

Scheme of Instruction & Syllabi

For
Master of Science
In
Chemistry

Two Years CBCS M.Sc. Course in Chemistry
(Academic Session: 2026-27)

Second Year



Department of Applied Sciences & Humanities

INVERTIS UNIVERSITY

Invertis Village

Bareilly-Lucknow NH-24, Bareilly-243123, India

Programme Outcomes (POs)

- PO1: Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries.
- PO2: Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
- PO3: Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
- PO4: Students will be able to clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.
- PO5: Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
- PO6: Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
- PO7: Students will be able to function as a member of an interdisciplinary problem solving team.
- PO8: The graduate has specific skills in planning and conducting advanced chemical experiments and applying structural-chemical characterisation techniques.
- PO9: Are able to use modern instrumentation and classical techniques, to design experiments, and to properly record the results of their experiment.
- PO10: Are able to use modern library searching and retrieval methods to obtain information about a topic, chemical, chemical technique, or an issue relating to chemistry.
- PO11: Students should be able to communicate scientific results in writing and in oral presentation.
- PO12: Students should become proficient in their specialized area of chemistry and acquire the basic tools needed to carry out independent chemical research.

Programme Educational Objectives (PEO)

- PEO-1: The Masters in Chemistry will extend your depth and breadth of knowledge in all branches of chemistry, suitable for a professional chemist capable of conducting research.
- PEO-2: To carryout research in the trust areas of chemistry. Will be able to communicate effectively the scientific information and research results in written and oral formats, to both professional scientists and to the public.
- PEO-3: To motivate critical thinking and analytical skills to solve complex chemical problems and the Ability to handle problems of practical relevance to society while complying with economical, environmental, ethical, and safety factors.
- PEO-4: To practice chemistry by performance of experiments in the laboratory classes. To perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusions.

M. Sc. CHEMISTRY (FIRST YEAR)

SEMESTER-I

S.No.	Course Code	Subject	Periods			Evaluation Scheme			Credit
			L	T	P	MSM	ESM	Total Marks	
1	MCH101	Coordination Chemistry	3	1	-	30	70	100	4
2	MCH102	Intermediates and Reaction Mechanism	3	1	-	30	70	100	4
3	MCH103	Quantum Chemistry and Stat. Mechanics	3	1	-	30	70	100	4
4	MCH104	Analytical Chemistry-I	3	1		30	70	100	4
5	MCH151	Inorganic Chemistry Practical-I	-	-	4	20	30	50	2
6	MCH152	Organic Chemistry Practical-I	-	-	4	20	30	50	2
7	MCH153	Physical Chemistry Practical-I	-	-	4	20	30	50	2
8	EPC001	WeXI AI Proficiency English Course	-	-	-	-	50	50	2
		Total	12	4	12	180	420	600	24

SEMESTER-II

S.No.	Course Code	Subject	Periods			Evaluation Scheme			Credit
			L	T	P	MSM	ESM	Total Marks	
1	MCH201	Organometallic Chemistry and Bioinorganic Chemistry	3	1	-	30	70	100	4
2	MCH202	Pericyclic Reaction and Photochemistry	3	1	-	30	70	100	4
3	MCH203	Electrochemistry, Chem. Kinetics and Macromolecules	3	1	-	30	70	100	4
4	MCH204	Analytical Chemistry-II	3	1	-	30	70	100	4
5	MCH251	Inorganic Chemistry Practical-II	-	-	4	20	30	50	2
6	MCH252	Organic Chemistry Practical-II	-	-	4	20	30	50	2
7	MCH253	Physical Chemistry. Practical-II	-	-	4	20	30	50	2
8	EPC002	WeXI AI Proficiency English Course	-	-	-	-	50	50	2
		Total	12	4	12	180	420	600	24

M. Sc. CHEMISTRY (SECOND YEAR)

SEMESTER -III

S.N	Course Code	Subject				Evaluation Scheme			Credit
			L	T	P	MSM	ESM	Total Marks	
1	MCH301	Supra molecular and Materials Chemistry	3	1	-	30	70	100	4
2	MCH302	Green Chemistry and Catalysis	3	1	-	30	70	100	4
3	MCH303	Molecular Spectroscopy and Group Theory	3	1	-	30	70	100	4
4	MCH304	Analytical Chemistry-III	3	1	-	30	70	100	4
5	MCH3011*	Advanced Inorganic Chemistry	3	1	-	30	70	100	4
6	MCH3012*	Stereochemistry and Heterocyclic Chemistry							
7	MCH3013*	Advanced Physical Chemistry							
8	MCH3014*	Advanced Analytical Chemistry							
9	MCH351*	Inorganic Chemistry Practical-III	-	-	4	20	30	50	2
10	MCH352*	Organic Chemistry Practical-III							
11	MCH353*	Physical Chemistry Practical-III							
12	MCH354*	Analytical Chemistry Practical-I							
13	MCH355**	Field Project/Internship	-	-	-	30	70	100	4
		Total	15	5	4	200	450	650	26

*Student has to choose only one (theory + lab) in the specialization.

**Students can carry out Field project/Internship after 2nd semester of the program

(Inorganic group)									
S.No.	Course Code	Subject	Evaluation Scheme						Credit
			L	T	P	MSM	ESM	Total Marks	
1	MCH4011	Spectroscopic Methods	3	1	-	30	70	100	4
2	MCH4012	Bioinorganic Chemistry	3	1	-	30	70	100	4
3	MCH4013	Analytical Techniques	3	1	-	30	70	100	4
4	MCH4014	Nuclear and Radiochemistry	3	1	-	30	70	100	4
5	MCH451	Inorganic Chemistry Practical-IV	-	-	4	20	30	50	2
6	MCH452	Project Dissertation	-	-	-	50	150	200	8
		Total	12	4	4	190	460	650	26

(Organic group)									
S.No.	Course Code	Subject	Evaluation Scheme						Credit
			L	T	P	MSM	ESM	Total Marks	
1	MCH4021	Advanced Organic Synthesis	3	1	-	30	70	100	4
2	MCH4022	Natural Products	3	1	-	30	70	100	4
3	MCH4023	Spectroscopy	3	1	-	30	70	100	4
4	MCH4024	Medicinal Chemistry	3	1	-	30	70	100	4
5	MCH453	Organic Chemistry Practical-IV	-	-	4	20	30	50	2
6	MCH454	Project Dissertation	-	-	-	50	150	200	8
		Total	12	4	4	190	460	650	26

(Physical group)									
S.No.	Course Code	Subject	Evaluation Scheme						Credit
			L	T	P	MSM	ESM	Total Marks	
1	MCH4031	Advanced Electrochemistry	3	1	-	30	70	100	4
2	MCH4032	Photo and Radio Chemistry	3	1	-	30	70	100	4
3	MCH4033	Biophysical Chemistry	3	1	-	30	70	100	4
4	MCH4034	Crystallography	3	1	-	30	70	100	4
5	MCH455	Physical Chemistry Practical-IV	-	-	4	20	30	50	2
6	MCH456	Project Dissertation	-	-	-	50	150	200	8
		Total	12	4	4	190	460	650	26

(Analytical group)									
S.No.	Course Code	Subject	Evaluation Scheme						Credit
			L	T	P	MSM	ESM	Total Marks	
1	MCH4041	Separation Techniques	3	1	-	30	70	100	4
2	MCH4042	Polarography	3	1	-	30	70	100	4
3	MCH4043	Spectroscopic Techniques	3	1	-	30	70	100	4
4	MCH4044	Micro Analytical Techniques	3	1	-	30	70	100	4
5	MCH457	Analytical Chemistry Practical-II	-	-	4	20	30	50	2
6	MCH458	Project Dissertation	-	-	-	50	150	200	8
		Total	12	4	4	190	460	650	26

SEMESTER-III

MCH301: Supramolecular and Materials Chemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of Supra molecular and Materials Chemistry

Course Objectives:

1. Provide a strong theoretical foundation in intermolecular forces.
2. Teach the principles of host-guest chemistry and the design of selective receptors like crown ethers, cyclodextrins, and calixarenes.
3. Examine how bottom-up fabrication approaches use thermodynamic and kinetic controls to build complex supramolecular architectures and molecular machines.
4. Connect supramolecular principles to the creation of functional nanomaterials, responsive polymers, and smart surfaces
5. Introduce modern spectroscopic and thermodynamic methods used to quantify binding constants and analyze complex equilibria.
6. To understand the atomic arrangement of atoms

Detailed Syllabus

Unit 1: Fundamentals of Supramolecular Chemistry

Definition, Types of non-covalent interactions (H-bonding, electrostatic (ion-ion, ion-dipole, dipole-dipole), hydrophobic and steric, π - π , van der Waals), concepts of host-guest complexation with examples from ionophore chemistry, crown ethers, cryptands, calixarenes, macrocyclic effect, self-assembly, molecular boxes and capsules.

Unit 2: Synthesis of Supramolecules

Synthesis of macrocycles, synthesis of receptors for cations and anions, and neutral molecules, non-covalent synthesis, metal directed self-assembly of complex supramolecular architecture– rotaxanes, catenanes. Application of supramolecular chemistry: Supramolecules in catalysis, as membrane transport, supramolecular devices and switches, memories, logic gates. Conversion of light into fuels and light into electricity.

Unit 3: Introduction to Nanoscale Materials

The nano-length scale, quantum confinement effect, consequences of quantum confinement of electrons, material dependence of nanoscale and quantum size-effect. Crystalline and amorphous nanomaterials, nanocrystals, surface energy and crystal facets. Ostwald ripening, nucleation and growth of nanoparticles. Physical and chemical characteristics of nanomaterials: Surface area measurement, determination of size and textural studies, composition and elemental analysis.

Unit 4: Synthesis and Applications of Nanomaterials

Concepts of top-down and bottom-up approaches, chemical, aerogel, aerosol, spray-pyrolysis, microemulsion, solvothermal, sonochemical, and microwave methods of synthesis. Reactivity studies by adsorption–CO₂ and destructive adsorption, detoxification by adsorption, air purification, modification of nanocrystalline metal oxides and their applications.

Text and Reference Books**References:**

1. Steed, J.W. and Aswood, J.L., "Supramolecular Chemistry", Wiley. 2000
2. Beer, P.D., Gale, P.A. and Smith, D.K., "Supramolecular Chemistry", Oxford Chemistry Printers, ISBN-10: 0-19-850447-0. 1999
3. Schneider, H.J. and Yatsimirsky, A., "Principles and Methods in Supramolecular Chemistry", Wiley-VCH, ISBN: 0-471-97253-3. 2000
4. Klabunde, K.J. (Ed.), "Nanoscale Materials in Chemistry", WileyInterscience, New York. 2001

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Articulate the significance of weak intermolecular forces and define the factors dictating molecular recognition and self-organization
CO2	Apply the concepts of preorganization and complementarity to rationally design simple receptors and supramolecular building blocks
CO3	Devise synthetic strategies and metal-directed or template-controlled reactions to construct supramolecular polymers, interlocked molecules, and nanomaterials
CO4	Evaluate the role of supramolecular chemistry in solving real-world challenges, such as targeted drug delivery, environmental sensing, and green nanotechnology
CO5	Analyze modern scientific literature and laboratory reports within the rapidly advancing fields of nanoscience and advanced functional materials
CO6	Understand the mechanism of particles in properties

MCH302: Green Chemistry and Catalysis

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: -

Concept of photochemistry & pericyclic reactions and chemistry of life processes.

Course Objectives:

1. To introduce the principles and assessment tools of Green Chemistry.
2. To familiarize students with green synthesis, alternative solvents, renewable feedstocks, and biocatalysis.
3. To develop an understanding of catalytic concepts and mechanisms.
4. To provide knowledge of green catalytic processes and emerging technologies.
5. Explore how catalysts drive sustainability by lowering activation energy, boosting selectivity, and enabling reactions at ambient conditions
6. Study industrial-scale transformations, such as enzymatic antibiotic production or catalytic synthesis of ibuprofen, to understand practical applications

Detailed Syllabus
Unit-1: Introduction of Green Chemistry

Green Chemistry: definition, need and historical background; the twelve principles of Green Chemistry (Anastas and Warner) with illustrative examples.

Green chemistry metrics: atom economy, E-factor, reaction mass efficiency (RME), carbon efficiency and environmental quotient (EQ); comparison of traditional and green routes for selected industrial products (e.g., ibuprofen, adipic acid). Green solvents: water, supercritical fluids (scCO₂), ionic liquids, deep eutectic solvents and solvent-free reactions — advantages and limitations.

