



# Darrang College (Autonomous)

# Syllabus for FYUGP B.Sc. Chemistry (Minor)

**Approved by:**

Board of Studies meeting held on 18-12-2025 &  
&  
Academic Council vide Resolution no. 2, dated 29-12-2025

**Prerequisites:**

- For Major in Chemistry a student must pass in Chemistry and Mathematics at XII level.

**Syllabus for FYUGP**  
**B.Sc. Chemistry (Minor)**

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**NEP-FYUGP Course Distribution**  
**Department of Chemistry, Darrang College (Autonomous)**

<b>Year</b>	<b>Semester</b>	<b>Course Title</b>	<b>Paper Code</b>	<b>Credit</b>
<b>Year 01</b>	<b>1<sup>st</sup> Semester</b>	<b>Chemistry-I</b>	<b>CHE-MN-01014</b>	<b>4</b>
	<b>2<sup>nd</sup> Semester</b>	<b>Chemistry-II</b>	<b>CHE-MN-02014</b>	<b>4</b>
<b>Year 02</b>	<b>3<sup>rd</sup> Semester</b>	<b>Chemistry-III</b>	<b>CHE-MN-03014</b>	<b>4</b>
	<b>4<sup>th</sup> Semester</b>	<b>Chemistry-IV</b>	<b>CHE-MN-04014</b>	<b>4</b>
<b>Year 03</b>	<b>5<sup>th</sup> Semester</b>	<b>Chemistry-V</b>	<b>CHE-MN-05014</b>	<b>4</b>
	<b>6<sup>th</sup> Semester</b>	<b>Chemistry-VI</b>	<b>CHE-MN-06014</b>	<b>4</b>

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### Detailed Syllabus of 1<sup>st</sup> Semester

<b>Semester</b>	<b>I</b>
<b>Title of the Course</b>	<b>Chemistry -I</b>
<b>Paper Code</b>	<b>CHE-MN-01014</b>
<b>Total Credits</b>	<b>4 (Theory: 03, Practical: 01)</b>
<b>Distribution of Marks</b>	<b>45 (End Semester Theory) + 25 (End Semester Practical) + 30 (Internal) [Sessional Exam: 15 marks, Home Assignment: 6 marks, Class Test: 5 marks, Attendance: 4 marks]</b>
<b>Course Outcomes</b>	<p>By the end of this course/module, students will be able to:</p> <ul style="list-style-type: none"> <li>• <b>CO 1: Explain the principles of atomic structure and electronic configuration</b>, and relate them to the placement of elements in the periodic table.</li> <li>• <b>CO 2: Analyze periodic trends</b> (e.g., atomic and ionic radii, ionization energy, electronegativity) to predict and explain the chemical behaviour of elements.</li> <li>• <b>CO 3: Describe the nature and energetics of ionic bonding</b>, including factors such as lattice energy, ion size, and charge, and use this to predict compound stability.</li> <li>• <b>CO 4: Identify and classify stereoisomers in organic molecules</b>, including chirality, enantiomers, and diastereomers, and explain their relevance in chemical and biological systems.</li> <li>• <b>CO 5: Evaluate the impact of electronic effects</b> such as inductive, resonance, and hyperconjugation on the stability, reactivity, and acidity/basicity of organic compounds.</li> <li>• <b>CO 6: Apply the gas laws and intermolecular force concepts</b> to explain the physical behaviour of substances in the gaseous and liquid states under various conditions.</li> </ul>
<b>No. of Required Classes</b>	<b>45 (Theory) + 30 (Practical)</b>
<b>Details of Course Designer</b>	<ol style="list-style-type: none"> <li>1. Dr. Pankaj Hazarika, HoD, Department of Chemistry</li> <li>2. Tumpa Paul, Associate Professor, Department of Chemistry</li> <li>3. Dr. Pinky Gogoi, Assistant Professor, Department of Chemistry</li> <li>4. Dr. Manash Protim Hazarika, Assistant Professor, Department of Chemistry</li> <li>5. Dr. Kashmiri Neog, Assistant Professor, Department of Chemistry</li> </ol>
<b>Textbook</b>	<ol style="list-style-type: none"> <li>1. Puri, B. R., Sharma, L. R., &amp; Kalia, K. C. <i>Inorganic Chemistry</i>.</li> <li>2. Prakash, S., Tuli, G.D., Basu, S.K. &amp; Madan, R. D. <i>Advanced Inorganic Chemistry (Vol. 1)</i>, S. Chand.</li> <li>3. Prasad, R. K. <i>Quantum Chemistry</i>.</li> <li>4. Sen, B. K. <i>Quantum Chemistry</i>.</li> <li>5. Kalsi, P. S. (2005). <i>Stereochemistry: Conformation and Mechanism</i>. New Age International.</li> <li>6. Singh, S., Mukherjee, S. P., &amp; Kapoor, R. P. <i>Organic Chemistry (Vol. I &amp; II)</i>.</li> </ol>

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	<p>7. Clayden, J., Greeves, N., Warren, S., &amp; Wothers, P. <i>Organic Chemistry</i>. Oxford University Press.</p> <p>8. Puri, B. R., Sharma, L. R., &amp; Pathania, M. S. (48th ed.). <i>Principles of Physical Chemistry</i>. Vishal Publishing Co.</p> <p>9. Kapoor, K. L. <i>A Textbook of Physical Chemistry (Vol. 1)</i>.</p>
<b>Reference Book</b>	<p>1. Cotton, F. A., &amp; Wilkinson, G. <i>Basic Inorganic Chemistry</i>.</p> <p>2. Ghosh, S. C. <i>Advanced General Organic Chemistry (Part I &amp; II)</i>.</p> <p>3. Huheey, J. E., Keiter, E. A., Keiter, R. L., &amp; Medhi, O. K. (5th ed.). <i>Inorganic Chemistry: Principles of Structure and Reactivity</i>. Pearson Education.</p> <p>4. Lee, J. D. (5th ed.). <i>Concise Inorganic Chemistry</i>. Pearson Education.</p> <p>5. March, J. <i>Advanced Organic Chemistry: Reactions, Mechanisms, and Structure</i>, Wiley.</p> <p>6. Finar, I. L. <i>Organic Chemistry (Vol. 1)</i>. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).</p> <p>7. Atkins, P., de Paula, J., &amp; Keeler, J. (11th ed.). <i>Atkins' Physical Chemistry</i>. Oxford University Press.</p> <p>8. Negi, A. S., &amp; Anand, S. C. <i>A Textbook of Physical Chemistry</i>. Wiley Eastern.</p> <p>9. Ball, D. W. (2007). <i>Physical Chemistry</i>. Thomson Press India.</p>

### Semester-I (Theory Credit: 03)

Unit	Content	L	T	P	Total Hours
<b>Unit I: Atomic structure</b>	Historical development on structure of atom; Bohr's model, H atom spectrum; black body radiation; photoelectric effect (qualitative treatment only); The dual behaviour and uncertainty. Quantum mechanical approach to atomic structure: concept of wave function, well behaved function, operator, normalised and orthogonal wave function, Schrödinger wave equation, eigenfunction, Significance of $\Psi$ and $\Psi^2$ , Particle in a 1-D box; Schrödinger equation of hydrogen atom (no derivation), radial and angular wave functions for hydrogen atom, probability distribution, quantum numbers, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations.	<b>5</b>	<b>3</b>	-	<b>8</b>
<b>Unit II: Periodicity and chemical behaviour</b>	Periodicity of the elements, effective nuclear charge; Slater's Rule; covalent and ionic radii, ionization energies, electronegativity (various scales), variation of electronegativity with bond order and hybridization, electron affinities.	<b>2</b>	<b>1</b>	-	<b>3</b>

