Semester-III: Chemistry III (3L- 0T-1P)

Graduate Attributes

i. ***Course Objective:***

This course extends the concepts of acids/bases and coordination chemistry as well as gives introductions to the redox reactions, ideal solutions and colligative properties. Further, the course is intended to apprise students about different classes of organic compounds, such as halogenated hydrocarbons, alcohols, phenols, thiols, epoxides and carbonyls.

Through the accompanying laboratory experiments on volumetric analysis, identification and preparation of derivatives and determination of physical properties of liquids, this course intends to make students learn about the qualitative and quantitative aspects of the analysis.

ii. ***Learning outcome:***

On successful completion of the course students will have significant knowledge of acids/bases as well as an overview of bonding in coordination compounds, principles of redox chemistry, solutions and their properties. Students will also be able to describe and classify organic compounds in terms of their functional groups and reactivity. Further experiments on acid/base and redox titrations will enable the students to consolidate their skills on quantitative analysis. In addition, qualitative analysis of organic compounds having common functional groups will give the students an idea about functional groups and their reactivities. Physical chemistry experiments will introduce the students to physical property measurements and kinetics of chemical reactions.

No. of Required Classes: 45 (Theory) + 30 (Practical)

No. of Contact Classes: 45 (Theory) + 30 (Practical)

No. of Non-Contact Classes:

iii. ***Particulars of Course Designer*** (Name, Institution, email id):

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2) Dr. Tridib Kumar Goswami, Gauhati University, tridib@gauhati.ac.in

Semester III: Chemistry-III (3 L-0 T-1 P)

Unit	Content	Contact Hrs
Unit I: Acid and Bases	Acid-base concepts, measure of acid and base strength, proton affinity, acidity and basicity of binary hydrogen compounds, inductive effect and strength of oxyacids, acidity of aqua ions, steric effect, proton sponge, solvation and acid base strength, non-aqueous solvents and acid base strength, levelling effect, superacids and superbases. Hard and soft acids and bases (HSAB), application of HSAB principle and symbiosis.	7
Unit II: Oxidation and reduction -I	Reduction potentials: Redox half-reactions, standard potentials and spontaneity, trends in standard potentials, the electrochemical series, Nernst equation (Influence of pH and concentration on electrode potential). Principles of redox titration and choice of redox indicators.	4
Unit III: Coordination chemistry-II	Valence bond theory (VBT), inner and outer orbital complexes, electroneutrality principle and back bonding, effects of hybridization in metal ligand bond strength and stability of complexes, choice of metal d-orbital(s) in hybridization in different coordination geometries, magnetic properties of complexes, drawback of VBT.	4
Unit IV: Aromaticity	Concepts of aromatic, anti-aromatic and non-aromatic compounds (including examples of cyclic carbocations, carbanions and heterocyclic compounds); Hückel's rule.	3
Unit V: Hydrocarbons and halogenated compounds	Methods of preparation, properties and relative reactivity of alkyl and aryl halides; Selectivity in electrophilic and nucleophilic substitution reactions (S_NAr), Preparation and reactions of diazonium salts; Benzyne mechanism.	4
Unit VI: Alcohols, phenols, thiols and related compounds	Preparation, properties and relative reactivity of 1°, 2°, and 3°-alcohols, ethers, epoxides (preparation and reactions with alcohols, ammonia derivatives and $LiAlH_4$). Thiols and sulfides; phenols (preparation, properties and reactivity; Reimer-Tiemann and Kolbe's-Schmidt Reactions)	4
Unit VII: Carbonyl compounds	Structure, reactivity and preparation; oxidations and reductions (Jones reagent, PCC and PDC, Oppenauer, Clemmensen, Wolff-Kishner, $NaBH_4$, $LiAlH_4$, MPV), Baeyer Villiger oxidation.	4

Unit VIII: Solution	Vapour pressure of solution. Ideal solutions, ideally diluted solutions and colligative properties. Raoult's law & Henry's Law. Thermodynamic derivation of colligative properties of solution (using chemical potentials) and their inter-relationships. Abnormal colligative properties.	7
Unit IX: Partial molar quantities	Fugacity, activity coefficients and concept of chemical potential: Gibbs Duhem equation and Duhem-Margules equation: their use and application, Enthalpy, free energy and entropy of mixing, excess thermodynamic functions.	8
Laboratory Course III	**Group A** (a) Acid-base titration: estimation of carbonate, bicarbonate and hydroxide. (b) Redox titration: estimation of Fe(II) using standardised $KMnO_4$ solution. (c) Determination of water of crystallisation of Mohr Salt using standardised $KMnO_4$ solution. (d) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal indicator (diphenylamine). **Group B** (a) Identification of functional groups in a given organic sample: Simple functional groups such as alcohols, phenols, amines, nitro, carbonyl and carboxylic acid groups. (b) Prepare derivatives of a given organic sample containing single functional group (i.e. alcohols, phenols, amines, nitro, carbonyl and carboxylic acid group). **Group C** (a) Determine the surface tension of a given solution at room temperature using a stalagmometer. (b) Determine the viscosity of a liquid at a given concentration at laboratory temperature, by viscometer. (c) Determine the composition of a given liquid mixture by viscosity method. (d) Study the variation of viscosity of sucrose solution with the concentration of the solute. (e) Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methylacetate. (*Students need to perform at least three experiments from Group A and C. Group B is compulsory.*)	30

Text/ Reference Books:	1. General and Inorganic Chemistry, R.P. Sarkar (part 1), 3rd edition, NCBA. 2. Concise Coordination Chemistry, R. Gopalan, V. Ramalingam, 1st edition, Vikash Publishing House. 3. Inorganic Chemistry (Principles of Structure and Reactivity), J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, 5th edition, Pearson Education. 4. Principles of Physical Chemistry, Puri, Sharma, Pathania, 48th edition, Vishal Publishing House. 5. Atkins Physical Chemistry, Atkins, de Paula and Keeler, 11th edition, Oxford University Press. 6. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Michael B. Smith 7th edition (Wiley). 7. Organic Chemistry, Volume 1, I. L. Finar, 5th edition. 8. Organic Chemistry, L. G. Wade Jr., Maya Shankar Singh, 6th edition. 9. Organic Chemistry, P. Y. Bruice, 8th edition, Pearson Eduacation.	