ST. PHILOMENA'S COLLEGE(AUTONOMOUS)

Affiliated to University of Mysore
Accredited by NAAC with 'B^{++}' Grade
Bannimantap, Mysore, Karnataka,
India-570015

DEPARTMENT OF CHEMISTRY

The Board of Studies in Chemistry which met on 14-09-2024

Approved the syllabus and pattern of examination for

Semester V and VI for the

Academic Year 2024-25

BOS COMMITTEE MEMBERS

Sl. No	Name of the Faculty	Designation
1	Ms. Agnes Sylvia D'Souza	Chairperson
2	Prof. M P Sadashiva	University Nominee
3	Dr. Umesh	Member
4	Mr. Ramayya Nayak K	Member
5	Dr. Jagadeesh Prasad	Member (External University)
6	Mrs. Barathi Kedarta S	Member (Industry)
7.	Dr. Alphonsus D'Souza	Member
8	Dr. Ravi J D Saldanha	Member
9	Mr. R. Britto Dominic Rayan	Member
10	Ms. Monica B	Member

Semester V BSc (Chemistry)
Core Course Content

Course Title: Chemistry-V	**Course Credits: 4**
Course Code: CHEDSC501	**L-T-P per week: 4-0-0**
Total Contact Hours:	**60**
Formative Assessment Marks:40	**Summative Assessment Marks:60**

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar/Field studies

Formative Assessment		
Assessment Occasion	Assessment type	Weightage in Marks
C1 First component	Test-40 marks test for 9minutes	10
C1 Second Component	Assignment	10
C2 First component		10
C2 Second Component		10
Total		40

Note: Any two different activities for C2 First component and C2 Second component can be selected from the below

Quiz/Project/Class room exercise/Practice exercise/Educational (industry/ institutes/ NGOs) visit/ field trip/ Field work/Viva voce/Role Play/Charts/ Models/Case study/Group discussion/Crosswords/ Presentation/seminar/Review – movie / Book/Research articles/e – content preparation

Course Objectives:

1.To provide students with a comprehensive understanding of coordination compounds. Classification of ligands, explore physical methods for studying complexes like changes in conductance, color, and pH.

2. To study the stability of metal complexes, both kinetically and thermodynamically. Factors influencing the stability

3. To provide students with a deep understanding of aromaticity, concepts the properties of various aromatic compounds. To familiarize students with stereochemistry principles, including chirality, conformational analysis, and nomenclature of complex ring systems.

4. To define, and classify the vitamins, as well as their structural elucidation, synthesis, and biological importance of specific vitamins such as Vitamin A and Vitamin C.

6. To explain Grothus-Draper's law and its significance. Calculate the quantum efficiency of a photochemical reaction, identify factors affecting quantum yield, and provide examples of reactions with high and low quantum yields.

7. Analyze the process of photosensitization using mercury as an example, and explain how it enhances the efficiency of photochemical reaction

8. Define phase, component, and degree of freedom, and provide examples to illustrate these terms. Apply Gibbs' phase rule to one-component systems, like the water system.

9. Explain the concept of reduced phase rule and reduced systems, using the Silver-lead system as an example. Describe the de-silverization of lead and the $FeCl_3$-H2O system with congruent melting points.

10.To provide students with a comprehensive understanding of the principles of molecular spectroscopy, fundamental concepts of electromagnetic radiation, molecular energy levels, absorption and emission spectra, and the Born-Oppenheimer approximation.

11. To equip students with the knowledge and skills necessary to perform spectroscopic analysis on different types of molecules. This includes the ability to analyze rotational, vibrational, Raman, and electronic spectra, as well as to apply selection rules and derive relevant equations.

Course Learning Outcomes

CO- No	After completing the course, the students will be able to	
CO-1	Name coordination compounds according to IUPAC nomenclature, to understand principles, and preparation of complexes,	Understand
CO-2	Recognize and differentiate between structural isomerism, stereoisomerism (geometrical and optical) in coordination compounds with CN 4 and 6.	Analyse and Apply
CO-3	To apply aromaticity principles to identify and analyze the aromatic properties of azulene, tropone, tropolone, annulenes, benzenoids, and meso-ionic compounds. Able to analyze the chirality of complex	Apply and Analyse

	molecules and perform conformational analysis.	
CO-4	To evaluate the biological importance of,vitamin A, Vitamin C, thiamine, pyridoxine, folic acid, pantothenic acid, riboflavin, α-tocopherol, biotin, vitamin K1, and vitamin K2. They will understand the structural features and synthesis of these vitamins and appreciate their role in human health.	Evaluate and create
CO- 5	Analyze and predict the behavior of photochemical reactions, taking into account Grothus-Draper's law and the quantum efficiency of reactions.	Application and Analysis
CO-6	Explain the principles of photophysical processes, including the Jablonski diagram and the role of photosensitization, fluorescence, phosphorescence, chemiluminescence, and bioluminescence.	Understanding and Application
CO-7	compare and contrast radiation chemistry with photochemistry, describe the primary and secondary stages in radiochemical reactions, and understand the units of radiation measurement. Students should also be capable of explaining the qualitative aspects of dosimeters.	Analyse
CO-8	Define and apply fundamental concepts in phase equilibria, such as phases, components, degree of freedom, and Gibbs' phase rule. They should also be able to analyze phase equilibria in one-component and two-component systems.	Understanding and application
Co-9	Apply the principles of molecular spectroscopy to analyze and interpret various types of spectra. They will be able to identify molecular energy levels, analyze rotational and vibrational spectra, and use spectroscopic data to determine bond lengths, force constants, and bond dissociation energies in diatomic and polyatomic molecules.	Application
Co-10	Solid comprehension of the underlying theories and concepts related to molecular spectroscopy. They will understand the selection rules governing different types of spectra, the quantum mechanical principles behind Raman spectroscopy, the Franck-Condon principle, and the potential energy curves for molecular orbitals. Students will be able to explain these concepts in detail and apply them to real-world spectroscopic problems.	Understanding

COURSE CONTENT

Unit-1	**Inorganic Chemistry**	**15 hrs**

1.1 d- Block elements: Position in the periodic table, electronic configuration, general characteristics, variable oxidation states, colour and magnetic properties, catalytic activity, complex formation. **4hrs**

