



**Darrang College
(Autonomous),
Tezpur-784001**

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

Prerequisites:

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

Approved by :

Board of Studies meeting held on 31th July, 2025

&

Academic Council vide Resolution no. 04, dated- 12/08/2025

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN CHEMISTRY, Darrang College (Autonomous)

Introduction:

The Chemistry syllabus at Darrang College (Autonomous) has been designed in alignment with the transformative vision of the **National Education Policy (NEP) 2020**, which emphasizes a holistic, multidisciplinary, and flexible education system rooted in Indian values and committed to nurturing globally competent individuals.

This syllabus aims to provide students with a strong foundation in the principles and applications of Chemistry, while also fostering scientific temper, critical thinking, creativity, and problem-solving abilities. It embraces the spirit of NEP 2020 by offering **multiple entry and exit options, skill-based learning, interdisciplinary integration, and continuous formative assessment.**

The curriculum is structured to support a learner-centric approach that balances core concepts, laboratory experience, environmental and ethical awareness, and the development of communication and research skills. Through this, students will not only gain knowledge in the chemical sciences but also be empowered to apply it responsibly in real-world contexts, contributing to sustainable development and societal progress.

Darrang College (Autonomous) reaffirms its commitment to academic excellence, innovation, and nation-building, preparing graduates to meet the scientific and technological challenges of the 21st century.

The Four-Year Undergraduate Programme (FYUGP) in Chemistry is designed to nurture a deep and holistic understanding of the chemical sciences, while promoting interdisciplinary learning, research aptitude, and employability. The programme aspires to prepare students for academic, industrial, and societal roles by fostering foundational knowledge, technical skills, and ethical awareness.

Aims of Four Year Under-Graduate Programme (FYUGP) in Chemistry:

The primary aims of the FYUGP in Chemistry are:

1. **To provide a strong foundation in chemical principles and their applications in diverse areas such as organic, inorganic, physical, analytical, and environmental chemistry.**

2. **To develop critical thinking, scientific reasoning, and analytical skills** that enable students to approach scientific problems methodically and creatively.
3. **To promote experiential learning through practical laboratory work, fieldwork, and research projects**, encouraging innovation, curiosity, and hands-on skills.
4. **To foster interdisciplinary learning and flexibility**, in accordance with NEP 2020, allowing students to explore connections between chemistry and fields such as biology, physics, environmental science, materials science, and computational studies.
5. **To enhance communication skills and ethical understanding**, ensuring that students can effectively disseminate scientific knowledge and apply it responsibly for societal and environmental well-being.
6. **To prepare students for diverse career paths**, including higher studies, research, teaching, industry, entrepreneurship, and public service, by integrating skill development and value-added courses.
7. **To cultivate a lifelong learning mindset and a spirit of inquiry**, aligned with the vision of building competent, compassionate, and self-reliant individuals for national and global development.

By fulfilling these aims, the FYUGP in Chemistry at Darrang College seeks to create graduates who are not only knowledgeable chemists but also responsible citizens and capable contributors to sustainable and inclusive growth.

Programme Outcome (PO) of (FYUGP) in Chemistry:

- **PO1: Fundamental Knowledge:** Demonstrate a solid understanding of the core areas of chemistry-organic, inorganic, physical, analytical, and interdisciplinary branches integrated with emerging fields like environmental chemistry, green chemistry, and materials science.
- **PO2: Scientific Thinking and Problem Solving:** Apply chemical knowledge and scientific methods to analyse, interpret, and solve real-world problems in laboratory and practical settings.
- **PO3: Laboratory and Technical Skills:** Acquire hands-on experience with classical and modern laboratory techniques, instrumentation, safety protocols, and data analysis relevant to chemical research and industry.

- **PO4: Research and Innovation:** Develop the ability to design and carry out experiments or research projects independently or collaboratively, fostering innovation, creativity, and inquiry-based learning.
- **PO5: Communication and Teamwork:** Communicate scientific ideas and research findings effectively through oral, written, and digital media, and work collaboratively in diverse teams.
- **PO6: Ethical and Environmental Responsibility:** Understand and practice ethical behaviour in scientific research and industry, while being sensitive to the environmental and societal impact of chemical substances and processes.
- **PO7: Interdisciplinary and Multidisciplinary Learning:** Integrate chemical knowledge with other disciplines such as physics, biology, mathematics, environmental science, and computational tools to address complex scientific questions.
- **PO8: Career Readiness and Lifelong Learning:** Be prepared for higher education, competitive examinations, professional roles in industry and research, or entrepreneurship, with an aptitude for continuous learning and upskilling.
- **PO9: Digital and Technological Proficiency:** Utilize information and communication technologies (ICT), computational tools, and digital resources for data handling, simulations, presentations, and scientific communication.
- **PO10: National Development and Global Citizenship:** Act as responsible citizens contributing to national development goals, sustainability, and global scientific progress, in alignment with the values promoted by NEP 2020.

