UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

1. APPLICABILITY

These regulations shall apply to the Masters in Chemistry programme from the session 2020-21.

2. Minimum eligibility for admission

A three/four years Bachelor's degree or equivalent with chemistry as one of the subject in final year awarded by University or Institute established as per law and recognized as equivalent by university with minimum 45% marks for general and OBC (SC/ST 40%) or equivalent grade shall constitute the minimum requirement for admission to the Masters in Chemistry Programme.

3. Programme Objectives

I. To enable the students to learn about the Periodic Table, Coordination Chemistry and Structure of Molecules, Properties of Compounds, Structural Determination of Complexes using theories and instruments.
II. To make the students to learn about the physical aspects of Atomic Structure, Dual Behaviour, Reaction Pathways with respect to time, various Energy Transformations, Molecular assembly at Nanolevel, Significance of Electrochemistry, Molecular Segregation using their symmetry.
III. To learn about the potential uses of Analytical, Industrial and Medicinal chemistry.
IV. To understand and apply principles of Organic Chemistry for understanding the Reaction mechanisms, Stereochemistry, Organic Synthesis, complex chemical structures, instrumental method of chemical analysis, Molecular rearrangements and separation techniques. To carry out laboratory experiments taught in Core Theory papers and to learn the principles of good laboratory practices.
V. To help the studentsôdevelop ability to make mathematical models for physical systems.
VI. To inculcate interest in research and provide to exposure to various research methodologies.

1. Programme Outcomes

PO-1. Demonstrate, solve and an understanding of major concepts in all disciplines of Chemistry independently and in group as well as draw logical conclusions through Project and Seminar Presentation.
PO-2. Employ critical thinking and the scientific knowledge to design, carry out, record and analyze the results of Chemistry experiments
PO-3. Equip students to face the employment challenges and instil confidence to turn into entrepreneur and also step into research career.
PO-4. Generation of new scientific insights or to the innovation of new applications of chemical research
PO-5. Present scientific and technical information resulting from laboratory experimentation in both written and oral formats.
PO-6. Apply modern methods of analysis to chemical systems in a laboratory setting.
PO-7. The students will become well versed in the mechanisms of all types of high level and complicated chemical reactions.
PO-8. The students will improve their competencies on par with their counterparts in premier institutions across the nation.

4. Programme Specific Outcomes

PSO-1. Appreciates the importance of various elements present in the periodic table, coordination chemistry and structure of molecules, properties of compounds, structural determination of complexes using theories and instruments.
PSO-2. Gathers attention about the physical aspects of atomic structure, dual behaviour, reaction pathways with respect to time, various energy transformations, molecular assembly in nanolevel, significance of electrochemistry, molecular segregation using their symmetry.
PSO-3. Learns about the potential uses of analytical, industrial chemistry and medicinal chemistry.
PSO-4. Understand and apply principles of Organic Chemistry for understanding the scientific phenomenon in Reaction mechanisms, Stereochemistry, Organic Synthesis, complex chemical structures, instrumental method of chemical analysis, molecular rearrangements and separation techniques.
PSO-5. Study of organometallic reactions.
PSO-6. Study of biological mechanisms using amino acids.
PSO-7. Learn the classical status of thermodynamics.

PSO-8. Carry out laboratory experiments taught in Core Theory papers and to understand good laboratory practices with safety.
PSO-9. Enhance studentsôability to develop mathematical models for physical systems.
PSO-10. Global level research opportunities to pursue Ph.D. programme targeted approach of CSIR/UGC ï NET examination
PSO-11. Discipline specific competitive exams conducted by service commission

5. Course Structure

The course structure of the Masters in Chemistry programme shall be as under.