1.1 Coordination compounds: Ligands, classification of ligands, physical methods in the study of complexes–change in conductance, color and pH. Nomenclature of co-ordination compounds, bridged complexes, Preparation of complexes-by simple addition reactions, substitution reactions and oxidation-reduction reactions. Applications of complexes **4hrs**

1.2 Metal - Ligand equilibria in solution: Stability of complexes, step-wise and overall formation constant and their relationship, Factors affecting the stability of metal complexes with reference to the nature of the metal ion and ligand, chelate effect. **4Hrs.**

1.3 Isomerism in co-ordination complexes: Structural isomerism-Ionization, Hydrate linkage, Ligand isomerism. Stereoisomerism–Geometrical and optical isomerism exhibited by co-ordination compounds of co-ordination number 4 and 6. **3hrs**

Unit-2 **Organic Chemistry** **15hrs**

2.1 Aromaticity, Homo-aromaticity of azulene, tropone, tropolone, annulenes(12,14,16,18), benzenoids, meso-ionic compounds**.** **2Hrs.**

2.2 Pesticides **05 Hrs**

Insecticides, Fungicides, and Herbicides: Definition, Classification, synthetic organic insecticides and fungicides, structural formulae and their importance of aldrin, BHC, Lindane, Malathion,

Herbicides: Definition, structural formulae and their importance of Diuren, 2,4-D [2,4- dichlorophenoxy acetic acid] and their importance.

Wood protectants: Definition, the importance of creosote oil, pentachlorophenols

2.3 Vitamins: Definition, classification. Structure elucidation (vitA), synthesis and biological importance of Vitamin A, and Vitamin C. Structural formulae and biological importance of thiamine, pyridoxine, folic acid, pantothenic acid, riboflavin, α-tocopherol, biotin, vitaminK_1 and vitamin K_2. **05Hrs**

2.4 Drugs: Introduction, chemotherapy and chemotherapeutic agents, Definition of drugs, types of drugs: antipyretics, analgesics, anesthetics, sedatives, Narcotics, antiseptics, antibacterials, antibiotics, antimalarials, sulphadrugs with examples, **03Hrs**

Synthesis of paracetamol sulphanilamide, sulphaguanidine and aspirin.

Unit-3 Physical Chemistry **15hrs**

3.1 Photochemistry: Laws of photochemistry: Grothus-Draper's law, Stark-Einstein law of photochemical equivalence. Quantum efficiency: definition, reasons for low quantum yield and high quantum yield with examples (formation of HBr and formation of HCl). Actinometers: Uranyl oxalate actinometer, Potassium ferrioxalate actinometer (Qualitative study).(Numerical problems)

3.2 Photo physical processes: photosensitization (mercury as an example & mechanism), photoinhibition, fluorescence and phosphorescence, chemiluminescence and bioluminescence (explanation with examples),

3.3 Radiation Chemistry: Definition, primary and secondary stages in radiochemical reactions, ionic yield, energy yield, comparison with photochemistry. Units of radiation-rad, gray, Roentgen. Dosimeters-Frick-dosimeter, ceric sulphate dosimeter (qualitative study) theories of radiolysis – Lind's and EHT theories. Radiolysis of water (qualitative study) and acetic acid. **10Hrs.**

3.4 Phase equilibria: Definition of the terms-phase, component and degree of freedom with examples. Statement of Gibb's phase rule. Applications: (a)one component system (water system); (b) reduced phase rule and reduced system, two component system(Silver-lead system, eutectic type), desilverization of lead Freezing mixtures: Definition and examples, explanation based on KI-water system. **5 Hrs**

Unit-4 Molecular Spectroscopy 15 hrs

4.1 Electromagnetic radiation: Regions of electromagnetic radiations (spectra), Quantum theory of EMR, molecular energy levels, absorption and emission spectra, Rotation spectroscopy: Selection rules, expression for rotational spectra of diatomic molecules for rigid rotator model, moment of inertia (expression to be derived) rotational energy rotational spectral lines, determination of bond lengths of diatomic molecules, isotopic substitution effect on rotational lines**.** 5hrs

4.2 **Vibrational spectroscopy:** Selection rules, classical equation of vibration**,** 5hrs

computation of force constant, expression for vibrational energy levels and potential energy of simple harmonic oscillator, zero-point energy, determination of force constant bond dissociation energies, fundamental frequencies. The number of degrees of freedom of vibrations polyatomic molecules, modes of vibration (CO_2 and H_2O).

4.3 Raman spectroscopy- Selection rules, origin of Raman spectrum, quantum mechanical theory, stokes and anti-stokes lines. Pure rotational Raman spectra of diatomic molecule (derivation), and vibrational rotational Raman spectra for diatomic molecule (explanation with equation). 5hrs

Electronic spectra: Concepts of potential energy curves for bonding and anti-bonding molecular orbitals, Franck-Condon principle.

Course Title: Chemistry Practical-5	**Course Credits: 4**
Course Code: CHEDSCP501	**Hours per week: 4**
Total Contact Hours: 60	
Formative Assessment Marks:25	**Summative Assessment Marks:25**

Course Objectives:

1. Aims to provide students with a comprehensive understanding of advanced organic preparations and estimations.
2. Course intends to equip students with the necessary skills and knowledge to carry out complex organic synthesis and quantitative analysis in a laboratory setting**.**

Course learning Outcome:

CO- No	After completing the course, the students will be able to	CDL
CO1	Understand and execute multistep synthesis techniques, demonstrating proficiency in converting one organic compound into another through controlled chemical reactions	Understand and apply
CO2	Apply knowledge of organic transformations to convert phthalic acid into anthranilic acid through a series of chemical reactions.	Apply

CO3	Develop proficiency in the synthesis of complex compounds by preparing 2,4-dinitrophenylhydrazine from chlorobenzene.	Evaluate and create
CO4	Master the art of transforming 2-chlorobenzoic acid into acridone, showcasing adaptability in organic synthesis techniques.	Evaluate and create
CO5	Demonstrate the ability to synthesize benzocaine from p-nitrobenzoic acid, highlighting the importance of reaction mechanisms and reagent selection.	Analyse and apply
CO6	Execute the Pechmann Reaction successfully, synthesizing coumarin from resorcinol and ethyl acetoacetate.	Create
CO7	Develop proficiency in using colorimetric techniques to accurately estimate the concentration of glucose in a given sample, emphasizing quantitative analysis skills.	Evaluate and create
CO8	Apply the formylation method to accurately estimate the concentration of amino acids, highlighting the versatility of quantitative analysis techniques.	Apply
CO9	Develop proficiency in estimating the concentration of carboxylic acids in a sample, showcasing a broad understanding of organic functional group analysis.	Evaluate and create
CO10	Demonstrate the ability to quantify amino groups in organic compounds, showcasing expertise in functional group estimation.	Analyse and apply
CO11	Master the saponification value determination method, emphasizing the ability to calculate and interpret relevant values for oil analysis.	Evaluate and create

