Dissemination of Education for Knowledge, Science and Culture"
Shikshanmaharshi Dr. Bapuji Salunkhe

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur

(An Empowered Autonomous Institute)

DEPARTMENT OF CHEMISTRY

Three/Four Years UG Programme

Department/Subject Specific Core or Major (DSC)

Curriculum, Teaching and Evaluation Structure

As Per NEP 2020

For

B. Sc. Part - III Chemistry (NEP – 1.0)
Semester-V & VI

SYLLABUS

to be implemented from Academic Year 2025-26

VIVEKANAND COLLEGE, KOLHAPUR
(EMPOWERED AUTONOMOUS)
Department of Chemistry

INTRODUCTION

The third-year B.Sc. Chemistry syllabus, structured under the framework of NEP-2020, aims to deepen students' understanding of core chemical principles while encouraging interdisciplinary learning and practical competence. This stage marks a significant transition from foundational knowledge to specialization and application.

Building upon the concepts covered in the first two years, the curriculum focuses on advanced topics in Organic, Inorganic, Physical, Analytical and Industrial Chemistry. It also integrates laboratory work, skill-based components, and elective options, allowing students to tailor their academic journey based on interests and career goals.

In line with NEP-2020, the syllabus emphasizes experiential learning, research orientation, and value-based education. Students are encouraged to develop scientific reasoning, problem-solving abilities, environmental awareness, and ethical thinking, all of which are essential for higher studies, competitive exams, or employment in industry and academia.

By the end of the third year, students will be well-prepared for entry-level roles in chemical industries, quality control labs, environmental agencies, or for pursuing further studies in Chemistry or allied sciences.

Program Outcomes (POs):

PO1: Disciplinary Knowledge: Graduates will gain in-depth understanding in their specific major or discipline, mastering the foundational principles and theories, as well as advanced concepts. Execute strong theoretical and practical understanding developed from the specific programme in the area of work.

PO2: Problem-Solving Skills: Graduates will learn to use their knowledge to identify, analyze, and solve problems related to their field of study.

PO3: Analytical Skills: Graduates will gain the ability to collect, analyze, interpret, and apply data in a variety of contexts. They might also learn to use specialized software or equipment.

PO4: Research Skills and Scientific temper: Depending on the field, graduates might learn how to design and conduct experiments or studies, analyze results, and draw conclusions. They might also learn to review and understand academic literature.

PO5: Communication Skills: Many programs emphasize the ability to communicate effectively, both orally and in writing. Graduates may learn to present complex information clearly and succinctly, write detailed reports, and collaborate effectively with others.

PO6: Ethics and Professionalism: Graduates may learn about the ethical and professional standards in their field, and how to apply them in real-world situations.

B.Sc. in Chemistry

Program Specific Outcomes (PSOs):

After successful completion of degree program in Chemistry a student should be able to;

PSO1: Understand fundamental facts and concepts in Chemistry as well as its applications so as to develop interest in the study of chemistry as a discipline.

PSO2: Develop the ability to apply the principles of Chemistry in practical.

PSO3: Acquire skills of different analytical techniques used in chemistry.

PSO4: Develop Skills to evaluate, analyze and interpret the chemical reactions by using various techniques.

PSO5: Acquire knowledge and skills required to hire in any sector related to chemistry as well as to admit for higher education.

VIVEKANAND COLLEGE, KOLHAPUR (EMPOWERED AUTONOMOUS)

Department of Chemistry

Teaching and Evaluation Scheme

(WEF 2025-26 NEP-1.0)

Three/Four- Years UG Programme

Department/Subject Specific Core or Major (DSC) as per NEP-2020

B.Sc. Chemistry

UG Certificate in Major

(B. Sc.-III Semester - V & VI)

Sr. No.	Course Abbr.	Course code	Course Name	Teaching Scheme Hours/week		Examination Scheme and Marks				Course Credits
				TH	PR	ESE	CIE	PR/PRO	Marks	
Semester-V										
1	DSC-IX	DSC03CHE51	Physical Chemistry	2	-	40	10	-	50	2
2	DSC-X	DSC03CHE52	Inorganic Chemistry	2	-	40	10	-	50	2
3	DSC-XI	DSC03CHE53	Organic Chemistry	2	-	40	10	-	50	2
4	DSE-I	DSE03CHE51	Analytical Chemistry	2	-	40	10	-	50	2
		DSE03CHE52	Applied Chemistry							
5	VSC-PR-IV	VSC03CHE51	Soil and Water Analysis	-	4	-	-	25	25	2
6	DSC-PR-V	DSC03CHE59	Chemistry Lab-V	-	12	-	-	75	75	6
7	FP	FRP03CHE51	Field Project	-	4	-	-	50	50	2
8	MIN-IX	MIN03CHE51	General Aspects of Chemistry - I	2	-	40	10	-	50	2
9	MIN-PR-V	MIN03CHE59	MIN Chemistry Lab-V	-	4	-	-	25	25	2
	Total			**10**	**24**	**200**	**50**	**175**	**425**	**22**
Semester-VI										
1	DSC-XII	DSC03CHE61	Physical Chemistry	2	-	40	10	-	50	2
2	DSC-XIII	DSC03CHE62	Inorganic Chemistry	2	-	40	10	-	50	2
3	DSC-XIV	DSC03CHE63	Organic Chemistry	2	-	40	10	-	50	2
4	DSE-II	DSE03CHE61	Industrial Chemistry	2	-	40	10	-	50	2

		DSE03CHE62	Computer Tools in Chemistry							
5	VSC-PR-V	VSC03CHE61	Food Analysis	-	4	-	-	25	25	2
6	OJT	OJT03CHE61	On Job Training	-	4	-	-	50	50	2
7	DSC-PR-VI	DSC03CHE69	Chemistry Lab-VI	-	12	-	-	75	75	6
8	MIN-X	MIN03CHE61	General Aspects of Chemistry - II	2	-	40	10	-	50	2
9	MIN-PR-VI	MIN03CHE69	MIN Chemistry Lab-VI	-	4	-	-	25	25	2
	Total			**10**	**24**	**200**	**50**	**175**	**425**	**22**
	Total marks for 3-year degree programme								**2650**	

Abbreviations: TH-Theory, PR-Practical, PRO- Project, ESE- End Semester Examination, CIE-Continuous Internal Examination

Note: Minimum passing for 10 marks Internal evaluation = 04 marks
Minimum passing for 25 marks Theory paper = 10 marks
Minimum passing for 40 marks Theory paper = 16 marks
Minimum passing for 25 marks Practical = 10 marks
Minimum passing for 50 marks Practical/FP/OJT = 20 marks
Passing percentage for Democracy, Election and Good Governance (DEGG) and Environmental Studies papers should be 40%

***Separate passing for each Head is Mandatory- SEE, CIE and Practical**

List of Laboratory Equipments

- **Apparatus & Equipments**

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
17. Silver, Zinc, Copper electrodes
18. Conductivity cell
19. Distilled water plant.
20. Refractometer
21. Freeze
22. Deep Freeze
23. H_2S Apparatus
24. Muffle Furnace
25. Magnetic Stirrer

- **Glassware & Porcelain ware:**
  1. Burette (25/50 ml)
  2. Micro burette (10 ml)
  3. Pipette (5 ml, 10 ml, 25 ml)
  4. Graduated Pipette (1/2/5/10 ml)
  5. Conical flask (100 ml, 250 ml)
  6. Beakers (100 ml, 250 ml, 500 ml)
  7. Volumetric flask (25ml, 50 ml, 100 ml, 250 ml)
  8. Gooch Crucible / Sintered glass Crucible
  9. Silica Crucible
  10. Watch glass
  11. Glass tubing
  12. Glass Funnel (3")
  13. Gas jar
  14. Glass rod
  15. Test Tubes (12 x100, 5x5x8)
  16. Evaporating dish
  17. TLC Unit
  18. Measuring cylinder
  19. Thile's tubes
  20. Fusion Tube
  21. Capillary tube
  22. Stopper bottle
  23. Thermometer ($1/10^{o}$, 360^{o})
  24. Water condenser
  25. Distillation flask (100 ml/ 250 ml)
  26. Titration tiles.
  27. Asbestos sheet.
  28. Desiccators

29. Clay pipe triangle

- **Iron & Wooden ware:**
  1. Burners
  2. Tripod stand
  3. Iron stand
  4. Wire gauze
  5. Burette stand
  6. Test tube stand
  7. Pair of tongs
  8. Test tube holder
  9. Spatula
  10. Copper foil

- **Chemicals:** All the chemicals required for experiments are mentioned in the syllabus.
- **Others:**
  1. Filter papers (Kalpi)
  2. Whatman Filter paper No. 1, 40, 41

Lab Safety Precautions / Measures in Chemistry Laboratory:

Part-I: Personal Precautions

1. All personnel must wear safety Goggles at all times.
2. Must wear the Lab. Aprons / Lab jacket and proper shoes.
3. Except in emergency, an over-hurried activity is forbidden.
4. Fume cupboard must be used whenever necessary.
5. Eating, Drinking and Smoking in the laboratories strictly forbidden.

Part-II: Use of safety and Emergency Equipment's

1. First aid kits.
2. Sand Bucket.
3. Fire extinguishers (dry chemical and carbon dioxide extinguisher).
4. Chemical storage cabinet with proper ventilation.
5. Material safety data sheets
6. Management of local exhaust system and fume hoods.
7. Sign in register if using instruments.

B. Sc. Part – III Semester - V CHEMISTRY (Major)

DSC-IX: DSC03CHE51: PHYSICAL CHEMISTRY

Theory: 30 hrs

Marks-50 (Credits: 02)

CO No.	On completion of the course, student will be able to:
CO1	Learn and understand quantum Chemistry, Heisenberg's uncertainty principle, concept of energy operators (Hamiltonian), learning of Schrodinger wave equation, physical interpretation of the ψ and ψ2 and particle in a one-dimensional box.
CO2	Acquire knowledge about spectroscopy, Electromagnetic spectrum, Energy level diagram, Study of rotational spectra of diatomic molecules: Rigid rotor model, Microwave oven, vibrational spectra of diatomic molecules, simple Harmonic oscillator model, Raman spectra: Concept of polarizability, pure rotational and pure Vibrational Raman spectra of diatomic molecules, related knowledge will be gained by the students.
CO3	Learn and understand photochemical laws, reactions and various photochemical phenomena.
CO4	Learn and understand the knowledge of emf measurements, types of electrodes, different types of cells, various applications of emf measurements.

