UNIVERSITY OF NORTH BENGAL

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

FYUGP syllabus

B.Sc. 4-YEAR UNDER GRADUATEPROGRAM (FYUGP) WITH CHEMISTRY AS MAJOR SUBJECT UNDER THE NEW CURRICULUM AND CREDIT FRAMEWORK, 2022

WITH EFFECT FROM THE 2023-2024 ACADEMIC SESSION

LAYOUT OF CHEMISTRY SYLLABUS

SEMESTER	*COURSE TYPE*	*PAPER DESCRIPTION*
1	MAJOR-1	ORGANIC CHEMISTRY-I
	MINOR-1	CHEMISTRY-I
	SEC-1	SOIL CHEMISTRY
	MDC-1	CHEMISTRY IN DAILY LIFE
2	MAJOR-2	INORGANIC CHEMISTRY-I
	MINOR-1	CHEMISTRY-I
	SEC-2	PHARMACEUTICAL CHEMISTRY
	MDC-2	MATERIAL CHEMISTRY
3	MAJOR-3	ORGANIC CHEMISTRY-II
	MAJOR-4	INORGANIC CHEMISTRY-II
	MAJOR-5	PHYSICAL CHEMISTRY-I
	MINOR-2	CHEMISTRY-II
	SEC-3	FOOD CHEMISTRY
4	MAJOR-6	ORGANIC CHEMISTRY-III
	MAJOR-7	INORGANIC CHEMISTRY-III
	MAJOR-8	PHYSICAL CHEMISTRY-II
	MINOR-2	CHEMISTRY-II
	MDC-3	GREEN CHEMISTRY
5	MAJOR-9	ORGANIC CHEMISTRY-IV
	MAJOR-10	INORGANIC CHEMISTRY-IV
	MAJOR-11	PHYSICAL CHEMISTRY-III
	MAJOR-12	PHYSICAL CHEMISTRY-IV
	MINOR-3	CHEMISTRY-III
6	MAJOR-13	ORGANIC CHEMISTRY-V
	MAJOR-14	INORGANIC CHEMISTRY-V
	MAJOR-15	PHYSICAL CHEMISTRY-V
	MAJOR-16	SPECTROSCOPY
	MINOR-3	CHEMISTRY-III
7	MAJOR-17	ORGANIC CHEMISTRY-VI
	MAJOR-18	INORGANIC CHEMISTRY-VI
	MAJOR-19	PHYSICAL CHEMISTRY-VI
	MINOR-4	CHEMISTRY-IV
8	MAJOR-20 (HONS. WITH &WITHOUT RESEARCH)	GREEN CHEMISTRY
	MAJOR-21 (HONS. WITHOUT RESEARCH)	ORGANIC CHEMISTRY-VII
	MAJOR-22 (HONS. WITHOUT RESEARCH)	INORGANIC CHEMISTRY-VII
	MAJOR-23 (HONS. WITHOUT RESEARCH)	PHYSICAL CHEMISTRY-VII
	MAJOR (HONS. WITH RESEARCH)	PROJECT WORK / DISSERTATION
	MINOR-4 (HONS. WITH & WITHOUT RESEARCH)	CHEMISTRY-IV

Semester-1

COURSE TYPE: MAJOR-1

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ11001	ORGANIC CHEMISTRY-I
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

COURSE TYPE: MINOR-1

PAPER CODE	PAPER DESCRIPTION
UCHEMIN10001	CHEMISTRY-I
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

COURSE TYPE: SKILL ENHANCEMENT-1

PAPER CODE	PAPER DESCRIPTION
UCHESEC11001	SOIL CHEMISTRY
Credit	Paper Type
3	TH + PLB
Paper Levels	Full Marks
100	75

COURSE TYPE: MULTIDISCIPLINARY-1

PAPER CODE	PAPER DESCRIPTION
UCHEMDC11001	CHEMISTRY IN DAILY LIFE
Credit	Paper Type
3	TH
Paper Levels	Full Marks
100	75

UNIVERSITY OF NORTH BENGAL

CHEMISTRY

Semester-1

MAJOR-1

Paper Code: UCHEMAJ11001

Paper Description: ORGANIC CHEMISTRY-I

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

ORGANIC CHEMISTRY-I

UNITI: Basics of Organic Chemistry

Hybridization of Organic compounds.

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

Homolytic and Heterolytic fission; Electrophiles and Nucleophiles; Types, shape and the relative stability of Carbocations, Carbanions and Free radicals.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions (definition with examples). **(12 Lectures)**

UNIT II: Chemistry of Hydrocarbons

***Carbon-Carbon sigma bonds*:** Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation-relative reactivity and selectivity.

***Carbon-Carbon pi-bonds*:** Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cbreactions, Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions, their mechanisms (Markownikov/*Anti*-Markownikov addition), hydroboration-oxidation, ozonolysis, catalytic reduction, *syn*- and *anti*-hydroxylation (oxidation), addition reactions in conjugated dienes; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethylbenzene.

Reactions of alkynes: Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes and Reduction reactions. **(21 Lectures)**

UNIT III: Aromatic Hydrocarbons

Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions, polynuclear hydrocarbons 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. **(12 Lectures)**

Reference Books:

- Morrison, R.N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I.L. *Organic Chemistry (Volume1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- McMurry, J. E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- 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.
- Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, 6th Ed., Harlow, 1961.

PRACTICAL

PRACTICAL (ORGANIC CHEMISTRY-I): (30 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 organic compounds.
4. Effect of impurities on the melting point-mixed melting point of two unknown Organic compounds.
5. (a) Preliminary characterization of aliphatic and aromatic compounds by ignition.
   (b) Detection of active unsaturation in organic compound.
   (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*, 5th Ed., Pearson, 2012.
- Vogel, A. *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., Pearson India, 2003.

SKILL ENHANCEMENT COURSE-1

Paper Code: UCHESEC11001

Paper Description: SOIL CHEMISTRY

Paper Type: TH + PLB (Credits: Theory-02, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

Theory: 30 Lectures [Each Lecture is 1 hour in duration]

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

SOIL CHEMISTRY

UNITI: Physical properties of soil

Brief introduction about soil and its formation; texture; structure; Soil Consistence, density and weight relationship, pore space and porosity, color, Soil Temperature. **(10 Lectures)**

UNIT II: Soil micronutrients

Deficiency Symptoms; Nitrogen cycle.

Role of sulfur in the environment, forms of sulfur in nature, mineralization of organic sulfur, oxidation of inorganic sulfur compounds. **(6 Lectures)**

UNITIII: Basic Chemistry of Soil

Chemical Composition, ion exchange, inorganic components, organic components (fulvic acid and humic acid). Sources of acidity, effects of acid rain, toxicities in acid soils, the influence of pH, determination of soil pH, nutrient availability with pH, pH preferences of plants, soil buffer capacity, and management of pH. **(12 Lectures)**

UNIT IV: Soil Compost

Preparation, examples of compost soil. Composting to increase soil fertility. **(2 Lectures)**

Reference Books:

- Foth, H.D. *Fundamentals of Soil Science*, 8th Ed., Wiley, 2016.
- McLaren, A.D. & Skujins, J. *Soil Biochemistry*, Vol.2, Marcel Dekker, INC, New York, 1971.
- Paul, E.A. & Clark, F.E. *Soil Microbiology and Biochemistry*, 2nd Ed., Academic Press, 1996.

PRACTICAL

PRACTICAL (SOIL CHEMISTRY): (30 HOURS)

A. Practical:

1. Determination of pH of different types of Soil.
2. Preparation of Compost.

B. Field visit and Project Report Submission

End Semester Examination (ESE):

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

Marks distribution

Experiment	10 marks
Project Work	05 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- White, R.E. *Principles and Practice of Soil Science*, 4th Ed. Wiley, 2005.
- Rachelle, S. *Compost*, 8th Ed. Flame Tree Publishing, 2009.

MULTIDISCIPLINARY COURSE-1

Paper Code: UCHEMDC11001

Paper Description: CHEMISTRY IN DAILY LIFE

Paper Type: TH (Credits: Theory-03)

Total Marks: 75 [Theory (ESE – 60); CE – 10; Attendance – 05]

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

CHEMISTRY IN DAILY LIFE

UNITI: Development of Chemistry

Historical perspective of Chemistry: Alchemy, Contribution of eminent scientists in the development of Chemistry, Importance of Chemistry in daily life. **(3 Lectures)**

UNIT II: Chemistry in Agriculture

Properties, applications and examples of Agrochemicals: Fertilizers, Natural and Artificial fertilizers, Pesticides, Insecticides and Fungicides. A brief idea about advanced techniques used in agriculture.

(4 Lectures)

UNIT III: Chemistry in the Food Industry

Food processing. The brief idea with examples of Food colour, Food preservatives, artificial food flavour, and artificial sweeteners. Common Identification methods of adulterated food. Basic knowledge about Salt, Sugar, and various Spices and their needs in our body.

Constituent elements, examples and uses of some organic compounds used as food: Carbohydrates, Fats and Proteins. **(8 Lectures)**

UNIT IV: Chemistry in Pharmaceutical Industry

Properties and functions of Medicinal drugs: Antipyretics, Antibiotics, Antacids, Antifungal agents, Antiseptics, Antimalarial agents and Antidiabetic agents. Chemicals used in First Aid and basic idea about surgical materials and sanitizers. Vaccines: names of common vaccines with functions, importance of immunization in children. **(8 Lectures)**

UNIT V: Chemistry in the Soap Industry

Raw materials, applications and examples of Bathing soaps, Laundry soaps, Medicinal soaps, Liquid soaps, Detergents, Floor cleaners, Dishwashers, Lavatory soaps and cleaners. The primary difference between soaps and detergents. **(5 Lectures)**

UNIT VI: Chemistry in Transport& Textile Industry

Coal, Petrol, Diesel, LPG, CNG.

