Teaching Plan

For

Session: 2024 – 2025 Honours (Even Semester)

Head of the Department, Chemistry
Morigaon College

Anamina Dawa

Head
Department of Chemistry
Morigaon College

or TDC 2nd Semester Honours

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr.Rituraj Das	**Unit I: Chemical bonding II (covalent bond and chemical forces)**	Valence bond theory (Heitler-London approach), energetics ofhybridization, equivalent and non-equivalent hybrid orbitals. Bent'srule, resonance and resonance energy, molecular orbital theory(MOT). Molecular orbital diagrams of homonuclear (N_2, O_2) andheteronuclear diatomic (CO, NO, CN^-), bonding in BeF_2 and HCl (idea of s-p mixing and orbital interaction). Valence shell electronpair repulsion theory (VSEPR). Covalent character in ioniccompounds, polarising power and polarizability. Fajan's rules andconsequences of polarisation. Ionic character in covalentcompounds: Bond moment and dipole moment. Percentage ioniccharacter from dipole moment and electronegativity difference.Weak chemical forces (van der Waals forces, ion-dipole forces,dipole-dipole interactions, induced dipole interactions,instantaneous dipole-induced dipole interactions and hydrogenbonding) and their effects on melting and boiling points, solubilityand hydration energy.	**20/01/2025 to 25/03/2025 (10 lectures)**	
	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. Berry Pseudorotation.	**27/03/2025 to 12/04/2024 (5 lectures)**	**Class test, quiz assignment**
Dr. Swagata Baruah	**Unit III: Reactive intermediates in organic reactions**	Formation, structure and stability of reactive intermediates: carbocations, carbanions, radicals, carbenes, nitrenes, benzyne (brief mechanistic perspective using concepts of substitution, addition, elimination and rearrangements reactions).	**21/01/2025 to 31/03/2025 (12 lectures)**	

	Unit IV: Acidity, basicity, and pKa	The definition of pK_a; Lewis acids and bases; organic acids and bases (factors affecting relative strength); substituents affect the pK_a (carbon acids).	**01/04/2025 to 11/04/2025 (3 lectures)**	**Class test, quiz assignment**
Dr. Arunima Sarma	**Unit V: Thermodynamics**	Mathematical treatment: exact and inexact differentials, partialderivatives, 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) indifferential forms: their molecular interpretation. Calculation of w,q, ΔU and ΔH for expansion of ideal gas under isothermal andadiabatic conditions for reversible and irreversible processes.Derivation of Joule-Thomson coefficient and inversiontemperature. Application of first law of thermodynamics: standard state, Standard enthalpy changes of physical and chemicaltransformations: fusion, sublimation, vaporization, solution,dilution, neutralization, ionization. Bond-dissociation energyKirchhoff'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:Gibbs function (G) and Helmholtz function (A) and their molecularinterpretation. Difference between free energy and standard freeenergy. Gibbs-Helmholtz equation, criteria for thermodynamicequilibrium and spontaneity of a process. Maxwell's Relations andtheir physical significance.	**22/01/2025 to 10/04/2025 (15 lectures)**	**Class test, quiz assignment**

Dr.Rituraj Das **Dr. Swagata Baruah**	**Laboratory Course II**	1. 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) $[Ni(DMG)_2]$ **Group B:** (a) Qualitative organic analysis for N, S and halogenin a given organic compounds (b) Detection of presence of unsaturation and aromaticity in an organic sample. (c) Identify acidic functional groups of a given organic sample (Acetic acid, Lactic acid, Tartaric acid and Phthalic acid) and determine the pKa by titrametric methods. **Group C:** (a) Determination of heat capacity of a calorimeter and enthalpy of neutralisation (eg. 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).	**22/01/2025 to 20/05/2025 (30 Lectures)**	

For TDC 4th Semester Honours

Inorganic Chemistry-I (3L -0T-1P)