Unit – I:	**Elementary quantum mechanics** 1.1 Introduction. 1.2 Limitations of classical mechanics, Black body radiation, Photoelectric effect, Dual nature of matter and energy: De Broglie hypothesis. 1.3 Heisenberg's uncertainty principle. 1.4 Concept of energy operators (Hamiltonian).	**[8]**

	1.5 Derivation of Schrodinger wave equation, well-behaved function. 1.6 Physical interpretation of the ψ and ψ^2. 1.7 Particle in a one-dimensional box.	
Unit - II:	**Molecular Spectroscopy** 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 Comparative study of IR and Raman spectra, rule of mutual exclusion-CO_2 molecule. 2.8 Numerical problems.	**[7]**
Unit-III:	**Photochemistry** 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.	**[8]**

	3.4 Factors affecting Quantum yield. 3.5 Photo sensitized reactions – Dissociation of H_2, Photosynthesis. 3.6 Examples of photochemical reactions–Photo dimerization 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-IV:	**Electromotive force** 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 [Derivation expected] and without transference [Derivation not expected] iii) Liquid- Liquid junction potential: Origin, elimination and determination. 4.6 Equilibrium constant from cell emf.	**[7]**

	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).	

Reference Books:

1. Physical Chemistry by G.M. Barrow, International student Edition, McGraw 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 Fried lander, Kennedy and Miller, John Wiley and Sons. Wiley International edition.
7. Essentials of Nuclear Chemistry byH. J. Arnikar, 4th edition. Wiley Eastern.
8. Principles of Physical Chemistry by Puri, Sharma, Pathania, Shobhanlal Nagin chand 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 McGraw-Hill.
11. Quantum Chemistry including molecular spectroscopy by B.K. Sen, Tata McGraw-Hill.
12. Text Book of Physical Chemistry by S. Glasstone, Macmillan India Ltd.
13. Advanced Physical Chemistry Gurdeep Raj GOEL Publishing House, 36th Edition
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.

B. Sc. Part – III Semester - V CHEMISTRY (Major)
DSC-X: DSC03CHE52: INORGANIC CHEMISTRY

Theory: 30 hrs
Marks-50 (Credits: 02)

CO No.	On completion of the course, student will be able to:
CO1	Understand the study of role of all chemical properties of solutes in Chemistry and also get a basic understanding of nano chemistry, nanotechnology and its fascinating aspects.
CO2	Gain an understanding of synthesis and applications of the semiconductors and superconductors in electrical and electronic devices.
CO3	Impart essential knowledge regarding classification, types, mechanism and applications of catalyst in industrial fields. They also understand geometry, stability, color and nature of bonding between metal ion and ligand in complexes.
CO4	Improve the level of understanding of structure, method of preparation and applications of organometallic compound in various fields.

Unit-I:	**Chemistry of Non aqueous Solvents** 1.1 Introduction, definition and characteristics of solvents, 1.2 Classification of solvents, 1.3 Physical properties and Acid-Base reactions in Liquid Ammonia (NH_3), Liquid Sulphur Dioxide (SO_2), anhydrous sulfuric acid (H_2SO_4) and anhydrous hydrogen fluoride (HF); 1.4 Molten salts as non-aqueous solvents	**[8]**
Unit-II:	**Metals, Semiconductors and Superconductors** 2.1 Introduction, 2.2 Properties of metallic solids, 2.3 Theories of bonding in metal: i) Free electron theory ii)	**[7]**

	Molecular orbital theory (Band theory), 2.4 Classification of solids as conductor, insulators and semiconductors on the basis of band theory, 2.5 Semiconductors, Types of semiconductors - intrinsic and extrinsic semiconductors, Applications of semiconductors, 2.6 Superconductors: Superconductivity, Meissner effect, Ceramic superconductors- Preparation and structures of mixed oxide YBa2Cu3O7-x, 2.7 Applications of superconductors.	
Unit-III:	**Catalysis and Molecular orbital theory (MOT)** **(A) Catalysis** 3.1 Introduction, 3.2 Classification of a catalytic reaction - Homogenous and Heterogeneous, Types of Catalysis, Characteristics of catalytic reactions, 3.3 Mechanism of catalysis - Intermediate compound formation theory and Adsorption theory, 3.4 Industrial applications of catalysis. **(B) Molecular orbital theory (MOT)** 3.5 Introduction, 3.6 MOT of octahedral complexes with sigma bonding such as $[Ti(H_2O)_6]^{3+}$, $[CoF_6]^{3-}$, $[Co(NH_3)_6]^{3+}$, 3.7 Merits and demerits of MOT.	**[8]**
Unit-IV:	**Organometallic Chemistry** 4.1 Definition, Nomenclature and EAN rule of organometallic compounds, 4.2 Synthesis and structural study of alkyl and aryl compounds of Li, Be and Al,	**[7]**

	4.3 Zeiss salt and ferrocene, 4.4 Preparation, structure, bonding and properties of mononuclear carbonyls: $[Ni(CO)_4]$, $[Fe(CO)_5]$, $[Cr(CO)_6]$.	

Reference Books:

1. Concise Inorganic Chemistry by J.D. Lee - 5th Edition.
2. Inorganic Chemistry, - D.F. Shiver & P.W. Atkins - C.H. Longford ELBS - 2nd Edition.
3. Basic Inorganic Chemistry, - F.A. Cotton and G. Wilkinson, Wiely Eastern Ltd 1992.
4. Concept and Model of Inorganic Chemistry by Douglas - Mc Daniels – 3rd Edition John Wiley publication.
5. Co-ordination Compounds by Baselo and Pearson
6. Inorganic Chemistry by J.E. Huheey, 4th Edition, Pearson Education.
7. Inorganic Chemistry by A. G. Sharpe - 3rdEdition
8. Principles of Bioinorganic Chemistry by S.J. Lippard and J.M. Berg, 1st Edition.
9. Advanced Inorganic Chemistry (4th Edition) Cotton and Wilkinson
10. Theoretical Inorganic Chemistry by Day and Selbine.
11. Organometallic Chemistry by R.C. Mehrotra A. Sing, Wiley Eastern Ltd. New Delhi.
12. Principles of Inorganic Chemistry by Puri, Sharma and Kalia, Vallabh Publication. Pitampur Delhi.
13. Textbook of Inorganic Chemistry by K.N. Upadhyaya Vikas Publishing House –New Delhi.
14. Inorganic Solids: An introduction to concepts in solid-state structural chemistry by Adam, D.M. John Wiley & Sons, 1974.

B. Sc. Part – III Semester - V CHEMISTRY (Major)
DSC-XI: DSC03CHE53: ORGANIC CHEMISTRY

Theory: 30 hrs
Marks-50 (Credits: 02)

CO No.	On completion of the course, student will be able to:
CO1	Understand basic concepts of spectroscopy.
CO2	Acquire knowledge of various spectroscopic techniques such as UV, IR, NMR and Mass Spectroscopy.
CO3	Interpret molecular structural formula by using spectroscopic techniques.
CO4	To make the solutions and find the structures of unknown organic compounds on the basis of IR, NMR, UV and Mass spectroscopic data.

Unit-I:	**Introduction to Spectroscopy and Ultra-violet (UV) Spectroscopy** **A) Introduction to Spectroscopy:** 1.1 Meaning of spectroscopy, Nature of electromagnetic radiation - wave length, frequency, energy, amplitude, wave number, and their relationship, 1.2 different units of measurement of wavelength frequency, different regions of electromagnetic radiations, 1.3 Interaction of radiation with matter-absorption, emission, florescence and scattering, 1.4 Types of spectroscopy and advantages of spectroscopic methods. 1.5 Energy types and energy levels of atoms and molecules. **B) Ultra-violet (UV) Spectroscopy:** 1.6 Introduction, Beer-Lamberts law, 1.7 absorption of U.V. radiation by organic molecule leading to different excitation, 1.8 Terms used in U.V. Spectroscopy- Chromophore, Auxochrome, Bathochromic shift, hypsochromic shift, hyperchromic and	**[8]**

	hypochromic effect, 1.9 Modes of electromagnetic transitions. 1.10 Effect of conjugation on position of U.V. band, 1.11 Calculation of λ-max by Woodward and Fisher rules for dienes and enones systems, Colour and visible spectrum, 1.12 Applications of U.V. Spectroscopy.	
Unit-II:	**Infra-Red (IR) Spectroscopy** 2.1 Introduction, Principle of I.R. Spectroscopy, 2.2 IR Instrumentation, schematic diagram, 2.3 Fundamental modes of vibrations, Condition for absorption of IR radiations, 2.4 Regions of I.R. Spectrum: fundamental group region, finger print region, 2.5 Hooks Law for Calculation of vibrational frequency, 2.6 IR Sampling, 2.7 Factors affecting on IR absorption frequency, 2.8 Characteristic of I.R. absorption of following functional groups Alkanes, alkenes, alkynes, Alcohol and phenols, Ethers, Carbonyl compounds, Amines, Nitro com, Aromatic Compounds.	**[7]**
Unit-III:	**Nuclear Magnetic Resonance (NMR) Spectroscopy** 3.1 Introduction, Principles of PMR Spectroscopy, 3.2 NMR- Instrumentation, Schematic diagram, 3.3 Magnetic and nonmagnetic nuclei, 3.4 Chemical shift - definition, measurement, calculation, 3.5 Factors affecting Chemical shift, Shielding, & deshielding, 3.6 Peak Integration, 3.7 Merits of TMS as PMR reference compounds,	**[8]**

	3.8 Coupling Constant, Types of Coupling Constant, Spin-spin splitting (n+1 rule), 3.9 Applications of NMR Spectroscopy	
Unit-IV:	**Mass spectroscopy and Combined Problems** **A) Mass spectroscopy:** 4.1 Introduction, Principle of mass spectroscopy, 4.2 Mass spectrometer – schematic diagram, 4.3 Types of ions produced in mass spectrum, 4.4 Fragmentation patterns of - alkanes, alkenes, aromatic hydrocarbons, alcohols, phenols, amines and carbonyl compounds, 4.5 McLaffrety rearrangement, 4.6 Applications of Mass Spectroscopy **B) Combined Problems** based on UV, IR, NMR and Mass Spectral data	**[7]**

Reference Books:

1. Absorption Spectroscopy of Organic Molecules by V. M. Parikh.
2. Spectroscopy of Organic compounds by P. S. Kalsi.
3. Elementary Organic Absorption Spectroscopy by Y. R. Sharma.
4. Instrumental Methods of Analysis (7th edition) by Willard, Merritt, Dean, Settle.
5. Spectroscopy by G. R. Chatwal and S. K. Anand
6. Spectroscopy by Pavia, Lampman, Kriz
7. Organic Spectroscopy (2nd edition) by Jag Mohan
8. Organic Spectroscopy (3rd edition) by William Kemp
9. Instrumental Methods of Chemical Analysis by H. Kaur.

