Department of Chemistry
Dr. Shakuntala Misra National Rehabilitaion University,
Mohaan Road, Lucknow-226017

Two Year Post Graduate

Course Structure

For

M.Sc. Chemistry

as

Per

National Education Policy-2020

w.e.f.:-2025-26

Department of Chemistry

Faculty of Science

Dr. Shakuntala Misra National Rehabilitaion University,

Department of Chemistry
Dr. Shakuntala Misra National Rehabilitaion University,
Mohaan Road, Lucknow-226017

Mohaan Road, Lucknow-226017

Course Structure of Semester-I M.Sc. Chemistry

Semester-I						
Paper Code	**Paper Title**	**Type**	**Credits**	**Internal Assessment**	**University Exam**	**Total Marks**
CY-101	Inorganic Chemistry-I	Core Course	4	25	75	100
CY-102	Organic Chemistry-I	Core Course	4	25	75	100
CY-103	Physical Chemistry-I	Core Course	4	25	75	100
CY-104	Environmental Chemistry	Core Course	4	25	75	100
CY-105	Advance Chemistry Practical-I	Core Course	4	00	100*	100
	Total Credits		**20**			**500**

*Bifurcation of 100 Marks in CY105 = 25 x 2 Experiments + 10 File Record + 10 Attendance + 30 Viva

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Inorganic Chemistry-I (Core Course)

Credits-4 **Paper Code-CY-101** **Marks (75+25)= 100**

Program Outcomes:

The objective of this course is to provide students coming in the first year of Masters programme new and advance understanding into the bonding properties of normal compounds and coordination complexes and their concomitant optoelectronic and magnetic applications.

Program Specific Outcomes:

- **PSO-1.** Students gain newer insight regarding the symmetry, bonding, electronic and magnetic properties of inorganic compounds and coordination complexes..
- **PSO -2.** This forms the basis of the development of newer molecule-based materials which can offer attractive electronic properties at the molecular level, supermolecular and supramolecular level.
- **PSO -3.** Also, the content dealing with the magnetic properties may create zeal amongst the students to design and develop new single molecule magnets which now a day are getting attraction as the contrast agents in magnetic resonance imaging (MRI).

Unit-I

(a) Symmetry and group theory

Symmetry elements & Operation, Determination of point group of a molecule, Flow chart for assign point group, Mathematical Requirement for a point group, Group, subgroup, class subclass, Character table, and construction of character tables for c2v and c3v groups.

Unit-II

(b) Stereochemistry and Bonding in Main Group Compounds

VSEPR theory & drawbacks, Bent rule, MO theory, Energy level diagram for F_2, O_2, CO, NO. Walsh diagram (triatomic and pentatomic).

Unit-III

Chemistry of Transition Metal Complexes

Limitation of crystal field theory, Molecular orbital theory, Octahedral, tetrahedral and square planar complexes,π-bonding and molecular orbital theory.Spectro chemical series, Jahn-Teller effect, stability of coordination complexes and factors effecting stability.

Unit-IV

Electronic Spectra of transition metal complexes

Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagram for transition metal complexes (d^1–d^9), calculation for Dq, and β parameter, charge transfer spectra, spectroscopic method for assignment of absolute configuration in optically active metal chelates and their stereo chemical information.

Unit-V

Magnetic properties of transition metal complexes

Magnetic moments, Magnetic properties of transition metal complexes, Inter-ion magnetic coupling, anomalous magnetic moments, magnetic exchange coupling and spin crossover, comparison of first transition series with 2nd and 3rd transition series.

Recommended Books:

1. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, John Wiley
2. Inorganic Chemistry, J. E. Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
3. Chemistry of the Elements, N. N. Greenwood and A. Earnshow, Pergamon.
4. Inorganic Electronic Spectroscopy, A. B. P. Lever, Elsevier
5. Magneto chemistry, R. L. Carlin, Springer Verlag
6. Modern Spectroscopy, J. M. Hollas, John Wiley.
7. Chemical Applications of Group Theory, F. A. Cotton.
8. Symmetry and Group theory: Some chemical applications, Ramashankar and Suresh Ameta, Himansh
9. u Publications, Udaipur, Delhi.
10. K. Veera Reddy, Symmetry and Spectroscopy of Molecules, New Age
11. Inorganic Chemistry, D. E. Shriver, P. W. Atkins and C. H. L. Langford, Oxford.

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Organic Chemistry-I (Core Course)

Credits-4 **Paper Code-CY-102** **Marks (75+25)= 100**

Program Outcomes:

The objective of this course is to provide students coming in the first year of Masters programme new and advance understanding about bonding, varied mechanistic approaches and some important reaction mechanism which they had not encountered in their degree programme.

Program Specific Outcomes:

After the completion of the course the students will acquire knowledge of:

- **PSO-1**: Aromaticity, non aromaticity and antiaromaticity in carbocyclic and heterocyclic compounds.
- **PSO-2**: mechanism and outcome of aliphatic electrophilic substitution reactions.
- **PSO-3**: properties and reactivity of stereoisomers and stability of an organic molecule based onstructure, including conformation and stereochemistry, Conformational analysis and its effect on organic reactivity,stereo selective and stereo specific synthesis.
- **PSO-4**: the various types of aliphatic nucleophilic substitution reactions and will give them a better understanding of the processes involved.
- **PSO-5**: mechanisms forvarious organic reactions and how to use their understanding of organic mechanism stop redict the outcome of reactions.
- **PSO-6**: molecular orbital symmetry and possibility of thermal and photochemical pericyclic reactions.

Unit I

Nature of bonding in organic molecules

Bonding in fullerenes, Aromaticity in benzenoid and non-benzenoid compound,alternateand non alternate hydrocarbons,energy of p-molecular orbitals, annulenes, antiaromaticity, Ψ–aromaticity homoaromaticity. Crown ether complexes and cryptands, cyclodextrins, catenanes and rotaxane.

Aliphatic electrophilic substitution

Biomolecular mechanism – SE2 and SE1. The SE1 mechanism, electrophilic substitution accompanied by doubled bond shifts. Effect of substrates, leaving group and solvent polarity.

Unit II

Stereochemistry

Conformational analysis of mono and di substituted cycloalkanes, (cyclohexane) decalines, effect of conformation on reactivity, stericstrain due to unavoidable crowding.Enantiotopic and diastereo topic atoms, group offaces, stereo specific and stereo selective synthesis, asymmetric synthesis, optical activity in absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape.

Unit III

Aliphatic nucleophilic substitution

The S_N2, S_N1 and SET mechanism.
The neigh boring group mechanism, neigh boring group participation by πbond, anchimeric assistance. Non classical carbocations, phenoniumions, norboryl system.

The S_Ni mechanism

Nucleophilic substitution at anallylic, aliphatic trigonal and vinylic carbon.Reactivity effect of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis, regio selectivity.

Unit IV

Reaction Mechanism: structure and reactivity

Hammonds postulate, Curtin-Hammett principle. Potential energy diagram, transition state and intermediates, methods of determining mechanism, isotope effect. Hard and soft acids and bases. Effect of structure on reactivity resonance and field effect, steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants, Taft equation.

Unit V

Pericyclic Reactions

Molecular orbital Symmetry, Frontier orbital of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward Halfmann correlation diagram, FMO and PMO approach, electrocyclic reaction –conrotatory and disrotatory motion,4n, 4n+2 and allyl systems. Cycloaddition –antarafacial and suprafacial addition, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3dipolarcycloaddition and chelotropic reactions. Sigma tropic rearrangement–Suprafacial and antarafacial shift of H,sigma tropic shift involving corban moieties,1,3,1,5, 1,7, 2,3and3,3-sigma tropic rearrangement. Claisen, copeandaza-copere arrangements.Enereaction.

Recommended books

1. Stereochemistry of Organic Compounds, Nasipuri, New Age International (P) Limited.
2. Stereochemistry of Carbon Compounds, E.L.Eliel and S.H.Wilen
3. Organic Chemistry, J.Clayden, N.Greeves, S.Warren and P.Wothers (Oxford Press.)
4. Advanced Organic Chemistry, A.F.A.Carey and R.J.Sundberg, 5th Ed.Springer (2007)
5. Advanced Organic Chemistry, J. March, 6th Ed.
6. Mechanism and structure in Organic Chemistry – E.S.Gould (Holt, Rinehart and Winston)
7. Textbook of Pericyclic Reaction, Concept and Application, K.C.Majumdar and P.Biswas, Scientific International Pvt. Ltd.
8. Photochemistry and Pericyclic Reactions, Jagdamba Singh and Jaya Singh, New Age International (P) Limited.
9. Guide book to Mechanism in Organic Chemistry, Orient Longman, Sykes, P.A New Delhi.

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Physical Chemistry-I (Core Course)

Credits- 4 **Paper Code CY-103** **Marks (75+25)=100**

Program Outcomes:

The objective of this course is to provide students coming in the first year of Master's program new and advance understanding into the applications of kinetics and thermodynamics of reaction rates, surface chemistry, macro molecules, electro chemistry and their application.

Program Specific Outcomes:

Students will gain an understanding of:

- **PSO-1.** The application of mathematical tools to calculate thermodynamic and kinetic properties.
- **PSO-2.** The theories of kinetics and thermodynamics of reaction rate with special reference to kinetic salt effect.
- **PSO-3.** The knowledge of basics of surface chemistry, macro molecules, micelles, electro chemistry and electro diffraction giving firm foundation in the fundamentals and applications.

Unit I

Theory of reaction rate

Failure of collision theory, activated complex and uni-molecular reaction i.e. Lindeman theory, thermodynamics of reaction rate. The ideas of reaction kinetics in solution with special reference to kinetic salt effects.

The fast reaction kinetics

Fundamental aspects of NMR, Relaxation and flow methods, flash photolysis. Preliminary ideas of molecular reaction dynamics. Simple ideas of Oscillatory chemical reaction. Photochemical reactions involving pyrolysis of molecules and kinetics of enzyme reaction.

Unit II

Surface chemistry

Adsorption

Surface tension, capillary action, pressure difference across curved surface (Laplaceequation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation surface area (BET equation), and surface film of liquids (electro–kinetic phenomenon) catalytic activity at surface. Micelle Surface active agent, classification of surface-activeagent, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactant, counter ion binding to micelles, thermodynamics of micellization – phase separation and moss action models, solubilization, micro emulsion, reverse micelles.

Unit III

Macro molecules

Polymer –definition, classification of polymer, electrically conducting fire resistant, liquid crystal polymer,), molecular mass, number and mass average molecular. Mass, molecular mass determination (osmometry, diffusion and light scattering methods), sedimentation and end group analysis method, chain configuration of macromolecules, calculation of average dimensions of various chain structures.

Unit IV

Electrochemistry

Electrolytic conductance of strong electrolytes, Activity, activity coefficient, Debye-Huckel theory for electrolytic solution, determination of activity and activity coefficient, ionic strength. Electrochemistryof solution, Debye-Huckel – Onsager treatment and its extension, ion solvent interaction, Debye Huckel, Bjerrum mode.Electrical phenomenon at interfaces and electrode processes. Thermodynamics of electrified interface equation, deviation of electro-capillary, Lippmann equation (surface excess), methods of determination, structure of electrified interfaces. Guoy Chapman, Stern, Bockris, Devanathan method.

Unit V

X-ray and electron diffraction

Bragg condition, Bragg method, Debye-Scherrer method of X-ray structural analysis of crystals, identification of unit cell from systematic absences in diffraction pattern. Structure of simple lattices and X-ray intensities, structure factor and its relation to intensity and electron density, phase problem. Description of the procedure for an X-ray structure analysis, absolute configuration of molecules. Scattering intensity vs. scattering angle, Wierl equation, measurement technique. Low energy electron diffraction.

Recommended Books:

1. P.W.Atkins, Physical Chemistry, Oxford University Press, New York.
2. S.Glasston, Physical Chemistry, Nostrand.
3. Advance Physical Chemistry (Vol-1,2,3,4), K.L.Kapoor, Mac Millan, India
4. Puri Sharma Pathania, Advance Physical Chemistry.
5. J.O.M.Bockris and A.K.N. Reddy, Modern Electro chemistry, Vol.2, Plenum Press, New York.
6. Statistical Thermodynamics, Second Edition, New Age International Limited Publisher, India by M.C.Gupta.
7. Introductory Quantum chemistry by A.K Chandra, Second Edition, Tata Mc Graw-Hill publishing company Limited, India.
8. Quantum chemistry through problems and solution by R.K Prasad, New age International Pvt Ltd, Publishers.
9. Molecular quantum Mechanics By P.W. Atkins Oxford University Press, Oxford New York
10. Physical Chemistry, Ira N. Levine.

