DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD.

Curriculum under Choice Based Credit &

Grading System

M.Sc.

Inorganic Chemistry

Semester–III & Iv

run at college level from the

Academic Year 2015-16 & onwards

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

Department of chemistry

Revised Syllabus

M.Sc. III & IV Semester Inorganic Chemistry

11.06.2015

Professor & Head
Dept. of Chemistry
Babasaheb Ambedkar
Marathwada University,
Aurangabad-431004.

Effective from June 2014

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The following will be the structure for revised syllabus for M. Sc. Inorganic Chemistry III & IV semester effective from June 2014

Semester	Paper Nos.	Title of Paper	Durations (Hr)	Max. Marks	Credits
III- Semester	CHE-313	Applications of Spectroscopy	60	50	4
	CHEI- 314	Bioinorganic and supramolecular Chemistry	60	50	4
	CHEI-315	Applied Inorganic chemistry	60	50	4
	CHEI-316	Chemistry of materials	60	50	4
IV semester	CHEI; 417	Nuclear Chemistry	60	50	4
	CHEI; 418	Photoinorganic Chemistry	60	50	4
	CHEI; 419	Therapeutic Bioinorganic and chemistry of forensic materials	60	50	4
IIIrd & IVth Semester Laboratory course	CHEI; 420	Organo transition metal chemistry	60	50	4
	CHEI- 421	Laboratory course (Inorganic)	135	50	4.5
	CHEI- 422	Laboratory course (Inorganic)	135	50	4.5
	CHEI- 423	Laboratory course (Inorganic)	135	50	4.5
	CHEI- 424	Project Work (inorganic)	135	50	4.5

CHE-313 Structural Elucidation by Spectral methods

Duration : 60 hrs **Marks : 50 Credit : 04**

UNIT-I ***Nuclear Magnetic Resonance Spectroscopy (^1H NMR)***

Elementary ideas (Recapitulation); Spin-spin couplings, Different types of couplings, factors affecting on coupling constants, Karplus equation, Spin systems (AB, AX, ABX, AMX), Rate processes, spin decoupling, shift reagents, Nuclear Overhauser effect (NOE), INEPT and INADEQUATE.

UNIT-II ***^{13}C Nuclear Magnetic Resonance Spectroscopy***

Elementary ideas, instrumental problems, chemical shifts (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbons); Effect of substituents on chemical shifts.

UNIT-III ***Mass Spectroscopy***

Introduction, ion production (EI, CI, FD and FAB), ion analysis, ion abundance, factors affecting on fragmentation, fragmentation of different functional groups, molecular ion peak, isotopic peaks, metastable peak, Nitrogen rule, McLafferty rearrangement, Retro-Diels-Alder reaction.

UNIT-IV

Problems based on joint applications of UV, IR, ^1H NMR, ^{13}C NMR and Mass spectroscopy.

UNIT-V

Mossbauer spectroscopy: Principle, factors affecting the line position and shape, isomer effect and Quadrupole splitting iron salt like compounds, complexes, carbonyl compounds (temperature dependence of isomer shift and Quadrupole splitting in simple compound and coordination, polynuclear complexes), Numericals.

Electron Spin Resonance Spectroscopy: Introduction, principle of ESR spectroscopy, presentation of spectrum, hyperfine splitting in various structures, hyperfine splitting digram of representative examples, factors affecting the magnitude of 'g' values, Zero field splitting, Kramer's degeneracy, Anisotropy in the hyperfine coupling constant, electron delocalization, instrumentation and applications.

Reference Books:

1 Introduction to Spectroscopy: D. L. Pavia, G. M. Lampman, G. S. Kriz
2 Spectrometric Identification of Organic Compounds: R. M. Silverstein & F. X. Webster
3 ^{13}C NMR Spectroscopy: G. C. Levy, R. L. Lichter, G. L. Nelson
4 Spectroscopic Methods in Organic Chemistry: D. H. Williams & I. Flemming
5 Absorption Spectroscopy of Organic Compounds: V. M. Parikh
6 Mass Spectrometry: K. G. Das & James
7 Coordination Chemistry by Experimental Methods: K. Barger
8 Coordination Chemistry vol. I: E. Martell
9 Physical Methods for Chemistry: R. S. Drago
10 Structural Methods in Inorganic Chemistry: E. A. V. Ebsworth & D. W. H. Rankin
11 Organic Structure Analysis: Philips Crews