B. Sc. Part – III Semester - V CHEMISTRY (Major)
DSE-I: DSE03CHE51: ANALYTICAL CHEMISTRY

Theory: 30 hrs
Marks-50 (Credits: 02)

CO No.	On completion of the course, student will be able to:
CO1	Acquire knowledge of theoretical and practical aspects of Soil, water and fertilizers analysis.
CO2	Acquire skills of various analytical techniques such as Flame photometry, potentiometry, and colorimetry.
CO3	Learn various aspects to apply analytical techniques to analyzed the samples.
CO4	Adopt the knowledge about basics and methodologies of various chromatography techniques.

	Unit-I:	**Chromatography** 1.1 Recapitulation: Definition and principle of chromatography, Types of chromatography **A) Gas Chromatography:** 1.2 Principle and theory of gas chromatography 1.3 Components of gas chromatography: Carrier gas tank, Sample Injector, Column (types of columns), Detector. 1.4 Types of gas chromatography: GSC and GLC 1.5 Applications of gas chromatography: **B) High-Performance Liquid Chromatography (HPLC):** 1.6 Principle and theory of HPLC, 1.7 Components of HPLC system: Mobile phase, Pump system, Injector, Column (types of columns and stationary phases), Detector, Data processing system 1.8 Types of HPLC: Normal phase HPLC, Reverse phase HPLC	**[8]**

	(RP-HPLC) 1.9 Mobile Phase and Stationary Phase: Selection of mobile phase, Types of stationary phases. 1.10 Applications of HPLC	
Unit-II:	**Flame Photometry** 2.1 Introduction, General principles of flame photometry, 2.2 Instrumentation: Block diagram, Burners (Premix and Lunder graph burners), mirror, slits, filters, detector (Photomultiplier tube), 2.3 Effect of solvent in flame photometry, 2.4 Experimental procedure of analysis (Standard addition and internal standard), 2.5 Interferences and Factors that influence the intensity of emitted radiation in a flame photometer, 2.6 Applications of flame photometry in real sample analysis, 2.7 Limitations of flame photometry.	**[7]**
Unit-III:	**Potentiometry and Colorimetry** **A) Potentiometry:** 3.1 General Introduction, 3.2 Potentiometric titrations – Classical and analytical methods for locating end points, 3.3 Types of Potentiometric Titration: Acid-base titration, Redox titration, Precipitation titration, 3.4 Advantages of potentiometric titrations, 3.5 Basic circuit of direct reading potentiometer. **B) Colorimetry:** 3.6 Introduction, Lambert-Beer's law, 3.7 Basic terms used-Transmittance, Optical Density, Opacity,	**[8]**

	Extinction coefficient, Deviation from Beer's law, 3.8 Classification of methods of 'colour' measurement or comparison - i) Photoelectric Colorimeter method- Single beam photo-electric colorimeter, 3.9 Determination of unknown concentration by using Concentration – Absorbance plot	
Unit-IV:	**Soil and Water Analysis** **A) Soil Analysis:** 4.1 Introduction to Soil Science: Soil Composition 4.2 Importance of Soil Testing and Analysis, 4.3 Sampling of Soil 4.4 Physical Characteristics of soil: Soil texture, Porosity, color, Soil structure. 4.5 Soil parameters testing: pH, Electrical Conductivity, Soil Organic carbon (Walkey-Black Method), Available Nitrogen, Total Sulphur. **B) Water Analysis:** 4.6 Introduction, 4.7 Physical analysis of water: Conductance, Colour, odour, Turbidity, TSS and taste. 4.8 Chemical Analysis: pH, TDS, Hardness, Alkalinity, Acidity, Sulphates, Nitrates, Dissolved Oxygen, Chemical Oxygen Demand, Biological Oxygen Demand.	**[7]**

Reference Books:

1. A. I. Vogel, Textbook of Quantitative Chemical Analysis, 6th ed, Pearson Education, 2002.

2. S. M. Khopkar, Analytical Chemistry Problems and Solutions, New Age International Publishers, 2002.
3. S. M. Khopkar, Basic Concepts of Analytical Chemistry, 3rd ed, New Age International Publishers, 2008.
4. D. A. Skoog, D. M. West, F. J. Holler, Fundamentals of Analytical Chemistry, 8th ed. Philadelphia, Saunders College Publishing, 1996.
5. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, 6th ed. Philadelphia, Saunders College Publishing, 1996.
6. G. R. Chatwal and S. K. Anand: Instrumental methods of Chemical Analysis, Himalaya Publishing House.
7. H. H. Willard, L. L. Merritt and J. A. Dean; Instrumental methods of Analysis, 7th ed. CBS Publishers, 1986.
8. Instrumental methods of chemical analysis – H. Kaur
9. Instrumental methods of chemical analysis –Willard, Merit & Dean
10. Text Book of Quantitative inorganic analysis – A.I. Vogel
11. Analytical chemistry – Walton
12. Textbook of qualitative inorganic analysis – Kolthoff and Sandel

B. Sc. Part – III Semester - V CHEMISTRY (Major)
DSE-I: DSE03CHE51: APPLIED CHEMISTRY

Theory: 30 hrs
Marks-50 (Credits: 02)

CO No.	On completion of the course, student will be able to:
CO1	Illustrate overall information regarding manufacture of fertilizers.
CO2	To understand the scintillation counter and Geiger Counter method, and range of α partials, Geiger Nuttal relation, Decay constant.
CO3	To improve the level of understanding of the techniques involve in ore dressing and extraction of cast iron from its ore are discussed.
CO4	Acquire knowledge of pharmaceuticals and its use.

Unit-I:	**Fertilizers** 1.1 General introduction, Classification of fertilizers, 1.2 Necessity and requirements of good fertilizers, 1.3 Manufacturing of the following fertilizers: Urea, calcium ammonium nitrate, ammonium phosphates, polyphosphate, triple superphosphate, compound and mixed fertilizers. 1.4 Introduction to biofertilizers.	**[8]**
Unit-II:	**Radioactivity and its Detection** 2.1 Introduction, 2.2 Detection and measurement of nuclear reactions by scintillation and Geiger Muller counter methods, 2.3 Decay constant, half-life and average life of radioactive elements, 2.4 Radioactive equilibrium and range of α-partials, 2.5 Geiger Nuttal relation,	**[7]**

	2.6 determination of radioactive constant (Decay constant), 2.7 Numerical problems.	
Unit-III:	**Iron and Steel** 3.1 Occurrence and ores of iron, 3.2 Definition of the Terms - Ore, Mineral, Slag, Flux, Gangue, Matrix, Calcinations, Reduction, Roasting, Smelting and Leaching, 3.3 Extraction of iron by Blast furnace. 3.4 Steel: Definition and types, Conversion of cast iron into steel by i) Bessemer process, ii) L.D. process, 3.5 Heat treatment on steel.	**[8]**
Unit-IV:	**A) Pharmaceuticals** 4.1 Introduction, importance, qualities of good drug, 4.2 Meaning of the terms: analgesic, antipyretic, anesthetics, antibiotics, anti-inflammatory, tranquilizer, antiallergic and cardiovascular, anti-hypertensive, anti-neoplastics sedative and hypnotics. 4.3 Synthesis and Uses: Isoniazide, benzocaine, ethambutal, **B) Retrosynthesis** 4.4 Introduction, 4.5 Terms used-Target molecule (TM), Disconnection, Synthons, Synthetic equivalence, Functional group interconversion (FGI), one group disconnection (w. r. t. suitable examples), 4.6 Retrosynthetic analysis and synthesis of Cinnamaldehyde, Cyclohexene, para methoxy acetophenone.	**[7]**

Reference Books:

1. A. I. Vogel, Textbook of Quantitative Chemical Analysis, 6th ed, Pearson Education, 2002.
2. S. M. Khopkar, Analytical Chemistry Problems and Solutions, New Age International Publishers, 2002.
3. S. M. Khopkar, Basic Concepts of Analytical Chemistry, 3rd ed, New Age International Publishers, 2008.
4. D. A. Skoog, D. M. West, F.J. Holler, Fundamentals of Analytical Chemistry, 8th ed. Philadelphia, Saunders College Publishing, 1996.
5. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, 6th ed. Philadelphia, Saunders College Publishing, 1996.
6. G. R. Chatwal and S. K. Anand: Instrumental methods of Chemical Analysis, Himalaya Publishing House.
7. H. H. Willard, L. L. Merritt and J. A. Dean; Instrumental methods of Analysis, 7th ed. CBS Publishers, 1986.
8. Instrumental methods of chemical analysis – H. Kaur
9. Instrumental methods of chemical analysis –Willard, Merit & Dean
10. Text Book of Quantitative inorganic analysis – A.I. Vogel
11. Analytical chemistry – Walton
12. Textbook of qualitative inorganic analysis – Kolthoff and Sandel

B. Sc. Part – III Semester - V CHEMISTRY (Minor)
MIN-IX: MIN03CHE51: GENERAL ASPECTS of CHEMISTRY - I

Theory: 30 hrs
Marks-50 (Credits: 02)

CO No.	On completion of the course, student will be able to:
CO1	Learn and understand photochemical laws, reactions and various photochemical phenomena.
CO2	Gain an understanding of synthesis and applications of the semiconductors and superconductors in electrical and electronic devices.
CO3	Understand basic concepts of spectroscopy.
CO4	Acquire knowledge of theoretical and practical aspects of Soil, water and fertilizers analysis.

