Modern Education Society's
Nowrosjee Wadia College
(An Autonomous College Affiliated to Savitribai Phule Pune University)

B.Sc. (Chemistry)
(Four Years Honors and Research Degree Program)

NEP-II

Third Year Bachelors of Science
(T. Y. B. Sc. CHEMISTRY)

From Academic Year 2026-27

Board of Studies in Chemistry
Nowrosjee Wadia College
Pune-411001

Table of Contents

1. Abbreviations Used

- POs : Program Outcomes
- PS : Program Structure
- PSOs : Program Specific Outcomes
- COs : Course Outcomes
- TLP : Teaching-Learning Process
- AM : Assessment Method
- DSC : Discipline Specific Core
- DSE : Discipline Specific Elective
- GE : Generic Elective
- OE : Open Elective
- VSC : Vocational Skill Course
- SEC : Skill Enhancement Course
- IKS : Indian Knowledge System
- AEC : Ability Enhancement Course
- VEC : Value Education Course
- OJT : On Job Training (Internship)
- FP : Field project
- CEP : Community engagement project
- CC : Co-curricular Courses
- RM : Research Methodology
- RP : Research Project
- MJ : Major Course
- MN : Minor Course

2. Introduction to Undergraduate Degree in Chemistry

As per the recommendations of UGC and Savitribai Phule University guidelines, the undergraduate (UG) degree course in Chemistry is a 6-semester course for 3-academic years **OR** 8-semester course for 4-academic years. The Teaching-Learning Process (TLP) is student- centric. It involves theory, practical and also vocational and skill- based components. It offers flexibility in program structure and ensures a strong foundation and in-depth knowledge in subject. Besides the DSCs (Major Core), students have optional courses from the syllabus comprising of DSEs (Minor), VSCs, SECs, IKSs and OEs. Thus, it will facilitate the interdisciplinary as well as multidisciplinary approach within the curriculum framework. It will also allow students to have maximum flexibility in pursuing studies at UG level to the extent of having the freedom to eventually design the degree with multiple exit options. Students will have these exit options depending upon the needs and aspirations in terms of his/her career goals. This will suit the present-day needs of students in terms of securing their paths toward higher studies or employment.

3. Program Duration and Exit Options

The duration of the UG Program is 4 years or 8 semesters. Students who desire to undergo a 3-year UG Program will be allowed to exit after completion of the 3rd year. If a student wants to leave after the completion of the first or second year, the student will be given a UG Certificate or UG Diploma, respectively, provided they secure the prescribed number of credits. Students who exit with a UG certificate or UG diploma are permitted to re-enter within three years and complete the degree Program. The minimum credit to be earned by a student per semester is 18 and the maximum 26 respectively. However, students are advised to earn 22-credits per semester. This provision is meant to provide students the comfort of the flexibility of semester-wise academic load. However, the mandatory numbers of credits which have to be secured for the award of Undergraduate Certificate/Undergraduate Diploma/Bachelor Degree in Chemistry are listed in **Table 1**.

Table1: List of awards of Undergraduate Certificate/ Undergraduate Diploma/Appropriate Bachelor's Degree in Chemistry

S. No.	Type of Award	Stage of Exit	Mandatory Credits to be Secured for the Award
1	Undergraduate Certificate in Chemistry	After successful completion of Semester First year	**44**
2	Undergraduate Diploma in Chemistry	After successful completion of Semester Second Year	**88**
3	Bachelor of Science in Chemistry	After successful completion of Third year	**132**
4	Bachelor of Science in Chemistry (Honors)	After successful completion of Semester Fourth year	**176**

4. Objectives of the Program

The UG degree in Chemistry aims to provide:

a. Comprehensive knowledge and coherent understanding of the Chemistry.

b. Knowledge and skills in Chemistry and related interdisciplinary areas thereby enhancing students' employability /entrepreneurship.

c. In-depth knowledge in Chemistry through understanding of key concepts, principles, theories and their manifestations.

d. Critical and analytical thinking, scientific reasoning, creativity, problem-solving skills, communication skills and teamwork.

e. Competence and skill in solving both theoretical and applied problems.

f. Exposure to the latest advances in Chemistry, allied disciplines and research.

g. Inculcate digital skills in Chemistry and interdisciplinary areas.

h. Moral and ethical awareness, leadership qualities, innovation, and life-long learning.

i. Multicultural and multilingual competence, inclusive spirit, and value education.

j. Responsibility for Community engagement and service.

5. Program Outcomes

PO No.	PO Statement After completing the Bachelor of Science Program, students will be able to-	Knowledge and Skill
PO-1	Gain a thorough knowledge and understanding of concepts and principles in Chemistry and other subjects.	Disciplinary knowledge
PO-2	Communicate the subject knowledge in a clear and simple manner in writing and oral.	Communication skill
PO-3	Identify the given problem and apply, theories/assumptions for solving the same related to real life situations	Critical thinking & problem solving
PO-4	Plan, execute, interpret and report the results of the experiments to investigate.	Research related skill
PO-5	Work effectively and respectfully as a team member in the classroom, laboratory and field-based situations.	Co-operation / teamwork
PO-6	Correlate the ideas, evidences and experiences to analyze and interpret the scientific information with learned scientific reasoning	Scientific reasoning
PO-7	Get sensibly aware with the subject facts that can be applied for the society.	Reflective thinking
PO-8	Apply modern library search tools to locate, retrieve, and evaluate subject-related information.	Information /digitally literacy
PO-9	Identify the subject resources required for a project and manage different projects	Self-directed learning
PO-10	Motivate and inspire other colleagues/students in the subject-related activities.	Leadership readiness / qualities
PO-11	Inculcate continuous learning habit through multiple Techniques	Lifelong readiness / qualities

6. Program Specific Outcomes

PSO No.	PSO Statement After completing the Bachelor of Science in Chemistry, students will be able to-	Knowledge and Skill
PSO-1	Demonstrate comprehensive knowledge and understanding of core principles, theories, and concepts in chemistry	Disciplinary knowledge
PSO-2	Apply critical thinking skills to analyze complex chemical phenomena, evaluate experimental data, and propose innovative solutions to theoretical and practical problems in chemistry.	Critical thinking & problem solving
PSO-3	Utilize resources such as textbooks, scientific literature, online courses and professional networks to pursue self-directed learning and stay abreast of recent advancements in chemistry.	Self-directed learning
PSO-4	Utilize digital tools, software, and databases effectively for literature research, data analysis, simulation, and visualization in chemistry.	Digitally literacy
PSO-5	Exhibit leadership qualities and interpersonal skills essential for collaboration, teamwork, and effective communication within multidisciplinary research teams and professional environments.	Leadership
PSO-6	Demonstrate readiness for professional practice or further education in chemistry by exhibiting qualities such as adaptability, resilience, professionalism, and a commitment to lifelong learning.	Readiness/qualities

7. Structure of the Program

The detailed framework of Undergraduate Degree Program in Chemistry is provided in Table 2.

Table 2 Program Structure of undergraduate degree Program in Chemistry

Credit Framework for Under Graduate (2024-25) (3 Subjects) for Faculty of Science and Technology

First Year (UG Degree)											
Level	**Sem**	**Subject-1**	**Subject-2**	**Subject-3**	**GE/OE**	**SEC**	**IKS**	**AEC**	**VEC**	**CC**	**Total**
4.5/100	I	2(T) + 2(P)	2(T) + 2(P)	2(T) + 2(P)	2(T)	2(T/P)	2(T) (Generic)	2(T)	2	--	22
	II	2(T) + 2(P)	2(T) + 2(P)	2(T) + 2(P)	2(T/P)	2(T/P)	--	2(T)	2	2(T)	22
										Total	**44**

Exit Option: Students on exit shall be awarded Undergraduate Certificate in Chemistry after securing the requisite 44 credits after completion of Semester II, followed by an exit 4-credit core NSQF Course(s) or Internship.

Continue Option: Student will select one subject as a major and one subject as a minor. One subject will be dropped.

Second Year (UG Degree)													
Level	**Sem**	**Credits Related to Major**				**Minor**	**GE/OE**	**SEC**	**IKS**	**AEC**	**VEC**	**CC**	**Total**
		Major Core	**Major Elective**	**VSC**	**FP/OJT/CEP**								
5.0/200	III	4(T) + 2(P)	--	2(T/P)	2(FP)	2(T) + 2(P)	2(T)	--	2(T) (Major Subject Specific)	2(T)	--	2	**22**
	IV	4(T) + 2(P)	--	2(T/P)	2(CEP)	2(T) + 2(P)	2(P)	2(T/P)	--	2(T)	--	2	22
Total													**44**

Exit Option: **Students on exit shall be awarded Undergraduate Diploma in Major and Minor with 88 credits and additional 4-credit core NSQF Course (s) or Internship.**

Continue Option: **Student will continue with major and minor.**

Third Year (UG Degree)													
Level	**Sem**	**Credits Related to Major**				**Minor**	**GE / OE**	**SEC**	**IKS**	**AEC**	**VEC**	**CC**	**Total**
		Major Core	**Major Elective**	**VSC**	**FP/OJT/ CEP**								
5.5/ 300	V	8(T) + 4(P)	2(T) + 2(P)	2(T/ P)	2(FP/CEP)	2(T)	--	--	--	--	--	--	**22**
	VI	8(T) + 4(P)	2(T) + 2(P)	2(T/ P)	4OJT	--	--	--	--	--	--	--	**22**
												Total	**44**

Exit Option: **Students on exit shall be awarded UG Degree in Major after securing the requisite 132 credits after completion of Semester VI. Or Continue with Major**

Fourth Year (Honours Degree with Research)													
Level	**Sem**	**Credits Related to Major**				**Minor**	**GE/ OE**	**SEC**	**IKS**	**AEC**	**VEC**	**CC**	**Total**
		Major Core	**Major Elective**	**VSC**	**FP/OJT/ CEP**								
6.0/ 400	VII	6(T) + 4(P)	2(T) + 2(T/P)	--	4(RP)	4 (RM)	--	--	--	--	--	--	**22**
	VIII	6(T) + 4(P)	2(T) + 2(T/P)	--	8(RP)	--	--	--	--	--	--	--	**22**
												Total	**44**

Students on exit shall be awarded Bachelor of Science (Honours with Research Degree) after securing the requisite 176 credits after completion of Semester VIII.

Fourth Year (Honours Degree without Research)													
Level	**Sem**	**Credits Related to Major**		**VSC**	**FP/OJT/ CEP**	**Minor**	**GE/ OE**	**SEC**	**IKS**	**AEC**	**VEC**	**CC**	**Total**
		Major Core	**Major Elective**										
6.0/ 400	VII	10(T) + 4(P)	2(T) + 2(T/P)	--	--	4 (RM)	--	--	--	--	--	--	22
	VIII	10(T) + 4(P)	2(T) + 2(T/P)	--	4 (OJT)	--	--	--	--	--	--	--	22
												Total	**44**

Students on exit shall be awarded Bachelor of Science (Honours Degree) after securing the requisite 176 credits after completion of Semester VIII.

8. General guidelines for the selection of subjects

Student has to choose three subjects from the same faculty in first year and at the start of second year he/she has to opt one subject as Major subject and one (from other two subjects) as Minor subject and the last one will be dropped by the students.

1. Student cannot select a subject as major or minor other than the subjects taken in first year.
2. OE is to be chosen compulsorily from faculty other than that of the major.
3. SEC to be selected from the basket of Skill courses approved by the university.
4. VSC, FP/OJT/CEP should be related to the major subject.
5. AEC, VEC, IKS (Generic), and CC will be provided by the university separately.

9. Teaching-Learning Process

a. The courses will be taught through the traditional chalk and talk method, laboratory work, ICT enabled teaching learning tools, project work, seminars, case studies, field work, internships, hands-on training, etc.

b. Students will be engaged in various students centric activities like experiential learning, problem solving methodologies, participative learning and ICT based teaching learning process.

c. ICT tools in Basic and Advanced Chemistry software will be used to make the teaching learning process efficient and engaging.

d. Critical, analytical and problem-solving abilities will be developed through project- based learning, internships, industrial visits and hands-on training.

e. The problem-solving methodologies like quizzes, review of books and research papers, like workshops, research-based competitions will be used.

f. The vocational and skill training will be done through vocational and skill-based courses.

g. The students will be introduced to advanced laboratory instruments for hands-on training.

10. Methods of Assessment

The primary objective of assessment will be to assess the learning outcomes of the course in tune with the broad outcomes of strengthening core theoretical knowledge base, practical laboratory skills, and research. Assessment will be based on continuous evaluation methods and end of semester examination.

Continuous Internal Evaluation:

During a semester, students' mastery of the various learning outcomes as described in the syllabus will be assessed through like Short Questions, Class Tests, Seminars, Presentations, Group Discussion, Quizzes, MCQs, Assignments, Tutorials, Project work, etc. Each theory paper and practical paper will

have 15 marks for internal assessment for 2 credit courses and 30 marks for internal assessment for 4 credit courses.

End Semester University Examinations:

The end-semester university examinations will be conducted for both theory and practical courses. Besides internal assessment, both theory paper and practical paper will be of 35 marks each (2 credit course) and 70 marks (4 credit course) for end of semester examination of the university.

Scheme of Examination:

The total marks for a 2-credits course are 50, and for a 4-credits course is 100.

Internal exams will be conducted by the college and external exams will be conducted by Savitribai Phule Pune University, Pune at the end of each semester.

Important for Practical Course:

a. It is mandatory to have a certified journal during the practical examination.
b. Use molar concentrations for volumetric/ estimation / synthesis experiment.
c. Use optimum concentrations and volumes.
d. Two burette methods should be used for volumetric analysis. (Homogeneous mixtures)
e. Use of microscale technique is recommended wherever possible

11. Structure of T. Y. B. Sc. Chemistry
Semester-V

Sr. No.	Course Title	Course Code	Major Core/ Major Elective	Credits
1	Physical Chemistry		Major Core	2
2	Inorganic Chemistry		Major Core	2
3	Organic Chemistry		Major Core	2
4	Analytical Chemistry		Major Core	2
5	Physical Chemistry Practical		Major Core	2
6	Inorganic Chemistry Practical		Major Core	2
7	Organic Chemistry Practical		Major Elective	2
8	A) Polymer Chemistry B) Environment and Green Chemistry D) Biochemistry	Anyone (Theory)	Major Elective	2
9	Isolation of Natural Products Practical		VSC	2
10	Field Project/Community Engagement Program		FP/CEP	2
11	Basic Chemistry-C Theory		Minor	2

Course Structure
Third Year
Semester-VI

Sr.No.	Course Title	Course Code	Major Core/ Major Elective	Credits
1	Physical Chemistry		Major Core	2
2	Inorganic Chemistry		Major Core	2
3	Organic Chemistry		Major Core	2
4	Analytical Chemistry		Major Core	2
5	Physical Chemistry Practical		Major Core	2
6	Organic Chemistry Practical		Major Core	2
7	Inorganic Chemistry Practical		Major Elective	2
8	A) Forensic Chemistry B) Soil and agro-Chemistry C) Medicinal Chemistry	Anyone (Theory)	Major elective	2
9	Synthesis, Extraction and Isolation of Industrial products Practical		VSC	2
10	On job Training (Practical)		OJT	4

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)** **NEP 2.0**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	
SUBJECT **Major Theory Paper-1: Physical Chemistry-I**		
T. Y. B. Sc.		**Credits - 2**
Semester-V		**Hours - 30**

Course specific outcomes-

1. To understand fundamental concept of Physical Chemistry.
2. To impart basic understanding of stoichiometric calculations.
3. To impart practical skills and learn basics behind experiments.
4. To prepare background for advanced and applied studies in chemistry.

