Lecture Planning: Even Semester
Department of Chemistry

Name of Faculty	Semester/ Paper	Marks	Topics (Theory)	Expected Lecture
Paper C-3 (Inorganic Chemistry)				
Dr. Pinky Saikia	II -SEMESTER (PAPER C-3)	14	**Unit III: Chemistry of Aliphatic Hydrocarbons** Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Special emphasis on preparation of alkenes by syn elimination – Pyrolysis of esters, Chugaev, Wittig and Heck Reaction. Reactions of alkenes: Electrophilic additions and their mechanisms (Markownikoff/ Anti Markownikoff addition), Regioselective (directional selectivity) and Streoselective addition reactions. Mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation), Simple effect of Streoselectivity & Streospecificity; 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.	12
Dr. Subrat Jyoti Borah		12	**Unit II: Stereochemistry** Definition and classification of streoisomerism, Representation of organic molecules in two & three dimensions, Fischer, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: Restricted rotation about C=C bonds, Physical & Chemical properties of Geometrical isomers, Cis–trans and, syn-anti isomerism, E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures & Epimers, Racemic mixture and resolution, Threo & Erythro forms, Relative and absolute configuration: D/L and R/S designations.	14

		10	**Unit IV: Cycloalkanes and Conformational analysis:** A. Cycloalkanes: Preparation and their relative stability, Baeyer strain theory, B. Conformation analysis of alkanes (Ethane and Butane): Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.	8
Dr. Bidisha Rani Bora		8 8	**Unit I: Basic Organic Chemistry** Organic Compounds: Classification and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic effects: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes, Nitrenes. Organic acids and bases; their relative strength, Hard and soft acids & bases. Energy profile diagrams of one step, two steps & three steps reactions, Activation energy, Kinetically Controlled & Thermodynamically Controlled reactions. **Unit V Aromatic Hydrocarbons** Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.	7 8
Paper C-4 (Physical Chemistry)				
Dr. Pinky Saikia	II-SEMESTER (Paper C-4)	26	**Unit I: Chemical Thermodynamics** Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its	30

			applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature. Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes. Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state	
Dr. Subrat Jyoti Borah		6 12	**Unit II: Systems of Variable Composition** Partial molar quantities, dependence of thermodynamic parameters on composition; GibbsDuhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases. **Unit III: Chemical Equilibrium** Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants Kp , Kc and Kx. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.	6 8
Dr. Bidisha Rani Bora		12	**Unit IV: Solutions and Colligative Properties** Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. 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	7

			calculating molar masses of normal,dissociated and associated solutes in solution.	
Paper: GE-2 Chemical Energetics, Equilibria and Functional Organic Chemistry				
Dr. Pinky Saikia	II SEMESTER (Paper GE-2)	10 8 4	**Unit I: Chemical Energetics** Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature– Kirchhoff's equation. **Unit IV: Aromatic Hydrocarbons** Preparation: (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene). **Unit V: Alkyl and Aryl Halides** Alkyl Halides: (Up to 5 Carbons): Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions. Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.	8 6 4
Dr. Subrat Jyoti Borah		6 12 4	**Unit II: Chemical Equilibrium** Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔGo , Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases. **Unit III: Ionic Equilibria** 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. **Unit V: Alkyl and Aryl Halides** Aryl Halides: Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl,	5 10 4

			vinyl and aryl halides.	
Dr. Bidisha Rani Bora		12	**Unit VI: Alcohols, Phenols and Ethers** (Up to 5 Carbons) Alcohols: Preparation: Preparation of 1o, 2o and 3o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Diols: (Up to 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement. Phenols: (Phenol case): Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction, Schotten – Baumann Reaction. Ethers (aliphatic and aromatic): Cleavage of ethers with HI. Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde): Preparation: from acid chlorides and from nitriles. Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's Reaction, Wittig Reaction, Benzoin Condensation. Clemensen Reduction and Wolff Kishner Reduction. Meerwein-Pondorff Verley Reduction.	12
Paper C-8 (Inorganic Chemistry)				
Dr. Pinky Saikia	IV-SEMESTER (Paper C-8)	16 5	**Unit II: Transition Elements** General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer and Bsworth diagrams). Difference between the first, second and third transition series. Chemistry of Ti, V, Cr, Mn, Fe and Co in various oxidation states (excuding their metallurgy) **Unit III: Lanthanoids and Actinoids** Electronic configuration, oxidation states, colour, spectral and magnetic properties, Lanthanide contraction, separation of lanthanides (ion-exchange method only)	15 5
Dr. Subrat Jyoti Borah	IV-SEMESTER (Paper C-8)	25	**Unit I: Coordination Chemistry** IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes. Labile and inert complexes. Werner's theory, valance bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry, Jahn-Teller	20

