

MAA VINDHYAVASINI UNIVERSITY MIRZAPUR (U.P.)



Syllabus For Chemistry Master of Science (M.Sc.)Two Year Programme (NEP-2020 Based Curriculum)

Effective from session 2026-27

Department of Chemistry

Faculty of Science and Technology


Dean
Faculty of Science And Technology
Maa Vindhyavasini University, Mirzapur

Vision of the Department: To provide advanced and comprehensive education in chemical sciences through the M.Sc. Chemistry program, fostering scientific knowledge, analytical thinking, research aptitude, and innovation. The department aims to develop competent professionals and researchers with ethical values, practical skills, and a commitment to addressing societal, industrial, and environmental challenges through chemistry. **Mission:** The Department of Chemistry is committed to imparting advanced theoretical and practical knowledge in various branches Of chemistry through a comprehensive M.Sc. curriculum. The department aims to foster research aptitude, analytical thinking, and problem-solving abilities among students through laboratory training, seminars, and project work. It strives to equip students with modern experimental, analytical, and computational skills relevant to academic, industrial, and research environments. The department also encourages innovation, interdisciplinary learning, and scientific temper to address environmental, industrial, and societal challenges. Along with academic excellence, the department is dedicated to developing ethical values, professional competence, leadership qualities, and lifelong learning skills, thereby preparing students for higher studies, research careers, competitive examinations, and employment opportunities in chemistry and allied fields.

Title: Master Of Science (Chemistry)

Objectives Of the Program:

1. To provide advanced and comprehensive knowledge in various branches of chemistry such as Organic, Inorganic, Physical, Analytical, and Applied Chemistry.
2. To develop scientific aptitude, analytical thinking, and problem-solving abilities among students.
3. TO impart practical laboratory Skills and training in modern analytical and instrumental techniques.
4. To promote research orientation, innovation, and interdisciplinary learning in chemical sciences.
5. To equip students with professional and technical skills required in chemical, pharmaceutical, environmental, and allied industries.
6. To encourage students to address industrial, environmental, and societal challenges through the application of chemistry


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Program Outcomes:

PO1- Acquire advanced knowledge and practical skills in various branches Of chemistry, enabling students to analyze and solve scientific, industrial, and environmental problems effectively.

P02- Develop research aptitude, professional competence, ethical values, and communication skills for higher studies, research, teaching, and employment in chemical and allied fields.

Program Specific Outcomes:

PSO1-Demonstrate proficiency in advanced laboratory techniques, modern analytical instruments, and experimental methods for chemical analysis, synthesis, and research applications.

PSO2- Apply knowledge of chemical sciences to solve problems related to industry, environment, healthcare, and research through scientific and interdisciplinary approaches.

Duration: The total duration of the program shall be of Two (02) years, spread over in four (04) semesters.

Seats: As per the allotment by MVVU, Mirzapur.

Eligibility Criteria: Bachelor of Science with chemistry as one of the major subjects

Admission Procedure: Admission procedure will take place as per the Maa Vindhyawasini University, Mirzapur admission guidelines in this regards.

Papers— I and II semester examination shall comprise four theory papers each of two hours duration. Whereas II and IV Semester examination shall comprise three theory papers each of the two hours duration and each semester will comprise practical examination of twelve hours duration which is spread over two days.


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**Semester Wise Paper Structure of
Program (M. Sc. Chemistry)
First Year**

Year	Semester	Course Code	Title of Paper	Theory/ Project	Credits	Total Marks
1	I	CHE-101	Inorganic Chemistry-I	Theory	4	100 (75+25)
		CHE-102	Organic Chemistry-I	Theory	4	100 (75+25)
		CHE-103	Physical Chemistry-I	Theory	4	100 (75+25)
		CHE-104	Analytical Chemistry-I	Theory	4	100 (75+25)
		CHE-105	Inorganic, Organic, practical, Vive-voce & Records	Practical	4	100 (75+25)
		Total			20	500
	II	CHE-201	Inorganic Chemistry-II	Theory	4	100 (75+25)
		CHE-202	Organic Chemistry-II	Theory	4	100 (75+25)
		CHE-203	Physical Chemistry-II	Theory	4	100 (75+25)
		CHE-204	Research Methodology & Analytical Techniques-II	Theory	4	100 (75+25)
		CHE-205	Inorganic, Organic, practical, Vive-voce & Records	Practical	4	100 (75+25)
					20	500
Total of First Year (1st and 2nd Semester)					40	1000

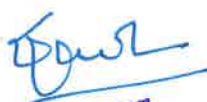


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Program (M. Sc. Chemistry)

Second Year

Year	Semester	Course Code	Title of Paper	Theory/ Project	Credits	Total Marks	
2	III	CHE-301	Application of Spectroscopy	Theory	4	100 (75+25)	
		CHE-302	Bioinorganic and Bioorganic Chemistry	Theory	4	100 (75+25)	
		CHE-303	Biophysical Chemistry and Solid State Chemistry	Theory	4	100 (75+25)	
		CHE-304	Inorganic, Organic, practical, Vive-voce & Records	Practical	4	100 (75+25)	
		CHE-305	Research Project	Project	4	100	
		Total				20	500
	IV	CHE-400 (A-H)	Elective Paper	Theory	4	100 (75+25)	
		CHE-400 (A-H)	Elective Paper	Theory	4	100 (75+25)	
		CHE-400 (A-H)	Elective Paper	Theory	4	100 (75+25)	
		CHE-401	Inorganic, Organic, practical, Vive-voce & Records	Theory	4	100 (75+25)	
		CHE-402	Research Project	Practical	4	100 (75+25)	
	Total				20	500	
Total of First Year (3 rd and 4 th Semester)					40	1000	


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Elective papers:

Out of eight elective papers, students select any three papers.

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|---|----------------------------------|
| A. Organo-transition Metal Chemistry | E. Heterocyclic Chemistry |
| B. Bioinorganic and Supra Molecular Chemistry | F. Chemistry of Natural Products |
| C. Photo Inorganic Chemistry | G. Medicinal Chemistry |
| D. Organic Synthesis-I | H. Polymer Chemistry |

Note: Internal assessment of 25 marks in each course will be done on the basis of assignment, class test and over all class performance.



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Program Name: M.Sc. (Chemistry)
Level: PG
Semester : First
Course Name: Inorganic Chemistry-I
Course Code: [CHE-101]
Course Type: Major

Credits: 04

Total Marks- 75+25=100

Course Objectives

1. Students will understand symmetry, group theory, and their chemical applications.
2. They will learn stereochemistry and bonding in main group compounds.
3. They will analyze metal—ligand equilibria and stability of complexes.
4. They will grasp crystal field and molecular orbital theories in coordination chemistry

Unit	Content	Teaching Hours	Mode of Teaching
I	Symmetry and Group Theory in Chemistry- Symmetry elements and symmetry operation, definitions of groups, subgroups, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Point Symmetry group. Schonflies symbols, representation of groups by matrices (representation of the C_n , C_{nv} , C_{nh} , D_{nh} etc groups to be worked Out explicitly). Character Of a representation. Character tables and their use in spectroscopy.	15	Online/Offline
II	Stereochemistry and Bonding in Main Group Compounds VSEPR, Walsh diagrams (triatomic molecule), dlt-plt bonds, bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules.	15	Online/Offline

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III	Metal-Ligand Equilibria in Solution Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH metry and spectrophotometry.	15	Online/Offline
IV	Metal-Ligand Bonding Limitation of crystal field theory, molecular orbital theory. Octahedral, tetrahedral and Square Planar complexes, it-bonding and molecular orbital theory	15	Online/Offline
	Total	60	

Course Outcome: After completing this course the scholar shall be able to

CO1: To identify molecular symmetry elements, assign point groups, and apply group theory to predict molecular properties, bonding, and spectroscopic behaviors.

CO2: The ability to explain the three-dimensional Structures, bonding theories (VSEPR, Walsh diagrams, Bent's rule), and reactivity of main group elements.

CO3: To understanding how metal ions interact with molecules (ligands) to form complexes. These interactions are fundamental to biological systems, industrial processes, and analytical chemistry.

CO4: Studying metal-ligand bonding provides essential insights into molecular structure, stability, and reactivity, enabling advancements in catalysis, materials science, and biochemistry

References:

1. F.A.Cotton and G. Wilkinson Advanced Inorganic Chemistry, 6th Wiley & Sons, New York.
2. Chemistry of the elements, N.N.Greenwood and A.Eamshaw, Pergammon.



3. Comprehensive Coordination Chemistry eds., G.Wilkinson, R.D.Gillars and J.A.MC Cleverty. Pergammon.

4. Magneto Chemistry, R.L.Carlin, Springer Verlag.

Suggested Reading:

1. James E.Huheey, Inorganic Chemistry, 4th Edn. (1993), Addison-Wesley Pub. co., New York.

2. Inorganic Electronic Spectroscopy, A.B.P.Lever, Elsevier.

E-Resources

<https://nptel.ac.in>

<https://swayam.gov.in>

<https://pubchem.ncbi.nlm.nih.gov>

<https://scholar.google.com>



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Maa Vinayakdasini University, Mirzapur

Program Name: M.Sc. (Chemistry)

Level: PG

Semester : First

Course Name: Organic Chemistry-I

Course Code: [CHE-102]

Course Type: Major

Credits: 04

Total Marks- 75+25=100

Course Objectives

1. Students will understand bonding, conjugation, and aromaticity in organic molecules.
2. They will develop skills in stereochemistry and reaction mechanism analysis.
3. They will analyze nucleophilic and electrophilic substitution reactions.
4. They will gain insight into structure—reactivity relationships in organic chemistry.

Unit	Content	Teaching Hours	Mode of Teaching
I	Nature of bonding in Organic Molecules- Delocalized chemical bonding-conjugation, cross Conjugation, resonance, hyperconjugation, bonding in fullerenes. Aromaticity in benzenoid and non-benzenoid Compounds, Huckel's rule, energy level of pi-molecular orbitals, annulenes, antiaromaticity.	15	Online/Offline
II	A-Stereochemistry- Conformational analysis of cycloalkanes, decalines, effect of conformation of reactivity Elements of symmetry, chirality, molecule with more than one chiral center, threo and erythro isomers, stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence Of chiral carbon biphenyls, allenes and spiranes	15	Online/Offline

	B-Reaction mechanism, Structure and reactivity Methods Of determining mechanism, isotope effect. Generation structure, stability and reactivity of benzyne, carbenes and nitrenes. Effect of structure on reactivity resonance and field effect, steric effect, quantitative treatment.		
III	Aliphatic nucleophilic substitution- The S_N^2 , S_N^1 , mixed S_N^1 and S_N^2 , the neighbouring group mechanism, neighbouring group participation by Pi and Sigma bonds, anchimeric assistance Classical and non-classical carbocations. The S_N mechanism nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile. Leaving group and reaction medium, ambident nucleophile, regioselectivity.	15	Online/Offline
IV	Aromatic Electrophilic Substitution- The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The Ortho/Para ratio, ipso attack, orientation in other ring systems. Vilsmeier reaction, Gattermann-Koch reaction. B- Aromatic nucleophilic substitution- The S_NAr . . S_Ni , benzyne and SRN_i mechanism. Reactivity effect of substrate structure, leaving group and attacking nucleophile. The Von Richter, Sommelet Hauser and Smiles Rearrangements.	15	Online/Offline
	Total	60	

Course Outcome: After completing this course the scholar shall be able to

CO1: Studying the nature of bonding in organic molecules—including hybridization, resonance, delocalization, and conjugation—is essential for predicting molecular geometry, stability, and reactivity.

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C02: The 3D arrangement of atoms—is crucial for understanding how molecular shape affects chemical reactivity, physical properties, and biological activity. Identifying highly reactive intermediates (like radicals or carbocations) helps in managing potentially explosive or runaway reactions.

C03: Studying aliphatic nucleophilic substitution (primarily S_N1 and S_N2 mechanism) is foundational to organic chemistry, providing crucial tools for designing chemical synthesis, predicting reaction outcomes, and understanding molecular behavior.

C04: Studying aromatic electrophilic and nucleophilic substitution (EAS) is crucial for understanding how to manipulate stable aromatic rings, providing foundational knowledge for synthetic chemistry, industrial production, and pharmaceutical development.

References:

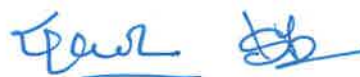
1. Advanced Organic Chemistry- Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A.Carey and R.J.Sundberg. Plenum.
3. Structure and Mechanism in Organic Chemistry, C.K.Ingold, Cornell University press.
4. Organic Chemistry, R.T.Morrison and R.N.Boyd. Prentice Hall.
5. Modern Organic Reactions H. O. House, Benjamin
6. Principles of Organic Synthesis, R.O.C.Normon and J .M.Coxon, Blackie Academic and professional.
7. Stereochemistry of Organic Compounds D.Nasipuri, New Age International.