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Murshid Iman	**Unit I: Introduction to molecular symmetry**	Symmetry elements and operations, molecular point groups, symmetry elements present in C2v, C3v, Td and Oh point group (pictorial representation), introductory idea of character tables, Mulliken symbols.	**21/01/2025 to 14/02/2025 (6 lectures)**	
	Unit II: d-block Chemistry	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.	**16/02/2025 to 21/03/2025 (8 lectures)**	
	Unit III Coordination chemistry III	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 (Δo, Δt), 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 $[Re_2Cl_8]2-$.	**23/03/2025 to 30/04/2025 (10 lectures)**	**Class test, quiz assignment**
Dr. Rituraj Das	**Unit IV: Metallurgy**	Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agents. Electrolytic reduction, methods of purification of metals: electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.	**24/01/2025 to 12/02/2025 (5 lectures)**	
	Unit V: Oxidation and reduction -II	Redox stability: reaction with water, oxidation by atmospheric oxygen, disproportionation and comproportionation, the influence of complexation, relation between solubility and standard potential. Diagrammatic representation of potential data (Latimer diagram, Frost diagram, Pourbaix diagram).	**15/02/2025 to 12/03/2025 (6 lectures)**	**Class test, quiz assignment**

Dr. Murshid Iman	**Unit VI: Lanthanoids and Actinoids**	Lanthanoids: electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only). Coordination chemistry of lanthanides. Actinoids: electronic configuration, oxidation states, magnetic properties, comparison with lanthanides.	**02/05/2025 to 25/05/2025 (6 lectures)**	
Anjan Bora	**Unit VII: Nuclear Chemistry**	Stability of nucleus and radioactive decay processes, Fermi theory, half-lives, auger effect, Mass defect, Nuclear reactions – notations, comparison with chemical reaction: Types of nuclear reactions. Applications of radioisotopes in age determination.	**05/02/2025 to 20/02/2025 (4 lectures)**	
Dr. Murshid Iman Dr. Rituraj Das	**Laboratory: Inorganic Qualitative Analysis**	Qualitative analysis of mixtures containing four cations and anions. Emphasis should be given to the understanding of reactions. The following radicals are suggested: CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+} Mixtures should preferably contain one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) or combination of anions such as CO_3^{2-} and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, Br^- and I^-, NO_3^- and Br^-, NO_3^- and I^-. Spot tests should be done whenever possible.	**21/01/2025 to 5/05/2025 (30 lectures)**	

Organic Chemistry I (3 L- 0 T- 1 P)

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Swagata Baruah	**Unit I: Carboxylic acids and their derivatives**	Preparation, properties and reactions of carboxylic acids: reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides; comparison of nucleophilic substitution at acyl group: mechanism of acidic and alkaline hydrolysis of esters; Claisen condensation, Dieckmann and Reformatsky reactions.	**23/01/2025 to 04/02/2025 (10 lectures)**	
	Unit II: Nitrogen containing functional groups	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. General methods for preparation of nitro compounds, nitriles and isonitriles and important reactions.	**10/02/2025 to 25/02/2025 (8 lectures)**	**Class test, quiz assignment**
Anjan Bora	**Unit III: Amino acids, peptides and proteins**	α-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); enolization reactions; thioesters; enzyme inhibitors; determination of peptide sequence.	**25/01/2025 to 15/02/2025 (7 lectures)**	
Anjan Bora	**Unit IV: Heterocyclic compounds**	Classification and nomenclature (5-numbered and 6-membered rings with one heteroatom); synthesis and reactions of furan, pyrrole, thiophene, pyridine and indoles: selected name reactions (Paal-Knorr synthesis, Knorr synthesis, Hantzsch synthesis, Fischer indole synthesis, Madelung synthesis)	**20/02/2025 to 7/03/2025 (7 lectures)**	
	Unit V: Alkaloids	Natural occurrence, general structural features, isolation and their physiological action; Hoffmann's exhaustive methylation, Emde's modification, structure elucidation of nicotine; medicinal importance of nicotine, hygrine, quinine, morphine and cocaine.	**10/03/2025 to 31/-3/2025 (6 lectures)**	**Class test, quiz assignment**