Processing of Natural fibers and Synthetic fibers for clothing, (Examples and properties); waterproof materials, heat and cold resistant clothes. **(5 Lectures)**

UNIT VII: Chemistry in the Cosmetic Industry

Composition, applications and examples of Talcum powder, Skincare and Baby care products, Creams and Lotions, Deodorants and Perfumes, Sunscreen, Nail polishes, Nail enamel. (**6 Lectures)**

UNIT VIII: Narcotic Drugs

Influence of Addictive Drugs in Society. A brief idea about harmful drugs like Cocaine, Brown sugar, Heroin, Angel dust. **(6 Lectures)**

Reference Books:

- Stocchi, E. *Industrial Chemistry*, Vol. I, Ellis Horwood Ltd., UK, 1990.
- Kent, J.A. *Riegel's Handbook of Industrial Chemistry*, 9th Ed., CBS Publisher, New Delhi, 1997.
- Manahan, S.E. *Environmental Chemistry*, 7th Ed., CRC Press, 2010.
- Timberlake, K. & Timberlake, W. *Basic Chemistry*, 5th Ed., Pearson, 2019.
- Myers, R. *The Basics of Chemistry*, Atlantic Publishers, 2003.

Semester-2

COURSE TYPE: MAJOR-2

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ12002	INORGANIC CHEMISTRY-I
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

COURSE TYPE: MINOR-1

PAPER CODE	PAPER DESCRIPTION
UCHEMIN10001	CHEMISTRY-I
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

COURSE TYPE: SKILL ENHANCEMENT-2

PAPER CODE	PAPER DESCRIPTION
UCHESEC12002	PHARMACEUTICAL CHEMISTRY
Credit	Paper Type
3	TH + PLB
Paper Levels	Full Marks
100	75

COURSE TYPE: MULTIDISCIPLINARY-2

PAPER CODE	PAPER DESCRIPTION
UCHEMDC12002	MATERIAL CHEMISTRY
Credit	Paper Type
3	TH
Paper Levels	Full Marks
100	75

Semester-2

MAJOR-2

Paper Code: UCHEMAJ12002

Paper Description: INORGANIC CHEMISTRY-I

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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 and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom .Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals.

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number. **(14 Lectures)**

UNIT II: Periodicity of Elements

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

a. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table
b. Atomic radii (van der Waals)
c. Ionic and crystal radii
d. Covalent radii (octahedral and tetrahedral)
e. Ionization enthalpy, 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, group electronegativity **(16 Lectures)**

UNIT III: Chemical Bonding

(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 and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

(ii) *Covalent bond:* Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals, Bent's rule. Molecular orbital theory. Molecular orbital diagrams of diatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths.

Fajan's rule of Ionic distortion and its application. **(15 Lectures)**

Reference Books:

- Lee, J. D. *Concise Inorganic Chemistry* ELBS,1991.
- Douglas, B.E. and McDaniel, D.H. C*oncepts & Models of Inorganic Chemistry* Oxford, 1970.
- Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.
- Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.

- Huheey, J.E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry*, 4th Ed., Harper Collins College Publishers, 1993.
- Shriver and Atkins' *Inorganic Chemistry*, 5th Ed., Oxford University Press, 2009.
- Cotton, F.A.; Wilkinson, G.; Murillo, C.A. & Bachmann, M. *Advanced Inorganic Chemistry*, 6th Ed., Wiley-Interscience, New York, 1999.

PRACTICAL

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

1. Qualitative analysis of **water-soluble** mixtures-**four ionic species** (two cations and two anions), out of the following:

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

   Anions: S^{2-}, SO_4^{2-}, NO_2^{-}, NO_3^{-}, Cl^{-}, Br^{-}, I^{-}

   Group analysis can be carried out but Cations can also be confirmed by 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:

- Mendham, J., A. I. *Vogel's Quantitative Chemical Analysis*, 6th Ed., Pearson, 2009.
- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.

SKILL ENHANCEMENT COURSE-2

Paper Code: UCHESEC12002

Paper Description: PHARMACEUTICAL CHEMISTRY

Paper Type: TH + PLB (Credits: Theory-02, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

Theory: 30 Lectures [Each Lecture is 1 hour in duration]

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

PHARMACEUTICAL CHEMISTRY

UNIT I: Introduction

Drug and medicine, classification of drugs, importance of drugs, working principle of drugs. Drug targets, binding with the targets, protein and nucleic acid as drug targets. **(4 Lectures)**

UNIT II: Drug Development

Screening of natural products, isolation and purification, structure determination, structure-activity relationship [The binding role of hydroxyl, amino groups, aromatic rings, and double bonds]; synthetic analogs [Variation of substituents, an extension of structure, chain extension/contractions, ring expansion/contractions, isosteres, simplification/rigidification of the structure]. **(10 Lectures)**

UNIT III: Synthesis and Applications of the Representative classes of Drugs

Analgesic [paracetamol, aspirin], antipyretic [Ketoprofen, Naproxen, Ibuprofen], Antidiabetic [Metformin, Acarbose, Chlorpropamide], Antihypertensive [captopril, atenolol], Antibacterial [Sulfonamides, Penicillins, Cephalosporins, Chloramphenicol], Antimalarial [Chloroquine, Piperaquine], Antiulcer [Pantoprazole, Cimetidine, Famotidine], Antiviral agents [HIV and flu-related drugs], Cardiovascular (Glyceryl trinitrate), Anti-leprosy (Dapsone),Central Nervous System agents (Phenobarbital, Diazepam, L-DOPA, Rivastigmine, Donepezil),Anticancer and Antidepressant. **(14 Lectures)**

UNIT IV: Vitamins and Natural products

Structure and biological importance of Vitamins. **(2 Lectures)**

Reference Books:

- Patrick, G. L. *Introduction to Medicinal Chemistry, Oxford University* Press, UK, 2013.
- Wermuth, C. G.; Aldous, D.; Raboisson, P.; Rognan, D. *The Practice of Medicinal Chemistry*, 4th Ed. Academic Press.
- Singh, H. & Kapoor, V.K. *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, Pitampura, New Delhi, 2012.
- Foye, W.O., Lemke, T.L. & William, D.A.: *Principles of Medicinal Chemistry*, 4th ed., B.I. Waverly Pvt. Ltd. New Delhi.

PRACTICAL

PRACTICAL (PHARMACEUTICAL CHEMISTRY): (30 HOURS)

A. Practical: (<u>any two</u>)

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (Antacid).
3. Preparation of methylsalicylate(oil of wintergreen).

B. Field visit and Project Report Submission

<u>End Semester Examination (ESE):</u>

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

Marks distribution

Experiment	10 marks
Project Work	05 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Reference Books:

- Beckett, A.H. & Stenlake, J.B. *Practical Pharmaceutical Chemistry*, Part 1, 4th Ed., CBS Publishers, 2005.

- Jenkins, G.L.; Knevel, A.M. & Digangi, F.E. *Quantitative Pharmaceutical Chemistry*, 6th Ed. CBS Publication, 2008.

MULTI DISCIPLINARY COURSE-2

Paper Code: UCHEMDC12002

Paper Description: MATERIALCHEMISTRY

Paper Type: TH (Credits: Theory-03)

Total Marks: 75 [Theory (ESE – 60); CE – 10; Attendance – 05]

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

MATERIAL CHEMISTRY

UNITI: Metals and Non-metals

Properties and Applications of Metals: Gold, Silver, Copper, Iron, Tin, Lead, Zinc, Aluminium, Magnesium, Mercury; Non-metals: Chlorine, Iodine. **(5 Lectures)**

UNIT II: Alloys

Composition, Properties and Applications of Stainless Steel, Brass, Bronze, Duralumin.

(4 Lectures)

UNIT III: Compounds

Composition, Properties and Applications of Baking Soda, Washing Soda, Chile saltpetre, Nitre, Green Vitriol, Blue Vitriol, White Vitriol, Limestone, Zincite, Plaster of Paris, Potash Alum, Bleaching Powder, Sand, Lime Mortar, Cement, Brick, Glass. **(10 Lectures)**

UNIT IV: Polymers

Classification of Polymers with definition and examples, Polymer nomenclature, General application of Polymeric materials. **(6 Lectures)**

UNIT V: Noble Gases

Characteristics and Uses of Helium, Neon, Argon, Krypton, Xenon, Radon. **(4 Lectures)**

UNIT VI: Acids and Bases

Properties and Uses of Acids: Hydrochloric acid, Sulphuric acid, Nitric acid, Phosphoric acid, Acetic acid; Bases: Sodium Hydroxide, Potassium Hydroxide, Ammonium Hydroxide. **(6 Lectures)**

UNIT VII: Water

Universal solvent, Water-soluble and Water-insoluble substances, Saturated and Unsaturated solution, Conditions for Solution formation, Anomalous Expansion of water, Importance of water. (**6 Lectures)**

UNIT VIII: Laboratory

Common Laboratory Apparatus and Equipment with their Uses, Precautions to be taken working in a Laboratory. **(4 Lectures)**

Reference Books:

- Stocchi, E. *Industrial Chemistry*, Vol I, Ellis Horwood Ltd., UK, 1990.
- Kent, J.A. *Riegel's Handbook of Industrial Chemistry*, 9th Ed., CBS Publisher, New Delhi, 1997.
- Manahan, S.E. *Environmental Chemistry*, 7th Ed., CRC Press, 2010.
- Timberlake, K. & Timberlake, W. *Basic Chemistry*, 5th Ed., Pearson, 2019.
- Myers, R. *The Basics of Chemistry*, Atlantic Publishers, 2003.
- Gangopadhyay, P.K. Application Oriented Chemistry, 2nd Ed., Book Syndicate (P) Ltd., 2002.
- Brown, T. *Chemistry-The Central Science*, 14th Ed., Pearson, 2017.