M. Sc. Inorganic chemistry Semester -III

CHEI- 314 Bioinorganic and Supramolecular Chemistry

Duration : 60 hrs **Marks : 50 Credit : 04**

Unit- I . Metalloenzymes: **[12 hrs]**

Structural and functional relationships and mechanisms of enzymatic reaction in the following metalloenzymes. **Zinc Enzymes:** carbonic anhydrase and carboxypeptidases, **Copper Enzymes:** super oxide dismutases **Iron Enzymes:** catalase and peroxidases, **Molybdenum Enzymes:** nitrogenase and xanthanine oxidase,**Coenzyme Vitamin:** B-12

Unit-II. Metal Nucleic Acid Interactions: **[12 hrs.]**

Introduction, nucleic acid structures, structures and binding sites in nitrogen bases, phosphates and sugar base. Coordination complexes of nucleic acids and their bases with metal ions. Hydrogen bonding, redox reaction and hydrolytic reaction of nucleic acids mechanisms of these reactions, natures role, pharmaceutical role, catalytic role

Unit-III . Molecular Recognition: **[12 hrs]**

Basic concepts and principles of supramolecular chemistry, Host-Guest interactions, spherical recognition, anionic receptors, porphyrin-sapphyrin systems, organometallic receptors, tetrahedral multiple and neutral molecular cleft recognition, enzyme models, molecular receptors, design and synthesis.

Unit - IV. Supramolecular reactions and catalysis **[12hrs]**

a. Catalysis by anion, cation and metal receptor molecules and co catalysis.

b. Molecular and supramolecular devices : likes Photonic, Electronic and ionic devices..

Unit-V: Techniques in Bioinorganic chemistry: **[12hrs]**

Principles and applications of electronic spectroscopy, IR spectroscopy, NMR spectroscopy, Raman spectroscopy

Reference Books:

1. Bioinorganic chemistry By:-Bertini Ivano, Gray H. B., Lippard S. J. & Valentine J. S.
2. Principles of Bioinorganic chemistry By:- S. J Lippard & M. J. Berg
3. Inorganic Biochemistry, (Vol.I & II) By:- G. L. Eicchorn.
4. Bioinorganic chemistry :- A. K. Das.
5. Bioinorganic chemistry - R. W. Hay.
6. Bioinorganic chemistry - Chatwal G. R. & A. K. Bhagi.
7. Supramolecular chemistry -Lehn J. M.
8. Bioinorganic & Supramolecular chemistry - Chatwal G. R. & A. K. Bhagi.
9. Bioinorganic, Bioorganic & Supramolecular chemistry By:-Kalasi P. S.
10. Supramolecular organometallic chemistry By:- j. L. Atwood and Jonathava W. steed, Macel Jekkar Publisher
11. Supramolecular Organometallic chemistry -Jean Marie-Lehn.

CHEI-315 Applied Inorganic chemistry

Duration : 60 hrs **Marks : 50 Credit : 04**

Unit -I. Basic concept of zeolites: **[12 hrs]**

Introduction, definition, classifications on the basis of morphological appearance, SBU, substitution of other iso-electronic metal ions, types of pore size. Lowenstein's rule, pore and channels, channel dimensions, shape of the pore opening, nomenclature of zeolites, structural aspect of zeolites, acidity of zeolite, identification of acidic sites, nature of active sites, synergetic effects, shape selectivity.

Unit-II Synthesis of zeolites **[12 hrs]**

General methods for synthesis of zeolite, hydrothermal treatment, mechanism of aluminosilicate formation during Sol-Gel, co-precipitation process, factors affecting the zeolite formation, general procedure for modification of zeolites, Oswald's rules of successive transformation, crystallization and its identification, factors affecting crystallization, template theory, organic additives, crystallizing zeolites, ZSM-5 from an organic free solvent system, synthesis in nonaqueous solvents.

