State

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

***Solid State*:** Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Millerindices, elementary ideas of symmetry, symmetry elements, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law. Analysis of crystal structure of NaCl, and KCl. **(15 Lectures)**

UNIT III: Chemical Equilibrium and Ionic Equilibria

***Chemical Equilibrium*:** Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

***Ionic Equilibria*:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly

soluble salts. Principles involved in separation of cations into groups and choice of group reagents. **(15 Lectures)**

Reference Books:

- Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
- Ball, D. W. *Physical Chemistry*, Thomson Press, India, 2007.
- Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa, 2004.
- Mortimer, R.G. *Physical Chemistry*, 3rd Ed., Elsevier, 2009.
- Engel, T. & Reid, P. *Physical Chemistry*, 3rd Ed., Pearson, 2013.
- Levine, I.N. *Physical Chemistry*, 6th Ed., Tata McGraw Hill, 2010.

PRACTICAL

PHYSICAL CHEMISTRY-I: (*any three*) **(30 HOURS)**

1. Determination of the Density of a liquid.
2. (a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer. **or**
   (b) Study of the variation of surface tension of a solution with concentration.
3. (a) Determination of the coefficient of viscosity of a liquid or dilute solution using an Ostwald's viscometer. **or**
   (b) Study of the variation of viscosity of an aqueous solution with concentration of solute.
4. Preparation of buffer solutions and measurement of pH of the buffer solutions along with comparison with the theoretical values:
   (a) Sodium acetate-acetic acid **or**
   (b) Ammonium chloride-ammonium hydroxide

End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

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

CHEMISTRY

Semester-II

DSC-2

Paper Code: CHEMDSC202

Paper Description: INORGANIC CHEMISTRY-I

Paper Type: L (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

INORGANIC CHEMISTRY-I

UNIT I: Atomic Structure

Bohr's theory, its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra.

Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, Shapes of s, p, and d atomic orbitals.

Pauli's Exclusion Principle, Hund's Rule, and Aufbau's Principle. Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations. **(15 Lectures)**

UNIT II: Periodicity of Elements

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

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in the periodic table.

(b) Atomic radii (van der Waals)

(c) Ionic and crystal radii.

(d) Covalent radii (octahedral and tetrahedral)

(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.

(f) Electron gain enthalpy, trends of electron gain enthalpy.

(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, and group electronegativity. **(15 Lectures)**

UNIT III: Chemical Bonding

Ionic Bonding: General characteristics of 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.
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.
MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing). Comparison of VB and MO approaches.
Dipole moment. Hydrogen Bonding. **(15 Lectures)**

Reference Books:

- Cotton, F.A., Wilkinson, G & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry*, Oxford, 1970.
- Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.
- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Huheey, J.E., Keiter, E.A., Keiter, R.L & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.

PRACTICAL

INORGANIC CHEMISTRY-I: **(30 HOURS)**

1. Qualitative analysis of **water-soluble** mixtures–**three ionic species** (two cations one anion or one cation and two anions) out of the following:

   Cations: Pb^{2+}, Cu^{2+}, Fe^{3+}, Ni^{2+}, Zn^{2+}, Ba^{2+}, Na^{+}, K^{+}, NH_4^{+}

   Anions: SO_4^{2-}, NO_3^{-}, Cl^{-}

   Cations can be confirmed by Group Analysis or Special tests wherever feasible.

   (Group Analysis is not mandatory**)**

End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Marr & Rockett, *Practical Inorganic Chemistry*, Wiley & Sons, 1972.
- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2002

CHEMISTRY

Semester-III

DSC-3

Paper Code: CHEMDSC303

Paper Description: ORGANIC CHEMISTRY-I

Paper Type: L (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

ORGANIC CHEMISTRY-I

UNIT I: Basics of Organic Chemistry

Concept of (i) Aromatic and non-aromatic hydrocarbons; (ii) Organic acids and bases; (iii) Electrophiles and Nucleophiles and (iv) Hybridisation of organic compounds.