CHDSCP-501: Chemistry Practical - V

(L: T:P=0:0:2) Contact Hours:60 Credits:2 Workload:4Hours/Week

PART-A: Organic Preparations (Multistep synthesis):

1. Preparation of *p*-bromoaniline from acetanilide.
2. Preparation of anthranilic acid from phthalic acid.
3. Preparation of benzanilide from benzophenone.
4. Preparation of 2,4-dinitrophenylhydrazine from chlorobenzene.
5. Preparation of acridone from 2-chlorobenzoicacid.
6. Preparation of benzocaine from p-nitro benzoic acid
7. Pechmann Reaction: Preparation of coumarin from resorcinol and ethyl acetoacetate.

8. Sandmeyer reaction: Preparation of 4-chlorotoluene from 4-toluidine.

PART-B: Organic Estimations:

1. Estimation of glucose by colorimetric method.
2. Estimation of aspirin by colorimetric method.
3. Estimation of ascorbic acid by iodometric method.
4. Estimation of amino acids by formylation method.
5. Estimation of carboxylic acid.
6. Estimation of amino group.
7. Determination of saponification value of oil.
8. Isolation of caffeine from tea powder.

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DSC-6: Chemistry - VI Paper Code: CHEDSC502

CLASS DURATION – THEORY: 04 HOURS/WEEK

Theory and Practical: Total Credits-06 (Theory-04, Practicals-02)

Course Objective:

1. The course is designed to provide students with a comprehensive understanding of advanced topics in physical and organic chemistry, including the modern concept of acids and bases, non-aqueous solvents, carbohydrates, heterocyclic compounds, quantum mechanics, and UV-Visible spectroscopy.
2. The primary objective is to equip students with advanced theoretical and practical knowledge in these areas of chemistry.

Course outcomes:

CO- No	**After completing the course, the students will be able to**	CDL
CO1	Understand and apply the Lux-Flood and Usanovich concepts of acids and bases, including the concept of the leveling effect.	Understand
CO2	Gain knowledge of non-aqueous solvents, their classification, dielectric constant, and donor and acceptor properties	Apply
CO3	Understand the unique chemistry of solutions of metals in liquid ammonia and the concept of hydrated electrons	Understand
CO4	Explore the characteristics of super acids and super bases and their significance in chemical reactions.	Analyse and apply
CO5	Explore amino sugars, their structural formulae, and conformational analysis.	Analyse and apply
CO6	Investigate the structure elucidation of disaccharides, such as sucrose, and partial structural formulae of polysaccharides like starch and cellulose.	Analyse
CO7	Explore colligative properties and their application in	Analyse and apply

	determining molar mass, including lowering of vapor pressure, elevation in boiling point, and depression in freezing point.	
CO8	Study the principles of osmosis, osmotic pressure, osmotic laws, and abnormal molecular mass	Understand and Analyse
CO9	Investigate semipermeable membranes, the determination of osmotic pressure, isotonic solutions, plasmolysis, and hemolysis.	Analyse
CO10	Learn the principles of UV-Visible spectroscopy, including measurement of absorption intensities, absorption maxima (λmax), and types of electronic transitions	Understand and apply
CO11	Apply Woodward-Fieser rules to calculate absorption maxima for various compounds, such as conjugated dienes, α,β-unsaturated carbonyl compounds, and other functional groups.	Apply
CO12	Understand the factors that influence absorption spectra, including solvent, temperature, and conjugation.	Understand

Course content:

Unit-1	**Inorganic Chemistry**	**15 Hours**
1.1	Modern concept of acids and bases: Lux-Flood and Usanovich concepts, solvent system and leveling effect. Hard-Soft Acids and Bases, Classification and Theoretical back grounds. Non-aqueous solvents: Classification of solvents, Properties of solvents (dielectric constant, donor and accept or properties) protic solvents glacial aceticacid) aprotic solvents (liquid SO_2, Solutions of metals in liquid ammonia, hydrated electron. Superacids and superbases.	**07 Hrs**
1.2	Chemistry of main group elements: Structure and bonding in boranes(B_2H_6,B_4H_{10}), carboranes($C_2B_9H_{13}$,$C_2B_6H_{12}$), Wades rules, borazines, phosphazines,	**04 Hrs**
1.3	f- Block elements: Position and electronic configuration in the periodic table, general characteristics, oxidation states, magnetic properties, complex formation and, lanthanide contraction-cause and its consequences, General survey of actinides-comparison with lanthanides, transuranic elements	**04 Hrs**
Unit-2:	**Organic Chemistry**	**15Hrs**

2.1	Carbohydrates: Introduction. Monosaccharides-Open and ring structure of glucose, mutarotation, epimerization. Interconversion reactions (aldose to ketose, ketose to aldose, chain elongation-Killiani-Fischer method, and chain degradation-Ruff's method), Determination ring size of glucose(methylation). Determination of configuration and conformational analysis of monosaccharides (glucose, galactose). Amino sugars: Structural formulae and conformations of α- and β- (glucosamine, galactosamine). Disaccharides-Structure elucidation of sucrose. Polysaccharides-partial structural formulae of starch and cellulose. Application of starch in titrimetric analysis.	08 Hrs
2.2	Heterocyclic compounds: Definition, classification and nomenclature. Furan-synthesis (from pentasan), reactions (nitration, acylation). Thiophene-synthesis (from sodium succinate), reactions (sulphonation, chlorination). Pyrrole-synthesis (from furan), reactions (diazotization, Riemer-Tiemann). Pyridine-synthesis (from acetylene), reactions (bromination, with $NaNH_2$). Aromaticity and basicity of pyrrole and pyrimidine. Indole: Synthesis (Fischer), reactions (Br_2/HOAc,$CHCl_3$/NaOH). Quinoline: Synthesis (Skraup), reactions (nitration, with $NaNH_2$, with $KMnO_4$/NaOH). Pyrazole: Synthesis (From acetylacetone and hydrazine), reactions (nitration, bromination)	**07 Hrs**
Unit-3	**Physical Chemistry**	**15 HRS**
3.1	Colligative properties: Definition and examples. Lowering of vapour pressure: Raoult's law (to be derived), relationship between relative lowering of vapour pressure and molar mass (to be derived). Experimental determination of molar mass of the solute by Dynamic method (Numerical problems).	**08 hrs**
3.11	Elevation in boiling point: Definition, its relation to lowering of vapour pressure and molar mass (to be derived). Ebullioscopic constant of the solvent and its relation to the Boiling point(only equation). Experimental determination of molar mass of the solute by Walker–Lumsden method (Numerical problems).	
3.12	Depression in freezing point: Definition, its relation to lowering of vapour pressure and molar mass (to be derived). Cryoscopic constant and its relation to melting point (only equation), Determination of molar mass of non-volatile solute by Rast method (Numerical problems)	

