



## **MODERN EDUCATION SOCIETY'S**


**Nowrosjee Wadia College, Pune**

**(Autonomous)**

**S.Y.B. Sc. Chemistry**

**Syllabus (NEP 2) as per National Education Policy 2020**

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	<b>MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)</b>	<b>Academic Year 2025-2026</b>
	<b>Bachelor of Science (Hons.) with research</b>	
<b>MAJOR - CHEMISTRY</b>		
<p><b>Preamble:</b></p> <p>Over the past decades the higher education system of our country has undergone substantial structural and functional changes resulting in both quantitative and qualitative development of the beneficiaries. Such changes have gained momentum with the introduction of Choice Based Credit System (CBCS) which further expects learning outcome-based curriculum in order to maximize the benefits of the newly designed curriculum. The learning outcome-based curriculum in general and in Chemistry in particular will definitely help the teachers of the discipline to visualize the curriculum more specifically in terms of the learning outcomes expected from the students at the end of the instructional process. It is pertinent to mention here that the purpose of education is to develop an integrated personality of the individual and the educational system provides all knowledge and skills to the learner for this.</p> <p>The Learning outcome-based curriculum framework (LOCF) has been prepared to support designing uniform, advanced and effective Chemistry curriculum for undergraduate studies in Chemistry. Each subject content aims to present a curriculum framework, specifying the curriculum aims, learning targets and objectives, and thus providing suggestions regarding curriculum planning, learning and teaching strategies, assessment and resources. In addition, the curriculum framework also provides examples of effective learning, teaching and assessment practices. A coherent understanding of the whole-undergraduate chemistry (major and pass) curriculum planning and the planning of student learning ability at subject levels can be established. Curriculum development is a collaborative and an on-going enhancement process, therefore, the same shall be updated and improved from time to time to meet new needs of students, teachers and society at large.</p> <p>The students in terms of providing opportunity for exposure to the students towards core courses, discipline specific courses, generic elective courses, ability enhancement courses and skill enhancement courses with special focus on technical, communication and subject specific skills through practical and other innovative transactional modes to develop</p>		

their employability skills. The learning outcome-based curriculum has categorically mentioned very well-defined expected outcomes for the Programme like core competency, communication skills, critical thinking, affective skills, problem-solving, analytical, reasoning, research-skills, teamwork, digital literacy, moral and ethical awareness, leadership readiness and so on along with very specific learning course outcomes at the starting of each course. Therefore, this template on Learning Outcomes based Curriculum Framework (LOCF) for B.Sc. with Chemistry/Chemistry Honors will definitely be a landmark in the field of outcome-based curriculum construction.

### **Aims of Bachelor's degree program in Chemistry**

The broad aims of bachelor's degree program in Chemistry are:

1. The aim of bachelor's degree program in chemistry is intended to provide:
2. Broad and balance knowledge in chemistry in addition to understanding of key chemical concepts, principles and theories.
3. To develop students' ability and skill to acquire expertise over solving both theoretical and applied chemistry problems.
4. To provide knowledge and skill to the students' thus enabling them to undertake further studies in chemistry in related areas or multidisciplinary areas that can be helpful for self-employment/ entrepreneurship.
5. To provide an environment that ensures cognitive development of students in a holistic manner. A complete dialogue about chemistry, chemical equations and its significance is fostered in this framework, rather than mere theoretical aspects
6. To provide the latest subject matter, both theoretical as well as practical, such a way to foster their core competency and discovery learning. A chemistry graduate as envisioned in this framework would be sufficiently competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.
7. To mold a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking and communication.
8. To enable the graduate, prepare for national as well as international competitive examinations, especially UGC-CSIR NET and UPSC Civil Services Examination.

### **Course Learning Outcomes**

The course learning outcomes are aligned with program learning outcomes but these are specific-to-specific courses offered in a program. The course level learning shall be reflected as program level learning. The core courses shall be the backbone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject together with multi-dimensional and multidisciplinary approach. In course learning outcomes, the student will attain subject knowledge in terms of individual course as well as holistically. The Course Learning Outcomes related to core courses and their linkage with each other is stated below:

1. Core competency

2. Critical Thinking
3. Analytical reasoning
4. Research skill
5. Team work
6. Problem solving
7. Exposure beyond discipline
8. Psychological skill
9. Digital Literacy
10. Moral and Ethical awareness
11. Additional academic knowledge

**Objectives:**

1. To help the students to build interdisciplinary approach with other faculty.
2. To empower students to excel in various research fields of chemical Sciences.
3. To inculcate sense of scientific responsibilities for social and environment awareness.
4. To acquaint the students with thrust areas of chemical science.
5. To adapt the internationally acknowledged Choice Based Credit System (CBCS) that offers opportunities to learn core subjects and to explore additional avenues of learning beyond the core subjects for complete development of an individual.

**Eligibility for the course B.Sc. Chemistry.**

Any candidate completed 12<sup>th</sup> Science.

**Examination pattern**

35 Marks for end semester examination and 15 marks for continuous evaluation pattern

35 Marks for External Practical examination and 15 Marks for Internal practical examination

**Passing marks**

Passing marks will be 40 % in each paper of continuous evaluation and end semester exam separately.

**Procedure for continuous evaluation**

Written test	10
Assignments / Tutorials	05
	15

**Nature of question paper for End semester examination**

<b>Question No.</b>	<b>Type</b>	<b>Max. Marks</b>
1	1 marks x 7 questions (Any 5)	05
2	2 marks x 6 questions (Any 5)	10
3	a) 4 marks x 2 questions (Any 1)	04
	b) 2 marks x 4 questions (Any 3)	06
4	a) 2 marks x 3 questions (Any 2)	04
	b) 3 marks x 3 questions (Any 2)	06
	<b>Total</b>	<b>35</b>

### **Revaluation**

There shall be revaluation of answer scripts of end semester examination (out of 35 marks) of theory papers only, but not of internal or continuous evaluation papers as per Ordinance no. 134 A and B

### **Grading system**


<b>Marks</b>	<b>Grade</b>	<b>Grade point</b>
80-100	O: Outstanding	10
70-79	A+: Excellent	9
60-69	A: Very Good	8
55-59	B+: Good	7
50-54	B: Above Average	6
45-49	C: Average	5
40-44	P: Pass	4
0-39	F: Fail	0
-	Ab: Absent	0

**Structure of S.Y.B.Sc. Chemistry Major/Minor/SEC/VSC/OE/FP/CEP**

Sem	Course type	Theory / Practical	Course Code	Course Title	No. of credits	No. of lecture in Hrs	Total Credits
III	Major Paper-I	Theory		Physical and Analytical Chemistry-I	2	30	06
	Major Paper-II	Theory		Organic and Inorganic Chemistry-I	2	30	
	Major Paper-III	Practical		Organic and Inorganic Chemistry Practical – I	2	60	
	Minor Paper-I	Theory		Overview of concepts in Chemistry A	2	30	04
	Minor Paper-I	Practical		Basic Chemistry practical – A	2	60	
	VSC-I	Practical		Practical Insights in Analytical Chemistry	2	60	02
	IKS	Theory		Beauty Aids, Cosmetics Manufacturing In Ancient Indian Literature	2	30	02
	OE-3	Theory		Chemistry in Daily Life	2	30	02
	FP				2	60	02
	Major Paper-IV	Theory		Physical and Analytical Chemistry-II	2	30	06
	Major Paper-V	Theory		Organic and Inorganic Chemistry-II	2	30	

IV	Major Paper-VII	Practical		Organic and Inorganic Chemistry Practical – II	2	60	
	Minor Paper-III	Theory		Overview of concepts in Chemistry B	2	30	04
	Minor Paper-IV	Practical		Basic Chemistry practical – B	2	60	
	VSC II	Theory		Analytical method of chemical analysis	2	30	02
	OE-IV	Theory		Food Adulteration and Safety	2	60	02
	SEC-III	Practical		Volumetric and Instrumentation Skills In Chemistry	2	60	02
	CEP				2	60	

# Semester III

	<b>MODERN EDUCATION SOCIETY'S</b> <b>Nowrosjee Wadia College, Pune</b> (Autonomous) <b>NEP 2.0</b>		<b>Academic Year 2025-2026</b>
	<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Major Theory Paper-1</b> <b>Physical and Analytical Chemistry</b>			
<b>S. Y. B. Sc.</b>			<b>Credits - 2</b>
<b>Semester- III</b>			<b>Hours - 30</b>
<b>Course specific outcomes-</b> <ol style="list-style-type: none"> <li>1. To understand fundamental concept of Physical, and Analytical Chemistry.</li> <li>2. To impart basic understanding of stoichiometric calculations.</li> <li>3. To impart practical skills and learn basics behind experiments.</li> <li>4. To prepare background for advanced and applied studies in chemistry.</li> </ol>			
<b>Sr. No.</b>	<b>Course Content / Syllabus</b>	<b>Lectures</b>	
<b>Unit 1</b>	<b>Chemical Kinetics</b> Introduction to kinetics, the rates of chemical reactions, definition of rates, rate laws and rate constants, reaction order and molecularity, determination of rate law, factors affecting reaction rates, integrated rate laws—zeroth-order reactions, first-order reactions, second-order reactions (with equal and unequal initial concentration of reactants), half-life period, methods for determination order of a reactions, Arrhenius equation-temperature dependence of reaction rates, numericals.	<b>8</b>	
<b>Unit 2</b>	<b>Surface Chemistry</b> Introduction to surface chemistry - some basic terms related to surface chemistry, adsorption, adsorption materials, factors affecting on adsorption, characteristics of adsorption, types of adsorptions, classification of adsorption isotherms, Langmuir adsorption isotherm, Freundlich adsorption isotherm), application of adsorption, numericals.	<b>7</b>	
<b>Unit 3</b>	<b>Errors in Quantitative Analysis</b>	<b>5</b>	

