



DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
M.Sc. Chemistry Two Year Postgraduate Course Structure
For students admitted in session 2025-26 onwards
Semester I

Semester I						
Paper	Paper Title	Type	Credits	Internal Assessment	Univ Exam	Total Marks
CHMCC-101	Inorganic Chemistry 1	Core Course 1	4	30	70	100
CHMCC-102	Organic Chemistry 1	Core Course 2	4	30	70	100
CHMCC-103	Physical Chemistry 1	Core Course 3	4	30	70	100
CHMCC-104	Advance Chemistry Practical 1	Core Course 4	4	-	100	100
CHMCC-105	Project and Seminar Presentation	Core Course 5	2	-	100	100
CHMVA-106	Separation Techniques	Value Added (Credited) Intradepartmental	2	30	70	100
CHMVA-107	Chemistry of Analgesics and Antipyretics					
			20			600
Only one paper out of CHMVA-106 and CHMVA-107 has to be studied.						



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Semester I

Credits 4

Inorganic Chemistry 1 (Core Course 1)
Paper Code CHMCC-101

Marks (70 + 30) = 100

Course Objective:

- 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.

Course Outcome:

- CO-1.** Students gain newer insight regarding the symmetry, bonding, electronic and magnetic properties of inorganic compounds and coordination complexes.
- CO-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.
- CO-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

- Symmetry and group Theory in chemistry:**
 - Symmetry element and operation, definition of mathematical group, sub group, cyclic group, conjugacy relation and classes, point symmetry group (Schonflies symbols), use of point group symmetry: optical activity, dipole moment, representation of group by matrices, character of representation, the great orthogonality theorem (without proof) and its importance, irreducible representation, character table and their use.

Unit II

- Stereochemistry and Bonding: Among main group compounds:**
 - VSEPR, Walsh diagrams (tri-and penta-atomic molecules), $d\pi-p\pi$ bonds, Bent rule and energetics of Hybridization, some simple reaction of covalently bonded molecules

Unit III

- Among Transition Metal complexes:**
 - Limitation of crystal field theory, Molecular orbital theory, Octahedral, tetrahedral and squareplanar complexes, π -bonding and molecular orbital theory.

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 stereochemical information.

Unit V

- Magnetic properties of transition metal complexes and Isopoly and Heteropoly acid:**
 - Anomalous magnetic moments, magnetic exchange coupling and spin crossover. Isopoly and Heteropoly acid and salts of V, Mo, W.



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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. Earnshaw, Pergamon.
4. Inorganic Electronic Spectroscopy, A. B. P. Lever, Elsevier
5. Magnetochemistry, 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, Himanshu Publications, Udaipur, Delhi.
9. K. Veera Reddy, Symmetry and Spectroscopy of Molecules, New Age
10. Inorganic Chemistry, D. E. Shriver, P. W. Atkins and C. H. L. Langford, Oxford



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Semester I

Credits 4

Organic Chemistry 1 (Core Course 2)
Paper Code CHMCC-102

Marks (70 + 30) = 100

Course Objective:

- 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.

Course Outcome:

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

- **CO-1:** aromaticity, nonaromaticity and antiaromaticity in carbocyclic and heterocyclic compounds.
- **CO-2:** mechanism and outcome of aliphatic electrophilic substitution reactions.
- **CO-3:** properties and reactivity of stereoisomers and stability of an organic molecule based on structure, including conformation and stereochemistry, Conformational analysis and its effect on organic reactivity, stereoselective and stereospecific synthesis.
- **CO-4:** the various types of aliphatic nucleophilic substitution reactions and will give them a better understanding of the processes involved.
- **CO-5:** mechanisms for various organic reactions and how to use their understanding of organic mechanisms to predict the outcome of reactions.
- **CO-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, alternate and nonalternate hydrocarbons, energy of p-molecular orbitals, annulenes, antiaromaticity, Ψ -aromaticity homoaromaticity. Crown ether complexes and cryptands, cyclodextrins, catenanes and rotaxane.
- **Aliphatic electrophilic substitution**
 - Bimolecular mechanism – S_E2 and S_E1 . The S_E1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and solvent polarity

Unit II

- **Stereochemistry**
 - Conformational analysis of mono and di substituted cycloalkanes, decalines, effect of conformation on reactivity, steric strain due to unavoidable crowding.
 - Enantiotopic and diastereotopic atoms, group of faces, stereospecific and stereoselective synthesis, asymmetric synthesis, optical activity in absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape.
 - Stereochemistry of compound containing nitrogen, sulphur and phosphorous.

Unit III

- **Aliphatic nucleophilic substitution**
 - **The S_N2 , S_N1 and SET mechanism.**
 - The neighboring group mechanism, neighboring group participation by π and bond, anchimeric assistance. Nonclassical carbocations, phenonium ions, norbornyl system.
 - **The S_Ni mechanism**
 - Nucleophilic substitution at an allylic, aliphatic trigonal and vinylic carbon.



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Semester I

Reactivity effect of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis, regioselectivity.

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, 1,3 dipolar cycloaddition and chelotropic reactions. Sigmatropic rearrangement – Suprafacial and antarafacial shift of H, sigmatropic shift involving carban moieties, 3,3 and 5,5-sigmatropic rearrangement. Claisen, cope and aza- cope rearrangements. Fluxional tautomerism. Ene reaction

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. Guidebook to Mechanism in Organic Chemistry, Orient Longman, Sykes, P. A New Delhi.



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Semester I

Unit III

• **Macromolecules**

- 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. Electrochemistry of 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.
- Mechanism of electrode reaction, overpotential current, current potential relation, Tafel equation, over-voltage and decomposition potential, Butler Volmer equation
- Introduction to corrosion, homogenous theory, form of corrosion, corrosion monitoring and prevention methodism.

