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

Semester III						
Paper	**Paper Title**	**Type**	**Credits**	**Internal Assessment**	**Univ Exam**	**Total Marks**
CHMCC-301	Inorganic Chemistry 3	Core Course 11	4	30	70	100
CHMCC-302	Organic Chemistry 3	Core Course 12	4	30	70	100
CHMCC-303	Advance Chemistry Practical 3	Core Course 13	4	-	100	100
CHMEL-304	Chemical Energetics and Radiochemistry	Elective Course 14 A	4	30	70	100
CHMEL-305	Electrochemistry	Elective Course 14 B				
CHMEL-306	Environmental Chemistry	Elective Course 15 A	2	30	70	100
CHMEL-307	Science of Technology of Cosmetics	Elective Course 15 B				
CHMSI-308	Summer Internship	Summer Internship	2	30	70	100
			20			600
Only one paper out of CHMEL – 304 and CHMEL – 305 has to be studied. Only one paper out of CHMEL – 306 and CHMEL – 307 has to be studied.						
Summer Internship will be of a duration of 2 – 3 weeks						

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Inorganic Chemistry 3 (Core Course 11)

Credits 4 **Paper Code CHMCC-301** **Marks (70 + 30) = 100**

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 same 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 to cope with their plausible solutions.
- **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
        - Essential and trace metals.
        - Na^+/K^+ Pump.
    - Vitamin B12, methyl cobalamine, Biomethylation.
    - 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 ionsulphur proteins, synthetic models.

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

Unit IV

- **Environmental Chemistry: Inorganic Pollutants**
  - Aquatic pollution: water quality parameters viz. dissolved oxygen, biochemical oxygendemand, heavy metals Cl^-, SO_4^{2-}, NO_3^-, PO_4^{3-} contents.
  - Soil pollution (including agricultural, viz. pesticides, fertilizers, plastics and metals),
- **Waste treatment.**
  - Industrial pollution, viz. cement, sugar, distillery, drug, paper and pulp.
  - Nuclear waste management.

Unit V

- **Selected Topics**
  - Chemistry of less familiar metals: Os, Ir, Ru, Rh, Pd
  - Platinium phosphine complexes
  - General method of preparation and important reactions (insertion reactions, metathetical reactions, Lewis acid-base reactions, reactions with protic compounds) of metal and metalloid amides.
  - 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.
  - 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, EllisNorwood.
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, UniversityScience 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.

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Organic Chemistry 3 (Core Course 12)

Credits 4 **Paper Code CHMCC-302** **Marks (70 + 30) = 100**

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 organicstructure 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 andapplications 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

- **Carbon-13 NMR Spectroscopy**
  - General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromaticand carbonyl carbon), coupling constants.
- **Two-dimension NMR spectroscopy**
  - Introduction to COSY and DEPT techniques.

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.

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Unit IV

- **Photochemistry of Alkenes**
  - Intramolecular reactions of the olefinic bond – geometrical isomerism, cyclisation reactions, rearrangement of 1, 4 - and 1, 5 – dienes.
- **Photochemistry of Carbonyl Compounds**
  - Intramolecular reactions of carbonyl compounds — saturated, cyclic and acyclic, and a,□-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 labelingand 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.
7. Principles of Biochemistry, A. L. Lehninger, Worth publisher.
8. Biochemistry, L. Stryer, W.H. Freeman.
9. Biochemistry, J David Rawn, Neil Patterson.
10. Biochemistry, Voet and Voet, John Wiley.
11. Outlines of Biochemistry, E. E. Conn and P.K. Stumpf, John Wiley.
12. Bioinorganic Chemistry: A Chemical Approach to Enzyme action, H. Dugas and Penny, Springer-Verlag
13. Macromolecules: Structure and Function, F. Wold, Prentice Hall.

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Advance Chemistry Practical 3 (Core Course 13)

Credits 4 **Paper Code CHMCC-303** **Marks = 100**

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) indifferentbranches 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 analysisof alloys and minerals.
- **CO-2.** Volumetric estimations and various titrations
- **CO-3.** Qualitative analysis, acetylation method, saponification value and extraction of organiccompounds.
- **CO-4.** The basic knowledge like preparation of solution, standardization of secondary solution, dilution, calibration, and handling of some sophisticated electronic related to the practicalsyllabus.
- **CO-5.** Freundlich Absorption Isotherm, enthalpy, molecular weight determinations by elevation in boiling point method, depression in freezing point method and viscosity method, surface tension, molecular energy and Parachor of given liquid.
- **CO-6.** To focus their aim for future prospects of Ph.D programme and pharmaceutical industry

INORGANIC CHEMISTRY

- Gravimetric estimations of complex mixtures involving two or three constituents, Analysis of alloysand minerals.
- Volumetric estimations:
    - EDTA titrations - Determination of Zn, Ca, Mg and Fe. Hardness of water.
    - $KBrO_3$ and KIO_3 titrations –Determination of As_2O_3 and $[Fe(CN)_6]^{4-}$.
    - Chloramine T – titrations - Determination of NO_2 in a sample.
    - Ceric Ammonium Sulphate titrations - Determination of Fe and organic acids.
- Colorimetric and Spectrophotometric analysis: Determination of iron, copper, ammonium, phosphate,fluoride and nitrite ions.

