Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

SHIVAJI UNIVERSITY, KOLHAPUR - 416004, MAHARASHTRA
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शिवाजी विद्यापीठ, कोल्हापूर -४१६००४,महाराष्ट्र
दूरध्वनी-ईपीएबीएक्स -२६०९०००, अभ्यासमंडळे विभाग दुरध्वनी ०२३१-२६०९०९४
०२३१-२६०९४८७

Ref.No.SU/BOS/Science/148 **Date: 26/05/2026**

The Principal,
All Concerned Affiliated Colleges/Institutions
Shivaji University, Kolhapur.

Subject: Regarding revised syllabi of B.Sc. Part-III (Sem.V & VI) degree programme under the Faculty of Science and Technology as per NEP-2020 (2.0)

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the syllabi, nature of question paper of B.Sc. Part-III (Sem.V & VI) degree programme under the Faculty of Science and Technology as per NEP-2020 (2.0).

B.Sc. Part-III (Sem. V & VI) as per NEP-2020 (2.0)			
1.	Botany	9.	Geology
2.	Physics	10.	Zoology
3.	Statistics	11.	Chemistry
4.	Mathematics	12.	Electronics
5.	Microbiology	13.	Drug Chemistry
6.	Industrial Microbiology	14.	Pollution
7.	Biochemistry	15.	Food Science and Quality Control
8.	Computer Science (Optional)	16	Biotechnology (Optional/Vocational)

This syllabus, nature of question and equivalence shall be implemented from the academic year 2026-2027 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website **www.unishivaji.ac.in>Syllabus>Syllabus as per NEP2020.**

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2026 & March/April 2027. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dy Registrar

Encl: as above

for information and necessary action

Copy to:

1	Dean, Faculty of Science & Technology	6	Appointment Section A & B
2	Director, Board of Examinations and Evaluation	7	I.T.Cell /Computer Centre
3	Chairman, Respective Board of Studies	8	Eligibility Section
4	B.Sc.-M.Sc. Exam Section	9	Affiliation Section (T.1) (T.2)
5	Internal Quality Assurance Cell (IQAC Cell)	10	P.G. Seminar Section

Shivaji University,

Kolhapur

Accredited By NAAC with 'A^{++}' Grade

Syllabus for

Bachelor of Science Part-III

(B. Sc. III)

In
Chemistry

(NEP-2.0)

To be implemented fromJune, 2026 onwards

SHIVAJI UNIVERSITY, KOLHAPUR
Revised Syllabus for the Bachelor of Science in Chemistry
(As per NEP- 2.0)
Applicable from the Academic Year 2026 –27

1. **Title**: B. Sc. III Chemistry, Shivaji University, Kolhapur Revised Syllabus as per NEP – 2.0
2. **Faculty**: Faculty of Science and Technology.
3. **Year of Implementation**: From June 2026
4. **Objectives of a Bachelor of Science (B.Sc.) in Chemistry Program include**:
    - Understand the fundamental principles, laws, concepts and formulas of Chemistry.
    - Develop problem-solving skills of students.
    - Gain practical experience by hands-on experience with instruments and develop laboratory skills.
    - Learn about advanced Chemistry and its applications for higher studies.
    - Learn to apply conceptual knowledge to practical work.
    - Learn to interpret chemical and physical phenomena through experimental evidence.
    - Learn to analyze and interpret data accurately through scientific reasoning and experimental hypothesis testing.
5. **Program Outcomes:**

    PO-1:- Students will gain fundamental knowledge of Chemistry which will help them for PG studies and Research.

    PO-2:- Students will be able to know good laboratory practices and lab safety.

    PO-3:- Students will become proficient in analyzing the various observations and chemical phenomena presented to him during the course.

    PO-4:- Students will be able to apply the fundamental knowledge to address the cross-cutting issues such as sustainable development.

    PO-5:- Students will be able to solve various problems by identifying the essential parts of a problem, formulate strategy for solving the problem, applying appropriate techniques to arrive at a solution, test the precision and accuracy of the solution and interpret the results.

PO-6:- Students will be able to communicate effectively i.e. being able to articulate, comprehend and write effective reports, make effective presentations and documentation and capable of expressing the subject through technical writing as well as through oral presentation.

6. **Program Specific Outcomes:**

PSO-1:- Students will be able to explain fundamental concepts of Inorganic, Physical, Organic and Analytical Chemistry.

PSO-2. Students will be able to Identify chemical formulae and solve numerical problems.

PSO-3. Students will be able to use modern chemical tools, Models, Charts and Equipment.

PSO-4. Students will be able to prepare and qualify for competitive examinations

PSO-5. Students will understand good laboratory practices and safety.

PSO-6. Students will develop research-oriented skills.

7. **Program Education Outcomes:**

PEO-1: Students after graduation (Graduates) will possess strong analytical, critical thinking, and problem-solving skills relevant to the field in chemistry and they will be prepared for careers in various sectors, including industry, research, and government, requiring a strong foundation in chemistry.

PEO-2: Graduates will be able to utilize their chemical knowledge and skills to address societal needs and challenges include areas like environmental sustainability, healthcare, energy solutions, and materials science.

PEO-3: Graduates will demonstrate a commitment to lifelong learning and professional development, and they will possess strong communication, teamwork, and leadership skills.

PEO-4: They will be able to apply their chemical knowledge and skills to solve problems and they will be prepared to adapt to the evolving landscape of the chemical sciences.

PEO-5: Graduates will be equipped to pursue further education, such as an M.Sc. or Ph.D., in chemistry or related disciplines and will be able to work effectively in multidisciplinary and interdisciplinary environments.

PEO-6 Graduates will be equipped to innovate and develop solutions that benefit society.

8. The B. Sc. III Course (Chemistry) (Level 5.5) will be of **Two Semesters (Sem. V and Sem VI)**.
9. Pattern of Examination: The Examinations will be conducted **semester-wise for Theory and Practical.**
10. **Fee structure**: As per Shivaji University guidelines.
11. **Eligibility Criteria for Admission to B. Sc. Part III (Level 5.5)**: Please see B. Sc. Rules and Regulations of Shivaji University, Kolhapur
12. **Medium of Instruction**: English
13. **Structure of course:** Given in Framework Chart
14. **Scheme of Teaching and Examination:**
    a. Each theory course paper constitute of 4 units require 30 hours of teaching lectures and there shall be two lectures per theory (2 Cr) course per week.
    b. B. Sc. III Chemistry Course will be of 44 Credits (1100 marks) .
    c. Examination of each **theory course** shall be of **50 marks** (40 university examination + 10 internal assessment). University examination of 40 marks (1.5 hours' duration) will be conducted at the end of each Semester. Internal assessment of 10 marks will be done before the semester examination during each semester.
    d. Examination of practical course shall be of 100 marks (4 Cr) and 50 marks (2 Cr) per semester.
    e. Practical Examination will be conducted in Odd-Odd and Even-Even semester pattern only.
    f. Pattern and Nature, marking scheme for theory and Practical Examination for Major Specific SEC and VSC courses are included in syllabus.
    g. Question papers will be set in the view of the entire syllabus and preferably covering each unit of the syllabus. Weightage should be provided to each unit as per the hours allotted for teaching.
15. **Standard of Passing:** The standard of passing shall be as per the following table.

	Semester End Exam	Internal Assessment	Course Exam (Total)
Maximum Marks	40	10	50
Minimum Marks required for passing	14	4	18

There shall be a separate head of passing for semester end examination and internal examination. ii) Minimum 18 marks out of 50 and 35 marks out of 100 are required for passing of practical examination of each course. iii) Passing criteria for OJT and Field Project (FP) as per the University guidelines.

Nature of Question paper and scheme of marking:

Theory question paper: Maximum marks -40

Total No. of questions – 3 All questions are compulsory. Question No.1 is MCQ type (8 Marks). Question number 2 is long answer type question Carries 16 marks. Question number 3 is short answer type question carries 16 marks. (Nature of question paper is provided at the end of syllabus.)

Shivaji University, Kolhapur
Bachelor of Science
Credit Framework
B. Sc. III-Chemistry (To be implemented from June 2026)

Level	Sem.	Major (Chemistry)		IDC/MDC/ OE/GE	VSC/SEC		AEC, VEC, IKS			OJT, FP, CEP, CC, RP			Total Credits	Degree/ Cum. Cr. MEME
		Mandatory	**Elective**	**OE (For Other Faculty)**	**VSC**	**SEC**	**AEC**	**VEC**	**IKS**	**CC**	**FP/ OJT**	**RP/ Dissert**		
5.5	V	PCH-501 Paper-IX Physical Chemistry (2 Cr) ICH-502 Paper-X Inorganic Chemistry (2 Cr) PRCH-504 Practical Paper in Physical Chemistry-V(a) (2 Cr) PRCH-505 Practical Paper in Inorganic Chemistry-V(b) (2 Cr)	**(Choose One) Elective Paper-I** OCHA-503 Organic Chemistry-A (2 Cr) **Or** OCHB-503 Organic Chemistry-B (2 Cr) **Choose One Elective Practical Paper-I** PRCHA-506 Organic Chemistry (2 Cr) **Or** PRCHB-506 Organic Chemistry (2 Cr)	CHOEPR-507 Exploring Fundamental Chemistry Experiments Practical Paper-V (2 Cr)	PRCHVSC-508 Vocational Skill Course Practical Paper-II (2 Cr) (Major specific)	--	AEC III (2 Cr) (English)	--	--	--	CHOJT-509 (4 Cr)	--	--	UG Degree 132
	Credits	**4(T)+4(P) =8**	**2(T)+2(P) =4**	**2 (P) =2**	**2(P)=2**	**--**	**2(T)=2**	**--**	**--**	**--**	**4**	**--**	**22**	
	VI	PCH-601 Paper-XI Physical Chemistry (2 Cr) ICH-602 Paper-XII Inorganic Chemistry (2 Cr) PRCH-604 Practical Paper in Physical Chemistry-VI(a) (2 Cr) PRCH-605 Practical Paper Inorganic Chemistry-VI(b) (2 Cr)	**Choose One Elective Paper-II** OCHC-603 Organic Chemistry-C (2 Cr) **Or** OCHD-603 Organic Chemistry-D (2 Cr) **(Choose One) Elective Practical Paper -II** PRCHC-606 Organic Chemistry (2 Cr) **Or** PRCHD-606 Organic Chemistry (2 Cr)	---	PRCHVSC-607 Vocational Skill Course Practical Paper-III (2 Cr) (Major specific)	CHSEC-608 Practical Skills in Chemistry Paper-III (2 Cr)	AEC-IV (2 Cr) (English)	--	CHIKS-609 Ancient Indian Chemistry (Major Specific) (2Cr)	--	CHFP-610 (2 Cr)	--	--	
	Credits	**4(T)+4(P) =8**	**2(T)+2(P) =4**	**--**	**2(P)=2**	**2(T)=2**	**2(T)=2**	**--**	**2(T)=2**	**--**	**2**	**--**	**22**	
Total Credits		**16**	**8**	**2**	**4**	**2**	**4**	**--**	**2**	**--**	**6+**	**--**	**44**	
		Exit Option: Exit Option:4 credits NSQF/Internship/Skill courses												

Structure of B. Sc. III Chemistry

B.Sc.-III (NEP-2.0) SEMESTER V

Sr. No.	Particulars	Course Code	Title of Paper
1	Mandatory Theory	BSU0325MML307E01	PCH-501 Paper -IX, Physical Chemistry (2 credits, 30 Hours)
2		BSU0325MML207E02	ICH-502 Paper -X, Inorganic Chemistry (2 credits, 30 Hours)
3	Elective Theory	BSU0325MEL307E01 BSU0325MEL307E02	**Elective Paper-I** OCHA-503 Organic Chemistry-A (2 credits, 30 Hours) **Or** OCHB-503 Organic Chemistry-B (2 credits, 30 Hours)
4	Mandatory Practical	BSU0325MMP307E01 BSU0325MMP307E02	PRCH-304 Practical Paper in Physical Chemistry-V(a) (2 credits, 60 Hours) PRCH-305 Practical Paper on Inorganic Chemistry-V(b) (2 credits, 60 Hours)
5	Elective Practical	BSU0325MEP307E01 BSU0325MEP307E02	**Elective Practical Paper-I** PRCHA-506 Practical Paper in Organic Chemistry-I (2 Cr, 60 Hours) **Or** PRCHB-506 Practical Paper in Organic Chemistry-I (2 Cr, 60 Hours)
6	OE (Basket)	BSU0325OEP307E	CHOEPR-507 Practical Paper-V Chemistry
7	VSC Major Specific	BSU0325VSP307E	PRCHVSC-508 Vocational Skill Course Practical Paper-II (2 credits, 60 Hours)
8	OJT Major Specific	BSU0325OJP307E	CHOJT-509 (4 credits, 120 Hours)

Major Mandatory (Theory)

PCH-501 Paper-IX Physical Chemistry (2 Credits, 30 hours)

Course Outcomes:

CO1: Students will Learn and understand quantum Chemistry, Heisenberg's uncertainty principle, the concept of energy operators (Hamiltonian), and the Schrödinger wave equation.

CO2: Students will gain knowledge about rotational, vibrational and Raman spectroscopy

CO3: Students will Learn and understand photochemical laws, reactions and various photochemical phenomena.

CO4: Students will gain knowledge of emf measurements, types of electrodes, different types of cells, and various applications of emf measurements.

Unit 1. Elementary quantum mechanics [07 Hours]

1.1 Introduction.

1.2 Drawbacks of classical mechanics, Black body radiation, Photoelectric effect, Compton effect, Duel nature of matter and energy: De Broglie hypothesis.

1.3 The Heisenberg's uncertainty principle.

1.4 Concept of energy operators (Hamiltonian).

1.5 Derivation of Schrodinger wave equation, well behaved function.

1.6 Physical interpretation of the ψ and $\psi 2$.

1.7 Numerical problems.

Unit 2. Spectroscopy [07 Hours]

2.1 Introduction.

2.2 Electromagnetic radiation.

2.3 Interaction of radiation with matter, Electromagnetic spectrum, Energy level diagram.

2.4 Rotational spectra of diatomic molecules: Rigid rotor model, moment of inertia, energy levels of rigid rotor, selection rules, Intensity of spectral lines, determination of bond length, isotope effect, Microwave oven

2.5 Vibrational spectra of diatomic molecules: Simple Harmonic oscillator model, Vibrational energies of diatomic molecules, Determination of force constant, overtones.

2.6 Raman spectra: Concept of polarizability, pure rotational and pure Vibrational Raman spectra of diatomic molecules, selection rules.

2.7 Numerical problems.

Unit 3. Photochemistry [07 Hours]

3.1 Introduction, Difference between thermal and photochemical processes.

3.2 Laws of photochemistry: i) Grotthus - Draper law ii) Lambert law iii) Lambert – Beer's law (with derivation) iv) Stark-Einstein law.