Unit-2: Green Synthetic Methodologies

Catalysis in Green Synthesis: The vital role of catalysts in green manufacturing. Homogeneous vs. heterogeneous green catalysis. Advantages of biocatalysis (enzymatic reactions), phase-transfer catalysis, and biomimetic catalysts over traditional stoichiometric reagents.

Non-Conventional Energy Sources: Activation of chemical reactions using sustainable energy inputs. Microwave-assisted Synthesis: Principles of dielectric heating, comparison with conventional thermal heating, solvent-free microwave reactions. Ultrasound-assisted (Sonochemical) Synthesis: Acoustic cavitation, mechanical and chemical effects, synthesis of organometallic and organic compounds.

Unit-3: Fundamentals of Catalysis

Basic Concepts and Classification of Catalysis

Catalytic cycle, activation energy, turnover number (TON), and turnover frequency (TOF). Classification into homogeneous, heterogeneous, and enzymatic catalysis with comparative features.

Homogeneous and Heterogeneous Catalysis

Homogeneous catalysis: acid–base catalysis, organometallic catalysts and their mechanisms – Wilkinson’s catalyst (hydrogenation), Wacker process, and hydroformylation (oxo process). Heterogeneous catalysis: adsorption models (Langmuir–Hinshelwood and Eley–Rideal mechanisms), zeolites and molecular sieves as shape-selective catalysts, and supported metal catalysts.

Unit-4: Green and Industrial Catalytic Processes

Phase-transfer catalysis: principle, types of phase-transfer catalysts (quaternary ammonium/phosphonium salts, crown ethers) and green synthetic applications.

Nanocatalysis: nanoparticles and nanostructured materials as catalysts, advantages of high surface-to-volume ratio, recoverability and recyclability of nanocatalysts.

Photocatalysis and electrocatalysis: semiconductor photocatalysts (TiO₂-based systems), visible-light photoredox catalysis, principles of electrocatalysis in green oxidation/reduction.

Green polymers and bioplastics (Polylactic acid – PLA). Real-world applications of green chemistry and catalysis in the textile, pharmaceutical, and agrochemical industries

Text and Reference Books

Reference Books:

1. Anastas, P. T. & Warner, J. C. (1998). Green Chemistry: Theory and Practice. Oxford University Press.
2. Ahluwalia, V. K. (2013). Green Chemistry: Environmentally Benign Reactions (2nd ed.). CRC Press / Ane Books.
3. Sharma, R. K. & Ahluwalia, V. K. (2012). Green Chemistry and Environment. CRC Press.
4. Clark, J. H. & Macquarrie, D. J. (Eds.) (2002). Handbook of Green Chemistry and Technology. Blackwell Science.
5. Sheldon, R. A., Arends, I. & Hanefeld, U. (2007). Green Chemistry and Catalysis. Wiley-VCH.
6. Cornils, B. & Herrmann, W. A. (Eds.) (2002). Applied Homogeneous Catalysis with Organometal-

lic Compounds (2nd ed.). Wiley-VCH.

7. Rothenberg, G. (2008). Catalysis: Concepts and Green Applications. Wiley-VCH.
8. Lancaster, M. (2016). Green Chemistry: An Introductory Text (3rd ed.). Royal Society of Chemistry.
9. Matlack, A. S. (2010). Introduction to Green Chemistry (2nd ed.). CRC Press.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Explain the twelve principles of Green Chemistry and evaluate the greenness of a chemical process using metrics such as atom economy, E-factor and reaction mass efficiency.
CO2	Describe green synthetic techniques including alternative solvents, renewable feedstocks, biocatalysis, microwave- and ultrasound-assisted synthesis, and solvent-free reactions.
CO3	Explain the fundamental concepts of catalysis (homogeneous, heterogeneous and enzymatic), catalytic cycles, turnover number/frequency, and correlate structure with catalytic activity.
CO4	Analyse the role of green and industrial catalytic processes such as phase-transfer catalysis, asymmetric catalysis, nanocatalysis, photocatalysis and organometallic catalysis in sustainable transformations.
CO5	Evaluate industrial case studies and emerging applications (Cativa/Monsanto process, click chemistry, flow chemistry, CO ₂ utilisation) and apply green chemistry and catalysis concepts to problems of the type asked in CSIR-NET and GATE Chemistry examinations.
CO6	Compare and select the most viable type of catalyst (metal-based, organocatalysts, or enzymes) for specific bulk or pharmaceutical syntheses

MCH303: Molecular Spectroscopy and Group Theory

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: -

Concept of spectroscopic methods and group theory.

Course Objectives:

1. To know about recapitulation of essential quantum mechanics.
2. To understand the determination of bond lengths and/ or atomic masses from microwave.
3. To learn the non-rigid rotator.
4. To learn the classification of polyatomic molecules.
5. To know the normal coordinate analysis of homonuclear and heteronuclear diatomic molecules.
6. To understand the symmetry and orientation of molecules.

Detailed Syllabus
Unit-1: Overview of Molecular Spectroscopy

Different aspects of molecular spectroscopy, the Born-oppenheimer approximation, transition probability, oscillator strength, the integrated absorption coefficient.

Unit-2: Rotational Spectroscopy

Rotational spectroscopy of diatomic molecules based on rigid rotator approximation. Determination of bond lengths and/ or atomic masses from microwave, Non-rigid rotator. Classification of polyatomic molecules. Rotation spectra of the linear, spherical top and asymmetric top polyatomic molecules.

Unit-3: Vibrational spectroscopy: Normal coordinate analysis of homonuclear and heteronuclear diatomic molecules. Derivation of selection rules for diatomic molecules based on Harmonic oscillator approximation. Anharmonic oscillator.

Unit-4: Raman spectroscopy: Stokes and anti-Stokes lines. Polarizability ellipsoids. Rotational and Vibrational Raman spectroscopy. Selection rules. Polariza-

tion of Raman lines.

Unit 5: Molecular Symmetry and Group theory

The concept of group, symmetry operation and symmetry element in molecules, matrix representation of symmetry operations, point groups, representation of group, reducible and irreducible representation, great orthogonality theorem and its consequences. Application of group theory to atomic orbitals in ligands fields. Prediction of infrared, Raman active vibration modes, and electronic transition.

Text and Reference Books

Reference Books:

1. Banwell, C.N. and McCash, E.L.M., "Fundamentals of Molecular Spectroscopy", 4th Ed. McGraw-Hill N. Y. 1999.
2. Graybeal, J.D., "Molecular Spectroscopy", McGraw-Hill. 1983.
3. Atkins, P. and Paula, J.de, "Physical Chemistry", 7th Ed., Oxford Univ. Press. 2003.
4. Levine, I. N. "Quantum Chemistry", 7th Ed., PHI Learning Pvt. Ltd., Delhi. 2013
5. McQuarrie, D. A. "Quantum Chemistry" Reprint, Viva Books. 2007
6. Atkins, P. "Molecular Quantum Mechanics", 4th Ed., Oxford University Press. 2010
7. Cotton, F. A., "Chemical Applications of Group Theory", Reprint, Wiley Eastern. 1994

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the Stokes and anti-Stokes lines. Polarizability ellipsoids. Rotational and Vibrational Raman spectroscopy.
CO2	Understand the Selection rules. Polarization of Raman lines.
CO3	Explain the selection rules for diatomic molecules based on Harmonic oscillator approximation.
CO4	Predict molecular chirality, dipole moments, and physical polarities using symmetry criteria
CO5	Determine electronic term symbols and analyze electronic transitions for both diatomic and polyatomic molecules
CO6	Identify and calculate fundamental spectroscopic parameters such as force constants, bond lengths, and moments of inertia

MCH304: Analytical Chemistry-III

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: -

Develop the photometric titrations and chemical sensors skills.

Course Objectives:

1. To know about photometric titration curves.
2. To understand the Job's method of continuous variation.
3. To learn the interface potentials.
4. To learn the hybrid composites.
5. To know the, galvanostatic intermittent titration technique.
6. To understand the metal-organic frameworks.

Detailed Syllabus

Unit-1: Photometric Titrations: photometric titration curves, acid-base titrations-monitoring pH indicators or unbuffered weak acids. **Complexometric titrations**-Metal-ion titrations using standard EDTA solutions (e.g., Cu vs. EDTA, Fe vs. EDTA using salicylic acid). **Redox titrations**-tracking the color change of oxidizing/reducing agents. **Precipitation titrations**-Measuring turbidity or the consumption of absorbing species. Quantitative applications, typical examples of one component and multicomponent analyses.

Unit-2: Spectrophotometric Determination of Stoichiometry of Complexes: Job's method of continuous variation, mole ratio and slope ratio analysis, Advantages and limitations, Typical examples of continuous variations plot for the metal–ligand complex between Fe^{2+} and *o*-phenanthroline, Fe^{2+} and salicylic acid, mole-ratio method for Ni [(3PPAN)₂] complex and Mn[APAN]₂ complex.

Unit-3: Galvanostatic Techniques

Three-electrode vs. two-electrode systems: Limitations of two-electrode setups, roles of the Luggin capillary and salt bridges. Interface potentials: Double-layer capacitance, faradaic vs. non-faradaic currents. Controlled-current methods: Chronopotentiometry., Galvanostatic Coulometry (Controlled-Current Coulometry), Battery charge/discharge cycling, galvanostatic intermittent titration technique (GITT), **Open Circuit Potential (OCP):** Baseline potential measurements without external current or voltage applied. **Zero Resistance Ammetry (ZRA):** Measuring galvanic currents for corrosion monitoring.

Unit-4: Materials for Advanced Chemical Sensors

Carbon-Based Nanomaterials, Metal and Metal Oxide Nanostructures, Silicon Nanowires and Semiconductor Materials, Metal-Organic Frameworks (MOFs) and Hybrid Composites, Emerging Materials, Challenges, Limitations, and Future Perspectives.

Text and Reference Books

Reference Books:

1. D.A. Skoog and D.M. West, *Fundamental of Analytical Chemistry*, International Edition, 7th Edition (1996), Saunders College Publishing, Philadelphia, Holt, London.
2. R.L. Pecsok, L.D. Shields, T. Cairns and L.C. McWilliam, *Modern Methods of Chemical Analysis*, 2nd (1976), John Wiley & Sons, New York.
3. D.A. Skoog, *Principles of Instrumental Analysis*, 5th Edition (1998), Saunders College of Publishing, Philadelphia, London.
4. Noam Eliaz and Eliezer Gileadi, *Physical Electrochemistry: Fundamentals, Techniques, and Applications*, 2nd Edition (2019), John Wiley & Sons, New York.
5. Chemical Sensors: Comprehensive Sensor Technologies Volume 4: Solid State Devices" by Ghenadii Korotcenkov
6. Rene Lalauze, *Chemical Sensors and Biosensors*, 2012, John Wiley & Sons, New York.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Explain the complexometric titrations-metal-ion titrations using standard EDTA solutions
CO2	Describe the continuous variations plot for the metal–ligand complex between Fe ²⁺ and o-phenanthroline.
CO3	Explain the measuring galvanic currents for corrosion monitoring
CO4	Describe the metal and metal oxide nanostructures
CO5	Explain the battery charge/discharge cycling
CO6	Describe the mole-ratio method for Ni [(3PPAN) ₂] complex and Mn[APAN] ₂ complex.

MCH3011: Advanced Inorganic Chemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of chemistry of inorganic rings and solution of multielectron problems.

Course Objectives:

1. To know about chemistry of inorganic rings.
2. To understand the water splitting reaction.
3. To learn the role of metals.
4. To learn the pillared clays and zeolites from measurement of surface area.
5. To know the introduction to the solution of multielectron problems.
6. To understand the evaluation of energy matrices using Slater's method.

Detailed Syllabus

Unit-1:

Current Trends in Organometallic Chemistry: Organometallic approach to water splitting, role of osmium, ruthenium, titanium, manganese complexes in water splitting, homolytic activation of water with nickel, closed circle water splitting model, E-H bond activation of ammonia and water by phosphorous compounds, oxygen atom transfer reaction, role of pincer ligands, multimetallic catalysis based on heterometallic complexes.