Dr. Swagata Baruah	**Unit VI: Organic spectroscopy**	Introduction to UV-visible and infrared spectroscopy in structure elucidation of organic compounds; relation between absorption spectroscopy and molecules containing conjugated C=C and C=O groups; analysis of compounds containing alkenes, alkynes and carbonyl compounds using infrared spectroscopy (conceptual aspects).	**15/03/2025 to 25/04/2025 (7 lectures)**	
Dr. Swagata Baruah Anjan Bora	**Laboratory: organic Qualitative Analysis**	1. Organic preparations (any two from each): benzoylation of organic compounds: amines (aniline, toluidines, anisidine) and phenols (phenol, β-naphthol, salicylic acid) by the following methods: (i) Using conventional method. (ii) Using green chemical approach. 2. Organic preparations (any three): (i) Bromination of acetanilide by conventional methods. (ii) Nitration of salicylic acid using ceric ammonium (green chemistry approach). (iii) Selective reduction of m-dinitrobenzene to m-nitroaniline (iv) Oxidation of ethanol/ isopropanol (iodoform reaction). (v) Aldol condensation using either conventional or green method. (vi) Benzil-Benzilic acid rearrangement. 3. 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).	**25/01/2025 to 3/05/2025 30 lectures**	

heoretical Chemistry (3L-0T-1P)

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Arunima Sarma Dr. Rituraj Das	**Unit I: Quantum Theory**	Planck's Quantization of energy and Hydrogen Line spectrum. Postulates of quantum mechanics and their physical interpretation, wavefunctions and quantum mechanical operators. Born interpretation. Well behaved wavefunctions and commutation relations. Orthonormality and physical meaning of expanding a wavefunction in orthonormal basis. Hermitian Operators and Real Eigenvalues, Eigenvectors: their physical significance. Particle in a 1-D box (complete solution with orthonormalization) and relation to conjugated polyenes. Heisenberg Uncertainty Principle from expectation values of 1 D box, extension to two and three-dimensional boxes. Qualitative idea of tunneling. Rotational Motion and Energy: Schrödinger equation of a rigid rotator and brief discussion of its results (solution not required). Quantization of rotational energy levels. Vibrational Motion: Schrödinger equation of a linear harmonic oscillator and brief discussion of its results (solution not required). Quantization of vibrational energy levels. Interpretation of zero point energy. Hamiltonian for 1 electron H-atom, its wavefunctions (only explanation, no derivation) and its	**22/01/2025 to 22/04/2025 37 lectures**	**Class test, quiz assignment**

		relation to atomic orbitals. Constructing Radial and Angular Distribution Curves from H-like wave functions. Quantum mechanical idea of chemical bond formation: Heitler-London's Valence bond theory. Atomic Units. Good quantum numbers for multi-electron systems and Atomic Term Symbols. LS and j-j coupling schemes.		
	Unit II: Molecular Properties	Intermolecular forces and potentials. Polarizability of atoms and molecules, dielectric constant and polarisation, molar polarisation for polar and non-polar molecules. Clausius- Mosotti equation (with derivation) and Debye equations: their applications.	**25/04/2025 to 4/05/2025 8 lectures**	

