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 students' develop 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 students' ability to develop mathematical models for physical systems.
PSO-10. Global level research opportunities to pursue Ph.D. programme targeted approach of CSIR/UGC – 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 or CHEL-402D, CHEL-402B or CHEL-402E and CHEL-402C or CHEL-402F			
CHEL-402A	Bioinorganic and Supramolecular Chemistry	**04**	Elective/ Intradepartmental Course

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

No.	Name of the Couse	Credit	Remark
CHEL-402B	Organotransition Metal Chemistry	**04**	Elective/ Intradepartmental Course
CHEL-402C	Organic Synthesis	**04**	Elective/ Intradepartmental Course
CHEL-402D	Medicinal Chemistry	**04**	Elective/ Intradepartmental Course
CHEL-402E	Polymer Chemistry	**04**	Elective/ Intradepartmental Course
CHEL-402F	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 Credit
	No. of Paper	Credits (L+T/	Total Credit	No. of Paper	Credits (L+T/P	Total Credit	No. of Paper	Credits (L+T/P	Total Credit	No. of Papers	Credit	
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

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

Semester III Syllabus
Core Course/MOOC
Paper Code CHCC-301: Inorganic Chemistry

Credits: 04 **Hours: 60**

Course Objective:

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.

Course Outcome:

CO-1. This semester deals with the some brief glimpses of bioinorganic and detailed investigation of multi-nuclear nuclear magnetic resonance (NMR) for diamagnetic compounds comprising of ^{19}F, ^{31}P, ^{119}Sn, ^{195}Pt and some other nuclei and Electron Spin Resonance (ESR) studies of paramagnetic compounds.

CO-2. Additionally, students get knowledge about the various pollutants existing in nature and their plausible solutions to cope with.

CO-3. After completing this semester the students are supposed to have some expertise in dealing with the multinuclear NMR and ESR.

CO-4. Also, they may get motivated to have inclination towards the bioinorganic chemistry in the next semester.

Unit I

Applications 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

Nuclear Magnetic Resonance Spectroscopy

Applications of multinuclear NMR with emphasis on **^{11}B,** ^{19}F, ^{31}P, ^{125}Te ^{119}Sn, and ^{195}Pt NMR.

Mössbauer Spectroscopy

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

Unit III

Bioinorganic Chemistry

Metal Ions in Biological Systems

(a) Essential and trace metals.
(b) Na^+/K^+Pump.
(c) Vitamin B12, methyl cobalamine, Biomethylation.
(d) Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemoerythrin, model synthetic complexes of iron, cobalt and copper

Electron Transfer in Biology

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

Nitrogenase

Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model systems.

Unit IV

Environmental Chemistry: Inorganic Pollutants

a. Aquatic pollution: water quality parameters viz. dissolved oxygen, biochemical oxygen demand, heavy metals Cl^-, SO_4^{2-}, NO_3^-, PO_4^{3-} contents.
b. Soil pollution (including agricultural, viz. pesticides, fertilizers, plastics and metals), Waste treatment.

c. Industrial pollution, viz. cement, sugar, distillery, drug, paper and pulp.
d. Nuclear waste management.

Unit V

Selected Topics

a. Chemistry of less familiar metals: Os, Ir, Ru, Rh, Pd
b. Platinium phosphine complexes
c. General method of preparation and important reactions (insertion reactions, metathetical reactions, Lewis acid-base reactions, reactions with protic compounds) of metal and metalloid amides.
d. Preparation 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 imaging agents in Nuclear Medicine
e. Principle, instrumentation and applications of TGA and DTA Ion exchange-preparation, mechanism, of exchange capacity of ion exchangers, Principle and applications of photometric and colorimetric techniques in inorganic analysis.

Recommended Books:

1. Physical Methods for Chemistry, R. S. Drago, Saunders Company.
2. Structural Methods in Inorganic Chemistry, E. A. V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS
3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Norwood.
4. Practical NMR Spectroscopy, M.L. Martin, J. J. Delpeuch and G. J. Martin, Heyden.
5. Principles of Bioinorganic Chemistry, S. J. Lippard and J. M. Berg, University Science Books
6. Bioinorganic Chemistry, I. Bertini, H. B. Gray, S. J. Lippard and J. S. Valentine, University Science Books.
7. Inorganic Biochemistry volume I and II. ed. G. L. Eichhorn, Elsevier
8. Fundamentals of analytical Chemistry, D. A. Skoog, D. M. West and F. J. Holler.

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

Semester III Syllabus

Core Course
Paper Code CHCC-302: Organic Chemistry

Credits:04 **Hours 60**

Course Objective:
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.