Unit-2:

Splitting of Orbitals in Metal Complexes: Introduction to the solution of multielectron problems, the central field approximation, angular momenta, step up and step down operators and their use in atomic spectra. Lande's interval rule. Evaluation of energy matrices using Slater's method. The weak and strong field cases. Generation of a secular determinant for 3F term (d^2) in weak field. Bethe's method of descending symmetry. Non octahedral fields, tetrahedral (including contribution of odd harmonics), trigonal and tetragonal (including D_s & D_t parameters). Spin orbit coupling and its magnitude in comparison to crystal field. Splitting of e_g and t_{2g} orbitals due to spin orbit coupling. For a d^1 and d^9

case. The use of double group D₄ and O. Effect of spin orbit coupling on A, E and T terms in octahedral fields.

Text and Reference Books

Reference Books:

1. Crabtree, R. H., "Organometallics and Catalysis: An Introduction", Wiley, 6th ed.
2. Marshal. C. E. The Physical Chemistry and Mineralogy of Soil Vol. I Soil Materials John Wiley & Sons. N.Y.(1964).
3. Wells, A. F. Structural Inorganic Chemistry 5th Ed, Oxford University Press, Oxford (1984).
4. Adams, D. M. Inorganic Solids. An Introduction to Concepts in Solid-State Structural Chemistry John Wiley & Sons, London (1974).
5. Azaroff, L. V. Introduction to Solids Tata McGraw Hill Publishing Co. Ltd. Bombay- New Delhi (1960).
6. Breck. D. W. Zeolites Molecular Sieves- Structure, Chemistry and Use. John Wiley & Sons N.Y. (1974).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the synthesis of hydrogen
CO2	Understand the chemistry of metals
CO3	Explain the water splitting
CO4	Develop the effect of spin orbit coupling on A, E and T terms in octahedral fields.
CO5	Calculate the Non octahedral fields, tetrahedral (including contribution of odd harmonics).
CO6	Illustrate the generation of a secular determinant for 3F term (d ²) in weak field.

MCH3012: Stereochemistry and Heterocyclic Chemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of stereochemistry and heterocyclic chemistry.

Course Objectives:

1. To know about racemic modification.
2. To understand the Cram's rule, Prelog's and Hotea's rules.
3. To learn the qualitative correlation between conformation and reactivity.
4. To learn the benzofused five membered heterocycles with one heteroatom.
5. To know the chemistry of bicyclic compounds containing one or more heteroatoms.
6. To understand the phenoxazines, phenothiazines, chemistry of porphyrins.

Detailed Syllabus

Section-A:

Stereochemistry

Classification, racemic modification, molecules with one, two or more chiral centres. Axial and planar chirality and helicity (P & M), Cahn-Ingold-Prelog (CIP) priority rules for *R/S*, *E/Z*, and *D/L* systems. Stereochemistry and configurations of allenes, spiranes, alkylidene, cycloalkanes, biphenyls and bridged biphenyls. Asymmetric induction: Cram's rule, Cram's Chelate Model, Felkin-Anh Model, Prelog's and Hotea's rules; dynamic stereochemistry, qualitative correlation between conformation and reactivity. Stereogenic and prochiral centres. Topicity of ligands (homotopic, enantiotopic, diastereotopic) and topicity of faces (*Re* and *Si*) and their nomenclature; Stereogenicity, chirogenicity, and pseudoasymmetry.

Section-B

Heterocyclic Chemistry

Introduction to heterocycles: Nomenclature, spectral characteristics, reactivity and aromaticity Synthesis and reactions of three and four membered hetero-

ocycles, e.g., aziridine, azirine, azetidine, oxiranes, thiarines, oxetenes and thietanes. Five membered rings with two heteroatoms: pyrazole, imidazole, oxazole, thiazole, isothiazole and benzofused analogs. Benzofused five membered heterocycles with one heteroatom, e.g. indole, benzofuran, benzothiophene. Chemistry of bicyclic compounds containing one or more heteroatoms. Benzofused six membered rings with one, two and three heteroatoms: benzopyrans, quinolines, isoquinolines, quinoxalines, acridines, phenoxazines, phenothiazines, chemistry of porphyrins.

Text and Reference Books

Reference Books:

1. Carey, F.A. & Sundberg, R. J. Advanced Organic Chemistry, Parts A & B, Plenum: U.S. (2004).
2. Carruthers, W. Modern Methods of Organic Synthesis Cambridge University Press (1971).
3. Acheson, R. M. introduction to the Chemistry of Heterocyclic Compounds John Wiley & Sons (1976).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Understand Cram's rule, Felkin-Anh rule and Prelog's rule.
CO2	Explain topicity of ligand and faces.
CO3	Explain the crown ethers and polymer supported reagents in organic synthesis.
CO4	Calculate the Benzofused six membered rings with one, two and three heteroatoms.
CO5	Illustrate the benzopyrans, quinolines, isoquinolines.
CO6	Analyze the role of the position of heteroatoms

MCH3013: Advanced Physical Chemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: -

Concept of irreversible thermodynamics and transport phenomena.

Course Objectives:

1. To know about meaning and scope of irreversible thermodynamics.
2. To understand the phenomenological laws- Linear laws.
3. To learn the Gibbs equation.
4. To learn the Fick's first and second laws.
5. To know the relation between lux and viscosity.
6. To understand the factors affecting the CMC of surfactants, counterion binding to micelles.

Detailed Syllabus

Unit-1: Irreversible thermodynamics: Meaning and scope of irreversible thermodynamics. Thermodynamic criteria for non-equilibrium states, Phenomenological laws- Linear laws, Gibbs equation, Onsager's reciprocal relation.

Unit-2: Transport phenomena: Diffusion coefficients, Fick's first and second laws, relation between lux and viscosity, relation between diffusion coefficient and mean free path, relation between thermal conductivity/viscosity and mean free path of a perfect gas, Einstein relation, Nernst-Einstein equation.

Unit-3: Models for electronic Study: Brief review of the postulates and various models, Hydrogen like and many electron systems, Slater determinations for ground and excited states of atoms. Approximation methods, Hartree-Fock methods, Electron correlation and post Hartree-Fock methods.

Unit-3: Density Functional Theory: Electron density and hole functions, The Hohenberg-Kohn theorems, the Kohn-Sham approach, exchange-correlation functionals.

Text and Reference Books

Reference Books:

1. Katchalsky, A. & Curren, P. F. Non Equilibrium Thermodynamics in Biophysics Harvard University Press: Cambridge (1965).
2. Zwanzig, R. Nonequilibrium Statistical Mechanics Oxford University Press (2001)
3. Laidler, K. J. Chemical Kinetics 3rd Ed., Benjamin Cummings (1997).
4. Szabo, A., Ostlund, N. S., "Modern quantum chemistry", 1 st Revised Edn, Dover Publishers
5. Cramer, C. J., "Essentials of computational chemistry", 2nd ed., John Wiley & Sons Ltd, West Sussex, England.
6. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 81h Ed., Oxford University Press (2006).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the thermodynamic criteria for non-equilibrium states.
CO2	Understand themicellization, hydrophobic interaction, critical micelle concentration (CMC).
CO3	Explain the, Krafft temperature, Factors affecting the CMC of surfactants.
CO4	Develop the, counterion binding to micelles, thermodynamics of micellization.
CO5	Calculate the, solubilization, microemulsions
CO6	Illustrate the, reverse micelles, surface films (eletrokinetic phenomena), catalytic activity at surfaces.

MCH3014: Advanced Analytical Chemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: -

Concept of Microanalysis of real-world samples and Inorganic microanalysis.

Course Objectives:

1. To know about Scope and objectives of microanalytical technique.
2. To understand the Microanalytical technique based on size and amount of the sample.
3. To learn the polymeric materials.
4. To learn the estimation of protein in egg albumin.
5. To know the saponification value of fats/oils.
6. To understand the estimation of blood cholesterol, DNA and RNA.

Detailed Syllabus

Unit-1: General introduction: Scope and objectives of microanalytical technique, Difference between micro and trace analysis, Microanalytical technique based on size and amount of the sample.
Unit-2: Microanalysis of real-world samples: Molecular recognition and targeted analysis using macrocyclic (crown ethers), macrobicyclic (cryptands), Supramolecular compounds (calixarenes) and polymeric materials.
Unit-3: Biochemical microanalysis: Estimation of carbohydrates, amino acids and ascorbic acid in biological systems, Estimation of protein in egg albumin, Estimation of free fatty acid, Iodine value and saponification value of fats/oils, Estimation of blood cholesterol, DNA and RNA.
Unit-4: Inorganic microanalysis: Principle, technique, qualitative and quantitative applications with special reference to Ring-oven technique and Ring colorimetric technique, chemical microscopy.
Unit-5: Organic microanalysis: Determination of alkoxy, acetyl, acyl, hydroxyl, carbonyl, active hydrogen, nitroso, sulfonyl, amides and ester groups, Determination of molecular weight

and percentage purity of carboxylic acid, estimation of sugars, estimation of unsaturation.

Unit-6: Microanalysis by kinetic methods: Theoretical basis, Kinetic parameters, Kinetic methods of microanalysis: Tangent, fixed time and addition method.

Text and Reference Books

Reference Books:

1. P.L. Kirk, *Quantitative Ultramicroanalysis*, John Wiley.
2. C.L. Wilson and D.L. Wilson, *Comprehensive Analytical Chemistry*", Vol. I (A) and I(B), Elsevier.
3. G.D. Christian, *Analytical Chemistry*, John Wiley & Sons, New York (2001).
4. S.M. Khopkar, *Analytical Chemistry of Macrocyclic and Supramolecular Compounds*, Narosa Publishing House, New Delhi (2002).
5. Jag Mohan, *Organic Analytical Chemistry - Theory and Practice*, Narosa Publishing House, New Delhi (2003).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the estimation of free fatty acid, Iodine value.
CO2	Understand the determination of alkoxy.
CO3	Explain the active hydrogen, nitroso.
CO4	Develop the percentage purity of carboxylic acid.
CO5	Calculate the estimation of unsaturation.
CO6	Illustrate the Tangent, fixed time and addition method.

MCH351: Inorganic Chemistry Practical-III

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Prerequisite: Develop the inorganic chemistry practical skills.

Course Objectives:

1. To know about Synthesis of inorganic complexes/compounds.
2. To understand the characterization by various physicochemical methods.
3. To learn the IR, UV, Visible, NMR, magnetic susceptibility.

Detailed Syllabus

Synthesis of inorganic complexes/compounds and their characterization by various physicochemical methods, viz. IR, UV, Visible, NMR, magnetic susceptibility etc. Selection can be made from the following or any other from the existed literature.

- (i) Metal acetylacetonates.
- (ii) Cis and trans isomers of $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$.
- (iii) Ion-exchange separation of oxidation states of vanadium.
- (iv) Preparation of Ferrocene.
- (v) Preparation of triphenyl phosphine Ph_3P , and its transition metal complexes.
- (vi) Determination of Cr(III) complexes: $[\text{Cr}(\text{H}_2\text{O})_6]\text{NO}_3 \cdot 3\text{H}_2\text{O}$; $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$; $[\text{Cr}(\text{en})_3]\text{Cl}_3$; $\text{Cr}(\text{acac})_3$.
- (vii) Tin(IV) iodide, Tin(IV) chloride, Tin(II) iodide.
- (viii) (N,N)-bis(salicylaldehyde)ethylenediamine Salen H₂; and its cobalt complex $[\text{Co}(\text{Salen})]$.
- (ix) Reaction of Cr(II) with multidentate ligands, a kinetics experiment.
- (x) Vanadyl acetylacetonate.
- (xi) Other new novel synthesis reported in literature from time to time.

Text and Reference Books

References:

1. Metal acetylacetonates *Inorg. Synth.* 1957, 5, 130.
2. Cis and trans isomers of $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$ *J. Chem. Soc.*, 1960, 4369.
3. Ion-exchange separation of oxidation states of vanadium. *J. Chem. Educ.*, 1980, 57, 316-319; 1978, 55, 55.
4. Preparation of Ferrocene. *J. Chem. Educ.* 1966, 43, 73; 1976, 53, 730.
5. Tin(IV) iodide, Tin(IV) chloride, Tin(II) iodide. *Inorg. Synth.* 1953, 4, 119.