Teaching Learning Process:

The programme allows using of varied pedagogical methods and techniques both within the classroom and in laboratories.

- Lecture
- Tutorial
- PowerPoint presentation
- Project Work/Dissertation
- Seminars/workshops/conferences
- Industry Visits/Field Visits

Teaching Learning Tools:

- White/Green/Black Board
- LCD projectors/Monitor
- Smart Board
- Model Demonstration
- Learning through lab experiments
- Industry and field visits

Assessment:

- Home assignment
- Project/Industry/Field Visit Report
- Seminar Presentation
- In semester/Sessional examinations (Theory and Practical)
- End Semester examinations (Theory and Practical)

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

Year	Semester	Course Title	Paper Code	Credit
Year 01	1st Semester	Chemistry-I	CHE-MJ-01014	4
	2nd Semester	Chemistry-II	CHE-MJ-02014	4
Year 02	3rd Semester	Major-3	CHE-MJ-03014	4
		Major-4	CHE-MJ-03024	
	4th Semester	Major-5	CHE-MJ-04014	4
		Major-6	CHE-MJ-04024	4
		Major-7	CHE-MJ-04034	4
		Major-8	CHE-MJ-04044	4
Year 03	5th Semester	Major-9	CHE-MJ-05014	4
		Major-10	CHE-MJ-05024	4
		Major-11	CHE-MJ-05034	4
	6th Semester	Major-12	CHE-MJ-06014	4
		Major-13	CHE-MJ-06024	4
		Major-14	CHE-MJ-06034	4
		Major-15	CHE-MJ-06044	4

FYUGP in Chemistry
Detailed Syllabus of 1st Semester

Title of the Course	Chemistry -I
Paper Code	CHE-MJ-01014
Total Credits	4 (Theory: 03, Practical: 01)
Distribution of Marks	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]
Course Outcomes	By the end of this course/module, students will be able to: • CO 1: Explain the principles of atomic structure and electronic configuration, and relate them to the placement of elements in the periodic table. • CO 2: Analyze periodic trends (e.g., atomic and ionic radii, ionization energy, electronegativity) to predict and explain the chemical behaviour of elements. • CO 3: Describe the nature and energetics of ionic bonding, including factors such as lattice energy, ion size, and charge, and use this to predict compound stability. • CO 4: Identify and classify stereoisomers in organic molecules, including chirality, enantiomers, and diastereomers, and explain their relevance in chemical and biological systems. • CO 5: Evaluate the impact of electronic effects such as inductive, resonance, and hyperconjugation on the stability, reactivity, and acidity/basicity of organic compounds. • CO 6: Apply the gas laws and intermolecular force concepts to explain the physical behaviour of substances in the gaseous and liquid states under various conditions.
No. of Required Classes	45 (Theory) + 30 (Practical)
Details of Course Designer	1. Dr. Pankaj Hazarika, HoD, Department of Chemistry 2. Tumpa Paul, Assistant Professor, Department of Chemistry 3. Dr. Manash Protim Hazarika, Assistant Professor, Department of Chemistry