3.3 Quantum yield, Reasons for high and low quantum yield.

3.4 Factors affecting Quantum yield.

3.5 Photosensitized reactions – Dissociation of H_2, Photosynthesis.

3.6 Photodimerisation of anthracene, decomposition of HI and HBr.

3.7 Jablonski diagram depicting various processes occurring in the excited state: Qualitative description of fluorescence and phosphorescence.

3.8 Chemiluminescence, Electroluminescence and Bioluminescence.

3.9 Numerical problems.

Unit 4. Electromotive force [09 Hours]

(Convention: Reduction potentials to be used)

4.1 Introduction

4.2 Thermodynamics of electrode potentials, Nernst equation for electrode and cell potentials in terms of activities.

4.3 E.M.F. series.

4.4 Types of electrodes: Description in terms of construction, representation, half cell reaction and emf equation for

i) Metal – metal ion electrode.

ii) Amalgam electrode.

iii) Metal – insoluble salt electrode.

iv) Gas – electrode.

v) Oxidation – Reduction electrode.

4.5 Reversible and Irreversible cells.

i. Chemical cells without transference.

ii. Concentration cells with and without transference.

a. Electrode concentration cell without transference reversible to cations and anions.
b. Electrolyte concentration cell without transference.
c. Electrolyte concentration cell with transference (only reversible to cations).

iii. Liquid – Liquid junction potential: Origin, elimination and determination.

4.6 Equilibrium constant from cell emf, Determination of the thermodynamic parameters such as ΔG, ΔH and ΔS.

4.7 Applications of emf measurements:

i. Determination of pH of solution using Hydrogen electrode.

ii. Solubility and solubility product of sparingly soluble salts (based on concentration cells).

4.8 Numerical problems.

Reference Books:

1. Physical Chemistry by G. M. Barrow, International student Edition, Mc Graw Hill.
2. University General Chemistry by C.N.R. Rao, Macmillan.
3. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
4. The Elements of Physical Chemistry by P. W. Atkins, Oxford.
5. Principles of Physical Chemistry by S. H. Maron, C. H. Prutton, 4th Edition.

6. Nuclear and Radiochemistry by Friedlander, Kennedy and Miller, John Wiley and Sons. Wiley International edition.
7. Essentials of Nuclear Chemistry by H. J. Arnikar, 4th edition. Wiley Eastern.
8. Principles of Physical Chemistry by Puri, Sharma, Pathania,Shobhanlal Naginchand and Company, Jalandar.
9. Instrumental methods of chemical analysis by Chatwal and Anand,5th Edition, Himalaya Publication.
10. Fundamentals of molecular spectroscopy by C. N. Banwell – Tata Mc Graw-Hill.
11. Quantum Chemistry including molecular spectroscopy by B. K. Sen,Tata Mc Graw -Hill.
12. Text Book of Physical Chemistry by S. Glasstone, Macmillan India Ltd.
13. Elements of Physical Chemistry by D. Lewis and S. Glasstone (Macmillan).
14. Principles of Physical Chemistry by Maron and Lando (Amerind).
15. Electrochemistry by S. Glasstone.
16. Physical Chemistry by W. J. Moore.
17. Basic Chemical Thermodynamics by V. V. Rao (Macmillan).
18. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).
19. Text Book of Physical Chemistry, Soni and Dharmarha.
20. Advanced Physical Chemistry Gurdeep Raj GOEL Publishing House, 36th Edition

ICH-502, Paper No.– X, Inorganic Chemistry (2 Credits, 30 Hours)

COURSE OUTCOMES (COs): Students will be able to

CO-1: Learn the properties, geometry, stability and nature of bonding between metal ion and ligand in complexes using Crystal Field Theory and Molecular Orbital Theory.

CO-2: Understand the preparation and applications of the semiconductors and Superconductors in electrical and electronic devices

CO-3: Study the structure, method of preparation and Applications of Organometallic compounds in various fields.

CO-4: Study the synthesis, Classification, types, mechanism, and catalytic applications of different catalysts in industrial fields.

Unit-1. Metal Ligand Bonding in Transition Metal Complexes [10 Hours]

1.1 Crystal field theory (CFT)

1.2 Introduction: Shapes of d-orbital's, Basic assumptions of CFT.

1.2.1 Crystal field splitting of d-orbital's of metal ion in octahedral, tetrahedral, square planar complexes and John-Teller distortion.

1.2.2 Factors affecting the Crystal field splitting.

1.2.3 High spin and low spin octahedral complexes w. r. t. Co (III).

1.2.4 Crystal Field stabilization energy (CFSE),Calculation with respect to octahedral complexes only.

1.2.5 Limitations of CFT.

1.3 Molecular orbital theory (MOT).

1.3.1 Introduction.

1.3.2 MOT of octahedral complexes with sigma bonding such as $[Ti(H_2O)_6]^{3+}$, $[CoF6]^{3-}$, $[Co(NH_3)_6]^{3+}$

1.3.3 Merits and Demerits of MOT.

Unit-2. Metals, Semiconductors and Superconductors. [8 Hours]

2.1 Introduction.

2.1 Properties of metallic solids.

2.2 Theories of bonding in metal.

2.2.1 Free electron theory.

2.2.2 Molecular orbital theory (Band theory).

2.3 Classification of solids as conductor, insulators and semiconductors on the basis of band theory.

2.4 Semiconductors-Types-intrinsic and extrinsic and applications of semiconductors.

2.5 Superconductors: Ceramic superconductors- Preparation and structures of mixed oxide $YBa_2Cu_3O_{7-x}$.

2.6 Applications of superconductors.

Unit-3. Organometallic Chemistry. [6 Hours]

4.1 Definition, Nomenclature of organometallic compounds.

4.2 Synthesis and structural study of alkyl and aryl compounds of Be and Al.

4.3 Mononuclear carbonyls – Nature of bonding in simple mononuclear carbonyls.:$[Ni(CO)_4]$, $[Fe(CO)_5]$, $[Cr(CO)_6]$.

Unit 4. Catalysis [6 Hours]

4.1 Introduction

4.2 Classification of catalytic reactions- Homogenous and Heterogenous

4.3 Types of catalysis..

4.4 Characteristics of catalytic reactions.

4.5 Mechanism of Catalysis.

i) Intermediate compound formation theory.

ii) Adsorption theory

4.6 Industrial applications of Catalysis.

Reference Books:

1. Concise Inorganic Chemistry (ELBS,5th Edition)–J. D. Lee.

2. Inorganic Chemistry (ELBS,3rd Edition) D. F. Shriver, P. W. Atkins, C. H. Lang Ford, Oxford University Press, 2nd Edition.

3. Basic Inorganic Chemistry: Cotton and Wilkinson.

4. Advanced Inorganic Chemistry (4th Edition) Cotton and Wilkinson.

5. Concepts and Models of Inorganic Chemistry: Douglas and Mc. Daniel.3rd Edition. John Wiley publication.

6. Structural principles in inorganic compounds. W. E. Addison.
7. Theoretical principles of Inorganic Chemistry–G. S. Manku.
8. Theoretical Inorganic Chemistry by Day and Selbine.
9. Co-ordination compounds. SFA Kettle.
10. Organometallic Chemistry by R. C. Mahrotra, A. Sing, Wiley Eastern Ltd. New Delhi.
11. Inorganic Chemistry by A. G. Sharpe, Addision–Wisley Longman –Inc.
12. Principles of Inorganic Chemistry by Puri, Sharma and Kalia,Vallabh Publication. Pitampur Delhi.
13. Text book of Inorganic Chemistry by K. N. Upadhyaya Vikas Publishing House–New Delhi.
14. Inorganic Chemistry 3rd Edition G. L. Miesslerand D. A.Tarr, pearson publication.
15. Co-ordination compounds by Baselo and Pearson.
16. UGC Inorganic chemistry by H. C. Khera, Pragati Prakashan
17. UGC Advanced Inorganic Chemistry by Agarwal and Keemtilal,Pragati Prakashan

Major Elective (Theory)

OCHA-503 Organic Chemistry-A Organic Chemistry (2 Credits, 30 Hours)

Course Outcomes (COs):
Students will be able to explain the

CO1. Fundamental principles of UV-Visible spectroscopy, including electronic transitions, spectral shifts, and the Beer-Lambert Law. Additionally, they will gain the skills to calculate the absorption maximum using the Woodward-Fieser rules and to understand its role in structural elucidation and chemical analysis.

CO2. Use of IR spectroscopy and Hooke's Law to calculate vibrational frequencies and identify vibrational modes in organic molecules. By examining selection rules, electronic effects, and key absorption bands, develop skills to differentiate

functional-group and fingerprint regions, aiding in the elucidation of molecular structures and the identification of chemical compounds.

CO3. Use of retrosynthetic analysis, disconnections, and synthons to deconstruct complex organic molecules. Develop proficiency in designing efficient synthetic pathways for target molecules by integrating knowledge of reaction mechanisms and reagents.

CO4. To describe the preparation and strategic use of key oxidizing and reducing reagents in organic transformations. They will explain the mechanisms and synthetic utility of name reactions, enabling them to predict products and design pathways for complex molecular synthesis.

Unit 1. UV-visible Spectroscopy [7 Hours]

1.1. Introduction to spectroscopy.

1.2. Beer-Lambert's law: Statement and expression.

1.3. Terms used in UV Spectroscopy: Chromophore, Auxochrome, Bathochromic shift, Hypsochromic shift, Hyperchromic and Hypochromic effect.

1.4. Modes of electromagnetic transitions and effect of conjugation on the position of UV bands.

1.5. Calculation of λmax by Woodward and Fischer rules for dienes.

1.6. Applications of UV Spectroscopy.

Unit 2. IR Spectroscopy [8 Hours]

2.1 Principle of IR Spectroscopy.

2.2 Hook's Law for Calculation of Vibrational Frequency.

2.3 Fundamental modes of vibrations: Types and calculation.

2.4 Conditions for absorption of IR radiation: Selection Rule.

2.5 Regions of the IR spectrum: Fundamental group region, fingerprint region.

2.6 Factors affecting IR absorption frequency: a) Effect of electronegativity, b) Inductive effect, c) Resonance effect, d) Hydrogen bonding, e) Ring size

2.7 Characteristic of IR absorption of the following functional groups: a) alkanes, alkenes, alkynes, b) alcohol and phenols, c) ethers, d) carbonyl compounds, e) amines, f) nitro compounds, and g) aromatic compounds.

2.8 Applications of IR spectroscopy.

Unit 3. Retrosynthesis [7 Hours]

3.1 Introduction.

3.2 Recapitulation of the basics of reaction mechanism and reagents.

3.3 Terms used in retrosynthesis: Target molecule (TM), Disconnection, Synthons, Synthetic equivalence, Functional group interconversion (FGI), one group disconnection (w. r. t. suitable examples).

3.4 Retrosynthetic analysis and synthesis of target molecules: Cinnamaldehyde, Cyclohexene, para-Methoxy acetophenone, Methyl-3-phenyl propionate, Paracetamol.

Unit 4. Reagents and Reactions in Organic Synthesis [8 Hours]

(A) Reagents: Preparation and applications of the following reagents.

a) Oxidizing reagents: i) Osmium tetroxide (OsO_4) ii) Selenium dioxide (SeO_2).

b) Reducing reagents: i) Lithium Aluminum Hydride ($LiAlH_4$), ii) Raney Nickel.

(B) Name Reactions: Statement, general reaction, mechanism, and synthetic applications of the following reactions.

a) Diels -Alder reaction.

b) Meerwein –Pondorff-Verley reduction.

c) Hofmann rearrangement.

d) Wittig reaction.

e) Wagner- Meerwein rearrangement.

f) Baeyer Villiger oxidation.

Reference Books:

1. Absorption Spectroscopy of Organic Molecules: V. M. Parikh.

2. Spectroscopy of Organic Compounds: P. S. Kalsi.

3. Elementary Organic Absorption Spectroscopy: Y. R. Sharma.
4. Instrumental Methods of Analysis: Willard, Merritt, Dean, Settle.
5. Spectroscopy: G. R. Chatwal and S. K. Anand
6. Spectroscopy: Pavia, Lampman, Kriz, Vyvyan
7. Organic Spectroscopy: JagMohan
8. Organic Spectroscopy (3rd edition): William Kemp
9. Advanced Organic Chemistry: Reactions, Mechanisms and Structure: Jerry March.
10. Reagents for Organic Synthesis: Louis F. Fieser, Mary Fieser.
11. A textbook of Organic Chemistry: Arun Bahl, B.S.Bhal
12. A guidebook to mechanisms in Organic Chemistry: Peter Syke.
13. Organic Synthesis: The Disconnection Approach: Stuart Warren.
14. Organic Synthesis Through Disconnection Approach: P. S. Kalsi
15. Fundamentals of Organic Synthesis: The Retrosynthetic Analysis: Ratan Kumar Kar
16. Organic Reactions and Their Mechanisms: P. S. Kalsi.
17. Advanced Organic Chemistry by B.S. Bahl & Arun Bhal.
18. Organic Chemistry: Morrison and Boyd.

OCHB-503 Organic Chemistry-B (2 Credits, 30 Hours)

Course Outcomes (COs): Students will be able to explain the

CO1: Fundamental principles of UV-Visible spectroscopy, including electronic transitions, spectral shifts, and the Beer-Lambert Law. Additionally, they will gain the skills to calculate the absorption maximum using Woodward-Fieser rules and the role in structural elucidation and chemical analysis

CO2: Apply the principles of IR Spectroscopy and Hooke's Law to calculate vibrational frequencies and identify fundamental modes of vibration in organic molecules. By analyzing selection rules, electronic effects, and characteristic absorption bands, they will develop the skills to differentiate between functional

group and fingerprint regions to elucidate molecular structures and identify various chemical compounds.

CO3: To classify and describe the occurrence, isolation, and general properties of terpenoids and alkaloids, and apply the isoprene rule to understand their structural frameworks. Furthermore, they will gain proficiency in using analytical evidence and chemical syntheses to determine the structures of natural products such as Citral and Nicotine.

CO4: To classify pesticides and fertilizers by chemical class and explain their mechanisms of action, including contact and systemic modes of action. They will also master integrated pest management (IPM) strategies and the chemical synthesis of key agrochemicals such as Carbaryl and Glyphosate via specific routes, including the Curtius rearrangement.

Unit 1. Fundamentals of UV-visible Spectroscopy [7 Hours]

1.1 Introduction to spectroscopy.

1.2 Beer-Lambert's law: Statement and expression.

1.3 Terms used in UV Spectroscopy: Chromophore, Auxochrome, Bathochromic shift, hypsochromic shift, hyperchromic and hypochromic effect.