6. (N,N)-bis(salicylaldehyde)ethylenediamine Salen H₂; and its cobalt complex [Co(Salen)]. J. Chem_Educ.1977, 54, 443,1973, 50, 670.
7. Reaction of Cr(III) with multidentate ligands, a kinetics experiment. J. Am. Chem. Soc.1953. 75, 5670.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the Metal acetylacetonates
CO2	Understand the Cis and trans isomers of [Co(en) ₂ C ₁₂]Cl.
CO3	Explain the Ion-exchange separation of oxidation states of vanadium.
CO4	Preparation of Ferrocene.
CO5	Preparation of triphenyl phosphine Ph ₃ P, and its transition metal complexes.
CO6	Illustrate the Cr(H ₂ O) ₆]NO ₃ .3H ₂ O; [Cr(H ₂ O) ₄ Cl ₂]Cl.2H ₂ O; [Cr(en) ₃]Cl ₃ ; Cr(acac) ₃ .

MCH352: Organic Chemistry Practical-III

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Prerequisite: Develop the organic chemistry practical skills.

Course Objectives:

1. To know about semi-micro qualitative analysis of single/poly functional compounds.
2. To learn the separation of mixtures by chemical and chromatographic methods.
3. To learn the isolation of caffeine from tea leaves.

Detailed Syllabus

Qualitative analysis

1. Semi-micro qualitative analysis of single/poly functional compounds (data).
2. Separation of mixtures by chemical and chromatographic methods.
3. Isolation of natural products
 - i. Isolation of caffeine from tea leaves
 - ii. Isolation of piperine from black pepper
 - iii. Isolation of 13-carotene from carrots
 - iv. Isolation of lycopene from tomatoes
 - v. Isolation of cholesterol from bile stones

Text and Reference Books

Reference Books:

1. Vogel, A. I. Vogel's Qualitative Inorganic Analysis - 7th ed. (revised by G. Svehla) Longmans (1996) ISBN 058-221866-7
2. Vogel, A. I. Vogel's Textbook of Quantitative Chemical Analysis - 5th Ed. Longman (1989).
3. Addison Ault Techniques and Experiments for Organic Chemistry 6th

Ed. University Science Books (1998).

4. Mann, F. G. & Saunders, B. C. Practical Organic Chemistry 4th Ed. Orient Longmans (1990).
5. Vogel, A. I. Vogel's Textbook of Practical Organic Chemistry 5th Ed. (revised by A.R. Tatchell et al.) Wiley (1989) ISBN 0582-46236-3

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the Separation of mixtures by chemical and chromatographic methods.
CO2	Understand the Isolation of 13-carotene from carrots.
CO3	Explain the Isolation of lycopene from tomatoes.
CO4	Develop the Isolation of cholesterol from bile stones.
CO5	Calculate the Isolation of natural products.
CO6	Illustrate the Isolation of piperine from black pepper.

MCH353: Physical Chemistry Practical-III

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Prerequisite: Develop the physical chemistry practical skills.

Course Objectives:

1. To know about Titrate a moderately strong acid (salicylic/mandelic acid).
2. To understand the double alkali method.
3. To learn the salt-line method.

Detailed Syllabus

1. Titrate a moderately strong acid (salicylic/mandelic acid) by the
 - (a) salt-line method
 - (b) double alkali method.
2. Titrate a mixture of copper sulphate, acetic acid and sulphuric acid with sodium hydroxide.
3. Titrate a tribasic acid (phosphoric acid) against NaOH and Ba(OH)₂ conductometrically.
4. Estimate the concentration of each component of a mixture of AgNO₃ and HNO₃ by conductometric titration against NaOH.
5. Determine the degree of hydrolysis of aniline hydrochloride.
6. Determine the critical micelle concentration of a surfactant(sodium lauryl sulphate) by the conductivity method.
7. Ternary phase diagram of water, benzene, and acetic acid.

Text and Reference Books

Reference Books:

1. Daniels, F., Williams, J. W., Bender, P., Alberty, R. A., Conwell, C. D. & Harriman, J. E. Experimental Physical Chemistry, McGraw-Hill (1962).
2. Das & R. C. & Behera, B., Experimental Physical Chemistry, Tata

McGraw-Hill Publishing Co. Pvt. Ltd. (1993).

3. Shoemaker, D. P., Garland, C. W. & Nibler, J. W. Experiments in Physical Chemistry, McGraw-Hill: New York (1996).

4. Day, R. A., Jr. & Underwood, A. L. Quantitative Analysis 3rd Ed. Prentice-Hall India Pvt. Ltd.: New Delhi (1977).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the titration of a mixture of copper sulphate.
CO2	Understand the titration of a tribasic acid.
CO3	Explain the estimation of the concentration of each component of a mixture of AgNO_3 and HNO_3 by conductometric titration against NaOH .
CO4	Determine the degree of hydrolysis of aniline hydrochloride.
CO5	Calculate the Ternary phase diagram of water, benzene, and acetic acid.
CO6	Illustrate the titration of a moderately strong acid.

MCH354: Analytical Chemistry Practical-I

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Prerequisite: Develop the analytical chemistry experiments skills.

Course Objectives:

1. To know about ferrous ammonium sulfate potentiometrically with standard ceric sulfate solution.
2. To understand the Conductometric titration of (I) strong acid, monobasic weak acid or polybasic weak acid with strong base.
3. To learn the Determination of Na_2CO_3 content (in %) of washing soda using a pH meter.

Detailed Syllabus

1. Determination of ferrous ammonium sulfate potentiometrically with standard ceric sulfate solution (Direct and back titration).
2. Determination of concentration of halide ion(s) in the given solution potentiometrically.
3. Conductometric titration of (I) strong acid, monobasic weak acid or polybasic weak acid with strong base (ii) zinc with EDTA, and (iii) KCl vs AgNO_3
4. To obtain the protolysis curves involving cases of weak acid, mixture of acids and polybasic acid employing a pH meter and determine the amount of the respective acid (in ppm) in the given solution
5. Determination of Na_2CO_3 content (in %) of washing soda using a pH meter
6. Analysis of mixture of carbonate and bicarbonate (percent in ppm range) using a pH meter or suitable indicators
7. To study the current-potential characteristics of Cd^{2+} ions using DC polarography, sampled DC, cyclic voltammetry and pulse polarographic techniques
8. Determination of Cd^{2+} ions concentration in given solution polarographically following (I) calibration (ii) standard addition and (iii) the pilot-ion procedures
9. Determination of Zn^{2+} ions present at the ppm level in the solution employing conventional D.C. and pulse polarographic techniques
10. Determination of trace metal impurities present in a polluted water sample by anodic stripping voltammetric procedure

Text and Reference Books

Reference Books:

1. Shoemaker, D. P., Garland, C. W. & Nibler, J. W. Experiments in Physical Chemistry, McGraw-Hill: New York (1996).
2. Day, R. A., Jr. & Underwood, A. L. Quantitative Analysis 3rd Ed. Prentice-Hall India Pvt. Ltd.: New Delhi (1977).
3. Burns, D. T. & Ratenbury, E. M. Introductory Practical Physical Chemistry Pergamon Press (1966).
4. Harris, D. C. •Quantitative Chemical Analysis 6th Ed. W. H. Freeman & Co. (2002).
5. Willard, H. H., L. L., Dean, J. A., Settle, F. A. (Eds.) Instrumental Analysis - 7th Ed., Wadsworth Publishing (February 1988) ISBN 0534081428.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the protolysis curves involving cases of weak acid, mixture of acids.
CO2	Understand the analysis of mixture of carbonate and bicarbonate.
CO3	Explain the current-potential characteristics of Cd^{2+} ions using DC polarography.
CO4	Develop the standard addition.
CO5	Calculate the Cd^{2+} ions concentration in given solution polarographically.
CO6	Illustrate the pilot-ion procedures.

SEMESTER-IV

INORGANIC CHEMISTRY SPECIALIZATION

MCH4011: Spectroscopic Methods

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: -

Concept of Vibrational spectroscopy and Electronic paramagnetic resonance spectroscopy.

Course Objectives:

1. To know about vibrational motion and energies.
2. To understand the number of vibrational modes.
3. To learn the quadrupole interactions.
4. To learn the resonance Raman spectroscopy.
5. To know the Pascal's constants derivation and its applications.
6. To understand the spin-orbit coupling.

Detailed Syllabus

Unit-1: Fundamental Concept: Fluorescence, delayed fluorescence (TADF & TFDF), fluorescence quantum yield, lifetime, stokes shift, solvent effects, types of quenching with kinetics, energy transfer mechanisms, electron transfer mechanisms, inter system crossing, phosphorescence, aggregation-induced emission, photochromism, photocatalysis, photodynamic therapy, light-emitting cells.

Unit-2: Mossbauer spectroscopy: Doppler shift and recoil energy, isomer shift and its interpretation, quadrupole interactions, effect of magnetic field on Mossbauer spectra, applications to metal complexes, metal carbonyls. Fe-S. cluster.

Unit-3: Magnetism: Types of magnetic behaviour, magnetic susceptibilities, Pascal's constants derivation and its applications. Spin-orbit coupling and susceptibility of transition metal ions and rare earths; magnetic moments of metal complexes with crystal field terms of A, E and T symmetry.

Unit-4: Symmetry and Spectra: Potential energy level diagram. Symmetry requirements for n to n^* transitions, oscillator strengths, transition moment integrals (electric dipole and magnetic dipole moment operator), selection rules, spin orbit and vibronic coupling contributions, mixing of d and p orbitals in certain symmetries. Polarized absorption spectra. Survey of the electronic spectra of tetragonal complexes. Calculation of Dq and β for $Ni(II)$ Oh complexes, nephelauxetic effect, effect of σ and π bonding on the energy of t_{2g} orbitals and DT spectrochemical series, effect of distortion on the d orbital energy level (T_d , D_{2d} , D_{4h}).

Unit-5: Nuclear magnetic resonance spectroscopy: Nuclear spin quantum number, I , and its calculation using the nuclear shell model, spin parity rules. Types of nuclei based on value of I , nuclear spin angular momentum quantum number, and its relation to classical magnetic moment. Behaviour of a bar magnet in a magnetic field. Application of chemical shifts.

Unit-6: Electronic paramagnetic resonance spectroscopy: Electronic Zeeman effect, Zeeman Hamiltonian and EPR transition energy. EPR spectrometers, presentation of spectra. The effects of electron Zeeman, nuclear Zeeman and electron nuclear hyperfine terms in the Hamiltonian on the energy of the hydrogen atom. Shift operators and the second order effect. Hyperfine splitting.

Text and Reference Books

Reference Books:

1. Ebsworth, E. A.O. Structural Methods in Inorganic Chemistry Blackwell Scientific Publications (1991).
2. Drago, R. S. Physical Methods in Chemistry W. B. Saunders Co.: U.K. (1977).
3. Carrington, A. & McLachlan, A. D. Introduction to Magnetic Resonance Chapman & Hall: N.Y. (1983).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the nuclear spin quantum number.
CO2	Understand the effects of electron Zeeman, nuclear Zeeman and electron nuclear hyperfine terms in the Hamiltonian on the energy of the hydrogen atom.
CO3	Explain the shift operators and the second order effect. Hyperfine splitting.
CO4	Develop the polarized absorption spectra. Survey of the electronic spectra of tetragonal complexes.
CO5	Calculate the quadrupole interactions, effect of magnetic field on Mossbauer spectra.
CO6	Illustrate the symmetry of an entire set of normal vibrations, Raman spectra and selection rules.

MCH4012: Bio-Inorganic Chemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: -

Concept of survey of organometallic complexes according to ligands. π bonded organometallic compounds and metal complexes as probes of structure and reactivity with metal substitution.

Course Objectives:

1. To know about structure and bonding.
2. To understand the nitrosyls, tertiary phosphines.
3. To learn the-, biotransformation of non metallic inorganic compounds.
4. To learn the metal-carbon multiple bonds.
5. To know the role of metal ions in replication and transcription process of nucleic acids.
6. To understand the biochemistry of dioxygen, bioinorganic chips and biosensors.