Sr. No.	Course Content / Syllabus	Lectures
Unit 1	**1. Quantum Chemistry** Introduction, de Broglie hypothesis, The Heisenberg's uncertainty principle, quantization of energy, Schrodinger wave equation, well behaved function, Particle in a one-, two and three-dimensional box (no derivation), Physical interpretation of the ψ and ψ2, sketching of wave function and probability densities for 1D box, Numericals. **Expected learning Outcome:** After successfully completion, students will be able to: 1. Know historical of development of quantum mechanics in chemistry. 2. Understand and explain the differences between classical and quantum mechanics. 3. Understand the idea of wave function 4. Understanding of De Broglie hypothesis and the uncertainty principle 5. Understanding the operators: Position, momentum and energy 6. Solving Schrodinger equation for 1D, 2D and 3D model 7. Physical interpretation of the ψ and ψ2 and sketching the wave function 8.Numerical Problems **Reference books:** 1) Principles of Physical Chemistry by Puri, Sharma, Pathania,;	**08**

	(Page No: 21-110) 2) Essential of Physical Chemistry, Bahl and Tuli (S. Chand).; (Page No: 50-58)	
Unit 2	**2. Investigation of Molecular structure** **Introduction:** Molar refraction and molecular structure, Dipole moment and molecular structure, electromagnetic spectrum, energy of molecules, Types of molecular spectra. **Microwave Spectroscopy:** Introduction, Classification of molecules on the basis of moment of Inertia, Rotational spectra of rigid diatomic molecules, relative intensities of spectral lines, effect of isotopic substitution on the rotational spectra, Determination of bond length and moment of inertia from rotational spectra, Problems **Infrared Spectroscopy:** Introduction, Simple Harmonic oscillator, fundamental modes of vibration (linear and non-liner molecule), force constant, Vibrational spectrum of a diatomic molecule: Vibrational Energy expression, Allowed vibrational energies, zero-point energy, Selection rule, Vibrational energy level diagram with transitions,Problems **Raman Spectroscopy:** Introduction, Classical and Quantum theory of Raman effect, Rayleigh, Stokes and anti-stokes lines, Pure rotational Raman spectra of linear diatomic molecules **Expected learning Outcome:** After studying this chapter, the student will be able to: 1. Understand the term additive and constitutive properties. 2. Understand the term specific volume, molar volume and molar refraction. 3. Understand the meaning of electrical polarization of molecule, induced and orientation polarization. 4. Dipole moment and its experimental determination by temperature variation method. 5. Electromagnetic spectrum, Nature of wave and its characteristics such as wavelength, wave number, frequency and velocity, Energy level diagram, 6. Classification of molecules on the basis of moment of Inertia, 7. Rotational spectra of rigid diatomic molecules, selection rules, nature of spectral lines.	**14**

	8.Explain the difference between Rayleigh, Stokes and anti-Stokes lines in a Raman spectrum. 9. Justify the difference in intensity between Stokes and anti-Stokes lines. 10. Draw the Stokes and anti-Stokes lines in a Raman spectrum 11. Raman spectra: Concept of polarizability, 12. Pure rotational Raman spectra of diatomic molecules, Energy Expression, Selection rule, Rotational energy level diagram, Rotational Raman spectrum and Problems **Reference books:** 1. Fundamentals of molecular spectroscopy by C.N. Banwell and E. M. McCash. (Page No: 33-59, 60-75, 111-119) 2. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000. (Page No: 413-455)	
Unit 3	**3. Photochemistry** Introduction, Difference between thermal and photochemical processes, Laws of photochemistry: i) Grothus - Draper law ii) Stark-Einstein law, Quantum yield, Reasons for high and low quantum yield., Factors affecting Quantum yield, Experimental method for the determination of quantum yield, types of photochemical reactions - photosynthesis, photolysis, photocatalysis, photosensitization, Jablonski diagram depicting various processes occurring in the excited state: Qualitative description of fluorescence and phosphorescence, Chemiluminescence, Problems **Expected learning Outcome:** After studying this chapter, the student will be able to know and understand: 1. Difference between thermal and photochemical processes. 2. photochemical laws: Grothus - Draper law, Stark-Einstein law, 3. Quantum yield and reasons for high and low quantum yield, 4. factors affecting the quantum yield, 5. Experimental method for the determination of quantum yield 6.Photochemical reactions: photosynthesis, photolysis,	**8**

	photocatalysis, photosensitization 7.Various photochemical phenomena like fluorescence and phosphorescence, Chemiluminescence, 8. Problems **Reference books:** 1. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).; (Page No: 1154-1178) 2. Principles of Physical Chemistry by Puri, Sharma, Pathania,; (Page No: 1112-1135) 3. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000. (Page No: 262-2810)	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	

Year- T.Y.B. Sc	**Major Chemistry Paper** **Inorganic Chemistry**	**Credits 2**
Semester-V		**Hours 30**

Course specific outcomes-

1. Utilize Molecular Orbital Theory to predict and interpret the properties of inorganic molecules.
2. Evaluate and propose plausible mechanisms for inorganic reactions
3. Explain the characteristic properties of transition metals, including variable oxidation states, formation of coloured complexes, and catalytic activity
4. Understand the lanthanide and actinide contractions and their consequences on chemical properties

Sr. No.	Course Content / Syllabus	Lectures
Unit 1	**Molecular Orbital Theory of Coordination Compounds** Electro-neutrality principle, multiple bonding (dπ-pπ and dπ-dπ), Nephelauxetic effect and Nephelauxetic series, Need and introduction of MOT, Assumptions, MO treatment to octahedral complexes with sigma bonding, Formation of MOs from metal orbitals and Composite Ligand Orbitals (CLO), MO correlation diagram for octahedral complexes with sigma bonding, effect of π bonding on MO correlation diagram, Charge transfer spectra, Advantages of MOT over VBT and CFT	**6**
Unit 2	**Inorganic Reaction Mechanism** Basic concepts of stability and lability, stability constants, Factors affecting lability, chelate effect. Classification of inorganic reactions, ligand substitution reactions: Intimate and stoichiometric mechanism of ligand substitution. Substitution Reactions in Four Coordinated square planar complexes: Trans effect and Trans effect series, applications of trans effect, stereochemistry of substitution.	**6**

Unit 3	**Chemistry of f-block elements** **Lanthanides:** Position in periodic table, Name and electronic configuration of lanthanides, Oxidation States, atomic and ionic radii, Lanthanide contraction, its causes and consequences on chemistry of Lanthanides and post lanthanide elements, Occurrence and separation: by Ion exchange and solvent extraction method, applications of lanthanides. **Actinides:** Position in periodic table, names and their electronic configurations. IUPAC nomenclature system for super heavy elements, Oxidation States, Occurrence and general methods of preparation of transuranic elements viz., Neutron Bombardment, Accelerated projectile bombardment and Heavy ion bombardment. Nuclear Fuels-Nuclear fission and fusion fuels, comparison between Lanthanides and Actinides	**10**
Unit 4	**Introduction to Molecular Symmetry** Symmetry elements and operations, Symmetry planes and reflections, the inversion centre, proper axes and proper rotations, improper axes and improper rotation, products of symmetry operations, equivalent symmetry elements and equivalent atoms, general relations among symmetry elements and symmetry operations. **Symmetry Classification of molecules-** The Point Groups of Simple molecules such as, C_2H_2, H_2O and BF_3	**8**
Learning outcomes	1. Students will be able to Capable of comparing various bonding approaches in coordination compounds 2. Gain the knowledge of inorganic reaction mechanisms available in the literature to solve chemical problems 3. Student will explore f-block elements, including lanthanides and actinides, covering their properties, behaviour, and uses 4. Students will learn the basic concept of Molecular symmetry and point groups.	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)** **NEP 2.0**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	
SUBJECT **Major Theory Paper: Organic Chemistry-I**		
T. Y. B. Sc. **Semester-V**		**Credits - 2** **Hours - 30**

Course specific outcomes-

1. To understand fundamental concept of Physical, and Analytical Chemistry.
2. To impart basic understanding of stoichiometric calculations.
3. To impart practical skills and learn basics behind experiments.
4. To prepare background for advanced and applied studies in chemistry.

Sr. No.	Course Content / Syllabus	Lectures
Unit 1	**1. Aromatic Electrophilic and Nucleophilic substitution Reactions** **A. Aromatic Electrophilic substitution** Arenium ion mechanism, orientation and reactivity, energy profile diagram, ortho, para, ipso attack, orientation in other ring systems, naphthalene, anthracene, six and five membered heterocycles, diazonium coupling. Important reactions like Friedel crafts alkylation and acylation, chloromethylation, sulphonation. **B. Aromatic nucleophilic substitution** Nitration, halogenation, formylation, SNAr, SN1, Benzyne and SNR1 reactions, reactivity: effect of substrate structure, leaving group and attacking nucleophile. **Expected learning Outcomes:** After studying this chapter, the student will be able to know 1. The basics of aromatic and nucleophilic substitution reactions. understand: 2. The effect of substituent on the orientation of incoming electrophile or nucleophile.	**8**
Unit 2	**2. Electrophilic addition and Elimination reactions** **A. Addition reactions**	**7**

	Addition to C-C multiple bonds - mechanism and stereochemical aspects of addition reaction involving electrophile, nucleophile and free radicals, Regio and chemo selectivity, orientation and reactivity, conjugate addition. **B. Elimination reactions** Introduction; Types of eliminations-1,1; 1,2 eliminations, Mechanism with evidences of E1andE2, E1cB reactions, stereochemistry of E1 and E2 elimination, Orientations and reactivity in E1 and E2 elimination- Hoffmann and Saytzeffs orientation, Factors affecting the reactivity- effect of structure, attacking base and leaving groups. **Expected learning Outcomes:** After studying this topic students are expected to know and understand: 1. Distinguish between addition and elimination reactions. solids / anisotropic and isotropic solids. 2. Explain the term E1, E2and E1Cb pathways for the elimination reactions. 3. Electrophilic addition reactions with factors influencing the orientation of addition.	
Unit 3	**3. Rearrangement Reactions** Introduction, Types of rearrangement, Types of reactive intermediate involved in different rearrangements, Rearrangement – Beckmann, Baeyer-Villager, Favorskii, Curtius, Lossen, Schmidt and Pinacol-Pinacolone with mechanism. Electrocyclic Rearrangements- Claisen, Cope and Mc-Lafferty rearrangements with mechanism. **Expected learning Outcomes:** After studying this topic students are expected to know 1. Molecular rearrangements -Basic definition 2. Types of rearrangement reactions occurring due to electron deficient carbo, nitrogen, oxygen and sigmatropic rearrangements 3. Illustrative examples on different types of rearrangements	**8**
Unit 4	**4. Reagents in Organic Synthesis**	**7**

	Reagents- Preparation and Applications of following reagents. Reducing Reagents: Lithium aluminum hydride LiAlH4, NaBH4, DIBAL-H, $Li(tBuO)_3AlH$ & Raney Nickel. Oxidizing Reagents: DMSO either with DCC or Ac2O, Dess Martin reagent, Osmium tetroxide, Selenium dioxide-(SeO2), DDQ. Expected learning Outcomes: After studying this topic students are expected to know 1. Different oxidizing and reducing reagents, 2. The mechanism of reactions involving various reducing and oxidizing reagents 3. Synthetic utility of the oxidizing and reducing agents **Reference books:** 1. Organic Chemistry –by J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford) 2. Advanced Organic Chemistry –by J. March 6th Edition 3. Advance Organic Chemistry (part A) –by A. Carey and R.J. Sundberg 4. Stereochemistry of carbon compound-by E.L. Eliel 5. Stereochemistry of organic compound-by Nasipuri 6. Guide book to Reaction Mechanism –Peter Sykes	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	
SUBJECT **Analytical Chemistry- I**		
T. Y. B. Sc.		**Credits - 2**
Semester- V		**Hours - 30**

Course specific outcomes-

1. Define basic terms in gravimetry, spectrophotometry, qualitative analysis and parameters in instrumental analysis.
2. Identify important parameters in analytical processes or estimations.
3. Perform quantitative calculations depending upon equations student has studied in the theory.

Chapter. No.	Title of Topic	No. of Llectures
1	Gravimetry	07
2	Inorganic Qualitative Analysis	06
3	Thermal methods of analysis	05
4	Parameters of instrumental analysis	04
5	UV-Visible spectroscopy	08
	Total	30

References

1. Vogel's textbook of Inorganic Quantitative Analysis, Jeffery, Basset, Mendham Deney, 5th Ed, Longman Scientific Technical, USA(copublished with John Wiley Sons)
2. Vogel's textbook of Inorganic Quantitative Analysis, Mendham, Deney Barnes6thEd, Pearson education
3. Analytical Chemistry by G. D. Christian, et al , Wiley, 6th Ed.
4. Modern Analytical Chemistry, David Harvey, Mc-Graw Hill Higher education
5. Vogel's Qualitative Inorganic Analysis, G. Svehla, Pearson, 7th Ed.
6. Principles of Instrumental Analysis: Holler, Skoog, Crouch 6th Ed. Thomson Publication

Learning outcomes

1. Define basic terms in gravimetry, spectrophotometry, qualitative analysis and parameters in instrumental analysis.
2. Identify important parameters in analytical processes or estimations.
3. Perform quantitative calculations depending upon equations student has studied in the theory. Furthermore, student should able to solve problems on the basis of theory.