Electronic Displacements: Inductive, Electromeric, Resonance and Mesomeric effects, Hyperconjugation.

Homolytic and Heterolytic fission; Idea of Carbocations, Carbanions, and Free radicals (Types, shape, and the relative stability).

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions. **(15 Lectures)**

UNIT II: Chemistry of Non-aromatic Hydrocarbons

Alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Halogenation of alkanes**.**

Alkenes and Alkynes: Formation of alkenes and alkynes. Preliminary concept of E1, E2 elimination reaction, Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions (Markownikoff/Anti Markownikoff addition), hydroboration-oxidation, ozonolysis,c atalytic reduction, hydroxylation.

Reactions of alkynes: Alkylation of terminal alkynes and reduction reactions. Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds. **(20 Lectures)**

UNIT III: Chemistry of Aromatic Hydrocarbons

Hydrogenation reaction of benzene, Directing effects of groups attached to benzene ring, Electrophilic aromatic substitution: Friedel-Craft's alkylation/acylation reaction, Halogenation, Nitration and Sulphonation reaction. **(10 Lectures)**

Reference Books:

- Claiden, J.; Warren, S. & Greeves, N. *Organic Chemistry*, 2nd Ed., Oxford University Press, 2012.
- Carruthers, W. *Some Modern Methods of Organic Synthesis*, 4th Ed., Cambridge University Press, 2004.
- Loudon, M. *Organic Chemistry*, Oxford University Press, 2002.

PRACTICAL

ORGANIC CHEMISTRY-I: **(30 HOURS)**

1. Purification of organic compounds by crystallization using the following solvents: (a)Water and (b)Alcohol
2. Determination of the melting points of organic compounds.
3. (a) Preliminary characterization of aliphatic and aromatic compounds by ignition.
   (b) Detection of active unsaturation in organic compounds.
   (c) Classification of Acidic and Alkaline compounds.

End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education, 2009.
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G. & Tatchell, A.R. *Practical Organic Chemistry*, 5thEd., Pearson, 2012.
- Vogel, A. *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., Pearson India, 2003.

CHEMISTRY

Semester-IV

DSC-4

Paper Code: CHEMDSC404

Paper Description: PHYSICAL CHEMISTRY-II

Paper Type: L (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

PHYSICAL CHEMISTRY-II

UNIT I: Thermodynamics

Basic Definitions and mathematical background. First Law, Enthalpy Functions, Relation between Cp and Cv, Joule-Thomson Experiment, Inversion of Temperature, Adiabatic Changes in State, Enthalpies of Chemical Changes, Important principles and definitions of thermochemistry. Hess's Law. The Second Law, Carnot Cycle and its efficiency.

Entropy, Variation of enthalpy of a reaction with temperature-Kirchhoff's equation. Statement of Third Law of thermodynamics. **(15 Lectures)**

UNIT II: Chemical Kinetics and Catalysis

Concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Specific reaction rate. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions. Pseudo-unimolecular reactions. 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.

Characteristics of catalysed reactions, Homogeneous and Heterogeneous catalysis (mechanism with examples), catalyst poisons and promoters, Acid-Base catalysis, Enzyme catalysis.

(20 Lectures)

UNIT III: Colloids

Definition with examples, Preparation of Colloidal systems, Purification of Sols, Classification of Colloid systems, Optical and electrical properties of Lyophobic Sols, Stability of Sols, Brownian motion, Gold Number. **(10 Lectures)**

Reference Books:

- Atkins, P.W.& Paula, J.de *Atkin's Physical Chemistry*,10th Ed., Oxford University Press, 2014.
- Ball, D.W. *Physical Chemistry*, Thomson Press, India, 2007.
- Levine, I.N. *Physical Chemistry*, 6th Ed., Tata McGraw Hill, 2010.
- McQuarrie, D.A. & Simon, J.D. *Molecular Thermodynamics*, Viva Books Pvt. Ltd., New Delhi, 2004.
- Barrow, G.M. *Physical Chemistry*, 4th Ed. Narosa, 2004.
- Castellan, G.W. *Physical Chemistry*,4th Ed., Narosa, 2004.
- Kotz, J.C.; Treichel, P.M. & Townsend, J.R. *General Chemistry*. Cengage Learning India Pvt. Ltd., New Delhi, 2009.
- Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa, 1998.
- Petrucci, R.H. *General Chemistry*, 5th Ed. Macmillan Publishing Co., New York, 1985.

