Anekant Education Society's

Tuljaram Chaturchand College, Baramati

413102 (Dist.Pune) (Autonomous)

Revised Syllabus for

M.Sc.(Chemistry) Part I (Semester II)

Choice based Credit System Syllabus to be implemented from Academic year 2022-2023

Title of the course: M.Sc. Chemistry

Structure of the course:

Sr. No.	Subject	Paper Code. (old)	Paper Code. (new)	Credits
1.	Fundamentals of Physical Chemistry- I	CHP-4101	PSCH111	Physical Chemistry I
2.	Molecular Symmetry and Chemistry of P- block elements	CHI-4102	PSCH112	Inorganic Chemistry I
3.	Basic Organic Chemistry	CHO-4103	PSCH113	Organic Chemistry I
4.	Safety in Chemical Laboratory and Good Laboratory Practices	CHA-4104	PSCH114	Safety in Chemical Laboratory and Good Laboratory Practices
5.	Physical Chemistry Practical	CHP-4105	PSCH115	Physical Chemistry Practical
6.	Organic Chemistry Practical	CHO-4106	PSCH116	Organic Chemistry Practical
7.	Human right I	HR 101	HR1	Human right I
8.	Introduction to cyber security 1	CYS 101	CYS1	Introduction to cyber security 1
9.	Fundamentals of Physical Chemistry- II	CHP-4201	PSCH121	Physical Chemistry II
10.	Coordination and Bioinorganic Chemistry	CHI-4202	PSCH122	Inorganic Chemistry II
11.	Synthetic organic chemistry and Spectroscopy	CHO-4203	PSCH123	Organic Chemistry II
12.	General Chemistry	CHA-4204	PSCH124	General Chemistry
13.	Inorganic Chemistry Practical	CHP-4205	PSCH125	Inorganic Chemistry Practical
14.	Analytical Chemistry Practical	CHO-4206	PSCH126	Analytical Chemistry Practical
15.	Human right II	HR 102	HRII	Human right II
16.	Introduction to cyber security II	CYS 102	CYSII	Introduction to cyber security II

PSCH 121
Physical Chemistry II
(4credits,48L)

Course Objectives:

1. Grasp the fundamental principles of spectroscopy, including Fourier transforms and factors influencing spectral lines.
2. Analyze rotation and vibrational spectra in microwave and infrared spectroscopy, considering isotopic substitution effects.
3. Understand Raman spectroscopy principles and electronic spectra of diatomic molecules, applying them in structural elucidation.
4. Explore advanced techniques such as ESR, Mössbauer spectroscopy, and NMR for diverse chemical applications.
5. Comprehend the principles of radioactivity, decay kinetics, and nuclear reactors, including applications in nuclear energy.
6. Investigate isotope separation methods, radiation chemistry principles, and their applications in various fields.
7. Apply radioisotopes in physico-chemical, analytical, and industrial applications, demonstrating practical skills.

Course Outcomes (COs):

CO1. Attain a foundational understanding of spectroscopic principles, enabling analysis and interpretation.
CO2. Demonstrate proficiency in analyzing rotation and vibrational spectra, considering isotopic substitution effects.
CO3. Apply Raman spectroscopy and electronic spectra knowledge in practical scenarios for structure elucidation.
CO4. Master advanced spectroscopic techniques like ESR, Mössbauer spectroscopy, and NMR for diverse chemical applications.
CO5. Gain an in-depth understanding of radioactivity, decay kinetics, and nuclear reactors for energy applications.
CO6. Apply knowledge of isotope separation and radiation chemistry principles in various scientific applications.
CO7. Demonstrate practical application skills using radioisotopes in physico-chemical, analytical, and industrial contexts.

SECTION-I
Molecular spectroscopy

1. Recapitulation: Fourier transforms, Regions of spectrum, factors affecting the width and intensity of spectral lines **(2L)**

2. Microwave spectroscopy: Rotation spectra of di and polyatomic molecules-rigid and non-rigid rotor, Effect of isotopic substitution, Problems **(3L)**

3. Infrared spectroscopy : Harmonic and Anharmonic oscillator, vibrational spectra of di and poly- atomic molecules, coarse and fine structure, Nuclear spin effect, applications **(5L)**

4.Raman Spectroscopy: Introduction, Rotational Raman- spectra, Vibrational Raman Spectra, polarization of light and Raman effect, structure elucidation from combined Raman and IR spectroscopy, applications, problems **(5L)**

5.Electronic spectroscopy of molecules: Born – Oppenheimer approximation, electronic spectra of diatomic molecules, vibrational coarse structure, rotational fine

structure, dissociation energy and dissociation products, electronic structure of diatomic molecules, molecular photoelectron spectroscopy, frank Condon principle, application **(6L)**

6. ESR and Mossbauer spectroscopy: Principle and applications. **(1L)**
NMR–Principle, Chemical shift, coupling constant, Chemical applications of ^{1}H-NMR in structure elucidation, problems **(2L)**

References:

1. Fundamentals of molecular spectroscopy: C. N. Banwell and E. Mc. Cash (Fourth edition).

2. Molecular Spectroscopy: P. S. Sindhu, New Age international Publication. (Second edition)

3. Molecular Spectroscopy: Suresh Chandra, Narosa Publication House (2009)

SECTION-II

Nuclear and Radiation Chemistry (2 Credits, 24L, 6 T**)**

1. Radioactivity: Recapitulation–Isotopes,Isobars,Isomers,Isotones, types of radioactive decay,Decay Kinetics,Detection and measurement of nuclear radiation(G.M. & Scintillation counter),Problems (Self study) **(2L)**

2. Nuclear Reactor: - The fission energy, The Natural uranium reactor, the four factor formula- There production factor K, the classification of reactor. Reactor power, Critical size of thermal reactor, excess reactivity & control, the Breeder reactor **(3L)**

3. Nuclear Reactions: Bethe's notation, Types of nuclear reactions, The compound nucleus theory, photonuclear reactions, Thermonuclear reactions, Fusion reactors **(4L)**

4.. Isotope separation & Preparation: Enrichment factor, various methods for separation of selected isotope,Typical reaction involved in preparation of radio isotopes:^{3}H, ^{14}C, ^{22}Na, ^{32}P, ^{35}S and ^{127}I. General Principles of using radioisotopes as a tracers. **(4L)**