Unit -III Characterization and applications of zeolite **[12 hrs]**

General characterization techniques for analysis of zeolites, Details on FTIR, Pyridine adsorbed- IR analysis, XRD analysis, ^{27}Al MAS NMR and ^{29} Si MAS NMR analysis , Temperature programmed desorption (TPD), probe molecules for TPD analysis , measurement and analysis with suitable examples. Zeolite catalyzed reactions, water softening treatment using zeolites.

Unite -IV. Basic Chemical Calculations: **[12 hrs.]**

Moles, mole percent composition, mole fraction, weight & volume percent analysis of solid in composition, **Material balance involving chemical reaction:** Introduction, material balances, definition of terms, Concept of Selectivity, Conversion, numericals

Unit –V

Catalysis, types of catalysis, catalyst, properties of catalyst, classification of catalysts, Sabtier's principle, classification of solid catalysis, fundamentals of heterogeneous catalysis, factor affecting the catalyst performance , promoters, types of promoters, Inhibitors , catalyst poisoning, overview on heterogeneously catalyzed process in industry, Principle of green chemistry, Atom economy, numericals.

Reference Books:

1.Molecular sieves: Principles of synthesis and Identifications R-Szostak.
2. Atlas of zeolite framework type; Ch. Barlocher, W M. Meier , D. H. Olson; 5th rev. Ed. Elsevier Amsterdam 2001
3.Stoichometry (SI Units): B.I. Bhatt & S.M. Vora.
4. Molecular Sieves Science and technology ; H. G. Karge, J Weitkamp Vol I to V , Springer
5.Industrial catalyst- A Practical Approach , Jens Hygen, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany
6. Heterogeneous Catalysis and Solid Catalysts , Olaf Deutschmann, Helmut Knozinger, Karl Kochloefl, Thomas Turek, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim

M. Sc. Inorganic chemistry Semester -III

CHEI-316 : Advances in material chemistry

Duration : 60 hrs **Marks : 50 Credit : 04**

Unit- I : General introduction & synthesis of nanomaterials by physical methods: [12 hrs]
Objective of study, synthesis of nanoparticles by physical method, mechanical methods- high energy ball milling, melt mixing, method based on evaporation, physical vapour deposition with consolidation. Ionized cluster beam deposition. Laser vaporization, Laser pyrolysis, sputter deposition, electric arc deposition, Chemical Vapour Deposition (CVD).

Unit- II : Synthesis of Nanomaterials by Chemical Methods : [12hrs]
Introduction, colloids and colloids in solution, interaction of colloids and medium, colloids in vacuum, colloids in medium, effect of charge on colloids, stearic repulsion, synthesis of colloids, growth of nanoparticles, synthesis of metal and semiconductor nanoparticles by colloidal route, Langmuir-Blodgett (L-B) method, sol gel method, electrochemical method.

Unit-III : Analysis Technique : [12hrs]
Introduction, microscopes, electron microscopes, SEM, TEM, Scanning probe microscope (SPM), Scanning Tunneling microscope, Atomic force microscope, X-ray diffraction, UV-visible and IR spectroscopy.

Unit-IV : Properties, types and application of Nanomaterials: [12hrs]
i).Properties of nanomaterials – Mechanical, electrical, optical, magnetic, semiconductor.
ii).Some special nanomaterials – Carbon nanotubes, porous silicon, Arogels, Zeolites.
iii).Application – Electronic, energy automobiles, sport and toys, textile, cosmetics, domestic appliances, biotechnology, medical, space, defence & environment.

Unit-V : Imperfections in solids: [12hrs]
Perfect and imperfect crystal, point defects, stoichiometric defects, Schootky & Frankle defects, thermodynamics of their formation, colour centers, Non-stoichiometric defects, metal excess and metal deficiency defects, line imperfections, Edge dislocation, Screw dislocation, Burgers circuits, Surface imperfections, grain boundaries & stacking falts.
Theories of solid states – free electron theory, band theory, refinement to simple band theory.

