



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

<b>Semester IV</b>						
<b>Paper</b>	<b>Paper Title</b>	<b>Type</b>	<b>Credits</b>	<b>Internal Assessment</b>	<b>Univ Exam</b>	<b>Total Marks</b>
CHMCC-401	Physical Chemistry 3	Core Course 16	<b>4</b>	30	70	100
CHMEL-402	Medicinal Chemistry	Elective Course 17 A	<b>4</b>	30	70	100
CHMEL-403	Organic Synthesis	Elective Course 17 B				
CHMEL-404	Bioinorganic and Supramolecular Chemistry	Elective Course 18 A	<b>4</b>	30	70	100
CHMEL-405	Organotransition Metal Chemistry	Elective Course 18 B				
CHMPR-406	Project and Dissertation, Evaluation and Viva-voce on submitted Dissertation	Master's Thesis	<b>8</b>	-	-	<b>200</b>
			<b>20</b>			<b>600</b>
Only one paper out of CHMEL – 402 and CHMEL – 403 has to be studied.						
Only one paper out of CHMEL – 404 and CHMEL – 405 has to be studied.						
Master's Thesis will be of a duration of 3 – 4 Months, either in the same institution or at any other research lab as per choice of the student. After the completion of training project report will be submitted, followed by its evaluation by presentation & viva-voce examination						



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**Semester IV**

**Physical Chemistry 3 (Core Course 16)**  
**Paper Code CHMCC-401**

**Credits 4**

**Marks (70 + 30) = 100**

**Course Objective:**

- 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

**Course Outcome:**

Students will gain knowledge in

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

**Unit I**

- **Solid State Reactions**
  - General principles, experimental procedures, co-precipitation as a precursor to solid state reactions, kinetics of solid-state reactions.
- **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, non-stoichiometry 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, superconductors. Optical Properties — Optical reflectance, photoconduction.
- **Organic Solids**
  - Electrically conducting solids, organic charge transfer complex, organic metals, new superconductors.

**Unit III**

- **Energy States of Molecules**
  - Franck – Condon Principle, Physical properties of excited molecules such as refractive index, pKa values and dipole moment. Light emission and chemical reaction from excited states, radiationless deactivation of excited states.
- **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 — photo-dissociation, gas-phase photolysis.
- **Photochemical Process and experimental techniques**
  - Photo-reduction, Photo-oxidation, Electron transfer reactions, Photoconduction, Chemiluminescence, Atom sensitized reactions, sensitization



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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.
- **Thermodynamics of Biopolymer Solutions**
  - Thermodynamics of biopolymer solutions, osmotic pressure, membrane equilibrium muscular contraction and energy generation in mechanochemical system.
- **Cell Membrane and Transport of Ions**
  - Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport. Nerve conduction.

**Recommended Books:**

1. Solid State Chemistry and its Application, A. R. West, Plenum
2. Principles of the Solid state, H. V. Keer, Wiley Eastern.
3. Solid State Chemistry, N.B. Hannay.
4. Solid State Chemistry, D.K. Chakrabarty, New age International.
5. Fundamentals of Photochemistry, K. K. Rohtagi-Mukherji, Wiley Eastern.
6. Essentials of Molecular Chemistry, A. Gilbert and J. Baggot, Blackwell.
7. Molecular photochemistry, N. J. Turro, W. A. Benjamin.
8. Introductory Photochemistry, A. Cox and T. Camp, McGraw-Hill
9. Photochemistry, R. P. Kundall and A. Gilbert, Thomson Nelson.
10. Organic photochemistry, J. Coxon and B. Halton, Cambridge University Press.



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**Credits 4**

**Medicinal Chemistry (Elective Course 17A)**  
**Paper Code CHMEL-402**

**Marks (70 + 30) = 100**

**Course Objective:**

- After successful completion of the third semester of Masters, students coming in fourth semester if opting this paper will be provided knowledge about the advanced about the various classes of medicinal compounds, their uses and the concepts of drug design, their receptor sites, receptor- ligand interactions.

**Course Outcome-**

After completing the course, students shall be able to-

- **CO-1.** describe the drug design, action of drug
- **CO-2.** describe the concept of receptors, thermokinetics and thermodynamics
- **CO-3.** describe the antineoplastic agents, cardiovascular agents and psychoactive agents and antibiotics.
- **CO-4.** describe the various stages involved in the development of a drug,
- **CO-5.** describe the "interaction between ligand and receptor" concept
- **CO-6.** identify and describe the connection between chemical structure and physical-chemical properties,
- **CO-7.** describe the design of organic compounds, for example, statistical or structure-based design
- **CO-8.** plan and conduct a medicinal chemistry project,
- **CO-9.** independently acquire and critically assess biological and medicinal information from databases
- **CO-10.** actively participate in discussions during seminars and group exercises,
- **CO-11.** present results verbally and in writing, and
- **CO-12.** communicate principles, problems and research results with specialists and non-specialists on issues within the scope of the content of the course.