Suggested reading:

1. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
2. Pericyclic Reactions. S.M_Mukherji, Macmillan India.
3. Reaction Mechanism in Organic Chemistry: S. M. Mukherji and S.P.Singh, Macmillan.
4. Stereochemistry of Organic Compounds, P.SKalsi, New Age, International,

E-Resources:

- <https://nptel.ac.in>
- <https://swayam.gov.in>
- <https://pubchem.ncbi.nlm.nih.gov>
- <https://scholar.google.com>



Program Name: M.Sc. (Chemistry)
Level: PG
Semester: First
Course Name: Physical Chemistry-I
Course Code: [CHE-103]
Course Type: Major

Credits: 04

Total Marks- 75+25=100

Course Objectives-

1. Students will understand the interaction Of electromagnetic radiation with matter and principles of spectroscopy.
2. They will gain knowledge of quantum mechanics and its application to atomic and molecular systems.
3. They will analyze molecular Structure using vibrational and rotational spectroscopy techniques.
4. They will also comprehend chemical kinetics and reaction dynamics in various systems.

Unit	Content	Teaching Hours	Mode of Teaching
I	A-Unifying Principles- Electromagnetic radiation, interaction of electromagnetic radiation with matter-absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering. Uncertainty relation and natural line width and natural line broadening, selection rules, intensity of spectral lines, Born Oppenheimer approximation, rotational, vibrational and electronic energy levels. B- Microwave Spectroscopy- Classification of molecules, rigid rotor model, Effect of isotopic substitution On the transition frequencies	15	Online/Offline

	intensities, non-rigid rotor. Stark effect. Applications.		
II	Vibrational Spectroscopy- A-Infrared Spectroscopy: Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strength; anharmonicity, P.Q.R. branches, vibrations of polyatomic molecules, Selection rules, normal modes of vibration, factors affecting the band positions and intensities. B-Raman Spectroscopy: Classical and quantum theories of Raman effect Pure rotational, vibrational and vibrational-rotational Raman Spectra, selection rules, mutual exclusion principle. Applications Of Raman spectroscopy.	15	Online/Offline
III	Quantum Chemistry- A-Fundamental Background: Operators, Postulates Of Quantum Mechanics, Hamiltonian for different systems, Angular momentum. B-Introduction to Exact quantum Mechanical Results: The Schrodinger equation, discussion of solutions of the Schrodinger equation to some model system viz, the harmonic oscillator, the rigid rotor. C-Approximate Methods: The Variation theorem, linear variation principle. Perturbation theory (First order and Application of variation method and perturbation theory to the Helium atom. D-Electronic structures Of Atoms: Russel-Saunders terms and coupling schemes, term symbols for the pn and dⁿ configurations Spin orbit coupling and Zeeman splitting, introduction to the methods of self-consistent field, Slater's type orbitals.	15	Online/Offline

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	E-Molecular orbital theory: Huckel theory of conjugated systems, bond Order and charged density calculations. Application to ethylene, butadiene, cyclo-butadiene and Benzene molecules.		
IV	Chemical Dynamics- Arrehenius equation and the activated complex theory, Ionic reactions kinetic salt effect, steady state kinetics. Dynamic chain(hydrogen-bromine reaction photochemical (hydrogen- bromine reaction hydrogen- chlorine reactions) and oscillatory reactions (Belousav Zhabotinsky reaction) General features of fast reaction study of fast reaction by relaxation method flash photolysis and the nuclear magnetic resonance method. Dynamics of unimolecular reactions (Lindemann Hinshelwood and Rice—Rampsperger-kassel—marcus (RRKM) theories Of unimolecular reactions)	15	Online/Offline
	Total	60	

Course Outcome: After completing this course the scholar shall be able to

C01: Studying electromagnetic radiation enables identifying chemical compositions via spectral signatures, developing safety regulations against radiation hazards, and advancing technologies like Sensors and solar energy harvesting. Microwave spectroscopy offers exceptionally high-resolution, precise determination of rotational energy levels, molecular geometries, bond lengths, and dipole moments.

C02: Infrared (IR) and Raman spectroscopy Offers rapid, non-destructive, and highly accurate analysis for identifying molecular structures, functional groups, and chemical compositions in solids, liquids, and gases.

C03: Quantum chemistry study enables precise, bottom-up modeling of molecular behaviors, accelerating innovation in drug discovery, materials science, and energy research.





C04: Chemical dynamics studies offer profound benefits by enabling the observation, understanding, and prediction Of fast, atomic-level molecular changes. These studies, Often combining experimental techniques with computational molecular dynamics (MI)) simulations, are critical for accelerating innovation in drug discovery, materials science, and chemical engineering.

References:

1. Modern Spectroscopy, J .Hollas, John Wiley.
2. Physical methods in Chemistry, RS. Drago. Saunders College.
3. Introduction to Molecular Spectroscopy G.M.BarrOw, McGraw Hill.
4. Physical Chemistry P _ W.Atkins, ELBS.
5. Quantum Chemistry, Ira N Prentice Hall.

Suggested reading:

1. Introduction to Quantum Chemistry, A.K.Chandra,Tata McGraw Hill.
2. X Coulson's valence, R.McWeeny, ELBS.
3. Chemical Kinetics, K.J .Laidlcr, Mcgraw-Hill

E-Resources:

- <https://nptel.ac.in>
- <https://swayam.gov.in>
- <https://pubchem.ncbi.nlm.nih&QV>
- <https://scholar.google.com>

Program Name:	M.Sc. (Chemistry)
Level:	PG
Semester:	First
Course Name:	Analytical Chemistry
Course Code:	[CHE-104]
Course Type:	Major
Credits: 04	

Total Marks- 75+25=100

Unit-1

Introduction

Role of analytical chemistry. Classification of analytical methods-classical and instrumental. Types of instrumental analysis, selecting an analytical method. Neatness and cleanliness, laboratory operations and practices, analytical balance. Techniques of weighing, errors. Volumetric glassware-cleaning and calibration of glassware. Sample preparations, dissolution and decompositions. gravimetric techniques. Selecting and handling of reagents. Laboratory notebooks. Safety in the analytical laboratory.

Unit-II

Errors and evaluation

Definition of terms in mean and median. Precision-standard deviation, relative standard deviation. Accuracy absolute error, relative error. Types of error in experimental data determinate (systematic), indeterminate (of random) and gross. Sources of errors and the effects upon the analytical results. Methods for reporting analytical data. Statistical evaluation of data-in determine errors, the uses of statistics.

Unit-III

A-Food analysis

Moisture, ash, crude protein, fat, crude fibre, carbohydrates, calcium, potassium, sodium and phosphate. Food adulteration-common adulterants in food, contamination in foodstuffs. Microscopic examination of food for adulterants. Pesticide analysis in food products. Extraction and purification of sample. HPLC.gas chromatography for

organophosphates. Thin layer chromatography for identification of chlorinated pesticides in food products.

B-Analysis of water pollution

Origin of waste types water pollutants and effects. Sources of water pollution domestic, industrial, agricultural, soil and radioactive waste as sources of pollution, objectives of analysis parameter for analysis-colour turbidity total solid conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of Microgen. Heavy metal pollution, public health significance of Cadmium, Chromium, copper, lead, zinc, manganese, mercury and arsenic. General survey of instrumental technique for the analysis of heavy metals in aqueous systems. Measurement at Do, BOD, COD. Pesticides as water pollutants and analysis. Water pollution law and standards.

Unit-IV

Analysis of soil, fuel, body fluids and drugs

- (a) Analysis of soil: moisture, pff, total nitrogen, phosphorus, silicon, lime, magnesia, manganese, sulphur and alkali salts. of
- (6) Fuel analysis: solid, liquid and gas, ultimate and proximate analysis-heating and value grading coal. Liquid fuels-flash point, aniline point, octane number and carbon residue. Gaseous fuels-producer gas and water gas-calorific value.
- (c) Chemical chemistry: Composition of blood collection and preservation of samples. Clinical analysis, serum electrolytes, blood glucose, blood urea, nitrogen, uric acid, albumin, globulins, barbiturates, acid and alkaline phosphatases. Immunoassay: principles of radioimmunoassay (RIA) and applications. The blood gas analysis trace elements in the body.
- (d) Drug analysis: Narcotic and dangerous drugs. Screening by gas and thin layer chromatography and (spectrophotometric) measurements.



Books suggested

1. Analytical chemistry, G.D. Christian, J. Wiley.
2. Fundamentals of analytical chemistry, D.A. Skoog, D.M. West and F.J. Holler, W.B. Saunders.
3. Analytical chemistry principles, J.S. Kennedy, W.B. Saunders.
4. Analytical chemistry principles and techniques, L.G. Hargis, Prentice Hall. 5. Principles of instrumental analysis, D.A. Skoog, J.L. Loary, W.B. Saunders.
6. Principles of instrumental analysis, D.A. Skoog, W.B. Saunders. 7. Quantitative analysis, R.A. Day Jr and A.L. Underwood, Prentice
8. Environmental solution analysis, S.M. Khopkar, Wiley Eastern. Hall.
9. Basic concepts of analytical chemistry, S.M. Khopkar, Wiley Eastern.
10. Handbook of instrumental techniques for analytical chemistry, F. Settle, Prentice Hall.



Program Name: M.Sc. (Chemistry)
Level: PG
Semester : First
Course Name: Practical (Inorganic, Organic, Physical, Viva-voce and Records)
Course Code: [CHE-105] P
Course Type: Major
Credits: 04 **Total Marks- 75+25=100**

Course Objectives-

1. Students will develop practical skills in qualitative and quantitative chemical analysis.
2. Perform separation, purification, and synthesis of organic compounds.
3. Apply experimental techniques in physical chemistry to study kinetics and equilibria.
4. Enhance laboratory skills, data interpretation, and scientific reasoning.

Unit	Content	Teaching Hours	Mode of Teaching
1	Inorganic Chemistry 20 Marks 1-Qualitative analysis of mixtures: Qualitative analysis of mixture containing trace elements Tl, Mo, W, Zr, Ti, Th, V, U (Two metal ions in cationic/anionic forms) and insoluble oxides, sulphates and halides. The mixture should not contain more than five cations and should be analyzed by semi micro technique. 2-Paper Chromatography: Paper chromatography separation of a mixture of the following and measurements of R _f values. a) Pb ²⁺ , Ag ⁺ , Hg ²⁺ ; b) Co ²⁺ , Ni ²⁺ , Cu ²⁺ ; c) Ba ²⁺ , Sr ²⁺ , Ca ²⁺	40	Offline
	Organic Chemistry 20 Marks 1. Qualitative Analysis Separation,		

II	purification, and identification of binary mixture. Preparation Of derivatives if possible. 2. Organic Synthesis a. Adipic acid by chromic acid oxidation of cyclohexanol. b. Triphenyl methanol from Benzoic acid. c. Dibenzal acetone from Benzaldehyde. d. p-chlorotoluene from p-toluidine e. Synthesis of p-nitroaniline and p-bromoaniline.	40	Offline
III	Physical Chemistry (Anyone) Marks:20 1. Study the adsorption of acetic acid on charcoal and draw the Freundlich isotherm. 2. Show that the order of reaction between acetone and Iodine is zero with respect to Iodine 3. Determination of congruent composition and temperature of a binary mixture e.g. diphenylamine- benzophenone system. 4. Determination of glass transition temperature of a given salt (e.g., CaCl_2) conductometrically. 5. Determination of the velocity constant of hydrolysis of an ester/ ionic reaction in micellar media. 6. Determination of the velocity Constant of decomposition of Benzene diazonium chloride. Viva: 05 Records: 10	40	Offline
	Total	120	

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Note:- A complete records of practical exercises; in Inorganic, Organic and Physical Chemistry done during the session must be produced by the candidates in three separate Record Books at the time of practical examination.

Course Outcome: After completing this course the scholar shall be able to

C01: The study identifies cation/anion mixtures (up to five) by systematically dissolving insoluble substances and applying separation techniques.

C02: Developing systematic, scalable, and environmentally friendly methods to isolate individual components and determine their chemical identities

C03: Studies in the organic synthesis of adipic acid (ADA) focus heavily on replacing traditional, polluting nitric acid oxidation with greener methods, such as using hydrogen peroxide (1-1202) and bio- based raw materials.

C04: Studies show that as the initial concentration of acetic acid increases, the amount adsorbed per gram of charcoal also increases.

References:

1. Skoog .D.A., West.D_M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia (2010)
2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson©(1988)

Suggested reading:

1. <https://labster.com/chemistry-virtual-labs/>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <https://chemcollective.org/vlabs>

E-Resources:

- <https://nptel.ac.in>
- <https://swayqpy.gpv.in>
- <https://pubchem.ncbi.nlm.nih.gov>
- <https://scholar.google.com>



Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Second
Course Name: Inorganic Chemistry-II (Paper-I)
Course Code: [CHE-201]
Course Type: Major
Credits: 04 **Total Marks- 75+25=100**

Course Objectives-

1. By the end of this course, students will understand the mechanisms and kinetics of transition metal complexes, including substitution and redox reactions.
2. They will be able to interpret electronic Spectra and magnetic properties using ligand field theory.
3. Students will gain knowledge of metal- π complexes and clusters, including their structure, bonding, and reactivity.
4. Overall, the course develops analytical skills for studying coordination compounds and their applications.