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<b>Unit III: Chemical bonding I (ionic interaction)</b>	General characteristics of ionic compounds; lattice and solvation energy; Born Lande equation with derivation and importance of Kapustinski equation for lattice energy, Madelung constant, Born Haber cycle for lattice energy calculation	<b>3</b>	<b>1</b>	-	<b>4</b>
<b>Unit IV: Structure of organic molecules</b>	Nature of bonding: hybridisation of atomic orbitals (qualitative VB and MO approach); effect of hybridization on bond properties.	<b>3</b>	<b>1</b>	-	<b>4</b>
<b>Unit V: Stereochemistry of organic molecules</b>	Representation of organic molecules in 2D and 3D (Fischer, Newman and Sawhorse projection formulae and their interconversions); Optical isomerism: Concepts of asymmetry, dissymmetry, optical activity, Specific rotation, Chirality, enantiomers, Diastereomers, racemic mixture, racemization and Resolution, Threo and Erythro forms, Meso structures & Epimers. Relative and absolute configuration: D/L and R/S designations. Walden inversion. Geometrical isomerism (cis-trans, syn-anti, E/Z notations); configuration and conformation, barriers to rotation, conformational analysis (ethane, butane, cyclohexane).	<b>5</b>	<b>3</b>	-	<b>8</b>
<b>Unit VI: Electronic effects in organic molecules</b>	Concept of electrophiles and nucleophiles; inductive effects; resonance, mesomeric effects, conjugation and delocalization and their application. Basic ideas about different types of reactions: (addition, substitution, elimination, rearrangement, polymerisation and condensation reactions.)	<b>2</b>	<b>1</b>	-	<b>3</b>
<b>Unit VII: Gaseous State</b>	Derivation of kinetic gas equation, Maxwell distribution of molecular speed, different types of speeds, collision properties, mean free path, determination of collision diameter, transport phenomenon in gases Causes of deviation from ideal gas behaviour, compressibility factor, Z, and its variation with pressure and temperature for different gases. State variables and equation of states for real gases; van der Waals equation of state, its derivation and application in explaining real gas behaviour. Reasons and examples of failure of van der Waal equation of state and interpretation of van der Waals pressure-volume isotherm. Critical state and phenomena, mathematical definition and interpretation of critical point, relation between critical constants and van der Waals constants: along with their thermodynamic interpretation. Introduction to virial equation and virial coefficients, derivation of Boyle temperature.	<b>5</b>	<b>3</b>	-	<b>8</b>
<b>Unit VIII:</b>	Qualitative treatment of the structure of the liquid state. Physical properties of liquids: vapour pressure, surface tension coefficient of viscosity, and their determination. Temperature variation of viscosity of liquids and comparison with that of gases. Effect of	<b>5</b>	<b>2</b>	-	<b>7</b>

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<b>Liquid State</b>	addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents (micelle formation and critical micelle concentration), Newtonian and non-Newtonian liquid, liquid crystals.				
<b>Semester-I (Practical Credit: 01)</b>					
<b>Unit</b>	<b>Content</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total Hours</b>
<b>Laboratory Course- I</b>	<p>1. Introduction to laboratory apparatus and safety measures in laboratory,</p> <p>2. Calibration of apparatus (volumetric flask, thermometer, melting point apparatus etc.)</p> <p><b>Group A</b></p> <p>a) Preparation of normal and molar solution, for example KCl, Na<sub>2</sub>C<sub>2</sub>O<sub>4</sub>, HCl, H<sub>2</sub>SO<sub>4</sub> etc. (Verification by conductometric measurement).</p> <p>b) Determination of solubility of a given salt at different temperature and plot solubility curve.</p> <p>c) Determination of water of crystallisation of hydrated salt by ignition and weighing.</p> <p><b>Group-B ((Minimum two experiments from Group-B)</b></p> <p>a) Purification of organic compounds by crystallization using water, alcohol and alcohol-water mixture.</p> <p>b) Determination of the melting points of organic compounds.</p> <p>c) Effect of impurities on the melting point – mixed melting point of two unknown organic compounds.</p> <p><b>Group-C (Minimum two experiments from Group-C)</b></p> <p>a) Evaluating the compressibility factor using standard packages such as Excel/Origin/Python/Fortran.</p> <p>b) Simulating an ideal/real gas using programming.</p> <p>c) To determine the partial molar volume of ethanol-water mixture at a given composition.</p> <p>d) Determine the surface tension of a given liquid at room temperature using stalagmometer by drop number method.</p> <p>e) Determine the surface tension of a given liquid by means of stalagmometer using drop weight method.</p> <p>f) Determine the composition of a given mixture by surface tension method.</p> <p>g) Study the variation of surface tension of detergent solutions with concentration.</p>	-	-	<b>30</b>	<b>30</b>

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### Detailed Syllabus of 2<sup>nd</sup> Semester

<b>Semester</b>	<b>II</b>
<b>Title of the Course</b>	<b>Chemistry -II</b>
<b>Paper Code</b>	<b>CHE-MN-02014</b>
<b>Total Credits</b>	<b>4 (Theory: 03, Practical: 01)</b>
<b>Distribution of Marks</b>	<b>45 (End Semester Theory) + 25 (End Semester Practical) + 30 (Internal) [Sessional Exam: 15 marks, Home Assignment: 6 marks, Class Test: 5 marks, Attendance: 4 marks]</b>
<b>Course Outcomes</b>	<p>By the end of this course/module, students will be able to:</p> <ul style="list-style-type: none"> <li>• <b>CO1:</b> Explain the nature, formation, and characteristics of covalent bonds and various intermolecular forces such as hydrogen bonding, van der Waals forces, and dipole interactions.</li> <li>• <b>CO2:</b> Analyze and predict molecular geometries, hybridization, and bond parameters in covalently bonded compounds.</li> <li>• <b>CO3:</b> Describe the basic structure and bonding theories of coordination compounds, including the application of VBT and CFT.</li> <li>• <b>CO4:</b> Identify and differentiate between types of isomerism (structural and stereoisomerism) in coordination complexes.</li> <li>• <b>CO5:</b> Understand the formation and stability of reactive intermediates such as carbocations, carbanions, free radicals, and carbenes in organic reactions.</li> <li>• <b>CO6:</b> Compare acidity and basicity of organic and inorganic compounds using concepts like resonance, inductive effect, and hybridization.</li> <li>• <b>CO7:</b> Determine and interpret pK<sub>a</sub> values to evaluate the strength of acids and bases in different chemical environments.</li> <li>• <b>CO8:</b> Apply the fundamental laws of thermodynamics to chemical systems and calculate thermodynamic quantities like enthalpy, entropy, and Gibbs free energy.</li> </ul>
<b>No. of Required Classes</b>	<b>45 (Theory) + 30 (Practical)</b>
<b>Details of Course Designer</b>	<ol style="list-style-type: none"> <li>1. Dr. Pankaj Hazarika, HoD, Department of Chemistry</li> <li>2. Tumpa Paul, Associate Professor, Department of Chemistry</li> <li>3. Dr. Pinky Gogoi, Assistant Professor, Department of Chemistry</li> <li>4. Dr. Manash Protim Hazarika, Assistant Professor, Department of Chemistry</li> <li>5. Dr. Kashmiri Neog, Assistant Professor, Department of Chemistry</li> </ol>

