M. C. E. Society's
Abeda Inamdar Senior College
Of Arts, Science and Commerce, Camp, Pune-411001
(Autonomous) Affiliated to Savitribai Phule Pune University
NAAC accredited 'A' Grade

B. Sc. Programme Objectives and Outcomes

Programme Objectives:

1. To develop conscience towards social responsibility, human values and sustainable development through curriculum delivery and extra-curricular activities

2. To develop scientific temperament with strong fundamental knowledge of the subject

3. To develop analytical thinking and problem-solving skills needed for various entrance and competitive examinations and Post Graduate Studies

4. To train students in laboratory skills and handling equipment along with soft skills needed for placement

Programme Outcomes:

1) The students will graduate with holistic development.

2) The students will be qualified to continue higher studies in their subject.

3) The students will be eligible to appear for various competitive examinations and pursue higher education.

4) The students will be able to apply for the jobs with a minimum requirement of B. Sc. Programme.

Programme Specific Objectives and Outcomes

Programme Specific Objectives:

The B.Sc. Chemistry Programme will enable the students;

PSOB-1. To develop fundamental understanding of Principles of Chemistry as a discipline.
PSOB-2. To understand various laws, concepts, formulae and develop problem solving skills in Chemistry.
PSOB-3. To familiarize with advance level Chemistry and applications required for higher studies.
PSOB-4. To get hands on training on various instruments and develop skills needed in Chemistry lab.

Programme Specific Outcomes:

After successful completion of B.Sc. Chemistry Course student will have:
PSOC-1. Fundamental knowledge of theory and practical courses in Chemistry.
PSOC-2. Understanding of structures, reactivity, mechanism and problem-solving skills.
PSOC-3. Knowledge and confidence to pursue higher studies in Chemistry.
PSOC-4. Skills in laboratory techniques and experience in instrument handling.

Structure of S. Y. B. Sc. Chemistry [CBCS]

Semester	Course code	Title of course	No. of Credits and Lectures
III	21SBCH231	Physical and Analytical Chemistry-I	2, 36 Lectures
III	21SBCH232	Organic and Inorganic Chemistry-I	2, 36 Lectures
III	21SBCH233	Practical Course in Chemistry-III	2, 48 Lectures
IV	21SBCH241	Physical and Analytical Chemistry-II	2, 36 Lectures
IV	21SBCH242	Organic and Inorganic Chemistry-II	2, 36 Lectures
IV	21SBCH243	Practical Course in Chemistry-IV	2, 48 Lectures

***N.B.:**

1. Each lecture (L) will be of 50 minutes.

2. Each practical of 3h 20 min and 12 practical per semester

3. 12 weeks for teaching 03 weeks for continuous assessments

4. For details refer UGC rules and regulation (CBCS for Science Program under Science & Technology)

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Choice Based Credit System [CBCS]

From Academic Year 2022-23

Syllabus for Second Year Bachelor of Science (S.Y. B. Sc.) Chemistry

Board of Studies (Chemistry)

Post Graduate Department of Chemistry and Research Center Abeda Inamdar Senior College of Arts, Science and Commerce, Pune-411001

SEMESTER-III

Course/ Paper Title	**Physical and Analytical Chemistry-I**
Course Code	**21SBCH231**
Semester	**III**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1	Fundamentals of chemical kinetics, integral equations, characteristics of different order of reaction and its determination.
2	Types of isotherms, its characteristics applications including surface area determination of adsorbent.
3	Fundamental's principle and applications of different common types of quantitative volumetric analysis in analytical chemistry.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit 1:** After Studying chemical kinetics student will able to learn: - 1. The concept of kinetics, terms used, rate laws, molecularity, order. 2. Explain factors affecting rate of reaction. 3. Explain / discuss / derive integrated rate laws, characteristics, expression for half-life and examples of zero order, first order, and second order reactions. 4. Determination of order of reaction by integrated rate equation method, graphical method, half-life method and differential method. 5. Explain / discuss the term energy of activation with the help of energy diagram. 6. Explanation for temperature coefficient and effect of temperature on rate constant 7. Derivation of Arrhenius equation and evaluation of energy of activation graphically. 8. Solve / discuss the problem based applying kinetic equations.
2	**Unit 2:** After Studying surface chemistry student will able to learn: - 1. Define / explain adsorption, classification of given processes into physical and chemical adsorption.