1.4 Modes of electromagnetic transitions and the effect of conjugation on the position of the UV band.

1.5 Calculation of λmax by Woodward and Fischer rules for dienes.

1.6 Applications of UV Spectroscopy.

Unit 2. Fundamentals of IR Spectroscopy [8 Hours]

2.1 Principle of IR Spectroscopy.

2.2 Hook's Law for the Calculation of Vibrational Frequency.

2.3 Fundamental modes of vibrations: Types and calculation.

2.4 Conditions for absorption of IR radiations: Selection Rule.

2.5 Regions of the IR spectrum: Fundamental group region, fingerprint region.

2.6 Factors affecting IR absorption frequency: a) Effect of electronegativity, b) Inductive effect, c) Resonance effect, d) Hydrogen bonding, e) Ring size

2.7 Characteristic of IR absorption of the following functional groups: a) alkanes, alkenes, alkynes, b) alcohol and phenols, c) ethers, d) carbonyl compounds, e) amines, f) nitro compounds, and g) aromatic compounds.

2.8 Applications of IR spectroscopy.

Unit 3: Natural Product: [7 Hours]

(A) Terpenoids:

3.1 Introduction: Occurrence, isolation, general characteristics, and classification of terpenoids.

3.2 General methods for structure determinations.

3.3 Isoprene rule.

3.4 Analytical evidence and synthesis of Citral.

(B) Alkaloids:

3.5 Introduction: Occurrence, isolation, classification, properties of alkaloids.

3.6 General methods for structure determination.

3.7 Analytical evidence and synthesis of Nicotine.

Unit 4: Agrochemicals [8 Hours]

4.1 Introduction to pesticides, fertilizers, plant growth regulators, and soil conditioners

4.2 Classification of pesticides: organophosphates, carbamates, and pyrethroids

4.3 Mechanism of action of pesticides: Fumigants, Contact pesticides, and ingestion Pesticides

4.4 Pest Management Strategies: Chemical Control, Integrated Pest Management (IPM), Biological, Cultural, Chemical, and Nanotechnology in Pesticide Development

4.5 Synthesis and applications of the following pesticides

a) Synthesis of carbamate intermediate via Curtius rearrangement

b) Synthesis of Carbaryl from Alpha-napthol and phosgene

c) Synthesis of Glyphosate via the hydrogen cyanide (HCN) route

d) Synthesis of Dithane

Reference Books:

1. Absorption Spectroscopy of Organic Molecules: V. M. Parikh.
2. Spectroscopy of Organic Compounds: P. S. Kalsi.
3. Elementary Organic Absorption Spectroscopy: Y. R. Sharma.
4. Instrumental Methods of Analysis: Willard, Merritt, Dean, Settle.
5. Spectroscopy: G. R. Chatwal and S. K. Anand
6. Spectroscopy: Pavia, Lampman, Kriz, Vyvyan
7. Organic Spectroscopy: JagMohan
8. Organic Spectroscopy (3rd edition): William Kemp
9. Organic Chemistry Natural Products: O. P.Agrawal
10. Organic Chemistry of Natural Products: Seema Singh and A. Singh.
11. Chemistry of Natural Products: Sujata V. Bhat, B.A. Nagasampagi, and Meenakshi Sivakumar
12. Fundamentals of Agriculture Vol.II: Arun Katyayan,
13. Essentials of Agriculture: Narayan A. Nagre (Eagle Vision Publications-Aurangabad)
14. Integrated Pest Management: Concepts and Approaches, G.S.Dhaliwal and R. Arora (Kalyani Publishers-Ludhiyana)
15. Agricultural Chemistry: L. Rakesh Sharma.
16. Indian Council of Agricultural Research (ICAR) Reports (2022).

Major Mandatory (Practical)

PRCH-504 Practical Paper in Physical Chemistry-V(a) (2 Credits, 60 Hours)

Course Outcomes: After Completion of course students will be able to

CO1: Learn the concept of reaction kinetics

CO2: Learn and understand the concept of Viscosity and its measurement using the Ostwald viscometer

CO3: Gain hands-on experience with a potentiometer, conductometer, pH meter, and refractometer instruments.

CO4: Understand the distribution law and concept of partition coefficient

PHYSICAL CHEMISTRY Experiments:

I. Non-instrumental Experiments:

A. Any one of the following.

1) Partition Law.

To determine the partition coefficient of CH_3COOH between H_2O and CCl_4.

2) Viscosity.

To determine the average molecular weight of a polymer by viscosity measurements.

B. Chemical kinetics. (Any two)

1. The study of energy of activation of first order reaction i.e. hydrolysis of methyl acetate in presence of 0.5 N HCl.

2. The study of energy of activation of second order reaction i.e. reaction between $K_2S_2O_8$ and KI (Equal concentrations).

3. To study the hydrolysis of methyl acetate by using its two concentrations in presence of 0.5 N HCl and hence find velocity constant of the reaction.

II. Instrumental experiments

A. Potentiometry (Any two)

1. Preparation of buffer solution and determination of their pH (Any five acetate buffer solutions by using standard solutions of acetic acid and sodium acetate), Theoretical calculation of pH values by using Henderson's equation.

2. Determination of standard electrode potential of Zn/Zn^{++}, Cu/Cu^{++}, Ag/Ag^{+} (Any two).

3. Titration of ferrous ammonium sulphate using $K_2Cr_2O_7$ solution and to calculate redox potential of Fe^{++}, Fe^{+++} system.

B. Conductometry (Any two).

N.B. i) 8 to 10 ml of 1N acid solution to be given by examiner in 100 ml volumetric flask & student should dilute it to 100 ml and 10ml of this solution is taken for titration.

1. To determine the normality of weak acid and strong acid from acid mixture by titrating it against standard 0.2 N NaOH solution by conductometric method.
2. To determine the normality of citric acid in lemon by titrating it against standard 0.2 N NaOH solution by conductometric method.
3. To determine $\lambda\infty$ of strong electrolyte (NaCl or KCl) and to verify Onsager equation.

C. Refractometry.

1. To determine the percentage composition of unknown mixture by (i) graphical method and (ii) by composition law (Densities of pure liquids A & B be given).

D. Colorimetry (Any One).

1. To verify Lambert – Beer's law using $CuSO_4$ solution.
2. To estimate Fe^{3+} ions using Salicylic acid by colorimetric titration.

E. pH – metry (Any One)

1. To determine the dissociation constant of monobasic acid (Acetic acid).
2. To determine hydrolysis constant of aniline hydrochloride.

PRCH-505 Practical Paper in Inorganic Chemistry-V(b) (2 Credits, 60 Hours)

CO1: Gain the practical skills to perform quantitative analysis

CO2: Perform quantitative analysis of ore and alloy and to determine the percentage of metal and ore using gravimetric analysis method.

CO3: Synthesize and to determine the percentage purity of inorganic compounds and complexes through standard preparation techniques.

CO4: Apply ion exchange chromatography method for separation and estimation of metal ions and inorganic species in complex mixtures.

INORGANIC CHEMISTRY EXPERIMENTS:

I) Gravimetric Estimations (G) (Any Two)

G1. Gravimetric estimation of iron as ferric oxide (Fe_2O_3) from the given solution containing ferrous ammonium sulphate, copper sulphate and free sulphuric acid.

G2. Gravimetric estimation of barium as barium chromate ($BaCrO_4$) from the given solution containing barium chloride, ferric chloride and free hydrochloric acid.

G3. Gravimetric estimation of zinc as zinc pyrophosphate($Zn_2P_2O_7$) from the given solution containing zinc sulphate, ferrous ammonium sulphate and free sulphuric acid.

II. Inorganic Preparations (P) (Any Three)

Preparations from the following with percentage yield:

P1. Preparation of potassium trioxalato aluminate (III).

P2. Preparation of Tetra ammine copper (II) chloride.

P3. Preparation of tris (thiourea) copper (I) sulphate.

P4. Preparation of potassium trioxalato ferrate (III).

III Determination of Percentage Purity (Any Four)

V1. Determination of percentage purity of ferrous ammonium sulpahte.

V2. Determination of percentage purity of tetrammine copper (II) sulphate.

V3. Determination of percentage purity of potassium (trioxalato-aluminate)(III).

V4. Determination of amount of sodium present in the given solution of common salt using cation exchange resin (By Acid Base Titration)

V5. Determination of amount of magnesium in the given solution containing (Mg^{2+} and Zn^{2+}) using anion exchange resin and standard solution of EDTA.

Reference Books:

1. Findlay's Practical Physical Chemistry (Longman)
2. Advanced Practical Physical Chemistry by J. B. Yadav, Goel publishing house.
3. Practical Physical Chemistry by B. D. Khosla, V. C. Garg (R. Chand and Co.)
4. Systematic experimental Physical Chemistry by Rajbhoj, Chandekar (Anjali Publicaiton) Aurangabad.
5. Practical Physical Chemistry: Nandkumari, Kothari and Lavande.
6. Practical Physical Chemistry by Gurtu (S. Chand).
7. Text Book of Qualitative Inorganic Analysis by A. I. Vogel (ELBS Longman).
8. A text book of quantitative Inorganic Analysis - A. I. Vogel.
9. Text book of Quantitative Inorganic Analysis - Kolthoff and Sandell.
10. Experimental Inorganic Chemistry - Palmer W. G.
11. Advanced Practical Inorganic Chemistry - Adams and Raynor.
12. Manual in Dairy Chemistry - I.C.A.R. Sub-Committee on Diary Education.
13. Chemical methods for environmental analysis - R. Ramesh and M. Anbu.

Major Elective (Practical)

Course Outcomes (COs): Students will be able

1. To conduct qualitative and quantitative analyses of organic compounds and gain proficiency in techniques such as separating binary mixtures, estimating compounds from samples, and synthesizing organic derivatives.
2. To separate binary organic mixtures into individual components by utilizing differences in solubility and chemical nature (acidic, phenolic, basic, or neutral). Develop skills to identify each component through qualitative

analysis, including detection of elements and functional groups and determination of physical constants.

3. To quantify organic compounds using titrimetric methods to measure specific functional groups or compounds. This will help develop skills in calculating and interpreting the purity of organic samples for accurate laboratory analysis.
4. To conduct organic synthesis and purification techniques for specific compounds, while mastering essential lab operations like refluxing, filtration, and recrystallization. Additionally, students will learn to calculate percentage yields and verify product purity through physical constants like melting points.

PRCHA-506 Elective Practical Paper in Organic Chemistry-I (2 Credits, 60 Hours)

1. (I) Qualitative Analysis (Solid + Solid and Solid + Liquid): Separation of a binary organic mixture and Identification of TWO components (At least 02 + 02 mixtures)

- Nature of Binary Mixtures: One mixture from each of the following types should be given:

  i) Acid + Phenol iv) Phenol + Base
  ii) Acid + Base v) Phenol + Neutral
  iii) Acid + Neutral vi) Base + Neutral

- The following compounds should be used for the preparation of binary organic mixtures.

  i) Acids: Benzoic acid, Phthalic acid, Salicylic acid, Cinnamic acid, Aspirin, Oxalic acid.
  ii) Phenols: α-naphthol, β-naphthol.
  iii) Bases: o-nitroaniline, m-nitroaniline, p-nitroaniline, aniline, o-toluidine, N, N- dimethylaniline.
  iv) Neutrals: Anthracene, acetanilide, m-dinitrobenzene, chloroform, carbon tetrachloride, acetone, nitrobenzene, ethyl acetate, ethyl benzoate, bromobenzene, urea, and thiourea.

(II) Quantitative Analysis: Organic Estimations (Any four)

1) Estimation of sucrose.
2) Saponification value of oil.
3) To determine the amount of acid and amide present in the given mixture of acid and amide.
4) Determination of the molecular weight of monobasic acid by the volumetric method.
5) To estimate the percentage purity of a given olefinic compound by the bromination method.

(III) Organic Preparations (Any three)

1) Multicomponent reaction - Preparation of Dihydropyrimidone.
2) Base-catalyzed Aldol condensation- Preparation of Dibenzal propanone.
3) Diazo coupling: Preparation of Phenyl azo β-Naphthol.
4) Methylation: Preparation of methyl-2-naphthyl ether (Nerolin) from β-Naphthol
5) Hydrolysis: Preparation of p-nitro aniline from p-nitro acetanilide.
6) Knoevenagel condensation reaction: Reaction of benzaldehyde and malononitrile.

Reference books:

1. Practical Organic Chemistry: A. I. Vogel.
2. Practical Organic Chemistry: O. P. Agarwal
3. Laboratory Manual for Principles of General Chemistry: J. A. Beran and Mark Lassiter (Wiley)
4. Fundamentals of Analytical Chemistry and Principles of Instrumental Analysis by Skoog, Holler & West
5. Practical Physical Chemistry by Dr. M. Satish Kumar
6. University Practical Chemistry (Combined Volume for Physical, Organic & Inorganic) by P.C. Kamboj
7. Practical Physical Chemistry by B. Viswanathan, P.S. Raghavan,

8. Advanced Practical Organic Chemistry by N.K. Vishnoi.
9. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis by V. K. Ahluwalia and Renu Aggarwal.

PRCHB-506 Elective Practical Paper in Organic Chemistry-I (2 Credits, 60 Hours)

(I) Qualitative Analysis (Solid + Solid and Solid + Liquid): Separation of a binary organic mixture and Identification of TWO components (At least 02 + 02 mixtures)

- Nature of Binary Mixtures: One mixture from each of the following types should be given:

  i) Acid + Phenol iv) Phenol + Base

  ii) Acid + Base v) Phenol + Neutral

  iii) Acid + Neutral vi) Base + Neutral

- The following compounds should be used for the preparation of binary organic mixtures.

  i) Acids: Benzoic acid, Phthalic acid, Salicylic acid, Cinnamic acid, Aspirin, Oxalic acid.

  ii) Phenols: α-naphthol, β-naphthol.

  iii) Bases: o-nitroaniline, m-nitroaniline, p-nitroaniline, aniline, o-toluidine, N, N- dimethylaniline.

  iv) Neutrals: Anthracene, acetanilide, m-dinitrobenzene, chloroform, carbon tetrachloride, acetone, nitrobenzene, ethyl acetate, ethyl benzoate, bromobenzene, urea, and thiourea.

(II) Quantitative Analysis: Organic Estimations (Any four)

1) Estimation of sucrose.

2) Saponification value of oil.

3) To determine the amount of acid and amide present in the given mixture of acid and amide.

4) Determination of the molecular weight of dibasic acid by the volumetric method.
5) Determination of iodine value of oil.

(III) Organic Preparations (Any three)

1) Multicomponent reaction - Preparation of Dihydropyrimidone.
2) Base-catalyzed Aldol condensation- Preparation of Dibenzal propanone.
3) Diazo coupling: Preparation of Methyl orange.
4) Methylation: Preparation of methyl-2-naphthyl ether (Nerolin) from β-Naphthol
5) Nitration: Preparation of picric acid from phenol.
6) Preparation of quinoxaline from benzyl and orthophenylendiamine.