Detailed Syllabus

Unit -1

Metal Bonding: General introduction, Structure and bonding, Survey of organometallic complexes according to ligands. π bonded organometallic compounds including carbonyls, nitrosyls, tertiary phosphines, hydrides, alkene, alkyne, cyclobutadiene, cyclopentadiene, arene compounds and their M.O. diagrams. Metal-carbon multiple bonds. Fluxional organometallic compounds including η^5 -allyl complexes and their characterization. Futuristic aspects of organo transition metal complexes as catalysts and in bio-inorganic chemistry. Role of metal ions in biological chelation therapy, chelating reagents in medicine, recent advances in cancer chemotherapy using chelates

Unit-2

Application of Metal Bonding: Fundamentals of inorganic biochemistry, geochemical effects on life systems, essential and non-essential elements in bio-systems. Role of alkali/alkaline earth metals in bio-systems. Role of d block elements and nonmetals in bio-systems. Role of metal ions in oxygen

carriers and synthetic oxygen carriers. Designing of chelating agents and metal chelates as medicines. Fixation of dinitrogen biologically and abiotically-, biotransformation of non metallic inorganic compounds. Environmental bioinorganic chemistry. Metal ions as probes for locating active sites. Anti-oxidants. Metal ions as antioxidants, metal ion enhancing catalytic activity of enzymes (Biocatalysts). Metal complexes of polynucleotides, nucleosides and nucleic acids (DNA & RNA) Template temperature, stability of DNA. Role of metal ions in replication and transcription process of nucleic acids. Biochemistry of dioxygen, bioinorganic chips and biosensors. Metals in the regulation of biochemical events. Transport and storage of metal ions in vivo. Metal complexes as probes of structure and reactivity with metal substitution.

Text and Reference Books

Reference Books:

1. Green, M. L. H. Organometallic Compounds Chapman & Hall: U.K. (1968).
2. Coates, U., Green, M. L. H. & Rowley, R. Principles of Organometallic Chemistry Chapman and Hall: U.K.(1988).
3. Lippard, S. J. & Berg, J. M. Principles of Bioinorganic Chemistry Univ. Science Books (1994).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the geo-chemical effects on life systems, essential and non-essential elements in bio-systems.
CO2	Understand the role of alkali/alkaline earth metals in bio-systems.
CO3	Explain the designing of chelating agents and metal chelates as medicines.
CO4	Develop the metals in the regulation of biochemical events.
CO5	Calculate the transport and storage of metal ions in vivo.
CO6	Illustrate the z-allyl complexes and their characterization.

MCH4013: Analytical Techniques

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of analytical techniques.

Course Objectives:

1. To know about polarography (DC, AC and pulse).
2. To understand the coulometry and anode stripping voltammetry.
3. To learn the dispersive and Fourier Transformed Raman.
4. To learn the Raman and surface Enhanced Raman Spectroscopy.
5. To know the GC-IR, TG-1R spectroscopy.
6. To understand the neutron diffraction and electron diffraction.

Detailed Syllabus

Unit-1: (i) Electroanalytical methods:- Polarography (DC, AC and pulse), cyclic voltammetry, coulometry and anode stripping voltammetry.
Unit-2: (ii) methods:- UV/Visible, X-ray photoelectron spectroscopy (XPS), Auger. Electron Spectroscopy (AL'S), ESCA, Atomic absorption and emission spectroscopy. (iii) Imaging Techniques: Electron microscopy (SEM, TEM)
Unit-3: (iv) Infrared Spectroscopy: Dispersive and Fourier Transformed Raman, Resonance Raman and Surface Enhanced Raman Spectroscopy-Dispersive and Fourier Transformed. (v) Hifanated Techniques: GC-IR, TG-1R Spectroscopy, GC-Mass Spectroscopy and any other.
Unit-4: (i) Diffraction Methods: Single crystal and Powder X-Ray Diffraction and their applications for inorganic compounds, neutron diffraction and electron diffraction.
Unit-5: (ii) Separation Methods: Theory and applications of separation methods in analytical chemistry: solvent extraction, ion exchangers including

liquid ion exchangers and chromatographic methods for identification and estimation of multicomponent systems (such as TLC, GC, HPLC, etc.).

(iii) Thermal Methods: TG, DTA, DSC and thermometric titrations.

Text and Reference Books

Reference Books:

1. Cheetham, A. K. & Day, P., Eds. Solid State Chemistry), Techniques Clarendon Press, Oxford (1987)
2. Christian, G. D., Analytical Chemistry, 60, Ed., John Wiley & Sons, Inc. (2004).
3. Skoog, D. A., West, D. M., Holler, R. J & Nieman, T. A. Principles of Instrumental Analysis Saunders Golden Sunburst Series (1997).
4. Willard, H. H., Merritt, L. L., Dean, J. A. & Settle, F. A. (Eds.) Instrumental Methods of Analysis -7th Ed., Wadsworth Publishing (1988) ISBN 0534081428
5. Khopkar, S. M. Concepts in Analytical Chemistry), Halsted (1984).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the cyclic voltammetry.
CO2	Understand the solvent extraction, ion exchangers including liquid ion exchangers.
CO3	Explain the chromatographic methods for identification and estimation of multicomponent systems.
CO4	Develop the TG, DTA, DSC and thermometric titrations.
CO5	Calculate the electron spectroscopy (AES), ESCA, Atomic absorption and emission spectroscopy.
CO6	Illustrate the Electron microscopy (SEM, TEM).

MCH4014: Nuclear and Radio Chemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of inorganic materials.

Course Objectives:

1. To know about band theory (Zone model, Brillouin Zones, Limitations of the Zone model).
2. To understand the magnetic and thermal properties of inorganic materials.
3. To learn the superconductors with special emphasis on the synthesis and structure of high temperature superconductors.
4. To learn the characteristic differences over bulk materials.
5. To know the Dynamic Light Scattering.
6. To understand the interaction of nuclear radiations with matter.

Detailed Syllabus

Unit -1 Inorganic Materials

Introduction to the solid state, metallic bond, Band theory (Zone model, Brillouin Zones, Limitations of the Zone model); Defects in solids, p-type and n-type; Inorganic semiconductors (use in transistors, IC, etc.); Electrical, optical, magnetic and thermal properties of inorganic materials, Superconductors with special emphasis on the synthesis and structure of high temperature superconductors. Solid State Lasers (Ruby, YAG and tunable lasers): Inorganic phosphor materials; synthesis and advantages of optical fibres over conducting fibres. Preparation of nanomaterials and their characteristic differences over bulk materials. Principles of Electron Microscopy, Dynamic Light Scattering.

Unit -2 Nuclear and Radiochemistry

Nuclear structure and nuclear stability. Nuclear Models. Radioactivity and nuclear reactions (including nuclear fission and fusion reactions). Hot atom Chemistry, Nuclear Fission and Fusion Reactors. The interaction of nuclear radiations

with matter. Radiation hazards and therapeutics. Tracer techniques and their applications. Isotope dilution and radio-activation methods analysis. Fission product analysis (e.g., the technique of isolating two or three different fission products of uranium (U), thorium (Th) and determining the yields).

Text and Reference Books

Reference Books:

Harvey, B. C. Introduction to Nuclear Chemistry Prentice-Hall (1969).

Keer, H. V. Principles of the Solid State Wiley Eastern Ltd.: New Delhi (1993).

West, A. R. Solid State Chemistry and its Applications John Wiley & Sons (1987).

Hannay, N. Treatise on Solid State Chemistry Plenum (1976).

Tirnp, G., Ed. Nanotechnology Springer-Verlag: N. Y. (1999).

Course Outcomes:

After completing this course, students will be able to achieve the followings

CO1	Describe the Solid State Lasers (Ruby, YAG and tunable lasers).
CO2	Understand the inorganic phosphor materials.
CO3	Explain the principles of Electron Microscopy,.
CO4	Develop the limitations of the Zone model); Defects in solids, p-type and n-type.
CO5	Calculate the nuclear structure and nuclear stability.
CO6	Illustrate the isotope dilution and radio-activation methods analysis.

MCH451: Inorganic Chemistry Practical-IV

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Prerequisite: Develop the experimental skills.

Course Objectives:

1. To know about analysis of ores.
2. To understand the metal oxalate hydrates.
3. To learn the pH- meter, potentiometer.

Detailed Syllabus

I.(a) Analysis of ores, alloys and inorganic substances by various chemical methods.
 (b) Instrumental methods of analysis utilising lame photometer., atomic absorption spectrophotometer, pH- meter, potentiometer, turbidimeter, electrochemical methods, separation of mixtures of metal ions by ion exchange chromatography.
 II. Synthesis and thermal analysis of group II metal oxalate hydrates.

Text and Reference Books

Reference Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the alloys and inorganic substances by various chemical methods.
CO2	Understand the synthesis and thermal analysis of group II metal oxalate hydrates.
CO3	Explain the instrumental methods of analysis utilising lame photometer.
CO4	Develop the atomic absorption spectrophotometer.
CO5	potentiometer, turbidimeter, electrochemical methods.
CO6	Illustrate the separation of mixtures of metal ions by ion exchange

MCH452: Project Dissertation

Teaching Scheme	Examination Scheme
Credits: 8	Class Test -20 Marks
	Teachers Assessment - 10Marks Attendance – 20 Marks
	End Semester Exam – 150 marks

Prerequisite: Concept of understand inorganic chemistry research problems and solutions.

Course Objectives:

1. To know about research and development in the field of chemical science.
2. To understand the problems and find the solutions.
3. To learn the advanced materials for industries requirements.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the mechanism of chemical reactions for completed research project.
CO2	Understand the problem and solutions.
CO3	Explain the importance of the research project.
CO4	Develop the new model and mechanism for the chemical reaction of research project.
CO5	Explain the importance materials for chemical science.
CO6	Illustrate the experimental procedure of chemical processes.

ORGANIC CHEMISTRY SPECIALIZATION

MCH4021: Advanced Organic Synthesis

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of philosophy of organic synthesis and supramolecular chemistry and carbocyclic rings.

Course Objectives:

1. To know about Chemoselectivity.
2. To understand the tandem reactions.
3. To learn the regioselectivity.
4. To learn the non-covalent synthesis.
5. To know the tropones. Tropolone.
6. To understand the stereoselectivity.

Detailed Syllabus

Unit-1: Development of Methodologies for Asymmetric Synthesis

Regioselectivity, stereoselectivity, diastereoselectivity and stereospecificity; asymmetric synthesis, asymmetric induction, substrate-controlled, reagent-controlled and catalyst-controlled asymmetric synthesis; chiral auxiliaries; optical and kinetic resolution; determination of enantiomeric excess (ee) and diastereomeric excess (de).

Unit-2: Advanced Organic Synthesis

Disconnection approach, synthons and synthetic equivalents, Reversal of polarity (Um-

polung), Chemoselectivity, One-group C–C disconnections, Two-group C–C disconnections, Disconnections of 1,3-difunctional compounds, Disconnections of 1,5-difunctional compounds, Tandem reactions, Domino reactions, Multicomponent reactions (MCRs)

Unit-3: Supramolecular Chemistry and Carbocyclic Rings

Principles of molecular recognition and molecular association; non-covalent interactions; self-assembly and self-organization; host-guest chemistry; supramolecular reactivity and catalysis; molecular devices and molecular machines.

Unit-4: Non-Benzenoid Aromatic and Polycyclic Compounds

Tropones, tropolones, azulenes, annulenes and metallocenes; aromaticity in non-benzenoid systems.

Bridged ring systems, caged molecules and adamantane.

Text and Reference Books

Reference Books:

1. Warren, S. Organic Synthesis: The Disconnection Approach John Wiley & Sons (1984).
2. Lehn, J-M, Supramolecular Chemistry: Concepts. & Perspectives. A Personal Account Vch Verlagsgesellschaft MbH (1995).
3. Viigtle, F. Supramolecular Chemistry: An Introduction John Wiley & Sons (1993).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the methodologies for asymmetric synthesis.
CO2	Understand the reversal of polarity.
CO3	Explain the diastereoselectivity and stereospecificity.
CO4	Develop the supramolecular reactivity and catalysis, molecular devices.
CO5	Calculate the bridged rings.
CO6	Illustrate the caged molecules and adamantane.

MCH4022: Natural Products

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: -

Concept of protein and alkaloids and polyphenols.

Course Objectives:

1. To know about squalene to lanosterol.
2. To understand the cholesterol, arternisinin.
3. To learn the methyl transferases, amino acid decarboxylases.
4. To learn the peptide alkaloids with examples.
5. To know the solid phase synthesis, combinatorial synthesis of peptide.
6. To understand the oxidative phenol coupling of selected alkaloids.