	Introduction to errors, limitation of analytical methods, classification of errors, accuracy, precision, minimization of errors, significant figures and computation methods of expressing accuracy and precision, mean and standard deviations, reliability of results and numericals.	
<b>Unit 4</b>	<p><b>Volumetric Analysis</b></p> <p>Introduction to volumetric analysis, classification of reactions in volumetric analysis, standard solutions, equivalents, normality, molality, oxidation numbers, preparation of standard solutions, primary and secondary standards. Types of Volumetric Analysis methods:</p> <ol style="list-style-type: none"> <li>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<sub>2</sub>CO<sub>3</sub> content in washing soda.</li> <li>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, Eriochrome black – T, Patton and Reeder’s indicator only), standard EDTA solution, determination of Ca (II) and Mg(II), total hardness of water.</li> <li>3. Redox Titrations: Definition of oxidizing agent, reducing agent, redox titration, K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> and KMnO<sub>4</sub> as oxidizing agents, 1,10-phenanthroline as indicator in reduction titration, diphenyl amine as oxidation indicator, KMnO<sub>4</sub> as self-indicator, Standard KMnO<sub>4</sub> solution and standardization with sodium oxalate, Determination of H<sub>2</sub>O<sub>2</sub>.</li> <li>4. Precipitation titrations: precipitation reactions, determination of end point (formation of coloured ppt, formation of soluble coloured compound, adsorption indicator), standard AgNO<sub>3</sub> solution, standardization of AgNO<sub>3</sub> solution, potassium chromate indicator- Mohr’s titration, determination of chloride and bromide, determination of iodide. Numericals based on analysis.</li> </ol>	<b>10</b>
	1. Atkins’ Physical Chemistry by Peter Atkins, Juliode Paula, James Keeler-11 <sup>th</sup> edition	

<b>References</b>	<ol style="list-style-type: none"> <li>2. Principles of physical chemistry by B. R. Puri, L. R. Sharma, M. S. Pathania</li> <li>3. Essentials of Physical chemistry by Bahl Tuli- Revised Multicolour Edition 2009, S. Chand and Company Ltd.</li> <li>4. Vogel's Text book of quantitative Chemical Analysis, 5<sup>th</sup> Ed. G. H. Jeffry, J. Basset, J. Mendham, R. C. Denney, Longman Scientific and Technical, 1989.</li> <li>5. Analytical Chemistry, G.D. Christian, P. K. Dasgupta, K. A. Schug, 7<sup>th</sup> Ed, Wiley, 2004.</li> <li>6. Fundamentals of Analytical Chemistry Skoog, west, Holler, Crouch, 9th Ed. Brooks/Cole, 2014/2004.</li> </ol>
<b>Learning outcomes</b>	<p><b>Chemical Kinetics</b></p> <p>After studying the Chemical Kinetics student will able to-</p> <ol style="list-style-type: none"> <li>1. Define/ Explain concept of kinetics, terms used, rate laws, molecularity, order.</li> <li>2. Explain factors affecting rate of reaction.</li> <li>3. Explain/ discuss/ derive integrated rate laws, characteristics, expression for half-life and examples of zero order, first order, and second order reactions.</li> <li>4. Determination of order of reaction by integrated rate equation method, graphical method, half-life method and differential method.</li> <li>5. Explain/ discuss the term energy of activation with the help of energy diagram.</li> <li>6. Explanation for temperature coefficient and effect of temperature on rate constant k.</li> <li>7. Derivation of Arrhenius equation and evaluation of energy of activation graphically.</li> <li>8. Derivations of collision theory and transition state theory of bimolecular reaction and comparison.</li> <li>9. Solve/ discuss the problem based applying theory and equations.</li> </ol> <p><b>Surface Chemistry</b></p> <ol style="list-style-type: none"> <li>1. Define/ explain adsorption, classification of given processes into physical and chemical adsorption.</li> <li>2. Discuss factors influencing adsorption, its characteristics, differentiate types as physisorption and Chemisorption</li> <li>3. Classification of Adsorption Isotherms, to derive isotherms.</li> <li>4. Explanation of adsorption results in the light of Langmuir adsorption isotherm, Freundlich adsorption Isotherm and BET theory.</li> </ol>

5. Apply adsorption process to real life problem.
6. Solve/discuss problems using theory.


### **Errors in Quantitative Analysis**

1. Define, explain and compare meaning of accuracy and precision.
2. Apply the methods of expressing the errors in analysis from results.
3. Explain/ discuss different terms related to errors in quantitative analysis.
4. Apply statistical methods to express his/ her analytical results in laboratory.
5. Solve problems applying equations.

### **Volumetric Analysis**

After studying the Volumetric Analysis student will be able to-

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 perform standardization of solutions.
5. To construct acid–base titration curves and perform 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.

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<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Major Theory Paper II NCHMJ232</b> <b>Organic and Inorganic Chemistry-I</b>		
<b>S. Y. B. Sc.</b>		<b>Credits- 2</b>
<b>Semester-III</b>		<b>Hours-30</b>
<b>Course Specific Outcome</b> <ol style="list-style-type: none"> <li>1. MOT study best to complete learning of inorganic compounds with covalent bonding</li> <li>2. Learning basic coordination chemistry, synthesis, reactivities, and nomenclature</li> <li>3. Hydrocarbons study for IUPAC nomenclature, basic reactions of EAS</li> <li>4. Aryl and alkyl halides for understanding of electrophilic and nucleophilic reactions, synthetic applications</li> <li>5. Phenol and ethers learning with reactivities and its applications with fundamental, name reactions for conceptual understanding</li> </ol>		
<b>Sr. No.</b>	<b>Course Content/ Syllabus</b>	<b>Lectures</b>
<b>Unit 1</b>	<b>Molecular Orbital Theory of Covalent Bonding</b> 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: $H_2^+$ molecule ion, $H_2$ molecule, $He_2^+$ molecule ion, $He_2$ molecule, $Li_2$ molecule, $Be_2$ molecule, $B_2$ molecule, $C_2$ molecule, $N_2$ molecule, $O_2$ molecule, $O_2^-$ and $O_2^{2-}$ ion, $F_2$ molecule, Heteronuclear diatomic molecules: NO, CO, HF.	<b>11</b>

<p><b>Unit 2</b></p>	<p><b>Introduction to Coordination chemistry</b></p> <p>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</p>	<p><b>04</b></p>
<p><b>Unit 3</b></p>	<p><b>Aromatic hydrocarbons</b></p> <p>Introduction and IUPAC nomenclature, preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).</p>	<p><b>04</b></p>
<p><b>Unit 4</b></p>	<p><b>Alkyl and Aryl Halides</b></p> <p><b>Alkyl Halides (up to 5 Carbons):</b> Introduction and IUPAC nomenclature, Types of Nucleophilic Substitution (<math>S_N^1</math>, <math>S_N^2</math> and <math>S_{Ni}</math>) reactions. Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite &amp; nitro formation, nitrile &amp; isonitrile formation. Williamson's ether synthesis: Elimination vs. substitution.</p> <p><b>Aryl Halides:</b> Introduction and IUPAC nomenclature, Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer and Gattermann reactions. Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by <math>-OH</math> group) and effect of nitro substituent. Benzyne Mechanism: <math>KNH_2/NH_3</math> (or <math>NaNH_2/NH_3</math>). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.</p>	<p><b>06</b></p>
<p><b>Unit 5</b></p>	<p><b>Alcohols, Phenols and Ethers</b></p> <p><b>Alcohols:</b> Introduction and IUPAC nomenclature, Preparation: Preparation of <math>1^\circ</math>, <math>2^\circ</math> and <math>3^\circ</math> 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. <math>KMnO_4</math>, acidic dichromate, conc. <math>HNO_3</math>). Oppeneauer oxidation Diols: (Up to 6 Carbons) oxidation of diols.</p>	<p><b>05</b></p>

	<p>Pinacol-Pinacolone rearrangement.</p> <p><b>Phenols:</b> Introduction and IUPAC nomenclature, Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann Reaction, Houben–Hoesch Condensation, Schotten–Baumann Reaction. <b>Ethers (aliphatic and aromatic):</b> Cleavage of ethers with HI.</p>
<b>References</b>	<p>References: (Inorganic Chemistry)</p> <ol style="list-style-type: none"> <li>1. Concise Inorganic Chemistry, J. D. Lee, 5<sup>th</sup> Ed (1996) Blackwell Science</li> <li>2. Inorganic Chemistry, James E. House, Academic Press (Elsevier), 2008</li> <li>3. Inorganic Chemistry by Miessler and Tarr, Third Ed. (2010), Pearson.</li> <li>4. Principles of Inorganic Chemistry, Brian W. Pfennig, Wiley (2015)</li> <li>5. Inorganic Chemistry, Catherine Housecroft, Alan G. Sharpe, Pearson Prentis Hall, 2008.</li> <li>6. Basics Inorganic Chemistry, Cotton and Wilkinson</li> </ol> <p>References: (Organic Chemistry)</p> <ol style="list-style-type: none"> <li>1. Morrison, R.T. &amp; Boyd, R.N. <i>Organic Chemistry</i>, Prentice Hall of India, Sixth Edition, 2002, 283-308.</li> <li>2. Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers <i>Organic Chemistry</i> - Oxford University Press, USA, 2<sup>nd</sup> Ed.</li> <li>3. Bahl, A. and Bahl, B.S. <i>Advanced Organic Chemistry</i>, S. Chand, 2010.</li> <li>4. Graham Solomon, T.W., Fryhle, C.B. &amp; Snyder, S.A. <i>Organic Chemistry</i>, John Wiley and Sons (2014).</li> <li>5. Mc Murry, J.E. <i>Fundamentals of Organic Chemistry</i>, 7<sup>th</sup> Ed. Cengage Learning India Edition, 2013.</li> <li>6. Sykes, P. <i>A Guidebook to Mechanism in Organic Chemistry</i>, Orient Longman, New Delhi (1988).</li> <li>7. Finar, I. L. <i>Organic Chemistry</i> (Vol. I and II), E.L.B.S.</li> </ol>
<b>Learning Outcome</b>	<p>After studying the <b>Molecular Orbital Theory</b> student will able to-</p> <ol style="list-style-type: none"> <li>1. Define terms related to molecular orbital theory (AO, MO, sigma bond,</li> </ol>

pi bond, bond order, magnetic property of molecules, etc).

2. Explain and apply LCAO principle for the formation of MO's from AO's.
3. Explain formation of different types of MO's from AO's.
4. Distinguish between atomic and molecular orbitals, bonding, anti-bonding and non-bonding molecular orbitals.
5. Draw and explain MO energy level diagrams for homo and hetero diatomic molecules. Explain bond order and magnetic property of molecule.
6. Explain formation and stability of molecule on the basis of bond order.
7. Apply MOT to explain bonding in diatomic molecules other than explained in syllabus.

After studying the **Introduction to Coordination Compounds** student will be able to-

1. Define different terms related to the coordination chemistry (double salt, coordination compounds, coordinate bond, ligand, central metal ion, complex ion, coordination number, magnetic moment, crystal field stabilization energy, types of ligands, chelate effect, etc.)
2. Explain Werner's theory of coordination compounds. Differentiate between primary and secondary valency. Correlate coordination number and structure of complex ion.