Reference books:

1. Practical Organic Chemistry: A. I. Vogel.
2. Practical Organic Chemistry: O. P. Agarwal
3. Laboratory Manual for Principles of General Chemistry: J. A. Beran and Mark Lassiter (Wiley)
4. Fundamentals of Analytical Chemistry and Principles of Instrumental Analysis by Skoog, Holler & West
5. Practical Physical Chemistry by Dr. M. Satish Kumar
6. University Practical Chemistry (Combined Volume for Physical, Organic & Inorganic) by P.C. Kamboj
7. Practical Physical Chemistry by B. Viswanathan, P.S. Raghavan,
8. Advanced Practical Organic Chemistry by N.K. Vishnoi.
9. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis by V. K. Ahluwalia and Renu Aggarwal.

CHOJT-509 (4 Credits, 120 Hours)

See Annexture-I

Structure of B. Sc. III Chemistry

B.Sc.-III (NEP-2.0) SEMESTER VI

Sr. No.	Particulars	Course Code	Title of Paper
1	Mandatory Theory	BSU0325MML307F01	PCH-601 Paper -XI, Physical Chemistry (2 credits, 30 Hours)
2		BSU0325MML307F02	ICH-602 Paper -XII, Inorganic Chemistry (2 credits, 30 Hours)
3	Elective Theory	BSU0325MEL307F01 BSU0325MEL307F02	**Elective Paper-II** OCHC-603 Organic Chemistry-C (2 credits, 30 Hours) **Or** OCHD-603 Organic Chemistry-D (2 credits, 30 Hours)
4	Mandatory Practical	BSU0325MMP307F01 BSU0325MMP307F02	PRCH-604 Practical Paper in Physical Chemistry-VI(a) (2 credits, 60 Hours) PRCH-605 Practical Paper in Inorganic Chemistry-VI(b) (2 credits, 60 Hours)
5	Elective Practical	BSU0325MEP307F01 BSU0325MEP307F02	**Elective Practical Paper -II** PRCHC-606 Practical Paper in Organic Chemistry-C (2 Cr, 60 Hours) **Or** PRCHD-606 Practical Paper in Organic Chemistry-D (2 Cr, 60 Hours)
6	VSC Major Specific	BSU0325VSP307F	PRCHVSC-607 Vocational Skill Course Practical Paper-III (2 credits, 60 Hours)
7	SEC (BASKET)	BSU0325SEP307F	CHSEC-608 Practical Skills in Chemistry Paper-III (2 credits, 60 Hours)
8	IKS Major Specific	BSU0325IKL307F	CHIKS-609 Ancient Indian Chemistry (2 credits, 30 Hours)
9	FP Major Specific	BSU0325FPP307F	CHFP-610 (2 credits, 60 Hours)

Major Mandatory (Theory)

PCH-601 Paper-XI Physical Chemistry (2 Credits, 30 hours)

Course Outcomes:

CO1: Students will Learn and understand the phase rule, including one-component, two-component, and three-component systems phase diagrams, with suitable examples.

CO2: Students will gain knowledge about Gibbs free energy, Helmholtz energy, Criteria for thermodynamic equilibrium and spontaneity and partial molar quantities

CO3: Students will Learn and understand Laws of crystallography and the determination of crystal structure by Bragg's method.

CO4: Students will gain knowledge of potentiometric techniques

Unit 1. Phase Equilibria [07 Hours]

1.1 Introduction.

1.2 Gibbs phase rule: Phase rule equation and explanation of terms involved in the equation.

1.3 Phase diagram, true and metastable equilibria.

1.4 One component systems:

i. Water system.

ii. Sulphur system with explanation for polymorphism.

1.5 Two component systems:

i. Eutectic system: (Ag – Pb system); Desilverisation of lead.

ii. Freezing mixture: (KI –H_2O system).

iii. Formation of compound with congruent melting point ($FeCl_3$ – H_2O).

Unit 2. Thermodynamics [08 Hours]

2.1 Introduction.

2.2 Free energy: Gibbs function (G) and Helmholtz function (A), Criteria for thermodynamic equilibrium and spontaneity.

2.3 Relation between ΔG and ΔH: Gibbs-Helmholtz equation.

2.4 Phase equilibria: Clapeyron – Clausius equation and its applications.

2.5 Thermodynamic derivation of law of mass action, Van't – Hoff isotherm and isochore.

2.6 Fugacity and activity concepts.

2.7 Partial molar quantities, Partial molar volume, Concept of chemical potential, Gibbs-Duhem equation.

2.8 Numerical problems.

Unit 3. The Solid State [08 Hours]

3.1 Introduction: Space lattice, lattice sites, lattice planes, unit cell.

3.2 Laws of crystallography:

i. Law of constancy of interfacial angles

ii. Law of rational indices

iii. Law of crystal symmetry.

3.3 Weiss indices and Miller indices.

3.4 Cubic lattice and types of cubic lattice, planes or faces of a simple cubic system, spacing of lattice planes.

3.5 Diffraction of X-rays, Derivation of Bragg's equation.

3.6 Determination of crystal structure by Bragg's method.

3.7 Determination of crystal structure of NaCl and KCl on the basis of Bragg's equation.

3.8 Numerical problems.

Unit 4. Potentiometric titrations [07 Hours]

4.1 Introduction.

4.2 Determination of pH.

4.3 Study of Quinhydrone and Glass electrodes and their use in determination of pH.

4.4 Potentiometric titrations: Classical and analytical methods for locating end points.

4.5 Acids- Bases titration with suitable example.

4.6 Redox titration with suitable example.

4.7 Precipitation titration with suitable example.

4.8 Basic circuit of direct reading potentiometer.

4.9 Advantages of potentiometric titrations.

Reference Books:

1. Physical Chemistry by G. M. Barrow, International student Edition, Mc Graw Hill.
2. University General Chemistry by C.N.R. Rao, Macmillan.
3. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
4. The Elements of Physical Chemistry by P. W. Atkins, Oxford.
5. Principles of Physical Chemistry by S. H. Maron, C. H. Prutton, 4th Edition.
6. Nuclear and Radiochemistry by Friedlander, Kennedy and Miller, John Wiley and Sons. Wiley International edition.
7. Essentials of Nuclear Chemistry by H. J. Arnikar, 4th edition. Wiley Eastern.
8. Principles of Physical Chemistry by Puri, Sharma, Pathania,Shobhanlal Naginchand and Company, Jalandar.
9. Instrumental methods of chemical analysis by Chatwal and Anand,5th Edition, Himalaya Publication.
10. Fundamentals of molecular spectroscopy by C. N. Banwell – Tata Mc Graw-Hill.
11. Quantum Chemistry including molecular spectroscopy by B. K. Sen,Tata Mc Graw -Hill.
12. Text Book of Physical Chemistry by S. Glasstone, Macmillan India Ltd.
13. Elements of Physical Chemistry by D. Lewis and S. Glasstone (Macmillan).
14. Principles of Physical Chemistry by Maron and Lando (Amerind).
15. Electrochemistry by S. Glasstone.

16. Physical Chemistry by W. J. Moore.
17. Basic Chemical Thermodynamics by V. V. Rao (Macmillan).
18. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).
19. Text Book of Physical Chemistry, Soni and Dharmarha.
20. Advanced Physical Chemistry Gurdeep Raj GOEL Publishing House, 36th Edition.

ICH-602, Paper No.– XII, Inorganic Chemistry (2 Credits, 30 Hours.)

COURSE OUTCOMES : Student will be able to

CO-1: Learn and focused on the mechanism of the reactions involved in Inorganic complexes of transition metals.

CO-2: Understand the thermodynamic and kinetic aspects of Metal complexes

CO-3: Study the characteristics properties of Actinides and generation of nuclear power with the help of nuclear reactions. Also studied role of Radio isotopes in medicinal, industrial and Archaeology fields.

CO-4: Study the Role of various metals and non metals useful for our Health.

Unit- 1. Inorganic Reaction mechanism [10 Hours]

1.1 Introduction.

1.2 Classification of Mechanism: Association, dissociation, interchange and the rate determining steps.

1.3 SN^1 and SN^2 reactions for inert and labile complexes.

1.4 Mechanism of substitution in cobalt (III) octahedral complexes.

1.5 Trans effect and its theories.

1.6 Applications of trans effect in synthesis of Pt(II) complexes.

Unit - 2. Thermodynamic and Kinetic Aspects of Metal Complexes. [06 Hours]

2.1 Introduction.

2.2 Thermodynamic stability.

2.3 Kinetic Stability.

2.4 Relation between thermodynamic and kinetic stability.

2.5 Stepwise stability constant.

2.6 Factors affecting the stability of complexes.

Unit 3. Actinide Elements and Nuclear Chemistry [10 Hours]

3.1Position of actinides in periodic table.

3.2 Electronic configuration.

3.3 General methods of preparation of transuranic elements.

3.3.1 Neutron capture–followed by β-decay.

3.3.2 Accelerated projectile bombardment.

3.3.3 Heavy ion bombardment.

3.4 IUPAC nomenclature of the super heavy elements with atomic number(Z) greater than 100.

3.5 Nuclear reactions and energetics of nuclear reactions.

3.6 Types of nuclear reactions

3.6.1 Artificial transmutation.

3.6.2 Artificial radioactivity.

3.6.3 Nuclear fission and its application in heavy water nuclear reactor.

3.6.4 Nuclear fusion.

3.7 Use of Thorium, Uranium and Plutonium in atomic energy

3.8 Applications of radio-isotopes as tracers.

3.8.1 Chemical investigation–Esterification.

3.8.2 Structural determination–Phosphorus pentachloride.

3.8.3 Analytical Chemistry–Isotopic dilution method for determination of volume of blood.

3.8.4 Age determination–Dating by C-14

Unit- 4. Bio-inorganic Chemistry. [4 Hours]

4.1 Introduction.

4.2 Essential and trace elements in biological process.

4.3 Metalloporphyrins with special reference to hemoglobin and myoglobin.

4.4 Biological role of alkali and alkaline earth metal ions with special reference to Na^+ ,K^+ and Ca^{2+}

Reference Books: (Use recent editions)

1. Concise Inorganic Chemistry (ELBS,5thEdition)–J. D. Lee.

2. Inorganic Chemistry (ELBS, 3rd Edition) D. F. Shriver, P. W. Atkins, C. H. Lang Ford, Oxford University Press, 2nd Edition.

3. Basic Inorganic Chemistry: Cotton and Wilkinson.

4. Advanced Inorganic Chemistry (4thEdn.) Cotton and Wilkinson.

5. Concepts and Models of Inorganic Chemistry: Douglas and Mc. Daniel.3rd Edition. John Wiley publication.

6. Structural principles in inorganic compounds. W. E. Addison.

7. Theoretical principles of Inorganic Chemistry–G. S. Manku.

8. Theoretical Inorganic Chemistry by Day and Selbine.

9. Co-ordination compounds. SFA Kettle.

10. Essentials of Nuclear Chemistry by H. J. Arnikar.

11. Nuclear Chemistry by M. N. Sastri

12. Organometallic Chemistry by R.C. Mahrotra A. Sing, Wiley Eastern Ltd. New Delhi.

13. Inorganic Chemistry by A. G. Sharpe, Addision–Wisley Longman–Inc.

14. Principles of Inorganic Chemistry by Puri, Sharma and Kalia,Vallabh Publication. Pitampur Delhi.

15. Text book of Inorganic Chemistry by K. N. Upadhyaya Vikas Publishing House–New Delhi.

15. Inorganic Chemistry 3rd edn G. L. Miessler and D. A.Tarr, pearson publication

16. Co-ordination compounds by Baselo and Pearson.

17. UGC Inorganic chemistry by H. C. Khera,Pragati prakashan

18. UGC Advance Inorganic Chemistry by Agarwal and Keemtilal, Pragati Prakashan

Major Elective (Theory) Paper-II

OCHC-603 Organic Chemistry-C (2 Credits, 30 Hours)

Course Outcomes (COs): Students will be able to explain the

1. The fundamental principles of PMR spectroscopy, including nuclear shielding, deshielding, and the role of TMS as a reference standard. They will develop proficiency in interpreting chemical shifts and spin-spin splitting (n+1 rule) to solve complex structural problems and determine the molecular frameworks of organic compounds.
2. The fundamental principles of Mass Spectrometry and the formation of various ions by analyzing specific fragmentation patterns, including the McLafferty rearrangement and the Nitrogen rule. They will also develop the skills to interpret mass spectra for the structural identification of organic molecules, such as alkanes, alkenes, and carbonyl compounds, in diverse analytical applications.
3. To describe the mechanisms and stereochemistry of electrophilic addition reactions to carbon-carbon double and triple bonds, including specialized transformations such as hydroboration-oxidation. They will also be able to predict reaction products by applying rules such as Markovnikov and Anti-Markovnikov addition, while accounting for carbocation rearrangements and stereochemical outcomes.
4. To classify medicinal agents, define the essential qualities of an ideal drug, and explain the therapeutic applications of specific compounds such as Benzocaine and Chloramphenicol. They will also master the chemical synthesis of key drugs, including Isoniazid and Ethambutol, and evaluate the physiological mechanisms of action of sulfonamide drugs in treating infections.

Unit 1. NMR Spectroscopy [8 Hours]

1.1 Principle of PMR Spectroscopy.

1.2 Instrumentation with a schematic diagram.

1.3 Magnetic and nonmagnetic nuclei.

1.4 Chemical shift: Definition, measurement, calculation, factors affecting chemical shift.

1.5 Merits of TMS as PMR reference compound.

1.6 Shielding and deshielding.

1.7 Spin-spin splitting (n+1 rule).

1.8 Applications of NMR Spectroscopy.

1.9 Problems based on NMR spectroscopy.

Unit 2. Introduction to Mass Spectroscopy. [7 Hours]

2.1 Principles of mass spectroscopy.

2.2 Mass spectrometer: Schematic diagram.

2.3 Types of ions produced during fragmentation.

2.4 Nitrogen rule

2.5 Fragmentation patterns of alkanes, alkenes, and carbonyl compounds.

2.6 McLafferty rearrangement.

2.7 Applications of Mass Spectroscopy.

Unit 3. Electrophilic addition to >C=C< and −C≡C− bonds [8 Hours]

(A) Addition to Carbon-Carbon double (>C=C<) bond:

3.1 Introduction.

3.2 Examples of addition reactions.

3.3 Mechanism of electrophilic addition to >C=C< bond: Orientation and reactivity

i) Hydrohalogenation.

ii) Anti-Markovnikoff's addition (peroxide effect).

iii) Rearrangements (support for the formation of carbocation).

iv) Addition of halogens.

v) Addition of water.

vi) Addition of hypohalous acids (HO-X).

vii) Hydroxylation (formation of 1,2-diols).

viii) Hydroboration-oxidation (formation of alcohol).

ix) Hydrogenation (formation of alkane).

x) Ozonolysis (formation of aldehydes & ketones).