		10	theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory. **Unit IV: Bioinorganic Chemistry** Metal ion present in biological systems, classification of elements according to their action in biological system. Geo chemical effect on distribution of metals. Sodium/ K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, use of chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin, storage and transfer of iron.	8
Paper C-9 (Organic Chemistry)				
Dr. Pinky Saikia	IV SEMESTER (Paper C-9)	14 12	**Unit I: Nitrogen Containing Functional Groups** Preparation and important reactions of nitro and compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid. Diazonium Salts: Preparation and their synthetic applications. Diazomethane & Diazoacetic Ester with synthetic application. **Unit II: Polynuclear Aromatic Hydrocarbons** Preparation and structure elucidation & Reactions of Polynuclear hydrocarbons : naphthalene phenanthrene and anthracene , and important derivatives of naphthalene and anthracene;.	12 8
Dr. Subrat Jyoti Borah		18	**Unit III: Heterocyclic Compound-I** Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Derivatives of furan: Furfural and furoic acid. **Heterocyclic Compound-II** Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner- Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction	15
Dr. Bidisha Rani Bora		6	**Unit IV: Alkaloids** Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's	6

		6	modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. **Unit V: Terpenes** Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral and α-terpineol.	5
Paper C-10 (Physical Chemistry)				
Dr. Pinky Saikia	IV-SEMESTER (Paper C-10)	22	**Unit I: Conductance** Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.	18
Dr. Subrat Jyoti Borah Dr. Bidisha Rani Bora		22 12	**Unit II: Electrochemistry** Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. 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/Sb2O3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation). **Unit III: Electrical & Magnetic Properties of Atoms and Molecules** Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.	20 8

Paper GE-4 (Transition metals, Coordination Chemistry, States of Matter and Chemical Kinetics)				
Dr. Pinky Saikia	IV-SEMESTER (Paper GE-4)	10 8	**Unit I: Transition Series Elements (3d series)** General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only). **Unit IV: Kinetic Theory of Gases Gases:** Kinetic Theory of Gases: Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO2. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision number and mean free path of molecules. Viscosity of gases, effect of temperature/pressure on coefficient of viscosity (qualitative treatment only).	8 8
Dr. Subrat Jyoti Borah		8 10 8	**Unit II: Coordination Chemistry** Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC (2005) system of nomenclature. **Unit III: Crystal Field Theory** Crystal Field Theory (CFT): Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination. **Unit VII: Chemical Kinetics** The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order	6 8 8

			reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).	
Dr. Bidisha Rani Bora		6 6	**Unit V: Liquids** Liquids: Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only) **Unit VI: Solids** Solids: Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. Bragg's law. Structures of NaCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.	6 6
Paper C-14 (Inorganic Chemistry)				
Dr. Pinky Saikia	VI-SEMESTER (Paper C-14)	10 20	**Unit I: Theoretical Principles in Qualitative Analysis (H2S 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. **Unit II: 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. π-acceptor behavior of CO(MO diagram of CO to be discussed), synergic effect and use of IR data to eplain 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 polymerization of ethane (Ziegler-Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.	7 18

			Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.	
Dr. Subrat Jyoti Borah		16 10	**Unit III: Reaction Kinetics and Mechanism** 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. **Unit IV: Catalysis by Organometallic Compounds** Study of the following industrial processes and their mechanism 1. Alkene hydrogenation (Wilkinson's Catalyst) 2. Hydroformylation (Co salts) 3. Wacker Process 4. Synthetic Gasoline (Fisher Tropsch reaction) 5. Synthesis gas by metal carbonyl complexes	10 8
Paper C-15 (Organic Chemistry)				
Dr. Pinky Saikia Dr. Subrat Jyoti Borah	VI-SEMESTER (Paper C-15)	26	**Unit I: Organic Spectroscopy** General principles 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. Mass spectrometry: Basic principles Applications of IR, UV, NMR and Mass for identification of simple organic molecules.	15 8
Dr. Bidisha Rani Bora		10	**Unit II: Carbohydrates** Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and	10