Apply IUPAC nomenclature to coordination compound

After studying the **Aromatic Hydrocarbons** student will be able to-

1. Identify and draw the structures aromatic hydrocarbons from their names or from structure name can be assigned.
2. Explain / discuss synthesis of aromatic hydrocarbons.
3. Give the mechanism of reactions involved.
4. Explain /Discuss important reactions of aromatic hydrocarbon.
5. To correlate reagent and reactions.


After studying the **Alkyl and Aryl Halides** student will be able to-

1. Identify and draw the structures alkyl / aryl halides from their names or from structure name can be assigned.

2. Explain / discuss synthesis of alkyl / aryl halides.
3. Write / discuss the mechanism of Nucleophilic Substitution ( $\text{SN}^1$ ,  $\text{SN}^2$  and  $\text{SNi}$ ) reactions.
4. Explain /Discuss important reactions of alkyl / aryl halides.
5. To correlate reagent and reactions.
6. Give synthesis of expected alkyl / aryl halides.


After studying the **Alcohols and Phenols** student will able to-

1. Identify and draw the structures alcohols / phenols from their names or from structure name can be assigned.
2. Able to differentiate between alcohols and phenols
3. Explain / discuss synthesis of alcohols / phenols.
4. Write / discuss the mechanism of various reactions involved.
5. Explain /Discuss important reactions of alcohols / phenols.
6. To correlate reagent and reactions of alcohols / phenols
7. Give synthesis of expected alcohols / phenols

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<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Major Chemistry Practical - Paper III</b> <b>Organic and Inorganic Chemistry Practical</b> <b>NCHMJ233</b>		
<b>S. Y. B. Sc.</b>		<b>Credits - 2</b>
<b>Semester-III</b>		<b>Hours - 60</b>
<b>Course specific outcomes-</b> <ol style="list-style-type: none"> <li>Students will demonstrate proficiency in fundamental laboratory techniques, including accurate measurement, titration, and handling of laboratory equipment, ensuring precision and reproducibility.</li> <li>Students will critically analyse the success of a synthetic procedure, identifying and troubleshooting issues that may arise during the analysis, preparation and separation of organic and inorganic compounds.</li> </ol>		
<b>Sr. No.</b>	<b>Course Content / Syllabus</b>	<b>Lectures</b>
<b>1</b>	<b>Section-1:</b> <b>Organic Chemistry Practical (Five Mixtures)</b> Organic Qualitative Analysis of given organic mixture (Five mixtures: solid-solid, solid-liquid and liquid –liquid type).	20
<b>2</b>	<b>Section -2:</b> <b>A. Inorganic quantitative analysis</b> 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 <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> -A Green Approach	04


3	Separation and Identification of metal ions by Column Chromatography	04
	<b>B. Synthesis of Coordination compounds</b>	
4	Synthesis of sodium cobaltinitrite (a laboratory chemical) from Co(II) salt and NaNO <sub>2</sub> salts. Comment on colour and magnetic properties of the complex.	04
5	Synthesis of potassium Tris(oxalate)aluminium (III) using Al metal powder (Scrap aluminium). Comment on colour and magnetic properties of the complex.	04
6	Synthesis of Tris(acetylacetonate) iron (III) by green chemistry method by reaction between Fe(OH) <sub>3</sub> and acac. Comment on colour and magnetic properties of the complex.	04
7	Synthesis of Tris(ethylenediamine) nickel (II) from Ni (II) salt, ethylenediamine and sodium thiosulfate. Comment on colour and magnetic properties of the complex.	04
8	Preparation of potassium trioxalato ferrate (III).	04
9	Nickel dimethyl glyoxime using microscale method	04
	<b>C. Inorganic colorimetric investigations</b>	
10	Prepare solution of Fe (III) and SCN <sup>-</sup> in different molar proportion, record their absorbance and calculate equilibrium constant of [Fe (SCN)] <sup>2+</sup> complex.	04
	<b>D. Titrimetric Estimations</b>	
11	Determination of percentage purity of ferrous ammonium sulphate.	04
12	Determination of percentage purity of tris(oxalate) aluminium (III).	04
13	Determination of percentage purity of Potassium trioxalato ferrate (II).	04
<b>References</b>	<ol style="list-style-type: none"> <li>1. Vogel's textbook of practical organic chemistry</li> <li>2. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Aggarwal</li> <li>3. Iron Analysis by Redox Titration A General Chemistry Experiment, Journal of Chemical Education, Volume 65, Number 2, February</li> </ol>	

	<p>1988.183.</p> <ol style="list-style-type: none"> <li>4. A Precise Method for Determining the CO<sub>2</sub> Content of Carbonate Materials, Journal of Chemical Education, Vol. 75, No. 12, December 1998.</li> <li>5. Vogel's Textbook Quantitative Chemical Analysis, 3rd and 6th Ed.</li> <li>6. Advanced Practical Chemistry, Jagdamba Sing et al, Pragati Prakashan, Merrut.</li> <li>7. Practical Chemistry, Panday, Bajpai, Giri, S.Chand and Co.</li> <li>8. Handbook of Preparative Inorganic Chemistry, Volume 2, Second Edition,</li> <li>9. Edited By Georg Braue R, Academic Press, New York, London, 1965. (Page-1541)</li> <li>10. Practical Chemistry, Panday, Bjpai, Giri, S.Chand and Co.</li> <li>11. McNeese, T.J.; Wierda, D.A. Synthesis of Potassium</li> <li>12. Tris(oxalato)aluminate(III) Trihydrate. Journal of Chemical Education, 1983, 60(11), 1001.</li> <li>13. Inorganic Syntheses Vol -1 by H S Booth. First Ed, 1939. (page-36).</li> <li>14. Novel Synthesis of Tris(acetylacetonato)-iron(III), Journal of Chem. Soc. Dalton Trans. 1983</li> <li>15. 13. Metal Acetylacetonate Synthesis Experiments: Which Is Greener?, Journal of Chemical Education, 2011, 88, 947–953, dx.doi.org/10.1021/ed100174f</li> <li>16. Experimental Inorganic/Physical Chemistry: An Investigative, Integrated Approach to Practical Project Work, MounirA. Malati, Woodhead Publishing Limited, 1999.</li> </ol>
<p><b>Learning outcomes</b></p>	<ol style="list-style-type: none"> <li>1. Interpret and analyse the results of qualitative tests to infer the Composition of unknown organic substances.</li> <li>2. Learn the principles of colorimetric, including the relationship between absorbance, concentration, and colour intensity.</li> <li>3. Understand the fundamental principles of coordination chemistry, including the nature of metal-ligand bonding, coordination numbers, and isomerism.</li> <li>4. Perform titrations accurately and precisely, using appropriate indicators and Calculate concentrations of unknown solutions based on titration data.</li> </ol>


	<b>MODERN EDUCATION SOCIETY'S</b> <b>Nowrosjee Wadia College, Pune</b> (Autonomous)	<b>Academic</b> <b>Year</b> <b>2025-2026</b>
<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Minor Chemistry paper I (Theory)</b> <b>Overview of concepts in Chemistry A</b>		
<b>S. Y. B. Sc.</b>		<b>Credits - 2</b>
<b>Semester-III</b>		<b>Hours - 30</b>
<b>Course specific outcomes-</b> <p>Students will be able to use critical thinking and scientific inquiry in the performance, design, interpretation, and documentation of laboratory experiments after completing this course, at a level suitable for success in an entry-level position in the chemical industry or a chemistry graduate Programme</p>		
<b>Sr. No.</b>	<b>Course Content / Syllabus</b>	<b>Lectures</b>
<b>Unit 1</b>	<b>Conductometry</b> 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 Numericals.	<b>7</b>
<b>Unit 2</b>	<b>Ideal and real solutions Introduction</b> 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,	<b>7</b>

	Problems	
<b>Unit 3</b>	<p><b>Aliphatic Hydrocarbons</b></p> <p>Functional group approach for the following reactions (preparations &amp; reactions) to be studied in context to their structure.</p> <p><b>Alkanes:</b> <i>Preparation:</i> Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. <i>Reactions:</i> Free radical Substitution: Halogenation.</p> <p><b>Alkenes:</b> <i>Preparation:</i> Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). <i>Reactions:</i> cis-addition (alk. <math>\text{KMnO}_4</math>) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, Oxymercuration-demercuration, Hydroboration-oxidation.</p> <p><b>Alkynes:</b> <i>Preparation:</i> Acetylene from <math>\text{CaC}_2</math> and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalide <i>Reactions:</i> formation of metal acetylides, addition of bromine and alkaline <math>\text{KMnO}_4</math>, ozonolysis and oxidation with hot alkaline <math>\text{KMnO}_4</math></p>	<b>10</b>
<b>Unit 4</b>	<p><b>Long form of periodic table</b></p> <p>s, p, d and f block elements, Detailed discussion of following properties of elements with reference to s and p block a) Effective nuclear charge, shielding or screening effect b) Atomic and ionic radii c) Crystal radii d) Covalent radii e) Ionization energies f) Electronegativity, Pauling's / electronegativity scale g) Oxidation states of elements</p>	<b>6</b>
<b>References</b>	<p>1. Nivaldo, J. and Tro, Ho Yu Au-Yeung, Introductory Chemistry, Pearson India Education, 2017, 5th edition.</p> <p>2. Timberlake, K. C., and Timberlake, W., Basic Chemistry, Pearson India Education, 2017, 4th edition.</p> <p>3. Pavia, D.L., Lampman, G. M., Kriz, G. S, and Engel, R.G., Microscale and Macroscale Techniques in the Organic Laboratory, Harcourt College Publishers, 2001, 1st edition.</p>	


	<p>4. Harris, D. C., Exploring Chemical Analysis, W. H. Freeman and Company, New York, 1993, 4th edition.</p> <p>5. Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman and Company, New York, 2010, 8th edition.</p>
<b>Learning outcomes</b>	After completing this course, students will be capable of performing, designing, interpreting, and documenting laboratory experiments at initial stage.