Semester-3

COURSE TYPE: MAJOR-3

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ23003	ORGANIC CHEMISTRY-II
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
200	75

COURSE TYPE: MAJOR-4

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ23004	INORGANIC CHEMISTRY-II
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
200	75

COURSE TYPE: MAJOR-5

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ23005	PHYSICAL CHEMISTRY-I
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
200	75

COURSE TYPE: MINOR-2

PAPER CODE	PAPER DESCRIPTION
UCHEMIN20002	CHEMISTRY-II
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
200	75

COURSE TYPE: SKILL ENHANCEMENT-3

PAPER CODE	PAPER DESCRIPTION
UCHESEC23003	FOOD CHEMISTRY
Credit	Paper Type
3	TH + PLB
Paper Levels	Full Marks
100	75

Semester-3

MAJOR-3

Paper Code: UCHEMAJ23003

Paper Description: ORGANIC CHEMISTRY-II

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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: Stereochemistry

Tetrahedral carbon, chirality, 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. *Re/Si* face, topicity: Homotopic, Heterotopic, Enantiotopic, Diasterotopic group.

Optical activity, specific rotation, Chirality. Asymmetry/Disymmetry, Enantiomers, Molecules with two or more chiral centres, Distereoisomers, Meso compounds, Racemic modification and resolution. Relative and absolute configuration: D/L and *R/S* designations, *threo-erythro* form, Atropisomerism. **(12 Lectures)**

UNIT II: Cycloalkanes and Conformational Analysis

Conformation and physical properties, conformation of ethane, propane, and butane (including substituted variety). Types of cycloalkanes and their relative stability, Baeyer strain theory,

Conformation analysis of cycloalkanes (cyclobutane, cyclopentane, cyclohexane, and mono and di-substituted cyclohexanes): Relative stability: Energy diagrams: Chair, Boat and Twist boat forms of cyclohexane. **(12 Lectures)**

UNIT III: Dynamic Stereochemistry

Introduction (Stereo-selective and stereo-specific reaction), dynamic stereochemistry of acyclic and cyclic molecules, nucleophilic substitution, elimination reactions and addition reactions. **(6 Lectures)**

UNIT IV: Chemistry of Halogenated Hydrocarbons:

Alkyl halides: Naming and structure of alkyl halides, methods of preparation, allylic bromination of alkenes, nucleophilic substitution reactions–SN1, SN2, and *SNi* mechanisms with stereochemical aspects and effect of solvent; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts, nucleophilic aromatic substitution; SNAr, cine Substitution.

Relative reactivity of alkyl, allyl/benzyl, vinyl, and aryl halides towards nucleophilic substitution reactions. **(15 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).
- Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.
- Kalsi, P. S. *Stereochemistry Conformation and Mechanism*, New Age International, 2005.
- 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.
- Carruthers, W. *Some Modern Methods of Organic Synthesis*, 4th Ed., Cambridge University Press, 2004

PRACTICAL

PRACTICAL (ORGANIC CHEMISTRY-II): (<u>any three</u>) (30 HOURS)

1. Detection of special elements in solid or liquid organic compounds.
2. Perform an Iodoform reaction with ethanol/Isopropanol/acetone/any suitable compound.
3. Preparation of Aryl halide involving diazonium salt.
4. Bromination of acetanilide by conventional method.
5. Bromination of acetanilide by green method (Bromate-bromide method).
6. Preparation of 1,3,5-tribromo benzene.

<u>End Semester Examination (ESE)</u>

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:

- Furniss, B.S. Hannaford, A. J. Smith, P.W.G. Tatchell, A. R. *Practical Organic Chemistry*, 5th Ed. Pearson, 2012.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education, 2009.

Semester-3

MAJOR-4

Paper Code: UCHEMAJ23004

Paper Description: INORGANIC CHEMISTRY-II

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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: Chemical Bonding

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

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

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

(15 Lectures)

UNIT II: General Principles of Metallurgy

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

(15 Lectures)

UNIT III: Acids and Bases

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.

(10 Lectures)

UNIT IV: Oxidation-Reduction

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class. **(5 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. and 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

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

1. Titrimetric Analysis:

(a) Calibration and use of apparatus

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

2. Acid-Base Titrations: (<u>any two</u>)

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

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

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

3. Oxidation-Reduction Titrimetry: (<u>any one</u>)

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

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

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

<u>End Semester Examination (ESE)</u>

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 Book:

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

Semester-3

MAJOR-5

Paper Code: UCHEMAJ23005

Paper Description: PHYSICAL CHEMISTRY-I

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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, Concept of temperature and Gas Laws from KTG. Collision Number, Collision frequency, Collision diameter, Mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η, variation of viscosity with temperature and pressure.

Maxwell distribution of speeds in one, two and three dimensions 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 heat capacity from equipartition principle.

Behavior of real gases: Deviations from ideal gas 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, mention of other equations of state (Berthelot, Dietirici), virial equation of state, van der Waals equation

expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with Van der Waals isotherms, continuity of states, critical state, relation between critical constants and Van der Waals constants, law of corresponding states.

(22 Lectures)

UNIT II: Liquid state

Physical properties of liquids, vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. **(5 Lectures)**

UNIT III: Solid state

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. Defects in crystals. Glasses and liquid crystals. **(18 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.

PRACTICAL

PRACTICAL (PHYSICAL CHEMISTRY-I): (<u>any two</u>) (30 HOURS)

1. Surface tension measurements:

(a) Determination of the surface tension of a liquid/ ethanol solution by Drop number method.

(b) Determination of composition of an unknown solution by Drop Number Method using solutions of known composition (solutions of ethanol may be used).

2. Viscosity measurement using Ostwald's viscometer:

(a) Determination of viscosity of aqueous solutions of polymer / ethanol / sugar at room temperature.

(b) Determination of composition of an unknown solution by Ostwald Viscometer using solutions of known composition (solutions of ethanol, Sucrose may be used).

3. Indexing of a given powder diffraction pattern of a cubic crystalline system.

<u>End Semester Examination (ESE)</u>

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.

SKILL ENHANCEMENT COURSE-3

Paper Code: UCHESEC23003

Paper Description: FOOD CHEMISTRY

Paper Type: TH + PLB (Credits: Theory-02, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

Theory: 30 Lectures [Each Lecture is 1 hour in duration]

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

FOOD CHEMISTRY

UNIT I: Introduction

Food Chemistry- definition, scope and importance; major food constituents and their physicochemical properties; role of water in food. **(2 Lectures)**

UNIT II: Carbohydrates, Lipids, Proteins, Amino acids in food

Carbohydrates in food: role and use of carbohydrates, chemical and functional properties of carbohydrates in food, starch and its modification, application in food and allied industries

Lipids in food: role and use of lipids in food, physicochemical properties of lipase, chemistry of rancidity, chemistry and technology of processing of fats and oils, and hydrogenation, effect of processing on functional properties and nutritive values of lipids.

Proteins and Amino acids in food: physical and chemical properties of food proteins, functional and nutritional properties of proteins.

Milk: Composition and Chemical analysis. Pasteurization, Homogenized milk, powdered milk: Dairy and Non-dairy milk powder, Processing: Butter, Cheese

Enzymes: Nature, classification and properties of food enzyme, enzyme activity in different food systems, commercial availability, removal of toxicants through enzymes, flavor production by enzymes.

Browning reaction in foods: Enzymatic and Non-Enzymatic browning in foods of vegetable and animal origin during storage and processing of foods. **(15 Lectures)**

UNIT III: Additives

Introduction, types of additives (Preservatives, Nutritional additives, coloring additives, Flavoring

agents, Texturing agents, miscellaneous additives). Benefits and risks of food additives.

Nutritive and non-nutritive sweeteners.

Nutritional Additives: Chemistry, structure, use/biological function, toxicity of Vitamin A, D, E, K, C, B1, B2, B3, B6, B9, H and Omega 3 and Omega 6 fatty acids), Function of Ca, P, Na, K, Cl, I, Zn, Mg and B. **(10 Lectures)**

UNIT IV: Chemistry of Indian Spices

Medicinal and pharmacological properties of Indian spices (Black pepper, Cardamom, Ginger, Cumin, Turmeric, Fennel, Fenugreek, Coriander, Ajowan, Bay and Curry leaf. **(3 Lectures)**

Reference Books:

- Meyer, H. L. Food Chemistry. Reinhold Publishing Corporation, NY, Chapman and Hall, Ltd, London
- Handbook of Food Chemistry, Cheung, Peter CK, Mehta, B.M Springer Reference, GmbH, Berlin Heidelberg

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PRACTICAL

PRACTICAL (FOOD CHEMISTRY): (30 HOURS)

A. Practical:

1. Collection of information on adulteration of some common foods from local market
2. Adulteration detection for Milk and Milk products
    - Detection of water in milk
    - Detection of detergent in milk
    - Detection of starch in milk and milk products (khoya, chenna, paneer)
    - Detection of mashed potatoes, sweet potatoes and other starches in ghee/butter
3. Adulteration detection for Oil And Fats
    - Detection of other oils in coconut oil
    - Detection of TOCP (Tri-Ortho-Cresyl-Phosphate) in oils and fats
    - Proper winterization of refined winterized salad oils
4. Adulteration detection for Sugar & Confectionery
    - Detection of sugar solution in honey
    - Detection of chalk powder in sugar/pithi sugar/jaggery
    - Detection of aluminium leaves in silver leaves
5. Adulteration detection for Food Grains & Its Products
    - Detection of extraneous matter (dust, pebble, stone, straw, weed seeds, damaged grain, weeviled grain, insects, rodent hair and excreta) in food grains
    - Detection of excess bran in wheat flour

6. Adulteration detection for Salt, Spices & Condiments
    - Detection of foreign resin in asafoetida (hing)
    - Detection of papaya seeds in black pepper
    - Detection of light blackberries in black pepper
7. Adulteration detection for Fruits & Vegetables
    - Detection of malachite green in green vegetables like bitter gourd, green chilli and others.
    - Detection of artificial colour on green peas.
    - Detection of rhodamine B in sweet potato.
8. Adulteration detection for Beverages
    - Detection of clay in coffee powder
    - Detection of chicory powder in coffee powder
    - Detection of exhausted tea in tea leaves
    - Detection of iron filings in tea leaves
9. Adulteration detection for chilli powder
    - Detection of Brick powder in chilli powder
    - Detection of salt powder in chilli powder
    - Detection of talc. powder in chilli powder
10. Invited lecture/training by local expert /Visit to a related nearby laboratory/ Assignments, Group discussion, Quiz etc.

