



Teaching Plan

For

Session: 2021 - 2022

Head of the Department, Chemistry

Morigaon College

For TDC Ist Semester Honours

Paper: CHE-HC-1016: INORGANIC CHEMISTRY-I; (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed	Remark
Dr. Murshid Iman	Atomic Structure	Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its 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 <i>s</i> , <i>p</i> , <i>d</i> and <i>f</i> orbitals. Contour boundary and probability diagrams. <i>Pauli's</i> Exclusion Principle, <i>Hund's</i> rule of maximum multiplicity, <i>Aufbau's</i> principle and its limitations, Variation of orbital energy with atomic number.	1.10.2021 to 30.10.2021 (14 Lectures)	Class test on 23.10.2021
	Periodicity of Elements	<i>s</i> , <i>p</i> , <i>d</i> , <i>f</i> block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to <i>s</i> & <i>p</i> -block. (a) Effective nuclear charge, shielding or screening effect, Slater's 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.	1.11.2021 to 23.11.2021 (16 Lectures)	Class test on 20.11.2021

		(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. Sanderson's electronegativity ratio.		
	Chemical Bonding	<p>(i) <i>Ionic bond</i>: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.</p> <p>(ii) <i>Covalent bond</i>: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. 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, CO_2, (idea of sp mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.</p> <p>(iii) <i>Metallic Bond</i>: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.</p> <p>(iv) <i>Weak Chemical Forces</i>: vander Waals forces, ion-dipole forces, dipole-</p>	25.11.2021 to 27.12.2021 (26 Lectures)	Class test on 18.12.2021

		dipole interactions, induced dipole interactions, instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.		
	Oxidation-Reduction	Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.	28.12.2021 to 31.12.2021 (4 Lectures)	Class test on 4.01.2022

Paper: INORGANIC CHEMISTRY-I: LAB; 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Murshid Iman	Titrimetric Analysis	(i) Calibration and use of common laboratory apparatus (ii) Preparation of solutions of different Molarity/Normality of titrants	1.10.2021 to 31.12.2021 (60 Lectures)	
	Acid-Base Titrations	(i) Estimation of carbonate and hydroxide present together in mixture. (ii) Estimation of carbonate and bicarbonate present together in a mixture. (iii) Estimation of free alkali present in different soaps/detergents		
	Oxidation-Reduction Titrimetry	(i) Estimation of Fe(II) and oxalic acid using standardized KMnO_4 solution. (ii) Estimation of oxalic acid and sodium oxalate in a given mixture. (iii) Estimation of Fe(II) with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal (diphenylamine, anthranilic acid) and external indicator.		

Paper: CHE-HC-1026: PHYSICAL CHEMISTRY I; (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Arunima Sarma	Gaseous state	<p>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.</p> <p>Maxwell distribution and its use in evaluating molecular velocities (average, root meansquare and most probable) and average kinetic energy.</p> <p>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 behaviour. Van der Waals equation of state, its 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.</p>	1.10.2021 to 2.11.2021 (18 Lectures)	Class test on 30.10.2021
	Liquidstate	<p>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. Qualitative discussion of structure of water.</p>	3.11.2021 to 13.11.2021 (6 Lectures)	Class test on 20.11.2021
	Molecular and Crystal Symmetry	Elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices.	15.11.2021 to 22.11.2021 (6 Lectures)	
	Solidstate	Nature of the solid state, law of constancy of interfacial angles, law of Fra	23.11.2021 to	

		tional indices, Miller indices; 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. Liquid crystals (Introductory idea)	6.12.2021 (10 Lectures)	
	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; 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. Multi-stage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.	7.12.2021 to 30.12.2021 (20 Lectures)	Class test on 31.12.2021

Paper: PHYSICAL CHEMISTRY I: LAB; 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed
Dr. Arunima Sarma	Surface tension measurements	a) Determine the surface tension by (i) drop number (ii) drop weight method. b) Study the variation of surface tension of detergent solutions with concentration.	1.10.2021 to 31.12.2021 (60 Lectures)
	Viscosity measurement using Ostwald's viscometer	a) Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature. b) Study the variation of viscosity of sucrose solution with the concentration of solute.	
	Indexing of a given powder diffraction pattern of a cubic crystalline system		
	pHmetry	a)	