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

CO-1: nuclear magnetic resonance spectroscopic and mass spectrometry techniques for organic structure elucidation of organic molecules.
CO-2: basics of photochemical reactions of alkenes, carbonyl and aromatic compounds.
CO-3: the fundamental properties and reactivity of biologically important carbohydrates molecules.
CO-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), virtual coupling. Stereochemistry, hindered rotation, Karplus curve-variation of coupling constant with dihedral angle. Simplification of complex spectra-nuclear magnetic double resonance, contact shift reagents, solvent effects. Fourier transform technique, nuclear Overhauser effect (NOE).
FT NMR, advantage of FT NMR, use of NMR in medical diagnostics.

Unit II

Two dimension NMR spectroscopy

Introduction to COSY and DEPT techniques.

Nuclear quadrupole resonance spectroscopy

Quadrupole nuclei, quadrupole moments, electric field gradient , coupling constant, splitting.

Carbon-13 NMR Spectroscopy

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

Unit III

Mass Spectrometry

Introduction, ion production – EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement. Nitrogen rule. High resolution mass spectrometery. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

Unit IV

Photochemistry

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, □, □-unsaturated and □,□-unsaturated compounds. Cyclohexadienones. Intermolecular cyloaddition reactions – dimerisations and oxetane formation.

Unit V

Bioorganic Chemistry

Enzymes

Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling

and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition. Co-enzymes (NAD+, NADP+, FMN, FAD).

Mechanism of Enzyme Action

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase A.

Biotechnological Applications of Enzymes

Large-scale production and purification of enzymes, techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilized enzymes, enzymes as targets for drug design. Clinical uses of enzymes, enzyme therapy, enzymes and recombinant DNA technology.

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.

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

Semester III Syllabus
Core Course
Paper Code CHCC-303: Physical Chemistry

Credits 04 **Hours 60**

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, super conductors. Optical Properties – Optical reflectance, photoconduction.

Magnetic Properties

Classification of materials: Quantum theory of paramagnetic- cooperative phenomenal magnetic domains, hysteresis.

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, Chemiluminiscence, Atom sensitized reactions, sensitization and quenching, Photosensitization, 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 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.

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

Semester III Syllabus
Core Course
Paper Code CHCC-304: Advanced Chemistry Practical Credits 4

Course Objective:
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.

Course Outcome:
In order to make students understand the theories taught to them in M.Sc. semester (III) indifferent branches of chemistry e.g. Inorganic, Organic and Physical, the followingpracticals 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 secondarysolution, dilution, calibration, and handling of some sophisticated electronic relatedto 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.Dprogramme and pharmaceuticalindustry

INORGANIC CHEMISTRY

1. Gravimetric estimations of complex mixtures involving two or three constituents, Analysis of alloys and minerals.
2. Volumetric estimations:
   i. EDTA titrations - Determination of Zn, Ca, Mg and Fe. Hardness of water.
   ii. $KBrO_3$ and KIO_3 titrations –Determination of As_2O_3 and $[Fe(CN)_6]^{4-}$.
   iii. Chloramine T – titrations - Determination of NO_2 in a sample.
   iv. Ceric Ammonium Sulphate titrations - Determination of Fe and organic acids.

ORGANIC CHEMISTRY
Quantitative analysis
Major Experiments-
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.
Minor Experiment-
Extraction of organic compounds.

PHYSICAL CHEMISTRY
General Experiments.

1. To verify Freundlich Adsorption Isotherm.
2. To determine enthalpy of given salt solution.
3. 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.
4. Determine molecular weight of a given polymer by viscosity method.
5. Find out surface tension, molecular energy and Parachor of given liquid at room temperature.
6. Determine molecular weight of a given electrolyte by depression in freezing point method.

Kinetics Experiments:

7. Study reaction kinetics between KI and $K_2S_2O_8$ by fractional change method and find out its order of reaction at a given temperature.
8. Study reaction kinetics between acetone and iodine by isolation method and determine its order of reaction at a given temperature.

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, 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.

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

Semester III Syllabus

Elective (Non-Credited)
Paper Code CHEL-301A: Environmental Chemistry

Credits 00 **Hours 60**

Course Objective:
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.

Course Outcome

CO-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.

CO-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.

CO-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 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. Green house 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 (5^{th}edition) McGraw Hill Professional.

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

Semester III Syllabus
Elective (Non-Credited)
Paper Code CHEL-301B: Chemistry of Natural Products

Credits 00 **Hours 60**

Course Objective:
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 classification, syntheses and properties of varied type of natural products.