1. Gravimetry (7 L)

Introduction to gravimetric analysis; Precipitation methods; The colloidal state; Supersaturation and precipitate formation; The purity of the precipitate: Co-precipitation; ; Conditions of precipitation; Precipitation from homogeneous solution; Washing the precipitate; Ignition of the precipitate: quantitative separations based upon precipitation methods: Fractional precipitation; Organic precipitants (8-hydroxyquinoline, DMG, Cupferron, Nitron, and Benzoinalfa oxime, Anthanilic acid), Gravimetric Calculations—How Much Analyte is there (Ref-3)

Applications of Gravimetry: Determination of Al(III) by 8-hydroxyquoline, Determination of calcium as oxalate; Determination of potassium as potassium tetraphenylborate, Determination of phosphate as ammonium molybdophosphate, Numericals. Key Reference-1: 417-428, 433-444, 446, 451, 464, 485; [Supplementary Ref-2: Pp-342 to 362]

2. Inorganic Qualitative Analysis (6 L)

Basic principle, common ion effect, solubility, solubility product, preparation of original solution, classification of basic radicals in groups, separation of basic radicals, removal of interfering anions (phosphate and borate), detection of acid radicals. Ref-6

3. Thermal methods of analysis (5 L)

General discussion, Thermogravimetry, Experimental factors affecting TG analysis, Instruments for thermogravimetry, Applications: Thermogravimetric analysis of CaC 2 O 4 H 2 O, CuSO 4 5H 2 O, Differential Thermal Analysis: Introduction, instrumentation for DTA and DSC, experimental and instrumental factors, applications: DTA of copper sulphate pentahydrate, Purity of pharmaceutical by DSC, Key Reference-2: 503-522, [Supplementary reference, Ref-4: 884-890, Ref-1: 428-433]

4. Parameters of instrumental analysis (4 L)

Techniques, Methods, Procedures, and Protocols, selecting an Analytical Method, Accuracy, Precision, Sensitivity, Selectivity, Robustness and Ruggedness, Scale of Operation, equipment, Time, and Cost, Making the Final Choice, Developing the Procedure, Calibration and Standardization, Sampling, Validation, Protocols, Key Reference -5: 35-48

5. UV-Visible spectroscopy (8 L)

Introduction, Theory of spectrophotometry and colorimetry-Beer's law, Application of

Beers Law, Spectrophotometry: Wavelength selection by prism and diffraction grating, Radiation source, cells, data presentation, single-beam spectrophotometer, Double-beam spectrophotometers, Choice solvent, general procedure for colorimetric estimation, simultaneous analysis, Applications: Estimation of metal ions from aqueous solution: Boron in steel, Chromium in steel with diphenyl carbazide reagent, ammonia in water, Chloride, Primary amine, Determination of phenol, spectrophotometric titration (example Cu(II) with EDTA), Determination of pKa value of indicator, Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method., Numericals Key Reference 2: 658-717 and Ref-1: 645-725

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(An Autonomous College)** **(NEP-2.0)**	**Academic Year 2026-2027**
	Bachelor of Science (UG Degree) in Chemistry	
SUBJECT **Major: Physical Chemistry Practical-I**		
T. Y. B. Sc.		**Credits - 02**
Semester-V		**Hours - 60**

Course specific outcomes-

1. To develop skills required in chemistry such as the appropriate handling of apparatus, instruments and chemicals.
2. The students will learn the laboratory skills needed to design, safety conduct and interpret chemical research.
3. To expose the students to an extent of experimental techniques using modern instrumentation.
4. The students will correlate the theory and experiments and understand their importance.
5. The students will develop the ability to effectively communicate scientific information and research results in written and oral formats.

	I. Chemical Kinetics (Any Two)	
1	To study the kinetics of iodination of acetone catalyzed by acid iodometrically.	**4**
2	To compare the strength of HCl and H_2SO_4 by studying the kinetics of inversion of cane sugar using same strength of two acids separately.	**4**
3	To overall determine the order of reaction between potassium persulphate and potassium iodide.	**4**
	II. Refractometry (Any Two)	
4	To determine the specific refractivities of the given liquids A and B and determine the percentage composition the mixture C.	**4**
5	To determine the molecular refraction of the given liquids A, B, C and D.	**4**
6	To determine the molar refraction of homologues methyl, ethyl, propyl and butyl alcohol and show the constancy contribution to the molar refraction by $-CH_2$ group.	**4**
7	Determine the refractive index of a series of salt solutions and determine the concentration of a salt of unknown solution.	**4**
	III. Spectrophotometry and Colorimetry (Any Two)	
8	To titrate Cu^{2+} ions with EDTA photometrically.	**4**
9	Verify Beer's law and determine unknown concentration and molar extinction coefficient of potassium permanganate.	**4**
10	Simultaneous determination of Co^{2+} and Ni^{2+} ions by colorimetry/spectro-photometry method.	**4**

	IV. Conductometry (Any Three)	
11	Determine the degree of hydrolysis and hydrolysis constant of sodium acetate conductometrically.	**4**
12	To determine the velocity constant of hydrolysis of ethyl acetate by NaOH solution by conduct metric method.	**4**
13	To determine the normality of citric acid in given fruit by titrating it against standard NaOH solution by conductometric method.	**4**
14	To estimate the amount of lead present in given solution of lead nitrate by conductometric titration with sodium sulphate.	**4**
15	To determine the relative strength of mono-chloro acetic acid and acetic acid conductometrically.	**4**
	V. Viscosity (Any One)	
16	To determine the molecular weight of a high polymer by using solutions of different concentrations.	**4**
17	Determine the radius of sucrose molecule from viscosity measurement.	**4**
	VI. Photo-flurometry	
18	Analysis of Riboflavin from vitamin supplementary capsules/syrup/tablet sample by Photo-flurometry.	**4**
	VII. Table Work	
19	Analysis of the given vibration-rotation spectrum of HCl (g).	**4**
20	**References** **1.** Vogel's Textbook of Quantitative chemical analysis 6th edition R.C. Denney, J. D. Barnes, M.J. K. Thomas. **2.** Advanced Practical Chemistry, Jagdamba Sing et al, Pragati Prakashan, Merrut. **3.** Practical Chemistry, Panday, Bajpai, Giri, S. Chand and Co. **4.** Colorimetric Determination of the Iron (III)-Thiocynate 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. **5.** Practical Physical Chemistry, Vishwanathan and Raghwan, Viva book. **6.** Practical Chemistry, O. P. Pandey, D. N. Bajpai Dr. S. Giri, S Chand Publication.	
21	**Learning outcomes** **1.** Students will get basic analytical and technical skills to work effectively in the various fields of chemistry. **2.** Students will able to calibrate and handle instruments like coductometer, colorimeter, photo-fluorometer, refractometer etc. **3.** Students will get skills required in chemistry such as handling of chemicals and preparation of solutions with various concentrations. **4.** They will have ability to present scientific and technical information resulting from laboratory experimentation in both written and oral formats.	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	
Year- T.Y.B. Sc	**Major Elective** **Inorganic Chemistry Practical-I**	**Credits 2**
Semester-V		**Hours 60**

Course specific outcomes-

1. Students will be able to perform standard inorganic chemistry laboratory techniques with accuracy and precision
2. Students will be able to perform quantitative analysis using volumetric and gravimetric methods
3. Students will gain experience in the synthesis and characterization of inorganic compounds
4. Students will be able to perform quantitative analysis using volumetric and gravimetric methods
5. Students will learn to optimize the experimental conditions for synthesizing Inorganic Compounds.

Sr. No.	Course Content / Syllabus	Lectures
Section 1	**Gravimetric Estimation** 1. Gravimetric estimation of Fe as Fe_2O_3 2. Gravimetric estimation of Ba as $BaSO_4$ using homogeneous precipitation method 3. Gravimetric estimation of Nickel as Ni-DMG 4. Analysis of Food/Pharmaceutical sample for ash and sulphated ash example-Aspirin 5. Gravimetric determination of Silica in Hydraulic Cement	**20**
Section 2	**Inorganic preparations (Any Four)** 1. Preparation of Potassium dioxalatocuprate (II), $[Cu(C_2O_4)_2]^{2-}$ 2. Preparation of Manganese (III) acetylacetonate $[Mn(acac)_3]$ 3. Preparation of Potassium trioxalatoferrate (III), $K_3[Fe(C_2O_4)_3]$. 4. Preparation of hexamminenickel (II) chloride, [Ni	**16**

	$(NH_3)_6]Cl_2$.	
Section 3	**Inorganic Qualitative Analysis (5 Expts.)** 1. Inorganic Qualitative analysis (Five mixtures) [One simple water-soluble mixture, two mixtures containing borates and two mixtures containing phosphates.	**20**
Section 4	**Compulsory Experiment** 1. $10Dq=\Delta_O$ measurements of hexaaqua complexes of 1^{st} series transition metals.	**4**
Learning outcomes	1. Students will learn and comprehend the core fundamentals and principles of contemporary inorganic chemistry experiments 2. To build students' understanding of theory and experiment, and apply it in practical settings 3. To introduce students to the fundamental practical skills required for chemistry laboratory work	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune (Autonomous)**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with research in Chemistry	
Year - T.Y.B.Sc.	**Name of Paper-Organic Chemistry Practical-I**	**Credits 2**
Semester-V		**Hours 60**

Course specific outcomes-

After studying the course students will be able to

1. To develop skills required in chemistry such as the appropriate handling of apparatus and chemicals.
2. The student will learn the laboratory skills needed to design, safely conduct and interpret chemical research.
3. To expose the students to an extent of experimental techniques using modern instrumentation.
   The student will develop the ability to effectively communicate scientific information and research results in written and oral formats.

Sr. No.	COURSE CONTENT / SYLLABUS	Hours
1	**Separation of Binary Mixtures and Qualitative Analysis (Any Six)** a) Solid-Solid (3 Mixtures) b) Solid-Liquid (2 Mixtures) c) Liquid-Liquid (1 Mixture) At least one mixture from each of the following should be given-Acid-Base, Acid- Phenol, Acid Neutral, Phenol-Base, Phenol-Neutral, Base-Neutral and Neutral- Neutral. (Solid-solid mixtures must be insoluble in water)	**30**
2	**Preparations** a) Preparation of 2,4-DNP derivative of Given carbonyl compound b) Preparation of Semicarbazone derivative of given organic compound c) Preparation of an Oxime derivative of a given compound.	**12**
3	**Estimations** a) Estimation of Ascorbic acid from a given tablet. b) Determination of saponification value of a given oil sample.	**12**

4	c) Estimation of glucose by iodometric method. Internal test	**6**
References	1. Vogel's Textbook of Practical Organic Chemistry, 5th edition Pearson India. 2. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Aggarwal 3. Advanced Practical Organic Chemistry by John Leonard, John Leonard, Barry Lygo, Garry Procter, 2nd edition, CRC Press. 4. Solvent-free Organic Synthesis by Koichi Tanaka. 5. Practical Organic Chemistry by Mann and Saunders, 4th edition, Pearson Education. 6. Advanced Practical Organic Chemistry by John Leonard, Barry Lygo, Garry Procter, 3rd Edition	
Learning outcomes	**Learning Outcomes:** **A) Separation of Binary Mixtures and Qualitative Analysis** **The students will be able to** 1. Perform the quantitative chemical analysis of binary mixture, explain principles behind it. 2. Separate, purify and analyze binary water insoluble mixture. 3. Separate, purify and analyze binary water-soluble mixture. 4. Understand the techniques involving drying and recrystallization by various method. 5. Familiarize the test involving identification of special elements. 6. Learn the confirmatory test for various functional groups. **B) Preparations** **The students will be able to** 1. Systematic working skill in laboratory will be imparted in student. 2. Learn the basic principles of green and sustainable chemistry. 3. Synthesis of various organic compounds through greener approach. 4. Do and understand stoichiometric calculations and relate them to green process metrics. 5. Learn alternative solvent media and energy sources for chemical processes. 6. Learn the preparations of derivative various functional groups aspects of electrical experiments. 7. Understand the techniques involving drying and recrystallization by various method.	

T.Y. B.Sc. Chemistry
Polymer Chemistry (CH-307)

2 Credits **30L**

Course Objectives: The students are expected to learn following aspects,

- The history of polymers.
- Classification and nomenclature of polymers.
- Chemistry behind the polymerization.
- Steps involved during polymerization.
- The techniques involved in polymersation.
- The need and method of polymer compounding.
- The different processes carried out to covert polymers into useful materials.
- The process and methods of polymer degradation.
- The methods of polymer waste management.
- The different polymers manufactured by industries in large scale.
- The polymers used for their thermal stability
- The different applications of thermosetting polymers.
- The preparation and applications natural and synthetic elastomers.
- The basic information about electricity conducting polymers.

Unit No.	Content	No. of hours per unit
Unit-I	**Introduction to polymers**	08
	1.1 Brief history 1.2 Basic terms: polymer, monomer, oligomers, polymerisation, degree of polymerisation, functionality Chemical composition of the environment 1.3 Characteristics of polymers 1.4 Classification of polymers: Natural and synthetic polymers, linear, branched, cross linked and network polymers, organic and inorganic polymers, Plastics, elastomers, fibers and liquid resins, Homopolymers and Co-polymers. Role of chemistry in environmental protection, Applications of polymers 1.5 Molecular forces and chemical bonding in polymers: Primary and secondary bond forces in polymers, cohesive energy. 1.6 Glass transition temperature of polymer. 1.7 Molecular weight of polymers: Number Average molecular mass (Mn) and weight average molecular mass (Mw) of polymers 1.8 polydispersity index	
Unit-II	**Chemistry of polymerization**	06
	2.1 Introduction	

	2.2 Chain Polymerization: Free radical Polymerization, Ionic polymerization, Co-ordination polymerization- Ziegler-Natta catalyst Photochemical smog: formation and effects 2.3 Step Polymerization: Polycondensation, Polyaddition-polymerisation, Ring opening polymerisation.	
Unit-III	**Polymerization techniques**	04
	3.1 Bulk polymerisation 3.2 Solution polymerisation 3.3 Suspension polymerisation 3.4 Emulsion polymerization 3.5 Melt polycondensation 3.6 Solution polycondensation 3.7 Interfacial condensation 3.8 Salient features of different polymerisation techniques.	
Unit-IV	**Polymer Processing and degradation**	08
	4.1 **Polymer Processing** 4.1.1 Compounding 4.1.2 Processing Techniques 4.1.3 Plastic Technology: Calendering, Die Casting, Film Casting, compression molding, Injection molding, Blow molding, thermoforming, Foaming 4.1.4Fibre Technology: Fibre Spinning- Melt spinning, Dry spinning , Wet spinning, Fibre after treatments : Scouring, Lubrications, Sizing, Dyeing, Finishing, Texture yarns, Nonwoven fabrics. **4.2 Polymer degradation:** 4.2.1 Process of degradation. Random and chain end degradation. 4.2.2 Methods of degradation: thermal degradation – factors affecting thermal stability; mechanical degradation – milling and mastication; photodegradation – photostabilisers; oxidative degradation – oxidants and antioxidants; hydrolytic degradation; degradation by high energy radiation, chemical degradation. 4.2.3 Polymer waste management.	
Unit-V	**Industrial Polymers**	04
	4.1 Thermoplastics: Polyethylene, Polypropylene, polystyrene, Polyacrylonitrile, Poly Vinyl Chloride, nylon and polyester. Persistent organic pollutants (POPs) 4.2 Thermosetting Plastics: Phenol formaldehyde and epoxide resin. 4.3 Elastomers: Natural rubber and synthetic rubber - Buna - N, Buna-S and neoprene. 4.4 Conducting Polymers: poly phenylene, poly pyrrole and poly acetylene	

References:

1. Polymer Science by V.R. Gowarikar, N.V.Vishvanathan, Jaydev Shreedhar New Age

International Ltd. Publisher 1996.

2. Textbook of Polymer Science by Fred Billmeyer, 3rd Edn. A Wiely-Interscience Publication John Wiley& Sons New York 1984. (Reprint 2008)
3. Introductory Polymer Chemistry by G.S.Misra New Age International (P) Ltd. Publisher 1996.
4. Polymer Chemistry by Charles E. Carraher (Jr.), 6th Edn, (First Indian Print 2005), New York- Basel.
5. Polymer Science – A Text Book by V.K. Ahluwalia, Anuradha Mishra.
6. Principle of Polymer Science by P. Bahadur, N.V. Sastry, 2nd Edn, Narosa Publishing House.