PRACTICAL

PHYSICAL CHEMISTRY-II: (any three) (30 HOURS)

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Calculation of enthalpy of ionization of ethanoic acid.
4. Study the kinetics of the following reactions:
5. Acid hydrolysis of methyl acetate with hydrochloric acid **or** Saponification of ethyl acetate.

End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Athawale, V.D. & Mathur, P. *Experimental Physical Chemistry*, New Age International, New Delhi, 2001.
- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co., New Delhi, 2011.
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry*, 8th Ed.; McGraw-Hill, New York, 2003.
- Halpern, A. M. & McBane, G. C. *Experimental Physical* Chemistry, 3rd Ed., W.H. Freeman & Co., New York, 2003.

CHEMISTRY

Semester-V

DSC-5

Paper Code: CHEMDSC505

Paper Description: INORGANIC CHEMISTRY-II

Paper Type: L (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

INORGANIC CHEMISTRY-II

UNIT I: Transition Elements, Lanthanoids and Actinoids

Transition Elements: General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states (Latimer diagrams).

Lanthanoids and Actinoids: Electronic configurations, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only). **(15 Lectures)**

UNIT II: Coordination Chemistry and Crystal Field Theory

Valence Bond Theory (VBT): Inner and outer orbital complexes of Fe, Co, Ni and Cu coordination numbers 4 and 6). Structural and stereoisomerism in complexes with

coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature.
Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of Δ_o. Spectrochemical series. Comparison of CFSE for O_h and T_d complexes, Tetragonal distortion of octahedral geometry, Jahn-Teller distortion, Square planar coordination. **(18 Lectures)**

UNIT III: Acids-Bases and Redox reactions

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.
Redox equations, Standard Electrode Potential and its application to inorganic reactions.
Principles involved in volumetric analysis **(12 Lectures)**

Reference Books:

- Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
- Wulfsberg, G. *Inorganic Chemistry*, Viva Books Pvt. Ltd.
- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry*, Oxford, 1970.
- Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.
- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Huheey, J.E., Keiter, E.A., Keiter, R.L & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
- Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd., 2008.

PRACTICAL

PRACTICAL (INORGANIC CHEMISTRY-II): (30 HOURS)

1. Acid-Base Titrations: (*any two*)

(a) Estimation of carbonate and hydroxide present together in mixture.
(b) Estimation of sodium carbonate and sodium bicarbonate present together in a mixture.
(c) Estimation of free alkali present in different soaps/detergents

2. Oxidation-Reduction Titrimetry: (*any two*)

(a) Estimation of oxalic acid by titrating it with $KMnO_4$.
(b) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
(c) Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
- Marr & Rockett, *Practical Inorganic Chemistry*, Wiley & Sons, 1972.
- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2002.

CHEMISTRY

Semester-V

DSC-6

Paper Code: CHEMDSC506

Paper Description: ORGANIC CHEMISTRY-II

Paper Type: L (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

ORGANIC CHEMISTRY-II

UNIT I: Halogenated Hydrocarbons

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.

Arylhalides: 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 and their use in synthesis of organic compounds.

(15 Lectures)

UNIT II: Alcohols, Phenols and Carboxylic acids

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions.

***Carboxylic acids*:** 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. **(15 Lectures)**

UNIT III: Carbonyl Compounds

Structure, preparation and reactivity of carbonyl compounds (Nucleophilic additions, Nucleophilic addition-elimination reactions, ammonia derivatives with mechanism). Umpolung of reactivity.

Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann rearrangement and Benzil-Benzilic acid rearrangement, Haloform reaction and Baeyer Villiger oxidation, Swarn oxidation.

Oxidations and reductions (Clemmensen, Wolff-Kishner, MPV, Selective reduction using metal hydrides ($LiAlH_4$, $NaBH_4$).

Addition reactions of unsaturated carbonyl compounds: Michael addition. Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

(15 Lectures)

Reference Books:

- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed., Cengage Learning India Edition, 2013.
- Carruthers, W. *Some Modern Methods of Organic Synthesis*, 4th Ed., Cambridge University Press, 2004.
- Loudon, M. *Organic Chemistry*, Oxford University Press, 2002.

PRACTICAL

ORGANIC CHEMISTRY-II: (30 HOURS)

1. Detection of special elements (N, S, Cl, Br, I) in organic compounds.
2. Identification of functional groups (Alcoholic-OH, Phenolic-OH, carbonyl group, carboxylic acid group).
3. Systematic Analysis of Non-nitrogenous Organic Compounds possessing mono functional Groups.

End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Mann, F. G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education, 2009.
- Vogel, A. *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., Pearson India, 2003.

CHEMISTRY

Semester-VI

DSC-7

Paper Code: CHEMDSC607

Paper Description: GREEN CHEMISTRY

Paper Type: L (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

GREEN CHEMISTRY

Green Chemistry – an overview, Principles of Green Chemistry.

Green chemistry metrics: atom economy, percentage yield, reaction mass efficiency, environmental factor,

Green synthetic methods: organic synthesis in aqueous media, Ionic liquids [design, synthesis and naming. Applications: advantages as reaction media, task-specific IL, NHC synthesis, advantages as ligand, comparison with phosphine ligand, NHC catalysed Umpolung reactions], Supercritical liquids, microwave-assisted organic reactions, Principle of sonochemistry, organic electrosynthesis and biocatalysis. Solvent-free organic reactions, Solid phase organic synthesis, Merrifield synthesis.

Metal catalyzed organic reactions, Homogeneous and heterogeneous catalysis. Transition-metal catalysed reductions, oxidations, epoxidation of alkenes, isomerization of unsaturated molecules, and hydrolysis. Alkene Metathesis, Oligomerisation and polymerization (Zeigler Natta polymerization), olefin oxidation (Wacker Process), Hydroformylation (oxoreaction), Fischer-Tropsch Reaction, Monsanto Acetic Acid Process, and Reppe Carbonylation.

Real-world Cases in Green Chemistry should be discussed:

- Surfactants for carbon dioxide – Replacing smog-producing and ozone-depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.
- Designing of environmentally safe marine antifoulant.
- Rightfit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments.
- An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn.

(45 Lectures)

Reference Books:

- Anatas, P.T & Warner J.K, *Green Chemistry-Theory and Practical*, Oxford University Press, 1998.
- Ahluwalia, V.K. & Kidwai, M. R. *New Trends in Green Chemistry*, Annamalaya Publishers, 2005.
- Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker, 2001.
- Cann, M.C. & Connely, M.E. *Real-World Cases in Green Chemistry*, ACS, Washington, 2000.

- Lancaster, M. *Green Chemistry: An Introductory text*, RSC Punblishing, 2nd Ed.
- Ryan, M.A. & Tinnesand M. *Introduction to Green Chemistry*, ACS, Washington, 2002.

PRACTICAL

GREEN CHEMISTRY: (any two) by green method (30 HOURS)

1. Solid-state synthesis of Benzillic acid.
2. Extraction of d-limulene from citrus fruits.
3. Solvent-free microwave-assisted one-pot synthesis of phthalocyanine complex of copper (II).
4. Bromination of acetanilide.

End Semester Examination (ESE):

At the end of the semester, a practical examination will be conducted as per the following guidelines.

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Anastas, P.T. & Warner, J.K. *Green Chemistry-Theory and Practical*, OxfordUniversity Press, 1998.