	2. Discuss factors influencing adsorption, its characteristics, concept of physisorption and Chemisorption 3. IUPAC Classification of Adsorption Isotherms. 4. Explanation of adsorption results in the light of Langmuir adsorption isotherm, Freundlich's adsorption Isotherm and BET theory. 5. Apply BET isotherm for surface area determination of adsorbent in the adsorption process to real life problem. 6. Solve / discuss problems using theory.
3	**Unit 3:** After studying the Volumetric Quantitative Analysis student will able to learn: - **1.** Explain / define different terms in volumetric analysis such as units of concentration, indicator, equivalence point, end point, standard solutions, primary and secondary standards, complexing agent, precipitating agent, oxidizing agent, reducing agent, redox indicators, acid base indicators, metallochromic indicators, etc. **2.** Perform calculations involved in volumetric analysis. **3.** Explain why indicator show colour change and pH range of colour change. **4.** To prepare standard solution and b. perform standardization of solutions. **5.** To construct acid – base titration curves and performs choice of indicator for particular titration. **6.** Explain / discuss acid-base titrations, complexometric titration / precipitation titration / redox titration. **7.** Apply volumetric methods of analysis to real problem in analytical chemistry / industry.

Syllabus

Unit No.	Title with Contents	No. of Lectures
1.	**Chemical Kinetics:** Introduction to kinetics, the rates of chemical reactions – definition of rates, rate laws, rate constants and its significance, factors affecting reaction rates, reaction order and molecularity, determination of rate law, integrated rate laws; zero-order reactions, first-order reactions, second-order reactions (with equal and unequal initial concentration of reactants), Third order reaction (only equal initial concentrations), half-life period, Examples of zero, first and second order reaction, methods for determination order of a reactions, Arrhenius equation- temperature dependence of reaction rates, interpretation of Arrhenius parameters. Numerical Problems. **Ref. No: 1- 725-728, 731-733, 741-742, 780-784.** **Ref. No: 2- 1033- 1067.**	**12**

2.	**Surface Chemistry:** Introduction to surface chemistry - some basic terms related to surface chemistry, adsorption, adsorption materials, factors affecting on adsorption, characteristics of adsorption, types of adsorptions, Langmuir adsorption isotherm, Freundlich's adsorption isotherm, BET theory (no derivation), determination of surface area of adsorbent by BET adsorption isotherm, IUPAC classification of adsorption isotherms, adsorption isobars, application of adsorption, problems. **Ref. No:1- 824-826, 832-837.** **Ref. No: 2- 1251-1264.** **Ref. No: 3- 932-938.**	**06**
3.	**Volumetric Quantitative Analysis:** Introduction to volumetric analysis, classification of reactions in volumetric analysis, standard solutions, preparation of standard solutions, primary and secondary standards. **Ref 4: Pg. No. 257 -260 Ref 5 Pg. No. 166-169** Types of Volumetric Analysis methods: **1. Neutralization titrations**: Theory of indicators, neutralization curves for strong acid strong base, weak acid strong base, weak base strong acid. Preparation of approximate 0.1 M HCl and standardization against anhydrous sodium carbonate, determination of Na_2CO_3 content in washing soda. **Ref 4: Pg No. 262 -274, 286, 295, Ref 5: Pg No. 282-296** **2. Complexometric Titrations:** Definition of complexing agent and complexometric titration, EDTA-as complexing agent (structure of EDTA and metal ion EDTA complex), Types of EDTA titration (direct and back titration), pH adjustment and amount of indicator in EDTA titration, metal ion indicators (general properties, solochrome black – T, Patton and Reeder's indicator only), standard EDTA solution, determination of Ca (II) and Mg (II), total hardness of water. **Ref 4: Pg No. 309-311, 314, 321-328, 332 Ref 5 Pg No. 322-334**	**18**

	3. Redox Titrations: Definition of oxidation, reduction, oxidizing agent, reducing agent, oxidation state, redox titration, $K_2Cr_2O_7$ and $KMnO_4$ as oxidizing agents, 1,10- phenanthroline as indicator in reduction titration, diphenyl amine as oxidation indicator, $KMnO_4$ as self-indicator, Standard $KMnO_4$ solution and standardization with sodium oxalate, Determination of H_2O_2. **Ref 4: Pg No. 364-372. Ref 5: Pg No. 437-445, 452-456.** **4. Precipitation titrations:** precipitation reactions, determination of end point (formation of coloured ppt, formation of soluble coloured compound, adsorption indicator), standard $AgNO_3$ soln., standardization of $AgNO_3$ soln. – potassium chromate indicator- Mohr's titration, determination of chloride and bromide, determination of iodide. Problems based on analysis. **Ref 4 Pg No : 340-351. Ref 5 Pg No. 366-374.**	

Reference Books:

1. Atkins' Physical Chemistry by Peter Atkins, Julio de Paula, James Keeler -11th edition
2. Principles of physical chemistry by B.R. Puri, L.R. Sharma, M.S. Pathania
3. Essentials of Physical chemistry by Bahl Tuli-Revised Multicolour Edition 2009, S. Chand and Company Ltd.
4. Vogel's Textbook of quantitative Chemical Analysis, 5th Ed. G. H. Jeffry, J. Basset, J. Mendham, R. C. Denney, Longman Scientific and Technical, 1989.
5. Analytical Chemistry, G. D. Christian, P. K. Dasgupta, K. A. Schug, 7th Ed, Wily, 2004.