		10 10	anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Assecnding and descending in monosaccharide; Interconversions of aldoses and ketoses; Killiani- Fischer synthesis and Ruff degradation. **Unit III: Dyes** Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing; 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 –structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples. **Unit IV: Polymers** Introduction and classification of polymers; Polymerisation reactions - Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Ziegler-Natta polymerisation of alkenes; 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; Biodegradable polymers with examples.	8 10
Paper DSE-602 (Industrial Chemicals and Environment)				
Dr. Pinky Saikia Dr. Subrat Jyoti Borah	VI-SEMESTER (Paper DSE-602)	30	**Unit III: Environment and its segments** Ecosystem, Biogeochemical cycles of carbon, nitrogen and sulphur. Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources,particle size and chemical nature. Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, major sources of air pollution. Pollution by SO_2, CO_2, CO, NOx, H_2S and other foul smeling gases, Methods of estimation of CO, NOx, SOx and control procedures. Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone Letion by oxides of nitrogen, chlorofluorocarbons and halogens, removal of sulphur from coal. Control of particulates. Water pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their	14 14

			treatment: electroplating, textile. Tannery, diary, petroleum and petrochemicals, agro, fertilizers etc. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (Reverse osmosis, electro dialysis, ion-exchange). Water quality parameters for waste watter, industrial water and domestic water.	
Dr. Bidisha Rani Bora		10 4 8 4	**Unit I: Industrial Gases and Inorganic Chemicals** Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: Oxygen, nitrogen, argon, neon,helium, hydrogen, acetylene, crbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene. Inorganic materials: Manufacture, application, analysis, and hazards in handling of the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate. **Unit II: Industrial Metallurgy** Preparation of metals (ferrous and non ferrous) and ultrapure metals for semiconductor technology. **Unit IV: Energy & Environment** Sources of energy: Coal, petrol and natural gas. Nuclear Fusion/ Fission, Solar energy, Hydrogen, Geothermal, Tidal and Hydel etc. Nuclear pollution: Disposal of nuclear waste, nuclear disaster and its management. **Unit V: Biocataysis** Introduction to biocatalysis: Importance in " Green Chemistry" and " Chemical Industry	8 3 8 2
Paper DSE-603(Dissertation)				
Dr. Pinky Saikia			Project Work	
Dr. Subrat Jyoti Borah			Project Work	

Signature of HoD

Lecture Planning: Odd Semester
Department of Chemistry

Name of Faculty	Semester/ Paper	Marks	Topics (Theory)	Expected Lecture
Paper C-1 (Inorganic Chemistry)				
Dr. Pinky Saikia	I SEMESTER (PAPER C-1)	15 24	**Unit II: Periodicity of Elements** Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral) (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (f) Electron gain enthalpy, trends of electron gain enthalpy. (g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. **Unit III: Chemical Bonding** i) Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Lande equation with derivation, lattice energy,Madelung constant, Born-Haber cycle and its application, Solvation energy. ii) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and – and π–ions containing lone pairs and bond pairs of electrons, multiple bonding (σ bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.	16 20

Dr. Subrat Jyoti Borah		13 4	**Unit I: Atomic Structure** Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its and significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f- orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations.Variation of orbital energy with atomic number **Unit-III Chemical Bonding** Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids. Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Hydrogen bonding (theories of hydrogen bonding, valence bond treatment). **Unit IV: Oxidation-Reduction** Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.	14 6 4
Paper C-2 (Physical Chemistry)				
Dr. Pinky Saikia	I SEMESTER (Paper C-2)	18	**Unit I: Gaseous state** Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η, variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities. Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behavior: van der Waals equation of state, its	20

			derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.	
Dr. Subrat Jyoti Borah		18	**<u>Unit IV: Ionic equilibria</u>** 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; dissociation constants of mono-, di-and triprotic acids (exact treatment). Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.	18
Dr. Bidisha Rani Bora		8 12	**<u>Unit II: Liquid state</u>** Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. **<u>Unit III: Solid state</u>** Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid	5 12

			crystals.	
Paper: GE-1 Atomic Structure, Bonding, General Organic Chemistry and Aliphatic Hydrocarbons				
Dr. Pinky Saikia	I SEMESTER (Paper GE-1)	15	**Unit II: Chemical Bonding and Molecular Structure Ionic Bonding:** General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+ . Comparison of VB and MO approaches.	16
Dr. Subrat Jyoti Borah		13	**Unit I: Atomic Structure** Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations. **Unit III: Fundamentals of Organic Chemistry**	13