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, Ramachandran diagram. 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, MacMillan, India
4. Puri Sharma Pathania, Advance Physical 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 McGraw-Hill publishing company Limited, India.
8. Quantum chemistry Through problems and solution by R.K Prasad, New age International PvtLmtd, 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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Semester I

Advance Chemistry Practical 1 (Core Course 4)
Paper Code CHMCC-104 **Marks = 100**

Course Objective:

- 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.

Course Outcome:

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

Students will learn:

- **CO-1.** Qualitative analysis of inorganic mixtures and insolubles.
- **CO-2.** Separation techniques of cations and anions by chromatography.
- **CO-3.** Qualitative analysis of three component organic mixture.
- **CO-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.
- **CO-5.** The basic knowledge of conductance, e.m.f, pH, kinetics and partition coefficient.
- **CO-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
 - 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 R_f values.

PHYSICAL CHEMISTRY

- **Conductance measurement**
 - To find out the equivalent conductance of a strong electrolyte at different concentrations at room temperature and the test the validity of Onsager equation.
 - Study hydrolysis of aniline hydrochloride by conductance method.
 - Determination of basicity of a given salt by conductance method.
- **Electrochemistry (EMF – Measurements) – Potentiometry / pH-metry**
 - Determination of EMF of Daniel Cell by Potentiometric method $Zn/ZnSO_4 (C_1) || CuSO_4 (C_2)/Cu$



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- Where C_1 and C_2 (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.
- **Partition coefficient**
 - To study the distribution of I_2 between CCl_4 and calculate the partition coefficient.
 - Determination of the partition coefficient of benzoic acid between water and benzene and comment on the molecular state of benzoic acid in benzene.

Distribution of Marks

Branch	Experiment	Viva	Class Record	Total
Inorganic	23	6	4	33
Organic	23	6	4	33
Physical	24	6	4	34
Total Marks				100

Recommended Book:

1. Vogel's 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. Marrant, B.W. Rockett, Van Nostrand.
6. The systematic Identification 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, Adward Arnoide.
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. Prichard, 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, Parul Mathur, 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, Bharati Bhavan.
24. Advanced Practical Physical Chemistry, JB Yadav.
25. Practical Organic Chemistry, Mann and Saunders.



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Semester I

Project and Seminar Presentation (Core Course 5)
Paper Code CHMCC-105 **Marks = 100**

Course Objective:

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

Course Outcome:

- CO-1. students should be able demonstrate ability to plan and strategize a scientific problem, and implement it within a reasonable time frame.
- CO-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.
- CO-3. In addition, students will be able to know the library search and handle the data in a meaningful way.
- CO-4. Also, students will be able to interpret the spectral data independently.
- CO-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.

Distribution of Marks

Class	Report	Viva	Presentation	Total
Internship	60	20	20	100



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Separation Techniques (Value Added Credited) Intradepartmental

Credits 2

Paper Code CHMVA-106

Marks (70 + 30) = 100

Course Objective:

- The objective of this course is to provide students coming in the first year of Masters program new insight into the separation and filtration technique which in turn pave the pathway for the purification and isolation of targeted compounds after rational synthesis.

Course Outcome:

- **CO-1.** Students will learn the methods of separating a mixture or solution of chemical substances to obtain the pure constituents.
- **CO-2.** Students will learn the traditional methods of purification such as crystallization, extraction and distillation.
- **CO-3.** Students will know the Celite filtration, a useful technique used to remove fine solids such as metal salt from the reaction mixture.
- **CO-4.** Students will learn the centrifugation techniques useful in the microanalysis and is based on density difference.
- **CO-5.** They also learn the chromatographic techniques as they give accurate and complete separation and purification of the compounds.
- **CO-6.** The students will also learn the modern techniques of chromatography such as flash chromatography, LPLC, HPLC and GC-MS etc.

Unit I

- Distillation
- Crystallization
- Membrane Process
- Filtration

Unit II

- Evaporation
- Extraction
- Celite Filtration
- Gel Filtration

Unit III

- Demister (Vapour)
- Adsorption & Stripping
- Centrifugation

Unit IV

- TLC
- Sephadex Chromatography
- Flash Chromatography
- LPLC
- HPLC
- Paper Chromatography

Unit V

- Counter current chromatography
- Ion exchange chromatography



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- GC – MS (Gas Chromatography)
- Column Chromatography
- Molecular Sieve Chromatography or size exclusion chromatograph

Recommended Books:

1. Lloyd R. Snyder LC Resources, Inc Walnut Creek, California
2. Colin F. Poole, Department of Chemistry, Wayne State University Detroit MI 48202, USA 2003 Elsevier.
3. J. D. Seader, and Ernest J. Henley, Separation Process Principles, Wiley, 2nd edition (2013).



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Unit V

- Synthesis of the following antipyretics:
 - Paracetamol
 - Aspirin
 - Indomethacin
 - Diclofenac sodium
 - Ibuprofen
 - Piroxicam

Recommended Books:

1. Thomas L. Lemke, David A. Williams, Victoria F. Roche, S. William Zito, Foye's Principles of Medicinal Chemistry, 7th Ed., Lippincott Williams & Wilkins, 2012.
2. Graham L. Patrick, "An Introduction to Medicinal Chemistry", 5th Ed. Oxford University Press 2013.
3. D. Sriram, P. Yogeeswari, Medicinal Chemistry, Pearson Education India, 2009.
4. Ashutosh Kar, Medicinal Chemistry, 4th Edition, New Age Publicational Publishers.