Detailed Syllabus

Unit-1: Peptides and Proteins

Classification and Structure: Naturally occurring peptides, depsipeptides and peptide alkaloids with suitable examples.

Peptide Sequence Determination: Chemical methods, enzymatic methods and mass spectrometric methods.

Peptide Synthesis: Modern methods of peptide synthesis; protecting and deprotecting groups; solid-phase peptide synthesis (SPPS); combinatorial peptide synthesis.

Unit-2: Carbohydrate

Classification and Chemistry of Carbohydrates: Naturally occurring monosaccharides and oligosaccharides; deoxy sugars, amino sugars, branched-chain sugars, sugar methyl ethers and sugar acid derivatives; polysaccharides and their structural features.

Unit-3: Terpenes and Steroids: Terpenoids and Steroids

Classification and biosynthesis of mono-, sesqui-, di- and triterpenoids, and steroids; biosynthesis from acetyl CoA and mevalonic acid, squalene to lanosterol, cholesterol to estradiol; diosgenin and its role in steroid hormone synthesis; general chemistry of cholesterol, artemisinin, gibberellic acid (GA₃) and azadirachtin.

Unit-4: Alkaloids and Polyphenols

Isolation and structure elucidation of alkaloids; biosynthesis and biogenesis of alkaloids; role of thiokinases, mixed-function oxygenases, methyltransferases and amino acid decarboxylases in alkaloid biosynthesis; oxidative phenolic coupling in alkaloid biosynthesis; polyphenols and their biosynthetic significance.

Text and Reference Books**Reference Books:**

1. Bodansky, M. Peptide Chemistry: A Practical Textbook Springer-Verlag (1988).
2. Dugas, H. & Penney, C. Bioorganic Chemistry: A Chemical Approach to Enzyme Action Springer-Verlag (1989).
3. Finar, I. L. & Finar, A. L. Organic Chemistry Vol. 2, Addison-Wesley (1998).
4. Finar, I. L. Organic Chemistry Vol.1, Longman (1998).
5. Sinden, R. P. DNA Structure and Function Academic Press (1994).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the acetyl CoA, mevalonic acid, acetoacetyl CoA.
CO2	Understand the Artemisinin, Gibberellin A ₃ , Azadirachtin.
CO3	Explain the biosynthesis and biogenesis of alkaloid using thiokinase.
CO4	Develop the mixed function oxygenases.
CO5	Calculate the branched chain sugars.
CO6	Illustrate the sugar methyl ethers and acid derivatives of sugars, polysaccharide.

MCH4023: Spectroscopy

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of chemical kinetics to decipher reaction mechanisms and diagnostic tools.

Course Objectives:

1. To know about effect of external magnetic field.
2. To understand the structural elucidation of simple and complex compounds.
3. To learn the splitting of molecules.
4. To learn the classification of polyatomic molecules.
5. To know the normal coordinate analysis of homonuclear and heteronuclear diatomic molecules.
6. To understand the quantum mechanical theory of NMR spectroscopy.

Detailed Syllabus

Unit-1: Principles of spectroscopy: Fundamentals of spectroscopy, electromagnetic radiation, atomic and molecular spectra, advantages of spectroscopic methods over classical methods.

Unit-2: NMR spectroscopy: Natural abundance of ^{13}C , ^{19}F and ^{31}P nuclei; the spinning nucleus, effect of external magnetic field. Chemical shift and its measurements. Factors influencing chemical shift, anisotropic effect: Integrals of protons. spin-spin coupling, splitting theory. Magnitude of coupling constant; Chemical and magnetic equivalence, Simplification of complex spectra (solvent. effect, field effect). Applications of PMR in structural elucidation of

simple and complex compounds.

Unit-3: Mass spectroscopy: Theory, instrumentation, and modifications, Unit mass and molecular ions; Important terms- singly, doubly/multiple charged ions, metastable peak, base peak, isotopic mass peaks, relative intensity.

Unit-4: IR Spectroscopy:

Principles, instrumentation, mechanism of interaction between molecule and radiation, fundamental modes of vibration and types, Region of IR spectra, vibrational frequency.

Unit-5: UV-Visible spectroscopy:

Principles, electronic transitions, chromophores and auxochromes, $\lambda_{\max}$ calculation in different types of molecules.

Text and Reference Books

Reference Books:

1. Carruthers, W. Modern Methods of Organic Synthesis Cambridge University Press (1971).
2. Kemp, W. Organic Spectroscopy 3rd Ed., W.H. Freeman & Co. (1991).
3. Silverstein, R.M. Bassler. G.C. & Morrill, T.C. Spectroscopic Identification of Organic Compounds John Wiley & Sons (1981).
4. March, J. Advanced Organic Chemistry John Wiley & Sons (1992).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the energy transitions, Chemical shift.
CO2	Understand the magnitude of coupling constant.
CO3	Explain the simplification of complex spectra.
CO4	Describe the stokes and anti-stokes lines. Polarizability ellipsoids. Rotational and Vibrational Raman spectroscopy.
CO5	Analyze the spectra of molecules
CO6	Develop the Theory of NMR spectroscopy, spins of common nucleus.

MCH4024: Medicinal Chemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of Medicinal chemistry and Bioactive compounds.

Course Objectives:

1. To acquire advanced knowledge of the general stages of modern drug discovery
2. To learn the strategies used in drug discovery
3. To learn the terms such as antimalarials and antibiotics.
4. To learn the chemistry of vitamins
5. To understand the chemistry of Hormones.
6. To know the solubility of vitamins and hormones.

Detailed Syllabus

Unit-1: Medicinal Chemistry

Introduction to the history of medicinal chemistry, Classification of drugs, Generic drugs, drug discovery and stages in modern drug discovery, lead discovery, pharmacophore identification and lead development, Screening of lead compounds. Sources of drugs: plants, microbial, animals, synthetic and semisynthetic etc. Introduction to antibiotics, Antibacterial quinolones, Antimalarial drugs, antianalgesic and anticancer drugs.

Unit-2: Vitamins: Classification of vitamins, Chemistry of vitamins A, C, D and E structure elucidation and synthesis, deficiency.

Unit-3: Hormones: General introduction of hormones including classification, mechanism of action.

Unit-4: Pyrethroids: Introduction; structure elucidation and synthesis of pyrethroids namely pyrethrins, cinerins and jasmoline.

Text and Reference Books

Reference Books:

1. Foye, W. C. (2008). Principles of Medicinal Chemistry, Publisher: Lea & Febiger, Philadelphia
2. Singh, H., Kapoor, V.K. (Latest Edition). Medicinal and Pharmaceutical Chemistry Vallabh Prakashan, Delhi
3. Finar, I. L., Organic Chemistry vol., 1 and 2
4. Organic Chemistry Natural Products Vol.-II O.P. Agarwal
5. Pyrethrins and Pyrethroid Insecticides Jerome J. Schleier and Robert K. D. Peterson

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the modern drug discovery
CO2	Understand the anti-malarials, anti-microbial and antibiotics.
CO3	Explain the pharmacophore and lead development
CO4	Understand about chemistry and solubility of vitamins
CO5	Explain about hormones
CO6	Understand about Synthetic pyrethroids.

MCH453: Organic Chemistry Practical-IV

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Prerequisite: -

Concept of quantitative analysis and advanced organic synthesis.

Course Objectives:

1. To know about estimation of glucose.
2. To understand the estimation of amino acids.
3. To learn the estimation of nitro group.

Detailed Syllabus

I. Quantitative analysis

- i. Estimation of glucose by chemical methods
- ii. Estimation of amino acids by chemical methods
- iii. Estimation of nitro group in organic compounds
- iv. Estimation of iodine by Vij's solution
- v. Estimation of carbohydrates, amino acids, proteins and caffeine by UV/VIS spectra
- vi. Estimation of a given mixture by NMR spectra

II Advanced organic synthesis

(i) Multistage synthesis including photochemical and enzymatic methods (some examples are given below)

Benzophenone → benzopinacol → benzopinacolone

Benzoin → benzil → benzilic acid

Cyclohexanone → cyclohexanone oxime → caprolactone

(ii) Enzymatic reaction: reduction of ethyl acetoacetate with Baker's yeast; PPL catalysed deacetylation of 2,4-diacetoxyacetophenone.

(iii) Use of ultrasound and microwaves in organic synthesis.

(iv) Application of phase transfer catalysis in organic synthesis.

Text and Reference Books

Reference Books:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the estimation of iodine by Vij's solution.
CO2	Understand the estimation of carbohydrates, amino acids, proteins and caffeine by UV/VIS spectra.
CO3	Explain the estimation of a given mixture by NMR spectra.
CO4	Develop the Multistage synthesis including photochemical and enzymatic methods.
CO5	Calculate the enzymatic reaction: reduction of ethyl acetoacetate.
CO6	Illustrate the use of ultrasound and microwaves in organic synthesis.

MCH454: Project Dissertation

Teaching Scheme	Examination Scheme
Credits: 8	Class Test -20 Marks
	Teachers Assessment - 10Marks Attendance – 20 Marks
	End Semester Exam – 150 marks

Prerequisite: Concept of understand organic chemistry research problems and solutions.

Course Objectives:

1. To know about research and development in the field of chemical science.
2. To understand the problems and find the solutions.
3. To learn the advanced materials for industries requirements.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO2	Understand the problem and solutions.
CO3	Explain the importance of the research project.
CO4	Develop the new model and mechanism for the chemical reaction of research project
CO5	Explain the importance materials for chemical science.
CO6	Illustrate the experimental procedure of chemical processes.

PHYSICAL CHEMISTRY SPECIALIZATION

MCH4031: Advanced Electrochemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of Electrochemical methods and Relaxation Methods.

Course Objectives:

1. To know about exchange current density.
2. To understand the Tafel plot, Multistep electrode reactions.
3. To learn the charge transfer at electrode-solution interfaces.
4. To learn the electrochemical instrumentations.
5. To know the thermodynamics of the double layer.
6. To understand the electrocatalysis.

Detailed Syllabus

Unit-1: Relaxation Methods-Theory and Techniques

Electrode kinetics: Overpotentials. Exchange current density, Derivation of ButlerVolmer equation and its implications, Tafel plot, Multistep electrode reactions, Determination of multistep electrode reactions, Mass transfer by diffusion.

Unit-2: Quantum aspects: Charge transfer at electrode-solution interfaces, Quan-

tization of charge transfer, Tunnelling.

Unit-3: Electrochemical methods: Controlled potential and current techniques, Hydrodynamic techniques, Electrochemical instrumentations, Scanning probe techniques.

Unit-4: Adsorption and Electric Double Layer: Thermodynamics of the double layer, Electrocapillary phenomena; Adsorption— Ionic and organic molecules_ Adsorption isotherms-Langmuir, Friamkin, temkin•
 Experimental evaluation of surface excesses and electrical parameters, Structure of electrified interfaces - Gouy-Chapman, Stern.

Unit-5: Bioelectrochemistry

Membrane potentials, Nernst-Planck equation, Hodgkin-Huxley equations, Core Conductor model, Electrocardiography

Unit-6: Applied Electrochemistry

Corrosion: Introduction to corrosion forms of corrosion, Corrosion monitoring and prevention methods Conversion and storage of electrochemical energy: Fuel cells and batteries. Electrocatalysis: Influence of various parameters, fly.drogen electrode

Text and Reference Books

Reference Books:

1. Bard, A. J. Faulkner, L. R. Electrochemical Methods: Fundamentals and Applications, 2nd Ed., John Wiley & Sons: New York, 2002.
2. Bockris, J.O' M. & Reddy, A. K. N. Modern Electrochemistry 1: Ionics 2nd Ed., Springer (1998).
3. Bockris, J.O' M. & Rceddv. A. K. N. Modern Electrochemistry2B: Electrodics in Chemistry Engineering, Biology and Environmental Science 2nd Ed. Springer (2001).
4. Brett, C. M. A. & Brett, A. M. 0. Electrochemistry Oxford University Press (1993).
5. Koryta, J., Dvorak, J. & Kavan, L. Principles of Electrochemistry John Wiley & Sons: NY (1993).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO2	Understand the quantization of charge transfer, Tunnelling.
CO3	Explain the conversion and storage of electrochemical energy: Fuel cells and batteries.
CO4	Develop the influence of various parameters.
CO5	Calculate the conductor model, Electrocardiography.
CO6	Illustrate the Nernst-Planck equation.