3.2 Semipermeable membrane: Definition, types with examples. Preparation of artificial semipermeable membrane (copper ferrocyanide) by Morse-Frazer method.

Osmotic pressure: Definition of osmosis, reverse osmosis and osmotic pressure. Determination of osmotic pressure by Berkely-Hartley's method (Numerical problems). Applications of osmotic pressure (mention only). 3Hrs

Osmotic laws and analogy with gas laws: Relationship between molar mass and osmotic pressure (to be derived). Isotonic solutions, plasmolysis and haemolysis. Abnormal molecular mass, causes, vantHoff's factor (Numerical problems).

3.3 Quantum Mechanics: Introduction, blackbody radiation, plank radiation law, photo electric effect, Compton effect, de Broglie concept and uncertainty principle.

Concepts of Operators: Algebra of operators, Laplacian, Hamiltonian, Linear and Hermitian operators. Eigen function and eigen values. 04Hrs

Postulates of quantum mechanics. Solutions of Schrödinger wave equation for a free particle, particle in a one-dimensional box.

Unit-4 **UV-Visible Spectroscopy** 15 Hrs

4.1 Introduction, measurement of absorption intensities, absorption maxima (λmax), instrumentation, types of electronic transitions, concept of chromophores and auxo chromes. Absorption and intensity shifts (bathochromic, hypsochromic, hyper chromic and hypochromic). Types of absorption bands (K,R,Band E-bands). The effect of solvents temperature and conjugation on absorption. 05 Hrs

4.2 Woodward-Fieser rules for calculation of absorption maxima for: Conjugated dienes (aliphatic, alicyclic, exocyclic, homo annular, hetero annular with and/or without extended conjugation, α, β-Unsaturated carbonyl compounds (aldehydes, ketones, carboxylic acids, esters with and/or without extended conjugation). Effect of steric hindrance and coplanarity (cis, trans isomers) on absorption. 07 hrs

4.3 Photochemistry: Introduction, Jablonski diagram, sensitizers, quenchers, sensitized and the non-sensitised reaction of 1,3-butadienes. Photochemical reaction and mechanism of carbonyl compounds Norrish type-I (one example) Norrish type-II (one example). 03 hrs

Barton reaction. Paterno Buchi reaction, photo-reduction of benzophenone.

CHEDSCP-601: Chemistry Practical -VI Practical

(LT: P) = (0:0:2) **Contact Hours:60** **Credits:2** **Workload:4Hours/Week**

Course Objectives:

1. Provide students with practical experience and theoretical knowledge in various titration methods and colorimetric estimations.
2. Equip students with the skills necessary to accurately determine concentrations, dissociation constants, and chemical properties of different substances using conductometric, potentiometric, and colorimetric techniques.

Course learning Outcome:

CO- No	After completing the course, the students will be able to	
CO1	Understanding of conductometric titration principles, specifically for weak acid-weak base systems. They will learn to interpret conductivity data to determine equivalence points and calculate dissociation constants.	Understand and apply
CO2	Develop the ability to conduct complex titrations, distinguishing and quantifying different acids in a mixture using conductometric methods.	Apply
CO3	Gain proficiency in potentiometric titration methods and apply them to determine the concentration of substances	Evaluate and create
CO4	Acquire skills in colorimetric analysis to estimate the concentration of Fe^{2+} ions in a solution through titration with ferrous ammonium sulfate (FAS) against potassium permanganate (KMnO4).	Create
CO5	Emphasize the use of quinhydrone electrode in potentiometric titrations to determine the pKa and Ka of weak acids, showcasing students' mastery of advanced techniques.	Understand and apply
CO6	Measure the dissociation constant (Ka) of a weak acid (formic acid) using potentiometric methods, highlighting their ability to perform and interpret complex chemical measurements	Analyse and apply
CO7	Apply colorimetric methods to determine the concentration of aspirin in a sample, demonstrating precision in quantitative analysis.	Apply
CO8	Gaining an understanding of the principles of potentiometric titration	Understand
CO9	Determine the pKa value of phosphoric acid using a pH meter, showcasing their ability to perform pH-related calculations and understand acid dissociation constants.	Analyse and apply

PART-A:

1. Conductometric titration of weak acid (CH_3COOH/HCOOH) versus weak base (Ammonium hydroxide).
2. Conductometric titration of a mixture of HCl and CH_3COOH versus NaOH.
3. Conductometric titration of strong acid (HCl) with salt ($CuSO_4$) versus NaOH.
4. Potentiometric titration of FAS versus $K_2Cr_2O_7$.
5. Potentiometric method of determination of dissociation constant of Formic acid.
6. Potentiometric titration of weak acid CH3COOH against a strong base NaOH using quinhydrone electrode and calculation of pka and ka of the weak acid.
7. Potentiometric estimation of Fe^{2+}ions concentration in the given solution by titration of FAS versus $KMnO_4$.

PART-B:

1. Determination of the isoelectric point of an amino acid by pH metry.
2. Determination of pH of acetic acid with sodium acetate buffer by pH metry
3. Potentiometric determination of pH of a buffer by using quinhydrone electrode.
4. Colorimetric determination of dissociation constant of a given indicator.
5. Potentiometric titration of $AgNO_3$ versus KCl (demonstration).
6. Conductometric titration of wekacid (CH_3COOH) with salt ($CuSO_4$) versus NaOH.
7. Determination of pKa value of phosphoric acid by pHmeter.