		<p>Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.</p> <p>b) Preparation of buffer solutions of different pH</p> <p>(i) Sodium acetate-acetic acid</p> <p>(ii) Ammonium chloride-ammonium hydroxide</p> <p>c) pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.</p> <p>d) Determination of dissociation constant of a weak acid.</p>	
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For TDC IIIrd Semester Honours

Paper: CHE-HC-3016: INORGANIC CHEMISTRY-II; (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Murshid Iman	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.	1.10.2021 to 8.10.2021 (6 Lectures)	
	Acids and Bases	Brønsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, leveling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle.	9.10.2021 to 28.10.2021 (8 Lectures)	
	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. Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrogen compounds, boranes, carboranes and graphitic compounds, silanes, oxides and oxoacids of nitrogen, phosphorus and chlorine. Peroxoacids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogen and basic properties of halogens.	29.10.2021 to 10.12.2021 (30 Lectures)	Class test on 30.10.2022
	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).	11.12.2021 to 20.12.2021 (8 Lectures)	
	Inorganic Polymers	Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Silicates-clays and zeolites, polyphosphazenes, metal-organic framework compounds (MOFs).	21.12.2021 to 30.12.2021 (8 Lectures)	Class test on 31.12.2021

Paper: INORGANIC CHEMISTRY-II: LAB; 60 Lectures

Name of Faculty	Unit	Content	Aims to complete
Dr. Murshid Iman	Iodo/Iodimetric Titrations	(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically). (ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetite iodimetrically (iii) Estimation of available chlorine in bleaching powder iodometrically.	1.10.2021 to 31.12.2021 (60 Lectures)
	Inorganic preparations	(i) Cuprous Chloride, CuCl (ii) Preparation of manganese(III) phosphate, $MnPO_4 \cdot H_2O$ (iii) Preparation of aluminium potassium sulphate $KAl(SO_4)_2 \cdot 12H_2O$ (Potash alum) or Chrome alum.	

Paper: CHE-HC-3026: ORGANIC CHEMISTRY-II; (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Swagata Baruah	Chemistry of Halogenated Hydrocarbons	Alkyl halides: Methods of preparation, 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; SN_{Ar} , 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.	1.10.2021 to 30.10.2021 (16 Lectures)	Class test on 22.10.2021
	Alcohols, Phenols, Ethers and Epoxides	Alcohols: preparation, properties and relative reactivity of 1° , 2° , 3° alcohols, Bouveault-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement; Phenols: Preparation and properties; Acidity and factors effecting it,	1.11.2021 to 25.11.2021 (16 Lectures)	Class test on 27.11.2021

		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		
	Carbonyl Compounds	Preparation, properties, structure and reactivity; 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 Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α - substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH_4 , NaBH_4 , MPV, PDC and PGC); Addition reactions of unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.	26.11.2021 to 13.12.2021 (14 Lectures)	Class test on 18.12.2021
	Carboxylic Acids and their Derivatives	Preparation, physical properties and reactions of monocarboxylic acids: 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 substitution at acyl group - Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann bromamide degradation and Curtius rearrangement.	14.12.2021 to 24.12.2021 (10 Lectures)	
	Sulphur containing compounds	Preparation and reactions of thiols, thioethers and sulphonic acids.	27.12.2021 to 30.12.2021 (4 Lectures)	Class test on 31.12.2021

Paper: ORGANIC CHEMISTRY-II: LAB; 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed
Dr. Swagata Baruah	Test of functional groups	Test of functional groups like alcohols, phenols, carbonyl and carboxylic acid group	1.10.2021 to 31.12.2021