Unit-I:	**Photophysical Chemistry** 1.1 Introduction, Difference between thermal and photochemical processes, 1.2 Laws of photochemistry: i) Grotthus-Draper law ii) Lambert law iii) Lambert– Beer's law (with derivation) iv) Stark-Einstein law, 1.3 Quantum yield, Reasons for high and low quantum yield, Factors affecting Quantum yield, 1.4 Photo sensitized reactions – Dissociation of H_2, Photosynthesis, 1.5 Examples of photochemical reactions – Photo dimerization of anthracene, decomposition of HI and HBr, 1.6 Jablonski diagram depicting various processes occurring in the excited state: Qualitative description of fluorescence and phosphorescence. 1.7 Chemiluminescence, Electroluminescence and	**08**

	Bioluminescence, Numerical problems.	
Unit-II:	**Electronic Properties of Materials** 2.1 Introduction, Properties of metallic solids, 2.2 Theories of bonding in metal: i) Free electron theory ii) 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 of semiconductors - intrinsic and extrinsic semiconductors, Applications of semiconductors, 2.5 Superconductors: Superconductivity, Meissner effect, Ceramic superconductors- Preparation and structures of mixed oxide $YBa_2Cu_3O_{7-x}$, 2.6 Applications of superconductors.	**07**
Unit-III:	**Introduction to Spectroscopy** 3.1 Meaning of spectroscopy, 3.2 Nature of electromagnetic radiation -wave length, frequency, energy, amplitude, wave number, and their relationship, different units of measurement of wavelength frequency, 3.3 different regions of electromagnetic radiations, 3.4 Interaction of radiation with matter-absorption, emission, florescence and scattering, 3.5 Types of spectroscopy and advantages of spectroscopic methods. 3.6 Energy types and energy levels of atoms and molecules. **Ultra-violet (UV) Spectroscopy:** 3.7 Introduction, Beer-Lamberts law, absorption of U.V.	**08**

	radiation by organic molecule leading to different excitation, 3.8 Terms used in U.V. Spectroscopy- Chromophore, Auxochrome, Bathochromic shift, hypsochromic shift, hyperchromic and hypochromic effect, 3.9 Modes of electromagnetic transitions. 3.10 Effect of conjugation on position of U.V. band, 3.11 Calculation of λ-max by Woodward and Fisher rules for dienes and enones systems, Colour and visible spectrum, 3.12 Applications of U.V. Spectroscopy.	
Unit-IV:	**Soil and Water Quality Assessment** **A) Soil Analysis:** 4.1 Introduction to Soil Science: Soil Composition 4.2 Importance of Soil Testing and Analysis, 4.3 Sampling of Soil 4.4 Physical Characteristics of soil: Soil texture, Porosity, color, Soil structure. 4.5 Soil parameters testing: pH, Electrical Conductivity, Soil Organic carbon (Walkey-Black Method), Available Nitrogen, Total Sulphur. **B) Water Analysis:** 4.6 Introduction, 4.7 Physical analysis of water: Conductance, Colour, odour, Turbidity, TSS and taste. 4.8 Chemical Analysis: pH, TDS, Hardness, Alkalinity, Acidity, Sulphates, Nitrates, Dissolved Oxygen, Chemical Oxygen Demand, Biological Oxygen Demand..	**07**

Reference Books:

1. A. I. Vogel, Textbook of Quantitative Chemical Analysis, 6th ed, Pearson Education, 2002.
2. S. M. Khopkar, Analytical Chemistry Problems and Solutions, New Age International Publishers, 2002.
3. S. M. Khopkar, Basic Concepts of Analytical Chemistry, 3rd ed, New Age International Publishers, 2008.
4. D. A. Skoog, D. M. West, F.J. Holler, Fundamentals of Analytical Chemistry, 8th ed. Philadelphia, Saunders College Publishing, 1996.
5. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis, 6th ed. Philadelphia, Saunders College Publishing, 1996.
6. G. R. Chatwal and S. K. Anand: Instrumental methods of Chemical Analysis, Himalaya Publishing House.
7. H. H. Willard, L. L. Merritt and J. A. Dean; Instrumental methods of Analysis, 7th ed. CBS Publishers, 1986.
8. Instrumental methods of chemical analysis – H. Kaur
9. Instrumental methods of chemical analysis –Willard, Merit & Dean
10. Text Book of Quantitative inorganic analysis – A.I. Vogel
11. Analytical chemistry – Walton
12. Textbook of qualitative inorganic analysis – Kolthoff and Sandel

B. Sc. Part – III Semester - V CHEMISTRY
DSC- PR-V: DSC03CHE59: CHEMISTRY LAB-V
Practical: Twelve hours week per batch
Marks: 75 (Credits: 06)

Physical Chemistry Practicals

Non-Instrumental Experiments

A. Chemical kinetics

1. The study of energy of activation of first order reaction i. e. hydrolysis of methyl acetate in presence of 0.5 N HCl/0.5 N H_2SO_4.
2. 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.

B. Partial molar volume

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

C. Phase Equilibria

To determine the limit of homogenous phase in the system Chloroform-acetic acid-water.

Instrumental Experiments

A. Potentiometry

1. Titration of strong acid with strong alkali.

N. B. i) 8 to 10 ml of 1 N acid solution to be given by examiner in 100 ml volumetric flask & student should dilute it to 100 ml and 10 ml 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. Determination of standard electrode potential of Zn/Zn^{++}, Cu/Cu^{++}, Ag/Ag^{+} (Any two).
3. Estimate the amount of Cl^-, Br^- and I^- in given unknown halide mixture by titrating it against standard $AgNO_3$ solution.

B. Conductometry

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

1. Titration of a mixture of weak acid and strong acid with strong alkali
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 conductometric method.

C. Colorimetry

1. To verify Lambert– Beer's law using $CuSO_4$ solution.
2. Determination of Chromium with 1,5-diphenylcarbazide colorimetrically.

D. pH metry

Determination of dissociation constant of monobasic acid (Acetic acid).

E. Refractometry

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).

F. Spectrophotometry

Determination of dissociation constant of acid by spectrophotometrically.

G. Making molecules on computer.

Inorganic Chemistry Practicals

Gravimetric Estimations: (G)

G1: Gravimetric estimation of iron as ferric oxide from the given solution containing ferrous ammonium sulphate, copper sulphate and free sulphuric 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 zinc as zinc pyrophosphate from the given solution containing zinc sulphate, ferrous ammonium sulphate and free hydrochloric acid.

Inorganic Preparations (P):

P1. Preparation of sodium cuprous thiosulphate

P2. Preparation of potassium trioxalato aluminate (III).

P3. Preparation of tris (ethylene diamine) nickel (II) thiosulphate.

P4. Preparation of tris(thiourea) cuprous sulphate.

P5. Preparation of potassium trioxalato ferrate (III).

P6. Preparation of ammonium diamine tetrathiocynatochromate (III) (Reineck's salt).

Titrimetric Estimations:

V1. Determination of percentage purity of tetrammine copper (II) sulphate.

V2. Determination of percentage purity of ferrous ammonium sulphate.

V3. Determination of percentage purity of potassium trioxalato aluminate.

V4. Determination of percentage purity of potassium trioxalato ferrate.

V5. Determination of strength of Zn+2 ions complexometrically by titrating against EDTA using xylenol orange

V6. Determination of strength of sodium chloride solution using Mohr's method.

Organic Chemistry Practicals

1. **Separation and identification of Binary Organic Mixtures: (Any Four) along with derivatives.**

i) Acid+ Phenol (Benzoic Acid + B-naphthol)

ii) Acid+ Base (Cinnamic Acid +p-nitroaniline)

iii) Acid+ Neutral (Phthalic acid +Acetanilide)

iv) Phenol+ Neutral (β-naphthol +Anthracene)

v) Phenol+ Base (β-naphthol + Acetone)

2. Preparation of Derivatives

i) Picrate derivative of β – Naphthol and anthracene.

ii) Oxalate derivative of Urea.

iii) Nitrate derivative of Urea.

3. Organic Estimations (Any Three):

i) Estimation of Sucrose. /Glucose

ii) Estimation of acid and ester present in given mixture of acid and ester.

iii) Estimation of Unsaturation

iv) Determination of equivalent weight of an ester.

4. Organic Preparations (Any Three):

Preparation of,

i) Dihydropyrimidone.

ii) Dibenzalpropanone.

iii) Hippuric acid from glycine.

iv) Ethylbenzene from acetophenone.

(Note: Any other relevant experiment may be added if required.)

Reference Books:

1) Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.

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

3) Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.

4) Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

5) Khosla, B. D.; Garg, V. C. and Gulati, A. *Senior Practical Physical Chemistry*, S. Chand & Company, New Delhi, 2011.

6) Nadkarni, Kothari and Lavande *Practical Book of Physical Chemistry*

7) Findley A., *Experimental Physical Chemistry*

8) Das, R. C., B, Behra, *Experimens in Physical Chemistry*

9) Yadav J. B. *Advance Practical Physical Chemistry*

10) Clarke *Handbook of Organic Quantitative Analysis*

11) Ahluwalia V. K., *Comprehensive Practical Organic Chemistry*

12) Kulkarni, V. S., Dastane, R. *Laboratory Handbook of Organic Qualitative Analysis and Separation*

13) Khopkar, S. M., *Basic Concepts in Analytical Chemistry*

B. Sc. Part – III Semester - V CHEMISTRY
MIN- PR-V: MIN03CHE59: MIN CHEMISTRY LAB-V
Practical: Four hours week per batch
Marks: 25 (Credits: 02)

1. Chemical kinetics

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.