Reference Books

- A firstcourseinFoodAnalysis–A.Y.Sathe,NewAgeInternational(P)Ltd.,1999 https://eatrightindia.gov.in/dart/
- Choudhary A., Gupta N., Hameed F., Choton S. An overview of food adulteration: Concept, sources, impact, challenges and detection. Int. J. Chem. Stud. 2020;8:2564–2573. doi: 10.22271/chemi.2020.v8.i1am.8655.
- Ayza A., Yilma Z. Patterns of milk and milk products adulteration in Boditti town and its surrounding, South Ethiopia. J. Agric. Sci. 2014;4:512–516.
- El-Loly M.M., Mansour A., Ahmed R. Evaluation of raw milk for common commercial additives and heat treatments. Internet J. Food Saf. 2013;15:7–10.
- Everstine K., Spink J., Kennedy S. Economically motivated adulteration (EMA) of food: Common characteristics of EMA incidents. J. Food Protection. 2013;76:723–735. doi: 10.4315/0362-028X.JFP-12-399.
- Food Safety, case studies–Ramesh.V.Bhat,NIN,1992
- https://old.fssai.gov.in/Portals/0/Pdf/Draft_Manuals/Beverages and confectionary.pdf
- https://cbseportal.com/project/Download-CBSE-XII-Chemistry-Project-Food-Adulteration#gsc.tab=0 (Downloadable e material on food adulteration
- https://www.fssai.gov.in/

End Semester Examination (ESE):

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

Marks distribution

Experiment	10 marks
Project Work	05 marks
Practical record notebook	03 marks
Viva-voce	02 marks

Semester-4

COURSE TYPE: MAJOR-6

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ24006	ORGANIC CHEMISTRY-III
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
200	75

COURSE TYPE: MAJOR-7

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ24007	INORGANIC CHEMISTRY-III
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
200	75

COURSE TYPE: MAJOR-8

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ24008	PHYSICAL CHEMISTRY-II
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

COURSE TYPE: MINOR-2

PAPER CODE	PAPER DESCRIPTION
UCHEMIN20002	CHEMISTRY-II
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
200	75

COURSE TYPE: MULTIDISCIPLINARY-3

PAPER CODE	PAPER DESCRIPTION
UCHEMDC23003	GREEN CHEMISTRY
Credit	Paper Type
3	TH
Paper Levels	Full Marks
100	75

Semester-4

MAJOR-6

Paper Code: UCHEMAJ24006

Paper Description: ORGANIC CHEMISTRY-III

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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: Alcohols, Phenols, Ethers and Epoxides

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

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

Ethers and Epoxides: Preparation [Ether: Williamson synthesis, Epoxidation (mCPBA, Darzens reaction, Corey-Chaykovsky Reaction, Sharpless epoxidation)] and reactions with acids and base. Reactions of epoxides with alcohols, ammonia derivatives, and $LiAlH_4$.

(15 Lectures)

UNIT II: Carbonyl Compounds

Structure, reactivity and preparation of carbonyl compounds.

Nucleophilic additions, Nucleophilic addition-elimination reactions, ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, Swarn oxidation, Pinnick oxidation, use of PDC, PGC, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, MPV, Selective reduction using metal hydrides ($LiAlH_4$, $NaBH_4$, $NaCNBH_3$, DIBALH) Umpolung of reactivity. Addition reactions of unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

(20 Lectures)

UNIT III: Carboxylic Acids and their Derivatives

Preparation, physical properties and reactions of monocarboxylic acids. Basic structures 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. **(10 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

PRACTICAL (ORGANIC CHEMISTRY-III): (<u>any three</u>) (30 HOURS)

1. Functional group tests: Alcoholic-OH, Phenolic-OH, carbonyl group and carboxylic acid group.
2. Identification of compounds by chemical reactions: Oxalic acid, Succinic acid, Tartaric acid, Citric acid, Cane sugar.
3. Qualitative analysis of unknown organic compounds containing Alcoholic-OH, Phenolic-OH, carbonyl group and carboxylic acid group.
4. Organic Preparation: (**<u>any three</u>**)

(a) Acetylation of Salicylic acid, 2-Napthol / Benzoylation of 2-Napthol, Resorcinol, 4-Cresol etc.

(b) Synthesis of Benzillic acid from Benzil.

(c) Aldol condensation either by Conventional or by Green method.

(d) Perform Hydrolysis of an amides / ester into carboxylic acid.

(e) Preparation of S-Benzyl isothiouronium salts of following carboxylic acids; Oxalic acid, Benzoic acid, Phenyl acetic acid, Phthalic acid.

(f) Preparation of Semicarbazone derivative of the following compounds; Acetone, Ethyl methyl ketone, Cyclohexanone, Benzaldehyde.

<u>End Semester Examination (ESE)</u>

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-4

MAJOR-7

Paper Code: UCHEMAJ24007

Paper Description: INORGANIC CHEMISTRY-III

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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-4

MAJOR-8

Paper Code: UCHEMAJ24008

Paper Description: PHYSICAL CHEMISTRY-II

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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: Chemical Thermodynamics

Intensive and extensive variables, partial derivatives, exact and inexact differential, 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, the relation between heat capacities, calculations of q, w, U, and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Thermochemistry: Heats of reactions: standard states, enthalpy of formation of molecules and ions, enthalpy of combustion and its applications, calculation of bond energy, bond dissociation energy, and resonance energy from thermodynamics data, Hess's law, the effect of temperature (Kirchhoff's equation) and pressure on enthalpy of reactions.

Second law: Concept of enthalpy, thermodynamics scale of temperature, statement of the second law of thermodynamics. Calculation of entropy change for reversible and irreversible processes.

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

Free Energy Functions: Gibbs and Helmholtz energy, variation of S, G, A with T, V, P, Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters, inversion temperature, Joule-Thomson coefficient for a van der Waals gas, Gibbs-Helmholtz equation, Maxwell relations, thermodynamic equation of state.

(25 Lectures)

UNIT II: Systems of Variable Composition

Partial molar quantities, the dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, the chemical potential of ideal mixtures, change in thermodynamic functions in the mixing of ideal gases, concept of fugacity. **(7 Lectures)**

UNIT III: Solutions and Colligative Properties

Dilute solutions, lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions.

Thermodynamic derivation using the chemical potential to derive relations between the four colligative properties: (i) relative lowering of vapor 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.

(13 Lectures)

Reference Books:

- Peter, A. & Paula, J. de. *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
- Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa, 2004.
- Engel, T. & Reid, P. *Physical Chemistry*, 3rd Ed. Prentice-Hall, 2012.
- 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.
- Metz, C.R. *Solved problems in Chemistry*, Schaum Series, 2006.

PRACTICAL

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

1. Thermochemistry:(<u>any three</u>)

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

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

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

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

e. Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.

f. Determination of enthalpy of hydration of copper sulphate.

g. Study of the solubility of benzoic acid in water and determination of ΔH.

<u>End Semester Examination (ESE)</u>

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.
- Athawale, V. D. & Mathur, P. *Experimental Physical Chemistry*, New Age International, New Delhi, 2001.

MULTI DISCIPLINARY COURSE-3

Paper Code: UCHEMDC23003

Paper Description: GREEN CHEMISTRY

Paper Type: TH (Credits: Theory-03)

Total Marks: 75 [Theory (ESE – 60); CE – 10; Attendance – 05]

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

GREEN CHEMISTRY

UNITI: Introduction

Definitions of Green Chemistry. Brief introduction of twelve principles of Green Chemistry, with examples. **(10 Lectures)**

UNIT II: Atom Economy

Special emphasis on atom economy, reducing toxicity, and green solvents. **(7 Lectures)**

UNIT III: Alternative Energy Source

Green Chemistry and catalysis, alternative sources of energy. Green energy and sustainability. **(8 Lectures)**

UNIT IV: Real World Cases in Green Chemistry

Surfactants for carbon dioxide–Replacing smog-producing and ozone-depleting solvents with CO_2 for precision cleaning and dry cleaning of garments. Right fit pigment: Synthetic azopigments to replace toxic organic and inorganic pigments. Designing of environmentally safe marine antifoulant. An efficient green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn. **(20 Lectures)**

Reference Books:

- Anastas, P. T. & Warner, J. K. *Green Chemistry-Theory and Practical*, Oxford University Press, 1998.
- Matlack, A. S. *Introduction to Green Chemistry*, Marcel Dekker, 2001.
- Cann, M. C. & Connely, M. E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington, 2000.

- Ryan, M. A. & Tinnes and, M. *Introduction to Green Chemistry*, American Chemical Society, Washington, 2002.
- Lancaster, M. *Green Chemistry: An Introductory Text*, RSC publishing, 2nd Edition.

Semester-5

COURSE TYPE: MAJOR-9

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ35009	ORGANIC CHEMISTRY-IV
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
300	75

COURSE TYPE: MAJOR-10

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ35010	INORGANIC CHEMISTRY-IV
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
300	75

COURSE TYPE: MAJOR-11

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ35011	PHYSICAL CHEMISTRY-III
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
300	75

COURSE TYPE: MAJOR-12

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ35012	PHYSICAL CHEMISTRY- IV
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
300	75

COURSE TYPE: MINOR-3

PAPER CODE	PAPER DESCRIPTION
UCHEMIN30003	CHEMISTRY-III
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
200	75

Semester-5

MAJOR-9

Paper Code: UCHEMAJ35009

Paper Description: ORGANIC CHEMISTRY-IV

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

ORGANIC CHEMISTRY-IV

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 IV: 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. T. & 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).
- Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds*, John Welly& Sons, 1976.
- Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc.
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning Indian Edition, 2013.
- Clayden, J.; Greeves, N.; Warren, S.& W. others, P. *Organic Chemistry*, Oxford University Press.
- Joule, J.A. & Mill, K. *Heterocyclic Chemistry*, 5th Ed. John Wiley & Sons, Inc.