MCH4032: Photo & Radio Chemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of Molecular photochemistry and Radiation dosimetry.

Course Objectives:

1. To know about transitions between states.
2. To understand the potential energy surface.
3. To learn the classical model of radiative transitions.
4. To learn the energy transfer.
5. To know the diffusion-controlled quenching.
6. To understand the various mechanisms of their formation and energy transfer processes).

Detailed Syllabus

Unit-1: Molecular photochemistry: An overview: Transitions between states (chemical, classical and quantum dynamics, vibronic states). Potential energy surfaces; transitions between potential energy surfaces, The Franck-Condon Principle and radiative transitions. A classical model of radiative transitions.

Unit-2: Photophysical radiationless transitions: Wave mechanical interpretation of radiationless transitions between state factors that influence the rate of vibrational relaxation. Energy transfer: Theory of radiationless energy transfer, energy transfer by electron exchange: An overlap or collision mechanism. The role of energetics in energy transfer mechanism. Diffusion controlled quenching.

Unit-3: Radiation Chemistry

An overview, G-value. The mechanism of interaction of high energy radiation with matter, Photoelectric effect, Compton effect, Pair production, total absorption coefficient, excitation and ionization, Stopping power and linear energy transfer.

Unit-4: Radiation dosimetry: Radiation dose and its measurement, standard free air chamber method, chemical dosimeter (Frick's Dosimeter). Short lived intermediates (ions, excited molecules, free radicals: Various mechanisms of their formation and energy transfer processes).

Text and Reference Books**Reference Books:**

1. Turro, N. J. Modern Molecular Photochemistry Univ, Science Books (1991).
2. Gilbert, A. & Baggot, .1. Essentials of Molecular Photochemistri' Blackwell Scientiic (1990).
3. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 81i, Ed., Oxford University Press (2006).
4. McQuarrie, D. A. & Simon, J. D. Physical Chemisty: A Molecular Approach 3rd Ed., Univ. Science Books (2001).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the transitions between states (chemical, classical and quantum dynamics, vibronic states).
CO2	Understand the transitions between potential energy surfaces.
CO3	Explain the theory of radiation less energy transfer, energy transfer by electron exchange.
CO4	Develop the the mechanism of interaction of high energy radiation with matter, Photoelectric effect.
CO5	Calculate the stopping power and linear energy transfer.
CO6	Illustrate the various mechanisms of their formation and energy transfer processes).

MCH4033: Biophysical Chemistry

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of fundamentals of biological macromolecules and optical methods and applications.

Course Objectives:

1. To know about: chemical bonds in biological systems.
2. To understand the properties and classification of amino acids.
3. To learn the **general principles**.
4. To learn the zonal sedimentation.
5. To know the capillary electrophoresis.
6. To understand the fluorescence spectroscopy.

Detailed Syllabus

Unit-1: Fundamentals of biological macromolecules: Chemical bonds in biological systems: Properties of water; Thermodynamic principles in biological systems; Properties and classification of amino acids; Structures of nucleic acids. Protein structure and function. Properties of nucleosides and nucleotides; composition of nucleic acids. **Methods for the separation of biomolecules: General principles, including Chromatography: Sedimentation, Moving Bounda-**

ry Sedimentation, Zonal Sedimentation, Electrophoresis, Isoelectric focusing, Capillary electrophoresis, MALDI/TOF.

Unit-2: Structural determinations: Physical methods. Ultracentrifugation and other hydrodynamic techniques; Light scattering, fundamental concepts, scattering from a number of small particles: Rayleigh scattering, scattering from particles that are not small compared to the wavelength of radiation; Dynamic light scattering; Low angle X-Ray scattering; Neutron scattering; Raman scattering

Unit-3: Optical methods and applications: Optical techniques in biological systems: Absorption spectroscopy, Fluorescence spectroscopy, Linear and Circular Dichroism, Single and multidimensional NMR spectroscopy.

Text and Reference Books

Reference Books:

1. Cantor, C. R. & Schimmel Biophysical Chemistry Vols. 1 -3, W. H. Freeman (1980)
2. Lehninger, A. L., Nelson, D. L. & Cox, M. M. Lehninger Principles of Biochemistry 4e, Ed., W. H. Freeman (2004).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the physical methods. Ultracentrifugation and other hydrodynamic techniques.
CO2	Understand the light scattering, fundamental concepts, scattering from a number of small particles.
CO3	Explain the Rayleigh scattering.
CO4	Develop the single and multidimensional NMR spectroscopy.
CO5	Calculate the neutron scattering; Raman scattering.
CO6	Illustrate the Linear and Circular Dichroism.

MCH4034: Crystallography

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of crystal structures and basic symmetry.

Course Objectives:

1. To know about description of a crystal structure in terms of atom positions.
2. To understand the relation of the crystal symmetry.
3. To learn the interaction of radiation with condensed matter.
4. To learn the Bragg condition.
5. To know the structure factor and its relation to intensity.
6. To understand the Fourier synthesis.

Detailed Syllabus

Unit-1: Crystal structures and basic symmetry

Overview: Description of a crystal structure in terms of atom positions, unit cells, and crystal symmetry; Relation of the crystal symmetry to the symmetry observed in a diffraction experiment for primitive, orthorhombic, tetragonal. Scattering and Diffraction Theory

Unit-2: X-Ray Diffraction: Interaction of radiation with condensed matter and how this can be used in generalized crystallography. Bragg condition, Miller indi-

ces, Laue method, Bragg method, Debye-Scherrer method of X-ray structural analysis of crystals, index reflections, identification of unit cells from systematic absences in diffraction pattern. Structure of simple lattices and X-ray intensities, Structure factor and its relation to intensity and electron density, Fourier synthesis.

Unit-3: Crystal defects and non-stoichiometry: Perfect and imperfect crystals, intrinsic and extrinsic defects- point defects, line and plane defects, vacancies- Schottky defects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry and defects.

Unit-4: Protein Crystallography

Basics of modern protein crystallography using Web-based material; different levels of structure exhibited by proteins; instrumentation, steps, and methods used in protein crystallography with appropriate case studies; concept of non-crystallographic symmetry to protein crystallography, Ramachandran diagram.

Unit-5: Electronic properties and band theory: Metals, insulators and semiconductors, electronic structure of solids- band theory, band structure of metals, insulators and semiconductors, intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, super conductors. Magnetic properties- Classification of materials: Quantum theory of paramagnetics cooperative phenomena - magnetic domains. Hysteresis.

Unit-6: Electron diffraction: Scattering intensity versus scattering angle, Wierl equation, measurement technique, elucidation of structure of simple gas phase molecules. Low energy electron diffraction and structure of surfaces.

Unit-7: Neutron diffraction: Scattering of neutrons by solids and liquids, magnetic scattering, measurement techniques. Elucidation of structure of magnetically ordered unit cells.

Text and Reference Books

Reference Books:

1. Moore, E. & Smart, L. Solid State Chemistry: An Introduction 2nd Ed. Chapman & Hall (1996).
2. Rhodes, G. Crystallography Made Crystal Clear: A Guide for Users of il-lacromolecular Models 3rd Ed. Elsevier (2006).
3. Massa, W. Crystal Structure Determination 2nd Ed. Springer (2004).

Course Outcomes:

CO1	Describe the perfect and imperfect crystals, intrinsic and extrinsic defects- point defects.
CO2	Understand the different levels of structure exhibited by proteins.
CO3	Explain the concept of non-crystallographic symmetry to protein crystallography, Ramachandran diagram.
CO4	Develop the intrinsic and extrinsic semiconductors.
CO5	Calculate the Wierl equation, measurement technique.
CO6	Illustrate the low energy electron diffraction and structure of surfaces.

MCH455: Physical Chemistry Practical-IV

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Prerequisite: Develop the practical skills.

Course Objectives:

1. To know about determination of surface tension by differential capillary method.
2. To understand the determination of g-value by ESR method.
3. To learn the spectrophotometric study on H-bonded complexation.

Detailed Syllabus

Determination of surface tension by differential capillary method.
Determination of molecular weight of a macromolecule by viscometry.
Determination of molecular weight by Victor Meyer's method.
Cryoscopy and determination of degree of dissociation.
Determination of g-value by ESR method.
Analysis of a UV spectrum and calculation of oscillator strength and transition moment.
Spectrophotometric study on H-bonded complexation.
Determination of ionization constant of a weak indicator acid.

Text and Reference Books

Reference Books:

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

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the analysis of a UV spectrum and calculation of oscillator strength and transition moment.
CO2	Understand the determination of ionization constant of a weak indicator acid.
CO3	Explain the determination of molecular weight of a macromolecule by viscometry.
CO4	Develop the determination of molecular weight by Victor Meyer's method.
CO5	Calculate the determination of g-value by ESR method.
CO6	Illustrate the spectrophotometric study on H-bonded complexation.

MCH456: Project Dissertation

Teaching Scheme	Examination Scheme
Credits: 8	Class Test -20 Marks
	Teachers Assessment - 10Marks Attendance – 20 Marks
	End Semester Exam – 150 marks

Prerequisite: Concept of understand physical chemistry research problems and solutions.

Course Objectives:

1. To know about research and development in the field of chemical science.
2. To understand the problems and find the solutions.
3. To learn the advanced materials for industries requirements.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the mechanism of chemical reactions for completed research project.
CO2	Understand the problem and solutions.
CO3	Explain the importance of the research project.
CO4	Develop the new model and mechanism for the chemical reaction of research project.
CO5	Explain the importance materials for chemical science.
CO6	Illustrate the experimental procedure of chemical processes.

ANALYTICAL CHEMISTRY SPECIALIZATION

MCH4041: Separation Techniques

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of separation techniques based on phase equilibria and separation techniques based on rate processes.

Course Objectives:

1. To know about principles of analytical separation: Plate theory, rate theory.
2. To understand the Craig concept of counter current distribution.
3. To learn the chromatography: Gas chromatography.
4. To learn the size exclusion chromatography.
5. To know the field separation methods: Electrophoresis.
6. To understand the Electrophoresis, Ultracentrifugation.

Detailed Syllabus

Unit-1: Separation Techniques Based on Phase Equilibria: Basic concept related to phase and equilibria, Principles of analytical separation: Plate theory, rate theory, Craig concept of counter current distribution, process optimization, Retention analysis; Resolution (Fundamental equation). Distillation: Fractional distillation, Molecular distillation. Chromatography: Gas chromatography (GC), Liquid chromatography (including high performance chromatography),

Ion-exchange chromatography, Ion chromatography, Size exclusion chromatography, Planar chromatography (PC, TLC, and HPTLC), Reverse phase chromatography & Bonded phase chromatography (BPC), Super critical fluid chromatography (SFC). Solvent Extraction: Liquid-Liquid and super critical fluid extraction, Quantitative treatment of various solvent, extraction equilibria. Sublimation: Normal and vacuum sublimation. Crystallization: Zone refining and Fractional.

Unit-2: Separation Techniques Based on Rate Processes:

(a) Barrier-separation methods: Membrane separation- Ultrafiltration, dialysis, electrodialysis, electro-osmosis, reverse osmosis Sedimentation equilibrium method.

(b) Field separation methods: Electrophoresis, Ultracentrifugation.

Text and Reference Books

Reference Books:

1. G.H. and H. Freiser, *Solvent Extraction in Analytical Chemistry*, 1st Edition (1958), John Wiley, New York.
2. B.L. Karger, L.R. Snyder and C. Howarth, *An Introduction to Separation Science*, 2nd Edition (1973), John Wiley, New York.
3. E.W. Berg, *Chemical Methods of Separation*, 1st Edition (1963), McGraw Hill, New York.
4. D.G. Peters, J.M. Hayes and C.M. Hieftj, *Chemical Separation and Measurements*, 2nd Edition (1974), Saunders Holt, London.
5. J.D. Seader and E.J. Henley, *Separation Process Principles*, 1st Edition (1998), John Wiley & Sons. Inc., New York. Edition(1998), JohnWiley&Sons.Inc., New York.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the reverse phase chromatography.
CO2	Understand the Barrier-separation methods: Membrane separation- Ultrafiltration, dialysis.
CO3	Explain the electrodialysis, electro-osmosis, reverse osmosis.
CO4	Develop the Super critical fluid chromatography (SFC). Solvent Extraction: Liquid-Liquid and super critical fluid extraction.
CO5	Explain the quantitative treatment of various solvent.
CO6	Illustrate the electrodialysis, electro-osmosis, reverse osmosis.