2. Conductometry

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

Titration of a mixture of weak acid and strong acid with strong alkali

3. Colorimetry

To verify Lambert– Beer's law using $CuSO_4$ solution.

4. pH metry

Determination of dissociation constant of monobasic acid (Acetic acid).

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

6. Inorganic Preparation: Preparation of potassium trioxalato aluminate (III).

7. Determination of percentage purity of tetrammine copper (II) sulphate.
8. Determination of percentage purity of ferrous ammonium sulphate.
9. **Separation and identification of Binary Organic Mixtures: (Any Two)**

   Picrate derivative of β – Naphthol and anthracene.
10. Estimation of Sucrose. /Glucose
11. Determination of equivalent weight of an ester.

B. Sc. Part – III Semester - V CHEMISTRY

VSC- PR-IV: VSC03CHE59: Soil and Water Analysis

Practical: Four hours week per batch

Marks: 25 (Credits: 02)

1. Determination of Total Suspended Solids of water sample.
2. Determination of Total Dissolved Solids of water sample.
3. Determination of COD of water sample.
4. Determination of DO of water sample.
5. Determination of BOD of water sample.
6. Determination of chloride in water by Potentiometric method.
7. Determination of Moisture Content in Soil Sample.
8. Determination of pH and Electrical Conductivity of soil sample using pH meter and Conductometer.
9. Determination of Soil Organic Carbon by Walkey-Black method.
10. Determination of Available Nitrogen in Soil by alkaline permanganate method.
11. Determination of Water holding capacity of soil sample.
12. Determination of available Phosphorous by Colorimeter (Olsen's Method)
13. Determination of ca in Soil by ammonium oxalate-ammonium chloride method.

References:

- Handbook of Agriculture – ICAR Publications
- Practical Agricultural Chemistry by S. L. Chopra
- FSSAI Manual of Water Analysis, Govt of India

B. Sc. Part – III Semester - V CHEMISTRY

FP: Field Project

Practical: Four hours per week per batch

Marks: 25 (Credits: 02)

The National Education Policy (NEP) 2020 emphasizes experiential learning, practical exposure, and interdisciplinary understanding to enhance student competence and societal relevance. As part of this vision, a Field Project is introduced at the undergraduate level, especially in the third year (fifth semester) of the B.Sc. program. This component aims to integrate academic learning with real-world applications through field-based investigations and community engagement.

Objectives of the Field Project:

- To promote hands-on learning and scientific thinking.
- To expose students to real-life environmental, industrial, or societal problems.
- To develop research, observation, data collection, and report writing skills.
- To enhance teamwork, communication, and ethical responsibility.

Nature of the Project:

- Students may undertake field projects individually or in small groups.
- The project should relate to the chemistry
-

Some suggested Areas of Field Project

- Environmental analysis (e.g., water, soil, or air testing; pollution studies).
- Industrial visits and chemical process documentation.
- Study of effluents and waste management in local industries.

- Analysis of agricultural soil and fertilizer content.
- Extraction and application of natural dyes from plants.
- Survey of medicinal plants and basic phytochemical analysis.
- Corrosion studies in local infrastructure.
- Analysis of chemical content in consumer products (soaps, detergents, food, etc.)
- Study of green chemistry practices in industry or institutions.
- Study of food adulterants using simple chemical tests.
- Monitoring chemical safety and waste disposal practices in labs or industries.

Methodology:

- Proposal Preparation: Selection of topic with objectives and methodology.
- Field Work: Data/sample collection, interviews, surveys, observation.
- Analysis: Compilation, analysis, and interpretation of collected data.
- Report Writing: Structured report with introduction, methods, results, and conclusions.
- Presentation: Oral/poster presentation before a departmental committee.

Evaluation Criteria:

Sr. No.	Parameters	Marks distribution	
		UG students (2 credit course) For 25 Marks	UG students (2 credit course) For 50 Marks
1	Problem finding (समस्या शोधणे)	3	5
2	data collection (डेटा संग्रह)	3	5
3	implementing solutions to actual problems (वास्तविक समस्यांवर उपाय योजना राबवणे)	10	20
4	Quality and effectiveness of presentation (सादरीकरणाची गुणवता आणि परिणामकारकता)	5	10
5	Field Project Report (क्षेत्र प्रकल्प अहवाल)	4	10
	Total marks	25	50

Credit structure & Duration:

Field Project shall be for 2 credits, i.e. **45 hours**. **1 credit shall be reserved for Classroom sessions (15 hours)** and **1 credit (30 hours) for Field Engagement.** It shall be compulsory for all students.

B. Sc. Part – III Semester - VI CHEMISTRY

DSC-XII: DSC03CHE61: PHYSICAL CHEMISTRY

Theory: 30 hrs.

Marks-50 (Credits: 02)

CO No.	On completion of the course, student will be able to:
CO1	Acquire knowledge about basic concept of adsorption, types of adsorptions, Freundlich, Langmuir adsorption isotherm, BET equation
CO2	Acquire knowledge about basic concept of Thermodynamics, free energy, Gibbs-Helmholtz equation and its applications, problem related with it.
CO3	Learn and understanding Space lattice, lattice sites, Lattice planes, Unit cell, Laws of crystallography, Weiss indices and Miller indices, Cubic lattices and types of cubic lattice, planes or faces of a simple cubic system, Diffraction of X rays, Derivation of Bragg's equation. Determination of crystal structure by Bragg's method, crystal structure of NaCl and KCl on the basis of Bragg's equation
CO4	Learning of kinetics, Simultaneous reactions such as i) opposing reaction ii) side reaction iii) consecutive reactions iv) chain reaction v) explosive reaction

Unit-I:	**Adsorption** 1.1 Introduction, Adsorption as a surface phenomenon (mechanism), 1.2 Definition of important basic terms: absorption, adsorption, adsorbant, adsorbate, interface etc., 1.3 Distinction between adsorption and absorption, 1.4 Characteristics of adsorption, Factors affecting adsorption, Types of adsorption, 1.5 Distinction between physical adsorption and chemical adsorption, 1.6 Adsorption isotherms: Freundlich, Langmuir adsorption isotherm, BET equation (derivation not expected), determination	**[7]**

	of surface area using Langmuir method and BET equations.	
Unit-II:	**Thermodynamics** 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. 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.	**[8]**
Unit-III:	**The Solid State** 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.	**[7]**

Unit-IV:	**Chemical Kinetics** 4.1 Introduction 4.2 Third Order Reaction –Derivation of rate constant, properties, examples 4.3 Steady state approximation (Statement, one example) 4.4 Simultaneous reactions such as i. Opposing or reversible or counter reaction: (Derivation of rate equation for first order opposed by first order expected) ii. Side reaction or parallel reactions (Derivation expected). iii. Consecutive or successive reactions (Derivation not expected).	**[8]**

Reference Books

1. P.W. Atkins, The Elements of Physical Chemistry: 4th ed. Oxford University Press, 2005.
2. G.M. Barrow, Physical Chemistry: 6th Ed, Tata McGraw Hill Publishing Co. Ltd., 2008.
3. G.K. Vemulapalli, Physical Chemistry: Prentice Hall of India Pvt. Ltd., 2009.
4. G.W. Castellan, Physical Chemistry: 3rd ed., Narosa Publishing House, 2004.
5. S. Glasstone, Text Book of Physical Chemistry, 2nd ed, Affiliated East West press Pvt. Ltd., New Delhi.
6. K.J. Laidler and J.H. Meiser, Physical Chemistry: 2nd ed. CBS, First Indian ed.1999.
7. S. Glasstone, Thermodynamics for Chemist: Affiliated East-West Press Pvt. Ltd., New Delhi.
8. Ira N. Levine, Physical Chemistry: 6th ed., Tata McGraw Hill, Inc., 2011.
9. Reisman Arnold, Phase equilibria–Edited by Ernest M. Loebe, New York and London

Academic Press.

10. F.D. Ferguson and P.K. Jones, Phase Rule: (Butter worth Publisher).
11. J.N. Murrell and E.A. Boucher, Properties of Liquids and Solution: Wiley, 1982.
12. D.K. Chakravarty, Adsorption and Catalysis, Oxford Publishers.1985
13. D.J. Shaw, Introduction to Colloid and Interface Science: Butterworth and Co., 1981.
14. D.H. Everett, Basic Principles of Colloid Science: Royal Society of Chemistry, 1988.
15. Thomas J.M. and Thomas W.J. Introduction to Principles of Heterogeneous Catalysis: VCH Publishers, New York, 2008.
16. Fried lander, Kennedy and Joseph W., Nuclear and Radiochemistry–John Wiley & Sons, NewYork, 1955.
17. Arnikar H.J., Essentials of Nuclear Chemistry: 4th ed, New Age International Ltd., Publishers, New Delhi.1955.
18. Principles of Adsorption and Adsorption Processes Douglas M. Ruthven John Wiley & Sons – 1984 - Technology & Engineering
19. Adsorption: Fundamental Processes and Applications Mehrorang Ghaedi Ghaedi Academic Press19 - Mar-2021-Science-728
20. An Introduction to Radioactivity by Richard Laws on, Introduction to Radioactivity Page R.S. Laws on October 1999.

B. Sc. Part – III Semester - VI CHEMISTRY
DSC-XIII: DSC03CHE62: INORGANIC CHEMISTRY
Theory: 30 hrs.
Marks-50 (Credits: 02)

CO No.	On completion of the course, student will be able to:
CO1	Study the important aspects of the mechanism of the reactions involved in inorganic complexes of transition metals.
CO2	Impart essential knowledge about various nuclear reactions and its applications.
CO3	Gain essential knowledge in students regarding the characteristics, properties and separation of lanthanides and Actinides are discussed. Also, Synthesis and IUPAC Nomenclature of transuranic elements (TU) explained.
CO4	To give the students a thorough knowledge of role of various metals and nonmetals in our health are discussed.