CHEMISTRY

Semester-VI

DSC-8

Paper Code: CHEMDSC608

Paper Description: BIOCHEMISTRY

Paper Type: L (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

BIOCHEMISTRY

***Carbohydrates*:** Open chain and cyclic structure: Glucose and Fructose, Mutarotation. Ascending and descending in monosaccharides. Structure of disaccharides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose).

Amino Acids, Peptides and Proteins: Preparation of Amino Acids: Strecker synthesis, Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis. Reactions:

complexation of amino acids with Cu(II) ions, ninhydrin test. An overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.

Lipids: Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, iodine number. Rancidity.

Enzymes: Characteristics of enzymes. Salient features of the active site of enzymes. Mechanism of enzyme action (taking trypsin as an example), coenzymes and cofactors and their role in biological reactions, enzyme inhibitors and their importance.

Concept of Energy in Biosystems: ATP: The universal currency of cellular energy, Agents for transfer of electrons in biological redox systems: NAD^+, FAD. Glycolysis, Krebs cycle.

Metalloproteins: Oxygen transporting and electron transporting. Heme proteins: Hemoglobin, Myoglobin, Hemerythrin, Hemocyanin, Cytochrome P450, Cytochrome c oxidase. Non-heme proteins: Copper in cytochrome c oxidase and in respiratory chain, blue copper proteins.

***Metalloenzymes*:** Zinc enzymes-carboxypeptidase and carbonic anhydrase. Iron enzyme-catalyses, peroxidase and cytochrome P-450. Copper enzyme-superoxide dismutase.

Role of alkali and alkaline earth metals in biological systems. Biological functions and toxicity caused by metal ions. Biological fixation of nitrogen. Chlorophyll-the photosynthetic catalyst, Bio-availability of metal ions. **(45 Lectures)**

Reference Books:

- Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, 6th Ed. W.H. Freeman and
- Co. 2006.
- Nelson, D.L., Cox, M.M. & Lehninger, A.L. *Principles of Biochemistry*, IV Edition,
- W.H. Freeman and Co. 2009.
- Murray, R.K., Granner, D.K., Mayes, P.A. & Rodwell, V.W. *Harper's Illustrated*
- *Biochemistry*, XXVIII Edition, Lange Medical Books/ McGraw-Hill, 2009.
- Lippard, J. & Berg, G.M. *Principles of Bio-Inorganic Chemistry*, Panima Publishing, 1994.

PRACTICAL

BIOCHEMISTRY: (*any two*) **(30 HOURS)**

1. Analysis of Carbohydrates: Aldoses and ketoses, reducing and non-reducing sugars.
2. Estimation of Glycine by Sorenson's Formalin method.
3. Study of the titration curve of Glycine.
4. Estimation of Protein by Lowry's method.
5. Detection of the optimum temperature for action of salivary amylase on starch.
6. Determination of the saponification value of an oil or fat.
7. Determine of the Iodine number of an oil or fat.
8. Isolation and characterization of DNA from onion/peas/cauliflower.

End Semester Examination (ESE)

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- *Manual of Biochemistry Workshop*, Department of Chemistry, University of Delhi, 2012.
- Arthur, I. V. *Quantitative Organic Analysis*, Pearson.

Semester-VII

DSC-9

Paper Code: CHEMDSC709

Paper Description: PHYSICAL CHEMISTRY-III

Paper Type: L (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

PHYSICAL CHEMISTRY-III

UNIT I: Electrochemical Cells

Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation, Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants and (iii) pH values, using hydrogen, quinone-hydroquinone, glass electrodes. Concentration cells with and without transference, liquid junction potential, determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation). **(22 Lectures)**

UNIT II: Conductance

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 rule.

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.