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Environmental Chemistry (Core Course)

Credits-4 **Paper Code-CY-104** **Marks (75+25)=100**

Program Outcomes:

After successful completion of the first year of Masters, students coming in third semester/second year and the objectives of this course are to provide knowledge about environmental chemistry and methods of analyses for the estimation of myriad of pollutants coming from domestic and industries.

Program Specific Outcomes:

- **PSO-1.** Environmental chemistry is an interdisciplinary science that includes atmospheric, aquatic and soil chemistry, as well as heavily relying on analytical chemistry and being related to environmental and other areas of science.
- **PSO-2.** By the knowledge of this paper student will understand the fate of chemical species in the air, soil, and water environments the effects of human activity and biological activity on these.
- **POS-3.** They will also be able to grasp the knowledge of industrial pollution and environmental toxicology.

Unit I

Environment

Introduction, Composition of atmosphere, Vertical temperature, heat budget of the earth atmospheric system, vertical stability atmosphere. Biogeochemical cycles of C,N,P,S and O. Bio distribution of elements.

Unit II

Hydrosphere

Chemical Composition of Water bodies- lakes, streams river and wet lands etc, hydrological cycle.

Aquatic Pollution: Inorganic, Organic, Pesticide, Agricultural, Industrial and Sewage, detergents, oil spills and oil pollutants, Water quality parameters-dissolved oxygen, biochemical oxygen demands, solids metals, content of chloride, Sulphate, phosphate, nitrate and micro-organisms water quality standards.

Unit III

Analytical Methods

Analytical methods for measuring BOD, DO, COD, F, Oil, Metals (As, Cd, Cr, Hg, Pb, Se etc) residual chloride and chlorine demand, Purification and treatment of water.

Soil

Composition, micro and macro nutrients, Pollution- fertilizers, pesticides, plastics and metals, waste treatment.

Unit IV

Atmosphere

Chemical Composition of atmosphere, Particles, Ions and radicals and their formation chemical and photochemical reaction in atmosphere smog formation, oxides of N,C,S,O and their effect, pollution by chemicals, petroleum, minerals, ChloroFluoro hydrocarbons. Greenhouse effect, acid rain, air pollution controls and their chemistry. Analytical methods for measuring air pollutants, continuous monitoring instruments,

Unit V

Industrial Pollution

Cement, sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants, metallurgy, polymers, drugs etc. Radionuclide analysis, Disposal of Wastes and their management.

Environmental Toxicology

Chemical solution to environmental problems, biodegradability, principles of decomposition, better industrial processes.

Recommended Books:

1. Manahan, Stanley E. Fundamentals of Environmental Chemistry Boca Raton: CRC Press LLC, 2001
2. Sonja Krause, Herbert M. Clark, James P. Ferris, Robert L. Strong Chemistry of the Environment, Elsevier Science & Technology Books 2002
3. Eugene R. Weiner Applications of Environmental Chemistry 2000 CRC Press, LLC
4. By Clair, N. Sawyer, Perry L. Mc Carty, Gene F. Parking Chemistry for environmental engineering and Science (5th edition) McGraw Hill Professional.

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Advance Chemistry Practical-I (Core Course)

Credits-4 **Paper Code CY-105** **Marks (75+25)=100**

Program Outcomes:

To provide students coming in the first year of Master's program advance understanding analysis and separation of inorganic and organic mixtures. Also, to provide advance insight about the electrochemical aspects of chemistry, about preparation of solutions standardization of secondary solution, conductance, e.m.f., pH, kinetics and partition coefficient.

Program Specific Outcomes:

In order to make students understand the theories taught to the min M.Sc. Sem. I in different branches of chemistry e.g. Inorganic, Organic, Physical, the following practical are introduced. Students will learn:

- **PSO-1**. Qualitative analysis of inorganic mixtures and insolubles.
- **PSO-2.** Separation techniques of cations and anions by chromatography.
- **PSO-3.** Qualitative analysis of three components organic mixture.
- **PSO-4.**The basic knowledge like preparation of solutions standardization of secondary solution, dilution, calibration and handling of some sophisticated electronic related to the practical syllabus.
- **PSO-5.** The basic knowledge of conductance, e.m.f, pH, kinetics and partition coefficient.
- **PSO-6.** To focus their aim for future prospects of Ph.D programme and Pharmaceutical industry.

INORGANIC CHEMISTRY

Qualitative analysis

Qualitative analysis of inorganic mixture of 8 radicals containing not more than two of the following less common metals: Tl, Mo, W, Zr, Th, V, U. Insoluble–oxides, sulfates and halides.

Chromatography

Separation of cations and anions by Paper chromatography and Column chromatography-Ion exchange.

ORGANIC CHEMISTRY

Qualitative analysis

Separation, purification, characterization and identification by making suitable derivatives of the three component Organic mixture (three solids or two solids and one liquid or two liquids and one solid) involving all the functional groups. Use TLC for checking the purity of the separated compounds and their derivatives and report their Rf values.

PHYSICAL CHEMISTRY

Conductance measurement

- To find out the equivalent conductance of astrongel ectrolyt eat different concentrations at room temperature and the test the validity of Onsager equation.
- Study hydrolysis of aniline hydro chloride by conductance method.
- Determination of basicity of agiven salt by conductance method.

Electro chemistry (EMF – Measurements) – Potentiometry / pH-metry

- Determination of EMF of Daniel Cell by Potentio metric method Zn/ZnSO4 (C1) II CuSO4 (C2)/Cu Where C1 and C2(i) same concentration (ii) different concentration and hence to see the effect of dilution.

- Determination of the solubility of a sparingly soluble salt in water by EMF method.

Chemical kinetics

- Determine the velocity constant and order of reaction for hydrolysis of ethyl acetate by sodium hydroxide at given temperature (saponification of an ester) by titration method.
- Study of kinetics of reaction between ethyl acetate and sodium hydroxide (saponification) by conductance method.

Recommended Book:

1. Vogels Textbook of Quantitative Analysis revised, J.Bessett, R.C.Denney, G.H. Jellery and J.Mendhan ELBS
2. Experimental Inorganic Chemistry by Mounir A, Malati, Horwood series in Chemical Science (Horwood publishing Chichester) 1999.
3. Inorganic Experiments, J.Derex woolings VCH
4. Micro scale Inorganic Chemistry, Z.Scafran, R.M.Pike and M.M. Singh Wiley.
5. Practical Inorganic Chemistry, G.Marrand, B.W. Rockett,Van Nostrand.
6. The systematic Indentification of Organic Compounds, R.L.Shringer and D.Y.Curlin.
7. Qualitative Analysis, R.A.Day, Jr. and A.L.Underwood, PrenticeHall.
8. Basic concept of Analysis chemistry, S.M.Chopkar, Wiley Bastern.
9. Synthesis and characterization of Inorganic compounds,W.L.Jolly, Prentice Hall.
10. Systematic Qualitative Organic Analysis, H.Middeton, Adward Arnoid.
11. Handbook of Organic Analysis Qualitative and Quantitative, H.Clark, Adward Ar.
12. Vogel's Textbook of Practical Organic Chemistry, A.R.Tatchell, John Wiley.
13. Practical Physical Chemistry, A.M.Jamesand F.E.Prichand, Longman.
14. Findley's Practical Physical Chemistry revised, B.P.Levitt, Longman.
15. Experimental Physical Chemistry, R.C.Dasand Bebera, Tata Mc Grawhill.
16. Senior Practical Physical Chemistry, B.D.Khosla andV.S.Barg (R.Chand and Co.,Delhi)
17. Experimental Physical Chemistry by D.P.Shoemaker Mc Grawhill, 7thEdition 2003.
18. Experiments in Chemistry, D.V. Jahagirdar, Himalaya Publishing House.
19. Practical Physical Chemistry, B.Vishwanathan and P.S.Raghwan, VivaBooks.
20. General Chemistry Experiments, Anil J Elias, University Press (2002).
21. Experimental Physical Chemistry, V.D. Athawale, Parul Mathur, New Age Internatial (P) Limited.
22. Systematic Experiment in chemistry, Arun Sethi, New Age International (P) Limited.
23. Experiments in Physical chemistry, J.C. Ghosh, Bharati Bhavan.
24. Advanced Practical Physical Chemistry, JB Yadav.
25. Practical Organic Chemistry, Mann and Saunders.

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Course Structure of Semester-II M.Sc. Chemistry

Semester-II						
Paper code	**Paper Title**	**Type**	**Credits**	**Internal Assessment**	**University Exam**	**Total Marks**
CY-201	Inorganic Chemistry-II	Core Course	4	25	75	100
CY-202	Organic Chemistry-II	Core Course	4	25	75	100
CY-203	Physical Chemistry-II	Core Course	4	25	75	100
CY-204	Water chemistry and waste management	Core Course	4	25	75	100
CY-205	Advance Chemistry Practical -II	Core Course	4	00	100*	100
	Total Credits		**20**			**500**

*Bifurcation of 100 Marks in CY-205 = 25 x 2 Experiments + 10 File Record + 10 Attendance + 30 Viva

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Inorganic Chemistry-II (Core Course)

Credits-4 **Paper Code-CY-201** **Marks(75+25) =100**

Program Outcomes:

The objective of this course is to provide students coming in the first year of Master's program understanding into molecular vibrational properties, solution behavior, kinetics and reaction mechanism of the coordination complexes. Also, some comparatively unknown but highly applicable organometallic complex syntheses and properties.

Program Specific Outcomes:

- **PSO-1.** In this semester students learn the reaction mechanism and vibrational properties associated with inorganic coordination complexes which now-a-days are gaining importance as Homogenous catalysts Electron transfer agents Sensors to detect ions as well as molecules such as nitro-aromatic compounds a noxious compound utilized as an ingredient in explosives Sensitizers in new-generation solar cells.
- **PSO-2.** To asses and describe the bonding properties in the targeted compounds which have been designed for above mentioned applications Fourier-Transform IR Spectroscopy and Raman spectroscopy have to be utilized. So, the student after accomplishing this semester is supposed to become expert in assessing the bonding situations in varied types of compounds.
- **PSO-3.** The bond formation is an important phenomenon in chemistry. In this semester students learn about the design of different highly reactive but potent organometallic compounds.
- **PSO-4.** This information can be a stepping stone to such students who are willing to excel themselves in industries in particular dealing with pharma sector.

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Inorganic Chemistry-II (Core Course)

Credits-4 **Paper Code-CY-201** **Marks(75+25) =100**

Unit I

Metal ligand equilibria in solution

Stepwise and overall formation constant, trends in stepwise constant, factors affecting the stability of metal complex with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin.

Unit II

Reaction mechanism of transition metal Complexes-I:

Energy profile of reaction, reactivity of metal complexes, inert and labile complexes, kinetics of octahedral substitution, substitution of square planar complexes, the trans effect, mechanism of the substitution reaction, redox reaction, electron transfer reaction, outer sphere type reactions, cross reaction and Marcus-Hush theory, inner sphere type reaction.

Unit III

Reaction mechanism of transition metal complexes-II:

Mechanism and Kinetics of substitution reaction, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct indirect evidence in favour of conjugate mechanism.

Unit IV

Main Group Organometallic Chemistry

Organoberyllium and Organosilicon compounds: preparation stability and important reaction. Metal carbonyls–reactions, structure and bonding, vibrational spectra of metal carbonyls for structural elucidation.

Unit V

Metal Clusters

Higher boranes, carboranes, metalloboranes and metallocarboranes. Metal carbonyls and halide clusters. Compounds with metal-metal multiple bonds. Using Wade Rule ccalculate the meta-metal bond and structure type.

Recommended Books

1. Inorganic Chemistry 4th ed. J E Huheey, E A Keiter, R . L. Kwiter, O. K. Medhi.
2. Inorganic Chemistry 6th Ed. Weller, Overton, Rourke, Armstrong.