(B) Addition to Carbon-Carbon triple (−C≡C−) bond:

3.4 Introduction.

3.5 Examples of addition reactions.

3.6 Mechanism of electrophilic addition to −C≡C−bond.

i) Addition of halogens.

ii) Addition of halogen acids.

iii) Addition of hydrogen.

iv) Addition of water.

v) Formation of metal acetylides.

Unit 4. Pharmaceuticals [7 Hours]

4.1 Introduction.

4.2 Classification of drugs.

4.3 Qualities of an ideal drug.

4.4 Synthesis and uses of ethambutol, phenobarbitone, isoniazide, benzocaine, Chloramphenicol and paludrine.

4.5 Drug action of sulpha drugs.

Reference Books:

1. Absorption Spectroscopy of Organic Molecules: V. M. Parikh.
2. Spectroscopy of Organic Compounds: P. S. Kalsi.
3. Elementary Organic Absorption Spectroscopy: Y. R. Sharma.
4. Instrumental Methods of Analysis: Willard, Merritt, Dean, Settle.
5. Spectroscopy: G. R. Chatwal and S. K. Anand
6. Spectroscopy: Pavia, Lampman, Kriz, Vyvyan
7. Advanced Organic Chemistry: Reactions, Mechanisms and Structure: Jerry March.
8. A textbook of Organic Chemistry: Arun Bahl, B.S.Bhal
9. A Guidebook to Mechanism in Organic Chemistry: Peter Syke.

10. Organic Reactions and Their Mechanisms: P. S. Kalsi.
11. Organic Chemistry: Morrison and Boyd.
12. Industrial Chemistry: R.K. Das.
13. Synthetic Drrugs: M.S.Yadav.

OCHD-603 Organic Chemistry-D (2 Credits, 30 Hours)

Course Outcomes (COs): Students will be able to explain the

CO1: To explain the fundamental principles of PMR spectroscopy, including nuclear shielding, deshielding, and the role of TMS as a reference standard. They will develop proficiency in interpreting chemical shifts and spin-spin splitting (n+1 rule) to solve complex structural problems and determine the molecular frameworks of organic compounds.

CO2: To explain the fundamental principles of Mass Spectrometry and the formation of various ions by analyzing specific fragmentation patterns, including the McLafferty rearrangement and the Nitrogen rule. They will also develop the skills to interpret mass spectra for the structural identification of organic molecules, such as alkanes, alkenes, and carbonyl compounds, in diverse analytical applications.

CO3: To classify polymers based on their origin and structure while explaining mechanisms of addition and Ziegler-Natta polymerization. Furthermore, they will gain proficiency in describing the synthesis and applications of commercial resins and conducting organic polymers, such as polyaniline and polypyrrole, for modern industrial and electronic applications.

CO4: To describe the industrial manufacturing process of cane sugar, covering key stages from juice extraction and clarification to crystallization and centrifugation. Additionally, they will identify the economic value of sugar industry by-products and explain the biochemical process of producing ethyl alcohol from molasses through fermentation

Unit 1. Fundamentals of NMR Spectroscopy [8 Hours]

1.1 Principle of PMR Spectroscopy.

1.2 Instrumentation with a schematic diagram.

1.3 Magnetic and nonmagnetic nuclei.

1.4 Chemical shift: Definition, measurement, calculation, factors affecting chemical shift.

1.5 Merits of TMS as PMR reference compound.

1.6 Shielding and deshielding.

1.7 Spin-spin splitting (n+1 rule).

1.8 Applications of NMR Spectroscopy.

1.9 Problems based on NMR spectroscopy.

Unit 2. Introduction to Mass Spectroscopy. [7 Hours]

2.1 Principles of mass spectroscopy.

2.2 Mass spectrometer: Schematic diagram.

2.3 Types of ions produced during fragmentation.

2.4 Nitrogen rule

2.5 Fragmentation patterns of alkanes, alkenes, and carbonyl compounds.

2.6 McLafferty rearrangement.

2.7 Applications of Mass Spectroscopy.

3. Synthetic polymers [7 Hours]

3.1 Introduction.

3.2 Classification of polymers based on a) origin, b) composition-organic, inorganic polymers, c) method of preparation, d) general physical properties, e) structure.

3.3 Addition Polymerization: Free radical addition and ionic addition polymerization.

3.4 Zigler-Nata polymerization.

3.5 Methods of preparation and applications of a) Polyethylene, b) Polystyrene, c) Polyvinyl chloride, d) Phenol-formaldehyde resin.

3.6 Conducting organic polymers: Synthesis and properties of a) Polyaniline, b) Polypyrrole.

3.7 Applications of conducting organic polymers.

4. Sugar Industry **[8 Hours]**

4.1 Introduction.

4.2 Manufacture of cane sugar in India: Extraction of juice, Clarification, Concentration, crystallization, centrifugation, and other details of the industrial process.

4.3 Byproducts of the sugar industry.

4.4 Manufacture of Ethyl Alcohol from Molasses: by Fermentation.

Reference Books:

1. Absorption Spectroscopy of Organic Molecules: V. M. Parikh.
2. Spectroscopy of Organic Compounds: P. S. Kalsi.
3. Elementary Organic Absorption Spectroscopy: Y. R. Sharma.
4. Instrumental Methods of Analysis: Willard, Merritt, Dean, Settle.
5. Spectroscopy: G. R. Chatwal and S. K. Anand
6. Spectroscopy: Pavia, Lampman, Kriz, Vyvyan
7. Introduction to Polymer Chemistry: Charles E. Carraher Jr
8. Textbook of Polymer Science: Fred W. Billmeyer Jr
9. Principles of Polymerization: George Odian
10. A Textbook of Polymer Chemistry: M.S. Bhatnagar
11. Introductory Polymer Chemistry by Gauri Shankar Misra
12. Textbook of Sugar Chemistry: Amit Arora
13. Sugar Manufacture in India: D.P. Kulkarni.
14. Principles of Sugar Technology by Pieter Honig

Major Mandatory (Practical)

PRCH-604 Practical Paper in Physical Chemistry-VI(a) (2 Credits, 60 Hours)

Course Outcomes: After Completion of course, students will be able to

CO1. Learn the concept of activation energy, and effect of salt on rate of reaction

CO2. Understand the adsorption isotherms.

CO3. Gain hands-on experience with a potentiometer, conductometer, pH meter experiments.

CO4. Learn the Beer-Lambert law, concept of dissociation constant

PHYSICAL CHEMISTRY EXPERIMENTS:

I. Non-instrumental Experiments:

A. Any one of the following.

1) Adsorption.

To investigate the adsorption of oxalic acid by activated charcoal and test the validity of the Freundlich & Langmuir isotherms.

2) Solubility.

To study the effect of addition of electrolyte (NaCl or KCl) on the solubility of Benzoic acid at room temperature.

B. Chemical kinetics. (Any two)

1. The study of energy of activation of first order reaction i.e. hydrolysis of methyl acetate in presence of 0.5 N H_2SO_4.

2. The study of energy of activation of second order reaction i.e. reaction between $K_2S_2O_8$ and KI (Unequal concentrations).

3. To study the effect of addition of electrolyte (KCl) on the reaction between $K_2S_2O_8$ and KI (Equal concentrations).

C. Partial molar volume.

1. To determine the partial molar volume of ethyl alcohol in a mixture of ethyl alcohol and water (Any seven mixtures be given).

II. Instrumental experiments

A. Potentiometry (Any two):

1. Titration of strong acid with strong alkali by using potentiometric method.

N.B. i) 8 to 10 ml of 1N acid solution to be given by examiner in 100 ml volumetric flask & student should dilute it to 100 ml and 10ml of this solution is taken for titration.

ii) Experiment is carried out by taking pilot run from 1 to 10 ml and then final run taking 0.2 ml reading in the range of end point.

2. Preparation of buffer solution and determination of their pH (Any five citro-phosphate buffer solutions using standard solution of Citric acid and Disodium hydrogen phosphate).

3. Estimate the amount of Cl^-, Br^- and I^- in given unknown halide mixture by titrating it against standard $AgNO_3$ solution.

B. Conductometry (Any two):

N.B. i) 8 to 10 ml of 1N acid solution to be given by examiner in 100 ml volumetric flask & student should dilute it to 100 ml and 10ml of this solution is taken for titration.

1. To determine the normality of weak acid by titrating it against a standard 0.2 N NaOH solution by the conductometric method.

2. To study the effect of substituent on dissociation constant of weak acid with respect to acetic acid and monochloroacetic acid (cell constant to be given).

N.B. Calculate K by using formula $K= \alpha^2.C/1- \alpha$

3. To determine the velocity constant of hydrolysis of ethyl acetate by NaOH solution by the conductometric method.

C. Refractometry:

1. To determine the molar refractivity of methyl acetate, ethyl acetate, n-hexane and carbon tetrachloride and calculate the refraction equivalents of C, H and Cl atoms.

D. Colorimetry (Any One):

1. To estimate of Fe^{+++} ions by thiocynate method.

2. To determine the order of reaction for the oxidation of alcohol by potassium dichromate and potassium permanganate in acidic medium colorimetrically.

E. pH – metry:

1. To determine the dissociation constant of dibasic acid (Malonic acid)

PRCH-605 Practical Paper in Inorganic Chemistry-VI(b) (2 Credits, 60 Hours)

CO1: Gain knowledge regarding practical applications of chemistry in daily life

CO2: Perform quantitative analysis of ore and alloy and to determine the percentage of metal and ore using gravimetric analysis method.

CO3: Synthesize and to determine the percentage purity of inorganic compounds and complexes through standard preparation techniques.

CO4: Apply ion exchange chromatography method for separation and estimation of metal ions and inorganic species in complex mixtures

INORGANIC CHEMISTRY EXPERIMENTS

I) Gravimetric Estimations (G) (Any Two)

G1. Gravimetric estimation of barium as barium sulphate ($BaSO_4$) from the given solution containing barium chloride, ferric chloride and free hydrochloric acid.

G2. Gravimetric estimation of nickel as bis (dimethylglyoximato) nickel (II) from the given solution containing nickel sulphate, ferrous ammonium sulphate and free Sulphuric acid.

G3. Gravimetric estimation of aluminium as aluminium oxinate potassium tris (8-hydroxy quinolato) aluminium (III) from the given solution containing potash alum ,copper sulphate and free sulphuric acid.

II. Inorganic Preparations (P) (Any Three)

Preparations from the following with percentage yield:

P1. Preparation of ammonium diamminetetrathiocynato chromate (III) (Reineck's salt).

P2. Preparation of ammonium trioxalato chromate (III).

P3. Preparation of hexathiourea plumbus (II) nitrate

P4. Preparation of chloropenta-ammine cobalt (III) chloride.

III Analysis of Commercial Samples (Any Four)

V1. Determination of percentage of Calcium in the given sample of milk powder or lime.

V2. Determination of amount of aluminum in the given solution of potash alum.

V3. Determination of titrable acidity in the given sample of milk or lassi.

V4. Determination of percentage purity of boric acid using supplied sodium hydroxide. (Standard succinic or oxalic acid solution to be prepared to standardise the given sodium hydroxide solution.)

V5. To determine the amount of HCl in given of commercial samples.

V6. . Determination of amount of zinc in the given solution containing (Mg^{2+} and Zn^{2+}) using anion exchange resin and standard solution of EDTA.

Reference Books:

1. Findlay's Practical Physical Chemistry (Longman)

2. Advanced Practical Physical Chemistry by J. B. Yadav, Goel publishing house.

3. Practical Physical Chemistry by B. D. Khosla, V. C. Garg (R. Chand and Co.)

4. Systematic experimental Physical Chemistry by Rajbhoj, Chandekar (Anjali Publicaiton) Aurangabad.

5. Practical Physical Chemistry: Nandkumari, Kothari and Lavande.

6. Practical Physical Chemistry by Gurtu (S. Chand).

7. Text Book of Qualitative Inorganic Analysis by A. I. Vogel (ELBS Longman).

8. A text book of quantitative Inorganic Analysis - A. I. Vogel.

9. Text book of Quantitative Inorganic Analysis - Kolthoff and Sandell.

10. Experimental Inorganic Chemistry - Palmer W. G.

11. Advanced Practical Inorganic Chemistry - Adams and Raynor.

12. Manual in Dairy Chemistry - I.C.A.R. Sub-Committee on Diary Education.

13. Chemical methods for environmental analysis - R. Ramesh and M. Anbu.

Major Elective (Practical)

Course Outcomes (COs): Students will be able

1. To conduct qualitative and quantitative analyses of organic compounds and gain proficiency in techniques such as separating binary mixtures, estimating compounds from samples, and synthesizing organic derivatives.
2. To separate binary organic mixtures into individual components by utilizing differences in solubility and chemical nature (acidic, phenolic, basic, or neutral). Develop skills to identify each component through qualitative analysis, including detection of elements and functional groups and determination of physical constants.
3. To quantify organic compounds using titrimetric methods to measure specific functional groups or compounds. This will help develop skills in calculating and interpreting the purity of organic samples for accurate laboratory analysis.
4. To conduct organic synthesis and purification techniques for specific compounds, while mastering essential lab operations like refluxing, filtration, and recrystallization. Additionally, students will learn to calculate percentage yields and verify product purity through physical constants like melting points.

PRCHC-605 Elective Practical Paper in Organic Chemistry-II (2 Credits, 60 Hours)

(I) Qualitative Analysis (Solid + Solid and Liquid + Liquids): Separation of binary organic mixture and Identification of TWO components (At least 02 + 02 mixtures)

- Nature of Binary Mixtures: One mixture from each of the following types should be given:

  i) Acid + Phenol iv) Phenol + Base

  ii) Acid + Base v) Phenol + Neutral

  iii) Acid + Neutral vi) Base + Neutral

- The following compounds should be used for the preparation of binary organic mixtures.

i) Acids: Benzoic acid, Phthalic acid, Salicylic acid, Cinnamic acid, Aspirin, Oxalic acid.

ii) Phenols: α-naphthol, β-naphthol.

iii) Bases: o-nitroaniline, m-nitroaniline, p-nitroaniline, aniline, o-toluidine, N, N- dimethylaniline.

iv) Neutrals: Anthracene, acetanilide, m-dinitrobenzene, chloroform, carbon tetrachloride, acetone, nitrobenzene, ethyl acetate, ethyl benzoate, bromobenzene, urea, and thiourea.