	<b>MODERN EDUCATION SOCIETY'S</b> <b>Nowrosjee Wadia College, Pune</b> (Autonomous)	<b>Academic</b> <b>Year</b> <b>2025-2026</b>
<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Minor Chemistry paper II (Practical)</b> <b>Basic Chemistry Practical A</b>		
<b>S. Y. B. Sc.</b>		<b>Credits - 2</b>
<b>Semester-III</b>		<b>Hours - 60</b>
<b>Course specific outcomes-</b> <ol style="list-style-type: none"> <li>1. Correlate theoretical concepts with experimental findings.</li> <li>2. Understand systematic methods of identification of substance by chemical methods.</li> <li>3. Perform organic and inorganic synthesis, monitoring reactions via methods like colour changes, precipitation, and thin-layer chromatography (TLC)</li> </ol>		
<b>Sr. No.</b>	<b>Course Content / Syllabus</b>	<b>Lectures</b>
<b>Section 1: Chemical and Lab Safety (Compulsory)</b>		
<b>1</b>	Toxicity of the compounds used in chemistry laboratory.	4
<b>2</b>	Safety symbol on labels of pack of chemicals and its meaning.	4
<b>Section 2: Organic Chemistry Practical (Compulsory)</b>		
<b>3-6</b>	Organic Qualitative Analysis of given organic mixture [Four mixtures: solid-solid (2), solid-liquid (1) and liquid –liquid (1) type]	16
<b>7</b>	Preparation of benzoic acid from ethyl benzoate (Identification and confirmatory Test of -COOH group, M.P and purity by TLC)	4
<b>8</b>	Preparation of <i>p</i> -bromoacetanilide from acetanilide using ceric ammonium nitrate and potassium bromide. (Green method)	4


	<b>Section 3: Inorganic Chemistry (Any two)</b>	
<b>9</b>	Synthesis of Tris(ethylenediamine) nickel (II) from Ni (II) salt, ethylenediamine and sodium thiosulfate. Comment on colour and magnetic properties of the complex.	4
<b>10</b>	Synthesis of potassium Tris(oxalate)aluminium (III) using Al metal powder (Scrap aluminium). Comment on colour and magnetic properties of the complex.	4
<b>11</b>	Estimation of Mn by Volhard's methods	4
	<b>Section 4: Physical Chemistry (Any two)</b>	
<b>12</b>	To Study the Acid catalysed hydrolysis of an ester (methyl Acetate) and to determine the rate constant (k). (first order reaction)	4
<b>13</b>	To determine the strength of FAS solution by using potassium ferricyanide as an external indicator.	4
<b>14</b>	Measurement of the pH of buffer solutions (Ammonium chloride-Ammonium acetate) and comparison of the values with theoretical values.	4
<b>References</b>	<ol style="list-style-type: none"> <li>1. Vogel's Textbook Quantitative Chemical Analysis, 3rd and 5th Ed.</li> <li>2. Green Chemistry Laboratory Manual for General Chemistry, Sally A. Henrie, CRC Press Taylor &amp; Francis Group, and Informa Business. 2015</li> <li>3. A laboratory manual for general, organic and biological chemistry, 3rd Ed. Pearson</li> </ol>	
<b>Learning outcomes</b>	<ol style="list-style-type: none"> <li>1. Perform the quantitative chemical analysis of substances explain principles behind it</li> <li>2. Systematic working skill in laboratory will be imparted in student</li> <li>3. Understand systematic methods of identification of substance by chemical methods</li> </ol>	

	<b>MODERN EDUCATION SOCIETY'S</b> <b>Nowrosjee Wadia College, Pune</b> <b>(Autonomous)</b>	<b>Academic</b> <b>Year</b> <b>2025-2026</b>
<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Vocational Skill Course (Practical)</b> <b>Practical insights in Analytical Chemistry</b>		
<b>S. Y. B. Sc.</b>		<b>Credits - 2</b>
<b>Semester-III</b>		<b>Hours - 60</b>
<b>Course specific outcomes-</b> <ol style="list-style-type: none"> <li>1. Verify theoretical principles experimentally</li> <li>2. Interpret the experimental data</li> <li>3. Improve analytical skills</li> <li>4. Correlate the theory and experiments and understand their importance</li> </ol>		
<b>Sr. No.</b>	<b>Course Content / Syllabus</b>	<b>Lectures</b>
<b>1</b>	Determination of Ca in presence of Mg using EDTA	<b>4</b>
<b>2</b>	Gravimetric estimation of Al as Al <sub>2</sub> O <sub>3</sub> .	<b>4</b>
<b>3</b>	Estimation of chlorine in water sample using Iodometric method.	<b>4</b>
<b>4</b>	Volumetric estimation of NO <sup>2-</sup> by using KMnO <sub>4</sub> solution.	<b>4</b>
<b>5</b>	Determination of sodium carbonate contents of washing soda by titration with standard solution of HCl. Express your results as average ± standard deviation	<b>4</b>
<b>6</b>	Estimation of Al (III) from the given aluminium salt solution by using Erichrome Black-T indicator (Back titration method).	<b>4</b>
<b>7</b>	Gravimetric estimation of Pb as PbCrO <sub>4</sub> .	<b>4</b>
<b>8</b>	a) Preparation of standard 0.05 N oxalic acid solution and standardization of approx. 0.05N KMnO <sub>4</sub> solution. b) Determination of the strength of given H <sub>2</sub> O <sub>2</sub> solution with standard 0.05 N KMnO <sub>4</sub> solutions.	<b>4</b>

9	Energy of activation of the reaction between $K_2S_2O_8$ and KI with unequal initial concentration.	4
10	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.	4
11	To obtain the temperature-composition phase diagram for a two-component liquid system with maximum (or minimum) boiling point and to determine the maximum (or minimum) boiling point and composition.	4
12	To compare the relative strength of HCl and $H_2SO_4$ or $HNO_3$ by studying the kinetics of hydrolysis of methyl acetate	4
13	To determine % of dissolved oxygen by Winkler's method	4
14	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.	4
15	To study the variation of mutual solubility temperature with % concentration for the phenol - water system	4
<b>References</b>	<ol style="list-style-type: none"> <li>1. Systematic experimental physical chemistry, S. W. Rajbhoj, T. K. Chondekar, Anjali publication.</li> <li>2. Practical Physical Chemistry, Vishwanathan and Raghwan, Viva book.</li> <li>3. Practical Chemistry, O. P. Pandey, D. N. Bajpai Dr. S. Giri, S Chand Publication</li> <li>4. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publication.</li> <li>5. Analytical Chemistry by G.D. Christian 6th edition.</li> <li>6. Vogel's Textbook of Quantitative chemical analysis 6th edition R.C. Denney, J.D. Barnes, M.J.K. Thomas</li> <li>7. Advanced Practical Chemistry, Jagdamba Sing et al, PragatiPrakashan, Merrut.</li> <li>8. Practical Chemistry, Panday, Bajpai, Giri, S.Chand and Co.</li> <li>9. 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, <i>Journal of Chemical Education</i>, Vol. 88 No.3, March 2011.</li> </ol>	
<b>Learning outcomes</b>	<ol style="list-style-type: none"> <li>1. Understanding the basics of Chemical Kinetics</li> <li>2. Understanding the basics of pH Metry</li> <li>3. Verify theoretical principles experimentally</li> <li>4. Interpret the experimental data</li> <li>5. Improve analytical skills</li> <li>6. Correlate the theory and experiments and understand their importance</li> </ol>	


	<b>MODERN EDUCATION SOCIETY'S</b> <b>Nowrosjee Wadia College, Pune</b> <b>(Autonomous)</b>	<b>Academic</b> <b>Year</b> <b>2025-2026</b>
<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Indian Knowledge System (IKS)</b> <b>Beauty Aids, Cosmetics Manufacturing in Ancient Indian Literature</b>		
<b>S. Y. B. Sc.</b>		<b>Credits - 2</b>
<b>Semester-III</b>		<b>Hours - 30</b>
<b>Course specific outcomes-</b> <ol style="list-style-type: none"> <li>1. Verify theoretical concepts of Ancient Indian Literature</li> <li>2. Improve Beauty Aids and Cosmetics skills</li> <li>3. Correlate the theory and experiments to understand their importance</li> </ol>		
<b>Sr.No</b>	<b>Course Content/Syllabus</b>	
<b>Unit-1</b>	<b>Introduction</b> History, Beauty aids and cosmetics and its development, PLANTA COSMETICA Including Sanskrit terms	<b>5</b>
<b>Unit-2</b>	<b>Cosmetics</b> Types of Skin and HERBAL COSMETICS, Facial Cosmetics, Oral Hygiene, Body Cosmetics , Cosmetics for Hair	<b>7</b>
<b>Unit-3</b>	<b>Formulation and Manufacturing Process of Various Cosmetics</b> Introduction, Lipsticks, Shampoos , Powders , Nail lacquers Creams, Toothpastes , Hair dyes	<b>8</b>
<b>Unit-4</b>	<b>Cosmetic Industry</b> Details study of Cosmetics Industry of India, Raw Material, Synthesis process, Phase-I ,Phase-2 study, Formulation , Packaging, Quality control ,Regulatory compliance , Distribution and Logistics	<b>10</b>
<b>Learning outcomes</b> <ol style="list-style-type: none"> <li>1. Understanding the basics Indian culture</li> </ol>		

	<ol style="list-style-type: none"><li>2. Understanding the basics of Indian Flora</li><li>3. To investigates young consumers' perceptions of herbal beauty products</li><li>4. Understanding the influenced global intellectual traditions, and to shaped modern science and technology</li></ol>
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	<b>MODERN EDUCATION SOCIETY'S</b> <b>Nowrosjee Wadia College, Pune</b> (Autonomous)	<b>Academic</b> <b>Year</b> <b>2025-2026</b>
<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Open Elective</b> <b>Chemistry in Daily Life</b>		
<b>S. Y. B. Sc.</b>		<b>Credits - 2</b>
<b>Semester- III</b>		<b>Hours - 30</b>
<b>Course specific outcomes-</b> <ol style="list-style-type: none"> <li>1. Understand the basic requirements of nutrients for human beings.</li> <li>2. Distinguish applications of Artificial Sweeteners and Flavors.</li> <li>3. Learn the chemistry of Additives.</li> <li>4. Build knowledge about various preservatives and methods of preserving food.</li> </ol>		
<b>Sr. No.</b>	<b>Course Content / Syllabus</b>	<b>Lectures</b>
<b>Unit 1</b>	<b>Chemistry of Nutrition</b> <ul style="list-style-type: none"> <li>• Nutrition and nutrients, classes of nutrients</li> <li>• General nutritional needs of human beings, malnutrition</li> <li>• Nutrient recommendation and daily allowance (RDA), calorific data of nutrients</li> <li>• Calculation of calorific value of food, food sources of carbohydrates, proteins, and fats</li> <li>• Problems associated with excess and deficiency of carbohydrates, proteins, and fast minerals</li> <li>• Functions of nutrients, minerals in the human body</li> <li>• Essential dietary elements: Ca, I, Fe, K, Na in health issues</li> <li>• Vitamins: sources and deficiency effects (A, B, C, D, E, K)</li> </ul>	<b>15 Lectures</b>
<b>Unit 2</b>	<b>Artificial Sweeteners and Flavours</b> <ul style="list-style-type: none"> <li>• Artificial Sweeteners: Aspartame, saccharine, dulcin, sucrose, and sodium cyclamate</li> <li>• Flavours: Vanillin, alkyl esters (fruit flavours), and monosodium glutamate</li> </ul>	<b>5 Lectures</b>
<b>Unit 3</b>	<b>Food Additives</b>	<b>5 Lectures</b>