**Unit I**

• **Drug Design**

- Design Development of new drugs, procedures followed in drug design, concept of lead Compound and lead modification, concepts of prodrugs and soft drugs, structure-activity relationship (SAR) factors affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism, spatial, consideration. Theories of drugs activity; occupancy theory, rate theory, induced fit theory.
- Quantitative structure activity relationship. History and development of QSAR.
- Concepts of drugs receptors. Elementary treatment of drug receptors. Elementary treatment of drug receptor interactions. Physico-chemical parameters; lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton surface activity parameter and redox potentials. Free-Wilson analysis, relationship between free-Wilson and Hansch analysis. LD-50, ED-50 (Mathematical derivations of equations excluded).

**Unit II**

• **Pharmacokinetics:**

- Introduction to drug absorption, disposition, elimination using pharmacokinetics important pharmacokinetic parameters in defining drug disposition and in therapeutics. Mention of uses of pharmacokinetics in drug development process



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- **Pharmacodynamics:**

- Introduction elementary treatment of enzyme stimulation, enzyme inhibition, sulphonamides, members active drugs, drug metabolism xenobiotics, biotransformation significance of drug medicinal chemistry.

#### Unit III

- **Antineoplastic Agents**

- Introduction, cancer chemotherapy, special problems, role of alkylating agents and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibitors. Synthesis of mechlorethamine, cyclophosphamide, melphalan, uracil, mustards, and 6-mercaptopurine. Recent development in cancer chemotherapy. Hormone and natural products.

#### Unit IV

- **Cardiovascular Drugs**

- Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathetic function, central intervention of cardiovascular output. Direct acting arteriolar dilators. Synthesis of amyl nitrate, sorbitrate, diltiazem, quinidine, verapamil, methyldopa, atenolol, oxyprenolol

- **Local Antiinfective Drugs**

- Introduction and general mode of action. Synthesis of sulphonamides, furazolidone, nalidixic acid, ciprofloxacin, norfloxacin, dapsone, amino salicylic acid, isoniazid, ethionamide, ethambutal, fluconazole, econazole, griseofulvin, chloroquin and primaquin.

#### Unit V

- **Psychoactive Drugs-The Chemotherapy of mind**

- Introduction, neurotransmitters, CNS depressants, general anaesthetics, mode of action hypnotics, sedatives, anti-anxiety drugs, benzodiazepines, buspirone, neurochemistry of mental diseases. Antipsychotic drugs-the neuroleptics antidepressants, butyrophenones, serendipity and drugs development, stereochemical aspects of psychotropic drugs. Synthesis of diazepam, oxazepam, chlorazepam, alprazolam phenytoin, ethosuximide, trimethadione, barbiturates, thiopental sodium, guletehimide.

- **Antibiotics**

- Cell wall biosynthesis, inhibitors, -lactone rings, antibiotics inhibiting protein synthesis. Synthesis of penicillin G, ampicillin, amoxicillin, chloramphenicol, cephalosporin, tetracycline and streptomycin.

#### Recommended Books:

1. Medicinal Chemistry, D. Sriram, P. Yogeeswari, Pearson Education.
2. Medicinal Chemistry, Ashutosh Kar, New Age International (P) Limited.
3. An Introduction to Medicinal Chemistry, Graham L. Patrick, Oxford University Press.
4. Textbook of Medicinal Chemistry, V. Alagarsamy, Elsevier Health Sciences.
5. The Practice of Medicinal Chemistry, Camille G. Wermuth, Elsevier Health Sciences.
6. Drug-like Properties: Concepts, Structure Design and Methods: From ADME to Toxicity Optimization, Edward H Kerns, Li Di, Elsevier Health Sciences.
7. 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.
8. 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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compounds, - difunctionalized 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-Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofman, Curtius, Schimdt, Baeyer-Villiger, 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-Cummings Publishing Co.
2. Organic Chemistry J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford Press.
3. Organic Synthesis, Pragati Edition, Jagdamba Singh 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. & Snyder, 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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**Semester IV**

**Bioinorganic and Supramolecular Chemistry (Elective Course 18A)**

**Credits 4**

**Paper Code CHMEL-404**

**Marks (70 + 30) = 100**

**Course Objective:**

- After successful completion of the third semester of Masters, students coming in fourth semester if opted this paper will be provided knowledge about the advanced bioinorganic chemistry also inculcating supramolecular aspects which form the firm basis for the development of luminescent sensors and supramolecular devices.