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<b>Textbook</b>	<ol style="list-style-type: none"> <li>Sarkar, R. P. (3rd ed., Part 1). <i>General and Inorganic Chemistry</i>. NCBA.</li> <li>Gopalan, R., &amp; Ramalingam, V. (1st ed.). <i>Concise Coordination Chemistry</i>. Vikas Publishing House.</li> <li>Clayden, J., Greeves, N., Warren, S., &amp; Wothers, P. <i>Organic Chemistry</i>. Oxford University Press.</li> <li>Kalsi, P. S. <i>Reaction Mechanism in Organic Chemistry</i>.</li> <li>Singh, S., Mukherjee, S. P., &amp; Kapoor, R. P. <i>Organic Chemistry (Vol. I &amp; II)</i>.</li> <li>Puri, B. R., Sharma, L. R., &amp; Pathania, M. S. (48th ed.). <i>Principles of Physical Chemistry</i>. Vishal Publishing Co.</li> <li>McQuarrie, D. A., &amp; Simon, J. D. (2004). <i>Molecular Thermodynamics</i>. Viva Books Pvt. Ltd., New Delhi.</li> </ol>
<b>Reference Book</b>	<ol style="list-style-type: none"> <li>Huheey, J. E., Keiter, E. A., Keiter, R. L., &amp; Medhi, O. K. (5th ed.). <i>Inorganic Chemistry: Principles of Structure and Reactivity</i>. Pearson Education.</li> <li>Puri, B. R., Sharma, L. R., &amp; Kalia, K. C. <i>Inorganic Chemistry</i>.</li> <li>Cotton, F. A., &amp; Wilkinson, G. <i>Basic Inorganic Chemistry</i>.</li> <li>Sykes, P. <i>A Guide Book to Mechanism in Organic Chemistry</i>. Longman.</li> <li>Ghosh, S. K. <i>Mechanism and Theory in Organic Chemistry</i>. New Central Book Agency.</li> <li>Atkins, P., de Paula, J., &amp; Keeler, J. (11th ed.). <i>Atkins' Physical Chemistry</i>. Oxford University Press.</li> <li>Levine, I. N. (2010). <i>Physical Chemistry</i> (6th ed.). Tata McGraw-Hill.</li> </ol>

### Semester-II (Theory Credit: 03)

Unit	Content	L	T	P	Total Hours
<b>Unit I: Chemical bonding II (covalent bond and chemical forces)</b>	Valence bond theory (Heitler-London approach), energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, resonance and resonance energy, molecular orbital theory (MOT). Molecular orbital diagrams of homonuclear (N <sub>2</sub> , O <sub>2</sub> ) and heteronuclear diatomic (CO, NO, CN <sup>-</sup> ), bonding in BeF <sub>2</sub> and HCl (idea of s-p mixing and orbital interaction). Valence shell electron pair repulsion theory (VSEPR). Covalent character in ionic compounds, polarising power and polarizability. Fajan's rules and consequences of polarisation. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference. Non-covalent bonding (van der Waals forces, ion-dipole forces, dipole-dipole interactions,	7	3	-	10

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	induced dipole interactions, instantaneous dipole-induced dipole interactions and hydrogen bonding) and their effects on melting and boiling points, solubility and hydration energy, Berry pseudo rotation.				
<b>Unit II: Coordination chemistry I (structure and isomerism)</b>	Introduction to coordination complexes (Werner theory, types of ligands) IUPAC nomenclature, isomerism in coordination complexes, stereochemistry of complexes with coordination numbers 4, 5, and 6.	<b>3</b>	<b>2</b>	<b>-</b>	<b>5</b>
<b>Unit III: Reactive intermediates in organic reactions</b>	Reactive intermediates: Carbocations, carbanions, free radicals, carbenes, nitrenes and benzyne. Types, Shape and their relative Stability. Rate constant and free energy of activation, energy profile diagrams for one-step and multi-step reactions.	<b>8</b>	<b>4</b>	<b>-</b>	<b>12</b>
<b>Unit IV: Acidity, basicity, and pK<sub>a</sub></b>	The definition of pK <sub>a</sub> ; Lewis acids and bases; organic acids and bases (factors affecting relative strength); substituents affect the pK <sub>a</sub> (carbon acids).	<b>2</b>	<b>1</b>	<b>-</b>	<b>3</b>
<b>Unit V: Thermodynamics</b>	Mathematical treatment: exact and inexact differentials, partial derivatives, Euler's reciprocity, cyclic rules, Intensive and extensive variables. Isolated, closed and open systems. Cyclic, reversible and irreversible processes. Zeroth law of thermodynamics. First law of thermodynamics, concept of heat (q) and work (w), internal energy(U) and enthalpy (H) in differential forms: their molecular interpretation. Calculation of w, q, ΔU and ΔH for expansion of ideal gas under isothermal and adiabatic conditions for reversible and irreversible processes. Derivation of Joule-Thomson coefficient and inversion temperature. Application of first law of thermodynamics: standard state, standard enthalpy changes of physical and chemical transformations: fusion, sublimation, vaporization, solution, dilution, neutralization, ionization. Bond-dissociation energy Kirchhoff's equation, relation between ΔH and ΔU of a reaction. Difference between enthalpy and standard enthalpy. Second law of thermodynamics, entropy (S) as a state function, molecular interpretation of entropy. Residual Entropy. Free energy: Gibb's function (G) and Helmholtz function (A) and their molecular interpretation. Difference between free energy and standard free energy. Gibbs-Helmholtz equation, criteria for thermodynamic	<b>10</b>	<b>5</b>	<b>-</b>	<b>15</b>

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	equilibrium and spontaneity of a process. Maxwell's Relations and their physical significance.				
<b>Semester-II (Practical Credit: 01)</b>					
Unit	Content	L	T	P	Total Hours
<b>Laboratory Course-II</b>	<p>Preparation of buffer solution and measurement of pH using pH meter (acetic acid-sodium acetate buffer)</p> <p><b>Group A:</b></p> <ol style="list-style-type: none"> <li>a) Determination of total hardness of water by titration against standardised EDTA solution.</li> <li>b) Synthesis of coordination compounds:               <ol style="list-style-type: none"> <li>i) Potassium tris(oxalato)chromate (III)</li> <li>ii) Nickel (II) dimethylglyoxime</li> </ol> </li> </ol> <p><b>Group B:</b></p> <ol style="list-style-type: none"> <li>a) Detection of presence of unsaturation and aromaticity in an organic sample.</li> <li>b) Qualitative organic analysis for N, S and halogen in a given organic compound.</li> <li>c) Identify acidic functional groups of a given organic sample (Acetic acid, Lactic acid, Tartaric acid and Phthalic acid) and determine the pKa by titrimetric methods.</li> </ol> <p><b>Group C:</b></p> <ol style="list-style-type: none"> <li>a) Determination of heat capacity of a calorimeter and enthalpy of neutralisation (e.g., hydrochloric acid with sodium hydroxide).</li> <li>b) Determine the enthalpy of solution of oxalic acid from solubility measurements.</li> <li>c) 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).</li> <li>d) Calculation of ionization enthalpy of ethanoic acid.</li> <li>e) Determination of enthalpy of hydration of copper sulphate.</li> </ol> <p><i>(Students are required to perform Exp. 1 and minimum of two from each group)</i></p>	-	-	<b>30</b>	<b>30</b>

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### Detailed Syllabus of 3<sup>rd</sup> Semester