T.Y. B.Sc. Chemistry
Environmental Chemistry (CH-307)

2 Credits **30L**

Course Objectives:

- To introduce fundamental concepts of environmental chemistry
- To understand chemical processes occurring in air, water, and soil
- To study the chemistry of pollutants and their environmental impact
- To create awareness about sustainability and green chemistry
- Understand the role of chemistry in environmental protection

Unit No.	Content	No. of hours per unit
Unit-I	**Fundamentals of Environmental Chemistry**	04
	1.1 Scope, relevance, and interdisciplinary nature of environmental chemistry 1.2 Environmental segments: atmosphere, hydrosphere, lithosphere, biosphere 1.3 Chemical composition of the environment 1.4 Biogeochemical cycles: carbon, nitrogen, sulfur, and phosphorus 1.5 Energy flow in ecosystems 1.6 Role of chemistry in environmental protection 1.7 Case study: Urban air pollution due to vehicular emissions.	
Unit-II	**Atmospheric Chemistry and Air pollution**	06
	2.1 Structure and chemical composition of the atmosphere 2.2 Air pollutants: classification, sources, and effects 2.3 Photochemical smog: formation and effects 2.4 Greenhouse gases, global warming, and climate change 2.5 Ozone layer depletion and control strategies 2.6 Case study: Bhopal Gas Tragedy	
Unit-III	**Water Chemistry and Water Pollution**	06
	3.1 Sources of water pollution: domestic, industrial, agricultural 3.2 Water quality parameters: pH, DO, BOD, COD, TDS, hardness 3.3 Eutrophication: causes, chemical mechanism and control 3.4 Water treatment methods: Physical processes, Chemical processes, biological processes 3.5 Drinking water standards (WHO/BIS) 3.6 Case study: River pollution and Sewage Treatment Plant (STP).	
Unit-IV	**Soil Chemistry & Solid Waste Management**	06
	4.1 Soil Composition and Soil Chemistry 4.2 Soil pollution: fertilizers, pesticides, and heavy metals 4.3 Chemistry of pesticides and their degradation 4.3 Solid Waste: classification and chemical composition 4.4 Hazardous waste and e-waste	

	4.5 Waste minimization and recycling strategies	
Unit-V	**Toxic Chemicals & Green Sustainable Chemistry**	08
	4.1 Heavy metals: sources, toxicity, and remediation 4.2 Persistent organic pollutants (POPs) 4.3 Principles of green chemistry 4.4 Green solvents: Water, Supercritical Carbon Dioxide ($scCO_2$), Ionic Liquids, Bio-Based Solvents, Glycerol, 2-Methyltetrahydrofuran (2-MeTHF), etc. 4.5 Sustainable development and ethics *Green solvents*: Water, Supercritical Carbon Dioxide ($scCO_2$), Ionic Liquids, Bio-Based Solvents, Glycerol, 2-Methyltetrahydrofuran (2-MeTHF), etc, *Green Catalysis* (Titanium Dioxide, Metal–Organic Frameworks (MOFs)) *Energy-efficient chemical processes*: heat integration, advanced catalysis (e.g., enzymes, nanocatalysts), process intensification (combining steps), using efficient equipment (pumps, motors), and implementing smart controls, all reducing costs and environmental impact (GHG emissions) 4.6 Environmental laws and regulations (India): Environment (Protection) Act, Water (Prevention and Control of Pollution) Act, Air (Prevention and Control of Pollution) Act, Hazardous and Solid Waste Management Rules; role of regulatory bodies in environmental protection.	

References:

1. Manahan, S. E., Environmental Chemistry, CRC Press
2. Baird, C. & Cann, M., Environmental Chemistry, W.H. Freeman
3. De, A. K., Environmental Chemistry, New Age International
4. Peavy & Rowland, Environmental Engineering

T.Y. B.Sc. Chemistry
Biochemistry (CH-307-MJ-T)

2 Credits **30L**

Course Objectives and Expected Learning Outcomes (COs & ELOs):

After successful completion of this course, the student will be able to:

- Get introduced to biomolecules and chemical bonds present in them.
- Understand the classification and biochemical significance of carbohydrates
- Explain the structure, stereochemistry, and reactions of carbohydrates using glucose as a model
- Understand properties and biological roles of mono-, di-, and polysaccharides
- Understand the classification and biochemical significance of lipids.
- Understand parameters to check purity of fats and oils.
- Understand the classification of vitamins.
- Understand the structure, biological importance, and deficiency disorders of vitamins.
- Understand the structure, classification, and properties of amino acids
- Explain important reactions of amino acids
- Understand peptide bond formation and protein classification
- Describe different levels of protein structure and their biological relevance
- Describe enzyme classes and subclasses with examples.
- Understand mechanisms of enzyme action
- Know the industrial and biological importance of enzymes.
- Understand the discovery of DNA as genetic material.
- Describe the structure and functions of RNA

Unit No.	Content	No. of hours per unit
Unit-I	**Carbohydrates**	08
	Chemical molecules of life, the structure of prokaryotic and eukaryotic cells, and the functions of eukaryotic cell organelles. Definition: Classification of Carbohydrates: Classification: Monosaccharides, Disaccharides, Polysaccharides, Biological significance of carbohydrates, Monosaccharides: Structure of aldoses and ketoses, D- and L-isomers, Ring structures of sugars: hemiacetals and hemiketals, Conformations of sugars, Anomers and epimers, Mutarotation, Reaction with phenyl hydrazine (Osazone formation), Disaccharides: Sucrose, lactose, and maltose, Glycosidic bond, Reducing and non-reducing disaccharides, Polysaccharides: Homopolysaccharides and heteropolysaccharides.	
Unit-II	**Lipids and Vitamins**	07
	Classification and biological significance of lipids. Fatty acids, Triacylglycerols, Properties of Triacylglycerols (Saponification, Rancidity), Tests to check purity of fats and oils (Iodine number, Saponification number, , Acid number), Lipoproteins, steroids (Cholesterol, Ergosterol). Definition, Classification of Vitamins- Fat-soluble and Water-soluble. Individual Vitamin: Vitamin A, D, E, K, C, B1, B2, B6, B12, Biotin, Niacin,	

	Folic acid, Pantothenic acid, (Chemistry, Functions, Sources, Deficiency symptoms).	
Unit-III	**Amino Acids and Proteins**	06
	Amino Acids: Classification based on R-group, Structures of amino acids, Physicochemical Properties; Amphoteric nature, and zwitterions, pKa values, Isoelectric point (pI), Concept of ampholytes, Reactions of Amino Acids: Ninhydrin reaction, Transamination, Oxidative deamination. Significance of these reactions, Amino acids as useful drugs (D-Penicillamine, N-Acetylcysteine, Gabapentin) Proteins: Classification based on: Function, Structural Hierarchy of proteins: Primary structure**,** Secondary structure**,** Tertiary structure**,** Quaternary structure**.**	
Unit-IV	**Introduction to Enzymes**	06
	Classification of Enzymes: Enzyme classes with examples, Chemical Nature and Properties of Enzymes: Isoenzymes, Active site: concept and features, Enzyme–substrate (ES) complex formation, Enzyme Specificity, Factors Affecting Enzyme Activity: Substrate concentration, enzyme concentration, pH, temperature, and mechanism of enzyme action: substrate strain theory. Enzyme Inhibition: Concept of enzyme inhibition, Allosteric enzymes, Conjugated Enzymes: Holoenzyme and Apoenzyme, Prosthetic groups, Industrial Applications of Enzymes	
Unit-V	**Nucleotides and Nucleic Acids**	03
	Introduction to Nucleic Acids, Functions of nucleic acids, Chemistry of Nitrogenous Bases: Purines and pyrimidines, General Composition of Nucleic Acids: Nucleosides and nucleotides, Structure of DNA: Watson–Crick model, Chargaff's rule of DNA composition, RNA: Structure and function of major RNA species.	

References:

1. **Lehninger's Principles of Biochemistry**, by Nelson and Cox, Macmillan Publisher, 4th Edition.
2. **Biochemistry**, Satyanarayana and Chakrapani, Arunabha Sen Books and Allied (P) Ltd., 5th Edition (2020).
3. **Principles of Biochemistry** (2008), 3rd Edition, Voet, D. J., Voet, J. G. and Pratt, C. W., John Wiley & Sons, Inc. (New York), ISBN: 13: 978-0470-23396-2.
4. **Harper's Illustrated Biochemistry**, (27th edition), ISBN-13:978-0071253017.
5. **Biochemistry** (2012), 7th Edition, Berg, J. M., Tymoczko, J. L. and Stryer, L., W.H. Freeman and Company (New York), ISBN: 10: 1-4292-2936-5, ISBN: 13: 978-1-4292-2936-4.
6. **Fundamentals of Biochemistry**, Jain and Jain, S. Chand, 7th Edition (2016).
7. **Organic Chemistry**, Morrison, R. T. & Boyd, R. N.

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	**Academic Year 2025-2026**
	Bachelor of Science (Hons.) with Research in Chemistry	
SUBJECT: VSC CHEMISTRY PRACTICAL **SUBJECT TITLE: NATURAL PRODUCTS**		
T. Y. B. Sc.		**Credits - 2**
Semester- v		**Hours - 60**

Course specific outcomes-

1) In this course students will be able to understand the chemistry of natural products obtained from plants and animals, their biosynthesis and applications in medicines.
2) Understand fundamental principles and advanced concepts of Natural Product.
3) Create chemical processes using a green approach for safer operations.

Sr. No.	Course Content / Syllabus (Total 12 Experiments to be performed)	Lectures
	Organic Estimations (Any Three)	
1.	Estimation of glucose from Honey	**4.**
2.	Estimation of glycine from Pumpkin seeds	**4.**
3.	Estimation of Iodine Value of Fats and Oils from Coconut oil.	**4.**
4.	Determination of tannins in Tea	**4.**
	Organic Extractions (Any Four)	
5.	Caffeine from tea leaves	**4.**
6.	Eugenol from cloves	**4.**
7.	Lycopene from tomato peels	**4.**
8.	Cinnamic acid from cinnamon	**4.**
9.	Trimyristin from nutmeg	**4.**
10.	Isolation of Piperine from Black Pepper.	**4.**
	Chromatography (Any two)	
11.	Identification of Plant Pigments (Carotenoids)/Leaf pigments (Spinach) by Thin Layer Chromatography	**4.**
12.	Identification of Flavonoids (Citrus fruits) by Paper Chromatography	**4.**
13.	Preparative Chromatography for (1) estragole, (2) ethyl cinnamate and (3) cinnamyl alcohol based on the intermolecular interactions.	**4.**
	Synthesis of Natural Products (Any Two)	
14.	Green Chemistry Approaches to the Synthesis of Flavonoid	**4.**
15.	To synthesize 7-Hydroxy, 4-methyl coumarin from resorcinol	**4.**
16.	Synthesis of Azelaic acid from Castor oil	**4.**
17.	Qualitative techniques for the determination of Alkaloids and Carbohydrates from Plant Turmeric/Nim/ Tobacco leaves /Potato **(Any One)**	**4.**

References	1. Vogel's Textbook of Practical Organic Chemistry2. Natural Products Chemistry Practical Manual: For Science & Pharmacy Courses -Anees A. Siddiqui 2. Natural Products: A Practical Approach to Extraction and Analysis. Oxford University Press. Smith - J., & Brown, L. (2020). 3. Chemistry of Natural products, a laboratory handbook-N.R.Krishnaswamy 4. Natural product chemistry ,Source ,seperation and structures -Raymond Copper ,Gorge Nicola 5. Natural Products: A laboratory Guide eBook-Ikan, Raphael . 6.
Learning outcomes	1. Understand the fundamental principles of natural product extraction, isolation, and characterization. 2. Identify different classes of natural products, including alkaloids, flavonoids, terpenoids, and glycosides. 3. Describe various techniques used in natural product research, such as chromatography and spectroscopy. 4. Develop problem-solving skills in the identification and evaluation of bioactive compounds. 5. Apply Good Laboratory Practices and safety protocols in handling natural product extracts and reagents.

-FP: Field Project

Course Type: Field Project (FP) **No. of Credits: 2**

Objective:

To engage students in field-based experiential learning by applying chemistry concepts to real-life problems or environments.

Course Outcomes

At the end of the course, student will be able to

1. Learn the fundamental chemistry concepts to real-world environmental and community
2. Understand the appropriate methodologies for collecting chemical and environmental data through fieldwork.
3. Apply the chemistry concepts to real life problems or environments
4. Analyse the experimental or observational data to derive meaningful conclusions about local chemical or environmental conditions.
5. Evaluate local problems through a scientific lens and suggest chemistry-based solutions or awareness strategies.
6. Prepare a scientific report and presentations based on their findings.

Field Project (FP) Guidelines

1. **Project Themes (Chemistry-Oriented):**
   - Water quality analysis of local sources.
   - Soil sampling and pH, salinity, and metal analysis.
   - Survey of household or industrial waste disposal and chemical hazards.
   - Study of local industries and their chemistry-related processes.
   - Investigation of adulteration in food samples.
   - Air quality monitoring.
   - Testing of cleaning agents, soaps, or cosmetics from local markets.
   - Chemistry awareness in nearby schools or communities.
   - Use of herbal medicines and local knowledge in chemistry.
   - Any other related to chemistry

2. **Process:**
   - Students may work individually or in groups (preferably 2–3 students/group).

- Selection of project topic in consultation with a faculty mentor.
- Planning of field visits, data collection tools, and methodology.
- Minimum 1 field visit is mandatory.
- Compilation of data, interpretation, and report writing.

3. **Duration:**

   Minimum **60 hours** (including planning, fieldwork, and report preparation).

4. **Report Structure:**

- Tittle page
- Certificate of completion of Field project from mentor and HOD.
- Declaration by candidate regarding plagiarism
- Index
- Abstract of the project
- Chapter-1: Introduction to problem (introduction, signification of research problems selected, aims and objectives) (5 to 6 pages)
- Chapter-2: Review of Literature (Related Research Problem) (5-6 pages)
- Chapter-3: Material and Methods/Methodology/Experimental (5-7 pages)
- Chapter-4: Results and Discussion or Data and Interpretation of data (8 – 10 pages)
- Chapter-5: Conclusions (1-2 pages)
- Bibliography/References
- Acknowledgement

Assessment Criteria (Suggested):

Criteria	Marks
Relevance and Originality	7
Data Collection & Analysis	7
Fieldwork Involvement	7
Report	7
Presentation/Viva	7
Total	**35 Marks**

Note: Remaining 15 marks for internal assessment

5. **General Guidelines (Common to FP and CEP):**

- Projects can be interdisciplinary but must involve chemistry as a core element.
- Ethical conduct and respect for community are essential.
- Students are encouraged to present their work in college exhibitions or seminars.
- Photographic or video evidence should support fieldwork/CEP.

6. **Faculty Responsibilities:**
   - Approve project topics.
   - Guide students throughout the project.
   - Monitor and document student participation.
   - Organize viva/presentation for evaluation.

CEP: Community Engagement Project (CEP)

Course Type: Community Engagement Project (CEP) **No. of Credits: 2**

Objective:

To sensitize students towards societal needs, promote citizenship behaviour, and contribute to community well-being using chemistry knowledge.