		1. Writing and plotting basic expressions and corresponding graphs (eg. Maxwell-Boltzmann distribution law, radial and angular distribution functions for H-atom etc.) using any spreadsheet software such as MSExcel/LibreOffice etc or simple programming language (GWBasic, FORTRAN, python etc) 2. Plotting the wavefunction and the energy expressions for particle in a box for n =1,2 and 3 using any spreadsheet software such as MSExcel/LibreOffice etc or simple programming language (GWBasic, FORTRAN, python etc). 3. Numerical evaluation of the the expectation values of position and square of momentum for particle in a 1 D box using the definition of the wavefunction and expectation value using any spreadsheet software such as MSExcel/LibreOffice etc or simple programming language (GWBasic, FORTRAN, python etc). 4. Plotting simple one-dimensional intermolecular potential energies (eg. harmonic, anharmonic, Lennard-Jones potential etc) using any spreadsheet software such as MSExcel/LibreOffice etc or simple programming language (GWBasic, FORTRAN, python etc) and interpreting the potentials. 5. Numerical solution of the 1D Schrodinger equation for particle in a box using any spreadsheet software such as MSExcel/LibreOffice etc or simple programming language (GWBasic, FORTRAN, python etc). 6. Numerical solution of the 1D Schrodinger equation for particle in a box (with constant nonzero potential, V) using any spreadsheet software such as MSExcel/LibreOffice etc or simple programming language (GWBasic, FORTRAN, python etc) and understand the role of V on the energy and wavefunction. 7. Geometry optimization (energy minimization): Making input file through selection of simple calculation method (e.g., STO/GTO, Hartree Fock or Density Functional Theory), basis set, specifying charge and multiplicity using any quantum chemistry software. 8. Frequency calculation: Locating results in output file, displaying calculated properties through molecular viewing software such as Avogadro, MacMolPlt, VMD, GaussView. 9. Calculation of the energy of the H-like atoms (H, He+ etc) using the simple theoretical methods and simple basis sets Tabulate the energy (in Hartree) and number of basis functions for each calculation. 10. Comparison of energy results with the exact value and discussing the effect of the number of basis functions and the discussion of the effect of increasing nuclear charge on the energy. 11. Performing optimization of simple organic molecules (like malonaldehyde) and obtain energy, dipole moment, charge on various atoms and important geometrical parameters such as bond length, bond angle, etc. 12. Perform geometry optimizations (energy minimizations) to calculate the energy of various conformations of molecules (e. g. butane, and predict the most stable conformation. 13. Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds. 14. Evaluation of band structure of simple solid state materials and identifying the Fermi level using any quantum chemistry software (like quantum espresso) and analyzing the results. ** Other experiments may be introduced from time to time.	**22/01/2025 to 30/04/2025 30 lectures**	

agnetic Resonance Spectroscopy and Analytical Techniques (3L-0T-1P)

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Arunima Sarma	**Unit I: NMR spectroscopy**	Nuclear spin quantum number, effect of magnetic field on the nuclear spin, Zeeman effect and nuclear magneton, and Larmor precision. Radiowaves and principles of NMR spectroscopy. Chemical shift and factors affecting it. Factors affecting intensity and spectral width. NMR peak area integration relative peak positions of organic functional groups eg. alkyl halides, olefins, alkynes, aldehyde, substituted benzenes (toluene, anisole, nitrobenzenes, halobenzene, chloronitrobenzene), first order coupling (splitting of the signals: ordinary ethanol, bromoehane, dibromoehanes), Spin-spin coupling and high resolution spectra, interpretation of PMR spectra of simple organic molecules such as methanol, ethanol, acetaldehyde, acetic acid and aromatic protons.	**28/01/2025 to 25/02/2025 (12 lectures)**	
	Unit II: ESR spectroscopy	Electron spin resonance and hyperfine splitting. g value and hyperfine constant, Bohr magneton, electron Zeeman splitting, electron nuclear hyperfine splitting, illustration using simple examples like H atom, methyl radical etc.	**02/03/2025 to 30/03/2025 (5 lectures)**	**Class test, quiz assignment**
Dr. Rituraj Das	**Unit III: Mass spectrometry**	Ionization techniques (electron impact, chemical ionization), making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), separation of ions on basis of mass to charge ratio, interpretation of the mass spectrum, base peak and molecular ion peak. Fragmentation patterns of common organic molecules along with McLafferty rearrangement. Determination of empirical chemical formula from molecular ion peak and isotopic distribution.	**10/02/2025 to 25/03/2025 (8 lectures)**	
Dr. Swagata Baruah	**Unit IV: Separation techniques**	Introduction to chromatography and its techniques, TLC, column chromatography, GC and HPLC.	**12/02/2025 to 13/03/2025 5 lectures**	**Class test, quiz assignment**