<b>Semester</b>	<b>III</b>
<b>Title of the Course</b>	<b>Chemistry -III</b>
<b>Paper Code</b>	<b>CHE-MN-03014</b>
<b>Total Credits</b>	<b>4 (Theory: 03, Practical: 01)</b>
<b>Distribution of Marks</b>	<b>45 (End Semester Theory) + 25 (End Semester Practical) + 30 (Internal) [Sessional Exam: 15 marks, Home Assignment: 6 marks, Class Test: 5 marks, Attendance: 4 marks]</b>
<b>Course Outcomes</b>	<p>By the end of this course/module, students will be able to:</p> <ul style="list-style-type: none"> <li>• <b>CO 1: Acid–Base Principles and Strength</b> Explain modern acid–base concepts and predict acid/base strength using proton affinity, inductive/steric effects, solvation, oxyacid structure, non-aqueous solvents, levelling effect, superacids, superbases, and related acidity models.</li> <li>• <b>CO 2: HSAB and Applications</b> Apply the Hard–Soft Acid–Base (HSAB) principle to justify stability, selectivity and feasibility in molecular interactions, coordination complexes and inorganic reaction pathways.</li> <li>• <b>CO 3: Redox Chemistry and Electrochemical Calculations</b> Interpret redox half-reactions, standard potentials and the electrochemical series; use the Nernst equation to calculate electrode potentials and predict effects of pH and concentration.</li> <li>• <b>CO 4: Valence Bond Theory of Coordination Compounds</b> Use VBT to predict hybridization, magnetic behaviour, geometry and stability of complexes; explain electroneutrality, back-bonding and distinguish inner- and outer-orbital complexes, including limitations of VBT.</li> <li>• <b>CO 6: Aromaticity and Electrophilic Aromatic Substitution</b> Classify molecules as aromatic, anti-aromatic or non-aromatic using Hückel's rule; explain EAS mechanisms (<math>\pi</math>-complex, <math>\sigma</math>-complex), directivity, ortho–para ratio and ipso substitution.</li> <li>• <b>CO 7: Nucleophilic Substitution &amp; Related Transformations</b> Compare <math>S_N1</math>, <math>S_N2</math>, <math>S_Ni</math> and <math>S_NAr</math> mechanisms with stereochemical and solvent effects; evaluate reactivity trends of alkyl/aryl halides and <b>apply</b> diazonium chemistry for functional group transformations.</li> <li>• <b>CO 8: Alcohols, Phenols, Thiols, Ethers &amp; Epoxides</b> Explain preparation, reactivity and interconversions of alcohols (<math>1^\circ</math>, <math>2^\circ</math>, <math>3^\circ</math>), diols (Pinacol–Pinacolone), ethers, epoxides, phenols and thiols; <b>predict</b> product outcomes for key named reactions and oxidative cleavages.</li> <li>• <b>CO 9: Thermodynamics of Solutions</b> Derive and <b>apply</b> colligative property relations using chemical potential; calculate molar masses of normal/dissociated/associated solutes; explain partial molar quantities, Gibbs–Duhem equation, mixing thermodynamics and excess functions.</li> </ul>
<b>No. of Required Classes</b>	<b>45 (Theory) + 30 (Practical)</b>

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<b>Details of Course Designer</b>	<ol style="list-style-type: none"><li>1. Dr. Pankaj Hazarika, HoD, Department of Chemistry</li><li>2. Tumpa Paul, Associate Professor, Department of Chemistry</li><li>3. Dr. Pinky Gogoi, Assistant Professor, Department of Chemistry</li><li>4. Dr. Manash Protim Hazarika, Assistant Professor, Department of Chemistry</li><li>5. Dr. Kashmiri Neog, Assistant Professor, Department of Chemistry</li></ol>
<b>Textbook</b>	<ol style="list-style-type: none"><li>1. General and Inorganic Chemistry, R.P. Sarkar (part 1), 3rd edition, NCBA.</li><li>2. Concise Coordination Chemistry, R. Gopalan, V. Ramalingam, 1st edition, Vikash Publishing House.</li><li>3. Principles of Physical Chemistry, Puri, Sharma, Pathania, 48th edition, Vishal Publishing House.</li><li>4. Organic Chemistry, Volume 1, I. L. Finar, 5th edition.</li><li>5. Organic Chemistry, L. G. Wade Jr., Maya Shankar Singh, 6th edition.</li><li>6. Puri, B. R., Sharma, L. R., &amp; Kalia, K. C. <i>Inorganic Chemistry</i>.</li><li>7. Prakash, S., Tuli, G.D., Basu, S.K. &amp; Madan, R. D. <i>Advanced Inorganic Chemistry (Vol. 1)</i>, S. Chand.</li><li>8. Prasad, R. K. <i>Quantum Chemistry</i>.</li><li>9. Sen, B. K. <i>Quantum Chemistry</i>.</li><li>10. Kalsi, P. S. (2005). <i>Stereochemistry: Conformation and Mechanism</i>. New Age International.</li><li>11. Singh, S., Mukherjee, S. P., &amp; Kapoor, R. P. <i>Organic Chemistry (Vol. I &amp; II)</i>.</li><li>12. Clayden, J., Greeves, N., Warren, S., &amp; Wothers, P. <i>Organic Chemistry</i>. Oxford University Press.</li><li>13. Puri, B. R., Sharma, L. R., &amp; Pathania, M. S. (48th ed.). <i>Principles of Physical Chemistry</i>. Vishal Publishing Co.</li><li>14. Kapoor, K. L. <i>A Textbook of Physical Chemistry (Vol. 3)</i>.</li><li>15. Rakshit, P.C., <i>Physical Chemistry (7<sup>th</sup> Ed.)</i></li></ol>
<b>Reference Book</b>	<ol style="list-style-type: none"><li>1. Atkins Physical Chemistry, Atkins, de Paula and Keeler, 11th edition, Oxford University Press.</li><li>2. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Michael B. Smith 7th edition (Wiley).</li><li>3. Organic Chemistry, P. Y. Bruice, 8th edition, Pearson Education</li><li>4. Inorganic Chemistry (Principles of Structure and Reactivity), J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, 5th edition, Pearson Education.</li><li>5. Cotton, F. A., &amp; Wilkinson, G. <i>Basic Inorganic Chemistry</i>.</li><li>6. Ghosh, S. C. <i>Advanced General Organic Chemistry (Part I &amp; II)</i>.</li></ol>

## Syllabus for FYUGP

### B.Sc. Chemistry (Minor)

7. Huheey, J. E., Keiter, E. A., Keiter, R. L., & Medhi, O. K. (5th ed.). *Inorganic Chemistry: Principles of Structure and Reactivity*. Pearson Education.
8. Lee, J. D. (5th ed.). *Concise Inorganic Chemistry*. Pearson Education.
9. March, J. *Advanced Organic Chemistry: Reactions, Mechanisms, and Structure*, Wiley.
10. Finar, I. L. *Organic Chemistry (Vol. 1)*. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
11. Atkins, P., de Paula, J., & Keeler, J. (11th ed.). *Atkins' Physical Chemistry*. Oxford University Press.
12. Negi, A. S., & Anand, S. C. *A Textbook of Physical Chemistry*. Wiley Eastern.
13. Ball, D. W. (2007). *Physical Chemistry*. Thomson Press India.

#### Semester-III (Theory Credit: 03)

Unit	Content	L	T	P	Total Hours
<b>Unit I: Acid and Bases</b>	Acid-base concepts, measure of acid and base strength, proton affinity, inductive effect and strength of oxyacids(P, S and Cl), acidity of aqua ions, steric effect, proton sponge, solvation and acid base strength, non-aqueous solvents and acid base strength, levelling effect, superacids and superbases. Hard and soft acids and bases (HSAB), application of HSAB principle.	4	3	-	7
<b>Unit II: Oxidation and reduction -I</b>	Reduction potentials: Redox half-reactions, standard potentials and spontaneity, trends in standard potentials, the electrochemical series, Nernst equation (Influence of pH and concentration on electrode potential). Principles of redox titration and choice of redox indicator	3	1	-	4
<b>Unit III: Coordination Chemistry-II</b>	Valence bond theory (VBT), inner and outer orbital complexes, electroneutrality principle and back bonding, effects of hybridization in metal ligand bond strength and stability of complexes, choice of metal d-orbital(s) in hybridization in different coordination geometries, magnetic properties of complexes, drawback of VBT	3	1	-	4
<b>Unit IV: Aromaticity</b>	Concepts of aromatic, anti-aromatic and non-aromatic compounds (including examples of cyclic carbocations, carbanions and heterocyclic compounds); Hückel's rule.	1	1	-	2
<b>Unit V: Electrophilic aromatic substitutions</b>	General mechanism (benzene as substrate) with evidence, formation of $\pi$ -complex and $\sigma$ -complex, Ortho-para ratio. Ipso substitution.	2	1	-	3