Additional References:

6. Principles of Chemical Kinetics-2nd Edition- James E. House
7. Physical Chemistry by Thomas Engel, Philip Reid, Warren Hehre.
8. Fundamentals of Analytical Chemistry- Skoog, west, Holler, Crouch, 9th Ed. Brooks / Cole, 2014/2004.

SEMESTER-III

Course/ Paper Title	**Organic and Inorganic Chemistry-I**
Course Code	**21SBCH232**
Semester	**III**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Sr. No.	Chapter Title	No. of Lectures
1.	Introduction to Coordination Chemistry	07
2.	Isomerism in Coordination Complexes	04
3.	Valance Bond Theory of Coordination Compounds	07
4.	Alkyl Halides	09
5.	Alcohol Phenol and Ether	09

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1.	The meaning of terms associated with coordination compounds and give IUPAC Names of Coordination Compounds,
2.	To Explain Werner's theory of coordination compounds. Differentiate between primary and secondary valency. Correlate coordination number and structure of complex ion.
3.	Functional Group Chemistry of Alkyl and Aryl Halides, Alcohol, Ether and Amines with mechanistic aspects of important reactions
4.	The skills required for converting a given molecule into a target molecule through multiple step reaction

Expected Course Specific Learning Outcomes

Sr. No.	Outcomes
1.	Understanding of all the basic concepts related to co-ordination compounds, IUPAC Nomenclature, Conceptual perception of related theories.
2.	Mechanistic understanding of nature and reactivity of alkyl halides, alcohol, ether, phenol, aldehydes, ketones, carboxylic acids and its derivatives, amines and aryl diazonium salts
3.	The ability to think and utilize the knowledge of organic reactions of various functional groups to suggest simple synthetic methodology

Syllabus

Unit No.	Title With Content	No. of Lectures
1	**Introduction to Coordination Compounds:** Double salt and coordination compound, basic definitions: coordinate bond, ligand, types of ligands, chelate, central metal ion, charge on complex ion, calculation of oxidation state of central metal ion, metal ligand ratio; Werner's work and theory, Effective atomic number, equilibrium constant, chelate effect, IUPAC nomenclature **(Ref.-1: 194-200, 222-224; Ref-4: 483-492) (Ref-6: 138-140)**	07
2	**Isomerism in Coordination Complexes:** Introduction, polymerization isomerism, ionization isomerism, hydrates isomerism, linkage isomerism, coordination isomerism, coordination position isomerism, geometric isomerism, optical isomerism. **(Ref-1: 232-236)**	04
3	**Valance Bond Theory of Coordination Compounds:** Aspects and assumptions of VBT, applications of VBT on the basis of hybridization to explain the structure and bonding in $[Ag(NH_3)_2]^+$, $[Ni(Cl_4)]^{2-}$, $[Ni(CN)_4]^{2-}$, $[Cr(H_2O)_6]^{3+}$, $[Fe(CN)_6]^{3-}$ (Inner orbital complex) and [FeF6]3-(outer orbital complex). Spin only formula, definitions of paramagnetic, diamagnetic. Use of observed magnetic moment in deciding the geometry in complexes with C.N.4, limitations of VBT. **(Ref-2: 592-597, Ref-3:350-351).**	07
4	**Alkyl Halides:** Introduction and IUPAC nomenclature, Preparation; from alkanes, alkenes and alcohols Reactions: Hydrolysis, nitrite and nitro formation, nitrile and iso nitrile formation. Williamson's synthesis: Types of Nucleophilic Substitution reactions (SN^1, SN^2 and SNi) and Mechanism Elimination Reactions of Alkyl halides with mechanism (E_1, E_2 and E_1CB). Elimination vs. substitution and factors affecting these reactions. **(Ref.-7: 165-211 and 943-967)**	09
5	**Alcohols, Phenols and Ethers (Up to 5 Carbons):** **Alcohols:** Introduction and IUPAC nomenclature, Preparation: Preparation of 1º, 2º and 3° alcohols using Grignard reagent, ester hydrolysis, reduction of aldehydes, ketones, carboxylic acid and esters. Reactions with sodium, HX (Lucas Test), esterification, Oxidation (with PCC, alc. $KMnO_4$, acidic dichromate, conc. HNO_3,) **Ethers (Aliphatic and Aromatic):** Classification, IUPAC nomenclature, Preparation: Williamson's Synthesis, Continuous Etherification Process, Diazomethane, Preparation Cleavage of ethers with HI. **Phenols (Phenol Case):** Introduction and IUPAC nomenclature, Preparation: From Cumene, diazonium salts. Reactions Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, **(Ref-7:213-244 and 889-912)**	09