Dr. Rituraj Das	**Unit V: Electroanalytical techniques**	Conductance measurements; EMF and cell reactions. Conductivity, equivalent, molar conductivity and their variation with dilution for weak and strong electrolytes. Conductometric titrations (only acid-base and acid base mixtures). Types of electrodes, standard electrode potential, cell reactions and salt bridges glass electrodes and others, concentration cells with transference and without transference, liquid junction potential and salt bridge, pH determination using hydrogen electrode and quinhydrone electrode, potentiometric titrations-qualitative treatment (acid-base, acid mixture and base and oxidation-reduction only). Zeta potential.	**27/03/2025 to 30/04/2025 (10 lectures)**	**Class test, quiz assignment**
Anjan Bora	**Unit VI: Diffraction**	Packing of solids and how solids diffract (reflection view and scattering view) Bragg's Law, Miller indices andreciprocal lattices. Laws of crystallography. Basics of X-ray diffraction (powder and single crystal).	**17/02/2025 to 26/03/2025 5 lectures**	
	Laboratory Courses	1. Determination of cell constant of a conductivity cell. 2. Determine the equivalent conductance of a strong electrolyte (e.g. NaCl) at various concentrations and verify the Onsager equation. 3. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid. 4. Perform the following conductometric titrations: (a) Strong acid vs. strong base (b) Weak acid vs. strong base (c) Mixture of strong acid and weak acid vs. strong base (d) Strong acid vs. weak base 4. Perform the following potentiometric titrations: (a) Strong acid vs. strong base (b) Weak acid vs. strong base (c) Dibasic acid vs. strong base (d) Potassium dichromate vs. Mohr's salt 5. Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step 6. Structure elucidation from simple proton NMR spectrum, MS. 7. Separation of organic compounds using TLC, column chromatography.	**01/02/2025 to 30/04/2025 30 lectures**	

TDC VI[th] Semester Honours

E-HC-6016: INORGANIC CHEMISTRY-IV (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Rituraj Das	Mechanism of Inorganic Reactions	Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans-effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes. Electron transfer reactions	22/01/25 to 13/02/25 (18 Lectures)	Class test on 15/02/24
Dr. Murshid Iman	Organometallic Compounds	Definition and classification of organometallic compounds on the basis of bond type.Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. □-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls. Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium. Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene	16/02/25 to 16/03/25 (22 Lectures)	Class test on 18/03/25
	Transition Metals in Catalysis	Study of the following industrial processes and their mechanism: 1. Alkene hydrogenation (Wilkinson's Catalyst)	19/03/25 to 02/04/25	Presentation

		2. Hydroformylation (Co catalysts) 3. Wacker Process 4. Synthetic gasoline (Fischer Tropsch reaction) 5. Synthesis gas by metal carbonyl complexes	**(10 Lectures)**	
	Theoretical Principles in Qualitative Inorganic Analysis (H_2S Scheme)	Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II	**4/04/25 to 30/04/25 (10 Lectures)**	

HE-HC-6016: INORGANIC CHEMISTRY-IV LAB; 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed
Dr. Murshid Iman Dr. Rituraj Das		Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested: CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+} Mixtures should preferably contain one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, PbSO4, CaF_2 or Al_2O_3) or combination of anions e.g. CO_3^{2-} and SO_3^{2-}, NO_2 and NO_3^-, Cland Br^-, Cland I^-, Brand I^-, NO_3^- and Br^-, NO_3^- and I^-. Spot tests should be done whenever possible. Synthesis of ammine complexes of Ni(II) and their ligand exchange reactions involving bidentate ligands like acetylacetone, dimethylglyoxime, glycine, etc. Preparation of acetylacetanato complexes of Cu^{2+}/Fe^{3+}. Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs. thermodynamic factors. Determination of εmax value from UV-visible spectra of complexes. Measurement of 10 Dq by spectrophotometric method, verification of spectrochemical series.	**22/01/25 to 30/04/25 (60 lectures)**

CHE-HC-6026: ORGANIC CHEMISTRY-V (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Swagata Baruah	Spectroscopy	Introduction to absorption and emission spectroscopy. UV Spectroscopy: Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers. IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis. NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpetation of NMR spectra of simple compounds. Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals. Applications of IR, UV and NMR for identification of simple organic and inorganic molecules.	22/01/25 to 23/02/25 (24 Lectures)	Class test on 26/02/25
	Carbohydrates	Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; KillianiFischer synthesis and Ruff degradation;Disaccharides – Structure elucidation of maltose, lactose and sucrose. Polysaccharides – Elementary treatment of starch, cellulose and glycogen.	27/02/25 to 18/03/25 (16 Lectures)	Class test on 04/04/2025
	Dyes	Classification, Colour and constitution; Mordant and Vat Dyes; Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet; Phthalein Dyes –Phenolphthalein and Fluorescein; Natural dyes synthesis of Alizarin and Indigotin; Edible Dyes with examples.	19/03/25 to 03/04/25 (8 Lectures)	