Textbook	1. Puri, B. R., Sharma, L. R., & Kalia, K. C. <i>Inorganic Chemistry</i>. 2. Prakash, S., Tuli, G.D., Basu, S.K. & Madan, R. D. <i>Advanced Inorganic Chemistry (Vol. I)</i>, S. Chand. 3. Prasad, R. K. <i>Quantum Chemistry</i>. 4. Sen, B. K. <i>Quantum Chemistry</i>. 5. Kalsi, P. S. (2005). <i>Stereochemistry: Conformation and Mechanism</i>. New Age International. 6. Singh, S., Mukherjee, S. P., & Kapoor, R. P. <i>Organic Chemistry (Vol. I & II)</i>. 7. Clayden, J., Greeves, N., Warren, S., & Wothers, P. <i>Organic Chemistry</i>. Oxford University Press. 8. Puri, B. R., Sharma, L. R., & Pathania, M. S. (48th ed.). <i>Principles of Physical Chemistry</i>. Vishal Publishing Co. 9. Kapoor, K. L. <i>A Textbook of Physical Chemistry (Vol. I)</i>.
Reference Book	1. Cotton, F. A., & Wilkinson, G. <i>Basic Inorganic Chemistry</i>. 2. Ghosh, S. C. <i>Advanced General Organic Chemistry (Part I & II)</i>. 3. Huheey, J. E., Keiter, E. A., Keiter, R. L., & Medhi, O. K. (5th ed.). <i>Inorganic Chemistry: Principles of Structure and Reactivity</i>. Pearson Education. 4. Lee, J. D. (5th ed.). <i>Concise Inorganic Chemistry</i>. Pearson Education. 5. March, J. <i>Advanced Organic Chemistry: Reactions, Mechanisms, and Structure</i>, Wiley. 6. Finar, I. L. <i>Organic Chemistry (Vol. I)</i>. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 7. Atkins, P., de Paula, J., & Keeler, J. (11th ed.). <i>Atkins' Physical Chemistry</i>. Oxford University Press. 8. Negi, A. S., & Anand, S. C. <i>A Textbook of Physical Chemistry</i>. Wiley Eastern. 9. Ball, D. W. (2007). <i>Physical Chemistry</i>. Thomson Press India.

Semester-1 (Theory Credit: 03)

Unit	Content	L	T	P	Total Hours
Unit I: Atomic structure	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 Ψ and Ψ^2 , Particle in a 1-D box; Schrödinger equation of hydrogen atom (no derivation), radial and angular wave functions for hydrogen atom, probability distribution,	5	3	-	8

	quantum numbers, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations.				
Unit II: Periodicity and chemical behaviour	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.	2	1	-	3
Unit III: Chemical bonding I (ionic interaction)	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	3	1	-	4
Unit IV: Structure of organic molecules	Nature of bonding: hybridisation of atomic orbitals (qualitative VB and MO approach); effect of hybridization on bond properties.	3	1	-	4
Unit V: Stereochemistry of organic molecules	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).	5	3	-	8
Unit VI: Electronic effects in organic molecules	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.)	2	1	-	3
Unit VII: Gaseous State	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	5	3	-	8

	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.				
Unit VIII: Liquid State	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 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.	5	2	-	7
Semester-1 (Practical Credit: 01)					
Unit	Content	L	T	P	Total Hours
Laboratory Course I	1. Introduction to laboratory apparatus and safety measures in laboratory, 2. Calibration of apparatus (volumetric flask, thermometer, melting point apparatus etc.) Group A a) Preparation of normal and molar solution, for example KCl, Na₂C₂O₄, HCl, H₂SO₄ etc. (Verification by conductometric measurement). b) Determination of solubility of a given salt at different temperature and plot solubility curve. c) Determination of water of crystallisation of hydrated salt by ignition and weighing. Group-B ((Minimum two experiments from Group-B) a) Purification of organic compounds by crystallization using water, alcohol and alcohol-water mixture. b) Determination of the melting points of organic compounds. c) Effect of impurities on the melting point – mixed melting point of two unknown organic compounds. Group-C (Minimum two experiments from Group-C) a) Evaluating the compressibility factor using standard packages such as Excel/Origin/Python/Fortran. b) Simulating an ideal/real gas using programming. c) To determine the partial molar volume of ethanol-water mixture at a given composition.	-	-	30	30

	d) Determine the surface tension of a given liquid at room temperature using stalagmometer by drop number method. e) Determine the surface tension of a given liquid by means of stalagmometer using drop weight method. f) Determine the composition of a given mixture by surface tension method. g) Study the variation of surface tension of detergent solutions with concentration.				
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FYUGP in Chemistry
Detailed Syllabus of 2nd Semester

Title of the Course	Chemistry -II
Paper Code	CHE-MJ-02014
Total Credits	4 (Theory: 03, Practical: 01)
Distribution of Marks	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]
Course Outcomes	By the end of this course/module, students will be able to: • CO1: Explain the nature, formation, and characteristics of covalent bonds and various intermolecular forces such as hydrogen bonding, van der Waals forces, and dipole interactions. • CO2: Analyze and predict molecular geometries, hybridization, and bond parameters in covalently bonded compounds. • CO3: Describe the basic structure and bonding theories of coordination compounds, including the application of VBT and CFT. • CO4: Identify and differentiate between types of isomerism (structural and stereoisomerism) in coordination complexes. • CO5: Understand the formation and stability of reactive intermediates such as carbocations, carbanions, free radicals, and carbenes in organic reactions. • CO6: Compare acidity and basicity of organic and inorganic compounds using concepts like resonance, inductive effect, and hybridization. • CO7: Determine and interpret pK_a values to evaluate the strength of acids and bases in different chemical environments. • CO8: Apply the fundamental laws of thermodynamics to chemical systems and calculate thermodynamic quantities like enthalpy, entropy, and Gibbs free energy.
No. of Required Classes	45 (Theory) + 30 (Practical)
Details of Course Designer	1. Dr. Pankaj Hazarika, HoD, Department of Chemistry 2. Tumpa Paul, Assistant Professor, Department of Chemistry 3. Dr. Manash Protim Hazarika, Assistant Professor, Department of Chemistry