6. Applications of radioisotopes in agriculture, Healthcare, Industry, Anaytical applications: Agricultural applications**;** Studies on soil plant relationship, Food preservation, Healthcare applications: Diagnostic applications: Radioimmunoassay, applications of RIA, Radiotherapy: Teletherapy, Gamma knife Brachytherapy,Analytical applications: Neutron activation analysis (NAA), Isotope dilution analysis (IDA), radiometric titration (RT) , radiation gauging, friction and wear out, gamma radiography. Problems **(6L)**

7.Elements of radiation chemistry – Radiation chemistry, interaction of radiation with matter,passage of neutrons through matter,interaction of γ-radiation with matter,Units for measuring radiation absorption, Radiation dosimetry, Radiolysis of water, free radicals in water radiolysis, Radiolysis, Fricke dosimetry, Problems **(5L)**

References:

1. Elements of Nuclear chemistry– H.J. Arnikar, fourth edition Wiley Estern Ltd.

2. Source book of atomic energy–S. Glasstone, D.Van Norton Company

3. Chemical applications of radioisotopes– H. J. M. Brown Buffer & Jammer Ltd.

4.Fundamentals of Radiochemistry- D.D. Sood, A. V. R. Reddy, N. Ramamoorthy

Choice Based Credit System Syllabus

(2022 Pattern)

Class: M.Sc. I (SEM. II) **Subject:** Chemistry

Course: Physical chemistry-II **Course Code**: PSCH 121

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Mapping of Course Outcomes with Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	0	0	0	0	3	0	0	0
CO2	3	3	0	0	0	0	0	0	0
CO3	3	3	0	0	0	3	0	0	0
CO4	3	3	0	3	0	3	0	0	0
CO5	3	0	0	3	3	0	0	0	0
CO6	3	3	0	3	3	3	0	0	0
CO7	3	3	0	3	3	3	3	0	0

Justification of mapping

PO1: Disciplinary Knowledge

CO1: Attain a foundational understanding of spectroscopic principles, enabling analysis and interpretation.

CO2: Demonstrate proficiency in analyzing rotation and vibrational spectra, considering isotopic substitution effects.

CO3: Apply Raman spectroscopy and electronic spectra knowledge in practical scenarios for structure elucidation.

CO4: Master advanced spectroscopic techniques like ESR, Mössbauer spectroscopy, and NMR for diverse chemical applications.

CO5: Gain an in-depth understanding of radioactivity, decay kinetics, and nuclear reactors for energy applications.

CO6: Apply knowledge of isotope separation and radiation chemistry principles in various scientific applications.

CO7: Demonstrate practical application skills using radioisotopes in physico-chemical, analytical, and industrial contexts.

PO2: Critical Thinking and Problem Solving

CO1: Attain a foundational understanding of spectroscopic principles, enabling analysis and interpretation.

CO3: Apply Raman spectroscopy and electronic spectra knowledge in practical scenarios for structure elucidation.

CO4: Master advanced spectroscopic techniques like ESR, Mössbauer spectroscopy, and NMR for diverse chemical applications.

CO6: Apply knowledge of isotope separation and radiation chemistry principles in various scientific applications.

CO7: Demonstrate practical application skills using radioisotopes in physico-chemical, analytical, and industrial contexts.

PO4: Research-related skills and Scientific temper

CO4: Master advanced spectroscopic techniques like ESR, Mössbauer spectroscopy, and NMR for diverse chemical applications.

CO5: Gain an in-depth understanding of radioactivity, decay kinetics, and nuclear reactors for energy applications.

CO6: Apply knowledge of isotope separation and radiation chemistry principles in various scientific applications.

CO7: Demonstrate practical application skills using radioisotopes in physico-chemical, analytical, and industrial contexts.

PO5: Trans-disciplinary Knowledge

CO5: Gain an in-depth understanding of radioactivity, decay kinetics, and nuclear reactors for energy applications.

CO6: Apply knowledge of isotope separation and radiation chemistry principles in various scientific applications.

CO7: Demonstrate practical application skills using radioisotopes in physico-chemical, analytical, and industrial contexts.

PO6: Personal and professional competence

CO1: Attain a foundational understanding of spectroscopic principles, enabling analysis and interpretation.

CO3: Apply Raman spectroscopy and electronic spectra knowledge in practical scenarios for structure elucidation.

CO4: Master advanced spectroscopic techniques like ESR, Mössbauer spectroscopy, and NMR for diverse chemical applications.

CO6: Apply knowledge of isotope separation and radiation chemistry principles in various scientific applications.

CO7: Demonstrate practical application skills using radioisotopes in physico-chemical, analytical, and industrial contexts.

PO7: Effective Citizenship and Ethics

CO7: Demonstrate practical application skills using radioisotopes in physico-chemical, analytical, and industrial contexts.

PSCH122: Inorganic Chemistry II,
Semester II (4 credits, 48L)

Course objectives:

The students are expected to learn,

1. Correlation diagram for Td and Oh ligand field
2. d-d transition, charge transfer spectra.
3. Basic Concepts, orgel diagram, Tanbe-sugano diagrams.
4. Hund's rule, interpretation of electronic spectra
5. Exploring the role of inorganic elements in biological systems.
6. Developing critical thinking and analytical skills through the analysis and interpretation of bioinorganic chemistry data.

Course Outcomes:

CO1: Student should understand interelectronicrepulsion.
CO2: Demonstrating knowledge of metalloproteins and their functions.
CO3: Exploring the various types of ligands and their coordination modes
CO4: Understanding the bioinorganic chemistry of essential and toxic metals
CO5: Exploring the applications of bioinorganic chemistry in medicine and drug design.
CO6: Developing problem-solving skills through the application of coordination chemistry principles to real-world scenarios.
CO7: Analyzing the electronic and magnetic properties of coordination compounds.

SECTION I

Coordination Chemistry (2 Credits, 24 lectures, 6 T)

A) Concept & Scope of Ligand Fields: (04L)

Recapitulation of CFT, Free ion Configuration, Terms and States, Energy level of transition metal ions, free ion terms, microstates, term wave functions, Quantum numbers, spin-orbits coupling.

B) Ligand field theory of coordination complexes: (07L)

Effect of ligand field on energy level of transition metal ions, weak cubic ligand field effect on Russell-Saunders terms, strong field effect, Orgel diagram, correlation diagrams, Tanabe-Sugano diagrams, spin pairing energies**.**

C) Electronic spectra of Transition Metal Complexes: (07L)

Introduction, Band intensities, band energies, band width and shapes, spectra of 1, 2 and 3rd row ions and rare earth ion complexes, spectrochemical and Nephlauxetic series, charge transfer and luminescence, spectra, calculations of Dq, B, β parameters, percentage of covalent character of metal complexes.

