Darrang College (Autonomous)

Syllabus for FYUGP

B.Sc. Chemistry (Minor)

Prerequisites:

- **For Minor in Chemistry a student must pass in Chemistry at XII level.**

Approved by :

Board of Studies meeting held on 31th July, 2025

&

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

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

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

Detailed Syllabus of 1st Semester

Title of the Course	**Chemistry -I**
Paper Code	**CHE-MN-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. *Inorganic Chemistry*. 2. Prakash, S., Tuli, G.D., Basu, S.K. & Madan, R. D. *Advanced Inorganic Chemistry (Vol. 1)*, S. Chand. 3. Prasad, R. K. *Quantum Chemistry*. 4. Sen, B. K. *Quantum Chemistry*. 5. Kalsi, P. S. (2005). *Stereochemistry: Conformation and Mechanism*. New Age International. 6. Singh, S., Mukherjee, S. P., & Kapoor, R. P. *Organic Chemistry (Vol. I & II)*. 7. Clayden, J., Greeves, N., Warren, S., & Wothers, P. *Organic Chemistry*. Oxford University Press. 8. Puri, B. R., Sharma, L. R., & Pathania, M. S. (48th ed.). *Principles of Physical Chemistry*. Vishal Publishing Co.

	1. Kapoor, K. L. *A Textbook of Physical Chemistry (Vol. 1)*.
Reference Book	1. Cotton, F. A., & Wilkinson, G. *Basic Inorganic Chemistry*. 2. Ghosh, S. C. *Advanced General Organic Chemistry (Part I & II)*. 3. Huheey, J. E., Keiter, E. A., Keiter, R. L., & Medhi, O. K. (5th ed.). *Inorganic Chemistry: Principles of Structure and Reactivity*. Pearson Education. 4. Lee, J. D. (5th ed.). *Concise Inorganic Chemistry*. Pearson Education. 5. March, J. *Advanced Organic Chemistry: Reactions, Mechanisms, and Structure*, Wiley. 6. Finar, I. L. *Organic Chemistry (Vol. 1)*. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 7. Atkins, P., de Paula, J., & Keeler, J. (11th ed.). *Atkins' Physical Chemistry*. Oxford University Press. 8. Negi, A. S., & Anand, S. C. *A Textbook of Physical Chemistry*. Wiley Eastern. 2. Ball, D. W. (2007). *Physical Chemistry*. 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, quantum numbers, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations.	**5**	**3**	**-**	**8**
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 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.	**5**	**3**	**-**	**8**
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, $Na_2C_2O_4$, HCl, H_2SO_4 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. 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.	**-**	**-**	**30**	**30**

Detailed Syllabus of 2nd Semester

Title of the Course	**Chemistry -II**
Paper Code	**CHE-MN-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 pKa 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). *General and Inorganic Chemistry*. NCBA. 2. Gopalan, R., & Ramalingam, V. (1st ed.). *Concise Coordination Chemistry*. Vikas Publishing House. 3. Clayden, J., Greeves, N., Warren, S., & Wothers, P. *Organic Chemistry*. Oxford University Press. 4. Kalsi, P. S. *Reaction Mechanism in Organic Chemistry*. 5. Singh, S., Mukherjee, S. P., & Kapoor, R. P. *Organic Chemistry (Vol. I & II)*. 6. Puri, B. R., Sharma, L. R., & Pathania, M. S. (48th ed.). *Principles of Physical Chemistry*. Vishal Publishing Co. 7. McQuarrie, D. A., & Simon, J. D. (2004). *Molecular Thermodynamics*. Viva Books Pvt. Ltd., New Delhi.
Reference Book	1. Huheey, J. E., Keiter, E. A., Keiter, R. L., & Medhi, O. K. (5th ed.). *Inorganic Chemistry: Principles of Structure and Reactivity*. Pearson Education. 2. Puri, B. R., Sharma, L. R., & Kalia, K. C. *Inorganic Chemistry*. 3. Cotton, F. A., & Wilkinson, G. *Basic Inorganic Chemistry*. 4. Sykes, P. *A Guide Book to Mechanism in Organic Chemistry*. Longman. 5. Ghosh, S. K. *Mechanism and Theory in Organic Chemistry*. New Central Book Agency. 6. Atkins, P., de Paula, J., & Keeler, J. (11th ed.). *Atkins' Physical Chemistry*. Oxford University Press. 8. Levine, I. N. (2010). *Physical Chemistry* (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 dipole-induced dipole interactions and hydrogen bonding) and their effects on	**7**	3	-	10

	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:** a) Determination of total hardness of water by titration against standardised EDTA solution. b) Synthesis of coordination compounds: i) Potassium tris(oxalato)chromate(III) ii) Nickel(II) dimethylglyoxime **Group B:** a) Detection of presence of unsaturation and aromaticity in an organic sample. b) Qualitative organic analysis for N, S and halogen in a given organic compound. 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. **Group C:** a) Determination of heat capacity of a calorimeter and enthalpy of neutralisation (e.g., hydrochloric acid with sodium hydroxide). b) Determine the enthalpy of solution of oxalic acid from solubility measurements. 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). d) Calculation of ionization enthalpy of ethanoic acid. e) Determination of enthalpy of hydration of copper sulphate. (***Students are required to perform Exp. 1 and minimum of two from each group***)	-	-	**30**	**30**