DSC-7: Chemistry - VII Paper Code: CHEDSC601

CLASS DURATION – THEORY: 04 HOURS/WEEK

Theory and Practical: Total Credits-06 (Theory-04, Practicals-02)

Course Objectives:

1. Students will be able to understand and explain the fundamental principles of inorganic chemistry, including metal-ligand bonding, crystal field theory, and magnetic properties of coordination compounds.

2. Students will develop a comprehensive knowledge of organic chemistry, including various aromatic electrophilic and nucleophilic substitution reactions, addition reactions, and elimination reactions.

3. Students will gain a deep understanding of physical chemistry concepts, such as ionic equilibria, Debye-Huckel theory, and electrochemistry, including the construction and working of electrochemical cells and their applications.

4. Students will become proficient in interpreting infrared (IR) spectroscopy data, including the position of IR absorption frequencies for a wide range of organic compounds and coordination complexes.

Course Outcomes

CO No.	After completing the course, the students will be able to	CDL
CO1	Describe the key features of metal-ligand bonding and its magnetic properties in various coordination complexes	Understand
CO2	Understand the principles of crystal field theory and its applications, including the prediction of colors and magnetic properties of transition metal complexes	Understand
CO3	Identify the limitations of valence bond theory and crystal field theory and recognize the need for other theories, such as molecular orbital theory, in understanding complex bonding.	Analyse and apply
CO4	Explain and apply the mechanisms of various electrophilic and nucleophilic substitution reactions in aromatic compounds	Analyse and apply
CO5	Describing the mechanisms of addition and elimination reactions and be able to relate reaction outcomes to substrate structure and reaction conditions.	Analyse
CO6	Understanding of ionic equilibria and be able to apply concepts like Ostwald's dilution law, Debye-Huckel theory, and the hydrolysis of salts in solving numerical problems.	Understand
CO7	Comprehend the principles of electrochemistry, including the construction and operation of electrochemical cells, determination of standard electrode potentials, and application of Nernst equation.	Application
CO8	interpreting IR spectra and understanding how different functional groups affect IR absorption frequencies in organic compounds and coordination complexes.	Evaluate and create

Course Content

Unit-1	**Inorganic Chemistry**	**15 Hours**
1.1	Metal-ligand bonding: Valence bond theory: Salient features,formation and magnetic cproperties of octahedral complexes $[Fe(CN)_6]^{4-}$, $[Fe(CN_6)]^{3-}$, $[Co(CN)_6]^{3-}$,$[CoF_6]^{3-}$$[Cr(H_2O)_6]^{3+}$and $[Fe(H_2O)_6]^{2+}$.Formation and magnetic properties of tetrahedral and square planar complexes $[Ni(CO)_4]$, $[Cu(NH_3)_4]^{2+}$ $[Ni(CN)_4]^{2-}$and $[Pt(Cl_4)]^{2-}$,limitations of VBT	**05 Hrs**
1.2	Crystal field theory: Salient features, splitting of d-orbitals in octahedral, tetrahedral, and square planar geometry. Applications-colors of transition metal complexes, magnetic properties of octahedral complex, CFSE and their uses. Factors affecting CFSE: Geometry of complexes, nature of the central metal ion, nature of ligand, and spectro chemical series. Limitations of CFT. Experimental evidence for metal-ligand covalent bonding in complexes, nephelauxetic effect.	**07 hrs**
1.3	Magnetic properties of coordination compounds: Introduction, magnetic permeability, magnetic flux, magnetic susceptibility and its determination-Gouy method, the effects of temperature on μ_{eff}, ferromagnetism, anti-ferromagnetism and ferrimagnetism.	**03 hrs**
Unit-2	**Organic Chemistry**	**15 hours**
2.1	Aromatic Electrophilic Substitution Reactions: Amination, sulfonylation, diazonium coupling, Vilsmeier-Haack reaction, Gatterman reaction, Gatterman-Koch reaction and Hoesch reaction. Aromatic Nucleophilic substitution reactions: The Goldberg reaction, Bucherer reaction, Schiemann reaction, von Richter reaction, and Sommelet-Hauser reactions	**07 hrs**
2.2	Addition Reactions: Addition reactions of cyclo propane ring. Addition reactions of carbon-hetero atom multiple bonds: Mechanism of metal hydride reduction (NaH, LiH, $LiAlH_4$, $NaBH_4$), Grignard reagent (CH_3MgBr) and organo lithium(CH3Li) of saturated and unsaturated carbonyl compounds. Hydrolysis of nitriles with mechanism. Wittig, Mannich and Stobbe reactions. Elimination Reactions: Effects of substrate structure, attacking base, the leaving group and the medium on elimination reactions. Chugaev reaction.	**08 hrs**
Unit-3	**Physical Chemistry**	**15 hrs**

3.1	Ionic equilibria: Ionic equilibria in aqueous solutions, strong and weak electrolytes-definition and examples. Ostwald's dilution law (to be derived) and its limitations. Debye-Huckel theory of strong electrolytes (relaxation time, electrophoretic effect and viscous effect). Activity and activity coefficient–definition and their relation. Hydrolysis of salts- Derivation of hydrolysis constant and degree of hydrolysis of the salt of weak acid and weak base (ammonium acetate as an example), effect of temperature on degree of hydrolysis. (Numerical problems)	**05 Hrs**
3.2	Electrochemistry-II: Electrolytic and Electro chemical cells (galvanic cells)- Daniel cell (construction, working and cell reaction). Reversible and irreversible cells, rules for representation of a cell, single electrode potential, Standard electrode potential, sign convention for electrode potential, Nernst equation for single electrode potential (Derivation).	03 Hrs
3.3	Reference electrodes: S t a n d a r d H y d r o g e n E l e c t r o d e Calomel electrode, Ag-AgCl electrode. (Construction, working, reaction and standard emf). Equilibrium constant and free energy of a cell reaction, Electrolyte Concentration cell with transport (example) concentration cell without transport, EMF of concentration cell (derivation). Liquid junction potential. Salt bridge. Application of concentration cell: Valency of ions and solubility product of sparingly soluble salt. Applications of EMF measurements in (a) Determination of pH of a solution using - (i) quinhydrone electrode, (ii)glass electrode. (b)Potentiometric titration- principle and location of end point in (i) Oxidation - reduction reaction, (ii) Precipitation reaction, iii) acid-base reaction.	07 Hrs
Unit-4	**Infrared Spectroscopy**	**15 Hours**
4.1	Infrared Spectroscopy: Introduction, principle, modes of vibrations, vibrational frequency. Factors influencing vibration frequencies (coupled vibration, electronic effects, and bond angles). Finger print region and its significance. Effects of H-bonding, conjugation, resonance, and ring size on IR absorptions.	**04Hrs**
4.2	IR absorption frequency positions in; Hydrocarbons (alkanes, alkenes, alkynes,) halogen compounds, alcohols and phenols, aldehydes (acetaldehyde, benzaldehyde) and ketones (acetone, acetophenone) , carboxylic acids (acetic acid, benzoic acid), amides (acetamide), amines(methylamine, aniline), amino acids(glycine, phenylalanine), nitro compounds (nitromethane. nitrobenzene)	**07 Hrs**