D) Magneto Chemistry (06L)

Origin magnetism, types of magnetism, Curie law, Curie-Weiss Law, Magnetic properties of complexes-paramagnetism 1st & 2nd Ordered Zeeman effect, quenching of orbital angular momentum by Ligand fields, Magnetic properties of A, E & T ground terms in complexes, spin free spin paired equilibria**.**

References:

1. Ligand field theory & its applications: B.N. Figgis & M.A. Hitachman (2000) Wiely VCH Publ.
2. Symmetry and spectroscopy of molecules, Second Ed^{n}, by K. Veera Reddy, New Age International Publication, 2009.

3. Elements of magnetochemistry, R. L. Datta and Syamal, Second Ed^{n}, Afiliated East West Press Pvt. Ltd. 2007.

SECTION-II

Bioinorganic Chemistry (2 Credits, 24 Lectures, 6 T)

1. Introductions of Bioinorganic chemistry, role of metals, metalloproteins and metalloenzyme. Principles of coordination chemistry related to bioinorganic chemistry research and protein, Nucleic acid and other metal bonding biomolecules. **(4L)**

2. Thermodynamic aspects - HSAB concept, chelate effect and Irving-William series, pK_a values of coordinated ligands, Tuning of redox potential, Biopolymer effects. Kinetic aspects- Electron transfer reaction, Electronic substitution reaction. Reactions of coordinated ligands and Template effect, concept of spontaneous self-assembly model compounds. **(6L)**

3. Biochemistry of Na, K and Ca with respect to Na/K pumps, Distribution of Cationic and anionic electrolytes in blood plasma and intracellular fluid, Calmodulin, Ionophores natural and synthetic application of Ionophores and Ca in blood Coagulation. **(8L)**

4. Biochemistry of following elements: **(6L)**

a) Iron: Ferritin, Transferrin, Ferredoxin, Rubredoxin, Porphyrin based system

b) Magnesium: Photosystem I

c) Manganese: Photosystem II

References:

1. Principle of Bioinorganic chemistry: S. J. Lippard and J.M. Berg

2. Bioinorganic chemistry: Inorganic elements in chemistry of life W. Kain and B. Schwederski

3. Bioinorganic chemistry: Bertini, Grey, Lippard and Valentine

4. Bioinorganic chemistry: R. J. P, Willams

5. Bioinorganic chemistry: Robert Hay Bioinorganic chemistry: M. N. Hughes

Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem II) **Subject**: Chemistry

Course: Inorganic Chemistry II **CourseCode**: PSCH:122

Weightage:1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

	Programme Outcomes(POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	0	0	0	0	0	0	0	0
CO2	2	2	0	0	3	0	0	0	0
CO3	0	3	0	3	0	0	0	0	0
CO4	3	0	0	0	0	3	0	2	0
CO5	3	2	0	2	2	2	0	0	0
CO6	0	3	0	2	3	1	0	3	2
CO7	0	3	0	1	0	0	0	0	0

Justification for the mapping

PO1:DisciplinaryKnowledge

CO1: Student should understand interelectronic repulsion.
CO2: Demonstrating knowledge of metalloproteins and their functions.
CO4: Understanding the bioinorganic chemistry of essential and toxic metals
CO5: Exploring the applications of bioinorganic chemistry in medicine and drug design.

PO2:CriticalThinkingandProblemSolving

CO2: Demonstrating knowledge of metalloproteins and their functions.
CO3: Exploring the various types of ligands and their coordination modes
CO5: Exploring the applications of bioinorganic chemistry in medicine and drug design.
CO6: Developing problem-solving skills through the application of coordination chemistry principles to real-world scenarios.
CO7: Analyzing the electronic and magnetic properties of coordination compounds.

PO4: Research related skills and Scientific temper

CO3: Exploring the various types of ligands and their coordination modes
CO5: Exploring the applications of bioinorganic chemistry in medicine and drug design.
CO6: Developing problem-solving skills through the application of coordination chemistry principles to real-world scenarios.
CO7: Analyzing the electronic and magnetic properties of coordination compounds.

PO5:Trans-disciplinary Knowledge

CO2: Demonstrating knowledge of metalloproteins and their functions.
CO5: Exploring the applications of bioinorganic chemistry in medicine and drug design.
CO6: Developing problem-solving skills through the application of coordination chemistry principles to real-world scenarios.

PO6:Personal and Professional Competence

CO4: Understanding the bioinorganic chemistry of essential and toxic metals
CO5: Exploring the applications of bioinorganic chemistry in medicine and drug design.
CO6: Developing problem-solving skills through the application of coordination chemistry principles to real-world scenarios.

PO8: Environment and sustainability

CO4: Understanding the bioinorganic chemistry of essential and toxic metals

CO6: Developing problem-solving skills through the application of coordination chemistry principles to real-world scenarios.

PO9:Self-directed and Life-long Learning

CO6: Developing problem-solving skills through the application of coordination chemistry principles to real-world scenarios.

PSCH123: Organic Chemistry II,
Semester II (4 credits, 48L)

Course objectives:

The students are expected to learn,

1. Construction of FMO and photochemical and thermal reactions
2. Laws of Photochemistry
3. Basic principles, photochemistry of carbonyl compounds, alkenes, dienes and aromatic compounds.
4. Norrish type I and II reaction, isomerization, Patterno-Buchi reaction
5. Chemical shifts and factors affecting chemical shifts
6. Complex and simple spin spin coupling.
7. Students will able to learn concepts in 13CMR, Mass spectroscopy and 1HNMR spectroscopy.

Course Outcomes:

CO1. Student will understand the Chemical shifts and factors affecting chemical shifts
CO2. Student will understand first order and second order spectra
CO3. Student will understand the coupling constant and spin notations.
CO4. Student will understand and solve the simple to moderate spectroscopy problems
CO5. Students will able to understand complex and simple spin spin coupling.
CO6. Students will able to do classification of spin system and simplification of complex spectra.
CO7. Students will able to learn concepts in 13CMR, Mass spectroscopy and 1HNMR spectroscopy.