(II) Quantitative Analysis: Organic Estimations (Any four)

1) Estimation of aspirin from methylsalicylate.

2) Estimation of ethylmethyl ketone

3) Analysis of ibuprofen content from pharmaceutical tablets.

4) Estimation of formalin.

5) Determination of caffeine from tea powder.

(III) Organic Preparations (Any three)

1) Base-catalyzed Aldol condensation- Preparation of Benzalacetophenone (Chalcone) from benzaldehyde and acetophenone.

2) Benzil- Benzilic acid rearrangement reaction: Preparation of Benzilic acid

3) Diazo coupling: Preparation of Methyl red.

4) Nitration: Preparation of m-dinitrobenzene from nitrobenzene

5) Preparation of S-Benzylisothiurronium chloride from Benzyl chloride and thiourea.

Reference books:

1. Practical Organic Chemistry: A. I. Vogel.
2. Practical Organic Chemistry: O. P. Agarwal
3. Laboratory Manual for Principles of General Chemistry: J. A. Beran and Mark Lassiter (Wiley)
4. Fundamentals of Analytical Chemistry and Principles of Instrumental Analysis by Skoog, Holler & West

5. Practical Physical Chemistry by Dr. M. Satish Kumar
6. University Practical Chemistry (Combined Volume for Physical, Organic & Inorganic) by P.C. Kamboj
7. Practical Physical Chemistry by B. Viswanathan, P.S. Raghavan,
8. Advanced Practical Organic Chemistry by N.K. Vishnoi.
9. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis by V. K. Ahluwalia and Renu Aggarwal.

PRCHD-605 Elective Practical Paper in Organic Chemistry-II (2 Credits, 60 Hours)

(I) Qualitative Analysis (Solid + Solid and Liquid + Liquids): Separation of binary organic mixture and Identification of TWO components (At least 02 + 02 mixtures)

- Nature of Binary Mixtures: One mixture from each of the following types should be given:

  i) Acid + Phenol iv) Phenol + Base
  ii) Acid + Base v) Phenol + Neutral
  iii) Acid + Neutral vi) Base + Neutral

- The following compounds should be used for the preparation of binary organic mixtures.

  i) Acids: Benzoic acid, Phthalic acid, Salicylic acid, Cinnamic acid, Aspirin, Oxalic acid.
  ii) Phenols: α-naphthol, β-naphthol.
  iii) Bases: o-nitroaniline, m-nitroaniline, p-nitroaniline, aniline, o-toluidine, N, N- dimethylaniline.
  iv) Neutrals: Anthracene, acetanilide, m-dinitrobenzene, chloroform, carbon tetrachloride, acetone, nitrobenzene, ethyl acetate, ethyl benzoate, bromobenzene, urea, and thiourea.

(II) Quantitative Analysis: Organic Estimations (Any four)

1) Estimation of ethyl methyl ketone

2) Estimation of aspirin from pharmaceutical tablet.

3) Analysis of ibuprofen from pharmaceutical tablets.

4) Estimation of formalin.

5) Estimation of fatty acid from soap sample.

(III) Organic Preparations (Any three)

1) Base-catalyzed Aldol condensation- Preparation of Benzalacetophenone (Chalcone) from benzaldehyde and acetophenone.

2) Benzil- Benzilic acid rearrangement reaction: Preparation of Benzilic acid

3) Sandmeyer reaction: Preparation of p-Chlorotoluene from p-Toluidine

4) Nitration: Preparation of 2,4-dinitrochlorobenzene from chlorobenzene

5) Acetylation: Preparation of acetanilide from aniline

NB:

1) All preparations should be carried out by considering the green Chemistry approach

2) Preparation of the derivative should be carried out on a small scale.

3) The starting compound should not be given more than one gram.

4) Calculation of the percentage practical yield in preparation is a must.

5) Recrystallization of crude product and its melting point.

6) TLC should confirm the product.

7) Assign reactions with a mechanism.

Reference books:

1. Practical Organic Chemistry: A. I. Vogel.
2. Practical Organic Chemistry: O. P. Agarwal
3. Laboratory Manual for Principles of General Chemistry: J. A. Beran and Mark Lassiter (Wiley)
4. Fundamentals of Analytical Chemistry and Principles of Instrumental Analysis by Skoog, Holler & West
5. Practical Physical Chemistry by Dr. M. Satish Kumar
6. University Practical Chemistry (Combined Volume for Physical, Organic & Inorganic) by P.C. Kamboj

7. Practical Physical Chemistry by B. Viswanathan, P.S. Raghavan,
8. Advanced Practical Organic Chemistry by N.K. Vishnoi.
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CHFP-610 (2 credits, 60 Hours)

See Annexure II

Shivaji University,

Kolhapur

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Syllabus for

Bachelor of Science Part-III

(B. Sc. III)

VOCATIONAL SKILL COURSE

IN

CHEMISTRY

(NEP-2.0)

To be implemented from

June 2026 onwards

VOCATIONAL SKILL COURSES

B. Sc. III, Semester V, VSC Practical Paper-II		
BSU0325VSP307E	**PRCHVSC-508 Vocational Skill Course in Chemistry Practical Paper-II**	**Credits:** 2 **Hours:** 60

Course Outcomes:
After completion of the course, the students will be able to:

CO1 Students will understand the concepts, principles, theories and practical applications of Chemistry
CO2 Students will develop synthesis and analysis skills
CO3 Students will gain knowledge of instruments like conductometer, refractometer etc.
CO4 Students will develop analytical skills.

Practicals:

Note: An explanation and understanding of theoretical concepts, mechanisms, reactions, and instrumentation are expected. (Perform at least 12-13 experiments)

1. Determination of caffeine in tea leaves or instant coffee.
2. Preparation of Soap and Evaluation of Its Cleansing Action.
3. Separation of organic mixtures by paper chromatography/Thin layer chromatography (TLC) and determination of Rf value.
4. Preparation of Phenol-Formaldehyde Resin (Bakelite)
5. Preparation of Urea-Formaldehyde Resin.
6. Purification of organic compounds by sublimation (e.g., camphor, naphthalene)
7. Isolation of casein and lactose from milk.
8. Isolation of piperine from black pepper.
9. Determine the pK value of acetic acid potentiometrically.
10. Construct the phase diagram for ethanol-benzene-water system.
11. Estimation of Aspirin by conductometric titration.
12. Estimation of chlorophylls in leaf pigments.

13. To investigate the reaction between potassium persulphate and potassium iodide by colorimetric measurements.
14. Estimation of boric acid by conductometric titration.
15. Determination of percentage purity of sodium benzoate sample by poteintiometric titration.
16. Comparison of cleansing powers of two samples of detergents using Stalagmometer.
17. Estimation of sulphanilamide by colorimetry.
18. Estimation of chloride ions by conductometric titration.
19. Determination of the composition of salt using refractometer.
20. To study the influence of solvents on the optical rotation of camphor.
21. Preparation of potash alum.

References:

1. Fundamentals of Analytical Chemistry; Skoog, West. Holler and Crouch 9th edition; Mary Finch. (2014).
2. Vogel's Textbook of Quantitative Chemical Analysis; 6th edition, Pearson Education Limited, (2007).
3. Industrial Chemistry by B. K. Sharma.
4. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co: New Delhi (2011).
5. Findlay's Practical Physical Chemistry (Longman) 2015.
6. Practical Physical Chemistry: Gurtu (S Chand) 2014.
7. Systematic Experimental Physical Chemistry: Rajbhoj, Chandekar (Anjali Publication) 2016.
8. Advanced Practical Physical Chemistry: J.B. Yadav (Goel Publishing House) 2015.
9. Vogel's Textbook of Quantitative Inorganic Chemistry by A. I. Vogel.
10. Physical Chemistry of Inorganic Qualitative Analysis by Kuricose & Rajaram.
11. Advanced Practical Organic Chemistry by N.K. Vishnoi. Vikas Publishing House Private Limited.

B.Sc. III Syllabus (NEP-2.0)

To be implemented from June 2026 onwards

VOCATIONAL SKILL COURSE

Semester V

Nature of Practical Exam

No. of Examination Days- 01

Semester-V Practical Paper-II (50 Marks)

Q. 1 Experiment I- 20 Marks

Q. 2 Experiment II - 20 Marks

Q. 3 Oral - 5 Marks

Q. 4 Journal- 5 Marks

VOCATIONAL SKILL COURSES

B. Sc. III, Semester VI, VSC Practical Paper-III		
BSU0325VSP307F	**PRCHVSC-607 Vocational Skill Course in Chemistry Practical Paper-III**	**Credits:** 2 **Hours:** 60

Course Outcomes:
After completion of the course, the students will be able to:

CO1 Students will learn the concept of optical rotation.
CO2 Students will learn different types of conductometric titrations.
CO3 Students will learn the use of computer techniques to solve the problems in chemistry.
CO4 Students will learn preparation skills.

Practicals:

Note: An explanation and understanding of theoretical concepts, mechanisms, reactions, and instrumentation are expected. (Perform at least 12-13 experiments)

1. To determine specific and molecular rotation of given compound and find out intrinsic rotation.
2. To determine the concentration of NH_4Cl/CH_3COONa using conductivity measurements.
3. To determine the concentration and complexation of Ni^{2+} with EDTA using conductivity measurements.
4. To determine the surface tension and Parachor values of given liquid using stalagmometer.
5. Verify Lambert-Beer's law and determine the concentration of $K_2Cr_2O_7$ in a solution of unknown concentration.
6. Preparation of pigment (zinc oxide).
7. Determination of free acidity in ammonium sulphate fertilizer.
8. To prepare borax from boric acid.
9. To estimate the Mg present in multivitamins.
10. Estimate the comparative effectiveness of different types of graphs like line, pi

chart and bar graph. (Data should be given)

11. Evaluate the absolute and method errors in a set of data collected during the determination of nitrogen in an organic compound. (Data should be given)

12. Indexing of a given powder diffraction pattern of a cubic crystalline system. (Data should be given)

13. Organic Preparation: Bromination of acetanilide/aniline/phenol

14. Organic Preparation: Nitration of toluene

15. Estimation of Iodine Content in Iodised Salt.

16. Determination of the iodine number of the given oil.

17. Preparation of biodiesel from waste cooking oil and characterization using TLC.

18. Study Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

19. Estimate percentage of available chlorine in bleaching powder.

References:

1. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.

2. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).

4. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

5. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015),Senior Practical Physical Chemistry, R. Chand & Co, New Delhi.

6. Kapoor, K.L. (2019),A Textbook of Physical Chemistry, Vol.7, 1st Edition, McGraw Hill Education.

7. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P.(2003), Experiments in Physical Chemistry, 8th Edition, McGraw-Hill, New York.

B.Sc. III Syllabus (NEP-2.0)

To be implemented from June 2026 onwards

VOCATIONAL SKILL COURSE

Semester VI

Nature of Practical Exam

No. of Examination Days- 01

Semester-VI Practical Paper-III (50 Marks)

Q. 1 Experiment I- 20 Marks

Q. 2 Experiment II - 20 Marks

Q. 3 Oral - 5 Marks

Q. 4 Journal- 5 Marks

Shivaji University,

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Syllabus for

Bachelor of Science Part-III

(B. Sc. III)

INDIAN KNOWLEDGE SYSTEM (IKS)

IN CHEMISTRY

(NEP-2.0)

To be implemented from

June 2026 onwards

Structure of B. Sc. III

Indian Knowledge System (IKS) in Chemistry

Sr. No.	Semester	Course Code	Title of Paper
1	VI	**BSU0325IKL307F**	CHIKS-609 **Ancient Indian Chemistry** (2 credits, 30 Hours)

Course Outcomes:

Upon completion of the course, student will be able to

1) Know the Indian Knowledge System and its significance in the protection of traditional knowledge.
2) Understand the need of the Indian Knowledge System and significance of the ancient Indian Chemistry.
3) Organize the contributions made by the ancient Indians in the field of Science and related concepts.
4) Know the contribution of Indians chemists in the development of chemistry.
5) Outline the chemistry heritage of ancient India.

Course Content

Unit. 1 : Vedic and Upaniṣadic Literature (9 Hours)

1.1 Introduction

1.2 Meaning and scope of "Chemistry" in ancient India (Rasāyana, Dhātuvāda, etc.)

1.3 Concept of matter (Dravya), elements (Mahābhūta, Bhūta), and transformation in Indian thought

1.4 Five elements (Pañca-mahābhūta): Ākāśa, Vāyu, Agni, Jala, Pṛthvī

1.5 Concept of transformation (Pariṇāma-vāda) and its relevance to chemical

change

1.6 Fire (Agni) as the central agent of transformation in Vedic sacrifices and early chemistry

Unit 2: Ancient Indian acid and base concepts (6 Hours)

2.1 Defination of acid and base and their classification based on Rasa taste by Charaka Samhita and Sushruta Samhita

2.2 Sources of Sour Taste substances (Fruits - lemon, orange, tamarind, grapes, some fermented fruit juices, etc., Vegetables- spinach , their characteristics and uses.

2.3 Plant ash based substances (Potash, Lye, ash of certain tree leaves) and their uses.

Unit 3: Metals in Ancient India (9 Hours)

Classification of metals in ancient India:

3.1 Survarṇa (gold) : Varieties, Description of different types of suvarṇa (Prākṛta suvarṇa, Sahaja suvarṇa, Vahni sambhūta suvarṇa, Khanija suvarṇa, Rasendra vedhaja suvarṇa), Pharmaco-therapeutic properties of gold.

3.2 Rajata (silver) : Varieties, Description of different types of rajata (Sahaja rajata, Khanija rajata, Kṛtrima rajata), Qualities of superior and inferior silver, Pharmaco- therapeutic properties of silver

3.3 Tāmra (copper): Varieties, Description of different types of tamrsa (mleccha and nepālaka tāmra), Qualities and inferior tāmra, Pharmaco-therapeutic properties of tāmra.

3.4 Loha (iron): Varieties, subvarieties, Pharmaco-therapeutic properties of muṇḍa loha.

3.5 Vaṅga (tin): Varieties, Physical properties, Pharmaco-therapeutic properties of vaṅga.

3.6 Nāga / Sīśa (lead): Physical properties of lead, Pharmaco-therapeutic properties of lead

3.7 Pittala (brass) : Varieties, Physical properties of superior pittala, Physical properties of superior and inferior properties of pittala, Pharmaco-therapeutic properties of pittala.