Course Outcome:
After the completion of the course the students will acquire knowledge of:
CO-1. Classification, stereochemistry and synthesis of some important terpenoids and carotenoids.
CO-2. Nomenclature, structure elucidation, physiological action and synthesis of Alkaloids.
CO-3. Occurence, basic structure, Isolation and synthesis of some prominent Steroids.
CO-4. Types of carbohydrates, structure elucidation, biological importance and Blood sugar.
CO-5. Types of plant pigments, their structure determination, isolation and synthesis of some significant plant pigments.

Unit I

Terpenoids and Carotenoids
Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule.
Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules: Citral, Geraniol, α-Terpeneol, Menthol, Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and β-Carotene.

Unit II

Alkaloids
Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, roe of alkaloids in plants.
Structure, stereochemistry, synthesis and biosynthesis of the following : Ephedrine, (+)- Coniine, Nicotine, Atropine, Quinine and Morphine.

Unit III

Steroids
Occurrence, Nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, Structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Biosynthesis of steroids.

Unit IV

Carboydrates
Structure, function, configuration & conformation of important derivatives of monosaccharides & glycosides; disaccharides (lactose, maltose and sucrose); Polysaccharides – structural polysaccharide (cellulose, chitin); storage polysaccharides (starch and glycogen).
Role of sugars in biological recognition.
Blood group determinants.

Unit V

Plant Pigments
Occurence, nomenclature and general methods of structure determination. Isolation and synthesis of Apigenin, Luteolin, Quercetin, Myrcetin, Quercetin 3-glucoside, Cyanidin, Hirsutidine.

Recommended Books:

1. Natural Products: Chemistry and Biological, J. Mann. R.S. Davidson, J.B, Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.
2. Organic Chemistry, Vol 2, I.L. Finar, ELBS.
3. Stereoselective Synthesis: A Practical Approach, M. Nogradi, VCH.
4. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
5. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt Hostettmann, M.P. Gupta and A. Marston, Harwood Academic publishers.

6. Introduction to flavonoids, B.A. Bohm, Harwood Academic Publishers.
7. New Trends in Natural product Chemistry, Atta-ur-Rahman And M.I. Choudhary, Harwood Academic Publishers.
8. Insecticides of Natural Origin, Sukh Dev, Harwood Academic Publishers.

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

M.Sc. Chemistry Semester III Syllabus
Summer Internship

Paper Code CHIN-301: Summer Internship

Credits 04

Course Objective:

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

After successful completion of the first year of Masters, students coming in third semester/second year will be provided exposure of 3-4 months in any Pharmaceutical or Scientific laboratory which will boost-up the moral of Masters students to work in a competitive environment and will groom their mind-set to become "***ATMANIRBHAR"***

Course Outcome:

CO-1. To learn the procedure of identifying, approaching, applying and getting approval of internship from pharmaceutical companies.
CO-2. To witness the entire work area of the pharmaceuticals.
CO-3. To understand the nature of job.
CO-4. To identify the RD procedures and technical skills involved.
CO-5. To understand the complete mechanism of the reactions involved in the manufacturing areas at different sectors.
CO-6. To correlate the manufacturing procedures with simple laboratory synthesis.
CO-7. To learn the environment aspects, pollution, their control involved in the manufacturing unit.
CO-8. To prepare a final evaluation report and presentation for the internship carried out for 90 to 100 days.

3-4 Months training in any Pharmaceutical or Scientific laboratory. After the completion of training project report will be submitted, followed by its evaluation by presentation & viva-voce examination.

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

Semester-III Syllabus
Interdepartmental
Paper Code CHIER-301: Concepts of Chemistry

Credits 4 **Hours 60**

Course Objective:

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 to the students from other faculties about the fundamental of chemistry.

Course Outcome:

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

CO-1. Use of arrow notations in Organic reactions mechanism, different kinds of polymer and their importance, different techniques of polymerization, each quantum number represents and how to obtain quantum numbers for any electron in an atom and determine the number of protons, neutrons, electrons and nuclei in elements and compounds.

CO-2. Periodic properties of all the elements, electronegativity and whether a bond is metallic, ionic, covalent or polar covalent.

CO-3. Predict atomic structure, chemical bonding or molecular geometry based on accepted models

CO-4. Electronic effects operates in covalent bonds, Types of Reactions and different types of Intermediates formed during the reactions

CO-5. Appropriate method of solution for a variety of Mathematic problems, basic physical quantities and various gas Laws for observation of behaviour of gas and Kinetic molecular model.

Unit I

Types of arrows used in Organic Reaction Mechanism – Curved arrow, half- headed and double headed arrows

Introduction of Polymers, natural and synthetic polymers, properties of polymers, Biomedical polymers and their importance

Quantum numbers. Zeeman effect. Pauli's exclusion principle. Aufbau principle. Effective nuclear charge, screening effect, Slater's rule- applications and limitations

Unit II

Classification of Elements and Periodicity of Properties, noble gases and s, p, d and f- block elements. Modern periodic teble. Position of hydrogen in the periodic table. Horizontal, vertical and diagonal relationships in the periodic table. Scales of electronegativity- Pauling, Mulliken and Allred Rochow scale.