Reference Books: (Inorganic Chemistry)

1. Concise Inorganic Chemistry, J. D. Lee, 5th Ed (1996) Blackwell Science
2. Inorganic Chemistry, James E. House, Academic Press (Elsevier), 2008
3. Inorganic Chemistry by Miessler and Tarr, Third Ed. (2010), Pearson.
4. Principles of Inorganic Chemistry, Brian W. Pfennig, Wiley (2015)
5. Inorganic Chemistry, Catherine Housecroft, Alan G. Sharpe, Pearson Prentis Hall, 2008.
6. Basics Inorganic Chemistry, Cotton and Wilkinson

Reference Books: (Organic Chemistry)

7. Morrison, R.T. and Boyd, R. N Organic Chemistry, Prentice Hall of India, 6th Edition, 2002, 283-308,

Additional Reading

8. A Guidebook to Mechanism in Organic Chemistry, by Peter Sykes, 6th Edn.
9. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

SEMESTER-III

Course/ Paper Title	**Practical Course in Chemistry-III**
Course Code	**21SBCH233**
Semester	**III**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1	Experimental methods to study the kinetics of chemical reactions
2	Adsorption phenomena through the specific experiment
3	Volumetric Estimations and significance in quantitative analysis
4	To carry out organic synthesis and analysis

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	To estimate the rate constant, order of reaction and energy of activation
2	To investigate the role of surface chemistry by the adsorption phenomena
3	To understand the principles of volumetric analysis.
4	Student should be able to understand principles of Organic Qualitative Analysis

Syllabus

Sr. No.	Title with Contents	Practical Sessions
	Section A: Chemical Kinetics: (Any Three)	
1.	To Study the acid catalysed hydrolysis of an ester (methyl Acetate) and determine the rate constant (k).	1
2.	To study the kinetics of saponification reaction between sodium hydroxide and ethyl acetate.	1
3.	To compare the relative strength of HCl and H_2SO_4 by studying the kinetics of hydrolysis of methyl acetate.	1
4.	To determine the order of the reaction with respect to $K_2S_2O_8$ by fractional life method following the kinetics of per sulphate-iodide reaction.	1
5.	To determine the energy of activation of the reaction between $K_2S_2O_8$ and KI with unequal initial concentration.	1
	Section B: Surface Chemistry (Any One)	

6.	Adsorption of a textile dye on commercial activated carbon: A Simple Experiment: To Explore the Role of Surface Chemistry (Ref. 4, Page No. 143-147)	1
7.	Adsorption of acetic acid on activated charcoal: To verify the Freundlich and Langmuir's adsorption isotherms	1
	Section C: Volumetric Quantitative Analysis (Any Two)	
8.	Estimation of Aspirin from a given tablet and find errors in quantitative analysis. (Standardization of acid must be performed with standard Na_2CO_3 solution, prepared from dried anhydrous AR grade Na_2CO_3)	1
9.	Determination of acetic acid in commercial vinegar by titrating with standard NaOH. Express your results as average ± standard deviation. (Standardization of base must be performed with standard KHP)	1
10.	Determination of Hardness of water from given sample by complexometric titration (Using E.D.T.A.) method and total dissolve solids by conductometry. Express your results as average ± standard deviation. (Standardization of Na_2EDTA must be performed with standard Zn (II) solution)	1
	Section D: Inorganic qualitative/quantitative experiments (Any Three)	
11.	Estimation of Fe(III) from given solution by converting it to Fe(II) using Zn metal and then by titrating with standard solution of $K_2Cr_2O_7$ -A Green Approach (Ref.-5,7).	1
12.	To determine the equivalent weight of a metal using eudiometric method	1
13.	Determination of $BaCO_3$ content in a given sample by precise determination of volume of CO_2 (Ref. 6)	1
14.	Separation and Identification of metal ions by Paper Chromatography (Ref.,7,8)	1
	Section E: Organic Qualitative Analysis (Three)	
15.	Solid-Solid Binary Mixture (two mixture)	2
16.	Liquid-Solid Binary Mixture	1

References:

1. Practical physical chemistry, A. Findlay, T.A. Kitchner (Longmans, Green and Co.)
2. Systematic experimental physical chemistry, S. W. Rajbhoj, T. K. Chondekar, Anjali publication.
3. Senior Practical Physical Chemistry, B.D. Khosla and V.S. Garg (R. Chand and Co., Delhi.)
4. Journal of Chemical Education, 2015, volume-92, Issue-1, Page No. 143-147 (Laboratory Experiment)
5. Iron Analysis by Redox Titration A General Chemistry Experiment, Journal of Chemical Education, Volume 65, Number 2, February 1988.183.
6. A Precise Method for Determining the CO_2 Content of Carbonate Materials, Journal of Chemical Education, Vol. 75, No. 12, December 1998.
7. Vogel's Textbook Quantitative Chemical Analysis, 3rd and 6th Ed.
8. Advanced Practical Chemistry, Jagdamba Sing et al, Pragati Prakashan, Merrut. Practical Chemistry, Panday, Bajpai, Giri, S.Chand and Co
9. College Practical Chemistry by H. N. Patel, S.P. Turakhia, S. S. Kelkar, N. S. Israney, S. R. Puniyani (Himalaya Publishing House, Mumbai)

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SEMESTER-IV

Course/ Paper Title	**Physical and Analytical Chemistry-II**
Course Code	**21SBCH241**
Semester	**IV**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1	Different phase diagrams for one component systems
2	Concepts and properties of completely miscible and partially miscible binary solutions.
3	Fundamentals of conductometry with respect to analysis
4	Fundamentals of colorimetry with respect to analysis

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit 1:** After Studying Phase equilibrium student will able to learn: - 1. Terms in phase equilibria such as- system, phase in system, components in system, degree of freedom, one / two component system, phase rule, etc. 2. Meaning and types of equilibrium such as true or static, metastable and unstable equilibrium. 3. Meaning of phase, component and degree of freedom. 4. Derivation of phase rule. 5. Description of one component system with respect to: Description of the curve, Phase rule relationship and typical features for i) Water system ii) Carbon dioxide system iii) Sulphur system
2	**Unit 2:** After Studying Ideal and real solution student will able to learn: - Various terms, laws, difference between ideal and non-ideal solutions. 1. Discuss / explain thermodynamic aspects of Ideal solutions-Gibbs free energy change, Volume change, Enthalpy change and entropy change of mixing of Ideal solution. 2. Differentiate between ideal and non-ideal solutions and can apply Raoult's law and Henrys law. 3. Interpretation of i) vapour pressure–composition diagram ii) temperature-composition diagram.

	4. Explain distillation of liquid solutions from temperature – composition diagram. 5. Explain / discuss azeotropes, Lever rule, Henrys law and its application. 6. Discuss / explain solubility of partially miscible liquids- systems with upper critical. Solution temperature, lower critical solution temperature and having both UCST and LCST. 7. Explain / discuss concept of distribution of solute amongst pair of immiscible solvents. 8. Derive distribution law and its thermodynamic proof. 9. Apply solvent extraction to separate the components of from mixture interest. 10. Solve problem by applying theory.
3	**Unit 3:** After Studying Conductometry student will able to learn: - 1. Explain / define different terms in conductometry such as electrolytic conductance, resistance, conductance, Ohm's law, cell constant, specific and equivalent conductance, molar conductance, Kohlrausch's law, etc. 2. Discuss / explain Kohlrausch's law and its Applications, Conductivity Cell, Conductivity Meter, Whetstone Bridge. 3. Explain / discuss conductometric titrations. 4. Apply conductometric methods of analysis to real problem in analytical laboratory. 5. Solve problems based on theory / equations. 6. Correlate different terms with each other and derive equations for their correlations.
4	**Unit 4:** After Studying Colorimetry student will able to learn: - 1. Explain / define different terms in Colorimetry such as radiant power, transmittance, absorbance, molar, Lamberts Law, Beer's Law, molar absorptivity 2. Discuss / explain / derive Beer's law of absorptivity. 3. Explain construction and working of colorimeter. 4. Apply colorimetric methods of analysis to real problem in analytical laboratory. 5. Solve problems based on theory / equations. 6. Correlate different terms with each other and derive equations for their correlations.

Syllabus

Unit No.	Title with Contents	No. of Lectures
1	**Phase Equilibrium**: Introduction; definitions of phase, components and degrees of freedom of a system; stability of phases, criteria of phase equilibrium. Gibbs phase rule and its thermodynamic derivation, phase diagrams of one- component systems- water, carbon dioxide and sulphur systems, problems. **Ref. No: 1, Page No- 119 - 126,** **Ref. No: 2, Page No – 661-675,** **Ref. No: 3, Page No 344- 354.**	**08**