	Organic preparations	<p>i) Acetylation of one of the following compounds: amines (aniline, <i>o</i>-, <i>m</i>-, <i>p</i>-toluidines <i>o</i>-, <i>m</i>-, <i>p</i>-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method: (a) Using conventional method. & (b) Using green approach</p> <p>ii) Benzoylation of one of the following amines (aniline, <i>o</i>-, <i>m</i>-, <i>p</i>-toluidines and <i>o</i>-, <i>m</i>-, <i>p</i>-anisidine) and one of the following phenols (β-naphthol, resorcinol, <i>p</i>-cresol) by Schotten-Baumann reaction.</p> <p>iii) Oxidation of ethanol/isopropanol (Iodoform reaction).</p> <p>iv) Bromination of any one of the following: (a) Acetanilide by conventional methods & (b) Acetanilide using green approach (Bromate-bromide method)</p> <p>v) Nitration of any one of the following: (a) Acetanilide/nitrobenzene by conventional method & (b) Salicylic acid by green approach (using ceric ammonium nitrate).</p> <p>vi) Selective reduction of <i>meta</i>-dinitrobenzene to <i>m</i>-nitroaniline.</p> <p>vii) Reduction of <i>p</i>-nitrobenzaldehyde by sodium borohydride.</p> <p>viii) Hydrolysis of amides and esters.</p> <p>ix) Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.</p> <p>x) <i>S</i>-Benzylisothiuronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenylacetic acid and phthalic acid).</p> <p>xi) Aldol condensation using either conventional or green method.</p> <p>xii) Benzil-Benzilic acid rearrangement.</p> <p>The above preparations should be done using 0.5-1 g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.</p>	(60 Lectures)
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Paper: CHE-HC-3036: PHYSICAL CHEMISTRY-III; (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed
Dr. Arunima Sarma	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 solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications.	1.10.2021 to 18.11.2021 (28 Lectures)

		Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. 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.	
	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 (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. Reaction mechanism- steady-state approximation and rate determining step approximation methods.	20.11.2021 to 13.12.2021 (18 Lectures)
	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.	14.12.2021 to 22.12.2021 (8 Lectures)
	Surface chemistry	Physical adsorption, chemisorption, adsorption isotherms, nature of adsorbed state.	23.12.2021 to 30.12.2021 (6 Lectures)

Paper: PHYSICAL CHEMISTRY-III: LAB; 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed
Dr. Arunima Sarma	Critical solution temperature and composition	Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.	1.10.2021 to 31.12.2021 (60 Lectures)
	Phase equilibria	Construction of the phase diagram using cooling curves or ignition tube method: (a) simple eutectic and (b) congruently melting systems.	
		Distribution of acetic/benzoic acid between water and cyclohexane.	
	Equilibrium	Study the equilibrium of at least one of the following reactions	

		by the distribution method: (i) $I_2(aq) + I^- \rightarrow I_3^-(aq)$ (ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$		
	Kinetics	Study the kinetics of the following reactions. (a) Initial rate method: Iodide-persulphate reaction (b) Integrated rate method: (i) Acid hydrolysis of methyl acetate with hydrochloric acid. (ii) Saponification of ethyl acetate. (c) Compare the strengths of HCl and H ₂ SO ₄ by studying kinetics of hydrolysis of methyl acetate.		
	Adsorption	Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.		

CHE-SE-3034: BASIC ANALYTICAL CHEMISTRY (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Arunima Sarma	Introduction	Introduction to Analytical Chemistry and its interdisciplinary nature. Concepts of sampling, Importance of accuracy, precision and source of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.	1.10.2021 to 29.10.2021 (10 lecturers)	
	Analysis of soil	Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators a. Determination of pH of soil samples. b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.	30.10.2021 to 20.11.2021 (9 lecturers)	Class test on 17.11.2021
	Analysis of water	(Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. a. Determination of pH, acidity and alkalinity of a water sample. b. Determination of dissolved oxygen (DO) of a water sample.	22.11.2021 to 8.12.2021 (8 lecturers)	
	Analysis of food products	Nutritional value of foods, idea about food processing and food preservations and adulteration. a. Identification of adulterants in some common food items like coffee	10.12.2021 to 22.12.2021 (8 lecturers)	