PRACTICAL

PRACTICAL (ORGANIC CHEMISTRY-IV): (<u>any three</u>) (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:(**<u>any two</u>**)
   (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.

<u>End Semester Examination (ESE)</u>

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-5

MAJOR-10

Paper Code: UCHEMAJ35010

Paper Description: INORGANIC CHEMISTRY-IV

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

INORGANIC CHEMISTRY-IV

UNIT I: Coordination Chemistry

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

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes. **(21 Lectures)**

UNIT II: Transition Elements

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Ebsworth 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). **(18 Lectures)**

UNIT III: Lanthanoids and Actinoids

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only). **(6 Lectures)**

Reference Books:

- Purcell, K.F. & Kotz, J.C. *Inorganic Chemistry*, W.B. Saunders Co, 1977.
- Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
- Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry*, Panima Publishing Company, 1994.
- Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley-VCH, 1999.
- Basolo, F, & Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.
- Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.

PRACTICAL

PRACTICAL (INORGANIC CHEMISTRY-IV): (<u>any two</u>) (30 HOURS)

1. Iodo / Iodimetry Titrations:

(a) Estimation of Cu (II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).

(b) Estimation of available chlorine in bleaching powder iodometrically.

2. Permanganometry/Dichrometry Titration:

(a) Estimation of Fe(II) and Fe(III) in a mixture by $KMnO_4$.

(b) Estimation of Fe(II) and Fe(III) in a mixture by $K_2Cr_2O_7$.

3. Quantitative Estimation of:

(a) Fe^{3+} and Cu^{2+}

(b) Fe^{3+} and Cr^{3+}

4. Complexometric Titration:

(a) Estimation of Copper in Chalcopyrites using standard EDTA solution.

(b) Estimation of Calcium in milk using standard EDTA solution.

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 Book:

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

Semester-5

MAJOR-11

Paper Code: UCHEMAJ35011

Paper Description: PHYSICAL CHEMISTRY-III

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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: Ionic equilibria

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. Buffer solutions, derivation of Henderson equation and its applications, buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry.

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

(15 Lectures)

UNIT II: Chemical Equilibrium

Criteria of thermodynamic equilibrium, Degree of advancement, Variation of free energy with advancement of reaction, chemical equilibria in ideal gases. Thermodynamic derivation of

relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Thermodynamic derivation of relations between the various equilibrium constants, *Kp*, *Kc* and *Kx*. Le Chatelier principle (quantitative treatment), equilibrium between ideal gases. **(15 Lectures)**

UNIT III: Phase Equilibria

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, the 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.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes. Nernst distribution law: its derivation and application. **(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, 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

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

1. pH metry: (<u>any three</u>)

(a) Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.

(b) Preparation of buffer solutions of different pH

i. Sodium acetate-acetic acid **or**

ii. Ammonium chloride-ammonium hydroxide

(c) pH metric titration of

i. strong acid vs. strong base **or**

ii. weak acid vs. strong base.

(d) Determination of dissociation constant of a weak acid.

<u>End Semester Examination (ESE)</u>

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-5

MAJOR-12

Paper Code: UCHEMAJ35012

Paper Description: PHYSICAL CHEMISTRY-IV

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

PHYSICAL CHEMISTRY-IV

UNIT I: Chemical Kinetics

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

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

(20 Lectures)

UNIT II: Catalysis

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples), and heterogenous catalysis (catalytic steps and examples) and their industrial applications.

Enzyme catalysis, Michaelis-Menten mechanism, Acid-base catalysis.

Deactivation or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts. **(10 Lectures)**

UNIT III: Surface Chemistry

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

(5 Lectures)

UNIT IV: Colloids

Classification, Preparation, Purification, Stability of colloids, Properties of colloids (optical, kinetic and electrical properties), Schulze Hardy Rule, Gold Number, Colloidal electrolytes and their properties, Iso-electric Point, Electrical double layer and Zeta Potential, Micelles.

(10 Lectures)

Reference Books:

- Peter Atkins & Julio De Paula, *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
- Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa, 2004.
- Engel, T. & Reid, P. *Physical Chemistry*, 3rd Ed., Prentice-Hall, 2012.
- Zundhal, S.S. *Chemistry Concepts and Applications*, Cengage, India, 2011.
- Ball, D. W. *Physical Chemistry*, Cengage, India, 2012.
- Mortimer, R. G. *Physical Chemistry*, 3rd Ed., Elsevier, NOIDA, UP, 2009.
- Levine, I. N. *Physical Chemistry*, 6th Ed., Tata McGraw-Hill, 2011.
- Metz, C. R. *Physical Chemistry*, 2nd Ed., Tata McGraw-Hill, 2009.

PRACTICAL

PRACTICAL (PHYSICAL CHEMISTRY-V): (30 HOURS)

1. **Study the kinetics of the following reactions: (<u>any one</u>)**
   (a) Initial rate method: Iodide-persulphate reaction
   (b) Integrated rate method:
      i. Acid hydrolysis of methyl acetate with hydrochloric acid.
      ii. Saponification of ethyl acetate.
   (c) Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

2. Adsorption

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

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*, 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.

Semester-6

COURSE TYPE: MAJOR-13

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ36013	ORGANIC CHEMISTRY-V
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
300	75

COURSE TYPE: MAJOR-14

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ36014	INORGANIC CHEMISTRY-V
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
300	75

COURSE TYPE: MAJOR-15

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ36015	PHYSICAL CHEMISTRY-V
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
300	75

COURSE TYPE: MAJOR-16

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ36016	SPECTROSCOPY
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
300	75

COURSE TYPE: MINOR-3

PAPER CODE	PAPER DESCRIPTION
UCHEMIN30003	CHEMISTRY-III
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
200	75

Semester-6

MAJOR-13

Paper Code: UCHEMAJ36013

Paper Description: ORGANIC CHEMISTRY-V

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

ORGANIC CHEMISTRY-V

UNIT I: Carbohydrates

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) and polysaccharides (starch and cellulose) excluding their structure elucidation. **(10 Lectures)**

UNIT II: Peptides and Proteins

Determination of Primary structure of Peptides by degradation: Edmann degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (up to dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) and C-activating groups and Merrifield solid-phase synthesis. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. **(10 Lectures)**

UNIT III: Lipids

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

(5 Lectures)

UNIT IV: Enzymes

Introduction, classification and characteristics of enzymes. Salient features of the active site of enzymes. Mechanism of enzyme action (taking trypsin as an 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, and the phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition, including allosteric inhibition). **(10 Lectures)**

UNIT V: Concept of Energy in Biosystems

Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism, anabolism).

ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: NAD^+, FAD^+.

Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis, fermentation, Krebs cycle. Overview of catabolic pathways of fat and protein.

Interrelationship in the metabolic pathways of protein, fat and carbohydrate. Caloric value of food, standard caloric content of food types. **(10 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.

PRACTICAL

PRACTICAL (ORGANIC CHEMISTRY-V): (<u>any three</u>) (30 HOURS)

1. (a) Identify monosaccharides and Polysaccharides (Molisch's Test, Iodine Test).
   (b) Distinguish aldose and ketose (Seliwanoff's Test).
   (c) Differentiate reducing and non-reducing sugar (Tollen's Test, Fehling's Test).
2. Perform Biuret test, Ammonium sulphate half saturation test, Saponification test.
3. Estimation of Protein by Lowry's method.
4. Detection of the optimum temperature for action of salivary amylase on starch.
5. Determine the saponification value of an oil or fat.
6. Determine the Iodine index of an oil or fat.
7. Isolate DNA from onion/peas/cauliflower.

<u>End Semester Examination (ESE):</u>

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-6

MAJOR-14

Paper Code: UCHEMAJ36014

Paper Description: INORGANIC CHEMISTRY-V

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

INORGANIC CHEMISTRY-V

UNIT I: Organometallic Compounds

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands.

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

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

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkylaluminium (dimer), concept of multicenter bonding in these compounds. Role of triethylaluminium in

polymerization of ethene (Ziegler-Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.

Ferrocene: Preparation and reactions (acetylation, alkylation, metalation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene. **(30 Lectures)**

UNIT II: Reaction Kinetics and Mechanism

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans-effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes. **(10 Lectures)**

UNIT III: Catalysis by Organometallic Compounds

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 **(5 Lectures)**

Reference Books:

- Cotton, F.A.G., Wilkinson & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd Ed. Wiley, India.
- Huheey, J. E., Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry*, *Principles of Structure and Reactivity*, 4th Ed., Harper Collins, 1993, Pearson, 2006.
- Sharpe, A.G. *Inorganic Chemistry*, 4th Indian Reprint, Pearson Education, 2005.
- Douglas, B. E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, 3rd Ed., John Wiley and Sons, NY, 1994.
- Lee, J.D. *Concise Inorganic Chemistry*, 5th Ed., John Wiley and Sons, 2008.
- Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
- Shriver, D.D. & P. Atkins, *Inorganic Chemistry*, 2nd Ed., Oxford University Press, 1994.

- Basolo, F. & Pearson, R. *Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution*, 2nd Ed., John Wiley & Sons Inc; NY.
- Purcell, K.F. & Kotz, J.C., *Inorganic Chemistry*, W.B. Saunders Co. 1977.
- Collman, J. P. et al. *Principles and Applications of Organotransition Metal Chemistry*, Mill Valley, CA: University Science Books, 1987.
- Crabtree, R. H. *The Organometallic Chemistry of the Transition Metals*, New York, NY: John Wiley, 2000.
- Spessard, G. O. & Miessler, G.L. *Organometallic Chemistry*, Upper Saddle River, NJ: Prentice-Hall, 1996.