ORGANIC CHEMISTRY

- **Quantitative analysis**
    - Determination of percentage or number of hydroxyl group in an organic compound by acetylationmethod.
    - Estimation of amines/phenols using bromate bromide solution/or acetylation method.
    - Determination of iodine and saponification value of an oil sample.
- **Extraction of organic compounds.**
    - Identification of organic compounds by using their spectral data (UV, IR, ^{1}H &^{13}C-NMR and MassSpectroscopy)

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PHYSICAL CHEMISTRY

- **General Experiments**
  - To verify Freundlich Adsorption Isotherm.
  - To determine molecular weight of a given electrolyte by elevation in boiling point method(Landsbigger method) and also find out its Van't Hoff factor.
  - Determine molecular weight of a given polymer by viscosity method.
  - Find out surface tension, molecular energy and Parachor of given liquid at room temperature.
- **E.M.F. Experiments:**
  - Titrate given mixed acids pH- metrically and find out their strengths.
  - Find out pK values of given acids pH metrically.
- **Spectrophotometer experiments**
  - Determination of stability constant of a metal ligand complex by spectrophotometeric method.
  - Investigation of reaction between potassium per-sulphate and potassium iodide by spectrophotometer method.

Distribution of Marks

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

Recommended Book:

1. 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, Adward Arnoid.
11. Handbook of Organic Analysis Qualitative and Quantitative, H. Clark, Adward Ar.
12. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
13. Practical Physical Chemistry, A.M. 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, Parul Mathur, New Age International (P) Limited.
22. Systematic Experiment in chemistry, Arun Sethi, New Age International (P) Limited.
23. Experiments in Physical chemistry, J.C. Ghosh, Bharati Bhavan.
24. Advanced Practical Physical Chemistry, JB Yadav.
25. Practical Organic Chemistry, Mann and Saunders.

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Chemical Energetics and Radiochemistry (Elective Course 14A)

Credit 4 **CHMEL-304** **MM 100 (75 + 25)**

Course Outcome:
Student will

- CO 1. Understand the introductory quantum mechanics and concept of third law of thermodynamics, distribution law and phase rule. CO 2. Get introduced to the law of photochemistry and photosensitized
- reactions energy transfer processes.
- CO 3. Study about the dilute solutions and colligative properties.
- CO 4. Get familiar with radiopharmaceuticals and radiochemistry.

Unit I

- **Introductory Quantum Mechanics:**
  - Plank's radiation law, photoelectric effect, optical activity, polarization (Clausius-Mossotti equation), orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment, temperature method and refractivity method, magnetic properties- paramagnetism, diamagnetism, and ferromagnetism.

Unit II

- **Thermodynamics - III**
  - Nernst heat theorem, statement and concept of residual entropy. Thermodynamic derivation of Nernst distribution law and its application. Chemical Potential, Phase equilibrium, Phase rule, derivation Gibbs phase rule and its applications.

Unit III

- **Photochemistry**
  - Interaction of radiation with matter, difference between thermal and photochemical processes.
  - Laws of photochemistry: Grothus-Drapper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non- radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples).

Unit IV

- **Colligative Properties:**
  - Ideal and non-ideal solutions, methods of expressing concentration of solutions, activity and activity coefficient, Relative lowering of vapour pressure, molecular weight determination, Osmosis, theory of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing point and its thermodynamic relation. Experimental methods of determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

Unit V

- **Radiochemistry**
  - Natural and induced radioactivity; radioactive decay----α-decay, β-decay, γ- decay; neutron emission, positron emission, electron capture; unit of radioactivity (Curie); half-life period; Geiger-Nuttal rule, radioactive displacement law, radioactive series.