Unit-I:	**Inorganic Reaction mechanism –** 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.	**[8]**
Unit-II:	**Nuclear Chemistry** 2.1 Nuclear reactions and energetic of nuclear reactions, 2.2 Types of nuclear reactions: i) Artificial transmutation ii)	**[7]**

	Artificial radioactivity iii) Nuclear fission and its application in Heavy water nuclear reactor iv) Nuclear fusion, 2.3 Applications of radio-isotopes as tracers: i) Chemical Investigation-Esterification ii) Structural Determination-Phosphorus pentachloride iii) Analytical Chemistry-Isotopic dilution method for determination of volume of blood iv) Age determination - Dating by C^{14}.	
Unit-III:	**Chemistry of f-Block Elements** **(A) Lanthanides** 3.1 Introduction, Occurrence, 3.2 Electronic Configuration, Oxidation State, 3.3 Lanthanide contraction, 3.4 Separation of Lanthanides by Ion exchange method. **(B) Actinides** 3.5 Position in periodic table, 3.6 Electronic configuration, 3.7 General methods of preparation of transuranic elements - i. Neutron capture - followed by β decay, ii. Accelerated projectile bombardment, iii. Heavy ion bombardment, 3.8 IUPAC nomenclature of the super heavy elements with atomic number (Z) greater than 100.	**[8]**
Unit-IV:	**Bio-inorganic Chemistry** 4.1 Introduction, 4.2 Essential and trace elements in biological process, 4.3 Metalloporphyrins with special reference to hemoglobin and myoglobin, 4.4 Role of metal ions present in biological systems with special	**[7]**

	reference to Na+, K+, Mg2+ and Ca2+ ions, 4.5 Na/K pump, 4.6 Role of Mg2+ ions in energy production and chlorophyll, Role of Ca2+ in blood clotting	

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. LangFord, Oxford University Press, 2nd Edition.
3. Basic Inorganic Chemistry: Cotton and Wilkinson.
4. Advanced Inorganic Chemistry (4th Edn.) 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.
16. Inorganic Chemistry 3rd edn G. L. Miessler and D.A. Tarr, pearson publication
17. Co-ordination compounds by Baselo and Pearson.
18. UGC Inorganic chemistry by H.C. Khera, Pragati prakashan
19. UGC Advance Inorganic Chemistry by Agarwal and Keemtilal, Pragati Prakashan

B. Sc. Part – III Semester - VI CHEMISTRY
DSC-XIV: DSC03CHE63: ORGANIC CHEMISTRY
Theory: 30 hrs.
Marks-50 (Credits: 02)

CO No.	On completion of the course, student will be able to:
CO1	Learn the mechanism of different organic name reactions and to become confident to solve the problems based on the reactions.
CO2	Adopt the utility of reagents in organic synthesis.
CO3	Understand the fundamentals of terpenoids and alkaloids.
CO4	Illustrate the applications of nucleophilic substitution reactions of aromatic compounds.

Unit-I:	**Name Reactions** 1.1 Beckmann, Benzilicacid, Baeyer Villiger, Diels-Alder reaction, Mannich Reaction, Michael Reaction, Fries, Dienone-Phenol rearrangement, 1.2 Problems based on reactions.	
Unit-II:	**Synthetic Reagents** 2.1 DDQ, OsO_4, N-bromo succinamide, Zn-Hg, DCC, $LiAlH_4$, CAN, Raney Ni, Diazomethane.	**[7]**
Unit-III:	**Natural product** **A) Terpenoid** 3.1 Introduction, Occurrence, Isolation, 3.2 General Characteristics, 3.3 Classification, 3.4 General Methods for structure determinations, 3.5 Isoprene rule,	**[8]**

	3.6 Analytical evidences and synthesis of Citral. **B) Alkaloids** 3.7 Introduction, Occurrence, Isolation, 3.8 Classification, Properties, 3.9 General Methods for structure determinations, 3.10 Analytical evidences and synthesis of Nicotine.	
Unit-IV:	**Electrophilic addition to >C=C< and −C≡C− bonds** **A) Addition to Carbon-Carbon double (>C=CC=C< bond)** 4.1 Introduction 4.2 Examples of addition reactions. 4.3 **Mechanism of electrophilic addition to >C=C< bond,** Orientation & reactivity for following reactions i. Hydrohalogenation. ii. Anti-Markovnikoff's addition (peroxide effect). iii. Rearrangements (support for formation of carbocation). iv. Addition of halogens. v. Addition of water. vi. Addition of hypohalous acids (HO-X). vii. Hydroxylation (formation of 1, A2-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:** 4.4 Introduction 4.5 Examples of addition reactions 4.6 **Mechanism of electrophilic addition to−C≡C−bond** Orientation & reactivity for following reactions	**[7]**

	i. Addition of halogens ii. Addition of halogen acids. iii. Addition of hydrogen. iv. Addition of water. v. Formation of metal acetylides.	

Reference Books:

1. Advanced Organic Chemistry: Reactions, Mechanisms and structure by-Jerry March.
2. Reagents for Organic Synthesis by Louis F. Fieser, Mary Fieser -1967.
3. Mechanism and Structure in Organic Chemistry. April, 1963 By Edwin S. Gould.
4. A text book of Organic Chemistry by Arun Bahl, B. S. Bhal Eighteenth Revised edition 2006.
5. A guidebook to mechanism in Organic Chemistry sixth Edition by Peter Syke.
6. Organic Synthesis: The Disconnection Approach by Stuart Warren.
7. Organic Synthesis Through Disconnection Approach by P. S. Kalsi
8. Fundamentals of Organic Synthesis the Retrosynthetic Analysis by Ratan Kumar Kar
9. Organic Reactions and Their Mechanisms P. S. Kalsi 3rd Revised edition.
10. Advanced organic Chemistry by B.S. Bahl & Arun Bhal (Reprint in 1997)
11. Organic Chemistry by Morrison and Boyd 6th edition.
12. Organic Chemistry Vol II Stereochemistry and the Chemistry of Natural Products (5th ed) by I. Linear.
13. Organic Chemistry Natural Products Vol I, by O. P. Agrawal
14. Industrial Chemistry-B.K. Sharma, Goyal publishing house, Mirut
15. Shreeves chemical process industries 5th Edition, G.T. Oustin, McGrawHill
16. Riegel`s hand book of Industrial chemistry, 9th Edition, JemsA.Kent
17. Industrial chemistry –R.K. Das, 2nd Edition, 1976

B. Sc. Part – III Semester - VI CHEMISTRY
DSE-II: DSE03CHE61: INDUSTRIAL CHEMISTRY
Theory: 30 hrs.
Marks-50 (Credits: 02)

CO No.	On completion of the course, student will be able to:
CO1	Understand the basics of industrial chemistry.
CO2	Learn the manufacturing processes of heavy chemicals.
CO3	Acquire knowledge of sugar and jaggery industry.
CO4	Gain and understand fermentation processes involved in manufacturing of alcohol.

Unit-I:	**Green Chemistry** 1.1 Introduction 1.2 Twelve principles of green chemistry 1.3 Goals of green chemistry, 1.4 Green chemicals: Green reagents, green catalyst, green solvents, 1.5 Green organic synthesis: Use of Zeolites, Natural catalysts, Biocatalysts, 1.6 Emerging green technologies: Microwave chemistry, Sonochemistry, Photochemistry, Electrochemistry, Mechanochemistry, 1.7 Green synthesis: Polycarbonate, Carbaryl pesticide, Ibuprofen.	**[8]**
Unit-II:	**Manufacturing of Heavy Chemicals** 2.1 Introduction 2.2 Manufacturing of NH_3 by Haber–Bosch process, Physico-chemical principles involved and uses of NH_3 2.3 Manufacturing of H_2SO_4 by contact process, Physicochemical	**[7]**

	principles involved, and uses of H_2SO_4. 2.4 Manufacturing of HNO_3 by Ostwald`s process, Physicochemical principles involved and uses of HNO_3.	
Unit-III:	**Manufacturing of Sugar and Jaggery** **A) Sugar:** 3.1 Introduction and Importance of sugar industry 3.2 Manufacturing of cane sugar: raw material, Extraction Clarification and Concentration of cane juice, Crystallization of sucrose, Centrifugation 3.3 Refining of cane sugar 3.4 Utilization of by-products of sugar industries. **B) Jaggery:** 3.5 Composition of Jaggery, Forms of jaggery, 3.6 Production process of jaggery 3.7 Analysis of Jaggery - Moisture content, pH, reducing and non- reducing sugar, color.	**[8]**
Unit-IV:	**Fermentation Industry** 4.1 Introduction and importance of fermentation industry 4.2 Basic requirement of fermentation process, 4.3 Factors favoring fermentation, fermentation operations. 4.4 Manufacturing of Industrial alcohol (Ethyl alcohol) from a) Molasses b) Food grains, c) manufacturing of alcohol from fruits (wine). 4.5 Grades of alcohols: Silence spirit, rectified spirit, absolute alcohol, proof spirit, denatured spirit, duty and duty free alcohol. 4.6 Importance of power alcohol as fuel.	**[7]**

Reference Books:

1. Industrial Chemistry - B. K. Sharma
2. Chemical process industries – Shrieve & Brink
3. Industrial chemistry – Kent
4. Industrial chemistry – Rogers
5. Industrial chemistry – R.K. Das
6. Mechanical chemistry – Burger
7. Nanotechnology: Principles and Practices –Sulbha Kulkarni
8. The Petroleum chemicals industry by R.F. Goldstine, & London
9. Fundamentals of petroleum chemical technology by P Below.
10. Petrochemicals Volume 1 and 2; A Chauvel and Lefevrev; Gulf Publishing company

B. Sc. Part – III Semester - VI CHEMISTRY
DSE-II: DSE03CHE62: Computer Tools in Chemistry
Theory: 30 hrs.
Marks-50 (Credits: 02)

CO No.	On completion of the course, student will be able to:
CO1	Develop proficiency in MS Office tools (Word, Excel, Power Point) for scientific documentation and analysis.
CO2	Enable students to prepare lab reports, research papers, and presentations.
CO3	Introduce data visualization and statistical analysis using MS Excel.
CO4	Enhance digital literacy and productivity in academic and research work.