No.	Name of the Couse	Credit	Remark
	Semester I		
CHCC-101	Inorganic Chemistry	**04**	Core Course
CHCC-102	Organic Chemistry	**04**	Core Course
CHCC-103	Physical Chemistry	**04**	Core Course
CHCC-104A CHCC-104B CHCC-104C	Inorganic Chemistry Practical Organic Chemistry Practical Physical Chemistry Practical	**04** **04** **04**	Core Course
CHVNC-101	* Separation Techniques Or * Chemistry of Analgesics and Antipyretics	**00**	Value Added (Non Credited)
	Semester Total	**24**	
	Semester II		
CHCC-201	Inorganic Chemistry	**04**	Core Course
CHCC-202	Organic Chemistry	**04**	Core Course
CHCC-203	Physical Chemistry	**04**	Core Course
CHCC-204A CHCC-204B CHCC-204C	Inorganic Chemistry Practical Organic Chemistry Practical Physical Chemistry Practical	**04** **04** **04**	Core Course
CHVNC-201	* Science of Technology of Cosmetics Or * Bioethanol as Fuel	**00**	Value Added (Non Credited)
	Semester Total	**24**	
	Semester III		
CHCC-301	Inorganic Chemistry	**04**	Core Course/MOOC
CHCC-302	Organic Chemistry	**04**	Core Course
CHCC-303	Physical Chemistry	**04**	Core Course
CHCC-304	Advance Chemistry Practical-I	**04**	Core Course
CHEL-301A	Environmental Chemistry	**00**	Elective (Non Credited)
CHEL-301B	Chemistry of Natural Products		
CHIN-301	Summer Internship	**04**	Summer Internship
CHIER-301	Concepts of Chemistry	**04**	Interdepartmental
	Semester Total	**24**	
	Semester IV		
CHCC-401	Advanced Chemistry Practical-II	**04**	Core Course
Any one papers from each CHEL-402A, CHEL-402B and CHEL-402C			
CHEL-402A	Bioinorganic and Supramolecular Chemistry Or	**04**	Elective/ Intradepartmental

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No.	Name of the Couse	Credit	Remark
	Organotransition Metal Chemistry		Course
CHEL-402B	Organic Synthesis Or Medicinal Chemistry	**04**	
CHEL-402C	Polymer Chemistry Or Electrochemistry	**04**	Elective/ Intradepartmental Course
CHMT-401	Project and Dissertation, Evaluation and Viva-voce on submitted Dissertation (Internal)	**08**	Master Thesis
	Semester Total	**24**	
	GRAND TOTAL	**96**	

* The offered courses shall be announced by the Head, Chemistry Department in the beginning of session every year.

CH – Subject; CHCC – Core Course; CHVNC –Value Added (Non-credited); CHEL – Elective; CHIER – Interdepartmental Course; CHIRA – Intradepartmental Course

Course Outlines

PROGRAMME STRUCTURE

The Master of Science in Chemistry is a Two Year Full Time Course consisting of Four Semesters.

Semester I
Semester II
Semester III
Semester IV

Sem	Core Course			Elective Course			Open elective Course			Value Added		Total Credits
	No. of Papers	Credits (L+T/P	Total Credit	No. of Paper	Credits (L+T/P)	Total Credit	No. of Paper	Credits (L+T/P	Total Credit	No. of Papers	Credits	
I	4	12+12	24	0	0+0	0	0	0+0	0	1	0	24
II	4	12+12	24	0	0+0	0	0	0+0	0	1	0	24
III	5	12+8	20	0	0+0	0	1	4+0	4	0	0	24
IV	2	4+8	12	3	4+4+4	12	0	0+0	0	0	0	24
Total Credits			80			12			4		0	96

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Semester-IV

Paper Code	Title of the paper	Credits	Int. Ass.	Uni. Exam.	Marks
CHCC - 401	Advance Chemistry Practical-II	**4**			
CHEL - 402A Intra-Departmental	Bioinorganic and Supramolecular Chemistry Or Organotransition Metal Chemistry	**4**			
CHEL - 402B Intra-Departmental	Organic Synthesis Or Medicinal Chemistry	**4**			
CHEL - 402C Intra-Departmental	Polymer Chemistry Or Electrochemistry	**4**			
CHMT - 401	Project and Dissertation, Evaluation and Viva-voce on submitted Dissertation (Internal)	**8**			
	Total	**24**			

Semester IV Syllabus
Core Course
Paper Code CHCC-401: Advanced Chemistry Practical — Credits 4

Note: Practical will be done based on the selected elective paper.