(23 Lectures)

Reference Books:

- Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
- Ball, D. W. *Physical Chemistry*, Thomson Press, India, 2007.
- Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa, 2004.
- Mortimer, R. G. *Physical Chemistry*, 3rd Ed., Elsevier, NOIDA, UP, 2009.
- Engel, T. & Reid, P. *Physical Chemistry*, 3rd Ed., Pearson, 2013.
- Peter, A. & Paula, J. de. *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
- McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics*, Viva Books *Pvt. Ltd*., New Delhi, 2004.
- Assael, M. J., Goodwin, A. R. H., Stamatoudis, M., Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics*, CRC Press, NY, 2011.
- Levine, I. N. *Physical Chemistry*, 6th Ed., Tata Mc Graw Hill, 2010.
- Peter Atkins & Julio De Paula, *Physical Chemistry*,10th Ed., Oxford University Press, 2014.
- Zundhal, S. S. *Chemistry Concepts and Applications*, Cengage India, 2011.
- Ball, D. W. *Physical Chemistry*, Cengage India, 2012.

PRACTICAL

PHYSICAL CHEMISTRY-III: **(30 HOURS)**

1. Conductometry: (any *two*)

(a) Determination of cell constant

(b) Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.

(c) Perform the following conductometric titrations: **(any two)**

i .Strong acid vs. strong base

ii. Weak acid vs. strong base

iii. Mixture of strong acid and weak acid vs. strong base

iv. Strong acid vs. weak base

2. Potentiometry:

Perform the following potentiometric titrations: **(any *two*)**

a. Strong acid vs. strong base

b. Weak acid vs. strong base

c. Dibasic acid vs. strong base

d. Potassium dichromate vs. Mohr's salt

End Semester Examination (ESE)

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Khosla, B. D., Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand &Co., New Delhi, 2011.
- Garland, C. W., Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry*, 8thEd., McGraw-Hill, New York, 2003.
- Halpern, A. M. & Mc Bane, G. C. *Experimental Physical Chemistry*, 3rd Ed., W.H. Freeman & Co., New York, 2003.

Semester-VII

DSC-10

Paper Code: CHEMDSC810

Paper Description: INORGANIC CHEMISTRY-III

Paper Type: L (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

INORGANIC CHEMISTRY-III

UNIT I: Chemistry of *s* and *p* Block Elements

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.

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses: Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, oxides and oxoacids of nitrogen, phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

(28 Lectures)

UNIT II: Noble Gases

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6. Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2, XeF_4 and XeF_6). Molecular shapes of noble gas compounds (VSEPR theory). **(9 Lectures)**

UNIT III: Inorganic Polymers

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates, phosphazenes, and polysulphates. **(8 Lectures)**

Reference Books:

- Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
- Douglas, B.E. & McDaniel, D.H. *Concepts & Models of Inorganic Chemistry*, Oxford, 1970.

- Day, M.C. & Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.
- Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
- Douglas, B.E, McDaniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry*, 3rd Ed., John Wiley Sons, N.Y. 1994.
- Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.
- Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
- Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry*, 4th Ed., Pearson, 2010.
- Atkin, P. Shriver & Atkins' *Inorganic Chemistry*, 5th Ed. Oxford University Press, 2010.

PRACTICAL

INORGANIC CHEMISTRY-III: **(30 HOURS)**

1. **Qualitative Inorganic Analysis of mixtures containing *four* radicals:**
   Emphasis should be given to the understanding of the chemistry of different reactions.
   The following radicals are suggested:
   NO_3^-, NO_2^-, S^{2-}, $S_2O_3^{2-}$, Cl^-, Br^-, I^-, H_3BO_3, BO_3^{3-}, PO_4^{3-}
   Pb^{2+}, Cu^{2+}, Cd^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, NH_4^+, K^+, Na^+, Mg^{2+}
   Mixtures should preferably contain one interfering anion, **or** insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$ or Al_2O_3) **or** combination of anions e.g. NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, Br^- and I^-, NO_3^- and Br^-, NO_3^- and I^-.
   (Spot tests or special tests should be done wherever feasible)

End Semester Examination (ESE)

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

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

Semester-VIII

DSC-111

Paper Code: CHEMDSC811

Paper Description: ORGANIC CHEMISTRY-III

Paper Type: L (Credits: Theory-03, Practical-01)

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

ORGANIC CHEMISTRY-III

UNIT I: Nitrogen-Containing Functional Groups

Preparation and important reactions of nitro, nitriles, isonitriles, and amides.