PRACTICAL

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

1. Gravimetric Analysis:(<u>any one</u>)

(a) Estimation of Nickel (II) using Dimethylglyoxime (DMG).

(b) Estimation of Copper as CuSCN.

(c) Estimation of Iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.

(d) Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$(aluminiumoxinate).

2. Inorganic Preparations:(<u>any four</u>)

(a)Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$

(b)*Cis* and *trans* $K[Cr(C_2O_4)_2(H_2O)_2]$ Potassium dioxalatodiaquachromate(III)

(c)Tetraamminecarbonatocobalt (III) ion

(d) Potassium tris(oxalate)ferrate(III)

(e) Cuprous Chloride, Cu_2Cl_2

(f) Preparation of Manganese(III) phosphate, $MnPO_4.H_2O$

(g) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum

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 Book:

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

Semester-6

MAJOR-15

Paper Code: UCHEMAJ36015

Paper Description: PHYSICAL CHEMISTRY-V

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

PHYSICAL CHEMISTRY-V

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.D. *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
- Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa, 2004.
- Mortimer, R. G. *Physical Chemistry*, 3rd Ed., Elsevier, NOIDA, UP, 2009.
- Barrow, G. M. *Physical Chemistry*, 5th Ed., Tata McGraw Hill, New Delhi, 2006.
- Engel, T. & Reid, P. *Physical Chemistry*, 3rd Ed., Prentice-Hall, 2012.
- Rogers, D. W. *Concise Physical Chemistry*, Wiley, 2010.
- Silbey, R. J., Alberty, R. A. & Bawendi, M. G. *Physical Chemistry*, 4th Ed., John Wiley & Sons, Inc. 2005.

PRACTICAL

PRACTICAL (PHYSICAL CHEMISTRY-VI): (30 HOURS)

1. Conductometry:(<u>any two</u>)

(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:(**<u>any two</u>**)

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:(**<u>any two</u>**)

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*, 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.

Semester-6

MAJOR-16

Paper Code: UCHEMAJ36016

Paper Description: SPECTROSCOPY

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

SPECTROSCOPY

UNIT I: Molecular Spectroscopy

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

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

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

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

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

(23 Lectures)

UNIT II: Organic Spectroscopy

General principles, Introduction to absorption and emission spectroscopy.

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

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

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin–Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds. Applications of IR, UV and NMR for identification of simple organic molecules.

Electron Spin Resonance (ESR) spectroscopy: principle, hyperfine structure, ESR of simple radicals. **(22 Lectures)**

Reference Books:

- Kemp, W. *Organic Spectroscopy*, Palgrave.
- Pavia, D. L. et al. *Introduction to Spectroscopy*, *5th* Ed. Cengage Learning India Ed. 2015.
- Silverstein, R.M.; Webster, F. & Kiemle. D. *Spectrometric Identification of Organic Compounds*.
- Banwell, C.N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).
- Kakkar, R. *Atomic & Molecular Spectroscopy*: *Concepts & Applications*, Cambridge University Press, 2015.

PRACTICAL

PRACTICAL (SPECTROSCOPY): (30 HOURS)

1. Identification of simple organic compounds by UV, IR, NMR spectroscopy.
   (At least spectral analysis of five compounds are recommended to consider).
2. Determination of absorbance of beet extract/ carotene/ butterfly pea extract /Hibiscus extract.

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:

- Robinson, J. W. *Practical Handbook of Chemistry*, 1st Edition, CRC Press, 1991.
- Harrison, G. R. *Practical Spectroscopy*, Read Books, 2011.

Semester-7

COURSE TYPE: MAJOR-17

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ47017	ORGANIC CHEMISTRY-VI
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
400	75

COURSE TYPE: MAJOR-18

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ47018	INORGANIC CHEMISTRY-VI
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
400	75

COURSE TYPE: MAJOR-19

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ47019	PHYSICAL CHEMISTRY-VI
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
400	75

COURSE TYPE: MINOR-4

PAPER CODE	PAPER DESCRIPTION
UCHEMIN40004	CHEMISTRY-IV
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
300	75

Semester-7

MAJOR-17

Paper Code: UCHEMAJ47017

Paper Description: ORGANIC CHEMISTRY-VI

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

ORGANIC CHEMISTRY-VI

UNIT I: Photochemistry

Basic principles, Jablonski diagram, photochemistry of olefinic compounds, Cis-trans isomerisation, stereomutation, Paterno-Buchi reaction, Norrish type I and II reactions, photoreduction of ketones, di-pi-methane rearrangement, photochemistry of arenes, Photoreaction in the solid state. Method of generation and detection (ESR) of radicals, radical initiators, reactivity pattern of radicals, substitution and addition reactions involving radicals, cyclization of radicals, allylic halogenation, auto-oxidation. **(20 Lectures)**

UNIT II: Pericyclic Reaction

Pericyclic reactions, Selection rules and stereochemistry of electrocyclic reactions, cycloadditions, sigmatropic rearrangements, carbene addition, cheleotropic reactions. 1,3 dipolar additions, Rationalization based on Frontier M.O. approach, correlation diagrams, Dewer-Zimmermann approach, Sommelet-Hauser, Cope, aza Cope and Claisen rearrangements, Ene Reaction, Wittig rearrangement, suitable examples of [(2π +2 π), (4π +2

π), (4π + 4π), (2π +2 π +2π)] and metal catalysed cycloaddition reactions.

(25 Lectures)

Reference Books:

- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Clayden, J. Greeves, N. Warren, S. Wothers, P. *Organic Chemistry*, Oxford University Press.
- Robert O Kan. *Organic Photochemistry*, McGraw-Hill, USA
- Albert Padwa. *Organic Photochemistry*.
- John D. Coyel, *Introduction to Organic Photochemistry*.

PRACTICAL

PRACTICAL (ORGANIC CHEMISTRY-V): (<u>any three</u>) (30 HOURS)

1. Perform thermal addition reaction involving Anthracene and Maleic anhydride / cycloaddition reaction with suitable substrates.
2. Preparation of Benzopinacol by Photoreduction of Benzophenone.
3. Experiment on (or Study of) thermal or photochemical electrocyclic reaction covering 4π electron system
4. Experiment on (or Study of) thermal or photochemical electrocyclic reaction covering 6π electron system.
5. Experiment on (or Study of) cyclo addition reaction covering two components having (2π +2 π)/ (4π +2 π)/ (4π + 4π) electron system.
6. Experiment on (or Study of) thermal sigmatropic reaction covering [3,3] shift.
7. Experiment on (or Study of) photoinduced cis-trans isomerization of compounds.

<u>End Semester Examination (ESE)</u>

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

References Books:

- Normann R.O.C & Coxon J.M. *Principles of Organic Synthesis*, 3rd Ed, CRC Press New York, 2012.
- Carey F.A. & Sundberg R. J. *Advanced Organic Chemistry*, Springer, India, 2012.

Semester-7

MAJOR-18

Paper Code: UCHEMAJ47018

Paper Description: INORGANIC CHEMISTRY-VI

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

INORGANIC CHEMISTRY-VI

UNIT I: Magnetochemistry

Magnetic properties: paramagnetism, ferro- and antiferro magnetism and diamagnetism, Pascal constants, Russell-Saunder's terms, Microstates: Equivalent and non-equivalent multi-electron systems, Hund's Rule, Spin-orbit coupling constant, Lande interval rule, Determination of magnetic susceptibility: Gouy's balance and Evan's method. Thermal energy and magnetic properties, Currie equation, Curie-Weiss law, 1st order Zeeman effect and 2nd order Zeeman effect, Magnetic properties of first transition series metal ions, lanthanides and actinides, orbital contribution and quenching of orbital magnetic moment by the crystal field, quantitative

relation between μ_{eff} and μ_s and its derivation, Spin-Orbit coupling and A, E, T ground terms, Spin pairing and cross-over region. **(30 Lectures)**

UNIT II: Nuclear Chemistry

Nuclear reactions, Nuclear Activation Analyses, Charged Particle Activation Analyses, Radiotracer Methods: Study of Chemical Reactions, Nuclear Medicine, Isotope Dilution Analysis. Radioanalytical techniques: Particle Induced X-ray Emissions.

(15 Lectures)

Reference Books:

- Carlin, R.L. *Magnetochemistry*, Springer Verlag, 1986.
- Kahn, O. *Molecular Magnetism*, VCH-Verlag, Weinheim, New York, 1993.
- Nicola A. *Magnetic Materials: Fundamentals and Applications*, Hardcover Spaldin, Cambridge University Press, 2010.
- Cullity, B.D. & Graham, C.D. *Introduction to Magnetic Materials*, Second Edition, Wiley.
- Loveland, W.D.; Morrissey, D.J. & Seaborg, G.T. *Modern Nuclear Chemistry*, Second Edition, Wiley, 2017.
- McPherson, P.A.C. *Principles of Nuclear Chemistry*, World Scientific, 2017.
- Choppin, G.R. & Rydberg, J. *Nuclear Chemistry: Theory and Applications*, Pergamon Press, 1980.

PRACTICAL

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

1. **Magnetochemistry:**
    a. Determination of magnetic moment of iron and nickel complexes.
2. **Nuclear Chemistry: (any two)**
    a. Determination of the Background Radiation
    b. Determination of the Half-life of a Radioactive Isotope
    c. Determination of the type of radiation from a source
    d. Absorption of Gamma photons (Shielding)
    e. Inverse Square Law

f. Precipitation reactions
g. Washing Efficiency
h. Wear Studies

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:

- Schuler, R.H. *Laboratory Experiments in Magnetochemistry*, J. Chem. Edu. 27 (11), 591, 1950.
- Katz, D.A. *Experiments for Nuclear Chemistry*, Pima Community College, USA, 2004.