		<p>peppercorn powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.</p> <p>Analysis of preservatives and colouring matter.</p>		
	Chromatography	<p>Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.</p> <p>a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).</p> <p>b. To compare paint samples by TLC method.</p>	24.12.2021 to 3.1.2022 (5 lecturers)	Class test on 29.12.2021
	Ion exchange	<p>Column, ion-exchange chromatography etc.</p> <p>Determination of ion exchange capacity of anion/cation exchange resin (using batch procedure if use of column is not feasible).</p>	5.01.2022 to 10.01.2022 (4 lecturers)	
	Analysis of cosmetics	<p>Major and minor constituents and their function</p> <p>a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.</p> <p>b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.</p>	21.1.2022 to 7.02.2022 (8 lecturers)	
	Suggested Applications (Anyone)	<p>a. To study the uses of phenolphthalein in rape cases.</p> <p>b. To analyze earson accelerants.</p> <p>c. To carry out analysis of gasoline.</p>	9.02.2022 to 11.02.2022 (2 lecturers)	Class test on 9.02.2022
	Suggested Instrumental demonstrations	<p>a. Estimation of macronutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.</p> <p>b. Spectrophotometric determination of Iron in Vitamin/Dietary Tablets.</p> <p>Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.</p>	12.02.2022 to 21.02.2022 (6 lecturers)	

For TDC Vth Semester Honours

Paper: CHE-HC-5016: ORGANIC CHEMISTRY-IV; (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed	Remarks
	Nucleic Acids	Components of nucleic acids; Nucleosides and nucleotides; Synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Polynucleotides: DNA and RNA	1.10.2021 to 22.10.2021 (9 Lectures)	
Dr. Swagata Baruah	Amino Acids, Peptides and Proteins	Amino acids, Peptides and their classification. α -Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pK_a values, isoelectric point and electrophoresis; 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	23.10.2021 to 15.11.2021 (16 Lectures)	Class test on 13.11.2021
	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).	16.11.2021 to 26.11.2021 (8 Lectures)	
	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, rancidity.	27.11.2021 to 4.12.2021 (6 Lectures)	
	Concept of Energy in Biosystems	Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism, anabolism). ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: NAD ⁺ , FAD. Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis, fermentation, Krebs cycle. Overview of catabolic pathways of fat and protein. Interrelationship in the metabolic pathways of protein, fat and carbohydrate. Calorific value of food, standard calorie content of food types.	6.12.2021 to 15.12.2021 (9 Lectures)	Class test on 18.12.2021

	Pharmaceutical Compounds: Structure and Importance	Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (turmeric), azadirachtin (neem), vitamin C and antacid (ranitidine).	16.12.2022 to 30.12.2022 (12 Lectures)	
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Paper: ORGANIC CHEMISTRY-IV: LAB; 60 Lectures

Name of Faculty	Unit	Content	Aims to complete
Dr. Swagata Baruah		Estimation of glycine by Sorenson's formalin method. Study of the titration curve of glycine. Estimation of proteins by Lowry's method. Study of the action of salivary amylase on starch at optimum conditions. Effect of temperature on the action of salivary amylase. Saponification value of an oil or a fat. Determination of Iodine number of an oil/ fat. Isolation and characterization of DNA from onion/ cauliflower/peas.	1.10.2021 to 31.12.2021 (60 Lectures)

Paper: CHE-HC-5026: PHYSICAL CHEMISTRY-V; (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Arunima Sarma	Quantum Chemistry	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 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.	1.10.2021 to 13.11.2021 (24 Lectures)	Class test on 12.11.2021

	<p>Spherical harmonics. Discussion of solution.</p> <p>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.</p> <p>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).</p> <p>Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches,</p> <p>LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.</p>		
Molecular Spectroscopy	<p>Interaction of electromagnetic radiation with molecules and various types of spectra; Born- Oppenheimer approximation.</p> <p>Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.</p> <p>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.</p> <p>Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.</p> <p>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.</p>	15.11.2021 to 15.12.2021 (24 Lectures)	Class test on 11.12.2021
Photochemistry	Characteristics of electromagnetic radiation, Lambert-Beer's law and its	16.12.2021 to	Class test on