3. Theory and Applications of UV Spectroscopy, H. H. Jaffe and M. Orchin, IBH- Oxford.
4. Introduction to Magnetic Resonance, A. Carrington and A.D. Maclachalan, Harper & Row.
5. Physical Methods for Chemistry, R. S. Drago, Saunders Company.
6. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
7. Organometallic Chemistry: A Unified Approach by R. C. Mehrotra and A. K. Singh

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Organic Chemistry-II (Core Course)

Credits-4 **Paper Code-CY-202** **Marks (75+25) =100**

Program Outcomes:

The objective of this course is to provide students coming in the first year of Masters program new and advance understanding mechanistic approaches in organic chemistry and basic characterization of organic compounds into electronic and IR spectroscopy.

Program Specific Outcomes:

After the completion of the course the students will acquire knowledge of:

- **PSO-1**: what are aromatic electrophilic and nucleophilic substitutions and their mechanism with the help of suitable examples.
- **PSO-2**: free radical reactions, their mechanism and also the reactivity towards aliphatic and aromatic substrates.
- **PSO-3**: addition reactions between carbon- carbon multiple bonds and hetero atom and carbon multiple bonds and mechanism of some specific name reactions.
- **PSO-4**: elimination reactions and rules used to study elimination reactions with the help of specific examples of elimination reactions.
- **PSO-5**: how to determine the structure of organic molecules using UV and IR spectroscopic techniques, λ max for polyenes and α, β-unsaturated carbonyl compounds, IR range for functional groups, solving structural problems based on UV-Vis, IR spectral data.

Unit I

Aromatic Electrophilic substitution

The arenium ion mechanism, Orientation and reactivity, energy profile diagram.The ortho / para ratio, ipso attack, orientation in other ring system. Diazonium coupling, Vilsmeir reaction, Gatterman-Koch reaction.

Aromatic Nucleophilic substitution

The SNAr, SN1, benzyne and SRN1 mechanisms. Reactivity-effect of substrates structure,leaving group and attacking nucleophile. The Von Richter, Sommelet–Houser and Smiles rearrangements.

Unit II

Free Radical Reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighboring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Alicyclic halogenation (NBS), oxidation of aldehyde to carboxylic acid, auto-oxidation, coupling of alkynes. Sandemeyer reaction. Hunsdiecker reaction.

Addition to Carbon – Carbon multiple bonds

Mechanistic and stereochemical aspects of addition reaction envolving electrophiles. Nucleophiles and free radicals, regio-and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, Michaels reaction.

Unit III

Addition to Carbon – Hetero multiple bond

Witting reaction. Mechanism of condensation reaction involving enolates-aldol,Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Sotobbe reaction. Hydrolysis of ester and amides, ammonolysis of esters.

Elimination Reactions

The E2, E1 and E1cB mechanism. Reactivity-effects of substrates structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

Unit IV

Infrared Spectroscopy

Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. FTIR.

Unit V

Ultraviolet and Visible Spectroscopy

Various electronic transitions (185-800 nm), Beer-Lambert Law, effect of solvent on electronic transitions, ultraviolet bands for unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and unsaturated carbonyl compounds. Steric effect in biphenyls.

Recommended books:

1. Silverstein and Basser, Spectrometric Identification of Organic Compounds, Willey.
2. Organic Spectroscopy, P.S. Kalsi, New Age International (P) Limited.
3. Spectroscopy of Organic Compounds, Pavia, Mery Finch Publication.
4. Organic Chemistry, J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press.)
5. Organic Spectroscopy, I Fleming, McGraw-Hill Inc., US.
6. H.O. House, Synthetic Organic Chemistry.

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Physical Chemistry-II (Core Course)

Credits-4 **Paper Code- CY-203** **Marks (75+25) =100**

Program Outcomes:

The objective of this course is to provide students coming in the first year of Masters program new and advance understanding into classical/statistical thermodynamics and quantum mechanics.

Program Specific Outcomes:

Students will recognize the importance of:

- **PSO-1.** the limitation of classical thermodynamics, Statistical thermodynamics and Non equilibrium thermodynamics.
- **PSO-2.** the difference between the classical and quantum mechanics.
- **PSO-3.** the connections between common approximation methods and standard chemical frame works (e.g. Born Oppenheimer approximation, molecular orbital theory.

Unit I

Unifying Principal

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, transition probability, transition moment, selection rules, intensity of spectral line.

Quantum Chemistry and its introduction to Quantum mechanical results

Discussion of solution of the Schrodinger equation to the same model system viz. particle in a 3D box, the harmonic oscillator, the two-particle rigid rotor, the hydrogen atom (with derivation).

Unit II

Approximate methods

The variation theorem, linear variation principle. Perturbation theory (first order and non-degenerate). Simple application of variation method in perturbation theory,Results of the time dependent perturbation theory, Comparison of the variation and perturbation methods with example.

Molecular Orbital Theory

Huckel theory of conjugated system, bond order and charge density calculation. Application to ethylene, butadiene etc. Introduction to extended Huckel theory.

Unit III

Angular Momentum:

Ordinary angular momentum, eigen functions for angular momentum, eigen values of

angular momentum.

Electronic structure of atom:

Electronic configuration, Russell-Saunders term and coupling schemes, Slater-Condon parameter, term separation energy of pn configuration, term separation energy for the dn configuration, magnetic effects: spin-orbit coupling and Zeeman splitting.

Unit IV

Classical Thermodynamics:

Partial molar quantities and their physical significance. Concepts of fugacity and determination of fugacity.

Phase transition:

Phase transition of first order and second order, Relation between heat of neutralization and their standard boiling point (thermodynamically)

Non-Equilibrium Thermodynamics:

Thermodynamic criteria for non – equilibrium state, entropy production and entropy flow, entropy balance equation for different irreversible processes (e.g. heat flow, chemical reaction etc.) transformation of generalized fluxes and forces, non-equilibrium stationary states, phenomenological equation, microscopic reversibility and Onsager's reciprocity relation, electro kinetic phenomena, diffusion, electric conduction.

Unit V

Statistical Thermodynamics:

System, assembly, ensemble averaging. Canonical, grand canonical and microcanonical ensembles. Thermodynamic probability and most probable distribution (Boltzman distribution law) and its mathematical derivation. Partition functions- translational, rotational, vibrational and electronic partition function, calculation of thermodynamic properties in the term of partition function. Application of partition function in equilibrium constant and heat capacity of solids.

Recommended Books:

1. P.W. Atkins, Physical Chemistry, Oxford University Press, New York.
2. S. Glasston, Physical Chemistry, Nostrand
3. Advance Physical Chemistry (Vol-1,2,3,4), K.L. Kapoor, Mac Millan, India
4. Puri Sharma Pathania, AdvancePhysical Chemistry.
5. J.O.M. Bockris and A.K.N. Reddy, Modern Electrochemistry, Vol.2, Plenum Press, New York.
6. Statistical Thermodynamics, Second Edition, New Age International Limited Publisher, India by M.C. Gupta
7. Introductory Quantum chemistry by A.K Chandra, Second Edition,Tata Mc Graw-Hill publishing company Limited, India
8. Quantum chemistry Through problems and solution by R.K Prasad, New age International Pvt Ltd, Publishers
9. Molecular quantum Mechanics By P.W. Atkins Oxford University Press, Oxford New York
10. Physical Chemistry By Ira N. Levine

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Water Chemistry and Waste Management (Core Course)

Credits-4 **Paper Code-CY-204** **Marks (75+25) =100**

Program Outcomes:

Understand characteristics of water and wastewater and its determination. Study the population growth, related water demand, wastewater generation and design periods for water and wastewater treatment units. Expose the students to understand components of water supply lines and sewer lines. Develop analytical skills and design of water and wastewater treatment units. Provide fundamental knowledge about various disposal standards for sewage.

Program Specific Outcomes:

At the end of this course students will be able to:

- **PSO-1** Understand assessment procedure and significance of physical, chemical and biological characteristics of water and wastewater.
- **PSO-2** Explain the process of self-purification of the sources of disposal and determine the degree of treatment of sewage based on the source of disposal of wastewater.
- **PSO-3** Evaluate the quantity estimation for public water supplies and sewage generation
- **PSO-4** Describe and design various parameters of collection and conveyance of water and waste water.
- **PSO-5**Design of water and wastewater treatment units.

Unit I

Water Chemistry

Water treatment and analysis: Characteristics of water, Types of impurities present, and their effect in water (Colour, Turbidity, Hardness), Hardness of water- Types of Hardness and degree of Hardness of water, Estimation of Hardness, Unit of Hardness, Disadvantages of Hard water.

Unit-II

Water Chemistry

Alkalinity of water-Types of Alkalinity, Different ions present in water and their significance, Potable water- Preteatment, Methods of treatment of water for domestic and industrial purpose-Sedimentation, Cougulation, Filteration, Disinfection-Chlorination, ozonization, Desalination of Brackish water.

Unit-III

Water Pollution

Classification of water pollutants. Wastewater: Constituents, BOD, COD measurements, municipal waste water, industrial wastewater and storm water, Arsenic contamination in ground water, Fluorosis, principle of wastewater treatment, treatment processes-physical, chemical and biological processes.

Unit IV

Solid and Liquid Wastes

Introduction and characterization of solid waste, solid waste disposal and management, recycling,

land filling, Ocean dumping, Sludge treatment, solid waste disposal. Sources, types, characteristics and disposal of liquid waste. Hazardous Wastes: Identifying hazardous, methods of identification, waste listed as hazardous waste.

Unit V

Wastes Management

Introduction, Solid and Liquid waste management guidelines, Technological options for liquid waste management, Technological options for solid waste management, Solid Waste, Types of wastes, Biodegradable Waste, Green Waste, Food Waste, Construction Waste, Waste Management Hierarchy, Waste Management 3R Concept, Solid Waste Disposal, Waste Management And Segregation, Waste Collection, Land filling, Composting, Practising Waste Management And Segregation, Advanced materials for treatment, mineralization of water, waste to wealth approach for waste management.

Recommended books:

1. Environmental chemistry by A.K. De
2. Rogers Manual of Industrial Chemistry, Vol. 1. Ed. By C. C. Furnas (Nastrand).
3. Outline of Chemical Technology by Dryden (Ed. And revised by Gopal Rao and Sitting) (Affiliated East-West Press.)
4. Standard Methods for the Examination of water and waste water-American Public Health Association.
5. Water pollution and management - C.K. Varashney - Wiley Eastern Ltd., Chennai - 20.
6. Fundamentals of ecology by M.C.Dash
7. A Text book of Environmental chemistry by W. Moore and F.A. Moore
8. Environmental Chemistry by Samir k. Banerji
9. A.I.Vogel-A text book of quantitative Inorganic analysis-ELBS,
10. F.D.Snell & F.M.Biffen-Commercial methods of analysis-D.B.Taraporavala & sons,
11. J.J.Elving and I.M.Kolthoff- Chemical analysis - A series of monographs on analytical chemistry and its applications -- Inter Science- Vol I to VII.

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Advance Chemistry Practical-II (Core Course)

Credits-4 **Paper Code-CY-205** **Marks (75+25) =100**

Program Outcomes:

The objective of this course is to provide students coming in the first year and second semester of Master's program about the new quantitative analyses and syntheses of some typical coordination complexes and organic compounds and their relevant spectroscopic Characterization as well as the use of spectrophotometer and electrochemical set-ups.

Program Specific Outcomes:

In order to make students understand the theories taught to them in M.Sc. semester (II) in different branches of chemistry e.g. Inorganic, Organic and Physical, the following practical experiments are introduced. Students will learn:

- **PSO-1.** Qualitative analysis and determination of two metal ions volumetrically and gravimetrically.
- **PSO-2.** The preparation of selected inorganic compounds and their characterization by spectroscopic method.
- **PSO-3.** Two steps synthesis involving different name reactions.
- **PSO-4.** The basic knowledge like preparation of solution, standardization of secondary solution, dilution, calibration, and handling of some sophisticated electronic related to the practical syllabus.
- **PSO-5.** The basic knowledge of conductance measurement, Ostwald dilution law, solubility of sparingly soluble substance, potentiometery, pH- metery, order of reaction, saponification of an ester, phase diagram of three component system, inversion of cane sugar by polarimetry and kinetics using Visible spectrophotometer.
- **PSO-6.** To focus their aim for future prospects of Ph.D. programme and pharmaceutical industry.