Course Objective:
After successful completion of the third semester of Masters, students coming in fourth semester will be provided experimental knowledge about the syntheses and characterization of typical coordination complexes in their enantiomeric pure forms. New and typical synthetic approaches for organic compounds with their concomitant characterization. Also, to provide experimental knowledge about the cryoscopy and refractometry.

Course Outcome:
In order to make students understand the theories taught to them in M.Sc. semester (IV) indifferent branches of chemistry e.g. Inorganic, Organic and Physical, the followingpracticals are introduced .Students will learn:

CO-1. Inorganic preparations in aqueous and organic medium.
CO-2. Colorimetric and spectrophotometric analysis.
CO-3. Three steps synthesis and identification of organic compound by their spectral data
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. The basic knowledge of kinetics by conductance method, pH determination pk value determination, spectrophotometer experiment, Cryoscopy method and Refractometry.
CO-6. To focus their aim for future prospects of Ph.D. programme and Pharmaceutical Industries.

INORGANIC CHEMISTRY
Inorganic preparation in aqueous and organic medium:

(i) Preparation and complete analysis of $K_3[Fe(C_2O_4)_3].3H_2O$
(ii) Preparation and separation of **cis** and **trans** ï $[Co(en)Cl_2]$
(iii) Preparation of $CuCl_2$. DMSO and Copper glycine complex.
(iv) Preparation of Ph_3P and its complexes.
(v) Preparation and reactions of ferrocene.
(vi) Preparation of $Mn(gly)_3$

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

ORGANIC CHEMISTRY

Three steps synthesis incorporating various name reactions.

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

PHYSICAL CHEMISTRY

Conductance Experiments:

1. Study of kinetics of reaction between ethyl acetate and sodium hydroxide (saponification) by conductance method.

E.M.F. Experiments:

2. Determine the pH values for given buffer systems using quinhydrone electrode.
3. Titrate given mixed acids pH- metrically and find out their strengths.
4. Find out pK values of given acids pH metrically.

Spectrophotometer experiments

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

Cryscopic Method

7. Determination of molecular weight of a non- volatile solute by cryoscopic method (water/benzene).

Refractometry

8. Determination of the molar refractivity of methyl alcohol, acetic acid, ethyl acetate and carbon tetrachloride and calculate the refraction equivalents of carbon, hydrogen and chloride atoms.

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. Vogelôs Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
13. Practical Physical Chemistry, A.M. James and F.E. Prichand, Longman.
14. Findleyôs 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, ArunSethi, 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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Semester IV Syllabus
Elective/Intradepartmental Course
Paper Code CHEL-402A: Bioinorganic and Supramolecular Chemistry

Credits 4 **Hours 60**

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

Unit III

Metal – Nucleic Acid Interactions

Metal ions and metal complex interactions, Metal complexes ï 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.

Unit IV

Supramolecular Chemistry-I

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

Unit V

Supramolecular Chemistry-II

a. Supramolecular reactivity and catalysis.

b. 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.

Semester IV Syllabus

Elective/Intradepartmental Course
Paper Code CHEL-402A: Organotransition Metal Chemistry

Credits 4 **Hours 60**

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 carbines ï 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 ï 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 Wilkinsonôs 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 η^2-olefine, η^3 allyl and dienyl complexes.

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 Wesley Longman (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 and K,
6. Wade, Chapman and Hall, London.

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Semester IV Syllabus
Elective/Intradepartmental Course
Paper Code CHEL-402B: Organic Synthesis

Credits 4 **Hours 60**

Course Objective:
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.

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

CO-1. describe methods for synthesis and transformation of the most common functional groups
CO-2. describe and apply stereochemical concepts such as chirality, stereoisomerism, and stereoselectivity in relation to chemical transformations
CO-3. identify, analyse and evaluate synthetic routes to target molecules using retrosynthesis
CO-4. apply organometallic reagents and reactions in organic synthesis
CO-5. Will learn the multistep synthesis of complex molecules
CO-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.
CO-6. give oral and written accounts on the content and results of the laboratory practicals.