Course Outcomes

At the end of the course, Student will be able to

1. Identify the chemical aspects of local community issues such as water quality, waste management, or household chemical safety.
2. Understand the societal issues and can provide a scientific solution
3. Apply chemistry knowledge to promote awareness about safe chemical practices, sustainability, and green alternatives in daily life.
4. Analyse the effectiveness of community engagement activities based on feedback and participation data.
5. Assess the societal issues through the group-based outreach and community interactions.
6. Plan chemistry-related awareness activities such as demonstrations, campaigns, or surveys in schools or local communities.

Community Engagement Project (CEP) Guidelines

1. **Themes (Chemistry Related):**
   - Awareness campaign on safe use of chemicals.

- Awareness drives on e-waste or plastic waste segregation.
- Demonstrations of eco-friendly household products (detergents, soaps, cleaners).
- Community survey on water purification methods and promoting alternatives.
- Public education on food safety (e.g., adulteration tests).
- Tree plantation with explanation of soil-plant-chemistry interaction.
- Participating in science exhibitions or awareness sessions in schools.
- Any other related to chemistry

2. Key Activities:

- Group discussions with community members.
- Designing posters, pamphlets, or short videos for awareness.Science demonstration sessions for school children or villagers.
- Surveys and interviews to collect feedback and awareness levels.

3. Duration:

Minimum **60 hours** of engagement (including preparation, visits, interaction, and reflection).

4. Report Structure:

- Tittle page
- Certificate of completion of Field project from mentor and HOD.
- Declaration by candidate regarding plagiarism
- Index
- Abstract of the project
- Chapter-1: Introduction to problem (introduction, signification of research problems selected, aims and objectives) (5 to 6 pages)
- Chapter-2: Review of Literature (Related Research Problem) (5-6 pages)
- Chapter-3: Material and Methods/Methodology/Experimental (5-7 pages)
- Chapter-4: Results and Discussion or Data and Interpretation of data (8 – 10 pages)
- Chapter-5: Conclusions (1-2 pages)
- Bibliography/References
- Acknowledgement

5. Assessment Criteria (Suggested):

Criteria	Marks
Planning and Initiative	7
Community Interaction	7
Contribution to Social Cause	7
Report & Reflection	7
Presentation	7
Total	**35 Marks**

Note: 15 marks for internal assessment

6. General Guidelines (Common to FP and CEP):

- Projects can be interdisciplinary but must involve chemistry as a core element.
- Ethical conduct and respect for community are essential.
- Students are encouraged to present their work in college exhibitions or seminars.
- Photographic or video evidence should support fieldwork/CEP.

7. Faculty Responsibilities:

- Approve project topics.
- Guide students throughout the project.
- Monitor and document student participation.
- Organize viva/presentation for evaluation.

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	**Academic Year 2026-2027**
	Bachelor of Science with Hons. in Chemistry	
Minor Chemistry Paper **Basic Chemistry-D**		
Year – T.Y.B.Sc.	**Name of Paper- Basic Chemistry-D**	**Credits 2**
Semester- V		**Hours 30**

Course specific outcomes-

1. To understand fundamental concept of organic compounds and reactions in Chemistry.
2. To impart basic understanding of coordination complexes.
3. To impart practical skills and learn basics behind experiments.
4. To prepare background for advanced and applied studies in chemistry.

Sr. No.	COURSE CONTENT / SYLLABUS	Lectures
Unit 1	**Fundamentals of organic chemistry** Physical Effects, Electronic Displacements: Inductive Effect, Resonance and Hyperconjugation, Hydrogen Bonding, Steric Effect, Strength of organic acids and bases, Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Hückel's rule, Aromaticity of Benzenoids and heterocyclic compounds.	**10**
Unit 2	**Volumetric Analysis** Definition, components of titration, end point and equivalence point, indicators, suitable and best indicators, criteria for reaction to study in volumetric analysis, types of reaction, Standard solutions, primary and secondary standards, types of volumetric analysis.	**10**
Unit 3	**Co-ordination Complexes** Definition, important terms, Properties, types of ligands, coordination number, Werner's theory, IUPAC nomenclature, double salt and coordination complexes, isomerism in coordination complexes (structural isomerism).	**10**
References	1. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010. 2. *Clayden* J. Greeves, N. & Warren S. Organic chemistry, 2nd Edition, Oxford, 2014. 3. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons, 2014. 4. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013. 5. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi, 1988. 6. Analytical Chemistry, G. D. Christian, P. K. Dasgupta, K. A. Schug, 7th	

	Ed, Wiley, 2004.. 7. Fundamentals of Analytical Chemistry- Skoog, west, Holler, Crouch, 9th Ed. Brooks /Cole, 2014/2004. 8. Basic Concept of Analytical Chemistry- S. M. Khopkar.
Learning outcomes	1. The students are expected to understand the fundamentals, principles, and recent developments in the subject area. 2. It is expected to inspire and boost interest of the students towards chemistry. 3. To develop students' theoretical knowledge with application in practical. 4. To make students aware about basic concepts applied in the industry.

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)** **NEP 2.0**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	
SUBJECT **Major Theory Paper-2: Physical Chemistry - II**		
T. Y. B. Sc.		**Credits - 2**
Semester-VI		**Hours - 30**

Course specific outcomes-

1. To understand fundamental concept of Physical Chemistry.
2. To impart basic understanding of stoichiometric calculations.
3. To impart practical skills and learn basics behind experiments.
4. To prepare background for advanced and applied studies in chemistry.

Sr. No.	Course Content / Syllabus	Lectures
Unit 1	**1. Electrochemical Cells** Electrochemical cells, reversible and irreversible cells with examples, The e.m.f. of electrochemical cell and its measurement, The Weston standard cell, Reference electrodes: The primary reference electrode and Secondary reference electrodes, The Nernst equation for E.M.F. of a cell. Types of reversible electrodes, the sign convention for electrode potentials, Thermodynamics of reversible cells and reversible electrodes, E.M.F. and equilibrium constant of cell reaction, Electrochemical series, Types of concentration cells, liquid junction potential, salt bridge, Applications of emf measurements: 1. Determination of pH of a solution by using hydrogen electrode, quinhydrone electrode and glass electrodes 2. Potentiometric titrations: i) Acid-base titrations, (ii) Redox titrations. (iii) Precipitation titration **Expected learning Outcomes:** After studying this chapter, the student will be able to know and understand: 1. Electrochemical cells: Explanation of Daniell cell, Conventions to represent electrochemical cells 2. Thermodynamic conditions of reversible cell, Explanations of reversible and irreversible electrochemical cell with suitable example,	**10**

	3. EMF of electrochemical cell and its measurement. 4. The Weston standard cell 5. The primary reference electrode: The standard hydrogen electrode (SHE) with reference to diagram, Construction, representation, working and limitation, 6. Secondary reference electrodes: (a) The calomel electrode, (b) The glass electrode (c) The silver-silver chloride electrode. Understanding of these electrodes with reference to diagram, representation, Construction, working Nernst Equation for theoretical determination of EMF 8. Types of Reversible electrodes: Metal-metal ion electrodes, Amalgam electrodes, Gas electrodes, Metal-metal insoluble salt electrodes, Oxidation-reduction electrodes with respect to examples, diagram, representation, construction, working (electrode reactions) and electrode potential. 9. Sign convention for electrode potentials and Electrochemical series 10. Standard electrode potentials, 11. Types of concentration cells: Concentration cells without and with transference Concentration cells with liquid junction potential 12. Liquid junction potential and salt bridge 13. Applications of emf measurements: 1. Determination of pH of a solution by using hydrogen electrode, quinhydrone electrode and glass electrodes 2. Potentiometric titrations: i) Acid-base titrations, (ii) Redox titrations and (iii) Precipitation **Reference books:** 1. Essential of Physical Chemistry, Bahl and Tuli (S. Chand)., (Page No: 1154-1178) 2. Principles of Physical Chemistry by Puri, Sharma, Pathania, (Page No: 835-880) 3. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000, (Page No: 320-412) 4) Modern Electrochemistry Second Edition by John O'M Bockris, Molecular Green Technology College Station, Texas and Amulya K. N. Reddy, President International	

	Energy Initiative Bangalore, India, (Page No: 1789-1888)	
Unit 2	**2. Crystal structure** Types of Solids: Isotropy and Anisotropy, Laws of crystallography: Law of constancy of interfacial angles, Law of rational indices, Law of crystal symmetry, Weiss indices and Miller indices, Crystal Structure: Parameters of the Unit Cells, Cubic Unit Cells: Three Types of Cubic Unit Cells, Calculation of Mass of the Unit Cell, Methods of Crystal structure analysis: The Laue method and Braggs method: Derivation of Bragg's equation, Determination of crystal structure of NaCl by Bragg's method, X ray analysis of NaCl crystal system, Calculation of d and λ for a crystal system, Numerical. **Expected learning Outcomes:** After studying this topic students are expected to know and understand: 1. Distinguish between crystalline and amorphous solids / anisotropic and isotropic solids. 2. Explain the term crystallography and laws of crystallography. 3. Weiss and Millers Indices, determination of Miller Indices 4. Bravais lattices, space groups, seven crystal systems and fourteen Bravais lattices; 5. Cubic lattice and types of cubic lattice 6. Distance between the planes for 100, 110 and 111 for cubic lattice 7. Methods of Crystal structure analysis: The Laue method and Braggs method: Derivation of Bragg's equation, 8. Determination of crystal structure of NaCl by Bragg's method, 9. X ray analysis of NaCl crystal system and Calculation of d and λ for a crystal system, 10. Problems **Reference books:** 1. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).,(Pp: 491-507, 518-528) 2. Principles of Physical Chemistry by Puri, Sharma, Pathania, (Page No: 1165-1180)	**6**

Unit 3	**3. Nuclear Chemistry** Radioactivity, Types of Radiations, Properties of Radiations, Detection and Measurement of Radioactivity: Cloud chamber, Ionization Chamber, Geiger-Muller Counter, Scintillation Counter and Film Badges, Nuclear structure, Classification of nuclides, Types of Radioactive Decay, The Group Displacement Law, Kinetics of Radioactive Decay, Half-life, average life, Energy released in nuclear reaction, Mass Defect, Nuclear Binding Energy, Some applications of radio-isotopes as tracers: Chemical investigation – Esterification, Friedel -Craft reaction, Structural determination – Phosphorus pentachloride, Age determination – use of tritium and C14 dating, Problems **Expected learning Outcomes:** After studying this topic students are expected to know 1. Radioactivity 2. Types and properties of radiations: alpha, beta and gamma 3. Detection and Measurement of Radioactivity: Cloud chamber, Ionization Chamber, Geiger-Muller Counter, Scintillation Counter, Film Badges 4. Types of radioactive decay: α- Decay, β-Decay and γ-Decay 5. The Group Displacement Law, Radioactive Disintegration Series 6. Kinetics of Radioactive Decay, Half-life, average life and units of radioactivity 7. Energy released in nuclear reaction: Einstein's equation, Mass Defect, Nuclear Binding Energy, 8. Application of radioisotopes as a tracer: Chemical investigation- Esterification, Friedel -Craft reaction and structure determination w.r.t PCl5, Age determination use of tritium and C14 dating. 9. Solve the problems based on this topic **Reference books:** 1. Elements of Nuclear Chemistry by H.J. Arnikar 2. Essential of Physical Chemistry, Bahl and Tuli (S. Chand)., (Page No: 117-145)	**6**
Unit 4	**Colligative Properties of dilute solutions**	**8**

	Introduction, Solution, electrolytes and nonelectrolytes, Meaning of term colligative property, relative lowering of vapour pressure of solvent in solution, elevation of B.P. of solvent in solution, Landsberger's method, freezing point depression, Beckmann's method, Osmosis and Osmotic pressure, Berkeley and Hartley method, application of colligative properties to determine molecular weight of nonelectrolyte. Numerical. **Expected learning Outcomes:** After studying this topic students are expected to know 1. Meaning of the terms-Solution, electrolytes, nonelectrolytes and colligative properties, 2. Lowering of vapour pressure of solvent in solution, 3. Elevation of B.P. of solvent in solution, Landsberger's method, 4. freezing point depression, Beckmann's method Osmosis and Osmotic pressure, Berkeley and Hartley method, 5. Application of colligative properties to determine molecular weight of nonelectrolyte, abnormal molecular weight, 6. Relation between Vant Hoff's factor and degree of dissociation of electrolyte by colligative property, 7. Problems. **Reference books:** 3) Principles of Physical Chemistry by Puri, Sharma, Pathania, (Page No: 778 - 800) 4) Essential of Physical Chemistry, Bahl and Tuli (S. Chand). (Page No: 614 - 684)	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	
Year- T.Y.B. Sc.	**Major Chemistry Paper** **Inorganic Chemistry**	**Credits 2**
Semester- VI		**Hours 30**

Course specific outcomes-

1. To understand M-C bond and to define organometallic compounds
2. Understand the phenomenon of catalysis, its basic principles and terminologies
3. To Understand the role of metals in non-enzymatic processes
4. Know the nature of solids and the crystal structures of solids

Sr. No.	Course Content / Syllabus	Lectures
Unit 1	**Organometallic Chemistry** Definition of Organometallic compounds and Organometallic chemistry, CO as a π-acid donor ligand, binary metal carbonyls, classification of metal carbonyls, synthesis of metal carbonyls; (a) Direct reaction (b) Reductive carbonylation (c) Photolysis and thermolysis. Hepticity, Molecular and electronic structures of binary metal carbonyls, Electron count in complexes (18 electron rule). Applications of organometallic compounds in industrial catalysis. Chemistry of ferrocene; Introduction, synthesis and physical properties of ferrocene. Reactions of ferrocene such as Friedel-Craft Acylation, Friedel-Craft Alkylation, Nitration and Halogenation	**10**

Unit 2	**Homogeneous and Heterogeneous catalysis** Introduction to Catalysis, basic principles, activity and selectivity in catalysis, Types of catalysis, homogeneous vs. heterogeneous catalysis, importance of catalysis in the synthesis of high value chemicals. Homogeneous catalysis: catalytic cycles for following reactions: a) Hydrogenation of olefins using Wilkinson complex, b) Carbonylation reaction: methanol to acetic acid process i.e. Monsanto processes Heterogeneous catalysis: History of the development of industrial heterogeneous catalysis, Classification of heterogeneous catalysts, supported metal catalyst, Role of support, Promoters and Poisons. Catalytic processes viz., a) Hydrogenation of olefins using Raney Nickel catalyst, b) Biodiesel synthesis using Heteropoly acids	**06**
Unit 3	**Bioinorganic Chemistry** Introduction, Role of metals in bioinorganic chemistry, Classification as enzymatic and non-enzymatic metals, enzymatic redox metals such as Cu (SOD) and enzymatic non-redox metals such as Zn (Hydrolase). Role of metals in enzymatic processes-Transition metals- Catalase, peroxidase and nitrogenase (Redox active). Metalloproteins-Iron Proteins-Introduction of Fe-S proteins, Electron transfer proteins (Fe-S, Fe_2S_2, Fe_3S_4, Fe_4S_4). Transport protein (transferrin) and Storage protein (ferritin) Bioinorganic Chemistry of Fe: Haemoglobin and myoglobin, its structure and functions and Bioinorganic Chemistry of Co: Vitamin B-12, its structure and function	**8**
Unit 5	**Ionic Solids** Crystalline and amorphous solids, crystal structures simple cubic, body centered cubic and face centered cubic, Properties of ionic solids, packing arrangements of anions in an ionic solids, Voids in crystal structure- tetrahedral and octahedral, Ionic radius, Palings univalent and crystal radii, Conversion of univalent radii to	**06**

	crystal radii, problems based on conversion of radii, Radius ratio effect, Lattice energy, Born-Lande equation, Born Haber cycle and its applications, Schottky and Frenkel defect	
References	1. Bioinorganic Chemistry Book by K. Hussain Reddy. First Edition 2003 Reprint 2005 2. Basic Organometallic Chemistry: Concepts, Syntheses and Applications of Transition Metals (CRC), B. D. Gupta and Anil J. Elias, Universities Press; 2nd Edition, 201 3. Homogeneous Catalysis: The Applications and Chemistry of Catalysis by Soluble Transition Metal Complexes, G.W. Parshall and S.D. Ittel, Wiley, New York 1992 4. Homogeneous Catalysis: Mechanisms and Industrial Applications, S. Bhaduri and D. Mukesh, Wiley, New York, 2000.pp 13-23, 55-61,85-102, 161-163 5. Principles of Bioinorganic Chemistry by S. J. Lippard and J. M. Berg, Panima Publishing Corporation, 1st Edn., Pages 1-13, 24, 285-290	
Learning outcomes	1. Students will learn the organometallic compounds such as metal carbonyls and ferrocene their uses in catalytic cycles 2. Introduction to catalysis, fundamental principles, activity and selectivity in catalysis, types of catalysis, comparison between homogeneous and heterogeneous catalysis 3. Students will learn the Metals in life. Enzymatic and non-enzymatic roles.	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)** **NEP 2.0**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	
SUBJECT **Major Theory Paper: Organic Chemistry-II**		
T. Y. B. Sc.		**Credits - 2**
Semester-VI		**Hours - 30**

Course specific outcomes-

5. To understand fundamental concept of Physical, and Analytical Chemistry.
6. To impart basic understanding of stoichiometric calculations.
7. To impart practical skills and learn basics behind experiments.
8. To prepare background for advanced and applied studies in chemistry.