Unit 4: Ancient Indian Chemists **[6 Hours]**

Contribution of Indians chemists in the development of chemistry

4.1 Nagarjuna,

4.2 Vagbhata,

4.3 Govindacharya,

4.4 Yashodhar,

4.5 Ramchandra,

4.6 Somdev

References:

1. Indian Alchemy Or Rasayana By S. Mahdihassan https://archive.org/details/IndianAlchemyOrRasayanaByS.Mahdihassan/page/n79/mo de/2up
2. History of Chemistry in ancient and medieval India Acharya Prafulla Chandra Ray (Edited by P.Ray, Indian Chemical Society, Calcutta, 1956, page no. 208-239
3. India's Glorius Scientific Tradition by Suresh Soni
4. Chapter 15- Scientists of Ancient India, https://digital.nios.ac.in/content/223en/CH.15.pdf
5. Some famous Indian Scientists by S Chandrasekhar, https://www.tifr.res.in/~outreach/biographies/scientists.pdf
6. Other source: Wikipedia https://en.wikipedia.org/wiki/List_of_Indian_scientists

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Syllabus for

Bachelor of Science Part-III

(B. Sc. III)

SKILL ENHANCEMENT COURSES

IN CHEMISTRY

(NEP-2.0)

To be implemented from

June 2026 onwards

B. Sc. III, Semester VI SKILL ENHANCEMENT COURSE in CHEMISTRY		
BSU0325SEP307F	**CHSEC-608 Practical Skill in Chemistry-III**	**Credits:** 2 **Hours:** 60

Course Outcomes:
After completion of the course, the students will be able to:

CO1: analyses water and soil samples

CO2: gain knowledge of methods to detect adulterations in food.

CO3: understand applications of separation techniques in analysis.

CO4: gain knowledge of instruments.

Perform the following experiments.

1. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.
2. Determination of free lime from soil samples.
3. Determination of pH and acidity of a water sample.
4. Determination of dissolved oxygen (DO) of a water sample.
5. Determination of Chemical Oxygen Demand (COD) of water sample.
6. Identification of adulterants in some common food items like coffee powder, chili powder, turmeric powder, coriander powder and pulses, etc.
7. Analysis of preservatives and colouring matter from food samples.
8. To compare paint samples by TLC method.
9. Determination of ion exchange capacity of anion / cation exchange resin.
10. To study the use of phenolphthalein in trap cases.
11. Preparing a word processing document having tables, chemical structures and chemical equations. (Data Should be provided).
12. **Instrumental demonstrations:** (Principle, Instrumentation and Working)

    (Any One)

    a. Spectrophotometer

    b. Flame Photometer

    c. Turbidimeter

Reference Books:

1. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.

2. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.

3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.,* Saunders College Publishing, Fort Worth (1992).

4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.

5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.

6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.

7. Freifelder, D. *Physical Biochemistry 2nd Ed.,* W.H. Freeman and Co., N.Y. USA (1982).

8. Cooper, T.G. *The Tools of Biochemistry,* John Wiley and Sons, N.Y. USA. 16 (1977).

9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.,* Prentice Hall.

10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.,* Prentice Hall.

11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.,* Marcel Dekker, Inc., New York (1995).

Shivaji University, Kolhapur

B.Sc. III Syllabus (NEP-2.0)
To be implemented from June 2026 onwards
SKILL ENHANCEMENT COURSE
Semester VI

Nature of Practical Exam

Semester-VI Practical Paper-III (50 Marks)

Q. 1 Experiment- 20 Marks

Q. 2 Experiment- 20 Marks

Q. 3 Oral- 5 Marks

Q. 4 Journal- 5 Marks

Shivaji University,

Kolhapur

Accredited By NAAC with 'A^{++}' Grade

Syllabus for

Bachelor of Arts/Commerce Part-III

(B. A./B. Com. III)

OPEN ELECTIVE

IN CHEMISTRY

(NEP-2.0)

To be implemented from

June 2026 onwards

Open Elective in Chemistry

Sr. No.	Semester	Course Code	Title of Paper
1	V	BSU0325OEP307E	CHOEPR-507 Exploring Fundamental Chemistry Experiments Paper-V (2 credits, 60 Hours)

Exploring Fundamental Chemistry Experiments

Course Outcomes:

On completion of the course, the students will be able to:

CO1: Gain the knowledge of preparation and standardization of solutions.
CO2: Gain knowledge of separation techniques.
CO3: Gain knowledge of the basic instruments.
CO4: Gain knowledge of indicators and titration technique.

Course Contents

Perform the following Experiments:

1. Determination of heat of ionization of weak acid by using polythene bottle.
2. To study the neutralization reaction between strong acid and strong base.
3. Determination of Cell constant of given conductivity cell using KCl solution. (N/10 and N/50 KCl) (Solutions should be prepared by the students).
4. Determination of viscosity of given liquids A and B (Density data of liquids, viscosity of water to be given) [Any two liquids from Acetone, Carbon tetra chloride, Chloroform, Ethyl alcohol, Benzyl alcohol, Ethylene glycol and n- propyl alcohol]
5. To study the reaction between Magnesium and HCl.
6. Determine melting point of given organic compound.
7. Determine functional groups present in given organic compound.

8. To study the purification of compound by recrystallization method.
9. To determine solubility of table salt and table sugar in water.
10. To separate cations of mixture using paper chromatography.
11. Preparation and standardization of H_2SO_4 solution from the bulk.
12. Preparation and standardization of HCl solution from the bulk.
13. Estimation of Aspirin tablet.
14. Estimation of Vitamin C from fruit juice.
15. Ammonium chloride is separated from sand by sublimation.
16. To study the different acid-base indicators and their uses.
17. To study the use of litmus papers and turmeric paper.

References:

1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson 2009.
2. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co: New Delhi (2011).
3. Practical Physical Chemistry : Gurtu (S. Chand) 2014.
4. Systematic Experimental Physical Chemistry : Rajbhoj, Chandekar (Anjali Publication) 2016.
5. Advanced Practical Chemistry by J. Singh, L. D. S. Yadav, R. K. P. Singh, I. R. Siddiqui et.al, Pragati Prakashan.
6. Vogel's Text Book of Qualitative Inorganic Analysis by A. I. Vogel .3rd and 6th edition.
7. Practical Organic Chemistry by A. I. Vogel.
8. Hand Book of Organic Qualitative Analysis by H. T. Clarke.
9. Practical Organic Chemistry by F.G. Mann and B. C. Saunders. Low – priced Textbook. ELBS. Longman.

Shivaji University, Kolhapur

B.A./B.Com. III Syllabus (NEP-2.0)

To be implemented from June 2026 onwards

Semester V

Open Elective Course in Chemistry

Nature of Practical Exam

Practical Paper-I (50 Marks)

Q. 1 Experiment- 20 Marks

Q. 2 Experiment- 20 Marks

Q. 3 Oral - 5 Marks

Q. 4 Journal- 5 Marks

Annexture I

B. Sc. III, Sem. V

OJT (On the Job Training)

(4 Credits, 120 Hours)

All students should complete the OJT before the start of SEM VI(Follow the timeline provided by SUK). For details, follow the Shivaji University guidelines.

Refer: SU/AM/240 dated 22/04/2024

After completion of OJT, the student should submit a detailed report. It should be evaluated by an expert committee.

Evaluation Scheme:

Sr No	**Particulars**	**Marks**
1	Effectiveness and Quality of Presentation	10
2	Knowledge Depth and Practical Skills	10
3	Diversity in study and presentation	10
4	Practical applications of taught concepts	10
5	OJT Report	30
6	Attendance, student log, Certificate, and evaluation	30
	Total	**100**

परिशिष्ट १- आंतरवासिता हमीपत्र

१. विद्यार्थ्याचे नाव	
२. सध्याचा पत्ता	
३. कायमस्वरुपी पत्ता	
४. ई-मेल आयडी	
५. भ्रमणध्वनी (मोबाईल)क्र.	
६. आधार क्र.	
७. पॅन क्र.	
८. एकूण जी.पी.ए.(सरासरी श्रेयांक) (आंतरवासिता करण्यापूर्वी पूर्ण केलेल्या सर्व सत्रांची सरासरी श्रेयांक)	
९. आंतरवासिता पध्दत (ऑफ लाईन/ऑ लाईन/हायब्रीड मोड)	
१०.आंतरवासिता प्राधान्ये	

	स्थळ (Place)	प्रमुख क्षेत्र (Sector)	संस्था/संघटना (Institute/ Qrganistion)
प्राधान्य-१			
प्राधान्य-२			
प्राधान्य-३			

मी आंतरवासिता धोरणाच्या अटी, शर्ती आणि आवश्यकतांशी सहमत आहे.
विद्यार्थ्यांची स्वाक्षरी: ----------
दिनांक:----------

सदर विद्यार्थ्याने आंतरवासिता परिचय वर्गात भाग घेतला आहे आणि आंतरवासिता कार्यक्रमात भाग घेण्यासाठी आवश्यक ती सर्व कागदपत्रे आणि प्रक्रियेच्या गरजा पूर्ण केल्या आहेत याची मी खात्री केली आहे. तसेच त्याने/तिच्या मार्गदर्शकाकडून मान्यता प्राप्त केली आहे.

विभागातील समन्वयक शिक्षकाची स्वाक्षरी

दिनांक:

परिशिष्ट २ (अ) व्यक्तिगत माहिती प्रपत्राचा नमुना

नाव : ----------

संपर्क क्रमांक आणि ईमेल आयडी ----------

शिक्षण ----------

उच्च शिक्षणसंस्थेचे नाव वर्ष

१२ वी/मुख्य विषय : सीजीपीए:

उच्च शिक्षणसंस्थेचे नाव : वर्ष

पदवी/मुख्य विषय : सीजीपीए:

आंतरवासिता/कामाचा अनुभव

संस्था - संघटना

प्रकल्प :

थोडक्यात माहिती :

शैक्षणिक अनुभव :

सत्र: वर्ष:

प्रकल्प :

थोडक्यात माहिती :

इतर कर्तृत्व आणि वैयक्तिक आवडी निवडी

विद्यार्थ्याची स्वाक्षरी

परिशिष्ट ३ संस्थेस सेवा पुरविण्याबाबतचे पत्र

(अधिविभाग/महाविद्यालयाच्या लेटरहेडवर)

प्रति,

व्यवस्थापक (मानव संसाधन)

.....

विषय : <वर्ग> मध्ये शिक्षण घेणा-या विद्यार्थ्यांना- - आठवडयांच्या आंतरवासिताची विनंती

मां. महोदय/महोदया,

< वर्ग> साली स्थापन झालेल्या <महाविद्यालय/विद्यापीठाचे नाव> ला सर्व शैक्षणिक उत्कृष्टता आणि पायाभूत सुविधांबद्दल----मध्ये राष्ट्रीय मूल्यांकन आणि मान्यता परिषदेने < --------- > श्रेणीची मान्यता दिली आहे.

वरील बाबी लक्षात घेता मी आपल्याला विनंती करतो की, आपल्या नामांकित संस्थेत कृपया आमच्या खालील <विद्यार्थी संख्या> विद्यार्थ्यांना व्यावहारिक प्रशिक्षणाची परवानगी द्यावी. आपली खातरजमा झाल्यानंतर विद्यार्थ्यांना प्रशिक्षणात दाखल होण्यासाठी किमान एक आठवडयाचा कालावधी द्यावा.

अ.क्र.	नाव	उपस्थिती क्र Roll No.	वर्ष, (प्रथम/द्वितीय/तृतीय/चतुर्थ)	विभाग (विषय)

या विद्यार्थ्यांची व्यक्तिगत माहिती प्रपत्रे या पत्रासोबत जोडलेली आहेत. आपल्याकडे रिक्त पदे असल्यास, कृपया वरील शाखांमधील विद्यार्थ्यांच्या मुलाखती घेण्यासाठी नियोजन करावे.

आपल्या संमतीची अपेक्षा!

आपला विश्वासू

नोडल अधिकारी/टीपीओ

(महाविद्यालयाचे/अधिविभागाचे नाव आणि दिनांक)

परिशिष्ट ४ विद्यार्थ्याचे कार्यमुक्तता पत्र

<अधिविभाग/महाविद्यालयाच्या लेटरहेड)>

प्रति,

मा. महाव्यवस्थापक (मानव संसाधन)

.....

विषय : विद्यार्थ्यांचे कार्यमुक्तता पत्र.

मा. महोदय/महोदया,

कृपया उपरिनिर्दिष्ट विषयाच्या संदर्भातील आपले पत्र/ई-मेल दिनांक.....पहा. आपल्या प्रतिष्ठित संस्थेत खालील विद्यार्थी आपल्या अनुमतीने व आपल्या मार्गदर्शनाखाली आणि देखरेखीखाली औद्योगिक आंतरवासिता प्रशिक्षण घेतील :

अ.क्र.	नाव	उपस्थिती क्र Roll No.	वर्ष (प्रथम/द्वितीय/तृतीय/चतुर्थ)	विभाग (विषय)

हे प्रशिक्षण अभ्यासक्रमाचा आवश्यक भाग असल्याने प्रशिक्षणासाठी अभ्यासक्रमात खालील मार्गदर्शक तत्त्वे निश्चित करण्यात आली आहेत. त्यामुळे कृपया संबंधित विद्यार्थ्यांस मार्गदर्शकाने खालील मार्गदर्शक तत्त्वे सूचित करावीत, अशी विनंती करण्यात येत आहे.

- आंतरवासिताचे वेळापत्रक तयार करून त्याची एक प्रत आम्हाला पाठवावी.
- प्रत्येक विद्यार्थ्याने आंतरवासिता दैनंदिनी तयार करून अहवाल देणे आवश्यक आहे.
- कृपया दररोज विद्यार्थ्यांची आंतरवासिता दैनंदिनी तपासावी.
- प्रशिक्षण काळातील कामाच्या वेळांबाबत सूचना देणे आणि उपस्थितीची नोंद राखणे

विद्यार्थ्यांच्या कामगिरीचे मूल्यमापन खाली नमूद केल्याप्रमाणे उत्कृष्ट, अतिशय चांगले, समाधानकारक व असमाधानकारक अशा गुणांकनाच्या आधारे करावे, अशी विनंती आहे.

- उपस्थिती आणि सामान्य वर्तन
- कामगार आणि पर्यवेक्षकांशी संबंध
- शिकण्यासाठी पुढाकार आणि प्रयत्न
- ज्ञान आणि कौशल्य सुधारणा
- संस्थेला दिलेले योगदान

प्रशिक्षण पूर्ण झाल्यानंतर सीलबंद लिफाफ्यात कामगिरीचा अहवाल, स्वाक्षरी करण्या-या अधिका-यास अग्रेषित करावा. या संदर्भातील आपल्या प्रयत्नांमुळे विद्यार्थ्यांचे ज्ञान आणि व्यावहारिक कौशल्ये यामध्ये सकारात्मक वाढ होईल. आपल्या सहकार्याबद्दल मन:पुर्वक धन्यवाद आणि त्यासाठी आम्ही कृतज्ञ आहोत.