MCH4042: Polarography

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of Polarography and modern polarography.

Course Objectives:

1. To know about electrode Processes.
2. To understand the diffusion current.
3. To learn the kinetic adsorption and capacitive currents.
4. To learn the necessity and development of new voltammetric techniques.
5. To know the differential and derivative voltammetry.
6. To understand the electro-spot testing.

Detailed Syllabus

Unit-1: General Introduction: Overviews of Electrode Processes, Electrocapillary curve and electrocapillary maximum potential, Exchange current, Polarization and overvoltage, Reference electrodes. Mercury electrodes (DME, SME, HMDE), Rotating platinum electrode. Three-electrode system.

Unit - 2: Polarography: Origin of polarography, Interpretation of a polarographic curve. Instrumentation. Limiting current, residual and charging current, diffusion current, migration current. Supporting electrolytes. Effect of supporting electrolyte on the limiting current. Diffusion coefficient and its evaluation. Ilkovic equation, its derivation and applications. Estimation of n -value(s). Theory and equations of different current- potential curves. Criteria of polarographic reversibility. Quasi-reversible and irreversible processes. Half- wave potentials and their significance. Interpretation of catalytic, kinetic, adsorption and capacitive currents. Polarographic maxima and maximum suppressors. Methods of quantitative analysis: absolute, comparative, the PILOT

ION and kinetic methods.

Unit-3: Modern Polarography: Necessity and development of new voltammetric techniques and their comparison with classical polarography. Fundamentals of sampled DC polarography (Tast), oscilliography, differential and derivative voltammetry, cyclic, pulse, alternating current and square wave polarography.

Unit-4: Related Techniques: Amperometric titration, Chronoamperometry, Chronopotentiometry. Controlled-potential and constant current coulometry. Stripping analysis, Electrogravimetry, Electrography and Electro-spot testing.

Text and Reference Books

Reference Books:

- 1.L. Meites, *Polarographic Techniques*, 2nd Edition (1965), John Wiley, New York.
- 2.J. Heyrovsky and K. Kuta, *Principles of Polarography*, 1st Edition (1966), Academic Press, New York.
- 3.D.A. Skoog, F.J. Holler and T.A. Nieman, *Principles of Instrumental Analysis*, 5th Edition (1998), Saunders College Publishing, Harcourt Brace & Company, U.S.A.
- 4.A.J. Bard and L.R. Faulkner, *Electrochemical Methods: Fundamentals and Applications*, 2nd Edition (2000), Wiley, New York.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the effect of supporting electrolyte on the limiting current.
CO2	Understand the theory and equations of different current-potential curves. Criteria of polarographic reversibility.
CO3	Explain the quasi-reversible and irreversible processes. Half-wave potentials and their significance.
CO4	Develop the comparative, the PILOT ION and kinetic methods.
CO5	Explain the Fundamentals of sampled DC polarography (Tast), oscilliography,.
CO6	Illustrate the Amperometric titration, Chronoamperometry, Chronopotentiometry.

MCH4043: Spectroscopic Techniques

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of Nuclear Magnetic Resonance Spectroscopy and Applications in analysis of special materials.

Course Objectives:

1. To know about infrared instruments.
2. To understand the Raman spectroscopy, Instrumentation.
3. To learn the theory of nuclear magnetic resonance.
4. To learn the two dimensional Fourier- transform NMR.
5. To know the atomic force microscopy (AFM).
6. To understand the food additives, petrochemicals.

Detailed Syllabus

Unit-1: Infrared Spectroscopy: Basic concept of Infrared instruments, typical applications of infrared spectroscopy (qualitative and quantitative) in homo and hetero molecules.
Unit-2: Raman Spectroscopy: Basic concept of Raman spectroscopy, Stokes and anti-Stokes splitting Instrumentation, Analytical applications of Raman spectroscopy
Unit-3: Nuclear Magnetic Resonance Spectroscopy: Theory of nuclear magnetic resonance, Environmental effects on NMR spectrometers, Applications of proton ^1H NMR, ^{13}C NMR, Two dimensional Fourier- transform NMR, Magnetic resonance imaging (MRI), Quantitative applications of NMR: Drug Analysis, Molecular Weight determination.
Unit-4: Electron Spin Resonance Spectroscopy: Theory, Instrumentation and Important analytical applications.

Unit-5: Electron Spectroscopy: Theory, Instrumentation and applications of Electron spectroscopy (ESCA and Auger), Scanning electron microscopy (SEM), Scanning tunneling microscopy (STM) and Atomic force microscopy (AFM), Transmission electron microscope (TEM).

Unit-7: Applications in analysis of special materials: Analysis of dairy products, food additives, petrochemicals (including liquid and gaseous fuels), drugs and pharmaceuticals and fertilizers.

Text and Reference Books

Reference Books:

1. D.A. Skoog, F.J. Holler and T.A. Nieman, *Principles of Instrumental Analysis*, 5th Edition (1998), Harcourt Brace & Company, Florida.
2. R.L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, *Modern Methods of Chemical Analysis*, 2nd Edition (1976), John Wiley, New York.
3. J.M. Hollas, *Modern Spectroscopy*, 3rd Edition (1996), John Wiley, New York.
4. H.A. Strobel, *Chemical Instrumentation – A Systematic Approach*, 2nd Edition (1973), Addison Wesley, Mass.
5. D.C. Garratt, *the Quantitative Analysis of Drugs*, 2nd Edition (1992), Chapman and Hall Ltd., London.
6. W. Horwitz (Editor), *Official Methods of Analysis*, 11th Edition (1970), Association of Official Analytical Chemists, Washington DC.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the typical applications of infrared spectroscopy (qualitative and quantitative).
CO2	Understand the drugs and pharmaceuticals and fertilizers.
CO3	Explain the Scanning electron microscopy (SEM).
CO4	Develop the instrumentation and applications of Electron spectroscopy (ESCA and Auger).
CO5	Calculate the molecular Weight determination.
CO6	Illustrate the magnetic resonance imaging (MRI), Quantitative applications of NMR.

MCH4044: Micro Analytical Techniques

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment - 6Marks Attendance – 12 Marks
Credits: 4	End Semester Exam – 70 marks

Prerequisite: Concept of Biochemical Microanalysis.

Course Objectives:

1. To know about scope and objectives of microanalytical technique.
2. To understand the microanalysis of real-world Samples.
3. To learn the Biochemical Microanalysis.
4. To learn the inorganic microanalysis.
5. To know the inorganic microanalysis.
6. To understand the Microanalysis by Kinetic Methods.

Detailed Syllabus

Unit-1: General Introduction: Fundamental concept of microanalytical technique, Difference between micro and trace analysis, Microanalytical technique based on size and amount of the sample.
Unit-2: Microanalysis of real-world Samples: Molecular recognition and targeted analysis using macrocyclic (crown ethers), macrobicyclic (cryptands), Supramolecular compounds (calixarenes) and polymeric materials.
Unit-3: Biochemical Microanalysis: Estimation of carbohydrates, amino acids and ascorbic acid in biological systems, Estimation of protein in egg albumin, Estimation of free fatty acid, Iodine value and saponification value of fats/oils, Estimation of blood cholesterol, DNA and RNA.
Unit-4: Inorganic microanalysis: Principle, Technique, qualitative and quantitative appli-

cations with special reference to Ring-oven technique and Ring colorimetric technique, Chemical microscopy.

Unit-5: Organic Microanalysis: Determination of alkoxy, acetyl, acyl, hydroxyl, carbonyl, active hydrogen, nitroso, sulfonyl, amides and ester groups, Determination of molecular weight and percentage purity of carboxylic acid, Estimation of sugars, Estimation of unsaturation.

Unit-6: Microanalysis by Kinetic Methods: Theoretical basis, Kinetic parameters, Kinetic methods of microanalysis: Tangent, fixed time and addition method.

Text and Reference Books

Reference Books:

1. P.L. Kirk, Quantitative Ultramicroanalysis, John, Wiley.
2. C.L. Wilson and D.L. Wilson, Comprehensive Analytical Chemistry”, Vol. I (A) and I(B), Elsevier.
3. G.D. Christian, Analytical Chemistry, John Wiley & Sons, New York (2001).
4. S.M. Khopkar, Analytical Chemistry of Macrocyclic and Supramolecular Compounds, Narosa Publishing House, New Delhi (2002).
5. Jag Mohan, Organic Analytical Chemistry - Theory and Practice, Narosa Publishing House, New Delhi (2003).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the difference between micro and trace analysis.
CO2	Understand the supramolecular compounds (calixarenes) and polymeric materials.
CO3	Explain the estimation of free fatty acid, Iodine value and saponification value of fats/oils.
CO4	Develop the ring colorimetric technique, Chemical microscopy.
CO5	Calculate the quantitative applications with special reference to Ring-oven technique.
CO6	Illustrate the percentage purity of carboxylic acid, Estimation of sugars.

MCH457: Analytical Chemistry Practical-II

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/Week	Class Test -8 Marks
	Teachers Assessment – 4 Marks Attendance – 8 Marks
Credits: 2	End Semester Exam – 30 marks

Prerequisite: Develop the experimental skills.

Course Objectives:

1. To know about determination of accuracy, precision, mean deviation.
2. To understand the composition of two sets of results in terms of significance.
3. To learn the solvent extraction: determination of Fe (III) by chloride extraction in ether.

Detailed Syllabus

Statistical Treatment of Results

2. Determination of accuracy, precision, mean deviation, standard deviation, coefficient of variation, normal error curve and least square fitting of certain set of experimental data in an analysis.
3. Composition of two sets of results in terms of significance (Precision and accuracy) by (i) student's t-test, (ii) F-test.
4. Solvent Extraction: Determination of Fe (III) by chloride extraction in ether.
5. Complexometric and Redox Titrations
6. Metal-EDTA titrations using Eriochrome Black T, Xylenol orange and PAN indicators (only back titration or substitution titration methods).
7. Estimation of the purity of oxalic acid employing standard Ce (IV) solution.
8. Spectrophotometric Analysis
9. Spectrophotometric determination (in ppm) of Fe (II) or Fe(III) using 1,10 Phenanthroline (or thiocyanate) as colorimetric reagent.
10. Colorimetric determination of chromium (VI) (in ppm) using 1,5 diphenyl carbazide as a reagent for colour development.
11. Quantitative analysis of APC tablet by NMR or IR spectroscopy
12. Water Analysis: Analysis of water samples for the following parameters
(i) BOD, (ii) COD, (iii) Dissolved oxygen, (iv) total phosphorous, (v) sulfur as SO₂, (vi) total hardness and chloride, (vii) total dissolved solids.

13. To prepare a buffer solution of known ionic strength and to find its maximum buffer capacity.

Text and Reference Books

Reference Books:

1. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
2. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the colorimetric determination of chromium (VI) (in ppm) using 1,5 diphenyl carbazide as a reagent for colour development.
CO2	Understand the Estimation of the purity of oxalic acid employing standard Ce (IV) solution.
CO3	Explain the composition of two sets of results in terms of significance (Precision and accuracy) by (I) student's t-test, (ii) F-test.
CO4	Develop the water analysis: analysis of water samples for the following parameters.
CO5	Explain the (i) BOD, (ii) COD, (iii) Dissolved oxygen, (iv) total phosphorous, (v) sulfur as SO ₂ , (vi) total hardness and chloride, (vii) total dissolved solids.
CO6	Illustrate the prepare a buffer solution of known ionic strength and to find its maximum buffer capacity.

MCH458: Project Dissertation

Teaching Scheme	Examination Scheme
Credits: 8	Class Test -20Marks
	Teachers Assessment - 10Marks Attendance – 20 Marks
	End Semester Exam – 150 marks

Prerequisite: Concept of understand analytical chemistry research problems and solutions.

Course Objectives:

1. To know about research and development in the field of chemical science.
2. To understand the problems and find the solutions.
3. To learn the advanced materials for industries requirements.

Course Outcomes:

After completing this course, students will be able to achieve the followings:

CO1	Describe the mechanism of chemical reactions for completed research project.
CO2	Understand the problem and solutions.
CO3	Explain the importance of the research project.
CO4	Develop the new model and mechanism for the chemical reaction of research project.
CO5	Explain the importance materials for chemical science.
CO6	Illustrate the experimental procedure of chemical processes.