Measurement of radioactivity: ionization chamber, Geiger Miller counters, scintillation counters. Applications: energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies, nuclear medicine-^{99m}Tc radiopharmaceuticals

Reference Books:

1. Physical Chemistry G.M. Barrow. International Student Edition IMC McGraw Hill.
2. Graduate Physical Chemistry, Volume III L.R. Sharma and M.S. Pathania, 2017.
3. Principles of Physical Chemistry, Volume III, B.R. Puri, L.P. Sharma and M.S. Pathania, Vishal Publications, Jalanadhar.
4. Quantum Chemistry by R.K. Prasad, New Age International Pvt. Ltd.
5. Elements of Physical Chemistry, P.W. Atkins, Oxford University Press
6. Physical Chemistry, R.A. Alberty: Wiley Eastern Ltd.
7. Physical Chemistry through Problems, S.K. Dogra and S. Dogra Wiley Eastern Ltd.

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Electrochemistry (Elective Course 14B)

Credits 4 **Paper Code CHMEL-305** **Marks (70 + 30) = 100**

Course Objective:

- After successful completion of the third semester of Masters, students coming in fourth semester if opting this paper will be provided knowledge about 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 donnanmembraneequilibrium.
- **CO-3.**the concept of physics and physical chemistry for the study of biologicalsystems 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 andsquare wave.
- **CO-5.** general principles of semi conductivity, semiconductors, conducting polymersand 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.

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

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Environmental Chemistry (Elective Course 15A)

Credits 2 **Paper Code CHMEL-301** **Marks 30 + 70 =100**

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**
  - Analytical methods for measuring BOD, DO, COD, F, Oil, Metals (As, Cd, Cr, Hg, Pb, Se etc) residualchloride and chlorine demand, Purification and treatment of water.
- **Soil**
  - Composition, micro and macro nutrients, Pollution- fertilizers, pesticides, plastics and metals, wastetreatment.

Unit IV

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

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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, betterindustrial 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.

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Science and Technology of Cosmetic (Elective Course 15B)

Credits 2 **Paper Code CHMEL-307** **Marks (70 + 30) = 100**

Course Objective:

- To provide students coming in the first year and second semester of Masters program better understanding into basic cosmetic technology which can form an apt platform for the student to move into cosmetic industry after completing their masters.

Course outcome:

- **CO-1.** This course allows students to understand and learn about the chemistry of cosmetics.
- **CO-2.** More specifically, this course aims to introduce the scientific aspects such as chemical,physical and biological functions of different ingredients present in the cosmetics.
- **CO-3.** This course also gives information about the formulation and technology of cosmetics

Unit I

- **General**
  - Basic concept of Cosmetics. Classification of cosmetic products for skin, hair and oral care.
  - Forms of cosmetics and their suitable examples: Solutions, creams, lotions, ointment, paste, gels, sticks, tablets, capsules, powders and aerosols.

Unit II

- **Cosmetic Ingredients and Classifications:**
  - Water, Surfactants, Foaming agents, Emulsifiers, and Solubilizers, rheological additives, Antioxidants, Antimicrobial and Chelating agents used as preservatives.

Unit III

- **Perfume:**
  - Classification of perfumes, Perfume ingredients
- **Colour Cosmetics:**
  - Building block and formulation of Lipsticks, mascara, and nail polish.Hair conditioner**:** Building blocks and formulation of Hair conditioners, hair oils, hair dye.Herbal cosmetics

Unit IV

- **Nanotechnology**
  - Use of nanotechnology in cosmetics, suspensions, creaming, cracking and phase inversion Micrometrics: Methods of determining particle size, optical microscopy, sieving, sedimentationmeasurements
- **Powders:**
  - Porosity, densities, bulkiness and flow properties.

Unit V

- **Rheology of Cosmetics:**
  - Newtonian systems, law of flow, kinematic viscosity, effect of temperature on viscosity,
  - Non-Newtonian systems – Plastic, pseudoplastic and dilant system, thixotropy determination ofviscosity,

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Semester III

Recommended Books:

1. Harry's Cosmeticology – Wilkinson, Moore, seventh edition, George Godwin.
2. Cosmetics – Formulation, Manufacturing and Quality Control, P.P. Sharma, 4th edition,Vandana Publications Pvt. Ltd., Delhi.
3. Drugs and Cosmetic act/rules by govt. of India Publication
4. Handbook of Cosmetic Science and Technology, 3rd Edition, André O. Barel, Marc Paye,Howard
5. Maibach, Marianne MahieuInforma Healthcare USA, Inc.

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Semester III

Summer Internship

Credits 2 **Paper Code CHMSI-308** **Marks = 100**

Course Objective:

- 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 ofinternship 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 manufacturingareas 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.

2 – 3 weeks training either in the same institution or at any other research lab as per choice of the student. After the completion of trainingproject report will be submitted, followed by its evaluation by presentation & viva-voce examination.

Distribution of Marks

Class	Report	Viva	Presentation	Total
Internship	60	20	20	100