UNIVERSITY OF NORTH BENGAL

Raja Rammohunpur, Dist. Darjeeling
Pin: 734 013, West Bengal, India

FYUGP syllabus

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

WITH EFFECT FROM THE ACADEMIC SESSION

2024-2025

Semester-III

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

COURSE TYPE: MULTIDISCIPLINARY-3

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

Semester-III

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 and decalin. **(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

ORGANIC CHEMISTRY-II: (any three) **(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.

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:

- 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-III

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

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: (*any two*)

(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: (*any one*)

(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.

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-III

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, Concepts and Applications of liquid crystals. **(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

PHYSICAL CHEMISTRY-I: (*any two*) **(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).

1. **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).

2. **Indexing of a given powder diffraction pattern of a cubic crystalline system.**

End Semester Examination (ESE)

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

Marks distribution

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

Reference Books:

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

Semester-III

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, Millerindices, elementary ideas of symmetry, symmetry elements, seven crystal systems and fourteen Bravais lattices; X-raydiffraction, 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

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 anOstwald's viscometer.

   a. 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.

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

Semester-III

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 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. Pasteurisation, 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. **(20 Lectures)**

UNIT III:

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. **(5 Lectures)**

Unit V: Pigments and flavours- Chlorophyll, Myoglobin and Haemoglobin, Anthocyanins, Flavanoids, Carotenoids, Tannins, Quinones and Xanthones

Flavours – Definition, flavor and nutrition, flavours and flavourings in food- source, extraction of flavourings, essential oils and oleoresins, flavor delivery systems, flavor modifiers.
Anti-oxidants, allergens, toxins and anti-nutritional factors in foods. **(8 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

FOOD CHEMISTRY: (30 HOURS)

A. Practical: (*any four*)

1. Collection of information on the adulteration of some common foods from a 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.

References

1. A firstcourseinFoodAnalysis–A.Y.Sathe,NewAgeInternational(P)Ltd.,1999
2. https://eatrightindia.gov.in/dart/
3. 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.
4. 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.
5. 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.
6. 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.
7. FoodSafety,casestudies–Ramesh.V.Bhat,NIN,1992
8. https://old.fssai.gov.in/Portals/0/Pdf/Draft_Manuals/Beverages and confectionary.pdf
9. https://cbseportal.com/project/Download-CBSE-XII-Chemistry-Project-Food-Adulteration#gsc.tab=0 (Downloadable e material on food adulteration
10. 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-III

MULTIDISCIPLINARY 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

UNIT I: 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 azo pigments 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. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington, 2002.
- Lancaster, M. *Green Chemistry: An Introductory Text*, RSC publishing, 2nd Edition.

Semester-IV

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

Semester-IV

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, Grignard Reagents, Organo-Lithium, Nucleophilic addition-elimination reactions, ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Robinson annulation, 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

ORGANIC CHEMISTRY-III: (any *three*) **(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:(**any *three***)
    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-Benzylisothiouronium salts of following carboxylic acids;
    a. Oxalic acid, Benzoic acid, Phenyl acetic acid, Phthalic acid.
    f) Preparation of Semicarbazone derivative of the following compounds; Acetone, Ethyl methyl ketone, Cyclohexanone, Benzaldehyde.

End Semester Examination (ESE)

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

Marks distribution

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

Reference Books:

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

- Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press, 2000.
- Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis*, University Press, 2000.

Semester-IV

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

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-IV

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

Objectives and limitations of thermodynamics, Some common thermodynamic terms – System, Surroundings, Boundary, Intensive and extensive variables, Thermodynamic equilibrium, Thermodynamic processes, 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. Joule's law and Joule-Thomson effect, Joule-Thomson coefficient, inversion temperature, relation between Joule-Thomson coefficient and other thermodynamic parameters, Comparison of isothermal and adiabatic expansion of an ideal gas.

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: Limitations of first law – The need for second law, Concept of entropy, thermodynamics or Kelvin scale of temperature, statement of the second law of thermodynamics. Carnot's cycle, Efficiency of a heat engine, Carnot's theorem, Calculation of entropy change for reversible and irreversible processes (Clausius inequality), Entropy changes of an ideal gas, Entropy changes in physical change and adiabatic process, Clausius inequality applied to an isolated system, Clausius inequality applied to system and surroundings (entropy of universe), statement of the second law of thermodynamics in terms of entropy change, entropy of mixture of ideal gases.

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, Nernst heat theorem.

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

(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

PHYSICAL CHEMISTRY-II: (30 HOURS)

1. Thermochemistry: (*any three*)

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.

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

Semester-IV

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.

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

(i) Atomic radii (van der Waals)
(j) Ionic and crystal radii.
(k) Covalent radii (octahedral and tetrahedral)
(l) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
(m) Electron gain enthalpy, trends of electron gain enthalpy.
(n) 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, Millerindices, elementary ideas of symmetry, symmetry elements, seven crystal systems and fourteen Bravais lattices; X-raydiffraction, 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

CHEMISTRY-II: **(30 HOURS)**

UNIT I: (*any two*)

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

UNIT III: (*any two*)

3. Determination of Density of a liquid.
4. 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 anOstwald'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.

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

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