INORGANIC CHEMISTRY

Quantitative analysis

- Separation and determination of two metal ion Cu-Ni, Cu-Zn., Cu-Fe etc. involving volumetric and gravimetric methods.

Inorganic preparation in aqueous and organic medium:

- Preparation and complete analysis of K3[Fe(C2O4)3].3H2O
- Preparation and separation of **cis** and **trans** –[Co(en)Cl2]
- Preparation of CuCl2. DMSO and Copper glycine complex.
- Preparation of Ph3P and its complexes.
- Preparation and reactions of ferrocene.
- Preparation of Mn(gly)3

ORGANIC CHEMISTRY

Two steps synthesis involving

- Acetylation

- Oxidation
- Grignard reaction
- Aldol condensation
- Sandmeyer reaction
- Acetoacetic ester Condensation
- Cannizzaro reaction
- Friedel Craft reaction
- Aromatic Electrophilic Substitution

PHYSICAL CHEMISTRY

Conductance measurements

Determine the equivalent conductance of a weak electrolyte at different concentration and hence test the validity of Ostwald's dilution Law. Determine the dissociation constant Ka/Kb of the weak electrolyte.

Potentiometry-Electrochemistry (EMF – Measurements)

Determine the EMF of a given a concentration cell by potentiometer and find out the effect of dilution on the EMF of cell.

Determine the pH a given buffer solution using given quinhydrone electrode.

Kinetics Experiments

Study reaction kinetics between KI and K2S2O8 by fractional change method and find out its order of reaction at a given temperature. Study reaction kinetics between acetone and iodine by isolation method and determine its order of reaction at a given temperature.

Phase Equilibria

Construct the phase diagram for three component system (eg. Ethanol, benzene and water or chloroform, acetic acid and water).

Spectro photometer

Study the kinetics of decomposition of the complex formed between sodium sulphide and sodium nitroprusside spectrophotometrically, and also find the order and rate constant of the reaction.

Recommended Book:

1. Vogels Text book of Quantitative Analysis revised, J. Bessett, R.C. Denney, G.H. Jellery and J.Mendhan ELBS
2. Experimental Inorganic Chemistry by Mounir A, Malati, Horwood series in Chemical Science (Horwood publishing Chichester) 1999.
3. Inorganic Experiments, J. Derexwoolings VCH
4. Microscale Inorganic Chemistry, Z. Scafran, R.M. Pike and M.M. Singh Wiley.
5. Practical Inorganic Chemistry, G. Marrand, B.W. Rockett, Van Nostrand.
6. The systematic Indentification of Organic Compounds, R.L. Shringer and D.Y. Curlin.

7. Qualitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
8. Basic concept of Analysis chemistry, S.M. Chopkar, Wiley Bastern.
9. Synthesis and characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.
10. Systematic Qualitative Organic Analysis, H. Middeton, AdwardArnoid.
11. Handbook of Organic Analysis Qualitative and Quantitative, H. Clark, Adward Ar.
12. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
13. Practical Physical Chemistry, A.M. James and F.E. Prichand, Longman.
14. Findley's Practical Physical Chemistry revised, B.P. Levitt, Longman.
15. Experimental Physical Chemistry, R.C. Das and Bebera, Tata Mc Grawhill.
16. Senior Practical Physical Chemistry, B.D. Khosla and V.S. Barg (R. Chand and Co., Delhi)
17. Experimental Physical Chemistry by D.P. Shoemaker Mc Grawhill, 7th Edition 2003.
18. Experiments in Chemistry, D.V. Jahagirdar, Himalaya Publishing House.
19. Practical Physical Chemistry, B. Vishwanathan and P.S. Raghwan, Viva Books.
20. General Chemistry Experiments, Anil J Elias, University Press (2002)
21. Experimental Physical Chemistry, V.D. Athawale, ParulMathur, New Age International (P)Limited.
22. Systematic Experiment in chemistry, Arun Sethi, New Age International (P) Limited.
23. Experiments in Physical chemistry, J.C. Ghosh, BharatiBhavan.
24. Advanced Practical Physical Chemistry, JB Yadav.
25. Practical Organic Chemistry, Mann and Saunders.

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Two Year Post Graduate

Course Structure

For

M.Sc. Chemistry

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Per

National Education Policy

Session 2025-2026

Department of Chemistry

Faculty of Science

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Course Structure of Semester-III M.Sc. Chemistry (Course work Mode)

Semester-III						
Paper	**Paper Title**	**Type**	**Credits**	**Internal Assessment**	**University Exam**	**Total Marks**
CY-301	Inorganic Chemistry-III	Core Course	4	25	75	100
CY-302	Organic Chemistry-III	Core Course	4	25	75	100
CY-303	Material Chemistry	Core Course	4	25	75	100
CY-304	Heterocyclic Chemistry	Core Course	4	25	75	100
CY-305	Advanced Chemistry Practical -III	optional	4	00	100*	100
	Total Credits		**20**			**500**

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Material Chemistry -III (Core Course)

Credits-4 **Paper Code-CY-303** **Marks(75+25) =100**

Program Outcome:

After successful completion of the first year of Masters, students coming in third semester/second year the objectives of this course is to provide knowledge about theoretical concepts of magnetism, theories of solid state reactions and biopolymers

Program Specific Outcome:

Students will gain knowledge in

- **PSO -1.** Basic theories and kinetics of solid-state reactions.
- **PSO -2.** Perfect and imperfect crystals and their defects. They will also gain the knowledge of electronic properties and band theory.
- **PSO -3.** The quantum theory of paramagnetism, hysteresis.
- **PSO -4.** The electrically conducting solids and new superconductors
- **PSO -5.** How to determine reaction mechanism and what is the gas phase photolysis.
- **PSO -6.** The experimental techniques and photo chemical processes.
- **PSO -7.** The biopolymers, their interactions, their thermodynamics and their molecular weight determination.
- **PSO -8.** The bioenergetics and statistical mechanics in biopolymers.
- **PSO -9.** The structure and function of cell membrane, transport of ions and applications of diffraction methods

Unit I

Crystal Defects and Non-Stoichiometry

Perfect and imperfect crystals, intrinsic and extrinsic defects – point defects, line and plane defects, vacancies, Schottky and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, colour centers, nonstoichiometry and defects.

Unit II

Electronic Properties and Band Theory

Metals, insulators and semiconductors, electronic structure of solids-band theory, band structure of metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, super conductors. Optical Properties – Optical reflectance, photoconduction.

Unit III

Determination of Reaction Mechanism

Classification, rate constants and life times of reactive energy states – determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions – photodissociation, gas-phase photolysis.

Photochemical Process and experimental techniques

Photo-reduction, Photo-oxidation, Electron transfer reactions, Photoconduction, Chemiluminiscence, Atom sensitized reactions, sensitization and quenching, Stern – Volmer equation. Photosynthesis, Photomorphogenesis and Photochemistry of vision. Spectrometry, Actinometry, Flash Photolysis and Laser Beam.

Unit IV

Biopolymers

Evaluation of size, shape, molecular weight and extent of hydration of biopolymers by various experimental techniques electrophoresis

Statistical Mechanics in Biopolymers

Chain configuration of macromolecules, statistical distribution end to end dimensions, calculation of average dimensions for various chain structures. Polypeptide and protein structures, introduction to protein folding problem.

Unit V

Biopolymer Interactions

Forces involved in biopolymer interactions. Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions. Multiple equilibria and various types of binding processes in biological systems.

Recommended Books:

1. Solid Sate Chemistry and its Application, A. R. West, Plenum
2. Principal Of The Solid state, H. V. Keer, Wiley Eastern.
3. Solid Sate Chemistry, N.B. Hannay.
4. Solid Sate Chemistry, D.K. Chakrabarty, New age Intenational.
5. Fundamental of Photochemistry,K. K. Rohtagi-Mukherji, , Wiley Eastern.
6. Essential Of Molecular Chemistry, A. Gilbert and J, Baggot, Blackwe II.
7. Molecular photochemistry, N. J. Turro, W. A. Benjamin.
8. Introductory Photochemistry, A. Cox and T. Camp, McGraw-Hill
9. Photochemistry, R. P. Kundalland A. Gilbert, Thomson Nelson.
10. Organic photochemistry, J.Coxon and B. Halten, Cambridge University Press.
11. Principles of Biochemistry, A. L. Lehninger, Worth publisher.
12. Biochemistry, L. Stryer, W.H. Freeman.
13. Biochemistry, J David Rawn, Neil Patterson.
14. Biochemistry, Voet and Voet, John Wiley.

15. Outlines of Biochemistry, E. E. Conn and P.K. Stumpf, John Wiley.
16. Bioinorganic Chemistry: A Chemical Approach to Enzyme action, H. Dugas and Penny, Springer-Verlag
17. Macromolecules: Structure and Function, F. Wold, Prentice Hall.

Heterocyclic Chemistry (Core Course)

Credits-4 **Paper Code-CY-304** **Marks (75+25) =100**

Program Outcome:

To give the quantitative ideas about the synthesis properties and uses of small and large heterocyclic rings.

Program Specific Outcome:

Upon successful learning, students will be able to

- **PSO-1.** learn about nomenclature and chemical behaviours of heterocycles.
- **PSO-2.** explore principle involved in cycle addition and cycle isolation reactions.
- **PSO-3.** investigate chemical behaviour of small ring heterocycles.
- **PSO-4.** explore chemical behaviour of large hetrocycles and the salts.

Unit-I

Nomenclature of Heterocycles

Replacement and sysmetic nomenclature (Hantzsch Windman system) for monocyclic, fused and bridged hetrocycles.

Aromatic Heterocycles

General chemical behavior of aromatic heterocycles , classifications (structural type) ,criteria of aromaticity (bond length, ring current and chemical shifts in 1H NMR-spectra , empirical resonance energy , delocalization energy and Dewar resonance energy , diamagnetic susceptibility exaltation).Heteroaromatic reactivity and tautomerism in aromatic hetericycles .

Unit-II

Non Aromatic Heteocycles

Strain bond angle and torsional strains and their consiquences in small ring heterocycles. Conformation of six membered heterocycles with refrence 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-electrophilic interactions.

Unit-III

Heterocyclic Synthesis

Principles of heterocyclic synthesis involving cyclization reactions and cyclo addition reactions .

Small Ring Heterocycles

Three membered and four membered heterocycles- synthesis and reactions of aziridines, oxiranes, thiiranes , azetidines, oxetanes and thietanes.

Unit-IV

Benzo-Fused Five Membered Heterocycles

Synthesis and reactions including medicinal applications of benzopyrroles, benzofurans and benzothiophenes.

Meso-Ionic Heterocycles

General c;assification,chemistry of some important meso-ionic heterocycles of type-A and B their applications.

Six Membered heterocycles with One Heteroatom

Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium & Thopyrylium salts and pyridones . Synthesis & reactions of quinolizinium and benzopyrelium salts , coumarins and ahromones.

Unit-V

Six Membered Heterocycles with Two or more Heteroatoms

Synthesis and reactions of diazines , triazines, tetrazines and thiazines .

Seven and Large Membered Heterocycles

Synthesis and reactions of azepines , oxepines , thiepines, diazepines, thiazepines, diazocines, dioxocines and dithiocines.

Recommended Books:

1. Heterocyclic Chemistry Vol.1-3R.R.Gupta, M.Kumar, V.Gupta, Springer Verlag
2. The Chemistry of Heterocycles, T.Eicher and S.Hauptmann, Thieme.
3. Heterocyclic Chemistry, J.A.Joule, K.Mills and G.F.Smith, Chapman and Hall.
4. Heterocyclic Chemistry, T.L.Gilchrist, LongmanScientific Technical.
5. Contemporatry Heterocyclic Chemistry, G.R.Newkome and W.W.Paudler, Wiley-Inter Science.
6. An Introduction to the Heterocyclic Compounds ,R.M.Acheson , John Wiley.

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Inorganic Chemistry-III (Core Course)

Credits-4 **Paper Code-CY-301** **Marks(75+25) =100**

Program Outcome:

After successful completion of the first year of Masters, students coming in third semester/second year will be provided knowledge about multinuclear NMR, ESR spectroscopic techniques which they had not learned in their entire academic career. Apart from that they will gain understanding into the bioinorganic chemistry, environmental, thermogravimetric and important analytical techniques.

