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

LAYOUT OF SYLLABUS FOR CHEMISTRY AS MAJOR SUBJECT

SEMESTER	*COURSE TYPE*	*PAPER DESCRIPTION*
1	MAJOR-1	ORGANIC CHEMISTRY-I
	MAJOR-2	INORGANIC CHEMISTRY-I
2	MAJOR-3	PHYSICAL CHEMISTRY-I
	MAJOR-4	ORGANIC CHEMISTRY-II
3	MAJOR-5	INORGANIC CHEMISTRY-II
	MAJOR-6	PHYSICAL CHEMISTRY-II
3	SEC	PHARMACEUTICAL CHEMISTRY
4	MAJOR-7	ORGANIC CHEMISTRY-III
	MAJOR-8	INORGANIC CHEMISTRY-III
5	MAJOR-9	PHYSICAL CHEMISTRY-III
	MAJOR-10	ORGANIC CHEMISTRY-IV
	MAJOR-11	INORGANIC CHEMISTRY-IV
	MAJOR-12	PHYSICAL CHEMISTRY-IV
6	MAJOR-13	ORGANIC CHEMISTRY-V
	MAJOR-14	INORGANIC CHEMISTRY-V
	MAJOR-15	PHYSICAL CHEMISTRY-V
	MAJOR-16	SPECTROSCOPY
7	MAJOR-17	RESEARCH METHODOLOGY
	MAJOR-18 (HONS. WITHOUT RESEARCH)	GREEN CHEMISTRY
	MAJOR-18 (HONS. WITH RESEARCH)	PROJECT/ DISSERTATION/ LITERATURE SURVEY
	MAJOR-19	PHYSICAL CHEMISTRY-VI
8	MAJOR-20	ORGANIC CHEMISTRY-VI
	MAJOR-21	INORGANIC CHEMISTRY-VI
	MAJOR-22 (HONS. WITHOUT RESEARCH)	BIOCHEMISTRY
	MAJOR-22 (HONS. WITH RESEARCH)	PROJECT WORK
	MAJOR-23 (HONS. WITHOUT RESEARCH)	POLYMER CHEMISTRY & ANALYTICAL CHEMISTRY

	MAJOR-23 (HONS. WITH RESEARCH)	PROJECT WORK

Semester-I

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: MAJOR-2

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

UNIVERSITY OF NORTH BENGAL
CHEMISTRY

Semester-I

MAJOR-1
Paper Code: UCHEMAJ11001
Paper Description: ORGANIC CHEMISTRY-I
Paper Type: TH + PLB (Credits: Theory-03, Practical-01)
Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 20)]
Theory: 45 Lectures [Each Lecture is 1 hour in duration]
Practical: 15 classes [Each class is 2 hours in duration]

ORGANIC CHEMISTRY-I

UNIT I: Basics of Organic Chemistry

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, Free radicals, Carbenes and Nitrenes.

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, E1cb reactions, 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*, 7thEd. 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

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.

Semester-I

MAJOR-2

Paper Code: UCHEMAJ11002

Paper Description: INORGANIC CHEMISTRY-I

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

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

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

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

INORGANIC CHEMISTRY-I

UNIT I: Atomic Structure

Bohr's theory, its limitations 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

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.

Semester-II

COURSE TYPE: MAJOR-3

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ12003	PHYSICAL CHEMISTRY-I
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

COURSE TYPE: MAJOR-4

PAPER CODE	PAPER DESCRIPTION
UCHEMAJ12004	ORGANIC CHEMISTRY-II
Credit	Paper Type
4	TH + PLB
Paper Levels	Full Marks
100	75

Semester-II

MAJOR-3

Paper Code: UCHEMAJ11003

Paper Description: PHYSICAL CHEMISTRY-I

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

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

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

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

PHYSICAL CHEMISTRY-I

UNIT I: Gaseous state

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation, 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, Liquid crystal (Preliminary Idea), Classification, phases, Properties and Applications. **(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).

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.**

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-II

MAJOR-4

Paper Code: UCHEMAJ11004

Paper Description: ORGANIC CHEMISTRY-II

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

Total Marks: 80 [Theory (ESE – 60); Practical (ESE – 206)]

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.

End Semester Examination (ESE)

Question pattern of 60 marks paper (Theory)

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