Sr. No.	Course Content / Syllabus	Lectures
Unit 1	**1. Chemistry of Natural Products** Terpenoids: Introduction, Isolation, Classification. Citral- structure determination using chemical and spectral methods, Synthesis of Citral by Barbier and Bouveault Synthesis. Alkaloids: Introduction, extraction, Purification, Some examples of alkaloids and their natural resources. Ephedrine- structure determination using chemical methods. Synthesis of Ephedrine by Nagai **Expected learning Outcomes:** After studying this chapter, the student will be able to know and understand: Chemistry of Natural Products- Terpenoids: Introduction, Isolation, Classification, Alkaloids: Introduction, extraction, Purification, Some examples	**7**
Unit 2	**2. Retrosynthetic Analysis and Applications** Introduction, Different terms used – Disconnection, Synthons, Synthetic equivalence, FGI, TM. One group disconnection, Retrosynthesis and Synthesis of target molecules: Acetophenone, Crotonaldehyde, Cyclohexene, Benzyl benzoate, and Benzyl diethyl malonate. **Expected learning Outcomes:**	**8**

	After studying this topic students are expected to know and understand: Disconnection, Synthons, Synthetic equivalence, FGI, TM. One group disconnection, Retrosynthesis and Synthesis of target molecules	
Unit 3	**3. Introduction to Spectroscopy** **2L** Introduction, meaning of spectroscopy, Types of spectroscopies, nature of electromagnetic radiation and regions of electromagnetic spectrum, Terms used in spectroscopy; wavelength, amplitude, frequency, wavenumber, energy and their relations and conversions. **A. Ultra Violet and Visible Spectroscopy** **3L** Introduction, Electromagnetic radiations, electronic transitions, λmax & εmax, chromophore, auxochrome, bathochromic and hypsochromic shifts, Application of visible, ultraviolet spectroscopy in organic molecules. Application of electronic spectroscopy and Woodward rules for calculating l max of conjugated dienes and α, β – unsaturated compounds. **B. Infra-Red Spectroscopy** **4L** Introduction, Infrared radiation and types of molecular vibrations, functional group and fingerprint region. Infra-red spectroscopy in organic molecules, IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions). **C. Nuclear Magnetic Resonance Spectroscopy (PMR)** **6L** Introduction, Principles, Magnetic and nonmagnetic nuclei, nuclear resonance, chemical shift, shielding, & de-shielding effect. Measurement of chemical shift, TMS as reference and its advantages, peak area, integration, spin-spin coupling, coupling constants, J-value, Combined Problems Based on U.V., I.R. and PMR Spectroscopy. **Expected learning Outcomes:** After studying this topic students are expected to know 1. Students will learn the principle of mass spectroscopy, its instrumentation and nature of mass spectrum.	**15**

2. Students will understand the principle of UV spectroscopy and the nature of UV spectrum. They will learn types of electronic excitations.
3. Students will be able to calculate maximum wavelength for any conjugated system. And from the value of λ-max they will be able to find out the extent of conjugation in the compound.
4. Students will understand the principle of IR spectroscopy, types of vibrations and the nature of IR spectrum.
5. From the IR spectrum, they will be able to find out IR frequencies of different functional groups. And thus, they will be able to find functional groups present in the compound.
6. Students will understand the principle of NMR spectroscopy and will understand various terms used in NMR spectroscopy. They will learn measurement of chemical shift and coupling constants.
7. Students will be able to interpret the NMR data and they will be able to use it for determination of structure of organic compounds.
8. Students will be able to determine the structure of simple organic compounds on the basis of spectral data such as λ max values, IR frequencies, chemical shift (δ values).

References

1. Designing Organic Synthesis by Stuart Warren 1983.
2. Organic Chemistry by Clayden, Greeves, Warren and Wothers.Second edition.
3. Organic Chemistry by I. L. Finar Vol. II Edn.V.
4. Organic Chemistry by Morrison and Boyd. VI Edn.
5. A Guidebook to Reaction Mechanism by Peter Sykes VI Edn
6. Pavia D.L.; Lampman G.M. Kriz G. S.; Vyvyan J.R. Spectroscopy, First Indian Reprint 2008 : Brooks/Cole CENGAGE Learning.
7. Silverstein and Basallar: Spectroscopic Identification of Organic Compounds.
8. M. Parikh :Absorption Spectroscopy Organic Compounds (John Wiley)
9. P. S. Kalsi : Spectroscopy of organic compounds (New Age)
10. J. R. Dyer: Application of absorption spectroscopy of organic compounds.
11. V. M. Parikh:Application spectroscopy of Organic molecules. (Mehata)

	12. D.W. Williams and Flemming: Spectroscopic methods of Organic compound. 13. Jackman and Stermineil: Application of NMR spectroscopy	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	
SUBJECT **Analytical Chemistry-II**		
T. Y. B. Sc.		**Credits - 2**
Semester-VI		**Hours - 30**

Course specific outcomes-

1. Define basic terms in solvent extraction, basics of chromatography, HPLC, GC, and AAS and AES.
2. Identify important parameters in analytical processes or estimations.
3. Explain different principles involved in the analyses using solvent extraction, basics of instrumental chromatography, HPLC, GC, and atomic spectroscopic techniques.
4. Perform quantitative calculations depending upon equations students has studied in the theory. Furthermore, student should able to solve problems on the basis of theory.

Chapter. No.	Title of Topic	No. of Llectures
1	**Solvent extraction**	07
2	**Instrumental Methods of Chromatographic Analysis**	03
3	**High Performance Liquid Chromatography**	05
4	**Gas Chromatography**	05
5	**Atomic Absorption Spectroscopy**	07
6	**Flame Emission Spectroscopy**	03
	Total	30

References

1. Vogel's textbook of Inorganic Quantitative Analysis, Jeffery, Basset, Mendham Deney, 5th Ed, Longman Scientific Technical, USA (copublished with John Wiley Sons)
2. Vogel's textbook of Inorganic Quantitative Analysis, Mendham, Deney Barnes, 6th Ed, Pearson education

	3. Analytical Chemistry by G. D. Christian, et al, Wiley, 6th Ed. 4. Principles of Instrumental Analysis: Holler, Skoog, Crouch 6th Ed. Thomson Publication 5. Modern Analytical Chemistry, David Harvey, Mc-Graw Hill Higher education 6. High performance Liquid Chromatography, (Analytical Chemistry through open learning series) Second Ed, Sandie Lindsay, Wiley 7. Gas Chromatography, (Analytical Chemistry through open learning series) 2nd Ed, Ian A. Fowlis, Wiley
Learning outcomes	**1.** Define basic terms in solvent extraction, basics of chromatography, HPLC, GC, and AAS and AES. **2.** Identify important parameters in analytical processes or estimations **3.** Explain different principles involved in the analyses using solvent extraction, basics of instrumental chromatography, HPLC, GC, and atomic spectroscopic techniques. **4.** Perform quantitative calculations depending upon equations students has studied in the theory. Furthermore, student should able to solve problems on the basis of theory.

1. Solvent extraction (7 L)

Introduction to solvent extraction, organic phase, Partition the theory of extraction (distribution coefficient, Distribution ratio, solute remaining unextracted, Separation coefficient), Factors favoring solvent extraction, Quantitative treatment to solvent extraction equilibrium, Ion association complexes, synergic extraction, some extraction reagent specifically used for inorganic ions (Acetylacetone, 8-Hydroxyquinoline, Diphenylthiocarbazone, Sodium diethyldithiocarbamate, Ammonium pyrrolidine dithiocarbamate), some practical aspects, Applications: determination of copper as the diethyldithiocarbamate complex, Determination of Fe(III) with 8-hydroxyquinoline, determination of nickel by synergistic extraction. Solid phase extraction (Ref-3) Numericals; **Key Reference-2**: 242- 253, [Supplementary Ref-3: 579-593]

2. Instrumental Methods of Chromatographic Analysis (3 L)

Principles of Chromatographic Separations, classification, Theory of Column Efficiency in Chromatography, (theoretical plate, rate theory of chromatography - the Van Deemter equation, efficiency and particle size in HPLC, retention factor efficiency and resolution,

Key Reference -4: 603-617, Supplementary reference-3: 547-556.

3. High Performance Liquid Chromatography (5 L)

Introduction, Types of liquid chromatography (liquid-solid, liquid-liquid, bonded phases), Choice of mode of separation, Equipment for HPLC: mobile phase, sample injection and column design (mobile phase, optimization of mobile phase, gradient elution, solvent delivery and sample injection, sample injection system, the column (effect of column length and column diameter), Choosing the Detector, Ultraviolet detector, Luminescence detector, RI detector, electrochemical detector, Column efficiency, HPLC chromatogram and its characteristics (retention time, peak height, peak area), method of quantitative analysis by HPLC, Example: determination of aspirin, phenacetin and caffeine in a mixture, numerical, **Key Reference -2:** 289-315, [Supplementary reference - Ref-3: 649 – 724, Ref-6: 1-325 - relevant part

4. Gas Chromatography (5 L)

Introduction, Apparatus: A supply of carrier gas from a high-pressure cylinder, Sample injection system and derivatization, the column (Packed columns, Open tubular columns), the detector (properties, hot wire detector or TCD, FID, ECD), Quantitative analysis by GC (Area normalization method and internal standard addition method), Elemental analysis, numerical Key **Reference-2: 317- 337, [**Supplementary reference - 7: 1-209 (relevant part)]

5. Atomic Absorption Spectroscopy (7 L)

Introduction, Elementary theory, Instrumentation, flames, the nebulizer-burner system, non-flame techniques, (graphite furnace, cold vapour technique), resonance line sources, monochromator, detectors, interferences, chemical interferences, background correction methods, Atomic absorption spectrophotometers, Experimental preliminaries (calibration curve methods, standard addition method) Preparation of sample (wet ashing, fusion, Dry ashing, microwave dissolution, concentration procedures), Detection limits, Estimation of Ca and Mg in water. **Key Ref-2**: 612 – 643

6. Flame Emission Spectroscopy (3 L)

Introduction, emission spectra, flame emission spectroscopy, flame photometers. Evaluation methods, calibration curve procedure, the standard addition technique, Applications: determination of alkali metals by flame photometry, determination of trace elements in contaminated soil by AAS. Numerical. **Key Reference-2:** 645-649, 655-656

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(An Autonomous College)** **(NEP-2.0)**	**Academic Year 2026-2027**
	Bachelor of Science (UG Degree) in Chemistry	

SUBJECT

Major : Physical Chemistry Practical-II

T. Y. B. Sc.		**Credits - 02**
Semester-VI		**Hours - 60**

Course specific outcomes-

1. To develop skills required in chemistry such as the appropriate handling of apparatus, instruments and chemicals.
2. The students will learn the laboratory skills needed to design, safety conduct and interpret chemical research.
3. To expose the students to an extent of experimental techniques using modern instrumentation.
4. The students will correlate the theory and experiments and understand their importance.
5. The students will develop the ability to effectively communicate scientific information and research results in written and oral formats

	I. Potentiometry (Any Four)	
1	To determine the pKa value of given monobasic weak acid by potentiometric titration.	**4**
2	To determine the formal redox potential of Fe^{2+}/ Fe^{3+} system potentiometrically.	**4**
3	To determine the amount of NaCl in the given solution by potentiometric titration against silver nitrate.	**4**
4	To determine the solubility product and solubility of AgCl potentiometrically using chemical cell.	**4**
5	To prepare standard 0.2M Na_2HPO_4 and 0.1M Citric acid solution, hence prepare four different buffer solutions using them. Determine the pH value of these and	
6	To determine the standard electrode potentials of Cu and Ag electrodes and to determine the EMF of a concentration cell.	
	II. pH metry (Any Three)	
7	To determine the degree of hydrolysis of aniline hydrochloride.	**4**
8	To determine the dissociation constant of oxalic acid by pH-metric titration with strong base.	**4**
9	Determination of pKa of given weak acid by pH metry titration with strong base	**4**
10	pH metric titration of strong acid against strong base by pH measurement and hence determine the concentration and strength of strong acid.	**4**

	III. Radioactivity (Any One)	
11	To determine plateau voltage of the given G M counter.	**4**
12	To determine the resolving time of GM counter.	
	IV. Colligative properties (Any One)	
13	To determine the molecular weight of solute by depression in freezing point method.	**4**
14	To study the association of Benzoic acid in benzene by Beckmann Method.	**4**
15	Determine the molecular weight of given electrolyte and non-electrolyte by Landsberger's method and to study the abnormal molecular weight of electrolyte	**4**
	V. Turbidometry (Any One)	
16	Determination of $SO4^{2-}$ and Cl^{-} by turbidimetric method	**4**
17	To determine the molecular weight of a given polymer by turbidometry.	**4**
	VI. Distribution Law (Any One)	
18	Study the distribution of benzoic acid between water and toluene	
19	Determine the partition coefficient of acetic acid between water and butanol.	
	VII. Table Work	
20	Analysis of crystal structure from X-ray diffraction spectra of any two compounds (Calculation d, lattice constant, crystal volume and density, and assigning planes to peaks using JCPDS data).	**4**
21	**References** **1.** Experimental Physical Chemistry by D. P. Shoemaker, Mc. Growhill, 7th Edition, 2003. **2.** Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House. **3.** Vogel's Textbook of Quantitative chemical analysis 6th edition R.C. Denney,J.D. Barnes, M.J.K. Thomas. **4.** Advanced Practical Chemistry, Jagdamba Sing et al, Pragati Prakashan, Merrut. **5.** Practical Chemistry, Panday, Bajpai, Giri, S.Chand and Co. **6.** Practical Physical Chemistry, Vishwanathan and Raghwan, Viva book. S. Giri, S. Chand Publication.	
22	**Learning outcomes** **1.** Students will get basic analytical and technical skills to work effectively in the various fields of chemistry. **2.** Students will able to calibrate and handle instruments like coductometer, colorimeter, photo-flurometer, refractometer etc. **3.** Students will get skills required in chemistry such as handling of chemicals and preparation of solutions with various concentrations. **4.** They will have ability to present scientific and technical information resulting from laboratory experimentation in both written and oral formats.	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune (Autonomous)**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with research in Chemistry	
Year - T.Y.B.Sc.	**Name of Paper-Organic Chemistry Practical-II**	**Credits 2**
Semester-VI		**Hours 60**

Course specific outcomes-

After studying the course students will be able to

1. To develop skills required in chemistry such as the appropriate handling of apparatus and chemicals.
2. The student will learn the laboratory skills needed to design, safely conduct and interpret chemical research.
3. To expose the students to an extent of experimental techniques using modern instrumentation.
   The student will develop the ability to effectively communicate scientific information and research results in written and oral formats.