	Polymers	Introduction and classification. Number average molecular weight, Weight average molecular weight, Degree of polymerization, Polydispersity Index. Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene); Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives; Introduction to liquid crystal polymers; Biodegradable and conducting polymers with examples.	**05/04/25to 30/04/25 (8 Lectures)**	**Presentation**

CHE-HC-6026: ORGANIC CHEMISTRY-V LAB; 60 Lectures

Name of Faculty	Content	Aims tobe completed
Dr. Swagata Baruah	1. Extraction of caffeine from tea leaves. 2. Preparation of sodium polyacrylate. 3. Preparation of urea formaldehyde. 4. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars 5. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols etc. 6. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy 7. Preparation of methyl orange.	**22/01/25 to 22/04/25 (60 lectures)**

HE-HE-6036: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Arunima Sarma	Silicate Industries	Glass: Glassy state and its properties, classification (silicate and non-silicate glasses).Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass,fluorosilicate, coloured glass, photosensitive glass. **Ceramics:** Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides,fullerenes carbon nanotubes and carbon fibre. **Cements:** Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.	25/01/25 to 17/02/25 (16 Lectures)	Class test on 19/02/25
	Fertilizers	Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammoniumnitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate,superphosphate,compound and mixed fertilizers, potassium chloride, potassium sulphate.	20/02/25 to 06/03/25 (8 Lectures)	Class test on 28/04/25
	Surface Coatings	Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels,emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.	09/03/25 to 27/03/25 (10 Lectures)	
	Batteries	Primary and secondary batteries, battery components and their role, Characteristics of battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.	01/04/25 to 10/04/25 (6 Lectures)	Presentation
	Alloys	Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels	16/04/25 to 25/04/25 (10 Lectures)	
Anjan Bora	Chemical explosives	Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.	26/04/25 to 30/04/25 (4 Lectures)	

	Catalysis	General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.Phase transfer catalysts, application of zeolites as catalysts.	10/02/25 to 13/04/25 (6 Lectures)	

E-HE-6036: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE: LAB; 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed
Dr. Arunima Sarma		1. Determination of free acidity in ammonium sulphate fertilizer. 2. Estimation of Calcium in Calcium ammonium nitrate fertilizer. 3. Estimation of phosphoric acid in superphosphate fertilizer. 4. Electroless metallic coatings on ceramic and plastic material. 5. Determination of composition of dolomite (by complexometric titration). 6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples. 7. Analysis of Cement. 8. Preparation of pigment (zinc oxide).	25/01/25 to 22/04/25 (60 lectures)

HE-HE-6046: RESEARCH METHODOLOGY FOR CHEMISTRY (Credits: Theory-05, Tutorials-01) Theory: 75Lectures

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Arunima Sarma	Literature Survey	Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples. Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index,Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus. Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information	24/01/25 to 10/02/25 (20 Lectures)	Class test on 12/02/25
	Methods of Scientific Research and Writing Scientific Papers	Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation. Writing scientific papers – justification for scientific contributions, bibliography,description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.	13/02/25 to 09/03/25 (20 Lectures)	Class test on 11/03/25
	Chemical Safety and Ethical Handling of Chemicals	Safe working procedure and protective environment, protective apparel, emergencyprocedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	12/03/25 to 28/03/25 (12 Lectures)	Class test on 30/03/25

Dr. Rituraj Das	**Data Analysis**	*The Investigative Approach:* Making and Recording Measurements. SI Units and their use.Scientific method and design of experiments. *Analysis and Presentation of Data:* Descriptive statistics. Choosing and using statistical tests.Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting,fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, *r* and its abuse. Basic aspects of multiple linear regression analysis.	**01/03/25 to 31/03/25 (13 Lectures)**	**Class test on 30/04/25**
	Electronics	Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.	**01/04/24 to 29/04/24 (10 Lectures)**	