2	**Ideal and Real Solutions:** Introduction, chemical potential of liquids - ideal solutions, ideal dilute solutions - Raoult's and Henry's Law, liquid mixtures, phase diagram of binary systems: liquids - vapour pressure diagrams, temperature composition diagrams, liquid-liquid phase diagrams, solubility of partially miscible liquids-critical solution temperature, effect of impurity on partially miscible liquids, Problems. **Ref. No: 1, Page Nos- 150-153, 155-157, 166 – 175,** **Ref. No: 2, Page No. - 750-775, 696-705** **Ref. No: 3, Page No. 261-292, 298- 302.**	**10**
3	**Conductometry:** Introduction, Electrolytic Conductance, Resistance, conductance, Ohm's law, cell constant, specific and equivalent conductance, molar conductance, variation of equivalent and specific conductance with concentrations, Kohlrausch's law and its applications, conductivity cell, conductivity meter, Whetstone Bridge, determination of cell constant, conductometric titrations (strong acid-strong base, strong acid-weak base, weak acid strong base) and Numerical. **Ref-4: 398-402, 414-423, 433-434,** **Ref-5: 519-527** **Ref-6: 528-532**	**09**
4	**Colorimetry:** Introduction, interaction of electromagnetic radiation with matter, essential terms: radiant power, transmittance, absorbance, molar, Lamberts Law, Beer's Law, Lambert-Beer's Law, molar absorptivity, deviations from Beer's Law, Colorimeter: Principle, Construction and components, Working. Applications–unknown conc. By calibration curve method, Determination of unknown concentration of Fe(III) by thiocyanate method, Numerical. **Ref 5: 645-651, 658-661, 690,** **Ref-6: 144-153, 157-160,**	**09**

Reference Books:

1. Atkins' Physical Chemistry by Peter Atkins, Julio de Paula, James Keeler -11th edition
2. Principles of physical chemistry by B.R. Puri, L.R. Sharma, M.S. Pathania
3. Essentials of Physical chemistry by Bahl Tuli-Revised Multicolour Edition 2009, S. Chand and Company Ltd.
4. Principles of Physical Chemistry, S.H. Marron and C. F. Pruton4th ed., Oxford and IBH publishing company / CBS, new Delhi.
5. Vogel's Textbook of quantitative Chemical Analysis, 5th Ed. G. H. Jeffry, J. Basset, J. Mendham, R. C. Denney, Longman Scientific and Technical, 1989.
6. Basic Concept of Analytical Chemistry- S. M. Khopkar
7. Vogel's Text Book of Practical Organic Chemistry, Furniss, Hannaford, Smith, Tatchel, 5th Ed., Longman Scientific and Technical, 2004.

Additional References:

8. Analytical Chemistry, G.R. Chatwal, Sham Anand.
9. Principles of Chemical Kinetics-2nd Edition- James E. House
10. Physical Chemistry by Thomas Engel, Philip Reid, Warren Hehre.

SEMESTER IV

Course/ Paper Title	**Organic and Inorganic Chemistry-II**
Course Code	**21SBCH242**
Semester	**IV**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Sr. No.	Chapter Title	No. of Lectures
1.	Crystal Field Theory	08
2.	Molecular Orbital Theory of Covalent Bonding	10
3.	Aldehydes and Ketones	05
4.	Carboxylic acids and their derivatives	04
5.	Amines and Diazonium Salts	04
6.	Organic Conversions	05

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1.	The theoretical and conceptual understanding of CFT and Splitting of Energy Levels
2.	Understanding of concepts of MOT, formation of diatomic molecules and their bond order
3.	Functional Group Chemistry of Aldehydes, Ketones, Carboxylic acids and derivatives, Amines and Diazonium salts
4.	The skills required for converting a given molecule into a target molecule through multiple step reaction

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1.	Ability to explain CFT and its conceptual aspects with examples
2.	Mechanistic understanding of nature and reactivity of aldehydes, ketones, carboxylic acids and its derivatives, amines and aryl diazonium salts
3.	The ability to think and utilize the knowledge of organic reactions of various functional groups to suggest simple synthetic methodology