SECTION I

Pericyclic Reactions and Photochemistry (2 Credits 24 Lectures)

A) Pericyclic Reactions (12 L)

Construction of Pi molecular orbitals of ethylene and 1, 3 Butadiene, Symmetry in Pi molecular orbitals, Frontier molecular orbitals, electrocyclic reactions Con and Dis rotatory ring closing and ring opening reactions, Selection rules and stereochemistry of electrocyclic reactions, Theory of cycloaddition reaction. FMO method, [2+2] and [4+2] cycloaddition, Ene reaction

B) Photochemistry: (12 L)

Law of Photochemistry, quantum yield, quenching, photochemistry of carbonyl compounds, alkenes, dienes and aromatic compounds and their application in organic synthesis alpha and beta cleavage Norrish type I and II reaction, isomerization, Patterno-Buchi reaction, Photo Fries Rearrangement.

SECTION-II

Spectroscopy (2 Credits 24 Lectures)

1. UV: (4L)

Factors affecting UV absorption and interpretation of UV spectra of aromatic compounds, Rules and Application of dines, eneons, and aromatic compound

2. IR: **(4 L)**

Principal, Basic Important functional group frequencies, factors affecting IR frequencies, interpretation of IRspectra

3. ^{1}H NMR: **(6 L)**

Fundamentals of $_{1}$H NMR, Coupling constant , factors affecting chemical shift, integration, coupling (1st order analysis), first order spectral analysis , D_2O exchange in H^1 NMR

4. Introduction to CMR: **(4 L)**

Natural abundance, chemical shift values, proton coupled and proton decoupled spectra, DEPT

5. Mass spectrometry: **(6 L)**

Principal, Instrumentation, Terminologies, Rules of fragmentation, McLafferty rearrangement, Rule of 13,fragmentation pattern of some important functional groups.

References:

1. Advanced Organic Chemistry, Part A – F. A. Carey and R. J. Sundberg, 5th Ed.

Springer (2007)

2. Excited states in Organic Chemistry- J.A. Barltrop and J.D.Coyle, John Wiley & sons

3. Photochemistry and Pericyclic reactions-Jagdamba Singh, Jaya Singh 3rd Ed.

4. Organic photochemistry: A visual approach-Jan Kopecky, VCH publishers (1992).

5. Conservation of orbital symmetry – R. B. Woodward and R. Hoffmann;

VerlagChemie, Academic press (1971).

6. Introduction to spectroscopy – D.l. Pavia, G.M. Lampman, G.S. Kriz, 3rd Edition

7. Spectroscopic methods in organic melecules – D.H. William & I Flemming Mc Graw Hill

8. Mechanism and Structure in Organic Chemistry - E.S. Gould

Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Out comes with Course Outcomes

Class: M.Sc. I (Sem I) Subject: Chemistry

Course: Organic Chemistry I

Course Code: PSCH 123

Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

	ProgrammeOutcomes(POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	0	2	2	2	0	0	2
CO2	3	2	0	0	0	0	0	0	3
CO3	3	0	0	3	2	0	0	0	2
CO4	2	0	0	3	2	0	0	0	3
CO5	3	2	0	0	0	0	0	0	2
CO6	2	2	0	0	0	1	0	0	0
CO7	3	0	0	2	2	0	0	0	0

PO1: Disciplinary Knowledge

CO1. Student will understand the Chemical shifts and factors affecting chemical shifts
CO2. Student will understand first order and second order spectra
CO3. Student will understand the coupling constant and spin notations.
CO4. Student will understand and solve the simple to moderate spectroscopy problems
CO5. Students will able to understand complex and simple spin spin coupling.
CO6. Students will able to do classification of spin system and simplification of complex spectra.
CO7. Students will able to learn concepts in 13CMR, Mass spectroscopy and 1HNMR spectroscopy.

PO2: Critical Thinking and Problem Solving

CO1. Student will understand the Chemical shifts and factors affecting chemical shifts
CO2. Student will understand first order and second order spectra
CO5. Students will able to understand complex and simple spin spin coupling.
CO6. Students will able to do classification of spin system and simplification of complex spectra.

PO4: Research-related skills and Scientific temper

CO1. Student will understand the Chemical shifts and factors affecting chemical shifts
CO3. Student will understand the coupling constant and spin notations.
CO4. Student will understand and solve the simple to moderate spectroscopy problems
CO7. Students will able to learn concepts in 13CMR, Mass spectroscopy and 1HNMR spectroscopy.

PO5: Trans-disciplinary Knowledge

CO1. Student will understand the Chemical shifts and factors affecting chemical shifts
CO3. Student will understand the coupling constant and spin notations.
CO4. Student will understand and solve the simple to moderate spectroscopy problems
CO7. Students will able to learn concepts in 13CMR, Mass spectroscopy and 1HNMR spectroscopy

PO6: Personal and Professional Competence

CO1. Student will understand the Chemical shifts and factors affecting chemical shifts
CO7. Students will able to learn concepts in 13CMR, Mass spectroscopy and 1HNMR spectroscopy.

PO9: Self-directed and Life-long Learning

CO1. Student will understand the Chemical shifts and factors affecting chemical shifts
CO2. Student will understand first order and second order spectra
CO3. Student will understand the coupling constant and spin notations.
CO4. Student will understand and solve the simple to moderate spectroscopy problems
CO5. Students will able to understand complex and simple spin spin coupling.

PSCH 124
GeneralChemistryII
(4credits,48L)

Course Objectives:

1. Master the principles and instrumentation of Mass Spectrometry, Gas Chromatography, and High-Performance Liquid Chromatography (HPLC), including optimization techniques.
2. Understand the scope of biochemistry in pharmaceutical sciences, biochemical reactions, and key aspects of prokaryotic and eukaryotic cell metabolism.
3. Acquire knowledge about the structure of cells, sub-cellular components, and biomembranes in prokaryotic and eukaryotic organisms.
4. Comprehend the structures, functions, and classifications of biomolecules, including proteins, carbohydrates, and lipids.
5. Explore enzyme kinetics, factors affecting enzyme reactions, enzyme inhibition, and applications of enzymes in biotechnology and medicinal compound manufacturing.
6. Develop skills in data handling, accuracy, precision, error classification, and significant figures using spreadsheets in analytical chemistry.
7. Understand quality systems, standards, and total quality management in chemical laboratories, including the responsibilities of laboratory staff for quality.

Course Outcomes (COs):

CO1. Demonstrate proficiency in the principles and application of Mass Spectrometry, Gas Chromatography, and High-Performance Liquid Chromatography.