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<b>Unit VI: Hydrocarbons and halogenated compounds</b>	Methods of preparation, properties and relative reactivity of alkyl and aryl halides; Nucleophilic substitution reactions: SN1, SN2, and SNi Mechanisms with stereochemical aspects and effect of solvent. Nucleophilic Aromatic Substitution SNAr and electrophilic substitution reaction. Nucleophilic substitution vs elimination. (SNAr), Preparation and reactions of diazonium salts;	<b>3</b>	<b>2</b>	<b>-</b>	<b>5</b>
<b>Unit VII: Alcohols, phenols, ethers and thiols</b>	Preparation, properties and relative reactivity of 1°, 2°, and 3°-alcohols, diols-Pinacol pinacolone rearrangement; ethers, epoxides (preparation and reactions with alcohols, ammonia derivatives and LiAlH <sub>4</sub> ). Thiols; phenols (preparation, properties and reactivity; Reimer-Tiemann and Kolbe's-Schmidt Reactions). Oxidation by periodic acid and lead tetraacetate.	<b>4</b>	<b>1</b>	<b>-</b>	<b>5</b>
<b>VIII: Solution</b>	Dilute solutions: lowering of vapour pressure, Ideal solutions, ideally diluted solutions, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties: [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.	<b>7</b>	<b>2</b>	<b>-</b>	<b>9</b>
<b>Unit IX: Partial molar quantities</b>	Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions (Enthalpy, free energy and entropy) in mixing of ideal gases, excess thermodynamic functions.	<b>4</b>	<b>2</b>	<b>-</b>	<b>6</b>
<b>Semester-III (Practical Credit: 01)</b>					
<b>Unit</b>	<b>Content</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total Hours</b>
<b>Laboratory Course-III</b>	<b>Group A</b> (a) Acid-base titration: estimation of carbonate, bicarbonate and hydroxide. (b) Redox titration: estimation of Fe(II) using standardised KMnO <sub>4</sub> solution. (c) Determination of water of crystallisation of Mohr Salt using standardised KMnO <sub>4</sub> solution. (d) Estimation of Fe(II) with K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> using internal indicator (diphenylamine). <b>Group B</b>	<b>-</b>	<b>-</b>	<b>30</b>	<b>30</b>

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	<p>(a) Qualitative analysis of solid organic compounds containing one functional group, preparation of suitable derivatives and determination of m.p.</p>			
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**Group C**

(a) Determine the surface tension of a given solution at room temperature using a stalagmometer.

(b) Determine the viscosity of a liquid at a given concentration at laboratory temperature, by viscometer.

(c) Determine the composition of a given liquid mixture by viscosity method.

(d) Study the variation of viscosity of sucrose solution with the concentration of the solute.

(e) Compare the strengths of HCl and H<sub>2</sub>SO<sub>4</sub> by studying kinetics of hydrolysis of methylacetate.

*(Students need to perform at least three experiments from Group A and C. Group B is compulsory.)*

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## B.Sc. Chemistry (Minor)

### Detailed Syllabus of 4<sup>th</sup> Semester

<b>Semester</b>	<b>IV</b>
<b>Title of the Course</b>	<b>Chemistry -IV</b>
<b>Paper Code</b>	<b>CHE-MN-04014</b>
<b>Total Credits</b>	<b>4 (Theory: 03, Practical: 01)</b>
<b>Distribution of Marks</b>	<b>45 (End Semester Theory) + 25 (End Semester Practical) + 30 (Internal) [Sessional Exam: 15 marks, Home Assignment: 6 marks, Class Test: 5 marks, Attendance: 4 marks]</b>
<b>Course Outcomes</b>	<p>By the end of this course/module, students will be able to:</p> <ul style="list-style-type: none"><li>• <b>CO 1: Symmetry &amp; Molecular Point Groups</b> Identify and apply symmetry elements and operations to classify molecules into appropriate point groups (<math>C_{2v}</math>, <math>C_{3v}</math>, <math>T_d</math>, <math>O_h</math>), interpret their pictorial representations, and use character tables and Mulliken symbols to predict molecular properties.</li><li>• <b>CO 2: Transition-Metal Chemistry Across the Series</b> Explain the chemistry of first-row transition elements (Ti–Cu) in various oxidation states, analyze their halides and oxides, and compare periodic trends across the first, second and third transition series.</li><li>• <b>CO 3: Crystal Field, Ligand Field &amp; MO Theories</b> Apply CFT to predict d-orbital splitting in different geometries (tetrahedral, square planar, trigonal bipyramidal, square pyramidal, octahedral), calculate CFSE, analyze effects of pairing energy, spectrochemical series and Jahn–Teller distortion; evaluate limitations of CFT and interpret bonding using ligand-field and qualitative MO theory, including <math>\pi</math>-bonding and metal–metal quadruple bonds (e.g., <math>[Re_2Cl_8]^{2-}</math>).</li><li>• <b>CO 4: Carbonyl Chemistry &amp; Reactivity Patterns</b> Explain structure, preparation and reactivity of carbonyl compounds, predict outcomes of nucleophilic additions and addition–elimination mechanisms with ammonia derivatives, rationalize oxidation–reduction reactions (Jones, PCC/PDC, Oppenauer, Baeyer–Villiger, Clemmensen, Wolff–Kishner, MPV), and analyze conjugate additions such as Michael reaction.</li><li>• <b>CO 5: Biomolecules: Amino Acids, Proteins &amp; Enzymes</b> Describe synthesis and reactions of <math>\alpha</math>-amino acids, interpret zwitterionic behaviour, <math>pK_a</math> values and isoelectric points; explain peptide bond structure and protein structural levels, analyze intramolecular interactions and mechanisms of enzyme action (acid–base catalysis) and inhibition, and determine peptide sequences using chemical logic.</li><li>• <b>CO 6: Chemical Kinetics &amp; Reaction Mechanisms</b> Derive differential and integrated rate laws for first, second and fractional-order reactions; determine reaction order and molecularity; analyze complex first-order kinetics (opposing, parallel, consecutive reactions, chain processes) using steady-state approximations; and</li></ul>

## Syllabus for FYUGP B.Sc. Chemistry (Minor)

	explain temperature dependence of rates through the Arrhenius equation, collision theory, Lindemann mechanism and transition-state theory.
<b>No. of Required Classes</b>	<b>45 (Theory) + 30 (Practical)</b>
<b>Details of Course Designer</b>	<ol style="list-style-type: none"> <li>1. Dr. Pankaj Hazarika, HoD, Department of Chemistry</li> <li>2. Tumpa Paul, Associate Professor, Department of Chemistry</li> <li>3. Dr. Pinky Gogoi, Assistant Professor, Department of Chemistry</li> <li>4. Dr. Manash Protim Hazarika, Assistant Professor, Department of Chemistry</li> <li>5. Dr. Kashmiri Neog, Assistant Professor, Department of Chemistry</li> </ol>
<b>Textbook</b>	<ol style="list-style-type: none"> <li>1. Principles of Inorganic Chemistry, 7th edition, Puri, Sharma, Kalia, Vishal Publishing Co.</li> <li>2. Inorganic Chemistry, G.L. Meissler and D. A. Tarr, 5th edition, Pearson.</li> <li>3. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren, 2<sup>nd</sup> Edition.</li> <li>4. Organic Chemistry, P. Y. Bruice, 8<sup>th</sup> Edition.</li> <li>5. Organic Chemistry, Volume 2, I. L. Finar, 5<sup>th</sup> Edition.</li> <li>6. Puri, B. R., Sharma, L. R., &amp; Pathania, M. S. (48th ed.). <i>Principles of Physical Chemistry</i>. Vishal Publishing Co.</li> <li>7. Kapoor, K. L. <i>A Textbook of Physical Chemistry (Vol. 5)</i>.</li> </ol>
<b>Reference Book</b>	<ol style="list-style-type: none"> <li>1. Inorganic Chemistry (Principles of Structure and Reactivity), J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, 5th edition, Pearson Education.</li> <li>2. Advanced Inorganic Chemistry, F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, Manfred Bochmann, Wiley.</li> <li>3. Vogel's Qualitative Inorganic Analysis, 7th Edition, G. Svehla, B Sivasankar, Pearson.</li> <li>4. Principles of Organic Synthesis, R. O. C. Norman, J. M. Coxon, 3<sup>rd</sup> Edition.</li> <li>5. V. K. Ahluwalia, S. Dhingra, Comprehensive Practical Organic Chemistry, University Press.</li> <li>6. Laidler, K. J. <i>Chemical Kinetics</i>. McGraw-Hill.</li> <li>7. Rakshit, P. C. (Enlarged 7<sup>th</sup> Ed.). <i>Physical Chemistry</i>. Sarat Book House.</li> </ol>