Textbook	1. Sarkar, R. P. (3rd ed., Part 1). <i>General and Inorganic Chemistry</i>. NCBA. 2. Gopalan, R., & Ramalingam, V. (1st ed.). <i>Concise Coordination Chemistry</i>. Vikas Publishing House. 3. Clayden, J., Greeves, N., Warren, S., & Wothers, P. <i>Organic Chemistry</i>. Oxford University Press. 4. Kalsi, P. S. <i>Reaction Mechanism in Organic Chemistry</i>. 5. Singh, S., Mukherjee, S. P., & Kapoor, R. P. <i>Organic Chemistry (Vol. I & II)</i>. 6. Puri, B. R., Sharma, L. R., & Pathania, M. S. (48th ed.). <i>Principles of Physical Chemistry</i>. Vishal Publishing Co. 7. McQuarrie, D. A., & Simon, J. D. (2004). <i>Molecular Thermodynamics</i>. Viva Books Pvt. Ltd., New Delhi.
Reference Book	1. Huheey, J. E., Keiter, E. A., Keiter, R. L., & Medhi, O. K. (5th ed.). <i>Inorganic Chemistry: Principles of Structure and Reactivity</i>. Pearson Education. 2. Puri, B. R., Sharma, L. R., & Kalia, K. C. <i>Inorganic Chemistry</i>. 3. Cotton, F. A., & Wilkinson, G. <i>Basic Inorganic Chemistry</i>. 4. Sykes, P. <i>A Guide Book to Mechanism in Organic Chemistry</i>. Longman. 5. Ghosh, S. K. <i>Mechanism and Theory in Organic Chemistry</i>. New Central Book Agency. 6. Atkins, P., de Paula, J., & Keeler, J. (11th ed.). <i>Atkins' Physical Chemistry</i>. Oxford University Press. 7. Levine, I. N. (2010). <i>Physical Chemistry</i> (6th ed.). Tata McGraw-Hill.

Semester-2 (Theory Credit: 03)

Unit	Content	L	T	P	Total Hours
Unit I: Chemical bonding II (covalent bond and chemical forces)	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 ₂ , O ₂) and heteronuclear diatomic (CO, NO, CN ⁻), bonding in BeF ₂ 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, induced dipole interactions, instantaneous	7	3	-	10

	dipole-induced dipole interactions and hydrogen bonding) and their effects on melting and boiling points, solubility and hydration energy, Berry pseudo rotation.				
Unit II: Coordination chemistry I (structure and isomerism)	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.	3	2	-	5
Unit III: Reactive intermediates in organic reactions	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.	8	4	-	12
Unit IV: Acidity, basicity, and pK_a	The definition of pK _a ; Lewis acids and bases; organic acids and bases (factors affecting relative strength); substituents affect the pK _a (carbon acids).	2	1	-	3
Unit V: Thermodynamics	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 equilibrium and spontaneity of a process. Maxwell's Relations and their physical significance.	10	5	-	15

Semester-2 (Practical Credit: 01)

Unit	Content	L	T	P	Total Hours
Laboratory Course-II	Preparation of buffer solution and measurement of pH using pH meter (acetic acid-sodium acetate buffer) Group A: - Determination of total hardness of water by titration against standardised EDTA solution. - Synthesis of coordination compounds: - Potassium tris(oxalato)chromate(III) - Nickel(II) dimethylglyoxime Group B: - Detection of presence of unsaturation and aromaticity in an organic sample. - Qualitative organic analysis for N, S and halogen in a given organic compound. - 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. Group C: - Determination of heat capacity of a calorimeter and enthalpy of neutralisation (e.g., hydrochloric acid with sodium hydroxide). - Determine the enthalpy of solution of oxalic acid from solubility measurements. - 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). - Calculation of ionization enthalpy of ethanoic acid. - Determination of enthalpy of hydration of copper sulphate. <i>(Students are required to perform Exp. 1 and minimum of two from each group)</i>	-	-	30	30