	<ul style="list-style-type: none"> <li>• Introduction to food additives: classification and role in food processing</li> <li>• Colorants in food: natural and synthetic food colors, regulations</li> <li>• Emulsifiers, stabilizers, and thickeners: lecithin, pectin, carrageenan, applications</li> <li>• Antioxidants in food: BHT, BHA, ascorbic acid, tocopherols, health effects</li> <li>• Sweeteners and flavor enhancers: artificial and natural sweeteners, MSG, safety concerns</li> </ul>	
<b>Unit 4</b>	<p><b>Food Preservatives</b></p> <ul style="list-style-type: none"> <li>• Introduction to food preservation: types of spoilage, natural vs. synthetic preservatives</li> <li>• Chemical preservatives: benzoates, sorbates, sulfites, nitrates, mechanism of action</li> <li>• Natural preservatives and antimicrobial agents: salt, sugar, vinegar, essential oils, bacteriocins</li> <li>• Physical methods of food preservation: pasteurization, freezing, irradiation, emerging technologies</li> <li>• Case studies and health implications: food adulteration, safety concerns, consumer awareness</li> </ul>	<b>5 Lectures</b>
<b>References</b>	<ol style="list-style-type: none"> <li>1. Belitz, H. D., Grosch, W., &amp; Schieberle, P. (2009). Food Chemistry (4th ed.). Springer.</li> <li>2. Coultate, T. P. (2016). Food: The Chemistry of Its Components (6th ed.). Royal Society of Chemistry.</li> <li>3. Fennema, O. R. (2008). Fennema's Food Chemistry (4th ed.). CRC Press.</li> <li>4. Potter, N. N., &amp; Hotchkiss, J. H. (2012). Food Science (5th ed.). Springer.</li> <li>5. Sharma, B. K. (2007). Industrial Chemistry (16th ed.). Goel Publishing House.</li> <li>6. Indian Food Safety and Standards Authority (FSSAI). Regulations and Guidelines on Food Additives and Preservatives.</li> </ol>	
<b>Learning outcomes</b>	<ol style="list-style-type: none"> <li>1. Understand the basic requirements of nutrients and their role in human health.</li> <li>2. Explain the chemistry behind artificial sweeteners and flavors, their applications, and safety concerns.</li> <li>3. Describe different types of food additives, their functions, and regulatory aspects.</li> <li>4. Discuss food preservation methods, including chemical, natural, and physical techniques.</li> <li>5. Analyze the impact of food additives and preservatives on health and consumer safety.</li> <li>6. Apply scientific knowledge to evaluate food labels and identify potential food adulteration.</li> </ol>	

# SEMESTER IV

	<b>MODERN EDUCATION SOCIETY'S</b> <b>Nowrosjee Wadia College, Pune</b> (Autonomous) NEP 2.0	<b>Academic</b> <b>Year</b> <b>2025-2026</b>
<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Major Theory Paper-1</b> <b>Physical and Analytical Chemistry</b>		
<b>S. Y. B. Sc.</b>		<b>Credits - 2</b>
<b>Semester- IV</b>		<b>Hours - 30</b>
<b>Course specific outcomes-</b> <ol style="list-style-type: none"> <li>1. To understand fundamental concept of Physical and Analytical Chemistry.</li> <li>2. To impart basic understanding of stoichiometric calculations.</li> <li>3. To impart practical skills and learn basics behind experiments.</li> <li>4. To prepare background for advanced and applied studies in chemistry</li> </ol>		
<b>Sr. No.</b>	<b>Course Content / Syllabus</b>	<b>Lectures</b>
<b>Unit 1</b>	<b>Phase equilibrium</b> 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 and numericals.	8
<b>Unit 2</b>	<b>Ideal and real solutions</b> 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	7

	liquids, Problems	
<b>Unit 3</b>	<p><b>Conductometry</b> 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 Numericals.</p>	<b>5</b>
<b>Unit 4</b>	<p><b>Colorimetry</b> Introduction, interaction of electromagnetic radiation with matter, essential terms: radiant power, transmittance, absorbance, Lambert's Law, Beer's Law, Lambert-Beer's Law, molar absorptivity, deviations from Beer's Law, Colorimeter: Principle, Construction and components, Working. Applications—determination of unknown conc. by calibration curve method, Determination of unknown concentration of Fe(III) by thiocyanate method, Numericals</p>	<b>5</b>
<b>Unit 5</b>	<p><b>Column Chromatography</b> Introduction, Principle of Column Chromatography, Ion Exchange Chromatography: Ion exchange resins, action of ion exchange resin (Ion exchange equilibria, Ion exchange capacity), Experimental technique, Application: i) Separation of Metal ions / non-metal ions on Ion Exchange Chromatography ( Zn(II) and Mg(II), Cl<sup>-</sup> and Br<sup>-</sup>), ii) Purification of water, Adsorption Chromatography –Liquid solid chromatography: Introduction, the technique of conventional chromatography, column packing materials, Selection of solvent for adsorption chromatography, Adsorption column preparation and loading, Application– Purification of anthracene</p>	<b>5</b>
<b>References</b>	<ol style="list-style-type: none"> <li>1. Samuel Glasstone, Thermodynamics for Chemists, Affiliated East West Private Limited.</li> <li>2. B S Bahl, G D Tuli, Arun Bahl, Essentials of Physical Chemistry</li> <li>3. Peter Atkins and Julio de Paula, Elements of Physical Chemistry, Sixth edition (2013), Oxford press</li> <li>5. Ball D. W., Physical Chemistry, Thomson Press, India (2007)</li> <li>4. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).</li> <li>5. Atkins' Physical Chemistry –Thermodynamics and Kinetics, 11th Edition, Oxford Press</li> </ol>	

	<ol style="list-style-type: none"> <li>6. Thomas Engel, Philip Reid; Physical Chemistry, Pearson Education (2006)</li> <li>7. Cotton, F.A., Wilkinson, G. &amp; Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.</li> <li>8. Douglas, B.E., McDaniel, D.H. &amp; Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley &amp; Sons.</li> <li>9. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.</li> </ol>
<p><b>Learning outcomes</b></p>	<p style="text-align: center;"><b>Phase equilibrium</b></p> <ol style="list-style-type: none"> <li>1. Define the terms in phase equilibria such as-system, phase in system, components in system, degree of freedom, one/ two component system, phase rule, etc.</li> <li>2. Explain meaning and Types of equilibrium such as true or static, meta stable and unstable equilibrium.</li> <li>3. Discuss meaning of phase, component and degree of freedom.</li> <li>4. Derive of phase rule.</li> <li>5. Explain of one component system with respect to: Description of the curve,</li> <li>6. Phase rule relationship and typical features for i) Water system ii) Carbon dioxide system iii) Sulphur system</li> </ol> <p style="text-align: center;"><b>Ideal and Real solutions</b></p> <ol style="list-style-type: none"> <li>1. Define various terms, laws, differentiate ideal and non-ideal solutions.</li> <li>2. Discuss/ explain thermodynamic aspects of Ideal solutions- Gibbs free energy change, Volume change, Enthalpy change and entropy change of mixing of Ideal solution.</li> <li>3. Differentiate between ideal and non-ideal solutions and can apply Raoult's law.</li> <li>4. Interpretation of i) vapour pressure– composition diagram ii) temperature composition diagram. Explain distillation of liquid solutions from temperature – composition diagram</li> <li>5. Explain/discuss azeotropes, Lever rule, Henrys law and its application.</li> <li>6. Discuss / explain solubility of partially miscible liquids- systems with upper critical. Solution temperature, lower critical solution temperature and having both UCST and LCST</li> <li>7. Explain/discuss concept of distribution of solute amongst pair of immiscible solvents</li> <li>8. Derive distribution law and its thermodynamic proof.</li> <li>9. Apply solvent extraction to separate the components of from mixture interest</li> <li>10. Solve problem by applying theory.</li> </ol>

### **Conductometry**


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

### **Colorimetry**

1. Explain/define different terms in Colorimetry such as radiant power,
2. transmittance, absorbance, molar, Lamberts Law, Beer's Law, molar absorptivity
3. Discuss/ explain/ derive Beer's law of absorptivity
4. Explain construction and working of colorimeter.
5. Apply colorimetric methods of analysis to real problem in analytical laboratory.
6. Solve problems based on theory/equations.
7. Correlate different terms with each other and derive equations for their correlations

### **Column Chromatography**

1. Explain/define different terms in column chromatography such as stationary phase, mobile phase, elution, adsorption, ion exchange resin, adsorbate, etc.
2. Explain properties of adsorbents, ion exchange resins, etc.
3. Discuss/ explain separation of ionic substances using resins.
4. Discuss/explain separation of substances using silica gel/alumina.
5. Apply column chromatographic process for real analysis in analytical laboratory.