CO2. Apply the principles of biochemistry in the context of pharmaceutical sciences, understanding biochemical reactions and cell metabolism.

CO3. Demonstrate understanding of cellular structures, sub-cellular components, and the structure, function, and properties of biomembranes.

CO4. Apply knowledge of biomolecules, including proteins, carbohydrates, and lipids, in biochemical analysis and pharmaceutical sciences.

CO5. Apply knowledge of enzyme kinetics, substrate interactions, and enzyme inhibition in practical scenarios and biotechnological applications.

CO6. Develop skills in accurate data handling, precision, error analysis, and presentation using spreadsheets in analytical chemistry.

CO7. Demonstrate proficiency in implementing quality systems, standards, and total quality management in chemical laboratories.

Section I

Part A –Modern Separation Methods and Hyphenated Techniques (2 Credits 24 Lectures)

A) Mass Spectrometry: (08 L)

Principle, Instrumentation, Ionization methods-Electron bombardment ionization, Arc and spark ionization, Photo-ionization, Thermal ionization, Chemical ionization, Mass Analyzer-Magnetic, Double focusing, Time of flight, Quadrupolar, Ion cyclotron resonance analyzer ,Correlation of mass

spectra with molecular structure and molecular weight ,Isotopic Abundances ,Fragmentation patterns, Quantitative analysis, Applications and Problems, Fourier transform mass spectrometry ,Tandem mass spectrometry, Inductively coupled plasma-mass spectrometry

B) Gas Chromatography (06L)

Introduction, Basic principle of GC, Instrumentation of GC, Sample injection–Split and splitless injection, Column types, Solid/Liquid Stationary phases ,Column switching techniques, Basic and specialized detectors ,elemental detection, Chiral separations, Gas chromatographs and chemical analysis, Application of GLC, Gas solid chromatography and Problems

C) High Performance Liquid Chromatography (06L)

Theory and instrumentation of HPLC, Optimization of column performance, Gradient elution and related procedure, Derivatization, Mobile phase Delivery System, Sample injection, Separation column, Detector, Interfacing HPLC With Mass spectrometry, Structure types of column packing, Adsorption Chromatography, Bonded phase chromatography, Reversed phase chromatography, Ion Pair Chromatography, Ion exchange Chromatography, Size Exclusion Chromatography and problem.

D) Hyphenated Techniques (04L)

Introduction,GC-MS, LC-MS theory working and applications

References:

1.Introduction to Instrumental Analysis,R.D.Braun,McGraw-Hill.Inc.1987
2.Instrumental Methods of chemical Analysis ,H. H.Willard, L.L.Merrite Jr.,J.A.Dean & F.A.SettleJr.,6th Edition, Wadsworth Publishing Company,USA,1986
3. Hand book of Instrumental Techniques for Analytical Chemistry, F.A.Settle editor, Prentice Hall Inc. A Simon and Schuster Company,New Jersey,1997
4. Fundamentals of Analytical Chemistry ,D.A. Skoog, D.M.west, F.J.Holler,S.R.Crouch,7th Edition,Thomson Asia Pte.Ltd,Singapore,2004

SECTION-II:

Part-B:Basic Biochemistry (2 Credits 24 Lectures) (02L)

1. Introduction to Biochemistry:

Scope of the subject in pharmaceutical sciences,Biochemical reactions, Highlights of prokaryotic and Eukaryotic cell metabolism.

2. Biochemical Morphology: **(04L)**

Prokaryotes and Eukaryotes,Cell structure,sub-cellular components: Nucleus, plasma membranes, endoplasmic reticulum,Lysosome,Peroxisomes,Golgiapparatus,and Mitochondria.

3. Biomembrane: **(04L)**

Structure, functions and composition, Model proposed, Function and properties of membrane, Transporthypothesis, Active and passive facilitated transport, Na+, K+,H+,pumps, glucose transport, Excitable membrane,drug transport.

4. Biomolecules: **(07L)**

Proteins*:* Introduction ,functional, classification of amino acids, classification ,physicochemical properties, Optical activity,Reaction with ninhydrin,Formaldehyde,Aminoacids,Essential and nonessential aminoacids,efficacy,structure,peptide bond,end group analysis,Helix,B-sheet structure,tertiary,quaternary structure, globular protein,fibrous protein,aminoacid therapy, Protein engineering Carbohydrates: complex carbohydrate, structure of Chitin, Starch, Glycogen+Metabolism
Lipids:definition, classification, functions, types of fattyacids,and its biological role and metabolism.

5. Enzymes **(07 L)**

Introduction, classification according to the reaction catalysis and source structure of enzyme, co factures, active sites, Binding sites, Km, Vmax, Enzyme kinetics, Double reciprocal plot, effect of substrate, pH ionic strength, Concentration, Temperature on the rate of enzyme reactions, Enzyme inhibition (competitive, uncompetitive, noncompetitive and irreversible),
Enzyme biotechnology. Manufacturing of medicinal compounds by enzymatic reactions, Penicillinacylase for the production 6-APA, Therapeutical uses of enzymes.

References:

1.Principals of biochemistry, Albert Lehninger (CBS Publisher and Distributers Pvt. Delhi.
2. Biochemistry Lubert Stryer,W.H.(Freeman and company New York)
3.Harper's Biochemistry by R.K.Murray, D.I.Granner, P.A.Mayes, (Prentice Hall International Inc.)
4.Practical Clinical Biochemistry, Harold Varley, (CBS Publisher and Distributers Pvt. Delhi.
5. Molecular Biology, J.D. Watson (The Benjamin/Cumming Company, Inc.)

Choice Based Credit System Syllabus

(2022 Pattern)

Class: M.Sc. I (SEM. II) **Subject**: Chemistry

Course: General chemistry **Course Code**: PSCH 124

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Mapping of Course Outcomes with Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	0	0	0	3	0	0	0
CO2	3	3	0	0	0	0	0	0	0
CO3	3	3	3	0	0	0	0	0	0
CO4	3	3	0	0	0	0	0	0	0
CO5	3	3	0	0	3	0	0	0	0
CO6	3	3	0	0	0	3	0	0	0
CO7	3	3	0	0	0	0	3	0	0

Justification of Mapping

PO1: Disciplinary Knowledge

CO1: Demonstrate proficiency in the principles and application of Mass Spectrometry, Gas Chromatography, and High-Performance Liquid Chromatography.