4.3 Coordination compounds: Changes in infrared spectra of donor molecules upon coordination(*N*,*N*-dimethyl acetamide, urea, mono carbonyl complexes)

04 Hrs

CHEDSCP-601 : Chemistry Practical -VII

(LT:P=0:0:2 ContactHours:60 Credits:2 Workload:4Hours/Week

Course Objectives

1. Students will be proficient in conducting gravimetric analyses, including the determination of various elements in different compounds using the appropriate precipitation and gravimetric techniques.

2. Students will develop skills in performing volumetric analyses, particularly the titration of different ions and elements in solution, and accurately calculating their concentrations.

3. Students will gain hands-on experience in the preparation of coordination complexes, learning the techniques involved in synthesizing specific compounds.

Course Outcomes (CO):

CO No.	After completing the course, the students will be able to	CDL
CO1	Conduct gravimetric analyses for elements like Fe, Ba, calcium, aluminum, magnesium, lead, and Ni, with proficiency in sample preparation and gravimetric techniques.	Analyse and apply
CO2	Accurately estimate the concentrations of various elements in solution through volumetric analyses, specifically Ca, Mg, Fe, Zn, and Ni, demonstrating their ability to perform titrations	Evaluate
CO3	Skilled in the synthesis of coordination complexes	Evaluate and create
CO4	Gain insight into the preparation of coordination compounds through demonstrations, including the synthesis of mercury tetra thiocyanto cobaltate (II), further enhancing their knowledge of coordination chemistry	Analyse and Apply

Course Content

PART-A: Gravimetric and Volumetric Analysis

1. Gravimetric determination of Fe in iron ore as Fe_2O_3.
2. Gravimetric determination of Ba as $BaSO_4$.
3. Gravimetric estimation of aluminum as aluminum oxide.
4. Gravimetric estimation of magnesium as magnesium8-hydroxyoxinate.
5. Gravimetric estimation of lead as lead chromate.
6. Gravimetric determination of Ni using DMG in Cu and Ni solution.
7. Gravimetric determination of Fe using NH_4OH in Fe and Cr solution.
8. Gravimetric estimation of Cu using NH_4SCN in Cu and Zn solution.
9. Volumetric estimation of Ca and Mg in dolomite solution.

PART-B: Preparation of co-ordination complexes

1. Preparation of hexammine nickel(III)chloride.
2. Preparation of chloropentaminecobalt(III)chloride.
3. Preparation of tris(oxalato)ferrate(III)and estimate the iron.
4. Preparation of hexamminecobalt(III)chloride (demonstration)
5. Preparation of mercurytetrathiocyantocobaltate(II)(demonstration).

Semester VI BSc

DSC-8: Chemistry - VIII Paper Code: CHEDSC602

CLASS DURATION – THEORY: 04 HOURS/WEEK

Theory and Practical: Total Credits-06 (Theory-04, Practicals-02)

Course objectives (CO):

CO1: Students will gain a comprehensive understanding of various inorganic and organic chemistry topics, including the constituents and functions of paints, the classification and applications of propellants, the properties and applications of abrasives, and the manufacture and uses of refractories.

CO2: Students will develop a strong knowledge of different chemical compounds and materials, such as ceramics, explosives, and fertilizers, including their origins, classifications, and applications.

CO3: Students will learn about the structural aspects of silicates and nanomaterials, understanding their unique properties and industrial applications.

CO4: In the field of organic chemistry, students will become proficient in various rearrangement reactions, understanding their mechanisms and applications, as well as amino acid and peptide synthesis and sequencing.

CO5: Students will explore chemical dynamics, understanding reaction kinetics, complex reactions, homogeneous catalysis, and the kinetics of fast reactions**.**

CO6: In the area of nuclear magnetic resonance spectroscopy, students will learn about 1H NMR spectroscopy, including its principles, instrumentation, and the interpretation of NMR spectra for various organic compounds.

Course Learning Outcomes (CLO):

CO No.	**After completing the course the students will be able to**	**CDL**
CO1	Explain the constituents and functions of paints, describe the manufacturing process of lithopone and titanium dioxide, and understand their applications.	Understand
CO2	Grasp the characteristics of propellants, classify them, and identify their various applications.	Analyse
CO3	Gain knowledge about abrasives, including their classification, hardness, and manufacturing processes for carborundum, alundum, and tungsten carbide, and recognize their applications.	Understand and analyse
CO4	Comprehend refractories, their properties, classification, and applications, and be able to describe the steps involved in the manufacture of refractories	Analyse and apply
CO5	Understand the economic importance and synthesis of nitrogenous and phosphate fertilizers.	Understand
CO6	Explain various rearrangement reactions, including Wagner-Meerwein, Fries, Beckmann, and others, and understand their mechanisms and applications	Evaluate
CO7	Understand chemical dynamics, the Arrhenius equation, thermodynamic parameters, and the influence of ionic strength on reaction rates.	Understand
CO8	Gain knowledge of fast reactions, including the methods used to study them, such as relaxation methods, flow methods, and flash photolysis.	Analyse
CO9	Explore complex reactions and homogeneous catalysis, including acid-base catalyzed reactions and enzyme-catalyzed reactions.	Evaluate
CO10	Perform structured determinations and interpret NMR spectra for various organic compounds, such as ethane, propane, and a wide range of other compounds.	Evaluate and apply

Course Content:

Inorganic Chemistry **15 Hours**

Unit-1 Polymers-inorganic polymers- differences between inorganic and organic polymers, types, T_g factors affecting T_g
Paints: Constituents and their functions, manufacture of lithopone and titanium dioxide. Fluorescent paints and refelectors-ZnS, BaS
Propellants: Definition, characteristics, classification and applications.
Abrasives: Definition, classification with examples, hardness, manufacture and applications of carborundum, alundum and tungsten carbide. 05 Hrs
Refractories: Definition, properties, classification with examples. Applications of refractories.