**Course Outcome:**

- **CO-1.** To recognize the importance of inorganic molecules in supporting organic biological systems.
- **CO-2.** To learn about how metal ions function as catalytic and structural centers in biological systems.
- **CO-3.** To learn about the metal ion transport and storage within cells and how any malfunction can result in various diseases.
- **CO-4.** To gain insight into cutting edge developments that utilizes metal ions for medical purposes.
- **CO-5.** To learn methods, including spectroscopy techniques, used to study metal ions in biological systems.
- **CO-6.** To develop an appreciation for the structure and function of metal ions in the biological systems and how chemists aim to mimic them.
- **CO-7.** A central theme of this course is to recognize the metal used for diagnosis and chemotherapy.
- **CO-7.** In the supramolecular chemistry the students gain expertise in developing varied type of sensors and photochemical molecular devices. Additionally, they get the basic knowledge of the biological phenomenon and hence they become able to design and develop the metal based drugs which is now-a-days gaining immense attention.

**Unit I**

- **Metal Storage Transport and Biomineralization**
  - Ferritin, transferrin and siderophores.
- **Calcium in Biology**
  - Calcium in living cells, transport and regulation, molecular aspects of intramolecular processes, extracellular binding proteins.

**Unit II**

- **Metalloenzymes**
  - Zinc enzymes – carboxypeptidase and carbonic anhydrase. Iron enzymes catalase, peroxidase and cytochrome P-450. Copper enzymes – superoxide dismutase. Molybdenum oxatransferase enzymes – xanthine oxidase. Coenzyme vitamin B12.

**Unit III**

- **Metal – Nucleic Acid Interactions**
  - Metal ions and metal complex interactions, Metal complexes – nucleic acids.
- **Metals in Medicine**
  - Metal deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs.



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**Unit IV**

• **Supramolecular Chemistry-I**

- Molecular recognition: Molecular receptors for different types of molecules including arisonic substrates, design and synthesis of coreceptor molecules and multiple recognition.
- Transport processes and carrier design.

**Unit V**

• **Supramolecular Chemistry-II**

- Supramolecular reactivity and catalysis
- Supramolecular devices. Supramolecular photochemistry, supramolecular electronic, ionic and switching devices.

**Recommended Books:**

1. Outlines of Biochemistry, E. E. Conn and P. K. Stumpf, John Wiley.
2. Macromolecules: Structure and Function, F. Wold, Prentice Hall.
3. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
4. Bioinorganic Chemistry, I. Bertini, H. B. Gray, S. J. Lippard and J. S. Valentine, University Science Books.
5. Inorganic Biochemistry vol. I and II. ed. G. L. Eichhorn, Elsevier.
6. Supramolecular Chemistry, J. W. Steel and J. L. Atwood
7. Bioinorganic Chemistry, K. H. Reddy, New Age.



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**Semester IV**

**Organotransition Metal Chemistry (Elective Course 18B)**

Credits 4

Paper Code CHMEL-405

Marks (70 + 30) = 100

**Course Objective:**

- 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 centers from transition and inner-transition periods as well as homogenous catalysis.

**Course Outcome:**

- **CO-1.** To know and understand the different properties and structures for organometallic compounds from different parts of the periodic table and their trends.
- **CO-2.** To know principal synthetic routes to various classes of organometallic compounds.
- **CO-3.** know and understand the reactivity of organometallic compounds including their application in synthesis.
- **CO-4.** To know methods and examples for the study of organometallic compounds in the gas phase, solution phase and solid state.
- **CO-5.** To know common ligand classes in organometallic chemistry, their effects on organometallic compounds, and influence on reactivity and catalysis.
- **CO-6.** To know and understand key mechanistic steps in reactions involving organometallic compounds.
- **CO-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 carbenes – 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  $\delta$ -Complexes with unsaturated organic molecules**
  - Alkenes, alkynes, allyl, dienes, dienyl and arene complexes – preparations, properties, nature of 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)



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**Unit V**

- **Fluxional Organometallic Compounds**
  - Fluxionality and dynamic equilibria in compounds such as  $h^2$ -olefine,  $h^3$  allyl and dieny complexes.
- **Organometallic Compounds of Lanthanides 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 Wesley Longman (Singapore) Pvt. Ltd.
3. Chemistry of the Elements, N. N. Greenwood and A. Earnshaw, 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 and K, Wade, Chapman and Hall, London.
- 6.



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**Semester IV**

**Master Thesis – Project and Dissertation**  
**Paper Code CHMPR-406** **Marks 200**  
**Credits 8**

In the last semester of Masters, the main objective of the exposure of students towards project/dissertation is to elevate their understanding into the practical and experimental aspects of some targeted areas of chemistry. This course will develop their analytical ability and will provide them an apt exposure to work in any research group and will motivate them to execute research in the area of their interest in chemical sciences.

**Course Outcome:**

- **CO-1.** students will be able 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.

3-4 Months training either in the same institution or at any other research lab as per choice of the student. After the completion of training project report will be submitted, followed by its evaluation by presentation & viva- voce examination.

**Distribution of Marks**

<b>Class</b>	<b>Report</b>	<b>Internal</b>	<b>Presentation</b>	<b>Viva</b>	<b>Total</b>
Master's Thesis	100	40	30	30	200