विद्यार्थी संस्थेच्या नियमांचे पालन करतील आणि आंतरवासितादरम्यान योग्य ती शिस्त पाळतील. विद्यार्थी आपल्याला तारखेनुसार अहवाल देतील सोबत-.कंपनी/संस्थेकडून आलेले पत्र या पत्राची प्रत

आपले विश्वासू,

नोडल अधिकारी/टीपीओ

(अधिविभागाचे/महाविद्यालयाचे नाव आणि दिनांक)

परिशिष्ट ५ विद्यार्थ्यांच्या कामांची दैनंदिनी (नोंदींचे स्वरूप)

आठवडा	नेमून दिलेले काम	केलेले उपक्रम	मुख्य शिक्षण (प्राप्त ज्ञान/ कौशल्ये)	पूरक टिप्पणी

उद्योग-पर्यवेक्षकाची स्वाक्षरी

परिशिष्ट ६ उपस्थिती पत्रक
(आंतरवासिता देण्या-या संस्थेच्या अधिकृत लेटरहेडवर)

संस्थेचे नाव व पत्ता

विद्यार्थ्याचे नाव	
उपस्थिती क्र.	
अभ्यासक्रमाचे नाव	
प्रशिक्षण सुरू होण्याची तारीख	
प्रशिक्षण पूर्ण होण्याची तारीख	

महिना आणि वर्ष :

आठवडा	सोमवार	मंगळवार	बुधवार	गुरूवार	शुक्रवार	शनिवार
१						
२						
३						
४						
५						
६						
७						
८						
९						
१०						

- उपस्थिती पत्रक प्रशिक्षण दैनंदिनीमध्ये चिकटवून ठेवावे. ते कापू नका किंवा फाडू नका.
- उपस्थिती रकान्यामध्ये लाल शाईने सुटया चिन्हांकित केल्या पाहिजेत. अनुपस्थितीला लाल शाई 'अ' म्हणून चिन्हांकित करावे

आंतरवासिता पर्यवेक्षकाचे नाव आणि स्वाक्षरी

परिशिष्ट ७ पर्यवेक्षकाचा आंतरवासिता-मूल्यमापन अहवाल
(आंतरवासिता देण्या-या संस्थेच्या अधिकृत लेटर हेडवर)

विद्यार्थ्याचे नाव ----------
दिनांक ----------
कार्य पर्यवेक्षकाचे नांव :----------
आंतरवासितेचे पदनाम ----------
संस्था/संघटना ----------
आंतरवासिताचा पत्ता ----------
आंतरवासिता तारखा ----------पासून ते ----------पर्यंत

कृपया आपण खालील वर्तन ज्या बारंबारीतेने काळजीपूर्वक पाहिले ते दर्शवून आंतरवासिता विद्यार्थ्याचे मूल्याकन करा:

मापदंड/निकष:	सुधारण होणे अपेक्षित	समाधानकारक	चांगला	उत्कष्ट
वर्तन Behaviors				
कामकाजातील विश्वासार्हता Performs in a dependable manner				
सहकारी आणि पर्यवेक्षकांबरोबर सहकार्य Cooperates with co-workers and supervisors				
कामकाजातील अभिरूची Shows interest in work				
प्रशिक्षणातील गती Learns quickly				
उपक्रमशीलता Shows initiative				
कामकाजातील गुणवत्ता Produces high quality work				
जबाबदारीचे भान Accepts responsibility				
टीका-टिपण्णची स्वीकार्हता Accepts criticism				
संघटनात्मक कौशल्यांतील निपुणता Demonstrates organizational skills				
तांत्रिक ज्ञान आणि कौशल्यांचा वापर Uses technical knowledge and expertise				
उचित न्यायनिर्णयक्षमता Shows good judgment				
नवनिर्मितीक्षमता आणि कल्पकता Demonstrates creativity/originality				
समस्यांचे प्रभावीपणे विश्लेषण Analyzes problems effectively				
स्वावलंबन Is self-reliant				
संवादक्षमता Communicates well				
प्रभावी लेखनशैली Writes effectively				
व्यावसायिक अभिवृत्ती Has a professional attitude				
व्यावसायिक वर्तनव्यवहार Gives a professional appearance				
वक्तशीरपणा Is punctual				
वेळेचा प्रभावी वापर Uses time effectively				

टांतरवासिता विद्यार्थ्याची सर्वांगीण कामगिरी :सुधारणा/समाधानकारक/चांगले/उत्कृष्ट (यापैकी टिक करा)
अतिरिक्त टिप्पण्या (असल्यास) :
उद्योग पर्यवेक्षकाची स्वाक्षरी ----------
नाव ----------

मानवसंसाधन व्यवस्थापकाची स्वाक्षरी ----------
नाव ----------

परिशिष्ट ८ विद्यार्थ्यांचा आंतरवासिता अनुभव : अभिप्राय

(आंतरवासिता पूर्ण झाल्यानंतर विद्यार्थ्यांनी भरावे)

विद्यार्थ्यांचे नाव : ----------
दिनांक : ----------
औद्योगिक पर्यवेक्षकाचे नाव : ----------
पदनाम : ----------
पर्यवेक्षक ईमेल ----------
आतंरवासिता: ----------सवेतन-------विनावेतन---------
संस्था/संघटना : ----------
आंतरवासिताचा
पत्ता:----------
शिक्षक समन्वयक : ----------
विभाग ----------
आंतरवासिता दिनांक ----------पासून ते ---------पर्यंत
आपल्या आंतरवासितांच्या कामाचे थोडक्यात वर्णन द्या (आपण जयासाठी जबाबदार आहात त्या कामांची नावे स्वरुप):
तुमचा आंतरवासिताचा अनुभव तुमच्या अभ्यासाच्या प्रमुख क्षेत्राशी संबंधित होता का?

- होय/ब-याच अंशी
- होय/थोडयाफार प्रमाणात
- नाही/अजिबात नाही

खालील विधानांशी आपण किती प्रमाणात सहमत किंवा असहमत आहात हे दर्शवा.

हा अनुभव असा आहे:	पूर्णपणे सहमत	सहमत	मत नाही	असहमत	पूर्णपणे असहमत
मला व्यवसाय क्षेत्र शोधण्याची संधी दिली Given me the opportunity toexplore a career field					
मला सराव करण्यासाठी वर्गातील सिध्दांतांचे उपयोजन करण्याची परवानगी दिली Allowed me to applyclassroom theory to practice					
माझी निर्णयक्षमता आणि समस्या सोडविण्याची कौशल्य विकसित करण्यास मदत केली Helped me develop my decision-making and problem-solving skills					
कायमस्वरुपी नोकरीपूर्वी मला कार्यविश्वाशी संबंधित ज्ञानप्राप्तीसाठी मदत झाली Expanded my knowledge about the work world prior to permanent employment					
मला माझे लेखी आणि मौखिक संप्रेषण कौशल्ये विकसित होण्यासाठी मदत dsyh- Helped me develop my written and oral communication skills					
नेतृत्व कौशल्ये वापरण्याची संधी दिली (इतरांवर प्रभाव पाडणे, इतरांसोबत कल्पना विकसित करणे, निर्णय घेण्यास आणि कृतीस अत्तेजन देणे) Provided a chance to use leadership skills (influence others, develop ideas with others, stimulate decision-making and action)					
कामाच्या संबंधातील नैतिक परिणामांबद्दल माझी संवेदनशीलता वाढविली Expanded my sensitivity to the ethical implications of the work involved					
अनोख्या परिस्थितीत आत्मविश्वासपूर्वक वागण्याकरिता आत्मकबळ दिले Made it possible for me to be more confident in new situations.					
मला माझे पारस्परिक कौशल्य सुधारण्याची संधी fnyh- Given me a chance to improve my interpersonalskills					
मला जबाबदारी हाताळायला आणि वेळेचा सुयोग्य वापर करायला मदत केली. Helped me learn to handle responsibility and use mytime wisely					
मला स्वत:चे नवीन पैलू शोधण्यात मदत केली जी मला पूर्वी माहित नव्हती Helped me discover new aspects of myself that I didn't know existed before					
मला नवी अभिरूची आतिण क्षमता विकसित करण्यासाठी मदत केली Helped me develop new interests and abilities					
मला माझ्या कार्यक्षेत्राची उद्दिष्टे स्पष्ट करण्यास मदत केली Helped me clarify my career goals					
मला भविष्यात रोजगार मिळू शकेल यासाठी आवश्यक संपर्क साधने पुरविली Provided me with contacts which may lead to future employment					

मला माहिती मिळविण्यासाठी आणि / किंवा ती वापरण्यासाठी संस्थेत उपलब्ध नसलेली उपकरणे वापरण्याची परवानगी दिली. Allowed me to equire information and/ or use equipment not available at my Institute					

- संस्थेच्या आंतरवासिता कार्यक्रमात शिक्षकांनी विद्यार्थ्यांसाठी मार्गदर्शक असणे अपेक्षित आहे.

  तुमच्या शिक्षक समन्वयकाने असे काम केले असे तुम्हाला वाटते का? होय/नाही नसल्यास का?

- आपल्या शिकण्याच्या करारामध्ये निर्धारित केलेली प्रारंभिक ध्येये, कार्ये आणि नवीन कौशल्ये आपण किती चांगल्या प्रकारे पूर्ण करू शकलात? आपण कोणत्या प्रकारे नवीन दिशा घेण्यास किंवा आपल्या कराराच्या पलीकडे विस्तार करण्यास सक्षम आहात? होय/नाही नसल्यास का?
- आपण कोणत्या क्षेत्रात सर्वात जास्त विकास आणि सुधारणा केली?
- आपल्या आंतरवासिता काळातील सर्वांत महत्त्वपूर्ण कामगिरी किंवा समाधानाचा क्षण कोणता होता?
- आंतरवासितामध्ये तुम्हाला काय आवडले नाही?
- तुमचा एकंदर अनुभव लक्षात घेता तुम्ही या आंतरवासिताचे मूल्यमापन कसे कराल?

  समाधानकारक/चांगले/उत्कृट (एकाला गोल करा)

- आपला आंतरवासिताचा अनुभव कसा सुधारता आला असता याबद्दल सूचना द्या (तुम्हाला अतिरिक्त जबाबदारी सांभाळता आली असती का? आपल्या आंतरवासिताबद्दल तुमच्या शिक्षकांशी अधिक चर्चा करणे आपल्याला आवडले असते का? बारकाईने देखरेखीची गरज होती का? अधिक उजळणीची गरज होती का?)

विद्यार्थ्यांची स्वाक्षरी ----------

नाव, ----------

उपस्थिती क्रमांक, ----------

दिनांक----------

परिशिष्ट ९ संस्थेचा आंतरवासिता मूल्यमापन अहवाल : नमुना प्रपत्र
(अधिविभागाच्या/महाविद्यालयाच्या लेटरहेडवर)

१. विद्यार्थ्यांचे नाव ----------
   भ्रमणध्वनी (मोबाईल) क्र. ----------
२. उपस्थिती क्र. ----------
३. शाखा/सत्र ----------
४. प्रशिक्षण कालावधी ----------
५. घरचा पत्ता (संपर्क क्रमांकासह) ----------
६. प्रशिक्षण (आंतरवासिता) स्थळाचा पत्ता ----------
७. प्रशिक्षण देणा-या संस्थेचा पत्ता ----------
८. प्रशिक्षण/पर्यवेक्षकाचे प्रभारीचे नाव/पदनाम ----------
९. कामाचे स्वरूप ----------
१०. मूल्यमापन दिनांक ----------
११. कृपया खालील बाबींचे मूल्यांकन करा :

अ.क्र.	तपशील	गुण पैकी	गुण पैकी	मिळालेले गुण
१.	सादरीकरणाची गुणवत्ता आणि परिणामकारकता	१०	५	
२	ज्ञानाची सखोलता आणि प्रात्यक्षिक कौशल्ये	१०	५	
३	शिकण्याच्या अनुभवाची विविधता आणि प्रासंगिता	१०	५	
४	व्यावहारिक अनुप्रयोग आणि शिकवलेल्या संकल्पनांशी संबंध	१०	५	
५	आंतरवासिता अहवाल	३०	१५	
६	उपस्थितीची नोंद, विद्यार्थी लॉग, पर्यवेक्षक मूल्यमापन	३०	१५	

समग्र श्रेणी :

मार्गदर्शकाची स्वाक्षरी

Annexture II

B. Sc. III, Sem. VI

Field Project

(2 Credits, 60 Hours)

Topics:

- Analytical, organic, and environmental studies, focusing on practical application, sustainability, and chemical analysis, water analysis, soil analysis, producing biofuels, investigating natural indicators, and synthesizing everyday products like soap or slime, Environmental & Analytical Chemistry, Air Quality, Pesticide Detection, Food Adulteration, Fermentation Studies, Extraction, Biodiesel Production, Corrosion Protection and any suitable topic related to Chemistry.

Format of Report

- Front Page
- Certificate
- Index
- Introduction
- Surveys, Field Visits
- Experimental Studies/Results/Observations/Calculations
- Summary, Findings and Outcomes
- References

Guidelines of Evaluation:

FP will be evaluated through a detailed report submission followed by oral examination evaluated by the examiners/experts appointed by the Examination Section of the University. Maximum 20 students per batch will be evaluated per day for FP. The FP will be evaluated as per the following marks distributions:

Sr. No.	Particulars	Marks (50)
1	Report as per format	15
2	Quality of Report	10
3	Knowledge Depth and Practical Skills	10
4	Oral Examination (Q and A Session)	15

Annexture III

List of Laboratory Equipment and Apparatus

1. Digital balance with 1 mg accuracy
2. Conductometer
3. Potentiometer
4. pH Meter
5. Polarimeter
6. Colorimeter
7. Thermostat
8. Electric Oven
9. Suction Pump
10. Crucible Heater
11. IR Lamp
12. Magnetic stirrer
13. Buckner funnel
14. Water bath / Thermostat.
15. Platinum electrode
16. Glass electrode, calomel electrode
17. Silver, Zinc, Copper electrodes
18. Conductivity cell
19. Distilled water plant.
20. Refractometer
21. Freeze
22. Deep Freeze
23. H2S Apparatus
24. Muffle Furnace
25. Hot Plate
26. Viscometer
27. Stalagmometer

28 Glassware & Porcelain ware: 1. Burette (25/50 ml) 2. Micro burette (10 ml) 3. Pipette (5 ml,10 ml,25ml) 4. Graduated Pipette (1/2/5/10 ml) 5. Conical flask(100 ml, 250 ml), 6. distillation assembly, 7. Watch glass 8. Volumetric flasks (25, 50, 100, 250 ml) 9. Beakers (100, 250, 500 ml) 10. Test tubes 11. Evaporating dish 12. Test tube holder 13. Pair of tongues 14. Wire gauze 15. Tripod stand 16. Glass rods 17. Funnel 18. Salt bridge 19. dryer