Semester-7

MAJOR-19

Paper Code: UCHEMAJ47019

Paper Description: PHYSICAL CHEMISTRY-VI

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

PHYSICAL CHEMISTRY-VI

UNIT I: Quantum Chemistry

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

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

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

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

Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB).

Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

(30 Lectures)

UNIT II: Photochemistry

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, the physical significance of absorption coefficients.

Laws of photochemistry, quantum yield, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching.

Role of photochemical reactions in biochemical processes, photo stationary states, chemiluminescence. **(15 Lectures)**

Reference Books:

- Chandra, A. K. *Introductory Quantum Chemistry*, Tata McGraw-Hill, 2001.
- House, J. E. *Fundamentals of Quantum Chemistry*, 2nd Ed. Elsevier, USA, 2004.
- Kakkar, R. *Atomic & Molecular Spectroscopy, Concepts & Applications*, Cambridge University Press, 2015.
- Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press, 2005.
- Albini, A. *Photochemistry*, RSC, 44, 2016.

PRACTICAL

PRACTICAL (PHYSICAL CHEMISTRY-IV): (<u>any three</u>) (30 HOURS)

1. Verify Lambert-Beer's law and determine the concentration of $KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration.
2. Study the (200-500) nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture in a 0.1 M H_2SO_4 and determine the λ_{max} values. Calculate the energies of the two transitions in different units ($Jmolecule^{-1}$, $kJmol^{-1}$, eV)
3. Study the kinetics of iodination of propanone in acidic medium.
4. Determine the amount of iron present in a sample using 1,10-phenathroline.
5. Determine the dissociation constant of an indicator (phenolphthalein).
6. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.
7. Analysis of the given vibration-rotation spectrum of HCl(g).
8. Study the pH dependence of UV-Vis spectrum (200-500) nm of $K_2Cr_2O_7$.

<u>End Semester Examination (ESE)</u>

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:

- Linde, C.B.; Meuter, N.; Zeller, D. & Tausch, M.W. *Teaching Photochemistry: Experimental Approaches and Digital Media*, Wiley-VCH, 2021.

Semester-8

COURSE TYPE: MAJOR-20

[HONOURS WITH RESEARCH & WITHOUT RESEARCH]

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ48020	GREEN CHEMISTRY
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
400	75

COURSE TYPE: MAJOR-21

[HONOURS WITHOUT RESEARCH]

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ48021	ORGANIC CHEMISTRY-VII
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
400	75

COURSE TYPE: MAJOR-22

[HONOURS WITHOUT RESEARCH]

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ48022	INORGANIC CHEMISTRY-VII
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
400	75

COURSE TYPE: MAJOR-23

[HONOURS WITHOUT RESEARCH]

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ48023	PHYSICAL CHEMISTRY-VII
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
400	75

COURSE TYPE: MAJOR

[HONOURS WITH RESEARCH]

PAPER DESCRIPTION: RESEARCH PROJECT/ DISSERTATION Credit=12

COURSE TYPE: MINOR-4

[HONOURS WITH RESEARCH & WITHOUT RESEARCH]

PAPER CODE	PAPER DESCRIPTION
UCHEMIN40004	CHEMISTRY-IV
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
300	75

Semester-8

MAJOR-20

[HONOURS WITH RESEARCH & WITHOUT RESEARCH]

Paper Code: UCHEMAJ48020

Paper Description: GREEN CHEMISTRY

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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:

- Lancaster, M. *Green Chemistry, An Introductory Text*, 3rd Edition, RSC, 2016.
- Anastas, P.T. & Warner, J.C. *Green Chemistry Theory and Practice*, Oxford University Press, 1998.
- Anastas, P. *Handbook of Green Chemistry*, Wiley-VCH, New York, 2010.
- James, C. & MacQuarrie, D. *Handbook of Green Chemistry and Technology*, Blackwell Science, Malden, MA, 2002.
- Horvath, I.T. & Anastas, P.T. *Innovations and Green Chemistry*, Chemical Reviews, 107, 2169-2173, 2007.
- Lancaster, M. *Green Chemistry*, Royal Society of Chemistry, London, 2002.
- Matlack, A. *Introduction to Green Chemistry*, 2nd ed., CRC Press, Boca Raton, FL, 2010.

PRACTICAL

PRACTICAL (GREEN CHEMISTRY): (any four) (30 HOURS)

1. The Grignard reaction
2. The Esterification reaction
3. The Alcohol Dehydration reaction-Zaitsev Elimination
4. The Oxidation reaction
5. The Polymerization reaction
6. The Aldol Condensation reaction

7. The Friedal Crafts Alkylation and Acylation reactions
8. The Diels Alder reaction
9. The Wittig reaction
10. The Substitution (S_N2) reaction.
11. Michael Addition

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:

- Roesky, H.W., Kennepohl, D. & Lehn, J.M. *Experiments in Green and Sustainable Chemistry*, Wiley-VCH, Weinheim, Germany, 2009.
- Anastas, P.T. & Warner, J.K. *Green Chemistry-Theory and Practical*, Oxford University Press, 1998.

Semester-8

MAJOR-21

[HONOURS WITHOUT RESEARCH]

Paper Code: UCHEMAJ48021

Paper Description: ORGANIC CHEMISTRY-VII

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

ORGANIC CHEMISTRY-VII

UNIT I: Alkaloids

Natural occurrence, General structural features, Isolation and their physiological action. Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. **(11 Lectures)**

UNIT II: Terpenoids

Classification, Isoprene rule, Elucidation of structure and synthesis of Citral, Neral andα-terpinol, sesqui-, di- and tri-terpenoids. **(7 Lectures)**

UNIT III: Flavonoids

Synthesis and reactions of coumarin and chromones; Occurrence, Nomenclature and general methods of structure determination, Isolation and synthesis of Apigenin, Luteolin, Quercetin, Myrcetin Quercetin 3-glucoside, Vitexin, Diadzein, Butulin, Aureusin, Cyanidin-7-arabinoside, Cyanidin, Hirsutidin, Biosynthesis of flavonoids-acetate and shikimic pathway.

(12 Lectures)

UNIT IV: Dyes

Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing; Synthesis and application of: Azo dyes- Methyl Orange and Congo Red (mechanism of Diazo Coupling); TriphenylMethane dyes- Malachite Green, Rosaniline and Crystal Violet; Phthalein Dyes-Phenolphthalein and Fluorescein; Natural Dyes- Structure Elucidation and Synthesis of Alizarin and Indigotin; Edible dyes with examples. **(10 Lectures)**

UNIT V: Retrosynthesis

A brief introduction to retrosynthesis. **(5 Lectures)**

Reference Books:

- Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Singh, J. Ali, S.M. & Singh, J. *Natural Product Chemistry,* Prajati Parakashan, 2010.

PRACTICAL

PRACTICAL (ORGANIC CHEMISTRY-VI): (<u>any three</u>) (30 HOURS)

1. Preparation of Methyl orange.
2. Separation of a binary mixture containing an acid and a neutral compound (e.g. Benzoic acid & Napthalene or any suitably chosen pair of compounds).
3. Separation of a binary mixture containing a basic and a neutral compound (e.g. Napthalene and 4-Toluidine or any suitably chosen pair of compounds).
4. Separation of a binary mixture containing Urea & Benzophenone.
5. Preparation of 7-Hydroxy-4-methyl coumarin using resorcinol and ethyl acetoacetate.
6. Extraction of Caffeine from tea leaves.
7. Extraction of Betalain from beetroot.
8. Extraction *d*-Limunine from peels of citrous fruit.

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, A.I. *Quantitative Organic Analysis*, Part 3, Pearson, 2012.
- 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-8

MAJOR-22

[HONOURS WITHOUT RESEARCH]

Paper Code: UCHEMAJ48022

Paper Description: INORGANIC CHEMISTRY-VII

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

INORGANIC CHEMISTRY-VII

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 (INORGANIC CHEMISTRY-VII): (any four) (30 HOURS)

- Determination of free acidity in ammonium sulphate fertilizer.
- Estimation of Calcium in Calcium ammonium nitrate fertilizer.
- Estimation of phosphoric acid in superphosphate fertilizer.
- Determination of composition of dolomite (by complexometric titration).
- Analysis of (Cu, Zn) in alloy.
- Analysis of Cement.
- 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.

Semester-8

MAJOR-23

[HONOURS WITH RESEARCH]

Paper Code: UCHEMAJ48023

Paper Description: RESEARCH PROJECT/ DISSERTATION

Paper Type: TH + PLB (Credits: 12)

Semester-8

MAJOR-23

[HONOURS WITHOUT RESEARCH]

Paper Code: UCHEMAJ48023

Paper Description: PHYSICAL CHEMISTRY-VII

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

PHYSICAL CHEMISTRY-VII

POLYMER CHEMISTRY

UNIT I:

Functionality and its importance: Addition and Condensation–Mechanism of Cationic, anionic and free radical addition polymerization. Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. **(5 Lectures)**

UNIT II:

Kinetics of Polymerization: Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization.

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

(10 Lectures)

UNIT III:

Determination of molecular weight of polymers:(*Mn*, *Mw*) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Glass transition temperature (Tg) and determination of Tg: Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

Rubbers: natural and synthetic; Buna-S, Chloroprene, and Neoprene; Vulcanization; Biodegradable polymers with examples. **(10 Lectures)**

ANALYTICAL CHEMISTRY

UNIT I: Qualitative and quantitative aspects of analysis

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data, F, Q and test, rejection of data, and confidence intervals. **(8 Lectures)**

UNIT II: Separation techniques

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch and continuous 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.