Program Specific Outcome:

- **PSO-1.** This semester deals with the same brief glimpses of bioinorganic and detailed investigation of multi-nuclear nuclear magnetic resonance (NMR) for diamagnetic compounds comprising of 19F, 31P, 119Sn, 195Pt and some other nuclei and Electron Spin Resonance (ESR) studies of paramagnetic compounds.
- **PSO-2.** Additionally, students get knowledge about the various pollutants existing in nature and to cope with their plausible solutions.
- **PSO-3.** After completing this semester, the students are supposed to have some expertise in dealing with the multinuclear NMR and ESR.
- **PSO-4.** Also, they may get motivated to have inclination towards the bioinorganic chemistry in the next semester.

Unit I

Application of Spectroscopy:

Electron Spin Resonance Spectroscopy:. Hyperfine 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) including biological systems and to inorganic free radicals such as PH_4, F_2, and $[BH_3]$.

Unit II

Mossbauer Spectroscopy: Basic Principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of Fe^{+2} and Fe^{+3} compounds including those of intermediate spin, (2) Sn^{+2} and Sn^{+4} compounds- nature of M-L bond, coordination number, structure and (3) detection of oxidation sate and in equivalent MB atoms.

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Organic Chemistry-III (Core Course)

Credits-4 **Paper Code-CY-302** **Marks (75+25) =100**

Program Outcome:

After successful completion of the first year of Masters, students coming in third semester/second year in this core course students will be provided knowledge about NMR, ESR spectroscopic techniques and mass spectrometry. Additionally, they will gain understanding into the photochemical reactions, bioorganic chemistry and enzyme catalysis.

Program Specific Outcome:

After the completion of the course the students will acquire knowledge of:

- **PSO-1**: nuclear magnetic resonance spectroscopic and mass spectrometry techniques for organic structure elucidation of organic molecules.
- **PSO-2**: Basics of photochemical reactions of alkenes, carbonyl and aromatic compounds.
- **PSO-3**: The fundamental properties and reactivity of biologically important carbohydrates molecules.
- **PSO-4**: Mechanism of action of enzymes, enzyme catalysed reactions, enzyme models and applications of enzymes.

Unit I

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, carboxylic acids, amines, amides &mercapto), chemical exchange, effect of deuteration, factor influencing coupling constant 'J'. Spin decoupling, complex spin-spin interaction between two, three, four and five nuclei (first order spectra).

Unit II

Carbon-13 NMR Spectroscopy

General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants.

Two-dimension NMR spectroscopy

Introduction to COSY and DEPT techniques.

Unit III

Mass Spectrometry

Basic principles, ionization techniques, isptope abundance, molecular ion , fragmentation processes of organic molecules, McLafferty rearrangement,deduction of structure using mass spectral fragmentation, FAB-Mass, High resolution MS, soft ionization methods, EI-MS and MALDI-MS.

Unit IV

Photochemistry of Alkenes

Intramolecular reactions of the olefinic bond – geometrical isomerism, cyclisation reactions, rearrangement of 1, 4 - and 1, 5 – dienes.

Photochemistry of Carbonyl Compounds

Intramolecular reactions of carbonyl compounds – saturated, cyclic and acyclic, and a,b-unsaturated compounds. Cyclohexadienones. Intermolecular cyloaddition reactions – dimerisations and oxetane formation.

Unit V

Atomic Absorption Spectroscopy

Introduction, Principal, difference between AAS and AES: Flame and ICP sources, Advantages of AASover AES, advantages and disadvantages of AAS. Instrumentation, Single anddouble beam AAS, detection limit and sensitivity, Interferences applications.

Recommended books:

1. Organic Photochemistry: A visual approach, Jan Kopecky, VCH publishers (1992).
2. Oganic Photochemistry, O. Kan, McGraw-Hill Inc., US.
3. Organic Chemistry, J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press).
4. Fundamentals of Photochemistry, KK Rohatagi, New Age International (P) Limited.
5. Bioorganic, Bioinorganic and Supramolecular Chemistry, P.S. Kalsi, New Age International
(P) Limited.
6. Principles of Molecular Photochemistry, Nicholas J. Turro, V. Ramamurthy J. C., Viva Books.

7. Comprehensive Heterocyclic Chemistry, A.R.Katrizky and C.W.Rees, eds. Pergamon Press.

Advance Chemistry Practical-III (Core Course)

Credits-2 **Paper Code-CY-305** **Marks =100**

Program Outcome:

After successful completion of the first year of Masters, students coming in third semester will be provided experimental knowledge about the separation and the quantitative analyses using gravimetric and volumetric methods. Different analytical techniques in organic chemistry, practical knowledge of surface chemistry and colligative properties.

Program Specific Outcome:

In order to make students understand the theories taught to them in M.Sc. semester (III) In different branches of chemistry e.g. Inorganic, Organic and Physical, the following practical are introduced. Students will learn:

- **CO-1.** Gravimetric estimation of complex mixture involving two or three constituents and analysis of alloys and minerals.
- **CO-2.** Volumetric estimations and various titrations
- **CO-3.** Qualitative analysis, acetylation method, saponification value and extraction of organic compounds.
- **CO-4.** The basic knowledge like preparation of solution, standardization of secondary solution, dilution, calibration, and handling of some sophisticated electronic related to the practical syllabus.
- **CO-5.** Freundlich Absorption Isotherm, enthalpy, molecular weight determinations by elevation in boiling point method, depression in freezing point method and viscosity method, surface tension, molecular energy and Parachor of given liquid.
- **CO-6.** To focus their aim for future prospects of Ph.D programme and pharmaceutical Industry

INORGANIC CHEMISTRY

Gravimetric estimations of complex mixtures involving two or three constituents, Analysis of alloys and minerals.

Volumetric estimations:

- EDTA titrations - Determination of Zn, Ca, Mg and Fe. Hardness of water.
- $KBrO_3$ and KIO_3 titrations –Determination of As_2O_3 and $[Fe(CN)_6]4-$.
- Chloramine T – titrations - Determination of NO_2 in a sample.
- Ceric Ammonium Sulphate titrations - Determination of Fe and organic acids.

ORGANIC CHEMISTRY

Quantitative analysis

- Determination of percentage or number of hydroxyl group in an organic compound by acetylation method.
- Estimation of amines/phenols using bromate bromide solution/or acetylation method.
- Determination of iodine and saponification value of an oil sample.

Recommended Book:

1. Vogels Text book of Quantitative Analysis revised, J. Bessett, R.C. Denney, G.H. Jellery and J. Mendhan ELBS
2. Experimental Inorganic Chemistry by Mounir A, Malati, Horwood series in Chemical Science (Horwood publishing Chichester) 1999.
3. Inorganic Experiments, J. Derexwoolings VCH
4. Microscale Inorganic Chemistry, Z. Scafran, R.M. Pike and M.M. Singh Wiley.
5. Practical Inorganic Chemistry, G. Marrand, B.W. Rockett, Van Nostrand.
6. The systematic Indentification of Organic Compounds, R.L. Shringer and D.Y. Curlin.
7. Qualitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
8. Basic concept of Analysis chemistry, S.M. Chopkar, Wiley Bastern.
9. Synthesis and characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.
10. Systematic Qualitative Organic Analysis, H. Middeton, AdwardArnoid.

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Course Structure of Semester-III M.Sc. Chemistry with Research

Semester-III						
Paper	**Paper Title**	**Type**	**Credits**	**Internal Assessment**	**University Exam**	**Total Marks**
CY-301	Inorganic Chemistry-III	Core Course	4	25	75	100
CY-302	Organic Chemistry-III	Core Course	4	25	75	100
CY-305	Advance Chemistry Practical -III	Core Course	2	00	100*	100
CY-306	Research Project[@]	Project#	10*	100[#]	00	100
	Total Credits		**20**			**400**

#Department of Chemistry, DSMNRU in the beginning of each session. CY-306 Midterm evaluation of Research Project shall be done in III semester and final evaluation shall be done in IV semester.

S.No	Topic	Marks
1	Review of literature with reference	20
2	Identification of problem"	20
3	Spiral Binding of Pre M.Sc. Thesis	20
4	Presentation	20
5	Viva-Voce	20

[@]Students can choose a Co-supervisor from other institutes with the permission of Supervisor to complete the Research Project.

Department of Chemistry
Dr. Shakuntala Misra National Rehabilitaion University, Mohaan Road, Lucknow-226017

Inorganic Chemistry-III (Core Course)

Credits-4 **Paper Code-CY-301** **Marks(75+25) =100**

Program Outcome:

After successful completion of the first year of Masters, students coming in third semester/second year will be provided knowledge about multinuclear NMR, ESR spectroscopic techniques which they had not learned in their entire academic career. Apart from that they will gain understanding into the bioinorganic chemistry, environmental, thermogravimetric and important analytical techniques.

Program Specific Outcome:

- **PSO-1.** This semester deals with the same brief glimpses of bioinorganic and detailed investigation of multi-nuclear nuclear magnetic resonance (NMR) for diamagnetic compounds comprising of 19F, 31P, 119Sn, 195Pt and some other nuclei and Electron Spin Resonance (ESR) studies of paramagnetic compounds.
- **PSO-2.** Additionally, students get knowledge about the various pollutants existing in nature and to cope with their plausible solutions.
- **PSO-3.** After completing this semester, the students are supposed to have some expertise in dealing with the multinuclear NMR and ESR.
- **PSO-4.** Also, they may get motivated to have inclination towards the bioinorganic chemistry in the next semester.

Unit I

Application of Spectroscopy:

Electron Spin Resonance Spectroscopy:. Hyperfine 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) including biological systems and to inorganic free radicals such as PH_4, F_2, and $[BH_3]$.

Unit II

Mossbauer Spectroscopy: Basic Principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of Fe^{+2} and Fe^{+3} compounds including those of intermediate spin, (2) Sn^{+2} and Sn^{+4} compounds- nature of M-L bond, coordination number, structure and (3) detection of oxidation sate and in equivalent MB atoms.

Unit III

Bioinorganic Chemistry

Metal Ions in Biological System

(a) Essential and trace metals. (b) Na^+/K^+ Pump (c) Vitamin B_{12} methyl cobalamine, Biomethylation.

(d) Heme protines and oxygen uptake, sturucture and function of haemoglobin, myoglobin,homocyanins and hemerythrin , model synthetic complexes of iron , cobalt and copper

Unit IV

Electron Tranfer in Biology

(a) Structure and function of metalloproteins in electron transport processes-cytochromes and ion-sulphur proteins,synthetic models.

(b) **Nitrogenase:** Biological nitrogen fixation, molybdenum nitogenase, spectroscopic and other evidence, other nitrogenises model systems.

Unit V

Selected Topics

I. Chemistry of less familiar metals: Os, Ir, Ru, Rh , Pd.
II. Platinum Phosphine complexes
III. General method of prepration and importent reactions (insertion reactions, metathetical reactions with protic compounds) of metal and metalloids amides .
IV. Prepration of important radio isotopes ($_1H^3$, $_6C^{14}$,$_{11}Na^{22}$, $_{15}P^{32}$, $_{16}S^{35}$) and applications of coordination compounds of Tc^{99} as imagining agents in nuclear Medicine

Books Suggested

16. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S.Cradock , ELBS
17. Progress in Inorganic Chemistry vol 8 f.A.Cotton , vol 15 ed.S.J.Lippard, Wiley.
18. NMR ,NQR EPR and Mossbauer spectroscopy in inorganic chemistry ,R.V.Parish,Ellis horwood .
19. Practical NMR Spectroscopy, M.L.Martin ,J.J.Delpeuch and G.J.Martin, Heyden
20. Principles of Bioinorganic Chemistry, S.J.Lippard and J.M.Berg, University science Books.
21. Bioinorganic Chemistry,I. Bertini, H.B.gray,S.J.Lippard & J.S.valentine, University science Books.
22. Inorganic Biochemistry vol. I and II G.L.Eichhorn Elsevier.
23. Progress in inorganic chemistry vol. 18 and 38 ed.J.J.Lippard, Wiley.
24. Environmental Chemistry, A.K.De,Wiley Eastern.
25. Environmental Pollution Analysis,S.M.Khopkar, Wiley Eastern.
26. Advance Inorganic Chemistry, F.A.Cotton and G.Wilkinson.
27. Inorganic Chemistry , J.E.Huheey.
28. Nuclear and Radiochemistry,G.Friedlander and J.W.Kennedy
29. Essentials of nuclear Chemistry, H.J.Arnikar
30. Quantitative Inorganic Analysis, A.I.Vogel.