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

***Diazonium Salts*:** Preparation and their synthetic applications. **(10 Lectures)**

UNIT II: Heterocyclic Compounds

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one and more heteroatom(s); Synthesis, reactions, and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis, Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Bischler-Napieralski reaction. **(20 Lectures)**

UNIT III: Amino Acids

Preparation of Amino Acids: Strecker synthesis, Gabriel's phthalimide synthesis.

Zwitterion, Isoelectric point, and Electrophoresis. Reactions of Amino acids: esterification of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test.

(7 Lectures)

UNIT III: Nucleic Acids

Components of nucleic acids, Nucleosides and nucleotides; Structure of nucleic acid, base pairing in DNA, nucleic acids and heredity; Structure, synthesis, and reactions of Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides; protein biosynthesis.

(8 Lectures)

Reference Books:

- Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Clayden J, Greeves N & Warren S, *Organic Chemistry*, 2nd Ed. Oxford University Press Inc, New York, 2001.
- Graham Solomons, T.W *Organic Chemistry*, John Wiley & Sons, Inc.

PRACTICAL

ORGANIC CHEMISTRY-III: (any *three*) **(30 HOURS)**

1. Functional group tests: Amino, Nitro, amido/imido group.
2. Estimation of glycine by Sorenson's formalin method.
3. Study of titration curve of glycine.
4. Qualitative analysis of unknown organic compounds containing Amino, Nitro, amido/imido group. Bifunctional compounds may also be taken for analysis.
5. Organic Preparation: **(any *two*)**
   (a) Nitration of acetanilide/nitro benzene by conventional method.
   (b) Nitration of Salicylic acid by Green method (using CAN).
   (c) Selective reduction of m-Dinitrobenzene to m-Nitro aniline.
   (d) Reduction of p-Nitro benzaldehyde by sodium borohydride.
   (e) Synthesis of N-Heterocyclic compounds.

End Semester Examination (ESE)

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education, 2009.
- Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. *Practical Organic Chemistry*, 5th Ed. Pearson, 2012.
- Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press, 2000.
- Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis*, University Press, 2000

Semester-VIII

DSC-112
Paper Code: CHEMDSC812
Paper Description: INDUSTRIAL CHEMISTRY
Paper Type: L (Credits: Theory-03, Practical-01)
Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]

Theory: 45 Lectures [Each Lecture is 1 hour in duration]

Practical: 15 classes [Each class is 2 hours in duration]

INDUSTRIAL CHEMISTRY

UNIT I: Silicate Industries

***Glass*:** Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, 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. **(15 Lectures)**

UNIT II: Fertilizers

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. **(8 Lectures)**

UNIT IIi: Surface Coatings

Objectives of coating surfaces, preliminary treatment of surface, classification of surface 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. **(12 Lectures)**

UNIT IV: Batteries

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery. Fuel cells and Solar cell. **(4 Lectures)**

UNIT V: Alloys

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

Composition and properties of different types of steels. **(6 Lectures)**

Reference Books:

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

PRACTICAL

PRACTICAL (INDUSTRIAL CHEMISTRY): (any *four*) (30 HOURS)

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, Zn) in alloy.
6. Analysis of Cement.
7. Preparation of pigment (zinc oxide).

End Semester Examination (ESE)

At the end of the semester, a practical examination will be conducted as per the following guidelines:

Marks distribution

Experiment	15 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

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

End Semester Examination (ESE)

Question pattern of 60 marks paper:

Serial No.	Questions to be answered	Out of	Marks for each Question	Total Marks
1	5	8	2	2x5 =10
2	6	8	5	5x6 =30
3	2	3	10	10x2 =20

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