CO2: Apply the principles of biochemistry in the context of pharmaceutical sciences, understanding biochemical reactions and cell metabolism.

CO3: Demonstrate understanding of cellular structures, sub-cellular components, and the structure, function, and properties of bio membranes.

CO4: Apply knowledge of biomolecules, including proteins, carbohydrates, and lipids, in biochemical analysis and pharmaceutical sciences.

CO5: Apply knowledge of enzyme kinetics, substrate interactions, and enzyme inhibition in practical scenarios and biotechnological applications.

CO6: Develop skills in accurate data handling, precision, error analysis, and presentation using spreadsheets in analytical chemistry.

CO7: Demonstrate proficiency in implementing quality systems, standards, and total quality management in chemical laboratories.

PO2: Critical Thinking and Problem Solving

CO1: Demonstrate proficiency in the principles and application of Mass Spectrometry, Gas Chromatography, and High-Performance Liquid Chromatography.

CO2: Apply the principles of biochemistry in the context of pharmaceutical sciences, understanding biochemical reactions and cell metabolism.

CO3: Demonstrate understanding of cellular structures, sub-cellular components, and the structure, function, and properties of biomembranes.

CO4: Apply knowledge of biomolecules, including proteins, carbohydrates, and lipids, in biochemical analysis and pharmaceutical sciences.

CO5: Apply knowledge of enzyme kinetics, substrate interactions, and enzyme inhibition in practical scenarios and biotechnological applications.

CO6: Develop skills in accurate data handling, precision, error analysis, and presentation using spreadsheets in analytical chemistry.

CO7: Demonstrate proficiency in implementing quality systems, standards, and total quality management in chemical laboratories.

PO3: Social competence

CO3: Demonstrate understanding of cellular structures, sub-cellular components, and the structure, function, and properties of biomembranes.

PO5: Trans-disciplinary knowledge

CO5: Apply knowledge of enzyme kinetics, substrate interactions, and enzyme inhibition in practical scenarios

and biotechnological applications.

PO6: Personal and professional competence

CO1: Demonstrate proficiency in the principles and application of Mass Spectrometry, Gas Chromatography, and High-Performance Liquid Chromatography.

CO6: Develop skills in accurate data handling, precision, error analysis, and presentation using spreadsheets in analytical chemistry.

PO7: Effective Citizenship and Ethics

CO7: Demonstrate proficiency in implementing quality systems, standards, and total quality management in chemical laboratories.

Inorganic Chemistry Practical

PSCHI125: INORGANIC CHEMISTRYS (4 Credits, 48 L)

Course Objectives:

1. To understand Methods of ore analysis.
2. To understand Methods of Alloy analysis.
3. To understand the methods of characterization of metal complexes.
4. To interpret given IR spectrum
5. To interpret given XRD spectrum
6. To understand handling of magnetic susceptibility.

Course Outcomes:

After successfully completing this course students will know,

CO1: Students will be able to Prepare solution of required concentration and handle the laboratory equipment.

CO2: Student able to calculate the quantity from observation of the experiment and interpret the result.

CO3 :gain hands on experience in using various laboratory techniques .

CO4: learn to observe & interpret chemical reactions involving inorganic compounds, including formation of precipitate and colour change.

CO5: Student should perform experiment accurately and able to perform calculations.

CO6: will develop critical thinking skills,apply their knowledge to troubleshoot experiments.

CO7: Student understand research ethics.

1. Alloy Analysis: - (Any 2)

a) Determination of Tin & lead from Solder alloy
b) Determination of Iron & Chromium or carbon from Stainless steel alloy.
c) Determination of Copper & Nickel from Cupronickel alloy.
d) Determination of Bismuth, Lead, Tin, Cadmium from Wood's metal. (any 2)
e) Determination of Aluminium, Nickel, Cobalt from Alnico alloy.

2. Inorganic synthesis & purity: (Any 6)

a) Chloro penta- amine cobalt (III) chloride.
b) Nitro penta -ammine cobalt (III) chloride.
c) Cis Potassium diaquo dioxalato Chromate (III).
d) Trans Potassium diaquo dioxalato Chromate (III) .
e) Potassium tri-oxalato Aluminate .
f) Tris (acetylacetanato) Mangnese (III).
g) Bis (acetylacetanato) Copper (II)
h) Tris (Ethylenediamine) Nickel (II) thiosulphate.

3. Inorganic Chracterization Techniques: (Any 1)

a) Solution state preparation of $[Ni(en)_3]S_2O_3$, $[Ni(H_2O)_6]Cl_2$, $[Ni(NH_3)_6]Cl_2$. Record absorption spectra in solution of three complexes and calculate 10 Dq. Arrange three ligands according to their increasing strength depending on observation.
b) Determination of Magnetic Susceptibility of Mercury tetracynato Cobalt or $[Fe(acac)_3]$ orFerrous ammonium sulphate by Faraday or Gouy's method .
c) Determination of equilibrium constant of M-L system Fe(III) Sulphosalicylic acid by Job's continuous variation method.
d) Estimation of Cu using iodometric method Potentiometrically.

4. Synthesis of Nanomaterials: (Any 2)

a) Synthesis of nanosized ZnO, its characterization by UV-Visible Spectroscopy & Removal of dye bye ZnO – Photo catalysis and determine the band gap by absorption spectroscopy.
b) Synthesis of nanosized alpha -Fe_2O_3 & Study of adsorption of Phosphate on it.
c) Synthesis of CdS nanoparticles.
d) ZnO, TiO_2, Fe_2O_3 nanoparticles powder XRD, SEM, TEM or any another Technique.(At least one spectral analysis/study should be done)

5. Synthesis & Chracterization: (Any 1)

a) Synthesis & Photochemistry of K $[Fe(C_2O_4)_3]3H_2O$
b) Kinetics of substitution reaction of $[Fe(Phen)_3]^{2+}$

6. Solvent Extraction and Colorimetric: (Any 1)
a) Determination of Cu(II) Solvent extraction as Dithiocarbamate complex.
b) Determination of Iron by solvent extraction techniques in a mixture of Fe (III)+Al(III) orFe (III)+Ni(III) using 8-hydroxyquinoline reagent.