### Semester-IV (Theory Credit: 03)

Unit	Content	L	T	P	Total Hours
<b>Unit I: Introduction to molecular symmetry</b>	Symmetry elements and operations, molecular point groups, symmetry elements present in $C_{2v}$ , $C_{3v}$ , $T_d$ and $O_h$ point group (pictorial representation), introductory idea of character tables, Mulliken symbols.	4	1	-	5
<b>Unit II: d-block Chemistry</b>	Chemistry of first row transition elements (Ti-Cu) in various oxidation states as halides and oxides, comparison of the first, second and third transition series elements.	2	1	-	3

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<b>Unit III: Coordination chemistry III</b>	Crystal Field Theory (CFT) (qualitative treatment): d-orbital splitting in tetrahedral, square planar, trigonal bipyramidal, square pyramidal and octahedral geometries, calculation of CFSE, thermodynamic and structural aspect of orbital splitting, pairing energies (contribution of exchange and coulomb energy), factors affecting the magnitude of $10 Dq$ ( $\Delta_o$ , $\Delta_t$ ), spectrochemical series, tetragonal distortions from octahedral geometry and Jahn-Teller theorem. Limitations of CFT (nephelauxetic effect and EPR evidences), Elementary idea on ligand field theory, molecular orbital theory (MOT) with special reference to sigma bonded octahedral and tetrahedral complexes (qualitative treatment only), pi bonding in octahedral complexes. Metal-metal quadruple bond in $[\text{Re}_2\text{C}_{18}]^{2-}$ .	<b>5</b>	<b>2</b>	<b>-</b>	<b>7</b>
<b>Unit IV: Carbonyl compounds</b>	Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Haloform reaction and, oxidation-reduction reactions (Jones reagent, PCC and PDC, Oppenauer and Bayer-villiger oxidation, Clemmensen, Wolff-Kishner, Merwein-Pondorff-Verley reduction), Addition reactions of unsaturated carbonyl compounds - Michael addition.	<b>7</b>	<b>2</b>	<b>-</b>	<b>9</b>
<b>Unit V: Amino acids, peptides and proteins</b>	$\alpha$ -Amino acids (synthesis and reactions); zwitterions, pKa values, isoelectric point and electrophoresis; structure of the peptide bond; primary, secondary and tertiary structures of proteins; intramolecular interactions in protein binding site; mechanism of enzyme action (acid-base catalysis); enzyme inhibitors; determination of peptide sequence.	<b>4</b>	<b>2</b>	<b>-</b>	<b>6</b>
<b>Unit VI: Chemical Kinetics</b>	Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated rate laws for first, second and fractional order reactions, pseudounimolecular reactions, determination of the order, kinetics of complex reactions (limited to first order): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.	<b>10</b>	<b>5</b>	<b>-</b>	<b>15</b>
<b>Semester-IV (Practical Credit: 01)</b>					
<b>Unit</b>	<b>Content</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total Hours</b>
<b>Laboratory Course-IV</b>	<b>Group A</b> Qualitative analysis of mixtures containing four cations and anions. Emphasis should be given to the understanding of reactions.	<b>-</b>	<b>-</b>	<b>30</b>	<b>30</b>

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The following radicals are suggested:  $\text{CO}_3^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{S}^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{S}_2\text{O}_3^{2-}$ ,  $\text{CH}_3\text{COO}^-$ ,  $\text{F}^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{NO}_3^-$ ,  $\text{BO}_3^{3-}$ ,  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{PO}_4^{3-}$ ,  $\text{NH}_4^+$ ,  $\text{K}^+$ ,  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Bi}^{3+}$ ,  $\text{Sn}^{2+}$ ,  $\text{Sb}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Cr}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ .

**Group B**

1. Organic preparations (any two from each): benzylation of organic compounds: amines (aniline, toluidines, anisidine) and phenols (phenol,  $\beta$ -naphthol, salicylic acid) by the following methods:

- a. Using conventional method.
- b. Using green chemical approach.

2. Chromatography:

(a) Separation of a mixture of two amino acids by ascending paper chromatography

(b) Separation of a mixture of *o*- and *p*-nitrophenol or *o*- and *p*-nitroaniline by thin layer chromatography (TLC).

**Group C**

1. Study the kinetics of the following reactions:

- a. Initial rate method: Iodide-persulphate reaction.
- b. Iodine-Clock reaction
- c. Integrated rate method:

2. Acid hydrolysis of methyl acetate with hydrochloric acid.

3. Saponification of ethyl acetate.

*(Students need to perform at least one experiment from each Group)*

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### Detailed Syllabus of 5<sup>th</sup> Semester

<b>Semester</b>	V
<b>Title of the Course</b>	Chemistry -V
<b>Paper Code</b>	CHE-MN-05014
<b>Total Credits</b>	4 (Theory: 03, Practical: 01)
<b>Distribution of Marks</b>	45 (End Semester Theory) + 25 (End Semester Practical) + 30 (Internal) [Sessional Exam: 15 marks, Home Assignment: 6 marks, Class Test: 5 marks, Attendance: 4 marks]
<b>Course Outcomes</b>	<p>By the end of this course/module, students will be able to:</p> <ul style="list-style-type: none"> <li>• <b>CO 1: Periodicity, Structure &amp; Bonding in s- and p-Block Elements</b> Explain the inert pair effect, anomalous behaviour of first-row elements, and diagonal relationship (B–Si); interpret allotropy, catenation, hydride classification, and complex-formation tendencies of s- and p-block elements, including structures and bonding in boron nitrides, borohydrides (diborane), carboranes, graphitic compounds and silanes.</li> <li>• <b>CO 2: Oxides, Oxyacids, Halogens &amp; Interhalogens</b> Describe the structure, preparation and properties of oxides and oxoacids of N, P, Cl and peroxy-acids of sulphur; explain the chemistry of halogens, interhalogen compounds, polyhalide ions and pseudohalogens, relating reactivity trends to periodic principles.</li> <li>• <b>CO 3: Noble Gas Chemistry</b> Rationalize the inertness and occurrences of noble gases, describe clathrate formation, and explain preparation, properties, shapes and bonding of XeF<sub>2</sub>, XeF<sub>4</sub> and XeF<sub>6</sub> using VSEPR, valence bond and MO theory (including linear MO treatment for XeF<sub>2</sub>).</li> <li>• <b>CO 4: Organic Functional Group Transformations (Carboxylic Acids, Derivatives, Amines &amp; Nitro Compounds)</b> Explain preparation, properties and reactivity of carboxylic acids, hydroxy acids, dicarboxylic and unsaturated acids; describe formation and reactions of acid chlorides, anhydrides, esters and amides (including mechanisms of ester hydrolysis), and apply synthetic reactions such as Claisen and Reformatsky. Discuss preparation, basicity, reactions and identification of amines, diazonium salt chemistry, and methods of formation and reactions of nitro compounds.</li> <li>• <b>CO 5: Electrochemistry: EMF, Cells, Applications &amp; Measurements</b> Apply Faraday's laws quantitatively; explain redox behaviour using half-cell potentials; distinguish reversible/irreversible cells; calculate EMF using the Nernst equation and relate it to free energy, enthalpy, entropy, equilibrium constants and pH. Interpret concentration cells, activity coefficients, transference numbers, liquid junction potentials, and discuss potentiometric titrations and industrial/metallurgical applications of electrolysis.</li> </ul>
<b>No. of Required Classes</b>	45 (Theory) + 30 (Practical)