Syllabus

Unit No.	Title With Content	No. of Lectures
1	**Crystal Field Theory:** Shapes of d-orbitals, Crystal field Theory (CFT): Assumptions, Application of CFT to i) Octahedral complexes (splitting of 'd' orbitals in Oh ligand field, effect of weak and strong ligand fields, colour absorbed and spectrochemical series, crystal splitting energy, Crystal field stabilization energy and factors affecting it, tetragonal distortion in Cu(II) complexes) ii) Square planar complexes and iii) Tetrahedral complexes; spin only magnetic moment of Oh and Td complexes. **(Ref-1:194-225)**	**08**
2	**Molecular Orbital Theory of Covalent Bonding:** Introduction to Molecular Orbital Method (MOT) and postulates of MO theory, LCAO approximation, s-s combination of orbitals, s-p combination of orbitals, p-p combination of orbitals, p-d combination of orbitals, d-d combination of orbitals, non-bonding combination of orbitals, Rules for linear combination of atomic orbitals, example of molecular orbital treatment for homonuclear diatomic molecules: Explain following molecules with respect to MO energy level diagram, bond order and magnetism: H2+ molecule ion, H2 molecule, He2+ molecule ion, He2 molecule, Li2 molecule, Be2 molecule, B2 molecule, C2 molecule, N2 molecule, O2 molecule, O2- and O22- ion, F2 molecule, Heteronuclear diatomic molecules: NO, CO, HF. **(Ref.-1:89-112, Ref-4: 278-292, Ref-5: 33-38)**	**10**
4	**Aldehydes and Ketones:** Aliphatic and aromatic (Formaldehyde, acetaldehyde, acetone and benzaldehyde) Introduction and IUPAC nomenclature, Preparation: from alkenes, acid chlorides and from nitriles. Reactions-Reaction with HCN, $NaHSO_3$, NH_2-G derivatives. Iodoform test, Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Clemenson's and Wolff Kishner reduction. **(Ref-7: 657-700 and 797-816)**	**05**
5	**Carboxylic acids and their derivatives:** Carboxylic acids (aliphatic and aromatic): Introduction and IUPAC nomenclature, Preparation: Acidic and Alkaline hydrolysis of esters. Reactions: Hell–Vohlard-Zelinsky Reaction. Carboxylic acid derivatives (aliphatic): (up to 5 carbons) Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their inter conversion. Reformatsky Reaction, Perkin Condensation **(Ref-7: 713-745 and 753-785)**	**04**
6	**Amines and Diazonium Salts:** **Amines (Aliphatic and Aromatic):** Introduction and IUPAC nomenclature, Preparation from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. Reactions: Hofmann vs. Saytzeff Elimination, Electrophilic substitution (Case Aniline): nitration, bromination, sulphonation. Diazonium salts: Preparation from aromatic amines.	**04**

	(Ref-7: 821-877)	
7	**Organic Conversions:** Problem solving approach to cover the reactions of all the families covered in First year as well as second year of B.Sc. Theoretical approach to designing small molecules through simple organic conversions and predicting the products in multistep reactions with the help of provided reagents. **Ref. (No specific reference)**	**05**

References:

Reference Books: (Inorganic Chemistry)

1. Concise Inorganic Chemistry, J. D. Lee, 5th Ed (1996) Blackwell Science
2. Inorganic Chemistry, James E. House, Academic Press (Elsevier), 2008
3. Inorganic Chemistry by Miessler and Tarr, Third Ed. (2010), Pearson.
4. Principles of Inorganic Chemistry, Brian W. Pfennig, Wiley (2015)
5. Inorganic Chemistry, Catherine Housecroft, Alan G. Sharpe, Pearson Prentis Hall, 2008.
6. Basics Inorganic Chemistry, Cotton and Wilkinson

Reference Books: (Organic Chemistry)

7. Morrison, R.T. and Boyd, R. N Organic Chemistry, Prentice Hall of India, 6th Edition, 2002, 283-308,

Additional Reading

8. A Guidebook to Mechanism in Organic Chemistry, by Peter Sykes, 6th Edn.
9. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

SEMESTER IV

Course/ Paper Title	**Practical Course in Chemistry-IV**
Course Code	**21SBCH243**
Semester	**IV**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Aims & Objectives of the Course: The student should be

Sr. No.	Objectives
1	Able to learn all the necessary laboratory skills needed for analysis and synthesis.
2	Able to grasp the correlation of theoretical and experimental aspects
3	Able to handle basic instruments and perform various laboratory techniques
4	Able to explain the outcomes/results of the experiments and systematically present the experimental findings with the help of graph, observation table, results, calculations and graph as per requirement.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	The student will be equipped with knowledge and skills required in Chemistry Laboratory
2	Student will be able to understand, execute and conclude the outcomes of a given experimental procedure
3	Student will be able handle instruments, synthesize and analyse organic and inorganic compounds and complexes respectively.
4	Develop consciousness towards green chemistry practices

Syllabus

Sr. No.	Title with Contents	Practical Sessions
	Section A: Ideal and Real solutions (Any One)	
1.	To study the variation of mutual solubility temperature with % concentration for the phenol - water system	1
2.	To study the effect of added electrolyte on the critical solution temperature of phenol-water system and to determine the concentration of the given solution of electrolyte	1
	Section B: Conductometry (Any Two)	