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Organic Chemistry-III (Core Course)

Credits-4 **Paper Code-CY-302** **Marks (75+25) =100**

Program Outcome:

After successful completion of the first year of Masters, students coming in third semester/second year in this core course students will be provided knowledge about NMR, ESR spectroscopic techniques and mass spectrometry. Additionally, they will gain understanding into the photochemical reactions, bioorganic chemistry and enzyme catalysis.

Program Specific Outcome:

After the completion of the course the students will acquire knowledge of:

- **PSO-1**: nuclear magnetic resonance spectroscopic and mass spectrometry techniques for organic structure elucidation of organic molecules.
- **PSO-2**: Basics of photochemical reactions of alkenes, carbonyl and aromatic compounds.
- **PSO-3**: The fundamental properties and reactivity of biologically important carbohydrates molecules.
- **PSO-4**: Mechanism of action of enzymes, enzyme catalysed reactions, enzyme models and applications of enzymes.

Unit I

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, carboxylic acids, amines, amides &mercapto), chemical exchange, effect of deuteration, factor influencing coupling constant 'J'. Spin decoupling, complex spin-spin interaction between two, three, four and five nuclei (first order spectra).

Unit II

Carbon-13 NMR Spectroscopy

General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants.

Two-dimension NMR spectroscopy

Introduction to COSY and DEPT techniques.

Unit III

Mass Spectrometry

Basic principles, ionization techniques, isptope abundance, molecular ion , fragmentation processes of organic molecules, McLafferty rearrangement,deduction of structure using mass spectral fragmentation, FAB-Mass, High resolution MS, soft ionization methods, EI-MS and MALDI-MS.

Unit IV

Photochemistry of Alkenes

Intramolecular reactions of the olefinic bond – geometrical isomerism, cyclisation reactions, rearrangement of 1, 4 - and 1, 5 – dienes.

Photochemistry of Carbonyl Compounds

Intramolecular reactions of carbonyl compounds – saturated, cyclic and acyclic, and a,b-unsaturated compounds. Cyclohexadienones. Intermolecular cyloaddition reactions – dimerisations and oxetane formation.

Unit V

Atomic Absorption Spectroscopy

Introduction, Principal, difference between AAS and AES: Flame and ICP sources, Advantages of AASover AES, advantages and disadvantages of AAS. Instrumentation, Single anddouble beam AAS, detection limit and sensitivity, Interferences applications.

Recommended books:

1. Organic Photochemistry: A visual approach, Jan Kopecky, VCH publishers (1992).
2. Oganic Photochemistry, O. Kan, McGraw-Hill Inc., US.
3. Organic Chemistry, J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press).
4. Fundamentals of Photochemistry, KK Rohatagi, New Age International (P) Limited.
5. Bioorganic, Bioinorganic and Supramolecular Chemistry, P.S. Kalsi, New Age International
(P) Limited.
6. Principles of Molecular Photochemistry, Nicholas J. Turro, V. Ramamurthy J. C., Viva Books.

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Advance Chemistry Practical-III (Core Course)

Credits-2 **Paper Code-CY-305** **Marks =100**

Program Outcome:

After successful completion of the first year of Masters, students coming in third semester will be provided experimental knowledge about the separation and the quantitative analyses using gravimetric and volumetric methods. Different analytical techniques in organic chemistry, practical knowledge of surface chemistry and colligative properties.

Program Specific Outcome:

In order to make students understand the theories taught to them in M.Sc. semester (III) In different branches of chemistry e.g. Inorganic, Organic and Physical, the following practical are introduced. Students will learn:

- **CO-1.** Gravimetric estimation of complex mixture involving two or three constituents and analysis of alloys and minerals.
- **CO-2.** Volumetric estimations and various titrations
- **CO-3.** Qualitative analysis, acetylation method, saponification value and extraction of organic compounds.
- **CO-4.** The basic knowledge like preparation of solution, standardization of secondary solution, dilution, calibration, and handling of some sophisticated electronic related to the practical syllabus.
- **CO-5.** Freundlich Absorption Isotherm, enthalpy, molecular weight determinations by elevation in boiling point method, depression in freezing point method and viscosity method, surface tension, molecular energy and Parachor of given liquid.
- **CO-6.** To focus their aim for future prospects of Ph.D programme and pharmaceutical Industry

INORGANIC CHEMISTRY

Gravimetric estimations of complex mixtures involving two or three constituents, Analysis of alloys and minerals.

Volumetric estimations:

- EDTA titrations - Determination of Zn, Ca, Mg and Fe. Hardness of water.
- $KBrO_3$ and KIO_3 titrations –Determination of As_2O_3 and $[Fe(CN)_6]4-$.
- Chloramine T – titrations - Determination of NO_2 in a sample.
- Ceric Ammonium Sulphate titrations - Determination of Fe and organic acids.

ORGANIC CHEMISTRY

Quantitative analysis

- Determination of percentage or number of hydroxyl group in an organic compound by acetylation method.
- Estimation of amines/phenols using bromate bromide solution/or acetylation method.
- Determination of iodine and saponification value of an oil sample.

Recommended Book:

1. Vogels Text book of Quantitative Analysis revised, J. Bessett, R.C. Denney, G.H. Jellery and J. Mendhan ELBS
2. Experimental Inorganic Chemistry by Mounir A, Malati, Horwood series in Chemical Science (Horwood publishing Chichester) 1999.
3. Inorganic Experiments, J. Derexwoolings VCH
4. Microscale Inorganic Chemistry, Z. Scafran, R.M. Pike and M.M. Singh Wiley.
5. Practical Inorganic Chemistry, G. Marrand, B.W. Rockett, Van Nostrand.
6. The systematic Indentification of Organic Compounds, R.L. Shringer and D.Y. Curlin.
7. Qualitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
8. Basic concept of Analysis chemistry, S.M. Chopkar, Wiley Bastern.
9. Synthesis and characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.
10. Systematic Qualitative Organic Analysis, H. Middeton, AdwardArnoid.

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Research Project

Credits-10 **Paper Code- CY-306** **Marks = 100**

Course Objective:

To inculcate in students, the art of public speaking, presentation and discussion of seminars.

Course Outcome:

- PSO-1. Students should be able demonstrate ability to plan and strategize a scientific problem, and implement it within a reasonable time frame.
- PSO-2. It is expected that after completing this project dissertation, students will learn to work independently and how to keep accurate/readable record of assigned project.
- PSO-3. In addition, students will be able to know the library search and handle the data in a meaningful way.
- PSO-4. Also, students will be able to interpret the spectral data independently.
- PSO-5. Subsequently, the students should be able to critically examine research articles, and improve their scientific writing/communication skills and power point presentation.

For project work and seminar presentation, the area of the work would be to be decided by the advisor/mentor based on syllabus of the current semester. On completion of the project work, students have to submit the work in the form of seminar followed by oral presentation in the presence of faculty members.

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Two Year Post Graduate

Course Structure

For

M.Sc. Chemistry

as

Per

National Education Policy

Session 2025-2026

Department of Chemistry

Faculty of Science

Dr. Shakuntala Misra National Rehabilitaion University,

Mohaan Road, Lucknow-226017

Department of Chemistry
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Course Structure of Semester-IV M.Sc. Chemistry (Course work Mode)

Semester IV						
Paper Code	**Paper Title**	**Type**	**Credits**	**Internal Assessment**	**University Exam**	**Total Marks**
CY-401	Organotransition Metal Chemistry	Core Course	4	25	75	100
CY-402	Organic Synthesis	Core Course	4	25	75	100
CY-403	Electrochemistry	Core Course	4	25	75	100
CY-404	Photochemistry	Core Course	4	25	75	100
CY-405	Advance Chemistry Practical -IV	Core Course	4	00	100*	100
	Total Credits		**20**			**500**

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Organotransition Metal Chemistry (Core Course)		
Credits 4	**Paper Code CY-401**	**Marks (75 +25) = 100**

Program Outcome:

After successful completion of the third semester of Masters, students coming in fourth semester if opted this elective paper will be provided knowledge about the advanced bonding, syntheses and properties of organometallics having varied class of metal centres from transition and inner-transition periods as well as homogenous catalysis.

Program Specific Outcome:

- **PSO-1.** To know and understand the different properties and structures for organometallic compounds from different parts of the periodic table and their trends.
- **PSO-2.** To know principal synthetic routes to various classes of organometallic compounds.
- **PSO-3.** know and understand the reactivity of organometallic compounds including their application in synthesis.
- **PSO-4.** To know methods and examples for the study of organometallic compounds in the gas phase, solution phase and solid state.
- **PSO-5.** To know common ligand classes in organometallic chemistry, their effects on organometallic compounds, and influence on reactivity and catalysis.
- **PSO-6.** To know and understand key mechanistic steps in reactions involving organometallic compounds.
- **PSO-7.** Students will learn about synthetically useful transformations including oxidations, reductions, enolate reactions, pericyclic reactions, organometallic reactions, and reactions of electron deficient species. The emphasis will be on developing a mechanistic understanding of selectivity and synthetic strategy.

Unit I

Compounds of Transition Metal-Carbon Multiple bonds

Alkylidenes, alkylidynes, low valent carbenes and carbines – synthesis, nature of bonds, structural characteristics, nucleophilic and electrophilic reactions on the ligands.

Transition Metal Compounds with Bonds to Hydrogen

Covalent hydrides: synthesis and important reactions.

Unit II

Transition metal ð–Complexes with unsaturated organic molecules

Alkenes, alkynes, allyl, dienes, dienyl and arene complexes – preparations, properties, natureof bonding and structural features. Important reactions related to nucleophilic and electrophilic attack on ligands.

Unit III

Transition Metal Compounds with Bonds to Carbon in Catalysis

General idea of important catalytic steps: ligand coordination and dissociation, insertion and elimination, nucleophilic attack on coordinated ligands, oxidative addition and reductive elimination reactions.

Unit IV

Homogeneous Catalysis

Hydrogenation of alkenes using Wilkinson's catalyst, Hydroformylation of alkenes using Co and Rh catalysts, Carbonylation of methanol to acetic acid (Monsanto process), Oxidation of alkenes (Wacker process)

Unit V

Fluxional Organometallic Compounds

Fluxionality and dynamic equillibria in compounds such as η2- olefine, η3 allyl and dienylcomplexes.

Organometallic Compounds of Lanthamides and Actinides

Methods of preparation, properties and structural features.

Recommended Books:

1. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, John Wiley
2. Inorganic Chemistry, J. E. Huheey, Ellen A. Keiter, Richard L. Keiter, Addison WesleyLongman (Singapore) Pvt. Ltd.
3. Chemistry of the Elements, N. N. Greenwood and A. Earnshow, Pergamon.
4. Organometallic Chemistry: A Unified Approach, R. C. Mehrotra and A. K. Singh, New Age
5. Principles of Organometallic Chemistry, G. E. Coates, M. L. H. Green, P. Powell andK,
6. Wade, Chapman and Hall, London.

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Organic Synthesis (Core Course)		
Credits 4	**Paper Code CY-402**	**Marks (75 +25) = 100**

Program Outcome:

After successful completion of the third semester of Masters, students coming in fourth semester will be provided knowledge about synthesis and transformation of the most common functional groups, stereochemical and stereoselectivity in chemical transformations. Synthetic routes to target molecules using retrosynthesis.

Program Specific Outcome:

On completion of the course, the student should be able to:

- PSO-1. describe methods for synthesis and transformation of the most common functional groups
- PSO-2. describe and apply stereo chemical concepts such as chirality, stereoisomerism, and stereo selectivity in relation to chemical transformations
- PSO-3. identify, analyse and evaluate synthetic routes to target molecules using retrosynthesis
- PSO-4. apply organometallic reagents and reactions in organic synthesis
- PSO-5. Will learn the multistep synthesis of complex molecules
- PSO-5. Plan and design experimental setups for various types of laboratory tests, perform transformations of importance for organic synthesis, perform basic risk assessment and document laboratory work in the form of laboratory journal.
- PSO-6. give oral and written accounts on the content and results of the laboratory practical's.