Ion-exchange: Principle, Types of ion-exchangers, Quality of resins, Swelling of resins, Action of ion-exchange resin, Ion-exchange equilibrium, Ion-exchange capacity, Deionization of water. (**12 Lectures)**

Reference Books:

- Seymour, R.B. & Carraher, C.E., *Polymer Chemistry: An Introduction*, Marcel Dekker, Inc. New York, 1981.
- Odian, G. *Principles of Polymerization*, 4th Ed., Wiley, 2004.
- Billmeyer, F.W. *Textbook of Polymer Science*, 2nd Ed., Wiley Interscience, 1971.
- Ghosh, P. *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991.
- Mendham, J., A. I. *Vogel's Quantitative Chemical Analysis*, 6th Ed., Pearson, 2009.
- Willard, H.H. et al. *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
- Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
- Khopkar, S.M. *Basic Concepts of Analytical Chemistry*, New Age International Publisher, 2009.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Ditts, R.V. *Analytical Chemistry*, Methods of Separation, van Nostrand, 1974.

PRACTICAL

PRACTICAL (POLYMER CHEMISTRY): (20 HOURS)

1. **Polymer synthesis: (<u>any two</u>)**

(a) Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).

i. Purification of monomer

ii. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)

(b) Preparation of nylon 6,6

(c) Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and Phenolphthalein.

i. Preparation of IPC

ii. Purification of IPC

iii. Interfacial polymerization

(d) Redox polymerization of acrylamide

(e) Precipitation polymerization of acrylonitrile

(f) Preparation of urea-formaldehyde resin

(g) Preparations of novalac resin/ resold resin.

(h) Microscale Emulsion Polymerization of Poly(methylacrylate).

2. Polymer characterization: (<u>any one</u>)

(a) Determination of molecular weight by viscometry:

i. Polyacrylamide-aq. $NaNO_2$ solution

ii. Poly vinyl proplylidine (PVP) in water

(b) Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.

(c) Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).

(d) Testing of mechanical properties of polymers.

(e) Determination of hydroxyl number of a polymer using colorimetric method.

PRACTICAL (ANALYTICAL CHEMISTRY): (10 HOURS)

1. Solvent Extraction: (any one)

(a) Determination of Nickel as the Dimethylglyoxime complex.

(b) Determination of Iron as the 8-Hydroxy Quinolate.

2. Ion exchange: (any one)

(a) Determination of the capacity of a cation exchange resin and an anion exchange resin (Column method).

(b) Determination of Na^+/K^+ in a given solution by Ion-Exchange method.

<u>End Semester Examination (ESE):</u>

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:

- Pinner, S.H. *A Practical Course in Polymer Chemistry*, Pergamon Press, 1961.
- *Vogel's Textbook of Quantitative Inorganic Analysis*, Fourth Edition, ELBS, 1986.

Semester-1 & Semester-2

COURSE TYPE: MINOR-1

PAPER CODE	PAPER DESCRIPTION
UCHEMIN10001	CHEMISTRY-I
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

Semester-3 & Semester-4

COURSE TYPE: MINOR-2

PAPER CODE	PAPER DESCRIPTION
UCHEMIN20002	CHEMISTRY-II
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
200	75

Semester-5 & Semester-6

COURSE TYPE: MINOR-3

PAPER CODE	PAPER DESCRIPTION
UCHEMIN30003	CHEMISTRY-III
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
200	75

Semester-7 & Semester-8

COURSE TYPE: MINOR-4

PAPER CODE	PAPER DESCRIPTION
UCHEMIN40004	CHEMISTRY-IV
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
300	75

Semester-1 & 2

MINOR-1

Paper Code: UCHEMIN10001

Paper Description: CHEMISTRY-I

Paper Type: TH + PLB (Credits: Theory-03, Practical-01)

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

CHEMISTRY-I

UNIT I: Basics of Organic Chemistry

Organic Compounds: Classification and Nomenclature, Hybridization.

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

Homolytic and Heterolytic fission; Electrophiles and Nucleophiles; Types, shape, and the relative stability of Carbocations, Carbanions, and Free radicals.

Introduction to types of organic reactions and their mechanism: Addition, Elimination (formation of alkenes and alkynes), and Substitution reactions.

Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. **(15 Lectures)**

UNIT II: Atomic Structure

Bohr's theory, its limitations, dual behaviour of matter andradiation, deBroglie'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, 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 III: 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)**

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.
- Lee, J.D. *Concise Inorganic Chemistry* ELBS,1991.
- 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.
- 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.

PRACTICAL

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

PRACTICAL (CHEMISTRY-I) (30 HOURS)

UNIT I:

1. Purification of organic compounds by crystallization using the following solvents: (a)Water, (b)Alcohol
2. Determination of the melting points of organic compounds.

UNIT II:

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

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

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

   Cations are to be confirmed by special tests /spot tests wherever Feasible. (**Group analysis not to be performed**)

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.
- Mendham, J., A.I. Vogel's *Quantitative Chemical Analysis*, 6thEd., Pearson, 2009.
- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.

Semester-3 & 4

MINOR-2

Paper Code: UCHEMIN20002

Paper Description: CHEMISTRY-II

Paper Type: TH + PLB

Credits: Theory-03, Practical-01

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

CHEMISTRY-II

UNIT I: Chemistry of Hydrocarbons

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

Alkene and Alkyne: 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, catalytic reduction, hydroxylation.

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

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.

(15 Lectures)

UNIT II: Periodicity of Elements

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

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

(b) Atomic radii (van der Waals)

(c) Ionic and crystal radii.

(d) Covalent radii (octahedral and tetrahedral)

(e) Ionization enthalpy, 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, group electronegativity. **(15 Lectures)**

UNIT III: Liquid and Solid State

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

Solid State: Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, 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)

Reference Books:

- Claiden, J.; Warren, S. & Greeves, N. *Organic Chemistry*, 2nd Ed., Oxford University Press, 2012.
- 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.
- Atkins, P.W.& Paula, J.de *Atkin's Physical Chemistry*,10th Ed., Oxford

University Press, 2014.

- Mortimer, R.G. *Physical Chemistry*, 3rd Ed., Elsevier,2009.
- Engel, T. & Reid, P. *Physical Chemistry*,3rd Ed., Pearson, 2013.
- Morrison, R.N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Ltd. Pearson Education.
- Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, 6th Ed., Harlow, 1961.
- Finar, I.L. *Organic Chemistry*, Volume 1, Dorling Kindersley (India) Ltd. Pearson Education.

PRACTICAL

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

PRACTICAL (CHEMISTRY-II): (30 HOURS)

UNIT I: (any two)

1. Preliminary characterization of aliphatic and aromatic compounds by ignition.
2. Detection of active unsaturation in Cinnamic acid or any suitable compound.
3. Bromination of Acetanilide by green method using Potassium bromide and Potassium bromate.

UNIT III: (any two)

1. Determination of Density of a liquid.
2. 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 solution with concentration.
3. a. Determination of the coefficient of viscosity of a liquid or dilute solution using an Ostwald's viscometer.

b. Study of the variation of viscosity of an aqueous solution with concentration of solute.

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

Semester-5 & 6

MINOR-3

Paper Code: UCHEMIN30003

Paper Description: CHEMISTRY-III

Paper Type: TH + PLB

Credits: Theory-03, Practical-01

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

CHEMISTRY-III

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.

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.

(15 Lectures)

UNIT II: Chemical Bonding

Ionic Bonding: General characteristics of ionic bonding. L attice 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.

(15 Lectures)

UNIT III: 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 are action with temperature-Kirchhoff's equation.

Statement of Third Law of thermodynamics. **(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.
- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry*, Oxford, 1970.
- Huheey, J.E., Keiter, E.A., Keiter, R.L & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India,2006.
- 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.

PRACTICAL

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

PRACTICAL (CHEMISTRY-III): (30 HOURS)

UNIT II:(any two)

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 $KMnO_4$.

UNIT III:(any two)

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.

Reference Books:

- Mendham, J., A.I. Vogel's *Quantitative Chemical Analysis*, 6thEd., Pearson, 2009.
- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
- Athawale, V.D. & Mathur, P. *Experimental Physical Chemistry*, New Age International, New Delhi, 2001.

Semester-7 & 8

MINOR-4

Paper Code: UCHEMIN40004

Paper Description: CHEMISTRY-IV

Paper Type: TH + PLB

Credits: Theory-03, Practical-01

Total Marks: 75 [Theory (ESE – 40); Practical (ESE – 20); CE – 10; Attendance – 05]

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

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

CHEMISTRY-IV

UNIT I: 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 II: Acids, Bases and Inorganic Polymers

Acids and Bases: 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.

Inorganic Polymers: Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects

and applications of silicones and siloxanes. Borazines, silicates, phosphazenes, and polysulphates. **(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.

(15 Lectures)

Reference Books:

- Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc..
- Carruthers, W. *Some Modern Methods of Organic Synthesis*, 4th Ed., Cambridge University Press, 2004.
- Loudon, M. *Organic Chemistry*, Oxford University Press, 2002.
- 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.
- 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.

PRACTICAL

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

PRACTICAL (CHEMISTRY-IV): (30 HOURS)

UNIT I:

1. Detection of special elements (N, S, Cl) in organic compounds.
2. Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional Groups (-carboxylic, phenolic, nitro, amines)

UNIT III:

1 . Measurement of pH of different solutions like aerated drinks/fruit juices/shampoos/soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

2. Preparation of buffer solutions:**(<u>any one</u>)**

a. Sodium acetate-acetic acid **or**

b. Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

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

End Semester Examination (ESE)

Question pattern of 40 marks paper:

Serial No.	Questions to be answered	Out of	Marks for each Question	Total Marks
1	5	8	2	5x2 =10
2	4	6	5	4x5 =20
3	1	2	10	1x10 =10

Question pattern of 60 marks paper:

Serial No.	Questions to be answered	Out of	Marks for each Question	Total Marks
1	5	8	2	5x2 =10
2	6	9	5	6x5 =30
3	2	4	10	2x10 =20

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