Sr. No.	COURSE CONTENT / SYLLABUS	Hours
	A. Single stage preparations (Any Four)	**16**
1	Ortho -Phenylene Diamine – Benzotriazole	
2	Diels -Alder reaction of Anthracene and Maleic Anhydride	
3	Reduction of 4-chlorobenzaldehyde by Sodium borohydride	
4	Nitration of Anisole by acetic anhydride and nitric acid.	
5	Preparation of Adipic acid from cyclohexanone	
	B. Double stage preparations (Any Four)	**24**
1	Benzoin to Benzil - Quinoxaline	
2	Benzaldehyde - Benzalproanone – Epoxide	
3	Benzoin -Benzil-Benzilic Acid	
4	Cyclohexanone-Phenyl hydrazone-1,2,3,4-Tetrahydrocarbazole	
5	Cyclohexanoe-Oxime-caprolactum	
	C. Column Chromatography (Any Two)	**8**
	D. Interpretation of IR and PMR spectra. (Two each)	**8**
	E. Internal test	**4**

References	1. Vogel's Textbook of Practical Organic Chemistry, 5th edition Pearson India. 2. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Aggarwal 3. Advanced Practical Organic Chemistry by John Leonard, John Leonard, Barry Lygo, Garry Procter, 2nd edition, CRC Press. 4. Solvent-free Organic Synthesis by Koichi Tanaka. 5. Practical Organic Chemistry by Mann and Saunders, 4th edition, Pearson Education. 6. Advanced Practical Organic Chemistry by John Leonard, Barry Lygo, Garry Procter, 3rd Edition	
Learning outcomes	**Learning Outcomes: The students will be able to** **A) Single stage preparations** **B) Double stage preparations** **C) Column chromatography** 1. Defines the basic parameters in chromatography 2. Explain the processes of a chromatography analysis 3. Describes the types and materials of column. 4. Explains the types of mobile phase and elution. **D) Interpretations of IR and PMR Spectra The students will be able to** 1. Explain "fingerprint region" of an infrared spectrum can used in the identification of anunknown compound. 2. Identify the functional group or groups present in a compound. 3. Identify the broad regions of the infrared spectrum in which occur absorptions caused byN−H, C−H, and O−H, C≡C and C≡N, C=O, C=N, and C=C. 4. Understand use NMR spectra to determine the structures of compounds. 5. Interpret integration of NMR spectra 6. Calculate coupling constants from 1 H NMR spectra. 7. Interpret elemental analysis technique	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	
Year- T.Y.B. Sc.	**Major Elective** **Inorganic Chemistry Practical-II**	**Credits 2**
Semester- VI		**Hours 60**
Sr. No.	**Course Content / Syllabus**	**Lectures**
Section 1	**Volumetric Estimations** 1. Analysis of Phosphate (PO_4^{3-}) from Fertilizer 2. Analysis of Calcium from milk powder 3. Analysis of Cu from Cu-Fungicide 4. Determination Mg from talcum powder 5. Strength of medicinal H_2O_2	**20**
Section 2	**Flame Photometry (Any one)** 1. Estimation of Na by flame photometry by calibration curve method 2. Estimation of K by flame photometry by calibration curve method	**04**
Section 3	**Column Chromatography** 1. Purification of water using cation exchange resin and	**16**

	analysis by qualitative analysis 2. Purification of water using anion exchange resin and analysis by qualitative analysis 3. Separation of metal cations by using column chromatography. (Two Mixtures)	
Section 3	**Inorganic Synthesis** 1. Synthesis of ZnO nanoparticles 2. Synthesis of acetylferrocene synthesis from ferrocene 3. Solvent free microwave assisted one pot synthesis of pthalocynin copper (II) complex 4. Preparation of Acetylsalicylic acid (Aspirin)-Zinc complex	**16**
Section 4	**Compulsory Experiment** 1. Quantitative determination of Manganese from tea leaves by colorimetry 2. Dye degradation by using Fenton's reagent	**08**
References	1) Vogel's textbook of Inorganic Quantitative Analysis, Jeffery, Basset, Mendham Deney, 5th Ed, Longman Scientific Technical, USA 2) Indian Pharmacoepia, Vol-2; 2007 3) Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horword Publishing, Chichester) 1999 4) Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House 5) Basics of Analytical toxicology, World Health Organization	
Learning outcomes	1. The students will understand the fundamentals, principles, of recent Inorganic Chemistry experiments 2. To develop students' theoretical and experimental knowledge with application in practicals. 3. To make students aware about basic practical skill requirement for the chemistry laboratory.	

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	
SUBJECT-Discipline Specific Core (DSC) Major Elective **SUBJECT TITLE- A) Introduction to Forensic Chemistry**		
T. Y. B. Sc.		**Credits - 2**
Semester- VI		**Hours - 30**

Course specific outcomes-

After successful completion of this course, students will be able to:

1. Understand the **role of chemistry in forensic science** and its application in crime investigation and the legal system.
2. Apply fundamental principles of **analytical, organic, and physical chemistry** to forensic evidence analysis.
3. Identify, classify, and analyze **forensic materials** such as drugs, poisons, explosives, inks, fibers, and biological traces.
4. Interpret forensic chemical data using **standard laboratory techniques and instrumental methods**.
5. Appreciate **ethical, legal, and quality assurance aspects** involved in forensic chemical investigation.

Sr. No.	Course Content / Syllabus	Lectures
Unit 1	**History of Development of Forensic Science in India** Functions of forensic science. Historical aspects of forensic science. Definitions and concepts in forensic science. Scope of forensic science. Need of forensic science. Basic principles of forensic science. Frye case and Daubert standard. Work nature of forensic science. Qualifications of forensic scientists. Duties & Code of conduct for forensic scientists	**8**
Unit 2	**Introduction to Narcotics Drugs and Psychotropic Substances** Definition of narcotics drugs and psychotropic substances. Broad classification – Narcotics, stimulants, depressants and hallucinogens. General characteristics and common example of each classification. Natural, synthetic and semi-synthetic narcotics drugs and	**9**

	psychotropic substances. Designer drugs. Tolerance, addiction and withdrawal symptoms of narcotics, drugs and psychotropic substances. Introduction to NDPS Act-1985 and awareness about Punishment for Offences	
Unit 3	**Analysis of Narcotics Drugs and Psychotropic Substances** Crime scene search for narcotic drugs and psychotropic substances – searching a suspect, searching a dwelling, searching a vehicle. Clandestine drug laboratories. Collection and preservation of drug evidence. Testing of narcotics drugs and psychotropic substances. Isolation techniques for purifying narcotics drugs and psychotropic substances – thin layer chromatography, gas-liquid chromatography and high-performance liquid chromatography. Presumptive and screening tests for narcotics drugs and psychotropic substances. Microcrystalline testing of Drug Abuse and Illicit Trafficking. Analysis of narcotics drugs and psychotropic substances in urine, and antemortem blood & in postmortem blood. Dope tests.	**13**
References	1. R. Saferstein, *Criminalistics*, 8th Edition, Prentice Hall, New Jersey (2004). Page No 10-26 2. S.B. Karch, *The Pathology of Drug Abuse*, CRC Press, Boca Raton (1996). Page No: 429-638. 3. A. Poklis, Forensic toxicology in, *Introduction to Forensic Sciences*, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton (1997). Page No: 116-141 4. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, *Techniques of Crime Scene Investigation*, CRC Press, Boca Raton (2013). Page No 323-337 5. THE NARCOTIC DRUGS AND PSYCHOTROPIC SUBSTANCES, ACT, 1985 https://legislative.gov.in/sites/default/files/A1985-61.pdf 6. THE NARCOTIC DRUGS SUBSTANCES AND PSYCHOTROPIC RULES, 1985 https://dor.gov.in/sites/default/files/Narcotic-Drugs-and-Psychotropic-Substances-Rules- 1985_0.pdf 6. National Policy on NDPS Govt. of India https://dor.gov.in/narcoticdrugspsychotropic/national-policy-ndps 7.National Policy on NDPS & Punishment for Offences https://dor.gov.in/narcoticdrugspsychotropic/punishment-offences	

	8. J.W. Robinson, *Undergraduate Instrumental Analysis*, 5th Edition, Marcel Dekker, Inc., New York (1995). Page No: 721-797 9. Analytical Techniques in Forensic Science Rosalind Wolstenholme, Sue Jickells, Shari Forbes, edition first edition 2021 John Wiley & Sons Ltd Page No; 51-68 10. FORENSIC ANALYTICAL TECHNIQUES Barbara Stuart University of Technology, Sydney, Australia, first edition 2013 John Wiley & Sons, Ltd. 143-166
Learning outcomes	At the end of the course, the learner will be able to: 1. Explain the **scope, significance, and limitations** of forensic chemistry in modern criminal investigations. 2. Describe the **chemical basis of forensic analyses** related to toxicology, arson, explosives, and drug identification. 3. Perform **qualitative and quantitative analysis** of forensic samples using classical and instrumental methods. 4. Correlate **chemical evidence with crime scenes** and draw scientifically valid conclusions. 5. Develop basic **problem-solving, critical thinking, and observation skills** relevant to forensic case studies.

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	
SUBJECT- Discipline Specific Core (DSC) Major Elective **SUBJECT TITLE- B) Chemistry of Soil and Agrochemicals**		
T. Y. B. Sc.		**Credits - 2**
Semester- VI		**Hours - 30**

Course specific outcomes-

After successful completion of this course, students will be able to understand the chemical composition, reactions, and fertility of soils, explain the chemistry, classification, and mechanism of action of agrochemicals, and apply chemical principles for sustainable agricultural practices, soil health management, and environmentally safe use of fertilizers and pesticides.

Sr. No.	Course Content / Syllabus	Lectures
Unit 1	**Soil Chemistry** Role of agricultural chemistry, Introduction to soil chemistry, definitions of soil, Soil components- Mineral component, organic matter or humus, soil atmosphere, soil water, soil microorganism. Physical properties of soil- Soil texture, soil structure, soil colour, soil temperature, soil density, porosity of soil, Surface soil and sub-soil, Functions of soil, Chemical properties of soil - Soil reactions, importance of soil reaction, factors controlling soil reactions, Buffer action, buffering capacity, importance of buffer reaction in agriculture, ion exchange and importance of ion exchange	5

Unit 2	**Problematic Soil and Soil testing** Introduction to problematic soils, Acid soils- formation of acid soil, effect of soil acidity on plant, reclamation of acidic soil, application of lime in improving the acidity of soil, lime requirements, Alkali Soil- formation of alkali soil, reclamation of alkali soil, Classification of alkali soil- saline soil, alkali soil, saline alkali soil, non-saline alkali soil, Soil testing - Introduction, different methods of soil fertility evaluation, Objectives of soil testing.	5
Unit 3	**Laboratory Methods of Soil Analysis (12 L)** Collection of soil Samples from field, Soil sample preparation for analysis of various parameters, Digestion and Extraction Procedures for soil, Project/ Hands on training of Analysis of various parameters of soil and writing project on it. (**Note: Students can perform minimum six experiments out of eight in the laboratory with the help of teacher and write report on it and submit to subject teacher. It is considered for internal marks of this course**). 1. Determination of pH of soil 2. Determination of EC and TDS of soil 3. Determination of soil organic matter of soil. 4. Determination of available nitrogen in soil. 5. Determination of available phosphorus from soil. 6. Determination of calcium and magnesium from soil by EDTA method. 7. Determination of sodium and potassium by flame photometry method. 8. Determination of carbonate and bicarbonates from soil. 9. Calculate the RSC, SAR, SSP, Salinity of soil. Interpretation of soil data and recommendations for soil use.	10