		6 10	Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule. **Unit IV: Stereochemistry** Conformation with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso Compounds. Threo and erythro; D and L; Cis-trans nomenclature; CIP Rules: R/S (for upto 2 chiral carbon atoms) and E/Z Nomenclature (for upto two C=C systems)	8 8
Dr. Bidisha Rani Bora		12	**Unit V: Aliphatic Hydrocarbons** Alkanes: (Up to 5 Carbons): Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation. Alkenes: (Up to 5 Carbons): Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti Markownikoff's addition), Hydration, Ozonolysis. Alkynes: (Up to 5 Carbons): Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinaldihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.	10
Paper C-5 (Inorganic Chemistry)				
Dr. Pinky Saikia	III SEMESTER (Paper C-5)	7 30	**Unit II: Acids and Bases** Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle. **Unit III: Chemistry of s and p Block Elements:** Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo	8 25

			acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.	
Dr. Subrat Jyoti Borah	III SEMESTER (Paper C-5)	5 7 7	**Unit I: General Principles of 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 agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining. **Unit IV: Noble gases** Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory). **Unit V: Inorganic Polymers** Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.	5 7 5
Paper C-6 (Organic Chemistry)				
Dr. Pinky Saikia	III SEMESTER (Paper C-6)	12	**Unit I: Chemistry of Halogenated Hydrocarbon** Alkyl halides: Methods of preparation including Hunsdiecker Reaction, nucleophilic substitution reactions – SN^1, SN^2 and SN^i mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination. Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg and Li – Use in synthesis of organic compounds	14
Dr. Subrat Jyoti Borah		14	**Unit II: Alcohols, Phenols, Ethers and Epoxides** Alcohols: preparation, properties and relative reactivity of 1° , 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by OsO4 ,alkaline KMnO4, periodic acid and lead tetraacetate Pinacol-Pinacolone rearrangement; Trihydric alcohols : Glycerol /Preparation & Properties . Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism; Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$ **Unit V: Sulphur containing compounds:** Preparation and reactions of thiols, thioethers and sulphonic acids.	12

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Dr. Bidisha Rani Bora		14 10	**Unit III: Carbonyl Compounds:** Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and BenzilBenzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α- substitution reactions, Clemmensen, Wolff-Kishner, MPV $LiAlH_4$, $NaBH_4$, PDC , PCC , SeO2, $Pb(OAc)_4$ & HIO_4 .(Synthetic applications only) Addition reactions of unsaturated carbonyl compounds: Michael addition. Unsaturated Aldehydes (Acrolein, Crotonaldehyde, Cinnamaldehyde) Unsaturated Ketone (MVK). Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate. **Unit IV: Carboxylic Acids and their Derivatives:** Preparation, physical properties and reactions of monocarboxylic acids (Acidity and factors affecting it): Typical 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; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmannbromamide degradation and Curtius rearrangement.	12 10
Paper C-7 (Physical Chemistry)				
Dr. Pinky Saikia	III SEMESTER (Paper C-7)	16	**Unit II: Chemical Kinetics** Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (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. **Unit IV: Surface chemistry** Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state.	15

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Dr. Subrat Jyoti Borah		20 12	**Unit I: Phase Equilibria** Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solidliquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems, water-chloroform-acetic acid system, triangular plots. Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications. **Unit III: Catalysis** Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.	20 5
Paper GE-3 (Solutions, Phase Equilibrium, Conductance, Electrochemistry and Functional Group Organic Chemistry-II				
Dr. Pinky Saikia	III SEMESTER (Paper GE-3)	8 6	**Unit I: Solutions** Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature composition curves of ideal and non-ideal solutions. Distillation of solutions. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction. **Unit III: Conductance** Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch's law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acidbase).	8 6
Dr. Subrat Jyoti Borah		6	**Unit II: Phase Equilibrium** Phases, components and degrees of freedom of a system, criteria of phase	6

		8 6	equilibrium. Gibbs Phase Rule and its thermodynamic deviation. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead –silver, FeCl3-H2O and Na-K only) **Unit IV: Electrochemistry** Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. PH determination using hydrogen electrode and quinhydrone electrode. **Unit VI: Amines and Diazonium Salts** Amines (Aliphatic and Aromatic): (Up to 5 carbons): Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation. Diazonium salts: Preparation: from aromatic amines. Reactions: conversion to benzene, phenol, dyes	7 6
Dr. Bidisha Rani Bora		6 8 8	**Unit V: Carboxylic acids and their derivatives** Carboxylic acids (aliphatic and aromatic): Preparation: Acidic and Alkaline hydrolysis of esters. Reactions: Hell – Vohlard - Zelinsky Reaction. Carboxylic acid derivatives (aliphatic): (upto 5 carbons) Preparation: Acid chlorides, anhydrides, Esters and Amides from acids and their interconversion. Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin Condensation. **Unit VII: Carbohydrates** Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. **Unit VIII: Amino Acids, Peptides and Proteins** Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis. Reactions of Amino acids: ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.	5 6 8
Paper C-11 (Organic Chemistry)				