## Syllabus for FYUGP

### B.Sc. Chemistry (Minor)

<b>Details of Course Designer</b>	<ol style="list-style-type: none"> <li>1. Dr. Pankaj Hazarika, HoD, Department of Chemistry</li> <li>2. Tumpa Paul, Associate Professor, Department of Chemistry</li> <li>3. Dr. Pinky Gogoi, Assistant Professor, Department of Chemistry</li> <li>4. Dr. Manash Protim Hazarika, Assistant Professor, Department of Chemistry</li> <li>5. Dr. Kashmiri Neog, Assistant Professor, Department of Chemistry</li> </ol>
<b>Textbook</b>	<ol style="list-style-type: none"> <li>1. Inorganic Chemistry, G.L. Meissler and D. A. Tarr, 5th edition, Pearson.</li> <li>2. Inorganic Chemistry, P. Atkins, Overtone Rourke, Weller and Armstrong 5th edition, Oxford.</li> <li>3. Principles of Inorganic Chemistry, 7th edition, Puri, Sharma, Kalia, Vishal Publishing Co.</li> <li>4. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren, 2<sup>nd</sup> Edition.</li> <li>5. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, 7<sup>th</sup> Edition.</li> <li>6. Organic Chemistry, Volume 2, I. L. Finar, 5<sup>th</sup> Edition.</li> <li>7. Organic Chemistry, Volume 3, Singh, Mukherjee, Kapoor.</li> <li>8. V. K. Ahluwalia, S. Dhingra, Comprehensive Practical Organic Chemistry, University Press.</li> <li>9. Puri, B. R., Sharma, L. R., &amp; Pathania, M. S. (48th ed.). <i>Principles of Physical Chemistry</i>. Vishal Publishing Co.</li> <li>10. Atkins, P., Paula, J. &amp; Keeler, J. (11<sup>th</sup> Ed.). (2018). <i>Atkins Physical Chemistry</i>. Oxford University Press.</li> </ol>
<b>Reference Book</b>	<ol style="list-style-type: none"> <li>1. Inorganic Chemistry (Principles of Structure and Reactivity), J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, 5th edition, Pearson Education.</li> <li>2. Advanced Inorganic Chemistry, F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, Manfred Bochmann, Wiley.</li> <li>3. Vogel's Qualitative Inorganic Analysis, 7th Edition, G. Svehla, B Sivasankar, Pearson.</li> <li>4. Advanced Organic Chemistry, R. Bruckner.</li> <li>5. Organic Chemistry, G. M. Loudon, 4<sup>th</sup> Edition</li> <li>6. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, Vogel's Textbook of Practical Organic Chemistry, Pearson, 2012.</li> <li>7. Rakshit, P. C. <i>Physical Chemistry</i>.</li> <li>8. Berry, R. S., Rice, S. A. &amp; Ross, J. (2<sup>nd</sup> Ed.), <i>Physical Chemistry</i>. Oxford University Press.</li> </ol>

#### Semester-V (Theory Credit: 03)

Unit	Content	L	T	P	Total Hours
<b>Unit I: Main Group elements</b>	Inert pair effect, Relative stability of different oxidation states, diagonal relationship between B and Si and anomalous behaviour of first member of each group.	<b>8</b>	<b>2</b>	-	10

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	<p>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.</p> <p>Structure, bonding, preparation, properties and uses. boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes.</p> <p>Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of Sulphur.</p> <p>Inter-halogen compounds, polyhalide ions, pseudo-halogens, properties of halogens.</p>				
<b>Unit II: Noble Gases</b>	<p>Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF<sub>2</sub>, XeF<sub>4</sub> and XeF<sub>6</sub>. Bonding in noble gas compounds (Valence bond and MO treatment for XeF<sub>2</sub>), Shapes of noble gas compounds (VSEPR theory).</p>	<b>3</b>	<b>2</b>	-	<b>5</b>
<b>Unit III: Carboxylic acids and their derivatives</b>	<p>Preparation, properties and reactions of carboxylic acids: reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic acids.</p> <p>Preparation and reactions of acid chlorides, anhydrides, esters and amides; mechanism of acidic and alkaline hydrolysis of esters; Claisen condensation, Reformatsky reactions.</p>	<b>6</b>	<b>2</b>	-	<b>8</b>
<b>Unit IV: Nitrogen containing functional groups</b>	<p>Preparation and properties of amines: effect of substituent and solvent on basicity; Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hofmann-elimination reaction; distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid. Diazonium Salts: preparation and their synthetic applications.</p> <p>General methods for preparation and reactions of nitro compounds.</p>	<b>5</b>	<b>2</b>	-	<b>7</b>
<b>Unit V: Electrochemistry</b>	<p>Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials. 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 and SbO/Sb<sub>2</sub>O<sub>3</sub> electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of</p>	<b>12</b>	<b>3</b>	-	<b>15</b>

**Syllabus for FYUGP**  
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	potentiometric titrations (acid-base, redox, precipitation). Applications of electrolysis in metallurgy and industry.				
<b>Semester-V (Practical Credit: 01)</b>					
Unit	Content	L	T	P	Total Hours
<b>Laboratory Course-V</b>	<p><b>Group A</b></p> <ol style="list-style-type: none"> <li>1. Estimation by volumetric method of any two of the following:               <ol style="list-style-type: none"> <li>a. Fe(III)- By standard KMnO<sub>4</sub> solution</li> <li>b. Fe(III) – By standard K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> solution</li> <li>c. Cu(II) – By Iodometric method.</li> </ol> </li> <li>2. Estimation of Ni(II) by gravimetric method.</li> </ol> <p><b>Group B</b></p> <ol style="list-style-type: none"> <li>1. Organic preparations (any three):               <ol style="list-style-type: none"> <li>a. Bromination of acetanilide by conventional methods.</li> <li>b. Nitration of salicylic acid using ceric ammonium (green chemistry approach).</li> <li>c. Selective reduction of <i>m</i>-dinitrobenzene to <i>m</i>-nitroaniline</li> <li>d. Oxidation of ethanol/ isopropanol (iodoform reaction).</li> <li>e. Aldol condensation using either conventional or green method.</li> <li>f. Benzil-Benzilic acid rearrangement.</li> </ol> </li> </ol> <p><b>Group C</b></p> <ol style="list-style-type: none"> <li>1. Perform the following potentiometric titrations:               <ol style="list-style-type: none"> <li>a. Strong acid vs. strong base</li> <li>b. Weak acid vs. strong base</li> <li>c. Dibasic acid vs. strong base</li> <li>d. Potassium dichromate vs. Mohr's salt</li> </ol> </li> </ol> <p><i>(Students need to perform at least one experiment from each Group)</i></p>	-	-	<b>30</b>	<b>30</b>