Unit	Content	Teaching Hours	Mode of Teaching
I	Reaction mechanism of Transition Metal Complexes Energy profile of a reaction, reaction reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reaction, reactions without metal ligands bond cleavage. Substitution reaction in square planar complexes, Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions,	15	Online/Offline




	outer sphere type reactions, inner sphere type reactions.		
II	Electronic spectra and Magnetic Properties of Transition Metal Complexes- Spectroscopic ground states; Orgel energy level (d1-d9 states); Charge transfer spectra; electronic spectra of octahedral and tetrahedral Co(II) and Ni(II) complexes and calculation Of ligand- field parameters.	15	Online/Offline
III	Metal π-Complexes Metal carbonyls, structure and bonding, vibrational spectra of Metal carbonyls for bonding and structural elucidation, important reactions of Metal carbonyls, preparation, bonding. Structure and important reactions of transition metal dioxygen complexes, tertiary phosphine as ligand.	15	Online/Offline
IV	Metal Clusters- A-Higher boranes, carboranes, metallocarboranes. B- Isopoly and hetero poly acids and salts.	15	Online/Offline
	Total	60	

Course Outcome: After completing this course the scholar shall be able to .

C01: Studying the reaction mechanisms of transition metal complexes is essential for optimizing industrial catalysis, developing novel therapeutics, and designing advanced materials. It enables the identification of intermediates, prediction of reaction rates (kinetics), and tailoring Of ligands to control selectivity, spin states, and redox properties for sustainable chemical transformations.

C02: Studying the electronic spectra and magnetic properties of transition metal complexes is essential for determining their molecular geometry, electronic Structure, and bonding characteristics.

C03: The study of metal carbonyls—coordination complexes of transition metals with carbon monoxide (CO) ligands—provides significant benefits across industrial, synthetic, and medical fields. They are essential in homogeneous catalysis for producing key chemical

intermediates, act as precursors for synthesizing complex organometallic compounds, and are used in high-purity metal production.

C04: The study of higher boranes, carboranes, and metallocarboranes offers significant benefits across medicinal chemistry, materials science, and energy technology, primarily due to their unique 3D aromaticity, electron-deficient structures, and high chemical stability. These compounds are increasingly used to design innovative medicines, advanced materials, and highly efficient catalysts.

References:

1. F.A.Cotton and G. Wilkinson Advanced Inorganic Chemistry, æEdn.(1999), John Wiley & Sons, New York.
2. Chemistry Of the elements. N. N. Greenwood and A Earnshaw, Pergammon.
3. Comprehensive Coordination Chemistry eds,, G Wilkinson, R.D. Gillars and J.A. Mc Cleverty. Pergammon.

Suggested reading:

1. James E.Huheey, Inorganic Chemistry, 4th Edition (1993), Addison-Wesley pub.CO., New York.
2. Inorganic Electronic Spectroscopy, A.B.P.Lever, Elsevier.

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- <https://nptel.ac.in>
- <https://swayam.gqv.in>
- <https://pubchem.ncbi.nlm.nih.gov>
- <https://scholar.google.com>





Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Second
Course Name: Organic Chemistry-II (Paper-II)
Course Code: [CHE-202]
Course Type: Major
Credits: 04 **Total Marks- 75+25=100**

Course Objectives:

1. Students will understand the mechanisms of free radical, addition, elimination, and pericyclic reactions.
2. They will be able to analyze regioselectivity, stereochemistry, and reactivity patterns in organic transformations.
3. Students will gain insight into reaction pathways involving and carbon— heteroatom bonds.
4. The course enhances problem-solving skills in predicting and rationalizing organic reaction outcomes.

Unit	Content	Teaching Hours	Mode of Teaching
I	Free Radical Reaction- free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridge head. The effect of solvent on reactivity. Arylation of aromatic compounds by diazonium salt, Hunsdiecker reaction.	15	Online/Offline
II	A-Addition to carbon-carbon multiple bond: Mechanistic and stereo-chemical aspects of addition reactions involving electrophile, nucleophile and free radicals, regio and chemo selectivity, orientation and reactivity. Hydrogenation or aromatic rings. Hydroboration,	15	Online/Offline

	Michael reaction. B-Addition to carbon hetero atom multiple bonds: Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles, Wittig reaction mechanism Of condensation reactions involving enolate, Knoevenagel, Mannich, Stobbe reactions. Hydrolysis of esters.		
III	Elimination reactions: The E2, E1 and E1cB mechanism. Orientation of double bond. Reactivity effect of substrate structures. Attacking base, the leaving group and the medium. Mechanism and orientation on Pyrolytic elimination.	15	Online/Offline
IV	Pericyclic reactions: Molecular Orbital symmetry, frontier orbitals of ethylene, 1,3-butadiene, and allyl System. Classification Of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions-conrotatory and disrotatory motions, 4n, 4n+2 systems. Cycloadditions-antarafacial and Suprafacial 'additions, 4n and 4n+2 system, Sigmatropic rearrangements-suprafacial and antarafacial shift Of H, sigmatropic shifts involving carbon moieties, 3,3 sigmatropic rearrangements. Claisen-Cope and Aza Cope rearrangement. Ene reaction.	15	Online/Offline
	Total	60	

Course Outcome: After completing this course the scholar shall be able to

CO1: Provides crucial insights into molecular mechanisms that drive both destructive diseases and essential physiological functions, offering benefits in medical, industrial, and nutritional fields.



C02: Studying addition reactions to carbon-carbon multiple bonds (or) is essential for organic synthesis, allowing for the construction of complex molecular architectures from simple precursors. Key benefits include mastering regioselectivity (e.g., Markovnikov's rule). Studying additions to carbon-heteroatom multiple bonds (e.g., C=O, C=N) provides essential insights for synthesizing complex, biologically active molecules, drugs, and functional materials.

C03: Studying elimination reactions (E1, E2, E1CB) is fundamental in chemistry, providing insights into synthetic pathways, reaction mechanisms, and industrial applications.

C04: Studying pericyclic reactions offers significant benefits in organic chemistry, particularly due to their concerted, single-step nature that allows for the precise, efficient construction of complex molecular architectures. They are a cornerstone of modern synthetic chemistry, offering high stereospecificity, predictability via orbital Symmetry rules, and alignment with green chemistry principles.

References:

1. Advanced Organic Chemistry- Reactions, Mechanism and Structure, Jerry March, JohnWiley.
2. Advanced Organic Chemistry, F_A.Carey and R.J.Sundberg. Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, K.Ingold, Cornell University press.
5. Modern Organic Reactions H.O.House, Benjamin
6. Principles of Organic Synthesis, R.O.C_Normon and J. M. Coxon, Blackie Academic and professional.
7. Stereochemistry of Organic Compounds D.Nasipuri, Age International.

Suggested reading:

1. Organic Chemistry, R. T.Morrison and R. N. Boyd. Prentice Hall.
2. Pericyclic Reactions. S.M. Mukherji, Macmillan India.
3. Reaction Mechanism in Organic Chemistry S.M .Mukherji and S.P.Singh, Macmillan.

E-Resources:

- <https://nptel.ac.in>
- <https://swavam.gov.in>
- <https://pubchem.ncbi.nlm.nih.gov>
- <https://scholar.google.com>



Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Second
Course Name: Physical Chemistry-II (Paper-III)
Course Code: [CHE-203]
Course Type: Major
Credits: 04 **Total Marks- 75+25=100**

Course Objectives:

1. By the end of this course, students will understand the principles of classical, statistical, and non-equilibrium thermodynamics and their applications.
2. They will be able to analyze surface phenomena, adsorption, and micellar systems.
3. Students will gain knowledge of macromolecules, polymer properties, and characterization techniques.
4. The course also develops understanding of electrochemical processes, kinetics, and instrumental methods for chemical analysis.

Unit	Content	Teaching Hours	Mode of Teaching
I	Thermodynamics- A-Classical Thermodynamics: Free energy and chemical potential. Partial, molar properties partial molar free energy, partial molar volume and its determination, Gibbs —Duhem equation, concept of fugacity (by graphical method). B-Statistical Thermodynamics: Concept of distribution, thermodynamic probability and most probable distribution. Canonical, grand canonical and micro canonical ensembles, The Boltzmann distribution law(no derivation). Partition Functions-translational, rotational, vibrational and electronic partition function. Calculation of thermodynamic properties in terms of partition	15	Online/Offline

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	function. Fermi-Dirac and Bose- Einstein statistics. C-Non-Equilibrium Thermodynamics: Thermodynamic criteria for non-equilibrium States, entropy production, Transformation of the generalized fluxes and forces non- equilibrium stationary phenomenological equations, Onsager's reciprocity relation		
II	Surface chemistry- A-Adsorption: Gibbs adsorption isotherm estimation of surface area (BET equation), surface films on liquids (Electro kinetic phenomenon), catalytic activity at surfaces. B-Micelles: Surface active agents, classification of surface active agents, micellization hydrophobic interactions, Critical micellar concentration (CMC) Factors affecting CMC Of surfactants counterion binding to Micelles, solubilization micro emulsion reverse micelles.	15	Online/Offline
III	Macromolecules: Polymer-definition, types of polymer, electrically conducting fire resistant, liquid crystal polymer, Kinetics Of polymerization, Molecular mass, number and mass average molecular mass, molecular mass determination (Osmometry, Viscometry diffusion and light scattering method) sedimentation chain configuration of macromolecules, Calculation of average dimension of various chain structures.	15	Online/Offline
IV	Electrochemistry: Debye- Huckel theory of activity coefficient of electrolytic Solutions, applicability and limitations of Debye- Huckel limiting law, ionic Strength, structure of electrified interfaces, Helmholtz- Perrin, Guoy-Chapman and Stern models. Over potentials, exchange Current density, derivation of Butler-volmer equation, Tafel plot.	15	Online/Offline

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	Electrocatalysis, Influence of various parameters, Hydrogen electrode. Polarography theory, interpretation of a polarographic Curve, instrumentation, limiting Current, residual and charging Current, diffusion current. Supporting electrolytes, Ilkovic equation, half wave potential and its significance.		
	Total	60	

Course Outcome: After completing this course the scholar shall be able to

C01: The study Of Classical, Statistical, and Nonequilibrium Thermodynamics provides a comprehensive framework for understanding energy, matter, and entropy across different scales and conditions. Classical thermodynamics provides universal laws for macroscopic systems, Statistical thermodynamics bridges microscopic behavior with bulk properties, and Nonequilibrium thermodynamics describes systems with time-dependent behavior and energy fluxes.

C02: The study Of adsorption and micelle formation is essential for understanding how surface-active agents (surfactants) interact with interfaces to alter their properties, with significant benefits in industrial, environmental, and pharmaceutical applications. Adsorption involves the accumulation of surfactant molecules at interfaces (solid-liquid, liquid-gas), while micelles are self-assembled structures formed when surfactants are present above their critical micelle concentration (CMC), allowing them to transport hydrophobic substances.

C03: Understanding of how molecular structure influences properties like, lightness, flexibility, and durability, leading to applications in healthcare, aerospace, and electronics. Key outcomes include mastering synthesis (polymerization) techniques, characterization of molecular weight, and the ability to innovate smarter, sustainable, and eco-friendly materials.





C04: Examining the interconversion of chemical and electrical energy, primarily through redox reactions. Key outcomes from this field span foundational chemical understanding, industrial applications, and advanced technological innovation.

References:

1. Kinetics and Mechanism of Chemical Transformations J.Rajaraman and J.Kuriacose McMillan.
2. Micelles, Theoretical and Applied Aspects, V.Moroi, Plenum.
3. Introduction to Polymer Science V.R. Gowarikar, N.V. Vishwanathan and J.Sridhar, Wiley Eastern.

Suggested Reading:

1. Modern Electrochemistry Vol. I and Vol. II J.O.M. Bockris and AK.N. Reddy, Plenum.
2. Physical Chemistry p. W.Atkins, ELBS

E-Resources:

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- <https://swayam.gov.in>
- <https://pubchem.ncbi.nlm.nih.gov>
- <https://scholar.google.com>



Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Second
Course Name: Research Methodology & Analytical Techniques (paper-IV)
Course Code: [CHE-204]
Course Type: Major
Credits: 04

Total Marks- 75+25=100

Unit- 1 Research Methodology Meaning. Objective Motivation and types of research Approaches its significance and methods vs methodology. Scientific methods of research. Research Problem Selection Necessity Basic Principal of Experimental and different Research design Separation technique involved in research-Distillation, Crystallization, Filtration, Evaporation, Extraction, Adsorption Centrifugation, TLC, GLC, and HPLC, Paper Chromatography

Unit- 2 Polarography: Coulometry and Current Voltage Curve, High Frequency Titrations Polarography, Differential Polarography, Derivative Polarography and Tast Polarography, Polarography of Inorganic Complexes and molten salts.