		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.	30.12.2021 (12 Lectures)	31.12.2021
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Paper: PHYSICAL CHEMISTRY-V: LAB; 60 Lectures

Name of Faculty	Unit	Content	Aims to complete
Dr. Arunima Sarma	UV/Visible spectroscopy	I. Study the 200-500 nm absorbance spectra of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1} , kJ mol^{-1} , cm^{-1} , eV). II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $\text{K}_2\text{Cr}_2\text{O}_7$. III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.	1.10.2021 to 31.12.2021 (60 Lectures)
	Colourimetry	I. Verify Lambert-Beer's law and determine the concentration of $\text{CuSO}_4/\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ in a solution of unknown concentration II. Determine the concentrations of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ in a mixture. III. Study the kinetics of iodination of propanone in acidic medium. IV. Determine the amount of iron present in a sample using 1,10-phenanthroline. V. Determine the dissociation constant of an indicator (phenolphthalein). VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide. VII. Analysis of the given vibration-rotation spectrum of HCl(g)	

Paper: CHE-HE-5026: ANALYTICAL METHODS IN CHEMISTRY; (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed	Remarks
Dr. Arunima Sarma	Qualitative and quantitative	Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate	1.10.2021 to 22.10.2021	

	aspects of analysis	errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.	(5 Lectures)	
Dr. Murshid Iman	Optical methods of analysis	<p>Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.</p> <p>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 metal complex composition using Job's method of continuous variation and mole ratio method.</p> <p>Infrared Spectroscopy: Basic principles of instrumentation (choice of source, monochromator & detector) for continuous wave and Fourier transform spectrometers; sampling techniques.</p> <p>Structure elucidation through interpretation of data. Effect and importance of isotope substitution.</p> <p>Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, and 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.</p>	7.10.2021 to 10.01.2022 (25 Lectures)	Class test on 27.12.2021
Dr. Murshid Iman	Thermal methods of analysis	Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.	11.01.2022 to 31.01.2022 (5 Lectures)	
Dr. Arunima Sarma	Electroanalytical methods	Classification of electroanalytical 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.	25.10.2021 to 17.11.2021 (10 Lectures)	
Dr. Swagata Baruah	Separation techniques	<p>Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation.</p> <p>Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.</p> <p>Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.</p>	5.10.2021 to 11.12.2021 (15 Lectures)	Class test on 8.01.2021

		<p>Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.</p> <p>Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC).</p> <p>Role of computers in instrumental methods of analysis.</p>		
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Paper: ANALYTICAL METHODS IN CHEMISTRY: LAB; 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed
Dr. Swagata Baruah	Separation Techniques	<p>I. Chromatography:</p> <p>(a) Separation of mixtures</p> <p>(i) Paper chromatographic separation of Fe³⁺, Al³⁺, and Cr³⁺.</p> <p>(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the <i>R_f</i> values.</p> <p>(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their <i>R_f</i> values.</p> <p>Chromatographic separation of the active ingredients of plants, flowers and juices by TLC</p>	<p>1.10.2021 to 10.01.2022 (60 Lectures)</p>
Dr. Murshid Iman	Solvent Extractions	<p>(i) To separate a mixture of Ni²⁺ & Fe²⁺ by complexation with DMG and extracting the Ni²⁺- DMG complex in chloroform, and determine its concentration by spectrophotometry.</p> <p>(ii) Solvent extraction of zirconium with amberliti LA-1, separation from a mixture of irons and gallium.</p>	
Dr. Swagata Baruah		Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.	
		Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.	
Dr. Arunima Sarma	Analysis of soil	<p>(i) Determination of pH of soil.</p> <p>(ii) Total soluble salt</p> <p>(iii) Estimation of calcium, magnesium, phosphate, nitrate</p>	
	Ion exchange	(i) Determination of exchange capacity of cation exchange resins and anion exchange	