3.	To determine the cell constant of the given cell using 0.01 M KCl solution and determine dissociation constant of a given monobasic weak acid.	1
4.	To investigate the conductometric titration of any one of the following a) Strong acid against strong base b) Strong base against weak acid.	1
5.	To determine the concentration of acetic acid in commercial vinegar by conductometric titration	1
	Section C: Inorganic Synthesis and Analysis (Any Two)	1
6.	Synthesis of sodium cobaltinitrite (a laboratory chemical) from Co (II) salt and $NaNO_2$ salts and the qualitative analysis of the ions. (Ref.-6, 7)	1
7.	Synthesis of potassium Tris(oxalate) aluminium (III) using Al metal powder (Scrap aluminium) and the qualitative analysis of the ions. (Ref-7, 8,9)	1
8.	Synthesis of Tris(acetylacetone)iron (III) by green chemistry method by reaction between $Fe(OH)_3$ and acac and the qualitative analysis of the ions. (Ref.- 10,11).	1
9.	Synthesis of Tris(ethylenediamine)nickel (II) from Ni(II) salt, ethylediamine and sodium thiosulfate and and the qualitative analysis of the ions.. (Ref.-12)	1
10.	Synthesis of Tetraammine Copper (II) and the qualitative analysis of the ions. (Ref.13)	1
	Section D: Inorganic Colorimetric Investigations (Any Two)	
11.	Prepare standard solutions of KMnO4 / CuSO4, record their absorbance and Verify Beer's Law and determine unknown concentration. (Compulsory)	1
12.	Prepare solution of Fe(III) and SCN of in different molar proportion, record their absorbance and calculate equilibrium constant of $[Fe(SCN)]^{2+}$ complex (Ref.-14,15)	1
13.	Prepare solution of Fe(III)/Cu(II) and salicylic acid in different molar proportion and determine metal ligand ratio in Fe(III) or Cu(II)–Salicylic acid complex. (Ref.-16, 17,18)	1
	Section E: Organic Estimations (Any Three)	
14.	Determination of Molecular Weight of Monobasic Acid	1
15.	Determination of Molecular Weight of Dibasic Acid	1
16.	Estimation of amount of acetamide	1
17.	Estimation of Vitamin C using ceric ammonium sulphate	1
	Section F: Organic Synthesis (Green Approach) (Any Two)	
18.	Acetylation of primary amine (Green Approach)	1
19.	Base catalysed Aldol condensation (Green Approach) LiOH	1
20.	Bromination of acetamide by ferric ammonium nitrate and KBr in aqueous medium	1

References:

1. Practical Physical Chemistry, A. Findlay, T.A. Kitchner (Longmans, Green and Co.)
2. Experiments in Physical Chemistry, J.M. Wilson, K.J. Newcombe, A.r. Denko. R.M.W. Richett (Pergamon Press)
3. Senior Practical Physical Chemistry, B.D. Khosla and V.S. Garg (R. Chand and Co., Delhi.)

4. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
5. Practical Physical Chemistry, B. Vishwanathan and P. S. Raghwan, Viva Books
6. Handbook of Preparative Inorganic Chemistry, Volume 2, Second Edition, Edited By Georg Braue R, Academic Press, New York, London, 1965. (Page-1541)
7. Practical Chemistry, Panday, Bjpai, Giri, S. Chand and Co.
8. McNeese, T.J.; Wierda, D.A. Synthesis of Potassium Tris(oxalato)aluminate(III) Trihydrate. Journal of Chemical Education,1983, 60(11), 1001.
9. Inorganic Syntheses Vol -1 by H S Booth. First Ed, 1939. (page-36).
10. Novel Synthesis of Tris(acetylacetonato)-iron(III), Journal of Chem. Soc. Dalton Trans. 1983
11. Metal Acetylacetonate Synthesis Experiments: Which Is Greener?, Journal of Chemical Education, 2011, 88, 947–953, dx.doi.org/10.1021/ed100174f.
12. Experimental Inorganic/Physical Chemistry: An Investigative, Integrated Approach to Practical Project Work, Mounir A. Malati, Woodhead Publishing Limited, 1999.
13. Vogel's Textbook Quantitative Chemical Analysis, 6th Ed.
14. Colorimetric Determination of the Iron (III)-Thiocyanate Reaction Equilibrium Constant with Calibration and Equilibrium Solutions Prepared in a Cuvette by Sequential Additions of One Reagent to the Other, Journal of Chemical Education, Vol.88 No.3 March 2011.
15. Experiments in chemistry, D. V. Jahagirdar, Himalaya publication.
16. A spectrophotometric study of complex formation between Fe(III) and salicylic acid, Kinya Ogawa, Nobuko Tobe, Bulletin of chemical society of Japan, 39, 227-232, 1966.
17. Salicylate determination by complexation with Fe (III) and optical absorbance spectroscopy
18. Determination of Equilibrium Constants of Metal Complexes from Spectrophotometric Measurements: An Undergraduate Laboratory Experiment, Journal of Chemical Education, Vol. 76, No. 9, September 1999.
19. College Practical Chemistry by H. N. Patel, S.P. Turakhia, S. S. Kelkar, N. S. Israney, S. R. Puniyani (Himalaya Publishing House, Mumbai)
20. Vogel's Textbook of Practical Organic Chemistry
21. T.Y.B.Sc. Practical Chemistry (2019 Pattern), Manali Prakashan
22. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Aggarwal

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Chairman, BOS, Chemistry