Optical Rotatory Dispersion & Circular Dichroism:

Chiroptical properties of Organic Molecules: Origin Theory CD, ORD-VCD-principles and application, haloketone rules, sector rules, helicity rules.

Unit-3 Thermal Analysis: Theory, methodology and application of thermogravimetric analysis (TGA), Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC), Principles, techniques and application of thermometric titration methods.

Unit- 4 Radiochemical Analysis: Radiochemical analysis, Dilution analysis activation analysis, Szilard chalmers reaction, Tracer technique and mass spectrography.

Recommended Books:

Analytical Chemistry, G.D. Christian, J. Wiley,

Fundamentals of Analytical chemistry D.A. Skoog D.A. Skoog D.M. West F.J. Holler
W.B. Saunders.

Analytical Chemistry-Principles 1,5. Kennedy, W.B. Saunders.

Analytical Chemistry-Principles and Techniques. L.G Hargis Prentice Hall

Principles of Instrumental Analysis, D.A. Skoog. And J.L. Loaiy. W.B. Saunders

C.R. Kothari, Research Methodology, Methods &, techniques New Age International.



Course Outcome: After completing this course the scholar shall be able to

References:

Suggested reading:

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- <https://nptel.ac.in>
- <https://swayam.gov.in>
- <https://pubchem.ncbi.nlm.nih.gov>
- <https://scholar.google.com>

Dr. S. S.

Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Second
Course Name: Practical (Inorganic, Organic, Physical, Viva-voce and Records)
Course Code: [CHE-205]
Course Type: Major
Credits: 04 **Total Marks- 75+25=100**

Course Objectives:

1. Develop hands-on skills in quantitative analysis and synthesis across inorganic, organic, and physical chemistry experiments.
2. Apply volumetric, gravimetric, and instrumental techniques to determine chemical composition and properties.
3. Analyze reaction kinetics, equilibrium, and solution behaviour using conductometric and cryoscopic methods.
4. Interpret experimental data accurately and maintain systematic laboratory records with scientific reporting

Unit	Content	Teaching Hours	Mode of Teaching
I	Inorganic Chemistry Marks:20 1. Quantitative estimation of two metal ions Cu-Ni, Ni- Zn, Cu-Fe etc involving volumetric and gravimetric methods. 2. Preparation of selective inorganic compounds (any One) (a) $\text{VO}(\text{acac})_2$ (b) $\text{Na}[\text{Cr}(\text{NH}_3)_2(\text{SCN})_4]$ (c) $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$ (d) Prussian Blue (e) $[\text{Co}(\text{Py})_2\text{Cl}_2]$ (f) $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \cdot \text{H}_2\text{O}$	40	Offline
	Organic Chemistry Marks:20		

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II	Quantitative Synthesis (Any Two) 1. Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method. 2. Estimation of amine/phenols using bromated bromide solution or acetylation method. 3. Determination of iodine and saponification values of an oil sample. 4. Determination of DO, COD and BOD of water sample.	40	Offline
III	Physical Chemistry (Anyone) Marks 20 1. Determination Of molecular weight of non-volatile and non-electrolyte/electrolyte by cryoscopic method and to determine the activity coefficient or an electrolyte. 2. Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte. 3. Determination of the velocity constant, order of the reaction and energy Of activation for saponification Of ethyl acetate by sodium hydroxide conductometrically. 4. Determination of solubility and solubility product of sparingly soluble salts (e.g PbSO₄, BaSO₄) conductometrically. 5. Determination of the strength of strong and weak acids in a given mixture conductometrically. Viva 05 Records 10	40	Offline
	Total	120	

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Note:-A complete records of practical exercises; in Inorganic, Organic and Physical Chemistry done during the session must be produced by the candidates in three separate Record Books at the time of practical examination.

Course Outcome: After completing this course the scholar shall be able to

CO1: Quantitative estimation of binary metal ion mixtures (Cu-Ni, Ni-Zn, Cu-Fe) involves leveraging their distinct chemical properties—specifically solubility, complex formation stability, and redox potentials—to separate and quantify them using [volumetric (titration) and gravimetric (precipitation/weighing) methods

CO2: Give the idea about accurately determines the hydroxyl number and percentage of -OH groups in alcohols and phenols.

CO3: Relies on the principle that the freezing point of a solvent decreases when a non-volatile solute is added, a colligative property directly proportional to the concentration of particles in solution.

CO4: Conductometric titration of a mixture containing a Strong acid (e.g., HCl) and a weak acid (e.g., CH_3COOH) with a strong base (NaOH) accurately determines their individual strengths. The study shows a two-step neutralization, resulting in a titration curve with two distinct inflection points: the first representing the neutralization of the strong acid and the second the weak acid, allowing calculation of each concentration

References:

1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
2. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
3. Harris, D.C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
4. Khopkar, S.M. Basic Concepts Of Analytical Chemistry. New Age International Publisher, 2009.
5. Skoog, D.X Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition

Suggested reading:

<https://www.labster.com/chemistry-virtual-labs/>
<https://www.vlab.co.in./broad-area-chemical-sciences>
<https://www.chemocollective.org/vlabs>

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Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Third
Course Name: Applications of Spectroscopy (Paper I)
Course Code: [CHE-301]
Course Type: Major

Credits: 04

Total Marks- 75+25=100

Course Objectives:

1. Understand the fundamental principles and applications of major spectroscopic techniques including UV-Visible, IR, NMR, ESR, Mössbauer, and Mass spectrometry.
2. Interpret spectral data to deduce structure, bonding, and electronic environment in inorganic and organic compounds.
3. Analyze molecular symmetry, functional groups, and reaction mechanisms using spectroscopic methods.
4. Apply spectroscopic techniques for qualitative and quantitative characterization in chemical research and analysis.

Unit	Content	Teaching Hours	Mode of Teaching
I	Applications of Spectroscopy in Inorganic Chemistry A-Vibrational Spectroscopy: Symmetry and shapes Of AB ₂ , AB ₃ and AB ₄ , mode Of bonding of ambidentate ligands such as thiocyanate, nitrate, sulphate and urea, application of Raman spectroscopy particularly for the study of ionic equilibrium in solution. B-Electron Spin Resonance Spectroscopy: Hyperline coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensors, application to transition metal complexes having one unpaired electron and inorganic free radicals such as PH ₄ ⁺ , F ₂ and BH ₃ .	15	Online/Offline

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	C-Mossbauer Spectroscopy: Basic principles, spectral parameters and spectrum display. Application of the techniques to the studies Of (1) bonding and structures of Fe^{2+} and Fe^{3+} compounds including those of intermediate spin and (2) Sn^{2+} and Sn^{4+} compounds nature of M-L bond, coordination number, structure.		
II	Applications of Spectroscopy-I in Inorganic Chemistry A-Ultraviolet and Visible Spectroscopy: Various electronic transitions (185-800 nm). Beer Lambert law. Effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, ultraviolet spectra of aromatic and heterocyclic compounds. B-Infrared Spectroscopy: Characteristic vibrational frequencies of aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides and acids), effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonances.	15	Online/Offline
III	Applications Of Spectroscopy-II in Organic Chemistry- A-Nuclear Magnetic Resonance Spectroscopy: General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism Of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols and carboxylic acids) chemical exchange, effect of deuteration, complex spin-spin interaction between two, three, four and five nuclei (first order spectra). B-Carbon-13 NMR Spectroscopy- General considerations, chemical shift (aliphatic, olefinic,	15	Online/Offline

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	alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants		
IV	Applications of Spectroscopy-III In Organic Chemistry Mass Spectrometry Introduction, ion production- EI, CI, FD and FAB, factors affecting the fragmentation, ion analysis, ion abundance, mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement, Nitrogen rule.	15	Online/Offline
	Total	60	

Course Outcome: After completing this course the scholar shall be able to

C01: Vibrational Spectroscopy, Electron Spin Resonance (ESR), and Mössbauer Spectroscopy are complementary analytical techniques used to probe molecular structure, dynamics, and electronic environments. While vibrational spectroscopy identifies molecular bonds, ESR focuses on unpaired electrons, and Mössbauer spectroscopy offers high-resolution insights into the nuclear environment of specific isotopes like ^{57}Fe .

C02: Ultraviolet-Visible (UV-Vis) and Infrared (IR) spectroscopy are complementary analytical techniques used to identify, quantify, and characterize molecular structures by measuring how matter absorbs or transmits electromagnetic radiation. UV-Vis (200-800 nm) identifies conjugated systems and electronic transitions, while IR (400-4000 cm^{-1}) identifies functional groups via molecular vibrations, providing, in combination, a comprehensive structural fingerprint of samples.

C03: Nuclear Magnetic Resonance (NMR) and Carbon-13 NMR spectroscopy are complementary, non-destructive analytical techniques used to determine organic molecular structures. ^1H NMR provides information on hydrogen environments, coupling, and neighboring protons. NMR offers direct insights into the carbon skeleton, typically displaying single peaks per distinct carbon.

C04: Mass Spectrometry (MS) is a powerful analytical technique used to identify unknown compounds, quantify known materials, and elucidate the structural and chemical properties of molecules.

References:

1. Physical Methods for Chemistry, R.S. Dargy, Saunders Company
2. Structural Methods in Inorganic Chemistry, E.A.V.Ebsworth, Rankin and Craddock-ELBS.
3. Infrared and Raman Spectra Inorganic and Coordination Compounds, K,Nakamoto, Wiley.
4. Progress in Inorganic Chemistry, 8th edition, F.A.Cotton
5. Transition Metal Chemistry, R.L.Carlin, vol.3, Dekker.
6. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Horwood.
7. Spectrometric Identification of Organic Compounds, R.M.Silverstein. G.C. Bassler and T.C. Morill, John Wiley.
8. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I-Fleming, TataMc-GrawHill.

Suggested reading:

1. Inorganic Electronic Spectroscopy, A.P.B.Lever, Elsevier practical NMR Spectroscopy.
2. M. L. Martin, J. J. Delpeuch and G. J. Martin, Heyden.
3. Introduction to NMR Spectroscopy, R.J. Abraham. J. Fischer and P. Loftus, Wiley.
4. Application of Spectroscopy of Organic Compounds, J .R. Dyer, Prentice Hal.

E-Resources:

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- <https://swayam.gov.in>
- <https://pubchem.ncbi.nlm.nih.gov>
- <https://scholar.google.com>



Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Third
Course Name: Bioinorganic and Bioorganic Chemistry (Paper II)
Course Code: [CHE-302]
Course Type: Major
Credits: 04 **Total Marks- 75+25=100**

Section-A: Bioinorganic

Course Objectives:

1. Comprehend the importance of metal ions in biological systems, including their roles as essential and trace elements and in ion transport.
2. Describe bioenergetics, the ATP cycle, and the involvement of metal complexes in energy transfer.
3. Examine the Structure and functions of oxygen-carrying proteins and metalloproteins in electron transfer processes.
4. Assess biological processes like nitrogen fixation and the role Of metalloenzymes such as nitrogenase.

Unit	Content	Teaching Hours	Mode of Teaching
I	A-Metal Ions in Biological Systems Essential and trace metals B-Na/KPump Role of metal ions in biological processes	10	Online/Offline
II	A-Bioenergetics and ATP cycle: DNA polymerization, glucose storage, metal complexes in transmission of energy: chlorophylls B-Transport and Storage of Dioxygen: Heme proteins and Oxygen uptake, structure and function of haemoglobin, myoglobin, haemocyanins and hemerythrin model synthetic complexes in iron, cobalt	10	Online/Offline

	and copper		
III	Electron Transfer in Biology: Structure and function Of metalloproteins transport processes- cytochromes and proteins.	05	Online/Offline
IV	Nitrogenase: Biological nitrogen fixation, molybdenum nitrogenase	05	Online/Offline
	Total	30	

Course Outcome: After completing this course the scholar shall be able to

C01 The study of metal ions in biological systems highlights their indispensable roles as structural and functional components of life, essential for enzymatic catalysis, oxygen transport, cellular signaling, and maintaining osmotic pressure.

C02: The study study involve understanding how cells produce ATP via metabolic pathways and oxygen-dependent respiration, how oxygen is transported by heme/non-heme proteins (hemoglobin, hemocyanin), and how ATP acts as the universal energy Currency for cellular work.

C03: Metalloproteins in electron transport (ET) have established that these proteins use embedded metal centers (iron, copper) and specific structural environments to facilitate rapid, long-range electron tunneling (often Å) in biological systems. Key outcomes indicate that protein structures act as media that tune redox potentials and electronic coupling interactions to maintain efficiency.