Dr. Pinky Saikia	V SEMESTER (Paper C-11)	10	**Unit VI: Pharmaceutical Compounds:** Structure and Importance Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Antacids : Ranitidine; Antibacterial : Providone—Iodine Solution, Synthesis and mode of action of Suphanilamides and other Sulphadrugs (sulphapyridine, sulphathiazole) Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C.	7
Dr. Subrat Jyoti Borah		10	**Unit V: Disconnection approach in Organic Synthesis** Elementary idea about disconnection, Synthon and Synthetic equivalent, Functionall group interconversion (FGI), Functional group addition (FGA)., simple examples off retrosynthesis of C-C bond formation (Corey House, Grignard, aldol condensation).. Retrosynthesis of monofunctionalised and Bi-functionalized (1,1 and 1,2) compounds.	8
Dr. Jnyandeep Saikia (Contractual)		8 10	**Unit I: Nucleic Acids** Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides. Structure of DNA (Watson & Model) and RNA, Genetic Code Biological role of DNA and RNA, Replication,Transcription and Translation (elementary idea only) **Unit II: Amino Acids, Peptides and Proteins** Amino acids, Peptides and their classification.α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis	8 10
Dr. Bidisha Rani Bora		10 8	**Unit III: Enzymes** Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition). **Unit IV: Lipids** Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.	6 4

Paper C-12 (Physical Chemistry)				
Dr. Pinky Saikia	V SEMESTER (Paper C-12)	22	**Unit I: Quantum Chemistry** Background of quantum mechanics, Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy. Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution. Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).	20
Dr. Subrat Jyoti Borah		22	**Unit II: Molecular Spectroscopy** Interaction of electromagnetic radiation with molecules and various types of spectra; BornOppenheimer approximation. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution. Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches. Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model. Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.	20

Dr. Jnyandeep Saikia (Contractual)		12	**Unit III: Photochemistry** Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.	10
Paper DSE-501(Analytical Methods in Chemistry)				
Dr. Pinky Saikia	V SEMESTER (Paper DSE-501)	4 15	**Unit III: Thermal Methods of analysis:** Theory of thermo-gravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture. **Unit V: Separation techniques** Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aueous solution, extraction of organic species from the aqueous and non-aqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: TLC and HPLC.	4 12
Dr. Subrat Jyoti Borah		4 25	**Unit I: Qualitative and quantitative aspects of analysis** Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals. **Unit II: UV-Visible and IR Spectrometry** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method. Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, effect and importance of isotope substitution. Flame	3 20

			Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.	
Dr. Bidisha Rani Bora		8	**Unit IV:Electro-analytical methods** Classification of electro-analytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points.Techniques used for the determination of pKa values.	6
Paper DSE-502 (Green Chemistry)				
Dr. Pinky Saikia	V SEMESTER (Paper DSE-502)	4 15	**Unit I: Introduction to Green Chemistry** What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations? Obstacles in the persuit of the goals of Green Chemistry. **Unit II: Principles of Green Chemistry and Designing a Chemical synthesis** Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following i) Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy,Calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. ii) Prevention/ minimization of hazardous/ toxic products reducing toxicity iii) Green solvents- supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solvents and how to compare greenness of solvents. iv) Energy reuirements for reactions-alternative sources of energy: use of microwaves and ultrasonic energy.	3 12
Dr. Subrat Jyoti Borah		15	**Unit II: Principles of Green Chemistry and Designing a Chemical synthesis** Selection of starting materials; avoidance of unnecessary derivatization-careful use of blocking/ protecting groups.Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis. vii)Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD " What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD,	12

			minimization, simplification, substitution, moderation and limitation. Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.	
Dr. Bidisha Rani Bora		15 10	**Unit III: Examples of Green Synthesis/ Reactions and some real world cases** Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis) Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents, Diels-Alder reaction and Decarboxylation. Ultrasound assisted reactions: sonochemical Simmons- Smith Reaction (Ultrasonic alternative to Iodine) Surfactants for carbon dioxide- replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning garments. Designing of Environmentally safe marine antifoulant. Rightfit pigments: synthetic azopigments to replace toxic organic and inorganic pigments. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn. Healthier Fats and Oil by Greeen Chemistry: Enzymatic Inter esterification for production of no Trans-Fats and Oils. Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting. **Unit IV: Future Trends in Green Chemistry:** Oxidation reagents and catalysts; Biominimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2 S3); Green chemistry in sustainable development.	13 6