Unit-I:	**Introduction to MS Office and MS Word** 1.1 Introduction: Overview of MS Office Suite (Word, Excel, PowerPoint, Outlook), 1.2 Importance of MS Office for Chemistry students, 1.3 Basics of file management (saving, exporting, sharing); 1.4 MS Word- Scientific Documentation: Creating & Formatting Chemistry Lab Reports, Inserting Tables, Images, and Chemical Equations, Citations and References (Using Mendeley/Zotero with Word), Table of Contents, Indexing, and Cross-Referencing, Templates for Thesis, Research Papers, and Assignments	**[7]**
Unit-II:	**Introduction to MS Excel – Data Handling & Analysis** 2.1 Basics of Spreadsheets (Cells, Formulas, Formatting), 2.2 Data Entry and Validation 2.3 Basic Statistical Functions (Mean, Median, Standard Deviation), Graphs & Charts (Bar, Line, Scatter Plots for Chemistry Data), Using Excel for Titration Calculations, Chemical Kinetics, and Stoichiometry, Trendline and Regression Analysis for Experimental Data, Pivot Tables for Data Organization	**[7]**
Unit-III:	**MS PowerPoint – Scientific Presentations** 3.1 Designing Effective Chemistry Presentations, Using Themes, Layouts, and SmartArt for Scientific Communication, Inserting Chemical Structures & Spectroscopy Data, 3.2 Animations and Transitions for Scientific Explanation, 3.3 Presenting Research, Findings & Poster Presentations	**[8]**

Unit-IV:	**Softwares for Chemistry** 4.1 Introduction to Chemdraw, Chemdoodle, 4.2 Marvinsketch, Origin, MestreNova, XRD Software, 4.3 Writing tools: Grammarly, Answerthepublic, Quillbot, Notion, Buzzsumo, Copyscape, Chatgpt, ginger. Referencing and citation tools: Endnote, Mendeley, Jabref, Zotero.	**[9]**

References

1. Microsoft Office 365: In Practice – Randy Nordell
2. The Craft of Scientific Writing – Michael Alley
3. Data Analysis with Microsoft Excel – Kenneth N. Berk & Patrick Carey
4. Presentation Zen – Garr Reynolds
5. ChemDraw User Guide – PerkinElmer
6. Mendeley – https://www.mendeley.com/

B. Sc. Part – III Semester – VI (NEP 1.0) CHEMISTRY (Minor)
MIN-X: MIN03CHE61: GENERAL ASPECTS of CHEMISTRY-II

Theory: 30 hrs
Marks-50 (Credits: 02)

CO No.	On completion of the course, student will be able to:
CO1	Acquire knowledge about basic concept of adsorption, types of adsorptions, Freundlich, Langmuir adsorption isotherm, BET equation
CO2	Impart essential knowledge in students regarding the various nuclear reactions and their applications.
CO3	Acquire knowledge of pharmaceuticals and its use.
CO4	Understand the basics of industrial chemistry.

Unit-I:	**Surface Chemistry** 1.1 Introduction 1.2 Adsorption as a surface phenomenon (mechanism), 1.3 Definition of important basic terms: absorption, adsorption, adsorbent, adsorbate, interface etc., 1.4 Distinction between adsorption and absorption, 1.5 Characteristics of adsorption, 1.6 Factors affecting adsorption, 1.7 Types of adsorptions, 1.8 Distinction between physical adsorption and chemical adsorption, 1.9 Adsorption isotherms: Freundlich, Langmuir adsorption isotherm, BET equation (derivation not expected), 1.10 Determination of surface area using Langmuir method and BET equations.	**[7]**

Unit-II:	**Fundamentals of Nuclear Science** 2.1 Introduction 2.2 Nuclear reactions and energetics of nuclear reactions, 2.3 Types of nuclear reactions: i) Artificial transmutation ii) Artificial radioactivity iii) Nuclear fission and its application in Heavy water nuclear reactor iv) Nuclear fusion, 2.4 Applications of radio-isotopes as tracers: i) Chemical investigation-Esterification ii) Structural determination-Phosphorus pentachloride iii) Analytical Chemistry-Isotopic dilution method for determination of volume of blood iv) Age determination - Dating by C^{14}.	**[8]**
Unit-III:	**Pharmaceutical Chemistry** 3.1 Introduction, importance, 3.2 Qualities of good drug 3.3 Classification of Drugs: analgesic, antipyretic, anesthetics, antibiotics, anti-inflammatory, tranquilizer, antialargic and cardiovascular, anti hypertensive, anti-neoplastics sedative and hypnotics. 3.4 Synthesis of Isoniazide	**[7]**
Unit-IV:	**Fundamentals of Green Chemistry** 4.1 Introduction, 4.2 Twelve principles of green chemistry, 4.3 Goals of green chemistry, 4.4 Green chemicals - Green reagents, green catalyst, green solvents, 4.5 Green organic synthesis - Use of Zeolites, Biocatalysts 4.6 Emerging green technologies-Microwave chemistry,	**[8]**

	Sonochemistry, Photochemistry, Mechanochemistry	

Reference Books:

1. Industrial Chemistry - B. K. Sharma
2. Chemical process industries – Shrieve & Brink
3. Industrial chemistry – Kent
4. Industrial chemistry – Rogers
5. Industrial chemistry – R.K. Das
6. Mechanical chemistry – Burger
7. Nanotechnology: Principles and Practices –Sulbha Kulkarni
8. The Petroleum chemicals industry by R.F. Goldstine, & London
9. Fundamentals of petroleum chemical technology by P Below.
10. Petrochemicals Volume 1 and 2; A Chauvel and Lefevrev; Gulf Publishing company

B. Sc. Part – III Semester - VI CHEMISTRY
DSC- PR-VI: DSC03CHE69: CHEMISTRY LAB-VI
Practical: Twelve hours week per batch
Marks: 75 (Credits: 06)

Physical Chemistry Practicals

Non-Instrumental Experiments

A. Chemical kinetics

1. The study of energy of activation of second order reaction i.e. reaction between $K_2S_2O_8$ and KI (Unequal concentrations).
2. The study of Effect of addition of electrolyte (NaCl or KCl) on reaction between second order reaction i.e. reaction between $K_2S_2O_8$ and KI (Equal concentrations).

B. Solubility.

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

C. Phase Equilibria

Construction of the Phase diagram of two component system-Diphenyl amine-benzophenone by cooling curve method and hence determination of eutectic temperature and eutectic composition.

D. Adsorption : Investigate the adsorption of oxalic acid by actvate dcharcoal and test the validity of Freundlich isotherms.

Instrumental Experiments

D. Potentiometry (Any two)

1. To prepare buffer solutions and determination of their pH (Any five buffer solutions), Theoretical calculation of pH values by using Henderson's equation.
2. Titration of ferrous ammonium sulphate using $K_2Cr_2O_7$ solution and to calculate redox potential of Fe^{++}, Fe^{+++}system.
3. Determination the activity coefficients of silver ions using concentration cell without transference potentiometrically.

E. Conductometry (Any Two)

1. To determine the normality of citric acid in lemon by titrating it against standard 0.2 N NaOH solution by conductometric method.
2. To investigate complexometric titration by conductometric method.
3. To determine λ_∞ of strong electrolyte (NaCl or KCl) and to verify Onsager equation.
4. Determine thermodynamic dissociation constant of weak acid by conductivity measurements.

F. Colorimetry

1. To estimate of Fe^{+++} ions by thiocyanate method.
2. Determination of phosphate in natural water colorimetrically.

G. pH metry

Determination of dissociation constant of Dibasic acid (Oxalic acid).

H. Polarimetry

To determine specific rotation of glucose polarimetrically.

I. Refractometry

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.

J. Nephelometry

To determine the turbidity of given solution by using nephelometry.

Inorganic Chemistry Practicals

1. Gravimetric Estimation: (G):

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

G2. Gravimetric estimation of aluminum as aluminum oxinate in a given solution using oxine (8-hydroxyquinoline).

G3. Gravimetric estimation of barium as barium chromate from the given solution containing barium chloride, ferric chloride and free hydrochloric acid.

2. Ion exchange method:

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

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

3. Inorganic Preparations (P):

P1. Preparation of chrome alum.

P2. Preparation of tetraammine carbonato cobalt (III) nitrate.

P3. Preparation of potassium dioxalatodiaqua chromate (III).

P4. Preparation of potassium dioxalato copper (II).

P5. Preparation of zinc oxide (ZnO).

4. Analysis of Commercial Samples:

V1. Determination of amount of aluminum in the given solution of potash alum.

V2. Determination of titratable acidity in the given sample of lassi.

V3. Determination of percentage purity of boric acid using supplied sodium hydroxide.

V4. To determine the strength of Ca2+ ions present in the given milk sample by EDTA back titration.

Organic Chemistry Practicals

1. **Separation and identification of Binary Organic Mixtures: (Any Four) along with derivatives.**
   - **i) Acid +Neutral (Phthalic acid +Acetone)**
   - **ii) Neutral + Neutral (Acetanilide +ethyl acetate)**
   - **iii) Base + Neutral (Aniline + Chloroform)**
   - **iv) Base + Neutral (Aniline + ethyl acetate)**
   - **v) Neutral + Neutral (Nitrobenzene+ acetone)**
2. **Preparation of Derivatives**
   - i) Iodoform derivative of Acetone
   - ii) 2:4 DNP derivative of Acetaldehyde
   - iii) m-Dinitrobenzene from Nitrobenzene
3. **Organic Estimations (Any Three):**
   - i) Estimation of Nitro group.
   - ii) Saponification value of Oil.
   - iii) Estimation of drug (Isoniazide/Ibuprofen).
   - iv) Determination of molecular weight of acid
4. **Organic Preparations: Any three.**

   Preparation of
   - i) Benzilic acid.
   - ii) 1,1-Bis 2 naphthol
   - iii) Adduct by Diel's Alder reaction between furan and maleic acid.
   - iv) Methyl phenyl sulfone (oxidation reaction)

   (Note: Any other relevant experiment may be added if required.)