Ionic bond – factors influencing the formation of ionic compounds – ionization energy, electron affinity and lattice energy; inert pair effect, Fajan's rules. Covalent bond – polarity of covalent bond.

Unit III

Valence bond theory (VBT) – sigma and pi bonds, hybridization, valence shell electron pair repulsion (VSEPR) theory and geometries of molecules – $BeCl_2$, H_2O, BF_3, NH_3, XeF_4, BrF_3, PCl_5, SF_6 and IF_7.

Molecularorbital theory (MOT) – bonding and antibonding orbitals, bond order, applications of MOT to H_2, He_2, N_2, O_2, O_2^+, O_2^-, HF and CO. Comparison between VBT and MOT.

Unit IV

Resonance and Inductive effect

Reaction Intermediates – Homolytic and Heterolytic bond breaking (carbonium ion, carbanion and free radical)

Types of Reactions – Addition, Elimination, Substitution and Rearrangement Reactions.

Unit V

Mathematical concepts:

Logarithm, anti-logarithm, functions, integrations and differentiation, partial differentiation, trigonometric functions, exponential functions, binary and decimal numbers.

Basics of physical chemistry:

Physical quantities- moles, mole fraction, normality, molality, molarity, formality, equivalent weight, molecular weight and their determination, SI units and derived units.

Kinetic molecular theory:

Ideal and non- ideal gases, laws of gases, the kinetic molecular model, expressions for the pressure of gas, molecular velocities and their relations, mean free path, collision diameter, collision number.

Recommended Books:

1. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.

2. Pradeep's Inorganic Chemistry, K. K. Bhasin, Pradeep Publication.
3. Chemistry for Degree Students, R. L. Madan, S. Chand Publishing.
4. Organic Chemistry, M. K. Jain, Shoban Lal & Co.
5. Pradeep's Organic Chemistry, S. N. Dhawan, Pradeep Publication.
6. Physical Chemistry, Puri Sharma &Pathania.
7. Pradeep Physical Chemistry, Khetrapal, Pradeep Publication.

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 students' develop 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 students' ability to develop mathematical models for physical systems.
PSO-10. Global level research opportunities to pursue Ph.D. programme targeted approach of CSIR/UGC – 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 or CHEL-402D, CHEL-402B or CHEL-402E and CHEL-402C or CHEL-402F			
CHEL-402A	Bioinorganic and Supramolecular Chemistry	**04**	Elective/ Intradepartmental Course

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

No.	Name of the Couse	Credit	Remark
CHEL-402B	Organotransition Metal Chemistry	**04**	Elective/ Intradepartmental Course
CHEL-402C	Organic Synthesis	**04**	Elective/ Intradepartmental Course
CHEL-402D	Medicinal Chemistry	**04**	Elective/ Intradepartmental Course
CHEL-402E	Polymer Chemistry	**04**	Elective/ Intradepartmental Course
CHEL-402F	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 Credit
	No. of Paper	Credits (L+T/	Total Credit	No. of Paper	Credits (L+T/P	Total Credit	No. of Paper	Credits (L+T/P	Total Credit	No. of Papers	Credit	
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

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

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	**4**			
CHEL – 402B Intra-Departmental	Organotransition Metal Chemistry	**4**			
CHEL – 402C Intra-Departmental	Organic Synthesis	**4**			
CHEL – 402D Intra-Departmental	Medicinal Chemistry	**4**			
CHEL – 402E Intra-Departmental	Polymer Chemistry	**4**			
CHEL – 402F Intra-Departmental	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** –$[Co(en)Cl_2]$
(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. 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, 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.

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

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 – 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.

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.

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

Semester IV Syllabus

Elective/Intradepartmental Course
Paper Code CHEL-402B: 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 – 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, 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)

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.

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

Semester IV Syllabus
Elective/Intradepartmental Course
Paper Code CHEL-402C: 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, α/β-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-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.

UNIVERSITY OF LUCKNOW
MASTERS OF CHEMISTRY PROGRAMME
REGULATION 2020

Semester IV Syllabus

Elective/Intradepartmental Course
Paper Code CHEL-402D: 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, “Me too” 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.

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REGULATION 2020

Semester IV Syllabus

Elective/Intradepartmental Course
Paper Code CHEL-402E: 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 – contact lens, dental, artificial heart, kidney, skin and blood cells – 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.

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REGULATION 2020

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

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REGULATION 2020

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.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(2ndEd.), 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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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.