# Syllabus for FYUGP

## B.Sc. Chemistry (Minor)

### Detailed Syllabus of 6<sup>th</sup> Semester

<b>Semester</b>	VI
<b>Title of the Course</b>	Chemistry -VI
<b>Paper Code</b>	CHE-MN-06014
<b>Total Credits</b>	4 (Theory: 03, Practical: 01)
<b>Distribution of Marks</b>	45 (End Semester Theory) + 25 (End Semester Practical) + 30 (Internal) [Sessional Exam: 15 marks, Home Assignment: 6 marks, Class Test: 5 marks, Attendance: 4 marks]
<b>Course Outcomes</b>	<p>By the end of this course/module, students will be able to:</p> <ul style="list-style-type: none"><li>• <b>CO 1:</b> The student will be able to classify organometallic compounds based on their metal-carbon bond type. They will also be able to apply the 18-Electron Rule to predict the stability and electron count of mononuclear, polynuclear, and substituted metal carbonyls (specifically from the 3d series),</li><li>• <b>CO 2:</b> The student will be able to analyze the chief modes of occurrence of metals based on their Standard Electrode Potentials. They will be able to interpret the Ellingham Diagram to determine the thermodynamic feasibility of reducing metal oxides using C and CO at varying temperatures, and explain the principles, procedures, and applications of advanced metal purification techniques, including electrolytic refining, the Kroll process, Mond's process, and Zone refining.</li><li>• <b>CO 3:</b> Explain the occurrence, classification and structural features of terpenes; apply isoprene rule; outline the synthesis of citral, neral and <math>\alpha</math>-terpineol; and describe heterocyclic alkaloids in terms of structure, isolation, physiological action and Hoffmann's exhaustive methylation, including the medicinal importance of major alkaloids.</li><li>• <b>CO 4:</b> Classify monosaccharides and interpret their stereochemical representations (Fischer, Haworth and conformational projections); explain epimers, anomers and mutarotation; perform aldose–ketose interconversions; and elucidate the structures of key disaccharides and polysaccharides such as maltose, lactose, sucrose, starch, cellulose and glycogen.</li><li>• <b>CO 5:</b> Describe unit cells, crystal systems, Bravais lattices, Miller indices and reciprocal lattices; apply Bragg's Law and vector concepts in crystallography; and analyse the structures, packing, defects and physical properties of ionic crystals, metals, semiconductors and insulators.</li><li>• <b>CO 6:</b> Apply thermodynamic principles to chemical equilibria by interpreting <math>\Delta G</math> and <math>\Delta G^\circ</math>, Le Chatelier's principle and gas-phase equilibrium constants; explain electrolyte behaviour including ionization, pH, common-ion effect, salt hydrolysis</li></ul>

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### B.Sc. Chemistry (Minor)

	and buffer action; and use solubility product concepts to predict precipitation and solubility of sparingly soluble salts.
<b>No. of Required Classes</b>	<b>45 (Theory) + 30 (Practical)</b>
<b>Details of Course Designer</b>	<ol style="list-style-type: none"> <li>1. Dr. Pankaj Hazarika, HoD, Department of Chemistry</li> <li>2. Tumpa Paul, Associate Professor, Department of Chemistry</li> <li>3. Dr. Pinky Gogoi, Assistant Professor, Department of Chemistry</li> <li>4. Dr. Manash Protim Hazarika, Assistant Professor, Department of Chemistry</li> <li>5. Dr. Kashmiri Neog, Assistant Professor, Department of Chemistry</li> </ol>
<b>Textbook</b>	<ol style="list-style-type: none"> <li>1. Inorganic Chemistry, G.L. Meissler and D. A. Tarr, 5th edition, Pearson.</li> <li>2. Inorganic Chemistry, P. Atkins, Overtone Rourke, Weller and Armstrong 5th edition, Oxford.</li> <li>3. Principles of Inorganic Chemistry, 7th edition, Puri, Sharma, Kalia, Vishal Publishing Co.</li> <li>4. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren, 2<sup>nd</sup> Edition.</li> <li>5. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, 7<sup>th</sup> Edition.</li> <li>6. Organic Chemistry, Volume 2, I. L. Finar, 5<sup>th</sup> Edition.</li> <li>7. Organic Chemistry, Volume 3, Singh, Mukherjee, Kapoor.</li> <li>8. V. K. Ahluwalia, S. Dhingra, Comprehensive Practical Organic Chemistry, University Press.</li> <li>9. Puri, B. R., Sharma, L. R., &amp; Pathania, M. S. (48th ed.). <i>Principles of Physical Chemistry</i>. Vishal Publishing Co.</li> <li>10. Atkins, P., Paula, J. &amp; Keeler, J. (11<sup>th</sup> Ed.). (2018). <i>Atkins Physical Chemistry</i>. Oxford University Press.</li> </ol>
<b>Reference Book</b>	<ol style="list-style-type: none"> <li>1. Inorganic Chemistry (Principles of Structure and Reactivity), J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, 5th edition, Pearson Education.</li> <li>2. Advanced Inorganic Chemistry, F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, Manfred Bochmann, Wiley.</li> <li>3. Vogel's Qualitative Inorganic Analysis, 7th Edition, G. Svehla, B Sivasankar, Pearson.</li> <li>4. Organic Chemistry, Volume 2, I. L. Finar, 5<sup>th</sup> Edition.</li> <li>5. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren, 2<sup>nd</sup> Edition.</li> <li>6. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, Vogel's Textbook of Practical Organic Chemistry, Pearson, 2012.</li> <li>7. Rakshit, P. C. <i>Physical Chemistry</i>.</li> <li>8. Berry, R. S., Rice, S. A. &amp; Ross, J. (2<sup>nd</sup> Ed.), <i>Physical Chemistry</i>. Oxford University Press.</li> </ol>

**Syllabus for FYUGP**  
**B.Sc. Chemistry (Minor)**

**Semester-VI (Theory Credit: 03)**

Unit	Content	L	T	P	Total Hours
<b>Unit I: Organometallics I</b>	Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands, 18 electron rule. Metal carbonyls: electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. Structures and preparation of mononuclear carbonyls of Cr and Fe. Pi -acceptor behaviour of CO (MO diagram of CO to be discussed), Bonding in metal carbonyls Zeise's salt: preparation structure and bonding.	7	2	-	9
<b>Unit II: Metallurgy</b>	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 agents. Electrolytic reduction, methods of purification of metals: electrolytic Kroll process, Mond's process, Zone refining.	4	2	-	6
<b>Unit III: Natural Products</b>	Occurrence of terpenes; structure and classification of terpenes, isoprene rule; synthesis of citral, neral and $\alpha$ -terpineol; Heterocyclic compounds and natural occurrence, general structural features, isolation and physiological action of alkaloids; Hoffmann's exhaustive methylation, medicinal importance of nicotine, hygrine, quinine, morphine and cocaine.	7	2	-	9
<b>Unit IV: Carbohydrate chemistry</b>	Classification of monosaccharides; absolute configuration of glucose and fructose, epimers and anomers; mutarotation; conformations of glucose (Fischer, Haworth and stereoscopic projections); interconversions of aldoses and ketoses; disaccharides: structure elucidation of maltose, lactose and sucrose. Polysaccharides -structures of starch, cellulose and glycogen.	4	2	-	6
<b>Unit V: Solid State</b>	Unit Cells, Miller indices, crystal systems and Bravais Lattices, elementary applications of vectors to crystal systems; Bragg's Law, Miller indices and reciprocal lattices. Laws of crystallography. Basics of X-ray diffraction (powder and single crystal). Structure of NaCl, CsCl, and KCl, diamond, and graphite; Close packing in metals and metal compounds, semiconductors, insulators; Defects in crystals, lattice energy; isomorphism; heat capacity of solids.	4	2	-	6

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<b>Unit VI: Chemical and Ionic Equilibria</b>	Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between $\Delta G$ and $\Delta G^\circ$ , Le Chatelier's principle. Relationships between $K_p$ , $K_c$ and $K_x$ for reactions involving ideal gases. 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. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.	<b>7</b>	<b>2</b>	<b>-</b>	<b>9</b>
<b>Semester-VI (Practical Credit: 01)</b>					
<b>Unit</b>	<b>Content</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total Hours</b>
<b>Laboratory Course-VI</b>	<ol style="list-style-type: none"> <li>1. Qualitative analysis of carbohydrates: aldoses and ketoses, reducing and non-reducing sugars.</li> <li>2. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, phenols, amines, nitro, carboxylic acids and carbonyl compounds).</li> <li>3. Indexing of Powder Diffraction Pattern of Cubic Crystal (Data Provided)</li> <li>4. Determination of Percentage Crystallinity from Powder X-Ray Diffraction (PXRD) Data (Data Provided)</li> </ol>	-	-	<b>30</b>	<b>30</b>