Unit I

Oxidation

Introduction. Different oxidative processes. Hydrocarbons-alkenes, aromatic rings, saturated C-H groups (activated and unactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxyalic acids. Amines, hydrazines, and sulphides.

Oxidations with ruthenium tetraoxide, iodobenzene diacetate and thallium (III) nitrate.

Unit II

Protecting Groups

Principle of protection of alcohol, amine, carbonyl and carboxyl group

Ring Synthesis

Saturated heterocycles, synthesis of aziridines, oxiranes, thiiranes, azitidine, oxetane,thietane, pyrones, pyrols, indole, isetan, coumarin and quinoxaline.

Unit III

Reduction

Introduction. Different reductive processes. Hydrocarbonsalkanes, alkenes, alkynes and aromatic rings. Carbonyl compounds-aldehydes, ketones, acids and their derivatives. Epoxides. Nitro, nitroso, azo and oxime groups.

Disconnection Approach

Introduction to synthons ans synthetic equivalents, disconnection approach, functional group interconversions, the importance of the order of the events in organic synthesis.

Two Group C-C Disconnections

Diels-Alder reaction, 1,3-difunctionalized compounds, a/ß-unsaturated carbonyl compounds, -difunctionlized compounds. Micheal addition and Robinson annelation.

Unit IV

Rearrangements

General mechanistic considerations – nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements-Pinacolpinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofman, Curtius, Schimdt, BaeyerVilliger, Shapiro reaction.

Unit V

Synthesis of Some Complex molecules

Application of the above in the synthesis of following compounds: Camphor, Longifoline, Cortisone, Reserpine, Vitamin D, Juvabione, Aphidicolin and Fredericamysin A.

Recommended Books:

1. H.O. House, Synthetic Organic Chemistry, Benjamin-CummingsPublishing Co.
2. Organic Chemistry J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford Press.
3. Organic Synthesis, Pragati Edition, JagdambaSingh and L.D.S Yadav.
4. Some modern methods of organic synthesis, W. Carruthers, Cambridge University Press.
5. Organic Reactions And Their Mechanisms, P. S. Kalsi, New Age Science.
6. Workbook for Organic Synthesis, Stuart Warren,John Wiley & Sons.
7. Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. Organic Chemistry, John Wiley & Sons.
8. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Nomenclature and Chemistry of three to five membered Heterocycles), Elsevier publication.
9. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Chemistry of six to eight membered N, O, S, P and Se heterocycles), Elsevier publication.

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Electrochemistry (Core Course)		
Credits 4	**Paper Code CY-403**	**Marks (75 +25) = 100**

Program Outcome:

After successful completion of the third semester of Masters, students coming in fourth semester if opting this paper will be provided knowledge about electrokinetic phenomenon, electro-osmosis and their application. They will also learn concept of electrochemical phenomenon in biological system.

Program Specific Outcome:

Students will gain better understanding of theoretical and quantitative treatment of:

- **PSO-1.** electro kinetic phenomenon, electro- osmosis, streaming potential andsedimentation potential.
- **PSO-2.** thechemical basis of biological phenomenon, cellular structure and donan membrane equilibrium.
- **PSO-3.**the concept of physics and physical chemistry for the study of biological systems
- e.g. core conductor model, limiting current in semi conductors etc.
- **PSO-4.** theories and importance of over voltage and different types of polarography e.g. pulse, Ac and square wave.
- **PSO-5.** general principles of semi conductivity, semiconductors, conducting polymers and fullerene – doped conductors.
- **PSO-6.** brief ideas of electrochemistry of molten electrolytes and non aqueous solvents.

Unit I

Electrokinetic Phenomenon

Electrokinetic Effects, Electrokinetic potential/Zeta potentials, Determination of zeta potential, influence of ions on electrokinetic phenomena, Electro-Osmosis, Streaming potential, Sedimentation potential. Theoretical and quantitative treatment of electrokinetic phenomena, Electrophonetic Mobility and Bound hydrogen ion.

Unit II

Bioelectrochemistry

Threshold phenomena, Donnan Membrane Equilibrium, Membrane Potential, Application of DonnanMembrance Equilibrium, Hodges-Huxely Equation, Core conductor model. Quantum Aspects of Charge transfer at electrode-solution interfaces, quantization of charge transfer tunneling. Semiconductor Interfaces: Theory of double layer semiconductor solution interfaces, Limiting current in semiconductor electrode.

Unit III

Polarography and Voltametry

Principle of polarography, variations of the conventional polarographic methods, Pulse Polarography, AC polarography, square wave polarography, Anodic stripping and Cyclic voltametry, Qualitative and quantitative application of polarography, Determination of stoichiometry and formation constants of complexes. Amperometric titrations and advantages.

Unit IV

Fuel Cells and Batteries

Fuel cell and its theory, different types of fuel cell, Solid oxide fuel cells(SOFC), Polymer electrolyte fuel cell(PEM), Direct Electrolyte Fuel Cell(DAFC), Super Capacitors. Theory Measurements and importance. Theories of Batteries : Solidstate batteries.

Unit V

Conductors and Semiconductors

General principles of semiconductivity and semiconductors, Temperature dependence of electrical resistances, Coherent Length, Piezoelectric effect, Piezoelectric and pyroelectric materials. Fullerenes-Doped conductors. Briefidea of Electrochemistry of molten electrolytes and non-aqueous solvents.

Recommended Books:

1. Modern Electrochemistry, Vol.1&2,J.M.Bockrisand A.K.N Reddy.Plenum
2. Introduction to electrochemistry, S.Glasston,VanNostrand.
3. Electro-Analytical Chemistry,J.J. Lingane,WilleyInterscience.
4. Polarography, D.R.Crow.J.V. Westwood, Methuen and Co.
5. Principle of Polarography, J. Heyrovsky, P>Zuman and L. Kuta
6. Solid state Electrochemistry, Haldil, Academis Press.
7. Electrochemistry of solids, H. Rickett, Springer Book.
8. Ions, Electrodes and Membranes, J. Koryta, Willey and Sons.
9. Electrochemistry, C. W Devis, George Newone, London.
10. Polarography and voltammetry, H.H Bauer & J.E.O" Reily.
11. Physical Chemistry, Thomas Engel and Philip Reid, L P E, Pearson Education.
12. Analytical Chemistry, Theory practice, U.N. Das, Sultan chand and Sons, New Delhi.
13. Principal of physical chemistry, S.H.Maron and C..F. Prutton, Oxford.
14. Electrode Kinetics, E. Gileadi, VCH Publishers Inc., New York.
15. Electrochemical Methods: Fundamental &applications(2nd Ed.), Bard& L. R.Faulkner, John Wiley & Sons, New York
16. Bioelectrochemistry: Fundamentals, Experimental Techniques and Applications, P.N.Bartlett, John Wiley & Sons, Ltd

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Photochemistry (Core Course)		
Credits 4	**Paper Code CY-404**	**Marks (75 +25) = 100**

Program Outcome:

This course aims at acquainting students with the detailed knowledge of pericyclic as well as photochemical reactions. Starting from the very basic ideas, and moving towards the classification using different approaches, electrocyclic and sigmatropic rearrangements will be discussed.

Program Specific Outcome:

At the completion of this course, students should be able to

- **PSO-1.** Students will learn the basic difference between photochemical and thermal reactions.
- **PSO-2.** Based on the different principles of photochemistry.
- **PSO-3.** they will be able to solve different practical problems.
- **PSO-4.** Further some well-known named reactions in this field will add.
- **PSO-5.** on to the knowledge of the students.

Unit I

Photochemical Reactions

Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

Unit II

Determination of Reaction Mechanism

Classification, rate constants and life times of reactive energy states-determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions.

Unit III

Photophysical process

Fluorescence and fluorescence quenching, Stern Volmer plot, Measurement of fluorescence and phosphorescence and lifetimes. Types of photochemical reaction-photo-dissociation, gas-phase photolysis.

Unit IV

Kinetics of Photochemical Reaction

Introduction to time-resolved techniques for absorption and emission measurements, detection and kinetics of reactive intermediates. Examples of low temperature matrix isolation of reactive intermediates.

Unit V

Fluorescence based sensors

Fluorescence based sensors examples of molecular and supramolecular systems. Conversion of solar energy to chemical and other forms of energies, solar photovoltaic cell, basic principle and design of the cell.

Recommended books

1. Physical Chemistry, Thomas Engel & Phillip Reid- Peerson's Publication
2. Fundamental of Photochemistry, K. K. Rohatgi-Mukherjee, New Age International (P) Ltd., New Delhi, 1986.
3. Principles of Fluorescence Spectroscopy, 3rd Ed., J. R. Lakowicz, Springer, New York, 2006.
4. Fundamentals of Photoinduced Electron Transfer, G. J. Kavarnos, VCH publishers Inc., New York, 1993.
5. Molecular Fluorescence: Principles and Applications, B. Valeur, Wiley-VCH Verlag GmbH, Weinheim, 2002.
6. Modern Molecular Photochemistry of Organic Molecules, N. J. Turro, V. Ramamurthy, J. C. Scaiano, University Science, Books, CA, 2010.
7. Photochemical Synthesis, I. Ninomiya, T. Naito, Academic Press, New York, 1989.

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Advance Chemistry Practical-IV (Core Course)

Credits-2 **Paper Code-CY-405** **Marks =100**

Program Outcome:

After successful completion of the first year of Masters, students coming in third semester will be provided experimental knowledge about the separation and the quantitative analyses using gravimetric and volumetric methods. Different analytical techniques in organic chemistry, practical knowledge of surface chemistry and colligative properties.

Program Specific Outcome:

In order to make students understand the theories taught to them in M.Sc. semester (III) In different branches of chemistry e.g. Inorganic, Organic and Physical, the following practical are introduced. Students will learn:

- **CO-1.** Gravimetric estimation of complex mixture involving two or three constituents and analysis of alloys and minerals.
- **CO-2.** Volumetric estimations and various titrations
- **CO-3.** Qualitative analysis, acetylation method, saponification value and extraction of organic compounds.
- **CO-4.** The basic knowledge like preparation of solution, standardization of secondary solution, dilution, calibration, and handling of some sophisticated electronic related to the practical syllabus.
- **CO-5.** Freundlich Absorption Isotherm, enthalpy, molecular weight determinations by elevation in boiling point method, depression in freezing point method and viscosity method, surface tension, molecular energy and Parachor of given liquid.
- **CO-6.** To focus their aim for future prospects of Ph.D programme and pharmaceutical Industry

INORGANIC CHEMISTRY

Colorimetric and Spectrophotometric analysis: Determination of iron, copper, ammonium,phosphate, fluoride and nitrite ions.

ORGANIC CHEMISTRY

Extraction of organic compounds.

- Identification of organic compounds by using their spectral data (UV, IR, 1H &13C-NMR and Mass Spectroscopy)

PHYSICAL CHEMISTRY

General Experiments

- To verify Freundlich Adsorption Isotherm.
- To determine molecular weight of a given electrolyte by elevation in boiling point method (Landsbigger method) and also find out its van't Hoff factor.
- Determine molecular weight of a given polymer by viscosity method.

- Find out surface tension, molecular energy and Parachor of given liquid at room temperature.

E.M.F. Experiments:

- Titrate given mixed acids pH- metrically and find out their strengths.
- Find out pK values of given acids pH metrically.

Spectrophotometer experiments

- Determination of stability constant of a metal ligant complex by spectrophotometeric method.
- Investigation of reaction between potassium per-sulphate and potassium iodide by spectrophotometer method.

Recommended Book:

1. Vogels Text book of Quantitative Analysis revised, J. Bessett, R.C. Denney, G.H. Jellery and J. Mendhan ELBS
2. Experimental Inorganic Chemistry by Mounir A, Malati, Horwood series in Chemical Science (Horwood publishing Chichester) 1999.
3. Inorganic Experiments, J. Derexwoolings VCH
4. Microscale Inorganic Chemistry, Z. Scafran, R.M. Pike and M.M. Singh Wiley.
5. Practical Inorganic Chemistry, G. Marrand, B.W. Rockett, Van Nostrand.
6. The systematic Indentification of Organic Compounds, R.L. Shringer and D.Y. Curlin.
7. Qualitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
8. Basic concept of Analysis chemistry, S.M. Chopkar, Wiley Bastern.
9. Synthesis and characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.
10. Systematic Qualitative Organic Analysis, H. Middeton, AdwardArnoid.