7. Report on Industrial visit.

References:

1) Text book of Quantitative Analysis, A.I. Vogel 4th edn (1992)
2) Electronic Spectroscopy by A.B. P. Lever.
3) Inorganic Synthesis (Vol. Series).
4) Practical Manual made by Department of Chemistry, University of Pune.
5) Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in chemical Science.
6) Experiments in chemistry, D. V. Jahagirdar, Himalaya Publishing House.
General Chemistry Experiments, Anil. J Elias, University Press

Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem II) **Subject**: Chemistry
Course:INORGANIC CHEMISTRY PRACTICALS **Course Code**: PSCH:125
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

	Programme Outcomes(POs)								
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	0	0	0	3	0	0	3
CO2	3	3	0	0	0	2	0	0	3
CO3	3	0	0	0	0	0	0	0	3
CO4	2	3	0	3	0	2	0	0	3
CO5	0	2	0	2	3	0	0	0	2
CO6	0	3	0	2	0	0	0	0	2
CO7	0	0	0	2	2	2	3	0	0

Justification for the mapping

PO1: Disciplinary Knowledge
CO1: Students will be able to Prepare solution of required concentration and handle the laboratory equipment.
CO2: Student able to calculate the quantity from observation of the experiment and interpret the result.
CO3: gain hands on experience in using various laboratory techniques.
CO4: learn to observe & interpret chemical reactions involving inorganic compounds, including formation of precipitate and colour change.

PO2: Critical Thinking and Problem Solving
CO1: Students will be able to Prepare solution of required concentration and handle the laboratory equipment.
CO2: Student able to calculate the quantity from observation of the experiment and interpret the result.
CO4: learn to observe & interpret chemical reactions involving inorganic compounds, including formation of precipitate and colour change.
CO5: Student should perform experiment accurately and able to perform calculations.
CO6: will develop critical thinking skills,apply their knowledge to troubleshoot experiments.

PO4: Research relatated skills and Scientific temper

CO4: learn to observe & interpret chemical reactions involving inorganic compounds, including formation of precipitate and colour change.
CO5: Student should perform experiment accurately and able to perform calculations.
CO6: will develop critical thinking skills,apply their knowledge to troubleshoot experiments.
CO7: Student understand research ethics.

PO5: Trans-disciplinary Knowledge

CO5: Student should perform experiment accurately and able to perform calculations.
CO7: Student understand research ethics.

PO6: Personal and Professional Competence

CO1: Students will be able to Prepare solution of required concentration and handle the laboratory equipment.
CO2: Student able to calculate the quantity from observation of the experiment and interpret the result.
CO4: learn to observe & interpret chemical reactions involving inorganic compounds, including formation of precipitate and colour change.
CO7: Student understand research ethics.

PO7: Effective citizenship and ethics

CO7: Student understand research ethics.

PO9: Self-directed and Life-long Learning

CO1: Students will be able to Prepare solution of required concentration and handle the laboratory equipment.
CO2: Student able to calculate the quantity from observation of the experiment and interpret the result.
CO3: gain hands on experience in using various laboratory techniques .
CO4: learn to observe & interpret chemical reactions involving inorganic compounds, including formation of precipitate and colour change.
CO5: Student should perform experiment accurately and able to perform calculations.
CO6: will develop critical thinking skills,apply their knowledge to troubleshoot experiments.

PSCH126
AnalyticalChemistryPractical
(4Credits)

Course Objectives:

1. Master statistical treatment of experimental data, crystal structure analysis from single crystal X-ray patterns, and error analysis using least square methods.
2. Utilize chemistry software (Chem Office, ACD/NMR Processor, Endnote) to draw structures, predict spectroscopic data, process NMR spectra, and manage references in scientific documents.
3. Develop skills in performing acid-base titrations for the determination of ibuprofen and indomethacin purity, as well as the analysis of Vitamin C in juices and squashes.
4. Apply conductometry techniques to determine concentrations of strong and weak acids, critical micelle concentration (CMC), study complex formation, and verify Debye Huckel theory for various electrolytes.
5. Perform potentiometric titrations to determine concentrations of acids, reductants, and oxidants, as well as complexometric determinations using disodium EDTA for Co2+, Al3+, and Cu2+.
6. Apply colorimetry and spectrophotometry techniques for the estimation of phosphate in wastewater, determination of equilibrium constants in M-L systems, solvent extraction studies, and kinetics of iodination of acetone.
7. Demonstrate proficiency in ion exchange chromatography for the separation and estimation of metal ions (Zn, Cd, Mg, Fe, Al) and flame photometry for the estimation of Ca, Na+, and K+ in various samples.

Course Outcomes (COs):

CO1. Demonstrate mastery in statistical treatment, crystal structure analysis, and error analysis, leading to accurate and reliable experimental data interpretation.

CO2. Utilize chemistry software effectively to draw structures, predict spectroscopic data, process NMR spectra, and manage references in scientific documents.

CO3. Apply volumetric analysis techniques to determine drug purity, Vitamin C content, and perform acid-base titrations in a laboratory setting.

CO4. Apply conductometry techniques for acid concentration determination, critical micelle concentration, complex formation studies, and verification of Debye Huckel theory.

CO5. Demonstrate proficiency in potentiometric titrations for acid and redox determination, as well as complexometric determinations using disodium EDTA.

CO6. Apply colorimetry and spectrophotometry techniques for various applications, including phosphate estimation, equilibrium constant determination, solvent extraction, and kinetics studies.

CO7. Demonstrate expertise in ion exchange chromatography for metal ion separation and estimation, as well as flame photometry for the estimation of Ca, Na+, and K+.

PSCH-126: -Analytical Chemistry Practical, Sem-II,(4 Credits,)

CO8. Table work: (Any Three)

a. Statistical treatment of experimental data.

b. Analysis of crystal structure from single crystal X-ray pattern.
c. Data analysis, error analysis, least square method.
d. Analysis of given spectra.

CO9. Use of Chemistry Software: (Any Two)

a. .Chem Office: Draw the Structures of simple organic compounds and find out IUPAC name,
Convert structure to name and predict ^{1}H-NMR and ^{13}CMR.
b. ACD/NMR processor: Convert FID file in spectrum, how to integrate, how to find J value.
c. Endnote: How to add references to word file.

CO10. Volumetric Analysis: (Any Two)

a. Determination of ibuprofen using acid-base titration.
b. Determination of percentage purity of indomethacin by acid–base titration.
c. Analysis of Vitamin C in juices and squashes.