Unit 4	**Fertilizers and Manures** **Fertilizers :**Introduction, Classification of nitrogenous fertilizers, reaction of ammonium sulphate, urea as a fertilizer in soil, Nano fertilizers- Nano-Fertilizers for Sustainable Crop Production, Nano urea- preparation, forms and application of nano urea,Phosphatic fertilizers- Classification of phosphatic fertilizers, reactions of superphosphate as a fertilizer in soil, Potassic fertilizers - Classification of potassic fertilizers, reactions of potash fertilizer in soil, Complex fertilizers- Characteristics, advantages and disadvantages, Mixed fertilizers - Characteristics, advantages and disadvantages, Time and mode of applications of fertilizers in the solid and liquid form to plants, Factors affecting efficiency of fertilizers. **Manures:** Introduction, Definition and classification of manures, Effect of bulky organic manures on soi, Farm yard manures (FYM), improved methods of handling FYM- Trench method for FYM, Factors affecting the composition of FYM, losses during the handling and storage of FYM, Gober gas-compost plant - construction and advantages, Biofertilizers - Definition, classification, role & advantages, Vermicompost - Preparation, effect of vermicompost on soil fertility.	5
Unit 5	**Protection of Plants** Classification of pesticides, Insecticide- Definition, Classification on the basis of mode of action and chemical properties, Inorganic insecticides - plants or animal origin insecticides- nicotine, pyrethrum, Rotenone, Synthetic organic insecticides – a) Organochlorine insecticides - DDT, BHC, Aldrin and dieldrin. b) Organophosphorus insecticides – Parathion, Malathion, c) Carbamate insecticides – Carbaryl, Baygon, Fungicide – Definition and Classification of fungicides, Inorganic fungicide- Copper fungicides a) Bordeaux mixture, b) Copper oxychloride, Organic fungicides- Dithiocarbamate, Quinone fungicides, Heterocyclic fungicides, Synthetic fungicides, Herbicides- Definition, Classification on	5

	the basis of mode of action- Selective and non-selective herbicides, classification based on their effect on weeds- contact, systemic herbicides. Classification on the basis of their chemical structures, Nano pesticides: Its Scope and Utility in Pest Management.	
References	1. A text book of soil science (Revise Edition) J. A. Daji. Revised by J. R. Kadam, N. D. Patil, Media promoters and publishers, Mumbai, 1996. 2. Text book of soil science, T. D. Biswas, S. K. Mukherjee, 2nd ed. Tata McGraw Hill Publishing company, New Delhi, 2017. 3. Introduction to Agronomy and soil, water management, V. G. Vaidya, K. R. Sahashtrabuddhe, (Continental Prakashan). 4. Principals of soil science, M. M. Rai, 4th ed. Million complex of India, Bombay, 1977. 5. Manures and fertilizers (12th ed.), K. S. Yawalkar, J. P. Agarwal and Bokde, Agri- horticulture publishing house, Nagpur, 2016. 6. Chemistry of insecticides and fungicides, U.S. Sreeramula (2nd ed.), oxford and IBH Publishing company, New Delhi. 7. Fundamentals of soil sciences, Henry D. Foth, 8th ed. John Wiley and Sons, 1990. Book Soft copy URL: https://1lib.in/book/634160/343570 8. A text book of soil science (Revise Edition) J. A. Daji. Revised by J. R. Kadam, N. D. Patil, Media promoters and publishers, Mumbai, 1996. 9. Text book of soil science, T. D. Biswas, S. K. Mukherjee, 2nd ed. Tata McGraw Hill Publishing company, New Delhi, 2017. 10. Introduction to Agronomy and soil, water management, V. G. Vaidya, K. R. Sahashtrabuddhe, (Continental Prakashan). 11. Principals of soil science, M. M. Rai, 4th ed. Million complex of India, Bombay, 1977. 12. Manures and fertilizers (12th ed.), K. S. Yawalkar, J. P. Agarwal and Bokde, Agri- horticulture publishing house, Nagpur, 2016. 13. Chemistry of insecticides and fungicides, U.S. Sreeramula (2nd ed.), oxford and IBH Publishing company, New Delhi. 14. Fundamentals of soil sciences, Henry D. Foth, 8th ed. John Wiley and Sons, 1990. Book Soft copy URL: https://1lib.in/book/634160/343570 15. Soil, Plant, Water and fertilizer analysis, P. K. Gupta, 2nd ed. Agrobios	

Publication, Jodhpur, India. Book Soft copy URL: https://content.kopykitab.com/ebooks/2016/06/7111/sample/sample_7111.pdf

16. Handbook of Biofertilizers and biopesticides, A. M. Deshmukh, R. M. Khobragade and P. D. Dixit, Oxford Book Company, Jaipur, India 2007. Book Soft copy URL: https://1lib.in/book/961124/8ecdcd
17. Essential Plant Nutrients uptake use efficiency and Management, M. Naeem, Abid A. Ansari, Sarvajeet Singh Gill Editor, Springer International Publishing AG, 2017. Book Soft copy URL: https://1lib.in/book/3376008/16ba17
18. The Use of Nutrients in crop plants, N.K. Fageria, CRC Press, Taylor and Francis Group, LLC, 2009. Book Soft copy URL: https://1lib.in/book/550595/3a2232
19. Agronomic Handbook – Management of crops, soils and their fertility, J. Benton Jones, Jr. CRC Press LLC, Washington D.C. 2003. Book Soft copy URL: https://1lib.in/book/946311/37a879
20. The chemistry of Organophosphorus Pesticide, Christa Fest, Karl-Julius Schmidt, 2nd revised ed., Springer, Verlag Berlin Heidelberg, New York, 1982. Book Soft copy URL: https://1lib.in/book/2137868/423f0a
21. Chemical Pesticide - Mode of action and Toxicology, Jorgen Stenersen, CRC Press, 2004. Book Soft copy URL: https://1lib.in/book/550607/97f6b8
22. Agrochemical and Pesticide safety Handbook, Michel F. Waxman, CRC Press, 1998. Book Soft Copy URL: https://1lib.in/book/2061906/6282cc
23. Basic Guide to Pesticides: Their Characteristics and Hazards, Shirley A. Briggs, Rachel Carson Council, First Edition, CRC Press, Taylor and Francis Group, 2017. Book Soft copy URL: https://1lib.in/book/3580723/94db6c
24. Principles of Soil Chemistry, Kim H. tan, 4th ed. revised and expanded, Marcel Dekker AG, New York, 1998. Book Soft copy URL: https://1lib.in/book/2572952/f500e1
25. Nano fertilizers, Nano Urea- URL: https://www.iffco.in/
26. Nano fertilizers & Nano Pesticides, URL: https://www.sciencedirect.com/science/article/pii/S0570178320300440 ,

	https://www.sciencedirect.com/science/article/pii/B9780128200926000124 27. Biofertilizers, URL: https://www.sciencedirect.com/topics/agricultural-and-biological- sciences/biofertilizers , 28. https://agritech.tnau.ac.in/ta/org_farm/orgfarm_biofertilizers.html, https://en.wikipedia.org/wiki/Biofertilizer 29. Nano Pesticides, URL: https://link.springer.com/article/10.1007/s10311-016-0600-4
Learning outcomes	On completion of this course, the learner will be able to: 1. **Explain** the chemical composition, properties, and classification of soils with respect to soil fertility and productivity. 2. **Analyze** soil chemical reactions including ion exchange, pH buffering, salinity, and nutrient availability. 3. **Describe** the chemistry, synthesis, and role of major and micronutrient fertilizers in crop production. 4. **Understand** the classification, chemical nature, and mode of action of pesticides, herbicides, and fungicides. 5. **Evaluate** the environmental impact, toxicity, and degradation of agrochemicals in soil and water systems. 6. **Apply** principles of green chemistry and sustainable agriculture for safe and judicious use of agrochemicals.

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	
SUBJECT-Discipline Specific Core (DSC) Major Elective **SUBJECT TITLE- C) Medicinal Chemistry**		
T. Y. B. Sc.		**Credits - 2**
Semester- VI		**Hours - 30**

Course specific outcomes-

1. This course introduces the principles of Medicinal Chemistry with emphasis on the relationship between chemical structure and biological activity.

2.It covers drug discovery processes, lead optimization, and basic pharmacokinetic and pharmacodynamic concepts.

3.Students learn mechanisms of action of major classes of drugs used in the treatment of common diseases.

4.The course highlights modern approaches such as rational drug design, prodrugs, and biomolecular targets.

Sr. No.	Course Content / Syllabus	Lectures
Unit 1	An Introduction to Drugs, their Action and Immunobiologicals **A.** Introduction, Need of new drugs, Historical background of drug discovery and design, Sources of drugs, Classification of drugs, Introduction to drug action. **B.** Immunobiologicals: Vaccines: Introduction, Methods of vaccine production: Inactivated pathogens, Live/Attenuated Pathogens and Cellular Antigen from a pathogen, SARS-CoV-19	6
Unit 2	**Bio-physicochemical Properties in Drug Action and Design** Introduction, Acidity/Basicity, Solubility, Ionization, Hydrophobic and hydrophilic properties, Lipinski Rule, **Terminology in Medicinal Chemistry:** Pharmacology, Pharmacophore, Pharmacodynamics, Pharmacokinetics, metabolites, antimetabolites and therapeutic index. Importance of stereochemistry in drug action (Example: Ibuprofen), Concept of	6

	rational drug design: Structure activity relationship, Drug-receptor understanding	
Unit 3	Drugs for Infectious Diseases: Introduction, Structures, Mode of Action and Applications**:** **A. Antimicrobial Agents**: Classification on i) Type of action: Bacteriostatic and Bactericidal ii) Source (Natural, Synthetic and Semisynthetic) iii) Spectrum of activity: Narrow and Broad Spectrum iv) Chemical structure: β-lactams (Penicillin), Macrolides (Azithromycin), and Sulphonamides (Sulfadiazine), **B. Anti-fungal and anti-viral agents**: Example: Amphotericin -B	9
Unit 4	Drugs for Non-infectious diseases Introduction, Structures, Mode of Action, and Applications**:** **A. i) Anti-inflammatory and Analgesic** Agents: Example: Aspirin, and Ibuprofen, **ii) Psychoactive Agents:** Sedatives and Hypnotics: Example: Benzodiazepines, **B. Metallodrugs as Chemotherapeutic Agents:** Examples: Aluminium based antacids, Salvarsan, and Cis Platin,	9
References	1. Fundamentals of Medicinal Chemistry by Gareth Thomas, University of Portsmouth, UK. 2. An Introduction to Medicinal Chemistry, Patrick, G. Oxford. University Press (Vth Edition). 3. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical, Charles Owens Wilson, John H. Block, Ole Gisvold, John Marlowe Beale. 4. Foye's Principles of Medicinal Chemistry by David A. Williams, Thomas L. Lemke, William O. Foye (VIIth Edition), Kluwer publication. 5. Medicinal chemistry, fourth edition, Ashutosh Kar (2007). 6. Metallodrugs in Medicinal Inorganic Chemistry Katja Dralle Mjos and Chris Orvig, Chem. Rev. 2014, 114, 4540-4563, http://dx.doi.org/10.1021/cr400460s 7. Metallodrugs are unique: opportunities and challenges of discovery and development, E. J. Anthony et.al. Chem. Sci., 2020, 11, 12888, http://dx.doi.org/10.1039/d0sc04082g. 8. Metallo-therapeutic Drugs And Metal-Based Diagnostic Agents by Marcel	

	Gielen and Edward R.T. Tiekink 9. Research and Development on Therapeutic Agents and Vaccines for COVID-19 and Related Human Coronavirus Diseases, Cynthia Liu et al., ACS Cent. Sci. 2020, 6, 315−331, http://dx.doi.org/10.1021/acscentsci.0c00272 10. A comprehensive overview of vaccines developed for pandemic viral pathogens over the past two decades including those in clinical trials for the current novel SARS-CoV-2, Kannan Damodharan et al., RSC Adv., 2021, 11, 20006– 20035,http://dx.doi.org/10.1039/d0ra09668g
Learning outcomes	**Learning Outcomes:** Upon completion of the course the student shall be able to understand, 1. The basics of medicinal chemistry, biophysical properties, overview of basic concepts of traditional systems of medicine. 2. Over view of the overall process of drug discovery, and the role played by medicinal chemistry in this process. 3. Biological activity parameters and importance of stereochemistry of drugs and receptors. 4. Knowledge of mechanism of action of drugs belonging to the classes of infectious and non-infectious diseases. 5. Enhancement of practical skills in synthesis, purification and analysis.

	MODERN EDUCATION SOCIETY'S **Nowrosjee Wadia College, Pune** **(Autonomous)**	**Academic Year 2026-2027**
	Bachelor of Science (Hons.) with Research in Chemistry	

SUBJECT-Vocational Skill Course (VSC)

SUBJECT TITLE- C) Synthesis, Extraction and Isolation of Industrial Products

T. Y. B. Sc.		**Credits - 2**
Semester- VI		**Hours - 60**

Course specific outcomes

1. Perform basic chemistry practicals with proper laboratory discipline.
2. Prepare simple organic compounds and polymers using standard methods.
3. Carry out chemical estimations using titration and colorimetric techniques.
4. Understand the use of chemicals in medicines, food, and daily-use products.
5. Prepare herbal and household products in the laboratory.

Sr. No.	**Course Content / Syllabus** (Total 12 Experiments to be performed)	**Hours**
	[A] Preparations (Any Four)	
1	Synthesis of Benzocaine from PABA	**4.**
2	Synthesis of Phenytoin	**4.**
3	Synthesis of Caprolactam / Nylon-6	**4.**
4	Synthesis of Nylon-66	**4.**
5	Nitration of salicylic acid by green approach (using ceric ammonium nitrate)	**4.**
6	Preparation of urea-formaldehyde resin	**4.**
	[B] Estimations (Any Four)	
7	To perform assay of aspirin / ibuprofen	**4.**
8	Estimation of curcumin in herbal face wash	**4.**
9	Estimation of calcium carbonate in egg shell	**4.**
10	Estimation of fluoride in toothpaste by colorimetry	**4.**
11	Estimation of ascorbic acid in fruit juice / vitamin C tablet (iodometric method)	**4.**
12	Estimation of phosphoric acid in superphosphate fertilizer	**4.**
13	Determination of organic carbon in soil sample.	**4.**
	[C] Preparations (Any Two)	
14	Preparation of herbal hand wash / face pack	**4.**
15	Preparation of talcum powder	**4.**
16	Preparation of herbal dyes	**4.**

	[D] Extractions (Any Two)	
17	Extraction of volatile oil from orange peel / lemongrass	**4.**
18	Separation of essential oil from sunflower seeds by soxhelt extractor	**4.**
19	Testing of turmeric powder, milk, mustard oil for adulteration.	**4.**
References	1. Vogel's Textbook of Practical Organic Chemistry2. Natural Products Chemistry Practical Manual: For Science & Pharmacy Courses -Anees A. Siddiqui 2. Natural Products: A Practical Approach to Extraction and Analysis. Oxford University Press. Smith - J., & Brown, L. (2020). 3. Chemistry of Natural products, a laboratory handbook-N.R.Krishnaswamy 4. Natural product chemistry ,Source,seperation and structures -Raymond Copper ,Gorge Nicola 5. Natural Products: A laboratory Guide eBook-Ikan, Raphael.	
Learning outcomes	1. Understand the fundamental principles of natural product extraction, isolation, and characterization. 2. Identify different classes of natural products, including alkaloids, flavonoids, terpenoids, and glycosides. 3. Describe various techniques used in natural product research, such as chromatography and spectroscopy. 4. Develop problem-solving skills in the identification and evaluation of bioactive compounds. 5. Apply Good Laboratory Practices and safety protocols in handling natural product extracts and reagents	

On Job Training/Internship (4 credits, 120 hours)

Students in this course will be required to do On the Job Training (OJT)/Internship in relevant industries/government sectors/institutes, etc. to gain practical training. As a prerequisite for OJT, the department may conduct necessary lectures/workshops/seminars. The course will be run as per the guidelines of the Institute /the University and Government of Maharashtra. Most of our graduates are expected to seek employment in industries, pursue teaching careers, or establish small enterprises after obtaining their B.Sc. degree. Therefore, the following options would be provided to the students to develop skilled and competent students.

a) Hands on Training on various analytical instruments- UV-Visible Spectrometer, Fourier Transform Infrared Spectrometer, Nuclear Magnetic Resonance Spectrometer, Mass Spectrometry, Gas Chromatography, HPLC, X-Ray Diffractometer, Powder X-ray Diffractometer, Thermal Analyzer (TGA-DSC), Scanning electron microscope, Transmission electron microscope, BET Surface Analyzer, Raman Spectrometer, CHN Analyzer

Note: Analytical instruments (from above list) should be selected for OJT that should complete 120 hours training.

OR

b) Teacher Training Course:

1) Development of MOOCS
2) Development of Learning Management System (LMS)

OR

c) Internship in Industry or National research laboratory.

OR

d) To develop Entrepreneurship, production of the following items, including packaging

1) Dye
2) Acids, caustic soda
3) Fire Extinguisher
4) Fertilizers
5) Any other industry material

OR

e) Field projects that are aligned with the Chemistry Subject.

A detailed report should be submitted for the evaluation of On Job Training/Internship