C04: Biological nitrogen fixation (BNF) via molybdenum (Mo) nitrogenase is a high-energy, multielectron reduction of N_2 to NH_3 driven by microorganisms, accounting for roughly half of the Earth's bioavailable nitrogen. Studies show it relies on a complex Fe Mo-cofactor, requires high ATP hydrolysis, and faces activity limits, though Mo-independent (V or Fe) nitrogenases exist as alternatives.




References:

1. Principle of Bioinorganic Chemistry, S.J. Lippard and J. M. Berg, University Science Books
2. Progress in Inorganic Chemistry, Vols 18 & 38ed. J.J. Lippard, Wiley.

Suggested reading:

1. Bioinorganic Chemistry, Bertini H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
2. Inorganic Biochemistry. Vol. I and IInd. G.L. Eichhorn, Elsevier.

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- <https://scholar.google.com>

Section-'B' Bio-organic Chemistry**Course Objectives:**

1. Understand fundamental concepts of bioorganic chemistry, including proximity effects and molecular adaptation in biological Systems.
2. Explain enzyme structure, classification, kinetics, mechanisms Of action, and different types Of enzyme-catalyzed reactions.
3. Analyze the role Of Coenzymes, enzyme models, and biomimetic systems in catalysis and molecular recognition.
4. Apply knowledge of enzymes in biotechnological and clinical contexts, including Unit immobilization techniques and drug design.



Unit	Content	Teaching Hours	Mode of Teaching
I	A-introduction- Basic consideration Proximity effects and molecular adaptation B-Enzymes- Nomenclature and classification, Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition.	05	Online/Offline
II	A-Mechanism of Enzyme Action Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase-A. B-Kinds Of Reactions Catalysed by Enzymes Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Transfer of sulphate, addition and elimination reactions, enolic intermediates in isomerization reactions, β-cleavage and condensation, Some isomerization and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.	10	Online/Offline
III	A- Co-Enzyme Chemistry- Cofactor as derived from vitamins coenzyme S, Prosthetic groups, apoenzymes structure and biological functions of coenzyme A thiamine pyrophosphate, pyridoxal phosphate. NAD⁺, NADP, FMN, FAD, lipoic acid, vitamin-B₁₂. B-Enzyme Models-	10	Online/Offline

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	Host-guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality. Biomimetic chemistry crown ethers, cryptates Cyclodextrins. cyclodextrin-based enzyme models calixarenes ionophores, micelles, synthetic enzymes or synzymes.		
IV	Biotechnological Applications of Enzymes: Large-scale production and purification of enzymes, techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilized enzymes, use of enzymes as targets for drug design. Clinical uses of enzymes, enzyme therapy.	05	Online/Offline
	Total	30	

Course Outcome: After completing this course the scholar shall be able

CO1: The study of metal ions in biological systems highlights their indispensable roles as structural and functional components of life, essential for enzymatic catalysis, oxygen transport, cellular signaling, and maintaining osmotic pressure.

CO2: Studies on the mechanism Of enzyme action have established that enzymes are specialized proteinaceous biocatalysts that accelerate chemical reactions—often by millions of times—without being consumed. They achieve this by binding specifically to substrates at their active sites, forming temporary enzyme-substrate (ES) complexes that lower the activation energy required for the reaction to proceed.

CO3: Coenzyme Chemistry focuses on studying non-protein organic molecules that assist enzymes in accelerating reactions, acting as crucial helpers in metabolism, energy transfer, and catalytic processes. Key study Outcomes include understanding how these molecules often derived from B-vitamins catalyze reactions that protein side chains cannot, such as redox chemistry and group transfers.

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C04: demonstrate that enzymes are highly efficient, eco-friendly biological catalysts tailored for industrial processes through genetic engineering, immobilization, and protein engineering. Key outcomes show improved thermostability, enhanced catalytic activity under harsh conditions, and significant advances in medical diagnostics, food production, and sustainable biofuel manufacturing.

References:

1. Bioorganic Chemistry: Achemical Approach to Enzyme Action, Hermann Dugws and C. Penny. Springer Verlag.
2. Understanding Enzymes, Trevor Palmer, Prentice Hall.
3. Fundamentals Of Enzymology. N.C.Price and I-Stevens. Oxford University press,
4. Immobilized Enzymes: An introduction and application in Biotechnology- Michael D. Trevan- John Wiley.
5. Enzyme Structure and Mechanism, A Fersht, W .H. Freeman.

Suggested reading:

1. Enzyme Chemistry: Impact and Applications, Ed.Collin J.Suck Chapman and Hall.
2. Enzyme Mechanisms De.M. I -Page and A.Williams_ Royal Society of Chemistry.
3. Biochemistry: The Chemical Reactions Of Living Cells. DE. Metzler. Academic press.

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- <https://pubchem.ncbi.nlm.nih.gov>
- <https://scholar.google.com>



Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Third
Course Name: Biophysical chemistry and Solid state chemistry (Paper-III)
Course Code: [CHE-303]
Course Type: Major
Credits: 04 **Total Marks- 75+25=100**

Course Objectives:

1. Understand the structure and function of biological cells, biomolecules, and the energetics of biochemical processes.
2. Explain biopolymer interactions, thermodynamics of solutions, and mechanisms of membrane transport and ion conduction.
3. Evaluate molecular properties of biopolymers using experimental and theoretical approaches.
4. Apply principles of solid-state chemistry, including crystal defects, non-stoichiometry, and electronic properties of materials.

Unit	Content	Teaching Hours	Mode of Teaching
I	A-Biological cell and its Constituents- Biological cell, structure and functions of proteins, enzymes-DNA and RNA in living systems. Helix coil transition. B-Bioenergetics Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis Of A TP, synthesis of ATP from ADP	15	Online/Offline
	A-Biopolymer Interactions- Forces involved in biopolymer interactions. Electrostatic charges and molecular expansion, hydrophobic force, dispersion force interactions.		

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II	Multiple equilibria and various types of binding processes in biological systems. Hydrogen ion titration curves. B-Thermodynamics of Biopolymer Solutions- Thermodynamics of biopolymer solutions, osmotic pressure membrane equilibrium, muscular contraction and energy generation in mechano-chemical system.v	15	Online/Offline
III	A-Cell membrane and Transport of ions- Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport. Nerve conduction. B-Biopolymers and their Molecular Weights- Evaluation of size shape molecular weight and extent of hydration of biopolymers by various experimental techniques. Sedimentation equilibrium, hydrodynamic methods, diffusion, sedimentation velocity viscosity electrophoresis and rotational motions	15	Online/Offline
IV	A-Solid State Reactions- General Principles for reaction between two solids: Reaction conditions, structural considerations, surface area, reactivity, kinetics Of solid state reactions. B-Crystal Defects and Nonstoichiometry- Perfect and imperfect crystals, intrinsic and extrinsic defects- point defects, vacancies- Schottky defects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, non- stoichiometry and defects. C-Electronic Properties and Band Theory- Metals, insulators and semiconductors, electronic structure of solids-band theory, band structure of metals, insulators and semiconductors, intrinsic and	15	Online/Offline

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	extrinsic semiconductors, doping semiconductors, p-n junctions, super conductors. Optical properties- optical reflectance, photoconduction- photoelectric effects.		
	Total	60	

Course Outcome: After completing this course the scholar shall be able to

C01 The biological cell is the fundamental structural and functional unit of life, operating as an open system that exchanges energy and matter with its environment. Cells utilize specialized constituents to maintain homeostasis, reproduce, and manage energy, a process heavily reliant on bioenergetics—the study of energy now, transformation, and storage (mainly ATP) within living Organisms.

C02: Studies on biopolymer interactions and the thermodynamics of their solutions reveal key insights into how molecules like proteins and polysaccharides behave in solvents, enabling the engineering of food, pharmaceutical, and bio-based material textures and stability. Key outcomes include the understanding Of phase separation, gelation mechanisms, and the impact of environmental conditions on molecular structure and stability

C03: The cell membrane, ion/biopolymer transport, and biopolymer molecular weights focus on understanding selective permeability, the energetics of transport, and the relationship between macromolecular Structure and biological function.

C04: Crystal defects and non-stoichiometry study key outcomes include altered electrical conductivity (semiconductors), color changes (F-centers), and modified mechanical strength. Non-stoichiometry breaks ideal stoichiometry through metal excess (e.g., NaCl) or deficiency (e.g. FeO, creating materials with unique electrical, magnetic, and optical properties, often acting as extrinsic semiconductors.

References:

1. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
2. Biochemistry, L. Stryer, W.H. Freeman.

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3. Biochemistry, J .David Rawn, Neil Patterson.
4. Outlines of Biochemistry, E.E. Conn and F. K. Stump F, John Wiley.
5. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, H. Dugas and C. penny, Springer Verlag.
6. Solid State Chemistry and its Applications, A.R, West. plenum.
7. Solid State Chemsitry, N .B.Hannay.

Suggested reading:

1. Biochemistry, Voetand Voet, John Wiley.
2. Marcomolecules: Structure and Functions, F. Wold. Prentice Hall.
3. Principles of the Solid State, H. V. Keer, Wiley Eastern.
4. Solid State Chemistry, D.K. Chakrabarty, New Age International.

E-Resources:

- <https://nptel.ac.in>
- <https://swayam.gov.in>
- <https://pubchem.ncbi.nlm.nih.gov>
- <https://scholar.google.com>

Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Third
Course Name: Practical (Inorganic, Organic, Physical, Viva and Records)
Course Code: [CHE-304]
Course Type: Major
Credits: 04 **Total Marks- 75+25=100**

Course Objectives:

1. Develop practical skills in the synthesis, separation, and characterization of inorganic and Organic compounds using standard laboratory techniques.
2. Apply chromatographic and qualitative analysis methods for identification and purification of chemical mixtures.
3. Perform isolation of biomolecules and determine physicochemical properties through thermodynamic and spectroscopic experiments.
4. Interpret experimental data (IR, UV-Vis, etc.) and demonstrate safe, accurate, and systematic laboratory practices.

Unit	Content	Teaching Hours	Mode of Teaching
I	Inorganic Chemistry Marks 20 1. Preparation of selected inorganic compounds and structural elucidation on the basis of given spectra (IR, ESR and MS) Selection can be made from the following I. Sodium amide II. Dichlorophenyl borane PhBCl_2 III. Sn(IV) Iodide, Tin(IV) chloride and Tin(II) iodide IV. Ammonium hexa chlorostannate $(\text{NH}_4)_2\text{SnCl}_6$ V. Trichlorodiphenylantimony(V) hydrate VI. Sodium Tetrathionate, $\text{Na}_2\text{S}_4\text{O}_6$	40	Offline

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	VII. Metal Complexes of dimethyl Sulfoxide, CuCl_2, 2DMSO. VIII. Metal acetylacetonate. IX. Ionexchange separation of oxidation State Of V. X. Preparation of Fe(II)chloride XI. Phosphine and its transition metal complexes. XII. Ferrocene XIII. Copper glycine Complex 2. Chromatographic Separations: a- Thin . layer chromatographic separation of Nickel, Manganese Cobalt and Zinc. Determination of R_f values. b- Cadmium and Zinc Zinc and Magnesium		
II	Organic Chemistry 20 Marks 1. Qualitative Analysis Separation and identification of components of a mixture of three organic compounds (three solids or two liquids and one solid, two solids and one liquid). Suitable derivatives to be prepared where possible. Purity Of the separated components should also be checked on TLC plates, Chemical analysis. 2. Isolation of the following I. Caffeine from tea leaves. II. Casein from milk Lactose from milk III. Nicotine dipicrate from tobacco IV. Lycopene from tomatoes.	40	Offline
III	Physical Chemistry (Anyone) Marks 20 Thermodynamics: I- Determination of partial molar volume of solute (e.g, KCl) I and	40	Offline

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	solvent in a binary mixture.' II- Determination of the temperature dependence Of the solubility of a compound in two solvents having similar intermolecular interactions (benzoic acid in water and in DMSO water mixture) and to calculate the partial molar heat solution Spectroscopy I. Determination of pKa of an indicator (e.g.methyl red) in (a) aqueous and (b) micellar media. II. Determination of stoichiometry and stability constant of inorganic (e.g. ferric-salicyclic acid) and Organic (e. g. amine iodine) complexes. Characterization of the complexes by electronic and IR spectral data. Viva: 05 Records: 10		
	Total	120	

Note: A complete records of practical exercises; in Inorganic, Organic and Physical Chemistry done during the session must be produced by the candidates in three separate Record Books at the time of practical examination.

Course Outcome: After completing this course the scholar shall be able to

C01: Involve a systematic approach integrating synthetic techniques with spectroscopic methods like Infrared (IR) Spectroscopy, Electron Spin Resonance (ESR) Spectroscopy, and Mass Spectrometry (MS).

C02: Thin layer chromatography (TLC) effectively separates Nickel (Ni^{2+}), Manganese (Mn^{2+}), Cobalt (Co^{2+}), and Zinc (Zn^{2+}) using silica gel, Separation is based on varying (R_f) values

C03: The ability to systematically separate a complex mixture into pure components and identify them using physicwal constants and functional group analysis.