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<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Major Paper II NCHMJ242</b> <b>Organic and Inorganic Chemistry-II</b>		
<b>S. Y. B. Sc.</b>		<b>Credits 2</b>
<b>Semester- IV</b>		<b>Hours 30</b>
<b>Course Specific Outcome</b> <ol style="list-style-type: none"> <li>1. Students must learn stereochemistry in an inorganic coordination complex.</li> <li>2. Study of VBT for the understanding of hybridization, bonding, and geometry</li> <li>3. Advancement of CFT to improve inorganic complex study and its reactivity.</li> <li>4. Study of carbonyl compounds reactions for basic understanding of reactivities</li> <li>5. Study of amines for various reactions and reactivities with applications</li> <li>6. Stereochemistry of cyclic compounds for fundamentals of advance stereochemistry</li> </ol>		
<b>Sr. No.</b>	<b>Course Content/ Syllabus</b>	<b>Lectures</b>
Unit 1	<b>Isomerism in coordination complexes</b> Introduction, polymerization isomerism, ionization isomerism, hydrates isomerism, linkage isomerism, coordination isomerism, coordination position isomerism, geometric isomerism, optical isomerism.	02
Unit 2	<b>Valance Bond Theory of Coordination Compound</b> Aspects and assumptions of VBT, applications of VBT on the basis of hybridization to explain the structure and bonding in $[\text{Ag}(\text{NH}_3)_2]^+$ , $[\text{Ni}(\text{Cl}_4)]^{2-}$ , $[\text{Ni}(\text{CN})_4]^{2-}$ , $[\text{Cr}(\text{H}_2\text{O}_6)]^{3+}$ , $[\text{Fe}(\text{CN})_6]^{3-}$ (Inner orbital complex) and $[\text{FeF}_6]^{3-}$ (outer orbital complex). Use of observed magnetic moment in deciding the geometry in complexes with C.N.4, limitations of VBT.	03

Unit 3	<p><b>Crystal Field Theory</b></p> <p>Shapes of d-orbitals, Crystal field Theory (CFT): Assumptions, Application of CFT to</p> <p>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)</p> <p>ii) Square planar complexes and iii) Tetrahedral complexes; spin only magnetic moment of Oh and Td complexes.</p>	10
Unit 4	<p><b>Aldehydes and Ketones (aliphatic and aromatic)</b></p> <p>(Formaldehyde, acetaldehyde, acetone and benzaldehyde)</p> <p>Introduction and IUPAC nomenclature, <i>Preparation</i>: from acid chlorides and from nitriles.</p> <p><b>Reactions</b> – Reaction with HCN, ROH, NaHSO<sub>3</sub>, NH<sub>2</sub>-G derivatives. Iodoform test, Aldol Condensation, Cannizzaro’s reaction, Wittig reaction, Benzoin condensation, Clemenson reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.</p>	04
Unit 5	<p><b>Carboxylic acids and their derivatives</b></p> <p><b>Carboxylic acids (aliphatic and aromatic):</b> Introduction and IUPAC nomenclature, <i>Preparation</i>: Acidic and Alkaline hydrolysis of esters. <i>Reactions</i>: Hell-Vohlard - Zelinsky Reaction.</p> <p><b>Carboxylic acid derivatives (aliphatic):</b> (up to 5 carbons) <i>Preparation</i>: Acid chlorides, Anhydrides, Esters and Amides from acids and their inter conversion. <i>Reaction</i>: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.</p>	05
Unit 6	<p><b>Stereochemistry of Cyclohexane</b></p> <p>Bayer’s strain theory, heat of combustion of cycloalkanes, structure of cyclohexane, axial and equatorial H atoms, conformations of cycloalkane, stability of conformations of cyclohexane, methyl and t-butyl monosubstituted cyclohexane, 1,1 and 1,2 dimethyl cyclohexane and their</p>	06

	stability.	
<b>References</b>	<p><b>References: (Inorganic Chemistry)</b></p> <ol style="list-style-type: none"> <li>1. Concise inorganic chemistry, J. D. Lee, 5<sup>th</sup> Ed (1996), Blackwell Science</li> <li>2. Inorganic Chemistry, James E. House, Academic Press (Elsevier), 2008</li> <li>3. Inorganic Chemistry by Miessler and Tarr, Third Ed. (2010), Pearson.</li> </ol> <p><b>References: (Organic Chemistry)</b></p> <ol style="list-style-type: none"> <li>1. Morrison, R.T. and Boyd, R.N. <i>Organic Chemistry</i>, Prentice Hall of India, Sixth Edition, 2002, 283-308.</li> </ol> <p><b>Other Reference Books for All Chapters:</b></p> <ol style="list-style-type: none"> <li>2. Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers, <i>Organic Chemistry</i>-Oxford University Press, USA, 2<sup>nd</sup> Ed.</li> <li>3. Bahl, A. and Bahl, B.S. <i>Advanced Organic Chemistry</i>, S. Chand, 2010.</li> <li>4. Graham Solomon, T. W., Fryhle, C. B. and Snyder, S. A. <i>Organic Chemistry</i>, John Wiley and Sons (2014).</li> <li>5. Mc Murry, J.E. <i>Fundamentals of Organic Chemistry</i>, 7<sup>th</sup> Ed. Cengage Learning India Edition, 2013.</li> <li>6. Sykes, P. <i>A Guidebook to Mechanism in Organic Chemistry</i>, Orient Longman, New Delhi (1988).</li> <li>7. Finar, I.L. <i>Organic Chemistry</i> (Vol. I &amp; II), E.L.B.S.</li> </ol>	
<b>Learning Outcome</b>	<p>After studying the <b>Isomerism in coordination complexes</b> student will able to-</p> <ol style="list-style-type: none"> <li>1. Isomerism in coordination complexes</li> <li>2. Explain different types of isomerism in coordination complexes.</li> </ol> <p>After studying the <b>Valence Bond Theory</b> student will able to-</p> <ol style="list-style-type: none"> <li>1. Apply principles of VBT to explain bonding in coordination compound of different geometries.</li> <li>2. Correlate no of unpaired electrons and orbitals used for bonding.</li> <li>3. Identify / explain / discuss inner and outer orbital complexes.</li> <li>4. Explain / discuss limitation of VBT.</li> </ol> <p>After studying the <b>Crystal Field Theory</b> student will able to-</p> <ol style="list-style-type: none"> <li>1. Explain principle of CFT.</li> <li>2. Apply crystal field theory to different type of complexes (Td, Oh, Sq, Pl complexes)</li> </ol>	

3. Explain: i) strong field and weak field ligand approach in Oh complexes  
ii) Magnetic properties of coordination compounds on the basis of weak and strong ligand field ligand concept. iii) Origin of colour of coordination complex.

4. Calculate field stabilization energy and magnetic moment for various complexes.

5. To identify Td and Sq. Pl complexes on the basis of magnetic properties / unpaired electrons.

6. Explain spectrochemical series, tetragonal distortion / Jahn-Teller effect in Cu (II) Oh complexes only.

After studying the **Aldehydes and Ketones** student will able to-

1. Identify and draw the structures aldehydes and ketones from their names or from structure name can be assigned.

2. Explain / discuss synthesis of aldehydes and ketones.

3. Write / discuss the mechanism reactions aldehydes and ketones.

4. Explain /Discuss important reactions of aldehydes and ketones.

5. To correlate reagent and reactions of aldehydes and ketones

6. Give synthesis of expected aldehydes and ketones.

7. Perform inter conversion of functional groups.

After studying the **Carboxylic acids and their derivatives** student will able to-

1. Identify and draw the structures carboxylic acids and their derivatives from their names or from structure name can be assigned.

2. Explain / discuss synthesis of carboxylic acids and their derivatives.

3. Write / discuss the mechanism reactions carboxylic acids and their derivatives.

4. Explain /Discuss important reactions of carboxylic acids and their derivatives.

5. Correlate reagent and reactions of carboxylic acids and their derivatives


6. Give synthesis of expected carboxylic acids and their derivatives.

7. Perform inter conversion of functional groups.


After studying the **Amines and Diazonium Salts** student will able to-

8. Identify and draw the structures amines from their names or from structure name can be assigned.

	<p>9. Explain / discuss synthesis of carboxylic amines.</p> <p>10. Write / discuss the mechanism reactions carboxylic amines.</p> <p>11. Explain / Discuss important reactions of carboxylic amines.</p> <p>12. To correlate reagent and reactions of carboxylic amines.</p> <p>13. Give synthesis diazonium salt from amines and reactions of diazonium salt.</p> <p>14. Perform inter conversion of functional groups.</p> <p>After studying the <b>Stereochemistry of Cyclohexane</b> student will able to-</p> <ol style="list-style-type: none"> <li>1. Draw the structures of different conformations of cyclohexane.</li> <li>2. Define terms such as axial hydrogen, equatorial hydrogen, confirmation, substituted cyclohexane, etc.</li> <li>3. Convert one conformation of cyclohexane to another conformation and should able to identify governing structural changes.</li> <li>4. Explain / discuss stability with respect to potential energy of different conformations of cyclohexane.</li> <li>5. Draw structures of different conformations of methyl / t-butyl monosubstituted cyclohexane (axial, equatorial) and 1, 2 dimethyl cyclohexane.</li> <li>6. Identify cis- and trans-isomers of 1, 2 dimethyl substituted cyclohexane and able to compare their stability.</li> </ol>
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<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Major Chemistry Practical (Paper III)</b> <b>Organic and Inorganic Chemistry Practical</b> <b>NCHMJ243</b>		
<b>S. Y. B. Sc.</b>		<b>Credits - 2</b>
<b>Semester-IV</b>		<b>Hours - 60</b>
<b>Course specific outcomes-</b> <ol style="list-style-type: none"> <li>1. Correlate theoretical concepts with experimental findings.</li> <li>2. Understand systematic methods of identification of substance by chemical methods.</li> <li>3. Perform organic and inorganic synthesis, monitoring reactions via methods like colour changes, precipitation, and thin-layer chromatography (TLC)</li> </ol>		
<b>Sr. No.</b>	<b>Course Content / Syllabus</b>	<b>Lectures</b>
	<p><b>Section 1: Inorganic Chemistry Practical</b></p> <p><b>1</b> Detection and removal interfering anion's from given Inorganic Mixtures</p> <p><b>Section-2: Organic Preparation</b></p> <p><b>2</b> Preparation of benzoic acid from ethyl benzoate (Identification and confirmatory Test of -COOH group, M.P and purity by TLC)</p> <p><b>3</b> Acetylation of primary amine (Green approach)</p> <p><b>4</b> Base catalysed Aldol condensation (Green approach)</p> <p><b>5</b> Preparation of <i>p</i>-bromoacetanilide from acetanilide using ceric ammonium nitrate and potassium bromide. (Green method)</p>	<p>16</p> <p>04</p> <p>04</p> <p>04</p> <p>04</p>