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Course Structure of Semester-IV M.Sc. Chemistry

(Coursework + Research mode)

Paper Code	Paper Title	Type	Credits	Internal Assessment	University Exam	Total Marks
CY-401	Organotransition Metal Chemistry	Core Course	4	25	75	100
CY-402	Organic Synthesis	Core Course	4	25	75	100
CY-405	Advance Chemistry Practical -IV	Core Course	2	00	100*	100
CY-406	Research Project	Core Course	10*	-	300	300
	Total Credits		**20**			**600**

#Department of Chemistry, DSMNRU in the beginning of each session. CY-406 Midterm evaluation of Research Project shall be done in III semester and final evaluation shall be done in IV semester.

Evaluation Scheme for Research Project (Semester IVth):

S.No.	Component	Marks
1	Presentation	50
2	Thesis	50
2	Viva Voce	100
3	Published or accepted research paper in Wave of Science Journal with more than 1 impact factor*	100
	Total	300

**If the student publishes research article from his research project in UGC CARE Listed Journals then he/she shall be awarded 25 additional marks provided that the maximum marks shall remain 100 only.

Evaluation shall be done by a board comprising supervisor (Internal Faculty Member) and Examiner (External Subject expert nominated by the university).

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Organotransition Metal Chemistry (Core Course)		
Credits 4	**Paper Code CY-401**	**Marks (75 +25) = 100**

Program Outcome:

After successful completion of the third semester of Masters, students coming in fourth semester if opted this elective paper will be provided knowledge about the advanced bonding, syntheses and properties of organometallics having varied class of metal centres from transition and inner-transition periods as well as homogenous catalysis.

Program Specific Outcome:

- **PSO-1.** To know and understand the different properties and structures for organometallic compounds from different parts of the periodic table and their trends.
- **PSO-2.** To know principal synthetic routes to various classes of organometallic compounds.
- **PSO-3.** know and understand the reactivity of organometallic compounds including their application in synthesis.
- **PSO-4.** To know methods and examples for the study of organometallic compounds in the gas phase, solution phase and solid state.
- **PSO-5.** To know common ligand classes in organometallic chemistry, their effects on organometallic compounds, and influence on reactivity and catalysis.
- **PSO-6.** To know and understand key mechanistic steps in reactions involving organometallic compounds.
- **PSO-7.** Students will learn about synthetically useful transformations including oxidations, reductions, enolate reactions, pericyclic reactions, organometallic reactions, and reactions of electron-deficient species. The emphasis will be on developing a mechanistic understanding of selectivity and synthetic strategy.

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Unit I

Compounds of Transition Metal-Carbon Multiple bonds

Alkylidenes, alkylidynes, low valent carbenes and carbines – synthesis, nature of bonds, structural characteristics, nucleophilic and electrophilic reactions on the ligands.

Transition Metal Compounds with Bonds to Hydrogen

Covalent hydrides: synthesis and important reactions.

Unit II

Transition metal ð–Complexes with unsaturated organic molecules

Alkenes, alkynes, allyl, dienes, dienyl and arene complexes – preparations, properties, natureof bonding and structural features. Important reactions related to nucleophilic and electrophilic attack on ligands.

Unit III

Transition Metal Compounds with Bonds to Carbon in Catalysis

General idea of important catalytic steps: ligand coordination and dissociation, insertion and elimination, nucleophilic attack on coordinated ligands, oxidative addition and reductive elimination reactions.

Unit IV

Homogeneous Catalysis

Hydrogenation of alkenes using Wilkinson's catalyst, Hydroformylation of alkenes using Co and Rh catalysts, Carbonylation of methanol to acetic acid (Monsanto process), Oxidation of alkenes (Wacker process)

Unit V

Fluxional Organometallic Compounds

Fluxionality and dynamic equillibria in compounds such as η2- olefine, η3 allyl and dienylcomplexes.

Organometallic Compounds of Lanthamides and Actinides

Methods of preparation, properties and structural features.

Recommended Books:

1. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, John Wiley
2. Inorganic Chemistry, J. E. Huheey, Ellen A. Keiter, Richard L. Keiter, Addison WesleyLongman (Singapore) Pvt. Ltd.
3. Chemistry of the Elements, N. N. Greenwood and A. Earnshow, Pergamon.
4. Organometallic Chemistry: A Unified Approach, R. C. Mehrotra and A. K. Singh, New Age
5. Principles of Organometallic Chemistry, G. E. Coates, M. L. H. Green, P. Powell andK,
6. Wade, Chapman and Hall, London.

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Organic Synthesis (Core Course)		
Credits 4	**Paper Code CY-402**	**Marks (75 +25) = 100**

Program Outcome:

After successful completion of the third semester of Masters, students coming in fourth semester will be provided knowledge about synthesis and transformation of the most common functional groups, stereochemical and stereoselectivity in chemical transformations. Synthetic routes to target molecules using retrosynthesis.

Program Specific Outcome:

On completion of the course, the student should be able to:

- PSO-1. describe methods for synthesis and transformation of the most common functional groups
- PSO-2. describe and apply stereo chemical concepts such as chirality, stereoisomerism, and stereo selectivity in relation to chemical transformations
- PSO-3. identify, analyse and evaluate synthetic routes to target molecules using retrosynthesis
- PSO-4. apply organometallic reagents and reactions in organic synthesis
- PSO-5. Will learn the multistep synthesis of complex molecules
- PSO-5. Plan and design experimental setups for various types of laboratory tests, perform transformations of importance for organic synthesis, perform basic risk assessment and document laboratory work in the form of laboratory journal.
- PSO-6. give oral and written accounts on the content and results of the laboratory practical's.

Unit I

Oxidation

Introduction. Different oxidative processes. Hydrocarbons-alkenes, aromatic rings, saturated C-H groups (activated and unactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxyalic acids. Amines, hydrazines, and sulphides.

Oxidations with ruthenium tetraoxide, iodobenzene diacetate and thallium (III) nitrate.

Unit II

Protecting Groups

Principle of protection of alcohol, amine, carbonyl and carboxyl group

Ring Synthesis

Saturated heterocycles, synthesis of aziridines, oxiranes, thiiranes, azitidine, oxetane,thietane, pyrones, pyrols, indole, isetan, coumarin and quinoxaline.

Unit III

Reduction

Introduction. Different reductive processes. Hydrocarbonsalkanes, alkenes, alkynes and aromatic rings. Carbonyl compounds-aldehydes, ketones, acids and their derivatives. Epoxides. Nitro, nitroso, azo and oxime groups.

Disconnection Approach

Introduction to synthons ans synthetic equivalents, disconnection approach, functional group interconversions, the importance of the order of the events in organic synthesis.

Two Group C-C Disconnections

Diels-Alder reaction, 1,3-difunctionalized compounds, a/ß-unsaturated carbonyl compounds, -difunctionlized compounds. Micheal addition and Robinson annelation.

Unit IV

Rearrangements

General mechanistic considerations – nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements-Pinacolpinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofman, Curtius, Schimdt, BaeyerVilliger, Shapiro reaction.

Unit V

Synthesis of Some Complex molecules

Application of the above in the synthesis of following compounds: Camphor, Longifoline, Cortisone, Reserpine, Vitamin D, Juvabione, Aphidicolin and Fredericamysin A.

Recommended Books:

1. H.O. House, Synthetic Organic Chemistry, Benjamin-CummingsPublishing Co.
2. Organic Chemistry J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford Press.
3. Organic Synthesis, Pragati Edition, JagdambaSingh and L.D.S Yadav.
4. Some modern methods of organic synthesis, W. Carruthers, Cambridge University Press.
5. Organic Reactions And Their Mechanisms, P. S. Kalsi, New Age Science.
6. Workbook for Organic Synthesis, Stuart Warren,John Wiley & Sons.
7. Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. Organic Chemistry, John Wiley & Sons.
8. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Nomenclature and Chemistry of three to five membered Heterocycles), Elsevier publication.
9. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Chemistry of six to eight membered N, O, S, P and Se heterocycles), Elsevier publication.

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Advance Chemistry Practical-IV (Core Course)

Credits-2 **Paper Code-CY-405** **Marks =100**

Program Outcome:

After successful completion of the first year of Masters, students coming in third semester will be provided experimental knowledge about the separation and the quantitative analyses using gravimetric and volumetric methods. Different analytical techniques in organic chemistry, practical knowledge of surface chemistry and colligative properties.

Program Specific Outcome:

In order to make students understand the theories taught to them in M.Sc. semester (III) In different branches of chemistry e.g. Inorganic, Organic and Physical, the following practical are introduced. Students will learn:

- **CO-1.** Gravimetric estimation of complex mixture involving two or three constituents and analysis of alloys and minerals.
- **CO-2.** Volumetric estimations and various titrations
- **CO-3.** Qualitative analysis, acetylation method, saponification value and extraction of organic compounds.
- **CO-4.** The basic knowledge like preparation of solution, standardization of secondary solution, dilution, calibration, and handling of some sophisticated electronic related to the practical syllabus.
- **CO-5.** Freundlich Absorption Isotherm, enthalpy, molecular weight determinations by elevation in boiling point method, depression in freezing point method and viscosity method, surface tension, molecular energy and Parachor of given liquid.
- **CO-6.** To focus their aim for future prospects of Ph.D programme and pharmaceutical Industry

INORGANIC CHEMISTRY

Colorimetric and Spectrophotometric analysis: Determination of iron, copper, ammonium,phosphate, fluoride and nitrite ions.

ORGANIC CHEMISTRY

Extraction of organic compounds.

- Identification of organic compounds by using their spectral data (UV, IR, 1H &13C-NMR and Mass Spectroscopy)

PHYSICAL CHEMISTRY

General Experiments

- To verify Freundlich Adsorption Isotherm.
- To determine molecular weight of a given electrolyte by elevation in boiling point method (Landsbigger method) and also find out its van't Hoff factor.
- Determine molecular weight of a given polymer by viscosity method.

- Find out surface tension, molecular energy and Parachor of given liquid at room temperature.

E.M.F. Experiments:

- Titrate given mixed acids pH- metrically and find out their strengths.
- Find out pK values of given acids pH metrically.

Spectrophotometer experiments

- Determination of stability constant of a metal ligant complex by spectrophotometeric method.
- Investigation of reaction between potassium per-sulphate and potassium iodide by spectrophotometer method.

Recommended Book:

1. Vogels Text book of Quantitative Analysis revised, J. Bessett, R.C. Denney, G.H. Jellery and J. Mendhan ELBS
2. Experimental Inorganic Chemistry by Mounir A, Malati, Horwood series in Chemical Science (Horwood publishing Chichester) 1999.
3. Inorganic Experiments, J. Derexwoolings VCH
4. Microscale Inorganic Chemistry, Z. Scafran, R.M. Pike and M.M. Singh Wiley.
5. Practical Inorganic Chemistry, G. Marrand, B.W. Rockett, Van Nostrand.
6. The systematic Indentification of Organic Compounds, R.L. Shringer and D.Y. Curlin.
7. Qualitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
8. Basic concept of Analysis chemistry, S.M. Chopkar, Wiley Bastern.
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Research Project

Credits-10 **Paper Code- CY-406** **Marks = 300**

Program Outcome:

To inculcate in students the art of public speaking, presentation and discussion of seminars.

Program Specific Outcome:

- **PSO-1.** Students should be able demonstrate ability to plan and strategize a scientific problem, and implement it within a reasonable time frame.
- **PSO-2.** It is expected that after completing this project dissertation, students will learn to work independently and how to keep accurate/readable record of assigned project.
- **PSO-3.** In addition, students will be able to know the library search and handle the data in a meaningful way.
- **PSO-4.** Also, students will be able to interpret the spectral data independently.
- **PSO-5.** Subsequently, the students should be able to critically examine research articles, and improve their scientific writing/communication skills and power point presentation.

For project work and seminar presentation, the area of the work would be to be decided by the advisor/mentor based on syllabus of the current semester. On completion of the project work, students have to submit the work in the form of seminar followed by oral presentation in the presence of faculty members.