CO11. Conductometry: (Any Four)

a. Determination of concentrations of strong acid and weak acid present in the mixture by titration with strong base.
b. Determination of critical micelle concentration (CMC) and □G of micellzation of sodium dodecyl sulphate (SDS).
c. Verification of Debye Huckel theory of ionic conductance for strong electrolytes KCl, $BaCl_2$, K_2SO_4, $K_3[Fe(CN)_6]$
d. Structural determination of metal complexes by conductometric measurements.
e. To study complex formation between Fe (III) with sulphosalicylic acid by conductometry.
f. Determination of the strength of commercial phosphoric acid/ vinegar by conductometric titration.

CO12. Potentiometry: (AnyTwo)

a. Determination of concentrations of strong acid and weak acid present in the mixture by titrating with strong base.
b. Determination of concentrations of reductant or oxidant by redox titration.
c. Complexometric determination using disodium EDTA of Co^{2+}, Al^{3+} and Cu^{2+}

CO13. Colorimetry/ Spectrophotometry:(Any Four)

a. Estimation of phosphate from waste water by calibration curve method.
b. Determination of equilibrium constant of M-L system such as Fe (III)–Sulphosalicylic acid by Job´s continuous variation method.
c. Determination of equilibrium constant of M-L system such as Fe (III) – resorcilic acid by Mole ratio method.
d. Determination of iron by solvent extraction technique in a mixture of Fe(III)+Al(III) or Fe(III)+Ni(III)using8-hydroxyquinoline reagent.
e. Determination of Cu (II) by solvent extraction as Dithiocarbamate/ 8-hydroxyquinoline complex.
f. Study of kinetics of iodination of acetone spectrophotometrically.

CO14. Ion Exchange Chromatography: (Any two)

a. Separation of mixture of Zn (II) and Cd (II) using Amberlite IRA 400 anion exchanger and quantitative estimation of separated ions Zn (II) and Cd (II).

b. Separation of mixture of Zn(II)and Mg (II) using Amberlite IRA-400 anion exchanger and quantitative estimation of separated ions Zn (II) and Mg (II).

c. Separation and estimation of Fe and Al on cation exchanger.

CO15. Flame photometry: (Any One)

a. Estimation of Ca in milk powder sample by flame photometry.

b. Determination of concentration of Na^+ and K^+ in oral rehydration sachet by flame photometry.

References:

1. Lab Manual: Selected experiments of Pharmaceutical Analysis, Aness A Siddiqui.

2. Experimental physical chemistry, Athawale, Mathur, Newage Int. Publishers.

3. Textbook of quantitative analysis A. I. Vogel 4^{th} Edition.
4. Experiments in Chemistry, D. V. Jahagirdar.

5. General Chemistry Experiments, Anil J .Elias University Press.

6. Ligand Field Theory, B. N. Figgis

7. Practical physical chemistry, A. Findlay, T.A. Kitchner (Longmans, Green and Co.)

8. Senior Practical Physical Chemistry, B. D. Khosla and V.S. Garg (R.Chand and Co.,Delhi.)
9. Practical physical chemistry, B. Vishwanathan and P.S.Raghavan,2^{nd} edition, (2012)

Choice Based Credit System Syllabus

(2022 Pattern)

Class: M.Sc. I (SEM. II) **Subject**: Chemistry

Course: Analytical Chemistry practical **Course Code**: PSCH 126

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	0	3	0	3	0	0	0
CO2	3	3	0	3	0	0	0	0	0
CO3	3	3	0	3	0	0	0	0	0
CO4	3	3	0	3	0	0	0	0	0
CO5	3	3	0	3	0	0	0	0	0
CO6	3	3	0	3	0	0	0	0	0
CO7	3	3	0	3	0	0	0	0	0

Justification of mapping

PO1: Disciplinary Knowledge

CO1: Demonstrate mastery in statistical treatment, crystal structure analysis, and error analysis, leading to accurate and reliable experimental data interpretation.

CO2: Utilize chemistry software effectively to draw structures, predict spectroscopic data, process NMR spectra, and manage references in scientific documents.

CO3: Apply volumetric analysis techniques to determine drug purity, Vitamin C content, and perform acid-base titrations in a laboratory setting.

CO4: Apply conductometry techniques for acid concentration determination, critical micelle concentration, complex formation studies, and verification of Debye Huckell theory.

CO5: Demonstrate proficiency in potentiometric titrations for acid and redox determination, as well as complexometric determinations using disodium EDTA.

CO6: Apply colorimetry and spectrophotometry techniques for various applications, including phosphate estimation, equilibrium constant determination, solvent extraction, and kinetics studies.

CO7: Demonstrate expertise in ion exchange chromatography for metal ion separation and estimation, as well as flame photometry for the estimation of Ca, Na+, and K+.

PO2: Critical Thinking and Problem Solving

CO1: Demonstrate mastery in statistical treatment, crystal structure analysis, and error analysis, leading to accurate and reliable experimental data interpretation.

CO2: Utilize chemistry software effectively to draw structures, predict spectroscopic data, process NMR spectra, and manage references in scientific documents.

CO3: Apply volumetric analysis techniques to determine drug purity, Vitamin C content, and perform acid-base titrations in a laboratory setting.

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CO6: Apply colorimetry and spectrophotometry techniques for various applications, including phosphate estimation, equilibrium constant determination, solvent extraction, and kinetics studies.

CO7: Demonstrate expertise in ion exchange chromatography for metal ion separation and estimation, as well as flame photometry for the estimation of Ca, Na+, and K+.

PO4: Research-related skills and Scientific temper

CO1: Demonstrate mastery in statistical treatment, crystal structure analysis, and error analysis, leading to accurate and reliable experimental data interpretation.

CO2: Utilize chemistry software effectively to draw structures, predict spectroscopic data, process NMR spectra, and manage references in scientific documents.

CO3: Apply volumetric analysis techniques to determine drug purity, Vitamin C content, and perform acid-base titrations in a laboratory setting.

CO4: Apply conductometry techniques for acid concentration determination, critical micelle concentration, complex formation studies, and verification of Debye Huckell theory.

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CO6: Apply colorimetry and spectrophotometry techniques for various applications, including phosphate estimation, equilibrium constant determination, solvent extraction, and kinetics studies.

CO7: Demonstrate expertise in ion exchange chromatography for metal ion separation and estimation, as well as flame photometry for the estimation of Ca, Na^+, and K^+.

PO6: Personal and professional competence

CO1: Demonstrate mastery in statistical treatment, crystal structure analysis, and error analysis, leading to accurate and reliable experimental data interpretation.