Reference Books:

1) Solid State Chemistry and applications- A.R. West (John Wiley and Sons)
2) Principles of the Solid State- H.V. Keer (Wiley Eastern Limited)
3) Nanotechnology: Principles and practices- Sulabha K. Kulkarni (capital Pub. Co.)
4) NANO- The next revolution –Mohan Surendra Rajan(National book Trust, India)
5) The British Glass Website- Types of Glass://www.britiglass.org.uk.
6) Fundamental of Nanotechnology – Gabor L. Hornyak, John J. Moore, Harry F. Tibbals, Joydeep Dutta.
7) Recent advances in the liquid phase synthesis of Inorganic Nanoparticles- B. L. Cushing , 8) V. L. Kolesmichenko & C.J.O".Connor Chemical Review 104, 3893-3946.(2004)

M. Sc. IV Semester Inorganic Chemistry

CHEI: 417 Nuclear Chemistry

Period : 60 hrs. **50 Marks** **Credit : 04**

Unit- I Nuclear particles and its properties **[12 hrs]**

The fundamental particles, roll call of elementary particles, composition of the nucleus, theories of nuclear composition, nuclear properties, mass defect and binding energy, nuclear stability explained by different factors.

Nuclear size and density, mechanical effects due to orbiting and spinning of nucleons, orbital angular momentum of the nucleons, Total angular momentum of the nucleons, magnetic quantum numbers, principal and radial quantum numbers, total angular momentum of nucleus, total magnetic nuclear angular momentum quantum number, The spin of odd Z odd N nuclei, The Nordhein rule.

Unit- II Nuclear models : **[12 hrs.]**

The shell model and its salient features, periodicity in nuclear properties- magic numbers, forces of nuclear potential, energy level in nuclear potential well, the sequence of filling the orbital including models, nuclear configuration. The liquid drop model, and its details and The Fermi gas model.

Unit III Radioactivity: **[12 hrs.]**

Historical, background, natural radioactive elements, general characteristics of α, β, γ rays, detection and measurement of radioactivity, the theory of radioactive disintegration, decay kinetics, units of radioactivity, parent daughter growth relationship- secular and transient equilibrium, theory of α decay, β decay – energetics of β decay problems of β decay, fermi theory of β decay, nuclear de-excitation – emission, numerical

Unit-IV Nuclear Reactions. **[12 hrs.]**

Definition and Bethes notation, nuclear reaction energetic, nuclear reaction and threshold energy, characteristics of nuclear reactions, types of nuclear reactions, conservation in nuclear reactions, nuclear reactions cross section, cross section and reaction rate, the compound nucleus theory, general properties of compound nucleus, optical model, direct interaction model, specific nuclear reactions- photonuclear reactions, stripping and pickup reactions evaporation, spallation, fragmentation, direct nuclear reactions, thermonuclear reactions.

Unit - V Radiation chemistry and its applications **[12hrs]**

A. Introduction of radiation with matter, primary effects due to charged particle/radiation, Linear energy transfer(LET), Bethes equation for LET, Bremsstrahulung, the cerenkov radians, interactions of electron with matter, interaction of neutrons with matter, interaction of heavy charged particles with matter. typical application of radioisotopes as tracers- chemical investigation, physio-chemical research, analytical applications, agricultural applications, industrial applications, use of nuclear radiations, radioisotope as a source of electricity

Reference Books.

1. Source of Atomic energy by s. Glasstance, D. Van Nostrand co. INC
2. Essentials of nuclear chemistry by H.J. Arnikar 4th Edn, New Age International(p) Ltd.
3. Introduction to Nuclear By chemistry B. G. Harvey,
4. Nuclear chemistry by M. G. Arora & M. Singh Anmol publication, New Delhi
5. Elements of nuclear chemistry by A. K. Srivastav, P. C. Jain, S. Chand & Co.
6. A text book of Nuclear chemistry by C.V. Shekar Deminant publication & distribution, New Delhi.
7. Radiochemistry & nuclear chemistry, 3rd edn G. chappin, Butterwerth-Heinemann.

M. Sc. Inorganic chemistry Semester -IV

CHEI :418 Photoinorganic Chemistry

Duration : 60 hrs **Marks : 50 Credit : 04**

Unit –I Basic concept of Photo Chemistry: **[12hrs]**

Introduction to photochemistry, laws of photochemistry, Quantum yield, deviation in quantum yield, Experimental determination of quantum yield, Quantum yield and reactivity, life time of electronically excited state, kinetic aspects of photochemical reactions, temperature dependence of photochemical reaction, Methods used to study the kinetics of photochemical reaction: Flow methods, flash photolysis methods, numerical on quantum yield calculations.