C04: Measures how the total volume of a solution changes when a small amount of solute or solvent is added.

References:

1. Skoog .D.A., West. D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing,
2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson ©(1988)

Suggested reading:

1. <https://www.labster.com/chemistry-virtual-labs/>
2. <https://www.vlab.co.in./broad-area-chemical-sciences>
3. <https://www.chemocollective.org/vlabs>

E-Resources:

- <https://nptel.ac.in>
- <https://swayam.gov.in>
- <https://pubchem.ncbi.nlm.nih.gov>
- <https://scholar.google.com>


Convener
Board of Studies
Maa Vinhyavasini University, Mirzapur



Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Fourth
Course Name: Organotransition Metal Chemistry (Elective Paper)
Course Code: [CHE-400A]
Course Type: Major
Credits: 04 **Total Marks- 75+25=100**

Student has option to select any three papers out of eight elective papers.

Course Objectives:

1. Understand the synthesis, structure, and reactivity of organo-transition metal compounds.
2. Analyze bonding in metal—carbon multiple bonds and transition metal π -complexes.
3. Gain knowledge of homogeneous catalysis and fluxional behavior in organometallic Systems.
4. Study of fluxional Organometallic compounds focuses on molecules that undergo rapid.

Unit	Content	Teaching Hours	Mode of Teaching
I	A-Alkyls and Aryls of Transition Metals- Types, routes of synthesis, stability and decomposition pathways, organo-copper in organic synthesis B-Compounds of Transition metal-Carbon Multiple Bonds- Alkylidenes, alkylidynes, low valent carbenes and carbenes- synthesis, nature Of bond, structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis.	15	Online/Offline
	A-Transition Metal π-Complexes- Transition metal π -complexes with unsaturated organic molecules, alkenes, alkynes, allyldiene, dienyl,		

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II	arene and trienyl complexes preparations, properties, nature of bonding and structural features, Important Reaction relationing to nucleophilic and electrophilic attack on ligands and to organic synthesis. B-Transition metal compounds with Bonds to Hydrogen	15	Online/Offline
III	Homogeneous Catalysis- Stoichiometric reaction for catalysis, homogenous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic Feaction involving carbon monoxide such as hydrocarbonylation olefin (oxo reaction), oxopalladation reaction, activation of C-H bond.	15	Online/Offline
IV	Fluxional Organometallic Compounds- Fluxionality and dynamic equilibria in compounds such as η^3 -Olefine , η^3 -allyl and dienyl complexes.	15	Online/Offline
	Total	60	

Course Outcome: After completing this course the scholar shall be able to

CO1: Transition metal alkyls/aryls and metal-carbon (M-C) multiple bonds focus on understanding M-C σ and π -bond stability, reactivity, and application in catalysis. Key outcomes include mastering synthetic methods (alkylation, oxidative addition), identifying decomposition pathways (e.g., β -hydride elimination), understanding 18-electron rule applications, and recognizing the role of ligands in stabilizing carbene/carbyne complexes for organic synthesis.

CO2: metal π -complexes, including alkene, alkyne, and allyl systems, reveal they are fundamental in Organometallic chemistry, acting as critical intermediaries in homogeneous catalysis (e.g., polymerization, hydrogenation).

CO3: Homogeneous catalysis study outcomes demonstrate high selectivity, efficiency, and precise mechanistic control in chemical transformations, primarily utilizing transition metal complexes and ligands. Key findings highlight improved reaction times via flow systems, superior enantiomeric selectivity in asymmetric

synthesis, and enhanced sustainability, while highlighting challenges in catalyst recovery, which are being addressed through immobilization techniques.

C04: The study of fluxional organometallic compounds focuses on molecules that undergo rapid, reversible intramolecular rearrangements between chemically equivalent or non-equivalent structures. These studies are critical for understanding dynamic behaviour that traditional static models overlook.

References:

1. Principles and application of organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, JR Norton and R G Finke, University Science books
2. The organometallic chemistry Of transition metals, R.H.Crabbtree, John Wiley

Suggested reading:

1. Metallo—organic Chemistry, A.J. Pearson Wiley
2. Organometallic Chemistry, R.C. Mehrotra and A Singh, New age International.

E-Resources:

3. <https://nptel.ac.in>
4. <https://swayam.gov.in>
5. <https://pubchem.ncbi.nlm.nih.gov>
6. <https://scholar.google.com>

 
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Maz Vidhyapeeth University, Mumbai

Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Fourth
Course Name: Bioinorganic and Supramolecular Chemistry (Elective Paper)
Course Code: [CHE-400B]
Course Type: Major
Credits: 04 **Total Marks- 75+25=100**

Course Outline:

1. Understand the role of metals in biological systems, including storage, transport, and biomineralization.
2. Analyze the structure and function of metalloenzymes and metal—nucleic acid interactions.
3. Gain knowledge of metals in medicine and principles Of supramolecular chemistry, including molecular recognition and self-assembly.
4. The development of self-assembled nanomaterials, smart responsive materials, and sophisticated biomedical applications

Unit	Content	Teaching Hours	Mode of Teaching
I	A-Metal Storage Transport and Biomineralization transferrin, and siderophores B-Calcium in Biology Ferritin, Calcium in living cells, transport and regulation, molecular aspects of intramolecular processes, extracellular binding proteins	15	Online/Offline
II	Metalloenzymes- Zinc enzymes-carboxypeptidase and carbonic anhydrase, Iro enzymes-catalase, peroxidase and cytochrome P-45(), Copper enzymes-superoxide dismutase, Molybdenum oxotransferase enzymes xanthine oxidase, Coenzyme vitamin B12.	15	Online/Offline

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III	A-Metal-Nucleic Acid Interactions- Metal ion and metal complex interactions, Metal complexes-nucleic acids B-Metals in Medicine- Metal deficiency and disease, toxic effects Of metals, metals for diagnosis and chemotherapy with particular reference to anticancer drugs.	15	Online/Offline
IV	Supramolecular Chemistry (A) Molecular Recognition: Molecular receptors for different types Of molecules including anionic substrates. Design an synthesis of co-receptor molecules and multiple recognition. (B) Supramolecular reactivity (C) Transport processes and carrier design (D) Supramolecular devices: supramolecular photochemistry, supramolecular electronic. ionic and switching devices, Some example of self-assembly in supramolecular chemistry.	15	Online/Offline
	Total	60	

Course Outcome: After completing this course the scholar shall be able to

CO1: Iron metabolism in biological systems relies on a specialized tripartite system of siderophores (microbial scavengers), transferrin (the vertebrate transport protein), and ferritin (the universal storage "bioreactor"). Recent studies highlight that these Systems don't just move iron—they manage a delicate balance between essential nutrition and lethal oxidative toxicity.

CO2: Metalloenzymes—proteins containing tightly bound metal ions that act as catalysts—span from defining fundamental biochemical mechanisms to developing targeted therapeutic agents for cancer and infectious diseases. Key research highlights include the role of metalloenzymes in maintaining metal homeostasis and the creation of artificial metalloenzymes for non-natural reactions.




C03: Metal-nucleic acid interactions are crucial for developing targeted therapies and diagnostics, utilizing metal complexes to bind to DNA/RNA, causing structural changes that can inhibit cancer cell growth or treat diseases. Metals in medicine studies show that metallic compounds are highly effective as targeted therapeutic and diagnostic agents, particularly in oncology and antimicrobial treatment.

C04: "chemistry beyond the molecule," focuses on non-covalent interactions to create complex, functional, and organized structures from molecular components. Key study outcomes include the development of self-assembled nanomaterials, smart responsive materials, and sophisticated biomedical applications.

References:

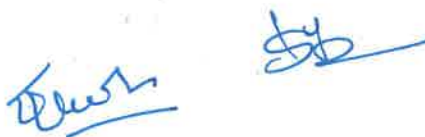
1. Inorganic Biochemistry 1st and 2nd ed. G.T. Eichborn, Elsevier.
2. Progress in Inorganic Chemistry. Vols 18 and 38 ed. J.J. Lipard. Wiley.
3. Supramolecular Chemistry. J.M. Lehn, VCH

Suggested reading:

1. Principles of Bioinorganic Chemistry S J. Lippard and J.M. Borg University Science Books.
2. Bioinorganic Chemistry-T. Bertini. RB. Gray. S J. Lipbard J.S. Valentine, University Science Books.

E-Resources:

1. <https://nptel.ac.in>
2. <https://swayam.gov.in>
3. <https://pubchem.ncbi.nlm.nih.gov>
4. <https://scholar.google.com>



Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Fourth
Course Name: Photoinorganic Chemistry (Elective Paper)
Course Code: [CHE-400C]
Course Type: Major
Credits: 04 **Total Marks- 75+25=100**

Course Outline:

1. Understand the fundamental principles of photochemistry, including excited states, energy transfer, and photochemical processes.
2. Analyze the properties and reactivity of excited States in metal complexes and their role in photochemical kinetics and redox reactions.
3. Gain knowledge of ligand field photochemistry and applications of metal complex sensitizers in energy conversion and catalysis.
4. Improving Power Conversion Efficiency (PCE) and long-term stability by optimizing molecular Structures and charge transfer mechanisms

Unit	Content	Teaching Hours	Mode of Teaching
I	Basics of Photochemistry- Absorption excitation, photochemical laws, quantum yield electronic excited states, life times- measurements of the times flash photolysis, stopped flow techniques. Energy dissipation by radiative and non-radiative processes, absorption spectra, Franck - Condon principle, photochemical stages-primary and secondary processes.	05	Online/Offline
II	A-properties of excited states- Structure, dipole moment, acid-base strengths, reactivity. photochemical kinetics calculation of rates of radiative processes. Biomolecular deactivation-	10	Online/Offline

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	quenching. B-Excited states of metal complexes- Excited States of metal complexes: comparison with organic compounds, electronically excited states of metal complexes, charge transfer spectra, charge transfer excitations methods for obtaining charge-transfer spectra.		
III	A-Ligand field photochemistry- Photo substitution photo oxidation. and photo reduction, lability and selectivity, zero vibrational levels Of ground State and excited state, energy content Of excited state, zero, zero spectroscopic energy, Development of the equations for redox potentials of the excited states. B- Redox reactions by excited metal complexes- Energy transfer under conditions of weak interaction and strong interaction-exciple formation; conditions Of the excited states to be useful as redox reactants, excited electron transfer, metal complexes as attractive candidates (2,2-bipyridine and 1,10-phenanthroline complexes), illustration of reducing and oxidising character of ruthenium +2(bipyridil complex, comparison with Fe (bipy)₃ role Of spin coupling life time of these complexes. Application of redox processes of low energy reactants into high energy products, chemical energy into light.	10	Online/Offline
IV	Metal complex sensitizers Metal complex sensitizer, electron relay, metal colloid Systems, semiconductor supported metal Or oxide Systems, water photolysis nitrogen fixation and carbon dioxide reduction.	05	Online/Offline
	Total	30	

Course Outcome: After completing this course the scholar shall be able to



C01: Photochemistry and quantum yield (QY) studies are crucial for assessing the efficiency and mechanisms of light-driven reactions, measuring the ratio Of photochemical events (molecules formed/consumed) to photons absorbed. Study outcomes Often highlight the stark contrast between primary photochemical acts and secondary reaction mechanisms.

C02: Excited states of metal complexes possess distinct structural, redox, and magnetic properties compared to their ground states, characterized by higher energy, altered bond lengths, and rapid, sometimes metastable lifetimes. Study outcomes focus on tuning photophysics—such as emission color and lifetime—via Metal-to-Ligand Charge Transfer (MLCT) and Ligand-Centered (LC) states for applications in OLEDs, photocatalysis, and solar energy conversion.

C03: Ligand field (LF) photochemistry and redox reactions by excited metal complexes are fundamental areas of inorganic chemistry that explore how light absorption modifies the chemical properties, reactivity, and electronic structure of coordination compounds. Study outcomes typically focus on the ability to trigger ligand substitution, isomerism, and redox changes at milder conditions compared to thermal reactions.

C04: The study of metal complex sensitizers, particularly within the context of dye-sensitized solar cells (DSSCs), focuses on improving Power Conversion Efficiency (PCE) and long-term stability by optimizing molecular structures and charge transfer mechanisms.

References:

1. Concepts Of inorganic photo chemistry, A.W. Adamson and P.D. Fleischauer, Wiley.
2. Inorganic photochemistry, J Chem. Educ. Vol .60, nO, 10, 1983
3. Progress in inorganic chemistry, vol, 30, Ed. S.J. Lippard, Wiley.
4. Elements of inorganic photochemistry. G J. Ferraudi, Wiley.