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, Ŭ/ƀ-unsaturated carbonyl compounds, -difunctionlized compounds. Micheal addition and Robinson annelation.

Unit IV

Rearrangements

General mechanistic considerations ï 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. &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.

Semester IV Syllabus

Elective/Intradepartmental Course
Paper Code CHEL-402B: Medicinal Chemistry

Credits 4 **Hours 60**

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

Cell signaling and diseases: Definition of Inter and intracellular signaling pathways, first and second messengers, receptors, effectors, signal transduction enzymes.
Drugs: Drug and type of pharmacological actions: Structurally nonspecific drugs; Structurally specific drugs, Drugs that do not act on receptors. Classification of drugs: natural, synthetic and biologics with examples.
Action of drug: Route of administration, binding of drugs to plasma protein binding and blood cells, First pass metabolism, biliary excretion and enterohepatic cycle, drug transport: Passive diffusion, Carrier Mediated transport, Transporter protein, Efflux pump via P-glycoprotein.
Drug design: Five stages of drug discovery and development, Definition of hit and lead molecules, General practices in medicinal chemistry: Targets including validation, chemical library, screening: in vitro, in vivo, in silico, model organisms and phenotypic screening. Source for hit molecules:

serendipity, endogenous source (hormones, monoclonal antibodies, microbial), Plants as traditional source, rational approach based on fragment based drug discovery and repositioning of drugs. Lead optimization: structure-activity and property relationship studies, structural and functional group modifications, structure-based drug design, Bioisosterism and stereoisomerism, prodrugs, ñMe tooò strategies.Quantitative structure-activity relationship (QSAR): Hansch Analysis and Related Approaches

Physico-chemical properties of compounds (MW, solubility, lipophilicity: logP and D, p*K*a, rule of five and three), drug-likeness and their role in drug design.
Case study: Rise of captopril, discovery of Taxol and Metformin

Unit II

Concept of receptors: Cell surface (GPCR, enyzme linked and ion channels) and intracellular receptors, drug-receptor theories, and spare receptors.
Pharmacokinetics: Definition of ADME, Affect of physiological barriers on ADME: Gut, liver, systemic circulation, aqueous and lipid environment, Affect of physicochemical properties of compounds on ADME, Phase I and II drug metabolism and pharmacokinetic drug-drug interaction, Elementary kinetics of ADME: concentration-time curve and its parameters, bioavailability, volume of distribution, clearance, Elementary One and two compartment models.
Pharmacodynamics: Biochemistry of enzymes: Enzymes as biocatalysts, binding and catalytic sites, cofactor: Apoenzyme and Holoenzyme, enzyme- substrate complex, Michaelis-Constant and MichaelisMenten equation.
Effect of inhibitors on enzyme activity: Reversible, competitive, noncompetitive and uncompetitive inhibitors.
Elementary drug-receptor complex formation and dissociation, drug-receptor binding parameters, drug- affinity, -efficacy and -potency, agonists and antagonists.
Pharmacodynamic drug-drug interaction

Unit III

Antineoplastic Agents
Introduction, cancer chemotheroy, special problemes, 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 6mercaptopurine. Recent development in cancer chemotherapy. Hormone and natural products.

Unit IV

Cardiovascular Drugs
Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathic 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, furrazolidone, nalidixin acid, ciproolloxacin, norfioxacin,dapsone, amino salicylic acid, isoniazid, ethionamide, ethambutal, fluconazole, econozole, 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, chloroazepum, alprazolam phenytoin, ethosuximde, trimethadione, barbiturates, thiopental sodium, guletehimide.

Antibiotics
Cell wall biosynthesis, inhiitors, -lactonem 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, AshutoshKar, 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.

Semester IV Syllabus

Elective/Intradepartmental Course
Paper Code CHEL-402C: Polymer Chemistry

Credits 4 **Hours 60**

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 properties, synthetic protocols, characterization and application of polymers.