6	Preparation of acetanilide from aniline using zinc metal and acetic acid	04
7	Preparation of <i>p</i> -nitroacetanilide from acetanilide using nitrating mixture	04
8	Synthesis of methyl salicylate (oil of wintergreen)	04
<b>Section 3: Organic Estimations</b>		
9	Determination of ethyl benzoate by hydrolysis method	04
10	Determination of aspirin from the tablet by hydrolysis method	04
11	To determine the amount of ethyl benzoate in given solution volumetrically	04
12	To determine the quantity of glucose in a given artificial sample of urine	04
13	To determine the amount of ethyl benzoate in given solution volumetrically	04
14	To determine the quantity of glucose in a given artificial sample of urine	04
<b>References</b>	4. Vogel's Textbook Quantitative Chemical Analysis, 3rd and 5th Ed. 5. Green Chemistry Laboratory Manual for General Chemistry, Sally A. Henrie, CRC Press Taylor & Francis Group, and Informa Business. 2015 6. A laboratory manual for general, organic and biological chemistry, 3rd Ed. Pearson	
<b>Learning outcomes</b>	4. Perform the quantitative chemical analysis of substances explain principles behind it 5. Systematic working skill in laboratory will be imparted in student 6. Understand systematic methods of identification of substance by chemical methods	


	<b>MODERN EDUCATION SOCIETY'S</b> <b>Nowrosjee Wadia College, Pune</b> (Autonomous)	<b>Academic</b> <b>Year</b> <b>2025-2026</b>
<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Minor Chemistry</b> <b>Overview of concepts in Chemistry B</b> (Theory)		
<b>S. Y. B. Sc.</b>		<b>Credits - 2</b>
<b>Semester-IV</b>		<b>Hours - 30</b>
<b>Course specific outcomes-</b> <ol style="list-style-type: none"> <li>1. To understand fundamental concept of Physical, Organic, Inorganic, and Analytical Chemistry.</li> <li>2. To impart basic understanding of stoichiometric calculations.</li> <li>3. To impart practical skills and learn basics behind experiments.</li> <li>4. To prepare background for advanced and applied studies in chemistry</li> </ol>		
<b>Sr. No.</b>	<b>Course Content / Syllabus</b>	<b>Lectures</b>
<b>Unit 1</b>	<b>Colorimetry</b> 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, Numericals.	<b>8</b>
<b>Unit 2</b>	<b>Introduction to errors</b> limitation of analytical methods, classification of errors, accuracy, precision, minimization of errors, significant figures and	<b>7</b>

	computation methods of expressing accuracy and precision, mean and standard deviations, reliability of results and numerical.	
<b>Unit 3</b>	<p><b>Thermodynamics</b></p> <p>Introduction, Definition, terms involved in the thermodynamics, thermodynamic systems internal energy and change in internal energy, Heat, Laws of thermodynamics: Introduction and Applications, , Free Energy and equilibrium - Concept, Definition and significance. The reaction Gibbs Energy, Exergonic and endergonic reaction. The perfect gas equilibrium, the general case of equilibrium, the relation between equilibrium constants, Molecular interpretation of equilibrium constant. The response of equilibria to conditions- response to pressure, response to temperature, Van't Haff equation, Value of K at different temperature, Problems.</p>	<b>8</b>
<b>Unit 4</b>	<p><b>Chromatography</b></p> <p>Introduction to chromatography, History of Chromatography. Thin Layer Chromatography: Theory and principles, outline of the method, surface adsorption and spot shape, Comparison of TLC with other forms of chromatography, adsorbents, preparation of plates, application of samples, development. Paper Chromatography- Origin, overview of technique, sample preparation, types of paper, solvents, equilibrium, development, sample application and detection, Identification, Quantitative methods, Applications of chromatography.</p>	<b>7</b>
<b>References</b>	<ol style="list-style-type: none"> <li>1. Morrison, R.T. &amp; Boyd, R.N. Organic Chemistry, Pearson, 2010.</li> <li>2. Clayden J. Greeves, N. &amp; Warren S. Organic chemistry, 2nd Edition, Oxford, 2014.</li> <li>3. Graham Solomon, T.W., Fryhle, C.B. &amp; Snyder, S.A. Organic Chemistry, John Wiley &amp; Sons, 2014.</li> <li>4. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.</li> <li>5. Braithwait &amp; F. J. Smith, Chromatographic method, 5th edition, Kluwer Academic publisher.</li> <li>6. D.A Skoog, D. M. West, F. J. Holler, &amp; S. R. Crouch, Fundamentals of</li> </ol>	


	<p>Analytical Chemistry, 9th edition.</p> <p>7. D. Harvey, Modern Analytical Chemistry, McGraw Hill Higher education.</p> <p>8. G. R. Chatwal, S. K. Anand, Instrumental Methods of Chemical Analysis, Himalaya Publishing House.</p>
<b>Learning outcomes</b>	<ol style="list-style-type: none"> <li>1. The students are expected to understand the fundamentals, principles, and recent developments in the subject area.</li> <li>2. It is expected to inspire and boost interest of the students towards chemistry as the main subject.</li> <li>3. To develop students theoretical knowledge with application in practicals.</li> <li>4. To make students aware about basic concepts applied in the industry.</li> </ol>

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<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Minor Chemistry Practical</b> <b>Basic Chemistry Practical B</b>		
<b>S. Y. B. Sc.</b>		<b>Credits - 2</b>
<b>Semester-IV</b>		<b>Hours - 60</b>
<b>Course specific outcomes-</b> <ol style="list-style-type: none"> <li>1. Correlate theoretical concepts with experimental findings.</li> <li>2. Understand systematic methods of identification of substance by chemical methods.</li> <li>3. Perform organic and inorganic synthesis, monitoring reactions via methods like colour changes, precipitation, and thin-layer chromatography (TLC)</li> </ol>		
<b>Sr. No.</b>	<b>Course Content / Syllabus</b>	<b>Lectures</b>
<b>Section 1: Chemical and Lab Safety (Compulsory)</b>		
<b>1</b>	What is MSDS sheets? MSDS sheets for hazardous chemicals (K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> , Benzene, Cadmium nitrate, Sodium metal)	4
<b>2</b>	Precaution in handling of hazardous substance like Concentrated acid, ammonia, organic solvent, etc.	4
<b>Section 2: Organic Chemistry Practical (Any Three)</b>		
<b>3</b>	Synthesis of methyl salicylate (oil of wintergreen)	4
<b>4</b>	Acetylation of primary amine (Green approach)	4
<b>5</b>	Determination of ethyl benzoate by hydrolysis method	4

6	To determine the quantity of glucose in a given artificial sample of urine	4
<b>Section 3: Inorganic Chemistry (Compulsory)</b>		
7-10	Inorganic qualitative analysis of compounds (Four compounds)	16
11	Iodometric estimation of copper from fungicide.	4
12	Colorimetric determination of iron using ammonium thiocyanate	4
<b>Section 4: Analytical Chemistry (Any Two)</b>		
13	Preparation of standard 0.05 N oxalic acid solution and standardization of approx. 0.05N KMnO <sub>4</sub> solution. Determination of the strength of given H <sub>2</sub> O <sub>2</sub> solution with standard 0.05 N KMnO <sub>4</sub> solutions.	4
14	Estimation of Zn <sup>2+</sup> by direct complexometric titration using EDTA.	4
15	Determination of magnesium from talcum powder using standard EDTA solution (Standardize EDTA solution using standard zinc sulphate solution).	4
<b>References</b>	<ol style="list-style-type: none"> <li>1. Vogel's Textbook Quantitative Chemical Analysis, 3rd and 5th Ed.</li> <li>2. Green Chemistry Laboratory Manual for General Chemistry, Sally A. Henrie, CRC Press Taylor &amp; Francis Group, and Informa Business. 2015</li> <li>3. A laboratory manual for general, organic and biological chemistry, 3rd Ed. Pearson</li> </ol>	
<b>Learning outcomes</b>	<ol style="list-style-type: none"> <li>1. Perform the quantitative chemical analysis of substances explain principles behind it</li> <li>2. Systematic working skill in laboratory will be imparted in student</li> <li>3. Understand systematic methods of identification of substance by chemical methods</li> </ol>	


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<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Vocational Skill Course</b> <b>ANALYTICAL METHODS OF CHEMICAL ANALYSIS</b>		
<b>S. Y. B. Sc.</b>		<b>Credits - 2</b>
<b>Semester- IV</b>		<b>Hours - 30</b>
<b>Course outcomes-</b> <p>1. Students should understand principles, theory and applications of instrumental and non-instrumental methods.</p> <p>2. Students will be able to critically evaluate and select appropriate analytical techniques based on sample characteristics and desired analytical parameter.</p>		
<b>Sr. No.</b>	<b>Course Content / Syllabus</b>	<b>Lectures</b>
<b>Unit 1</b>	<b>Titrimetric Analysis-</b> Introduction, Classification of reactions in titrimetric analysis, Neutralization reactions, complex formation reactions, precipitation reactions, oxidation-reduction reactions. Standard solutions, preparation of standard solutions, primary standard solutions.	6
<b>Unit 2</b>	<b>Theory of Acid-Base Titrations</b> Neutralization indicators, Ionisation constant of indicator, apparent indicator constant, color changes and pH range of certain indicators, preparation of indicator solutions, mixed indicators, universal indicators, neutralization curves	6

<p><b>Unit 3</b></p>	<p><b>Gravimetric Methods of Analysis</b></p> <p>Principles of gravimetric analysis, Gravimetric factor, Conditions for precipitation, Theory of precipitation, Types of precipitants, organic precipitants &amp; advantages, Purity of precipitates, Co-precipitation and post-precipitation, Precipitation from homogeneous solution, washing of the precipitates, Drying and ignition of precipitates, Gravimetric estimation of Barium</p>	<p>9</p>
<p><b>Unit 4</b></p>	<p><b>Electroanalytical Methods</b></p> <p>Types of Electroanalytical Methods. I) Interfacial methods – a) Potentiometry: Principle, Electrochemical cell, Electrodes- (i) Indicator and (ii) Reference electrodes –Hydrogen Electrode, Quinhydrone Electrode, Saturated Calomel Electrode. Numerical Problems. Application of Potentiometry – Assay of Sulphanilamide b) Voltammetry – three electrode assembly; Introduction to types of voltametric techniques, micro electrodes, Over potential and Polarization.</p> <p>II) Bulk methods – Conductometry, Conductivity Cell, Specific Conductivity, Equivalent Conductivity. Numerical Problems. Applications of conductometry. Estimation of Cl<sup>-</sup> using AgNO<sub>3</sub>. Determination of Aspirin with KOH.</p>	<p>9</p>
<p><b>References</b></p>	<p>1.Vogel’s textbook of quantitative inorganic analysis including elementary instrumental analysis.</p> <p>2. Seamus P.J. Higson: Analytical Chemistry</p> <p>3. Douglas A. Skoog and Donald M.West: Fundamentals of Analytical Chemistry.</p> <p>4. Daniel C Harris: Quantitative Chemical Analysis</p> <p>5. Freifelder and Kealy: Analytical Chemistry.</p>	
<p><b>Learning outcomes</b></p>	<p>1.The course will provide appropriate theoretical background and develop practical skills for analysing materials even in trace amounts using modern analytical methods and instruments.</p> <p>2.This course will inculcate a problem solving approach by coordinating different analytical techniques.</p> <p>3.Students can select appropriate techniques by analyzing different types of samples based on sensitivity, accuracy and specificity.</p> <p>4.Students can evaluate the advantages and limitations of instrumental and non-instrumental methods.</p>	