1.2 Ceramics: Introduction, types, manufacturing process, applications.
Explosives: Origin of explosive and classification. Preparation and explosive properties of lead azide, cyclonite (RDX).
Fertilizers: Economic importance and synthesis of nitrogenous fertilizers-CAN, ammonium sulfate, ammonium nitrate, barium sulphate, zinc sulphate and urea. Phosphate fertilizers-calcium dihydrogen phosphate, superphosphate. 05 Hrs

1.3 Silicates: Structure, classification- silicates with discrete anions, silicates containing chain anion, silicates with layer structure, silicones with three-dimensional net-work and applications.

1.4 Nanotechnology: Definition, uses and nature of nanotechnology. 03 Hrs
Nanomaterials: Definition, properties and applications. Carbon nanotubes: Definition, types, methods of preparation (mention), properties and industrial applications of carbon nanotubes, Nanowires: Definition, types, production of crystalline nanowires by vapour-liquid-solid synthesis method, application of nanowires.

Unit-2 **Organic Chemistry** **15 Hours**

2.1 Rearrangements: Reaction and mechanism of Wagner-Meerwein, Fries, Beckmann, Hofmann, Benzil-benzilic acid, Favorskii, Dienone-phenol, and Benzidine rearrangement. Baeyer-Villiger oxidation, Arndt-Eistert reaction. 07 Hrs

2.2	Amino acids and Peptides: Synthesis (from α-halogen acids, Gabriel phthalimide, malonic ester), reactions (alkyl halides, nitrous acid, acid halide, NH_3, $LiAlH_4$).Classification and nomenclature of peptides. Sanger and Edman methods of sequencing. Cleavage of peptide bond by chemical and enzymatic methods. Peptide synthesis- Protection of amino group (Boc-) and carboxyl group as alkyl esters. Use of DCC, and HOBt in peptide bond formation reactions. Deprotection and racemization in peptide synthesis.	**08 Hrs**
Unit-3	**Physical Chemistry**	**15 Hrs**
3.1	Chemical Dynamics: Arrhenius equation-characteristics, Significance of energy of activation, Temperature coefficient and its evaluation. Thermodynamical formulation of reaction rates (Thermodynamic parameters). Reaction between ions in solutions – Influence of ionic strength on reaction rates – primary and secondary salt effects, Complex reactions: Kinetics of parallel reactions, consecutive reaction, reversible reactions (qualitative treatment**).**	**07 Hrs**
3.2	Kinetics of homogeneous catalysis –kinetics of acid-base catalyzed reactions-specific acid and specific base catalysis, general acid base catalysis. Enzyme catalyzed reactions, Mechanism (Lock and Key theory), Significance of Michaelis-Menten constant, Effects of enzyme concentration, pH, Temperature, catalysts and Inhibitors on enzyme activity. Kinetics of fast reactions: Introduction, Study of reactions by relaxation method (Temperature and pressure jump), flow method (continuous flow method and stopped flow method), Flash photolysis and Shock tube method.	08 Hrs
Unit-4	**Nuclear Magnetic Resonance Spectroscopy**	15 Hours
4.1	^{1}HNMR spectroscopy: Introduction (including magnetic properties of nuclei, spin population), relaxation process (spin-spin, spin-lattice, number of signals.	02Hrs

4.2	Instrumentation: chemical shifts, internal standards, shielding and deshielding effects. Factors affecting chemical shift (inductive, VanderWaals, anisotropic, H-bonding).Solvents used. Peak area and proton counting, splitting of the signals, spin-spin coupling, equivalent and non-equivalent protons. . Calculation of atoms ratio from the height of signals. Coupling constant (germinal & vicinal coupling). Restricted rotation**.**	07Hrs
4.3	Interpretation of spectra of; ethane, propane, 1-bromopropane, 2-bromopropane, ethylene, propene, acetylene, methylamine, dimethylamine, trimethylamine, ethylacetate, ethylbenzene, ethylalcohol, p-cresol, benzoic acid, benzaldehyde, acetaldehyde, toulene acetophenone,	06 Hrs

CHEDSCP-602 Chemistry Practical -VIII

(L: T:P=0:0:2) Contact Hours:60 Credits:2 Workload:4Hours/Week

Course objectives:

1. To Equip students with the knowledge to study the kinetics of various reactions, such as hydrolysis, saponification, and oxidation, enabling them to calculate rate constants, activation energy, and assess the effects of different variables on reaction rates.
2. To Enable students to master quantitative methods such as conductometry, potentiometry, and spectrophotometry for analyzing reaction progress, determining concentrations, and studying equilibrium in chemical systems.
3. To Provide hands-on experience in synthesizing various organic compounds, including reactions like Cannizzaro, Friedel-Crafts, and oxidation, while learning purification techniques like crystallization, distillation, and chromatography for isolating and characterizing products.
4. To Teach students the application of chromatographic techniques, including paper chromatography, TLC, and column chromatography, to separate and identify organic compounds and reaction intermediates, such as isomeric forms of nitroanilines and leaf pigments.