Course outcome

Students will learn to

CO-1. define related concepts of polymers.
CO-2. summarize historical evolution of the polymers.
CO-3. recognize monomers and polymers.
CO-4. evaluate the structure of polymers.
CO-5. recognize bonds between polymer chains.
CO-6. debate thermal character and affecting factors of thermal behaviours.
CO-7. use determining method of molecular weights.
CO-8. categorize polymers.
CO-9. explain polymers production processes.

Unit I

Polymerisation reaction

Step growth Polymerization: Theory of reactivity of large monomeric molecules, ring formation vs. chain formation. Polymerization: Chain Reaction, Free radical, Cationic, Anionic and living polymers. Coordination and co-polymerization. Polymerization conditions and polymer reactions. Three dimensional network polymerisation.

Unit II

Polymer Charcterisation

Analysis and testing of polymers; chemical analysis, IR and NMR of polymers. X-ray diffraction study. Microscopy. Thermal analysis and physical testing hardness, tensile strength. Fatigue, impact, Tear resistance and abrasion resistance.

Unit III

Structure and Properties

Morphology and order in crystalline polymer-configurations of polymer chains. Crystal structures of polymers. Morphology of crystalline polymers, strain-induced morphology, crystallization and melting. Polymer structure and property relationship. Melting point (Tm), effect of chain flexibility and other steric factors. Entropy and heat of fusion. The glass transition temperature (Tg), Relationship between T_m and T_g. Polymer structure and property relationship.

Unit IV

Polymer processing

General ideas about elastomers, plastics and fibres. Compounding and valcanization of elastomers. Processing techniques: Calendering, die casting, rotational casting, film casting, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming and reinforcing and fibre spinning.

Unit V

Some Commercial and Speciality Polymers

Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins silicone and PTFE polymers. Speciality polymers: Fire retarding polymers and electrically conducting polymers, liquid crystal polymer. Biomedical polymers ï contact lens, dental, artificial heart, kidney, skin and blood cells ï polymers.

Recommended Books:

1. Textbooks of Polymer science, F.W. Billmeyer, Jr. Wiley.
2. Polymer Science,V.R.Gowariker, N.V.Vishwanathan and J. Sreedhar, Wiley-Estern.
3. Functional Monomers and Polymers, K. Takemoto, Y.Inaki and R.M. Ottanbrite.
4. Contemporary Polymer Chemistry, H. R. Alcock and F.W. Lambe, Prentice hall.
5. Physics and Chemistry of Polymers, J.M.G. Cowie, Blackie Academic and Professional.

M.Sc. Chemistry Semester IV Syllabus
Elective/Intradepartmental Course
Paper Code CHEL-402C: Electrochemistry

Credits 04 **Hours 60**

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 electrokinetic phenomenon, electro-osmosis and their application. They will also learn concept of electrochemical phenomenon in biological system.

Course outcome:

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

CO-1.electro kinetic phenomenon, electro- osmosis, streaming potential and sedimentation potential.

CO-2.the chemical basis of biological phenomenon, cellular structure and donnanmembrane equilibrium.

CO-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.

CO-4.theories and importance of over voltage and different types of polarography e.g. pulse, Ac and square wave.

CO-5. general principles of semi conductivity, semiconductors, conducting polymers and fullerene ï doped conductors.

CO-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 : Solid state 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. Brief idea of Electrochemistry of molten electrolytes and non-aqueous solvents.

Recommended Books:

1. ModernElectrochemistry,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.OòReily.
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(2^{nd}Ed.), Bard & L. R. Faulkner, John Wiley & Sons, New York
16. Bioelectrochemistry: Fundamentals, Experimental Techniques and Applications, P. N. Bartlett, John Wiley & Sons, Ltd

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

Semester IV Syllabus
Master Thesis
Paper Code CHMT-401: Project and Dissertation

Credits 8

Course Objective:

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.

For project work and dissertation, the area of the work would be to be decided by the advisor/mentor. On completion of the project work, students have to submit the work in the form of a dissertation followed by oral presentation in the presence of faculty members.