Suggested reading:

1. Photochemistry of coordination compounds. V. Balzan and V .Carassiti, academic press



Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Fourth
Course Name: Organic Synthesis-I (Elective Paper)
Course Code: [CHE-400D]
Course Type: Major

Credits: 04

Total Marks- 75+25=100

Course Outline:

1. Understand principles, preparation, properties, and applications of organometallic reagents with mechanistic insight.
2. Develop knowledge of oxidation, reduction, and rearrangement reactions in organic synthesis.
3. Gain understanding of aromatic compounds, metallocenes, and their role in modern synthetic chemistry.
4. The identification of "non-innocent" phosphorus centers that enable unique room-temperature phosphorescence, and the role of non-benzenoid aromatics in advanced optoelectronics due to their tunable band gaps.

Unit	Content	Teaching Hours	Mode of Teaching
I	Organometallic Reagents: Principles, preparations, properties and applications of the following inorganic synthesis with mechanistic details. A. Group I and II metal organic compounds Li, Mg, Hg, Cd, Zn compounds. B. Transition metals Cu, Pd, Ni, Fe, Co, Ti compounds.	15	Online/Offline
II	A-Oxidation Introduction different oxidative processes. Hydrocarbons-alkenes, aromatic rings, saturated C-H groups (activated and inactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxylic acid.	15	Online/Offline

	Amines, hydrazines and sulphides. Oxidation with ruthenium tetra oxide, iodo-benzene diacetate and thallium(II)nitrate B-Reduction Introduction, different reductive processes. Hydrocarbons-alkanes, alkynes and aromatic rings. Carbonyl compound-aldehydes, ketones, acids and their derivatives. Epoxides. Nitro, nitroso, azo and oxime groups. Hydrogenolysis.		
III	Rearrangements- General mechanistic consideration: nature Of migration, migratory aptitude, memory effects. A detailed study Of the following rearrangements Pinacol-pinacolone, wagner-meerwein, Demjanov, Benzil- Benzilicacid, Favorskii, Aarndt-Eistert synthesis, Neber, Beckmann, Curtius, Schmidt, Baeyer-Villiger, Shapiro reaction	15	Online/Offline
IV	Metallocenes- Nonbenzenoid Aromatic and polycyclic aromatic compound General consideration, synthesis and reactions Of some representative compounds.	15	Online/Offline
	Total	60	

Course Outcome: After completing this course the scholar shall be able to

C01: Understand principles, preparation, properties, and applications of organometallic reagents with mechanistic insight.

C02: Develop knowledge of oxidation, reduction, and rearrangement reactions in organic synthesis.

C03: Molecular rearrangements are crucial transformations in organic synthesis, involving the migration of atoms or groups to an electron-deficient or electron-rich center. The study outcomes of these named reactions primarily focus on understanding their regioselectivity, stereochemistry, and synthetic utility.

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C04: metallocenes, nonbenzenoid aromatics, and polycyclic aromatic compounds (PACs) have focused on their unique electronic structures, optoelectronic applications, and environmental/biological impacts. Key outcomes include the discovery of novel nonbenzenoid PAMs (polycyclic aromatic molecules) with high-efficiency hole-transporting capabilities (up to 14% efficiency in perovskite solar cells)

References:

1. Modern synthetic reactions, H.O.House, WA. Benjamin.
2. Some modern methods of organic synthesis, W.Carruthers, Cambridge Univ. Press.
3. Principles of organic synthesis, R.O.C. Norman and J.M.Coxon, Blackie academic and professional.
4. Rodd's chemistry Of carbon compounds, EdS Coffey Elevier.

Suggested reading:

1. Advanced organic chemistry part B, F.A.Carey and R.J.Sundberg. Plenum Press.
2. Advanced organic chemistry, reactions mechanisms and Structure, J.March, JohnWiley.

E-Resources:

1. <https://nptel.ac.in>
2. <https://swayam.gov.in>
3. <https://pubchem.ncbi.nlm.nih.gov>
4. <https://scholar.google.com>



Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Fourth
Course Name: Heterocyclic Chemistry (Elective Paper)
Course Code: [CHE-400E]
Course Type: Major
Credits: 04 **Total Marks- 75+25=100**

Course Objectives:

1. Understand nomenclature, structure, and aromatic/non-aromatic behavior of heterocyclic compounds.
2. Gain knowledge of synthesis and reactions of small, fused, and various heterocyclic systems.
3. Develop insight into the chemistry and applications of five-, six-, and higher-membered heterocycles in organic and medicinal chemistry.
4. The ability to perform high-diversity synthesis via strained ring-opening, the creation of efficient multi-component reactions (MCRs), and the construction Of bio-active compounds.

Unit	Content	Teaching Hours	Mode of Teaching
I	A-Nomenclature of Heterocycles- Replacement and systematic nomenclature (Hantzsch Widman system) for monocyclic, fused and bridged heterocycles. B-Aromatic heterocycles- General chemical behavior of aromatic heterocycles, classification (Structural type), criteria of aromaticity (bond lengths ring current and chemical shifts in ^1H -NMR-spectra. Empirical resonance energy) resonance energy, delocalization energy and dewar resonance energy, diamagnetic susceptibility exaltations). Heteroaromatic reactivity and tautomerism in	15	Online/Offline

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	aromatic heterocycles. C-Non-aromatic Heterocycles- Strain bond angle and torsional strains and their consequence in small ring heterocycles. Conformation of six- membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3- diaxial interaction. Stereo-electronic effects-anomeric and related effects. Attractive interactions-hydrogen bonding and intermolecular nucleophilic interactions.		
II	A-Heterocyclic Synthesis- Principles of heterocyclic synthesis, cyclization reactions and cycloaddition reactions. B-Small Ring Heterocycles- Three membered and four membered heterocycles- synthesis and reaction of aziridine, oxiranes. Thiranes, azetidines, oxetanes and thietanes.	15	Online/Offline
III	A-Benzo-Fused Five-membered Heterocycles- Synthesis and reactions including medicinal application Of benzo-pyrroles, benzo-furans and benzo-thiophenes B-Meso-ionic Heterocycles- General classification, chemistry of some important mesoionic heterocycles of type A and B and their applications. C-Six-membered Heterocycles with one Heteroatoms Synthesis and reaction of pyrylium salts and pyrones and their comparison with pyridinium and thio pyrylium salts and pyridines. Synthesis and reactions of quinolizinium and benzpyridinium salts, coumarins and chromones.	15	Online/Offline
IV	A-Six-membered Heterocycles- with two or more Heteroatoms Synthesis and reaction of diazines, triazines and thiazines.	15	Online/Offline

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	B-Seven-and large—Membered Heterocycles Synthesis and reaction Of azepines, oxepines, thiepinines, diazepines, thiazapines, azocine, diazocines, dioxocines and dithiocines.		
	Total	60	

Course Outcome: After completing this course the scholar shall be able to

C01: Focus on the ability to name (nomenclature), classify based on stability (aromatic vs. non- aromatic), and predict the reactivity of these structures

C02: Heterocyclic synthesis, particularly regarding small-ring systems (3- and 4 - membered), focus on developing versatile building blocks for pharmaceutical and material sciences.

C03: Mastering the synthesis and biological applications of indole, benzofuran, benzothiophene, and meso-ionic compounds like sydnones

C04: Six-membered heterocycles with two or more heteroatoms (diazines, triazines, morpholines) are crucial in medicinal chemistry, forming the backbone Of many pharmaceuticals (e.g., Imatinib, Ciprofloxacin). Seven-and larger membered heterocycles (azepines, oxepines, thiepinines) are less common but show unique, stable structures with specialized applications.

References:

1. "Heterocyclic Chemistry" Vol, I-3R.R_Gupta, M Kumar and V.Gupta, Springer, Verlag 2
2. Heterocyclic chemistry, J.A.Joule, K.Mills and G. F Smith, Chapman and Hall.
3. Contemporary Heterocyclic chemistry. G.R.Newkome and W W .Paudler, Wiley-Inter Science.
4. Comprehensive Heterocyclic Chemistry, A.R.Katritzky and C.W.rees. Eds. Pergamon press.

Suggested reading:

1. Chemistry Of Heterocycles, T Eicher and S.Hauptmann, Thieme.
2. An Introducticm to the Heterocyclic Compounds, R.M. Acheson, John Wiley.
3. Heterocyclic chemistry, T.LGilchrist, Longmane Scientific Technical.

Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Fourth
Course Name: Natural Products (Elective Paper)
Course Code: [CHE-400F]
Course Type: Major
Credits: 04 **Total Marks-** 75+25=100

Course Objectives:

1. Understand Classification, structure determination, biosynthesis, and synthesis Of natural products like terpenoids and carotenoids.
2. Gain knowledge of alkaloids, steroids, plant pigments, and porphyrins including their structure, properties, and biological roles.
3. Develop insight into synthesis and applications of biologically important compounds such as prostaglandins, pyrethroids, and rotenones.
4. Ability to promote plant growth through nanocarrier delivery Systems and their role as highly stable geochemical indicators that can persist for millions of years in the fossil record

Unit	Content	Teaching Hours	Mode of Teaching
1	Trapezoids and Carotenoids- Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule: Structure determination stereochemistry, biosynthesis and synthesis Of the following representative molecules: Citral Geran oil, a-terpeneol, Menthol, farnesol, Ziniberene, Santonin, Phytol, Abietic acid and β -Carotene.	15	Online/Offline




II	A-Alkaloids- Definition, nomenclature and physiological action, occurrence, isolation, general methods Of Structure elucidation, degradation, classification based on nitrogen heterocyclic ring role of alkaloids in plants. Structure, stereochemistry, synthesis and biosynthesis Of the following : ephedrine, (+)-Conline, Nicotine, Atropine, Quinine and morphine. B-Steroids- Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, Structure determination and synthesis of Cholestrol, Bile acids, Androsterone, Testosterone, Estrone, Progestorne, Aldosterone, Biosynthesis Of steroids.	15	Online/Offline
III	A-Plant Pigments- Occurrence, nomenclature and general methods Of determination, Isolation and synthesis of A pigenin, Luteolin, quercetin, myrcetin, Quercetine 3-glucoside, Vitexi Diadzein, Butein, Aureusin, Cyanidin-7-arabinoside, acid pathway. B-Porphyrins Structure and synthesis of Hemoglobin and Chlorophyll. A-Prostaglandins structure, ,	15	Online/Offline
IV	A-Prostaglandine: Occurrence, nomenclature, classification, biogenesis and physiological effects, Synthesis Of PGE2 β-Pyrethroids and Rotenones- Synthesis and reaction of Pyrethroids and Rotenones (For structure elucidation, emphasis to be placed on the use of spectral parameters wherever possible).	15	Online/Offline
	Total	60	

Course Outcome: After completing this course the scholar shall be able to -




C01: Focus exclusively on the health benefits, dietary sources, and mechanisms of action of carotenoids (plant pigments). Carotenoids are bright-colored, fat-soluble compounds synthesized by plants, algae, and bacteria, known for their powerful antioxidant, anti-inflammatory, and health-promoting properties.

C02: Alkaloids and steroids—specifically steroidal alkaloids—highlight their potent role in treating cancer, inflammatory diseases, and neurological disorders. Recent research focuses on how structural modifications (e.g., adding nitrogen groups to steroidal backbones) can enhance drug efficacy and reduce side effects.

C03: Study Outcomes regarding plant pigments and porphyrins focus on their dual role as essential biological drivers of photosynthesis and bioactive compounds with high pharmacological and agricultural value. Key findings highlight their ability to promote plant growth through nanocarrier delivery systems and their role as highly stable geochemical indicators that can persist for millions of years in the fossil

C04: Prostaglandins, pyrethroids, and rotenones highlight distinct roles in biological systems, ranging from mediating inflammation and immune response to inducing significant neurotoxicity and metabolic dysfunction. Prostaglandins (PGs) generally act as lipid mediators in mammals and insects, while pyrethroids and rotenone are utilized as potent pesticides with known detrimental effects on non-target species, including neurological damage, hormonal disruption, and multi-organ toxicity.

References:

1. Natural Products: Chemistry and Biological Significance, Mannm R.S.Davidson, J.B.Hobbs, D.V.Banthrope and .B.Harbome, Longman, Essex.
2. Organic Chemistry, Vol-2, I.L. Finar, ELBS
3. Rodd's' Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
4. Introduction of Flavonoids, B.A. Bohm, Harwood Academic Publishers.
5. New Trends in Natural Product Chemistry, .Atta-ur-Rahaman apd M.I. Choudhary, Harwood Academic Publishers.
6. Insecticides of Natural Origin, Sukh Dev, Harwood Academic publishers.

Suggested reading:

1. Stereoselective Synthesis: A Practical Approach, M. Nogradi, VCH.

2. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed Kurt hostettmann, M.P. Gupta and A. Marston, Harwood Academic publishers.