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<b>Bachelor of Science (Hons.) with Research in</b> <b>Chemistry</b>		
<b>Open Elective</b> <b>Food Adulteration and Safety</b>		
<b>S. Y. B. Sc.</b>		<b>Credits - 2</b>
<b>Semester-IV</b>		<b>Hours - 30</b>
<b>Course specific outcomes-</b> <ol style="list-style-type: none"> <li>1. <b>Understand the Chemistry of Food Adulteration</b> – Identify common food adulterants and their impact on health.</li> <li>2. <b>Perform Adulteration Detection Tests</b> – Apply chemical and physical tests to detect adulteration in dairy, beverages, staples, spices, processed foods, and fruits/vegetables.</li> <li>3. <b>Analyze Regulatory and Safety Standards</b> – Understand the role of food safety organizations (FSSAI, FDA, Codex Alimentarius) in maintaining food quality.</li> <li>4. <b>Evaluate the Health Impacts of Adulteration</b> – Recognize the toxic effects of adulterants on human health and well-being.</li> <li>5. <b>Enhance Consumer Awareness and Safety Practices</b> – Learn how to interpret food labels, identify pure foods, and promote food safety practices.</li> <li>6. <b>Explore Future Trends in Food Safety</b> – Understand emerging technologies such as AI-based food detection and blockchain in food supply chains.</li> </ol>		
<b>Sr. No.</b>	<b>Course Content / Syllabus</b>	<b>Lectures</b>
<b>Unit 1</b>	<b>Introduction to Food Adulteration</b> <ul style="list-style-type: none"> <li>• Definition, history, and need for food safety regulations</li> <li>• Types of food adulteration: intentional, incidental, and metallic contamination</li> <li>• Common adulterants in food and their health impacts</li> <li>• Methods of food quality testing: laboratory vs. household methods</li> <li>• Regulatory bodies and food safety standards (FSSAI, FDA, Codex Alimentarius)</li> </ul>	<b>5 Lectures</b>
<b>Unit 2</b>	<b>Detection of Adulteration in Essential Food Items</b> <ul style="list-style-type: none"> <li>• Detection of adulteration in dairy products: milk (starch, detergent, urea, formalin, hydrogen peroxide, synthetic</li> </ul>	<b>10 Lectures</b>

	<p>milk, ammonium sulfate, salt)</p> <ul style="list-style-type: none"> <li>• Detection of adulteration in beverages: tea (iron fillings, used tea leaves, artificial coloring, foreign leaves, tamarind seed powder), coffee (tamarind seed powder)</li> <li>• Detection of adulteration in staple foods: sugar (washing soda, chalk powder, saccharin, urea, sodium sulfate, lead acetate), salt (powdered stone, chalk powder, sodium bicarbonate, insoluble impurities), plastic rice</li> <li>• Detection of adulteration in spices and condiments: turmeric (metanil yellow, lead chromate, chalk powder, starch, synthetic colors), chilli powder (brick powder, artificial color, soapstone)</li> </ul>	
<b>Unit 3</b>	<p><b>Detection of Adulteration in Processed and Packaged Foods (10 Lectures)</b></p> <ul style="list-style-type: none"> <li>• Detection of adulteration in honey (sugar syrup, starch), soft drinks (sugar content using Benedict's test)</li> <li>• Detection of adulteration in cooking oil (vanaspati test), ice cream (washing powder test)</li> <li>• Detection of adulteration in pulses (artificial polishing agents like lead salts, non-edible oil, artificial colors)</li> <li>• Detection of adulteration in butter (vanaspati, starch)</li> <li>• Detection of artificial ripening agents in fruits and vegetables (calcium carbide, ethylene gas)</li> </ul>	<b>10 Lectures</b>
<b>Unit 4</b>	<p><b>Food Safety, Public Health, and Consumer Awareness (5 Lectures)</b></p> <ul style="list-style-type: none"> <li>• Health risks associated with food adulteration: toxicity, carcinogenic effects, kidney damage, metabolic disorders</li> <li>• Role of government agencies and regulations in food safety</li> <li>• Consumer awareness: reading labels, identifying pure foods, home testing methods</li> <li>• Case studies on food adulteration scandals and legal actions</li> <li>• Future trends in food safety: AI-based food detection, blockchain in food supply chains</li> </ul>	<b>5 Lectures</b>
<b>References</b>	<ol style="list-style-type: none"> <li>1. Jayashree Ghosh (2018). A Textbook of Pharmaceutical Chemistry. S. Chand Publishing.</li> <li>2. S. Srilakshmi (2021). Food Science (8th Ed.). New Age International Publishers.</li> <li>3. Ranganna, S. (2017). Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw-Hill.</li> <li>4. Pomeranz, Y., &amp; Meloan, C. E. (2017). Food Analysis: Theory and Practice. Springer.</li> <li>5. FSSAI (Food Safety and Standards Authority of India). Manual of Methods of Analysis of Foods. B. Sivasankar (2020). Food Processing and Preservation. PHI Learning Pvt. Ltd.</li> </ol>	

<b>Learning outcomes</b>	<ol style="list-style-type: none"><li>1. Be able to identify and classify common food adulterants using chemical and physical detection methods.</li><li>2. Demonstrate practical skills in performing food adulteration tests and interpreting results.</li><li>3. Understand legal and regulatory frameworks governing food safety and quality.</li><li>4. Assess the impact of adulterated food on human health and recognize associated diseases.</li><li>5. Develop awareness of consumer rights and responsibilities in ensuring food safety.</li><li>6. Explore technological advancements in food safety, including digital traceability and smart detection systems.</li></ol>
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	<b>MODERN EDUCATION SOCIETY'S</b> <b>Nowrosjee Wadia College, Pune</b> (Autonomous)	<b>Academic</b> <b>Year</b> <b>2025-2026</b>
<b>Bachelor of Science (Hons.) with Research in Chemistry</b>		
<b>Skill Enhancement Course</b> <b>Volumetric and Instrumentation Skills in Chemistry practical</b>		
<b>S. Y. B. Sc.</b>		<b>Credits - 2</b>
<b>Semester- IV</b>		<b>Hours - 60</b>
<b>Course specific outcomes-</b> <ol style="list-style-type: none"> <li>1. Verify theoretical principles experimentally</li> <li>2. Interpret the experimental data</li> <li>3. Improve analytical skills</li> <li>4. Correlate the theory and experiments and understand their importance</li> </ol>		
<b>Sr. No.</b>	<b>Course Content / Syllabus</b>	<b>Lectures</b>
<b>1</b>	Determination of total alkalinity in antacids in terms of calcium carbonates (two different samples).	<b>4</b>
<b>2</b>	To Study the Acid catalysed hydrolysis of an ester (methyl Acetate) and to determine the rate constant (k).	<b>4</b>
<b>3</b>	To study the kinetics of saponification reaction between sodium hydroxide and ethyl acetate.	<b>4</b>
<b>4</b>	To determine equivalence point of neutralisation of acetic acid by pH-metric titration with NaOH and to find best indicator for the titration.	<b>4</b>
<b>5</b>	Preparation of standard solutions of $\text{KMnO}_4$ / $\text{CuSO}_4$ , measurement of their absorbance values and verification of Beer's law.	<b>4</b>
<b>6</b>	Determination of 'Vitamin C' from Orange / Lemon juice by iodate method (two different samples).	<b>4</b>

7	Estimation of $Zn^{2+}$ by direct complexometric titration using EDTA.	4
8	Determination of magnesium from talcum powder using standard EDTA solution (Standardize EDTA solution using standard zinc sulphate solution).	4
9	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.	4
10	To investigate the conductometric titration of Strong acid against strong base.	4
11	To verify the Freundlich and Langmuir adsorption isotherm for adsorption of acetic acid on activated charcoal.	4
12	Prepare solution of Fe (III)/Cu (II) and salicylic acid different molar proportion and determine metal ligand ratio in Fe (III) or Cu (II)–Salicylic acid complex.	4
13	Colorimetric determination of iron using ammonium thiocyanate	4
14	Iodometric estimation of copper from fungicide	4
15	Determination of iodine from salt using sodium thiosulphate (Standardize sodium thiosulphate solution using standard potassium dichromate solution).	4
<b>References</b>	<ol style="list-style-type: none"> <li>1. Systematic experimental physical chemistry, S. W. Rajbhoj, T. K. Chondekar, Anjali publication.</li> <li>2. Practical Physical Chemistry, Vishwanathan and Raghwan, Viva book.</li> <li>3. Practical Chemistry, O. P. Pandey, D. N. Bajpai Dr. S. Giri, S Chand Publication</li> <li>4. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publication.</li> <li>5. Analytical Chemistry by G.D. Christian 6th edition.</li> <li>6. Vogel's Textbook of Quantitative chemical analysis 6th edition R.C. Denney, J.D. Barnes, M.J.K. Thomas</li> <li>7. Advanced Practical Chemistry, Jagdamba Sing et al, PragatiPrakashan, Merrut.</li> <li>8. Practical Chemistry, Panday, Bajpai, Giri, S.Chand and Co.</li> <li>9. 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, <i>Journal of Chemical Education</i>, Vol. 88 No.3, March 2011.</li> </ol>	
<b>Learning outcomes</b>	<ol style="list-style-type: none"> <li>1. Understanding the basics of Chemical Kinetics</li> <li>2. Understanding the basics of pH Metry</li> <li>3. Understanding the basics of conductometry</li> </ol>	

	<ol style="list-style-type: none"><li>4. Understanding the basics of colorimetry</li><li>5. Understanding the basics of Freundlich and Langmuir's adsorption theory</li><li>6. Verify theoretical principles experimentally</li><li>7. Interpret the experimental data</li><li>8. Improve analytical skills</li><li>9. Correlate the theory and experiments and understand their importance</li></ol>
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