Dr. Murshid Iman		resins. (ii) Separation of metal ions from their binary mixture. (iii) Separation of amino acids from organic acids by ion exchange chromatography.	
Dr. Arunima Sarma	Spectrophotometry	(i) Determination of <i>pKa</i> values of indicator using spectrophotometry. (ii) Structural characterization of compounds by infrared spectroscopy. (iii) Determination of dissolved oxygen in water. (iv) Determination of chemical oxygen demand (COD). (v) Determination of Biological oxygen demand (BOD). (vi) Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.	

Paper: CHE-HE-5066: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS; (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

Name of Faculty	Unit	Content	Aims to be completed
Dr. Arunima Sarma	Introduction to spectroscopic methods of analysis	Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.	5.10.2021 to 21.10.2021 (4 Lectures)
Dr. Arunima Sarma	Molecular spectroscopy	<i>Infrared spectroscopy:</i> Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection. <i>UV-Visible/ Near IR</i> - emission, absorption, fluorescence and photoacoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoacoustic, fluorescent tags).	23.10.2021 to 7.12.2021 (16 Lectures)
	Separation	<i>Chromatography:</i> Gas chromatography, liquid chromatography, supercritical fluids,	4.10.2021 to

Dr. Swagata Baruah	techniques	Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis. Immunoassays and DNA techniques <i>Mass spectroscopy:</i> Making the gaseous molecule into an ion (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, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).	8.12.2021 (16 Lectures)
Dr. Swagata Baruah Dr. Arunima Sarma	Elemental analysis	Mass spectrometry (electrical discharges). Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).	9.12.2021 to 24.12.2021 (8 Lectures)
Dr. Swagata Baruah	NMR spectroscopy	Principle, Instrumentation, Factors affecting chemical shift, Spin coupling, Applications.	13.12.2021 to 21.12.2021 (4 Lectures)
Dr. Arunima Sarma	Electroanalytical Methods	Potentiometry & Voltammetry	28.12.2021 to 6.01.2022 (4 Lectures)
Dr. Arunima Sarma	Radiochemical Methods		8.01.2022 to 22.01.2022 (4 Lectures)
Dr. Murshid Iman	X-ray analysis and electron spectroscopy (surface analysis)		1.10.2021 to 29.10.2021 (4 Lectures)

Paper: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS: LAB; 60 Lectures

Name of Faculty	Unit	Content	Aims to be
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			completed
1. Dr. Arunima Sarma, 2. Dr. Murshid Iman, 3. Dr. Swagata Baruah		1. Safety Practices in the Chemistry Laboratory	1.10.2021 to 10.01.2022 (60 Lectures)
		2. Determination of the isoelectric pH of a protein.	
		3. Titration curve of an amino acid.	
		4. Determination of the void volume of a gel filtration column.	
		5. Determination of a Mixture of Cobalt and Nickel (UV/Vis-spec.)	
		6. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)	
		7. IR Absorption Spectra (Study of Aldehydes and Ketones)	
		8. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption	
		9. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)	
		10. Separation of Carbohydrates by HPLC	
		11. Determination of Caffeine in Beverages by HPLC	
		12. Potentiometric Titration of a Chloride-Iodide Mixture	
		13. Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple	
		14. Nuclear Magnetic Resonance	
		15. Use of fluorescence to do "presumptive tests" to identify blood or other body fluids.	
		16. Use of "presumptive tests" for anthrax or cocaine	
		17. Collection, preservation, and control of blood evidence being used for DNA testing	
		18. Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome)	
		19. Use of sequencing for the analysis of mitochondrial DNA	
		20. Laboratory analysis to confirm anthrax or cocaine	
		21. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives	
		22. Detection of illegal drugs or steroids in athletes	
		23. Detection of pollutants or illegal dumping	
		24. Fibre analysis	
		<i>At least 10 experiments to be performed.</i>	