Reference Books:

1) Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.

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

3) Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.

4) Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.

5) Khosla, B. D.; Garg, V. C. and Gulati, A. *Senior Practical Physical Chemistry*, S. Chand & Company, New Delhi, 2011.

6) Nadkarni, Kothari and Lavande *Practical Book of Physical Chemistry*

7) Findley A., *Experimental Physical Chemistry*

8) Das, R. C., B, Behra, *Experimens in Physical Chemistry*

9) Yadav J. B. *Advance Practical Physical Chemistry*

10) Clarke *Handbook of Organic Quantitative Analysis*

11) Ahluvalia V. K., *Comprehensive Practical Organic Chemistry*

12) Kulkarni, V. S., Dastane, R. *Laboratory Handbook of Organic Qualitative Analysis and Separation*

13) Khopkar, S. M., *Basic Concepts in Analytical Chemistry*

B. Sc. Part – III Semester - VI CHEMISTRY
MIN- PR-VI: MIN03CHE69: MIN CHEMISTRY LAB-V
Practical: Four hours week per batch
Marks: 25 (Credits: 02)

1. Separation and identification of Binary Organic Mixtures: (Any Two) along with derivatives.
   a. Iodoform derivative of Acetone.
   b. 2:4 DNP derivative of Acetaldehyde.
2. Estimation of Nitro group.
3. Determination of molecular weight of acid
4. Gravimetric estimation of iron as ferric oxide from the given solution containing ferrous ammonium sulphate, copper sulphate and free sulphuric acid.
5. Preparation of chrome alum.
6. Determination of amount of aluminum in the given solution of potash alum.
7. Determination of titratable acidity in the given sample of lassi.
8. Chemical Kinetics: The study of Effect of addition of electrolyte (NaCl or KCl) on reaction between second order reaction i.e. reaction between $K_2S_2O_8$ and KI (Equal concentrations).
9. Solubility: To study the effect of addition of electrolyte (NaCl or KCl) on the solubility of Benzoic acid at room temperature.
10. Colorimetry: To estimate of Fe^{+++} ions by thiocyanate method.
11. Conductometry: To determine the normality of citric acid in lemon by titrating it against standard 0.2 N NaOH solution by conductometric method.

B. Sc. Part – III Semester - VI CHEMISTRY
VSC- PR-V: VSC03CHE69: Food Analysis
Practical: Four hours week per batch
Marks: 25 (Credits: 02)

CO No.	On completion of the course, student will be able to:
CO1	Understand the various forms and causes of food adulteration, including mixing, substitution, and misbranding.
CO2	Recognize the health risks associated with adulterated food products.
CO3	Interpret experimental data to assess the purity and quality of food samples.
CO4	Understand the ethical implications of food adulteration and the importance of maintaining food integrity.

1. Preparation of different buffer solutions.
2. Determination of viscosity of different food samples
3. Analysis of different food dyes or pigments.
4. Determination of reducing and non-reducing sugars from different food samples.
5. Qualitative detection of adulterants in Atta, Maida, Besan, Biscuit, Black pepper, Butter, Ghee, Chilli, Powder, Honey, Tea, Turmeric Powder, and soft drinks.
6. Test for adulterants in Sugar, Jaggery, Honey, Milk, Ghee, plantation Crops (Tea, coffee), Turmeric, and spices (Cardamom, cloves, pepper).
7. Determination of Vitamin C by titration method.
8. Determination of Ash and Acid insoluble ash of Turmeric.
9. Determination of alkalinity of food samples i. e. Tea and coffee
10. Determination of the total hardness of different market samples

11. Determination of casein from different milk samples.

12. Estimation of starch

13. Visits to different analytical field laboratories, exhibitions, conferences, workshops, etc.

References:

FSSAI Manual of Food Analysis, Govt of India.

B. Sc. Part – III Semester - VI CHEMISTRY
OJT: On Job Training
Practical: Four hours week per batch
Marks: 25 (Credits: 02)

As per NEP 2020, On-the-Job Training (OJT) is designed to help B.Sc. Chemistry students connect theoretical knowledge with practical applications. Through hands-on experience in industries, research labs, quality control units, or environmental testing centers, students gain real-world exposure.

OJT enhances understanding of chemical processes, instrumentation, safety practices, and industrial standards. It develops practical skills, problem-solving ability, and prepares students for careers in chemical, pharmaceutical, or allied sectors.

Duration:

Credits	Training Duration	Preparation & write up duration	Total duration	Schedule	Activities
2	**60 hours:** 1. 8-days (7.5 hours per day) OR 2. 10-days(6 hours per day) OR 3. 15-days (4 hours per day)	**15 hours**	**75 hours**	After 5th Semester	Industrial/ Govt./ NGO/MSME/ Rural Internship/ Innovation / Entre-preneurship

Evaluation of OJT:

Sr. No.	Parameters	Marks distribution			
		UG students (2 credit course) for 25 marks		UG students (2 credit course) for 50 marks	
		Maximum Marks	Marks obtained	Maximum Marks	Marks obtained
1	Quality and effectiveness of presentation (सादरीकरणाची गुणवत्ता आणि परिणामकारकता)	5		5	
2	Depth of knowledge and demonstrated skills (ज्ञानाची खोली आणि प्रात्यक्षिक कौशल्ये)	5		5	
3	Variety and relevance of learning experience (शिकण्याच्या अनुभवाची विविधता आणि प्रासंगिकता)	5		15	
4	Practical applications and relationships with concepts taught in the course (अभ्यासक्रमात शिकवलेल्या संकल्पनांशी व्यावहारिक अनुप्रयोग आणि संबंध)	-		5	
5	Internship Report (इंटर्नशिप रिपोर्ट)	5		10	
6	Attendance record, student log, supervisor evaluation (उपस्थितीची नोंद, विद्यार्थी लॉग, पर्यवेक्षक मूल्यमापन)	5		10	
	Total marks	**25**		**50**	

Overall grade: _____

Scheme of teaching and examination

- The semester examination will be conducted at the end of each term (both theory and practical examination)
- Theory paper will be of 40 marks each and 10 marks for internal evaluation (CIE) i.e.

Oral/Seminar/Test/ Assignment conducted in the mid of the term. One practical will be of 25 marks.

- Question papers will be set in the view of the entire syllabus and preferably covering each unit of the syllabus. Marks allotted to questions should be in proportion to the lectures allotted to respective units.
- The duration of each theory paper for the examination will be of 2 hours.
- Sem-V Field project work and Sem- VI On job Training for 50 marks.

Nature of Practical Examination

The practical examination will be 75 marks. The distribution of marks will be as follows: Each Section has 25 marks. The duration of practical examination will be of two days- six and half hours per day.

Seat No.	

Ques. paper code	

VIVEKANAND COLLEGE, KOLHAPUR
(EMPOWERED AUTONOMOUS)

B.Sc. Part- III (Chemistry) (Semester-V/VI) Examination……..

Course Code and Name: DSC03CHE11: Inorganic Chemistry

Day: Time: 2 hours

Date: --/--/---- Marks : 40

Instructions:

1) All the questions are compulsory.
2) Figures to the right indicate full marks.
3) Draw neat labelled diagrams wherever necessary.
4) Use of log table/calculator is allowed.

Q. 1. Select correct alternative (One mark each): [8]

i) Xyzabcdefghijklmnop ----------

a) -------- b) -------- c) -------- d) --------

ii) Xyzabcdefghijklmnop ----------

a) -------- b) -------- c) -------- d) --------

iii) Xyzabcdefghijklmnop ----------

a) -------- b) -------- c) -------- d) --------

iv) Xyzabcdefghijklmnop ----------

a) -------- b) -------- c) -------- d) --------

v) Xyzabcdefghijklmnop ----------

a) -------- b) -------- c) -------- d) --------

vi) Xyzabcdefghijklmnop ----------

a) -------- b) -------- c) -------- d) --------

vii) Xyzabcdefghijklmnop ----------

a) -------- b) -------- c) -------- d) --------

viii) Xyzabcdefghijklmnop ----------

a) -------- b) -------- c) -------- d) --------

Q.2. Attempt any TWO (Eight marks each): [16]

i) Xyzabcdefghijklmnop.

ii) Xyzabcdefghijklmnop.

iii) Xyzabcdefghijklmnop.

Q.3. Attempt any FOUR (Four marks each): [16]

i) Xyzabcdefghijklmnop.

ii) Xyzabcdefghijklmnop.

iii) Xyzabcdefghijklmnop.

iv) Xyzabcdefghijklmnop.

v) Xyzabcdefghijklmnop.

vi) Xyzabcdefghijklmnop.

Evaluation Pattern for practical Course:

Marks Distribution of Practical (LAB) course: Total Marks: 25

Course	Experimental work	Journal assessment	Seminar/ Mini Project	Total Marks
Major	60	15	-	75
Minor	20	05	-	25
VSC	20	05	-	25
FP/OJT	-	-	50	50

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

Dr. (Mrs). S, D, Shirke
HEAD
DEPARTMENT OF CHEMISTRY
VIVEKANAND COLLEGE, KOLHAPUR
(EMPOWERED AUTONOMOUS)

COs for Practicals in chemistry

1. Understand the principles of GLP and safety in the laboratory.
2. Interpret the safety data sheets to categorize chemicals according to their hazards.
3. Enhance their overall knowledge of handling Glassware and apparatus used in the laboratory.
4. Enhance their overall skills of preparation of various reagents used in the laboratory.
5. Gain the knowledge of preparation and standardization of solutions.
6. Gain knowledge of separation techniques.
7. Enhance their knowledge of the calibration of instruments.
8. Enhance their knowledge of maintenance of electrodes and equipment.
9. Understand the concepts, principles, theories and practical applications of Chemistry
10. Understand the simple techniques of synthesis and analysis
11. Gain basic knowledge of instruments to be used for analysis.
12. Develop analytical skills