E-Resources:

1. <https://nptel.ac.in>
2. <https://swayam.gov.in>
3. <https://pubchem.ncbi.nlm.nih.gov>
4. <https://scholar.google.com>

Four

SB

Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Fourth
Course Name: Medicinal Chemistry (Elective Paper)
Course Code: [CHE-400G]
Course Type: Major

Credits: 04

Total Marks- 75+25=100

Course Objectives:

1. Understand principles of drug design, SAR, receptor interactions, and pharmacokinetics in drug development.
2. Gain knowledge of various therapeutic agents including anti-cancer, cardiovascular, anti-infective, and psychoactive drugs.
3. Develop insight into the synthesis, mechanism of action, and applications of important drugs and antibiotics.
4. Cardiovascular drugs, particularly ACE inhibitors (ACE-Is), ARBS, and beta-blockers, have shown promise in mitigating these effects, though their efficacy varies, and clinical trial results on their prevention capabilities have been mixed.

Unit	Content	Teaching Hours	Mode of Teaching
I	A-Drug design- Relationship between Chemical structure and biological activity (SAR). Receptor site theory approach to drug design. Introduction to combinatorial synthesis in drug discovery. B-Pharmacokinetics- Introduction of drug absorption, desorption, elimination using pharmacokinetics, important pharmacokinetics parameters in determining drug disposition and in therapeutics. Mention of uses of pharmacokinetics in drug development process.	15	Online/Offline



II	A-Anti neoplastic Agents- Introduction, cancer chemo-therapy, role of alkylating agents and antimetabolites in treatment of cancer. Synthesis of mechlorethamine, cyclophosphamide, melphan, mechalorethamine, cyclophosphamide melphalan, uracil, mustards, and σ-mercaptapurine.di β-Cardiovascular Drug- Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathetic function central intervention of cardiovascular Output. Direct acting arteriolar dialators. Synthesis Of amyl nitrates orbitrate, deltizem, quitridine, veramil and atenolal.	15	Online/Offline
III	A-Local Anti-infective Drugs- Introduction and general mode of action. Synthesis Of sulphonamides, turatolidone, ciprofloxacin, norfloxacin, dopone, aminosalicic acid, isoniazid, ethionamid, thambutal, fluconatole, ariseofulvin, chlorogenin, primaqion. β-Psychoactive Drugs-The Chemo therapy of mind Introduction, neurotransmitters, CNS depressant, general anaesthetics, mode of action of hypnotics, sedatives, antianxiety drugs, Antipsychotic drugs- the neuroleptics, antidepressant, butyrophenones, serendipity and drug development. Synthesis of diatepam, oxatepam, chloratepam, alpratalam, phenyloin barbiturates.	15	Online/Offline
IV	Antibiotics Cell wall biosynthesis inhibitors, β -lactam rings antibiotics inhibiting protein synthesis, synthesis of penicillin, chloramphenicol, cephalosponin and streptomycin.	15	Online/Offline
Total		60	

Course Outcome: After completing this course the scholar shall be able to




C01: Drug design integrated with pharmacokinetics (PK) optimizes lead compounds by evaluating ADME properties (Absorption, Distribution, Metabolism, Excretion) early, reducing attrition rates from 39% to near Key outcomes include determining optimal dosage, assessing drug-drug interactions (DDIs), defining therapeutic windows, and validating drug safety before human trials.

C02: Anti-neoplastic agents, including anthracyclines, HER2 inhibitors, and VEGF inhibitors, Often cause significant cardiovascular toxicity (CTX), including left ventricular dysfunction, heart failure (HF), and hypertension.

C03: Based on academic literature and clinical studies, the "chemotherapy of mind" (psychoactive drugs) and the use of anti-infective agents particularly when interacting or within the context of "local anti-infective therapy" show distinct outcomes related to symptom reduction, drug interaction risks, and potential neuropsychiatric side effects. **C04:** Studies On antibiotic Outcomes indicate that while these drugs are vital for treating infections, their overuse and misuse are driving a global crisis of antibiotic resistance. Key findings show that 7- day courses are often as effective as 14-day regimens, and that roughly 30% Of outpatient prescriptions are unnecessary, often involving broad-spectrum drugs that accelerate resistance.

References:

1. A.Granguage Introduction to Medical Chemistry, Wiley-VCH.
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry. Ed. Robert F.dorgc
3. S.S.Pandeyaand J.R.Dimmock. An Introduction to Drug Design New Age International.
4. M. E.Wolff, Burgees Medicinal Chemistry and Drug Discovery, John Wiley.

Suggested reading:

1. Goodman and Gilman's Pharmacological Basis of therapeutics, Mc Graw-Hill.
2. R.B. Silvernnanm, The Organic Chemistry or Drug Design and Drug Action. Academic press.
3. D. Lednicer, Strategies for Organic Drug Synthesis and Design,, John Wiley.

E-Resources:

1. <https://nptel.ac.in>
2. <https://swayam.gov.in>
3. <https://pubchem.ncbi.nlm.nih.gov>
4. <https://scholar.google.com>



Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Fourth
Course Name: Polymer Chemistry (Elective Paper)
Course Code: [CHE-400H]
Course Type: Major

Credits: 04

Total Marks- 75+25=100

Course Objectives:

1. Understand the basic concepts Of polymers, including synthesis, classification, and polymerization techniques.
2. Analyze polymer characterization methods, molecular weight determination, and structure— property relationships.
3. Gain knowledge of polymer processing techniques and applications of commercial and functional polymers.
4. Studying Polymer Processing and Properties of Commercial Polymers provides an in-depth Unit understanding of how chemical structures.

Unit	Content	Teaching Hours	Mode of Teaching
I	Basics- Importance of polymers. Basic concepts: Monomers, repeat units, degree of polymerization. Linear, branched and network polymers, Classification of polymers Polymerization: condensation, addition, radical chain-ionic and co-ordination and copolymerization. Polymerization conditions and polymer reactions. Polymerization in bomogeneous and heterogeneous Systems.	15	Online/Offline
	Polymer Characterization Polydispersion-average molecular weight concept.		





II	Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution. The practical significance Of molecular weight. Measurement of molecular weights. End group, viscosity. light scattering, osmotic and ultracentrifugation methods. Analysis and testing of polymers. Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study. Microscopy. Thermal analysis and physical testing- tensile strength. Fatigue, impact, tear resistance. Hardness and abrasion resistance.	15	Online/Offline
III	Structure and Properties- Morphology and order in crystal fine polymers- configurations of polymer Chains. Crystal structures of polymers. Morphology of crystalline polymers polymers, strain-induced morphology, crystallization and melting. Polymer Structure and physical properties-crystalline melting point "T_m-melting points of homogeneous series, effect of chain flexibility and other steric factros, entropy and heat of fusion. The glass transition temperature, T_g-Relationship between T_m and T_g, Effects of molecular weight, diluents, chemical structure, chain topology, branching and Cross linking. Property requirements and polymer utilization.	15	Online/Offline
IV	A-Polymer Processing- Plastics, elastomers and fibers Compounding Processing techniques Caledering diecasting, rotational casting film casting injection moulding. blow moulding. extrusion moulding thermolorming, foamian, reinforcing and fibre spinning. B-Properties of Commerical Polymers Polyethylene, Polyvinyl chloride polyamides polyesters, phenolic resins. epoxy resins and silicone	15	Online/Offline

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	polymers. Functional polymers, tire retarding polymers and electrically conducting polymers. Biomedical polymers-contact lens, dental polymers, .artificial heart. Kidney, skin and blood cells.		
	Total	60	

Course Outcome: After completing this course the scholar shall be able to-

CO1: Understanding the relationship between molecular structure and macroscopic properties, including polymer classification, synthesis techniques (addition/condensation), characterization methods (molecular weight/thermal transitions), and engineering applications. Students will gain skills to relate polymer architectures to properties like elasticity, viscosity, and solubility.

CO2: Polymer Characterization studies determine the molecular structure, weight and morphology of polymers to connect their molecular makeup to functional performance. Key outcomes include verifying material compliance, predicting mechanical behavior (strength/durability), ensuring safety in applications, and optimizing material formulation for industries like aerospace and medical devices.

CO3: Focus on understanding how the microscopic arrangement of monomers (macromolecules) dictates the macroscopic, physical, and chemical behaviour of materials. The primary study outcomes focus on identifying how chain structure, morphology, and molecular weight translate into usable engineering properties, such as high-temperature resistance, flexibility, conductivity, and biodegradation.

CO4: Studying Polymer Processing and Properties of Commercial Polymers provides an in-depth understanding of how chemical structures, Synthesis methods, and processing conditions (such as injection molding or extrusion) dictate the final physical, mechanical, and thermal properties of materials.

References:

1. Polymer Science, V.R. Gowarker, NV. Viswanathan and I Sreedhar, Wiley-Eastern.
2. Functional Monomers and Polymers. K.Takemoto, Y Anaki and RM. Rttanbrite. •
3. Contemporary polymer Chemistry, HR.Alcock and F.W.Lambe, Prentice Hall.

Suggested reading:

1. Physics and Chemistry of polymer, I .M.G. Cowie, Blackie Academic and Professional.
2. Textbook Of Polymer Science, F.W. Billmeyer Jr, Wiley.

Sur

Sp

Program Name: M.Sc. (Chemistry)
Level: PG
Semester: Fourth
Course Name: Practical (Inorganic, Organic, Physical, Viva & Records)
Course Code: [CHE-401] P
Course Type: Major

Credits: 04

Total Marks- 75+25=100

Course Objectives:

1. Apply various analytical techniques such as spectrophotometry, flame photometry, chromatography, and polarography for qualitative and quantitative analysis of chemical substances.
2. Perform multi-step organic synthesis and identify compounds using spectral data and experimental methods.
3. Evaluate electrochemical properties through EMF measurements, potentiometric titrations, and determination of equilibrium constants and ionic product.

Unit	Content	Teaching Hours	Mode of Teaching
I	Inorganic Chemistry (Any two) (A) Spectrophotometric Determination a- Manganese/chromium vanadium in steel sample. b- Nickel/ molybdenum/ tungsten/ vanadium/ uranium by extractive spectrophotometric method. c- Fluoride /nitrate/ phosphate I d- Iron-phenanthroline complex: job's Method. (B) Flame Photometric Determinations: a- Sodium and Potassium when Present	40	Online/Offline

	together b- Lithium/ calcium/ Barium/ Strontium c- Cadmium and Magnesium in tap water.		
II	Organic Chemistry Marks 20 (A) Multi Step Synthesis of organic Compounds Preparation of organic compounds involving not more than three stages. i) Benzanilide from Benzene ii) Benzilic acid from Benzoin iii) Quinoline from Aniline iv) 2-phenylindole from phenylhydrazine. v) Alkylation of diethyl malonate with alkyl halide. (B) Paper Chromatography Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of R_f values. Identification of organic compounds on the basis of given spectral data (UV, IR, PMR, CMR and MS)	40	Online/Offline
III	Physical Chemistry Marks 20 (A) Polarography i- Estimation of in a mixture of Pb^{2+} and Cd^{2+}/Zn^{2+} and Ni^{2+} by polarography. Determination of dissolved oxygen in aqueous solution of organic solvents. (B) EM.F. Measurement i- Determination of the equilibrium constant of the reaction $H_2Q/2Ag^+$ (Hydroquinone) u $Q+2W+2Ag$ (Quinhydrone)	40	Online/Offline

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	ii- Determination of activity coefficient of electrolytes. iii- Potentiometric titration of a solution of Fe^{2+} against $\text{K}_2\text{Cr}_2\text{O}_7$ and the determination of the redox Potential of $\text{Fe}^{2+}/\text{Fe}^{3+}$ system. iv- Determination of ionic product of water (K_w)		
	Viva 05 Records 10		
	Total	120	

Note:- A complete records of practical exercises; in Inorganic, Organic and Physical Chemistry done during the session must be produced by the candidates in three separate Record Books at the time Of practical examination.

Course Outcome: After completing this course the scholar shall be able to

CO1: Spectrophotometric determination studies consistently yield highly accurate, rapid, and cost- effective outcomes for quantifying analytes.

CO2: Studies on Flame Photometric Determinations consistently yield outcomes validating it as a highly specific, rapid, and cost-effective method for the routine quantification of easily excitable alkali and alkaline earth metals

CO3: Paper chromatography effectively separates a mixture Of glucose, fructose, and sucrose by partitioning them between the stationary paper and a moving solvent. The distinct migration distances (measured as R_f values) and unique color reactions allow for the clear identification and separation of these sugars.

CO4: The potentiometric titration of (Fe^{2+}) with ($\text{Cr}_2\text{O}_7^{2-}$) determines the exact concentration of ferrous ions in a sample. By monitoring the electrical potential of the solution with a platinum indicator electrode and a reference electrode.

References:

1. Skoog .D.A., West.D.M and Holler. F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, IO).
2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" PearsonC(1988).

Suggested reading:

1. <https://www.labster.com/chemistry-virtual-labs/>
2. <https://www.vlab.co.in/broad-area-chemical-sciences>
3. <http://chemcollective.org/vlabs>

E-Resources:

1. <https://nptel.ac.in>
2. <https://swayam.gov.in>
3. <https://pubchem.ncbi.nlm.nih.gov>
4. <https://scholar.google.com>



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