Course outcome

CO No.	After completing the course, the students will be able to	CDL
CO1	Conduct hydrolysis reactions, compare the rates of hydrolysis, and evaluate the	Apply

	relative strength of acids using rate data	
CO2	Understand how to calculate the energy of activation from rate constants obtained at different temperatures and identify the effect of temperature on reaction rates.	Understand and apply
CO3	Acquire the skills to conduct spectro photometric measurements, determine reaction rates, and calculate rate constants.	Evaluate and create
CO4	Perform conductometric titrations, understand the concept of equivalent conductance, and determine the strengths of various solutions using conductivity measurements.	Analyse and apply
CO5	Calculate partial molar volumes, understand the concept of apparent molar volume, and apply the method to the NaCl-H2O system.	Understand and apply
CO6	Perform a Friedel-Crafts reaction, learn the mechanism, and isolate the product while understanding the concept of electrophilic aromatic substitution.	Apply
CO7	Perform the synthesis of N-phenyl-2,4-dinitroaniline, understand the reaction mechanism, and purify the product.	Apply
CO8	Gain practical experience in conducting the Cannizarro reaction, understanding the reaction mechanism, and isolating the products.	Evaluate and create
CO9	Perform the synthesis of 2,4-dichlorophenoxyacetic acid, including the reaction steps and purification methods.	Apply

Course Content

PART-A:

1. Hydrolysis of methyl acetate in presence of two different concentrations of HCl and determination of the relative strength.
2. Determination of energy of activation for the reaction between $K_2S_2O_8$ versus KI(firstorder) in two different temperatures.
3. Determination of rate constant for the reaction between chloramine-T and indigo carmine dye in pH10 buffer medium spectro photometrically.
4. Conductometric determination of strength of HCl, CH_3COOH and $CuSO_4$ versus NaOH.
5. Conductometric titration of sodium sulphate versus $BaCl_2$.
6. Conductometric determination second order rate constant for the saponification of ethylacetate.
7. Determination of partial molar volume of NaCl-H_2O system by apparent molar volume method.

8. Potentiometric titration of acid mixture (CH_3COOH and $ClCH_2COOH$) versus NaOH.

PART-B: Organic Preparations

1. Cannizarro reaction of benzaldehyde.
2. Oxidation of cyclohexanol.
3. Preparation of p-iodonitrobenzene
4. Preparation of 2,4,6-tribromoaniline.
5. Paper Chromatographic separation of green leaf pigments.
6. Separation of p- and o- nitroaniline by TLC method (solvent extraction).
7. Separation of ortho- and para- nitroaniline by column chromatography.

Reference Books for Discipline Specific Course

Reference Books for Inorganic Chemistry

1. Lee, J.D. Concise Inorganic Chemistry ELBS,1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd Ed.,Wiley.
3. Douglas, B.E., McDaniel, D.H. &Alexander, J. J. Concepts and Models in Inorganic Chemistry, John Wiley &Sons.
4. Huheey, J. E., Keiter, E.A., Keiter, R.L. & Medhi, O. K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India,2006.
5. Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, Oxford University Press.
6. Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd.
7. Rodgers, G. E. Inorganic & Solid-State Chemistry, Cengage Learning India Ltd.,2008.
8. Mark Weller and Fraser Armstrong, 5 Edition, Oxford University Press (2011-2012)

Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry. John Wiley & Sons, 1974.

9. G.L. Miessler & Donald A. Tarr: Inorganic Chemistry, Pearson Publication.
10. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
11. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., New York (1985).

1. Organic Chemistry-P. Y. Bruice, 7th Edition, Pearson Education Pvt. Ltd., New Delhi(2013).
2. Heterocyclic Chemistry- R. K. Bansal, 3rd Edition, New- Age International, New Delhi,2004.
3. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition,2013.
4. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi(1988).
5. Stereochemistry-Conformation and Mechanism-P. S. Kalsi, Wiley-Eastern Ltd, NewDelhi.
6. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson,2010.
7. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand,2010.
8. Graham Solomons, T. W., Fryhle, C. B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons(2014).
9. Organic Chemistry Volume-I, II- I. L. Finar, 6th Edition, ELBS London(2004).
10. Organic Chemistry-F. A. Carey, 4th Edition, McGraw Hill(2000).
11. Modern Organic Chemistry - R.O.C. Norman and D.J. Waddington, ELBS,1983.
12. Understanding Organic reaction mechanisms - A. Jacobs, Cambridge Univ. Press,1998.
13. Organic Chemistry - L. Ferguson, Von Nostrand,1985.
14. Organic Chemistry - M. K. Jain, Nagin & Co.,1987.
15. Organic Chemistry- Mehta and Mehta, PHI Learning Pvt. Ltd, NewDelhi,2005.

Physical Chemistry

1. Barrow, G.M. Physical Chemistry, Tata McGraw-Hill,2007.
2. Castellan, G.W. Physical Chemistry, 4th Ed. Narosa,2004.
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi,2009.
4. P.W. Atkins: Physical Chemistry,2002.
5. W.J. Moore: Physical Chemistry,1972.
6. Text Book of Physical Chemistry - P. L. Soni, S. Chand & Co.,1993.

7. Text Book of Physical Chemistry - S. Glasstone, Mackmillan India Ltd.,1982.
8. Principles of Physical Chemistry - B. R. Puri, L. R. Sharma and M. S. Patania, S. L. N. Chand & Co.1987.
9. Physical Chemistry - Alberty R. A. and Silbey, R. J. John Wiley and sons,1992.
10. Physical Chemistry - G. M. Barrow, McGraw Hill,1986.
11. Physical Chemistry (3rd Edition) - Gilbert W. Castilian, Narosa Publishing House,1985.
12. Chemical Kinetics by K. J. Laidler, Tata McGraw Hill Publishing Co., New Delhi.
13. Kinetics and Reaction Mechanisms by Frost and Pearson, Wiley, New York,1981.

Analytical Chemistry

1. Jeffery, G.H., Bassett, J., Mendham, J.& Denney,R.C.
2. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons,1989.
3. Willard, H. H., Merritt, L.L., Dean, J. & Settle, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
4. Christian, G.D; Analytical Chemistry, VI Ed. John Wiley & Sons, New York,2004.
5. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman,2001.
6. Skoog, D. A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed,2017.
7. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand,1974.

Blueprint of End semester examination

Duration: 2 ½ hours		**Max. Marks**: 60
The question paper contains 5 parts		
Part-A	Answer any 6 out of 8questions **(two questions from each unit)**	6 X 2 = 12
Part-B (Inorganic Chemistry)	Answer any 2 out of 3 questions	2 x 6 = 12
Part-C (Organic Chemistry)	Answer any 2 out of 3 questions	2 x 6 = 12
Part-D (Physical Chemistry)	Answer any 2 out of 3 questions	2 x 6 = 12
Part-E (Analytical Chemistry)	Answer any 2 out of 3 questions **Pattern:** (3 + 3) / (4 + 2)	2 x 6 = 12