Unit- II Physical properties of electronically excited molecules : **[12 hrs]**

Nature of changes on electronic excitation, potential energy diagram, shapes of absorption bands and franck condon principal, emission spectra, environmental effect on absorption and emission spectra. **Photo physical process in electronically excited molecule:**Types of physical pathways, Jablonski diagram, theory of radiationless transition, theory of radiative process, bimolecular quenching, experimental results.

Unit III. Excited States of Metal Complexes: **[12 hrs.]**

Spectroscopic states of d^1 to d^{10} configurations, Ligand field excited states of Co(II), Cr(III), Ru(II), Ru(III), Fe(II) and Rh(III) in an octahedral omplexes, Excited states of organic ligand with examples, selection rules for electronic transitions. **Charge transfer photochemistry** :Introduction, charge transfer absorption spectra, types of charge transfer excitations and their energy level scheme for charge transfer excitations, Types of reactions observed by CTTM, Models of photoredox system.

Unit-IV. Ligand field photo chemistry of transition metal complexes : **[12hrs]**

Photochemistry Cr(III) of complexes : Photo-substitutions, properties of ligand field excited states ,Photo aquation reactions, photolysis rule , photoisomerization , photo recimization, photoanation reactions, sensitizer, energy transfer process, Mechanism of photo sensitization, photo reactive excited state, The Doublet hypothesis, Role of quartet excited states, Photochemistry of Co(III) complexes : Introduction, energy level diagram, Photoaquations in Co(III) amine, Co(III) cynide complexes, Fe(II) low spin complexes., Ru(II) ammine derivative complexes, Photo redox properties of (Ru(III) complexes, Ce(III) and Ce(IV) complexes.

Unit-V. Photochemical reactions on solid surface: **[12hrs]**

Introduction, Photo catalysis, photoreactive oxide materials, relation between band gap & energy, wavelength, photo electron transfer mechanism, energy level diagram of solid acceptor and donor levels. Supported photo catalyst: Types of support & need , Supported Semiconductor supported metal oxides for Photolysis of water, Decomposition of organic pollutants, experimental setup, and end product of organic moieties. OLED, Solar energy conversion and its storage.

Reference Books :

1. Concepts of Inorganic Photo chemistry, W. Adamson ,
2. Inorganic spectroscopy , A. B. P. Lever
3. Symmetry and spectroscopy of Molecule, K. Veera Reddy,
4. Inorganic Chemistry, J. E. Huhey
5. Fundamental of Photochemistry, Rohatgi Mukherjee
6. Inorganic chemistry , Attkin and shriver
7. Advanced Inorganic Chemistry, Gurdeep Raj.
8. A. W. Maverick and Harry B. Gray , Pure and applied chemistry, 52, 2339- 2348
9. Peter C Ford, The Photosubstitution Reactions of Rhodium (III) Ammine complexes, Journal of Chemical Education, 60, 10, 831, (1983).
10.Richard J Watts, Ruthenium Polypyridyls, Journal of Chemical Education, 60, 10, 835, (1983).
11.J. N. Demas, Photophysical Pathways in metal complexes, Journal of Chemical Education, 60, 10, 803, **(1983)**
12.L. D. Kirk, , Chromium Ammines and Acidoammines, Journal of Chemical Education, 60, 10, 843, **(1983)**
13. D. Chatterjee , Visible light induced photo degradation of organic pollutants on dye Adsorbed TiO_2 surface : Bull. Cat. Soc. of. India 2,,56-58, **2004**

M. Sc. Inorganic chemistry Semester -IV

CHEI- 419 Therapeutic Bioinorganic and chemistry of forensic materials

Duration : 60 hrs **Marks : 50 Credit : 04**

Unit- I: Metal ions in carcinogenesis: **[12 hrs.]**

General and biochemical aspects of cancer, carcinogens and anticancer agents. Carcinogenesis and its mechanism. Role of metal complexes and Pt(II) and (IV) as anticancer agents, anticancer activity of rhodium, gold, copper, and cobalt complexes. Selenium and its biochemical role and its mechanism of cacinostatic actions. Some representative metallodrugs containing arsenic, antimony, gold, mercury and tin metal. Antibacterial, antifungal and antiviral activity of metal; complexes.

Unit- II: Chemistry of Forensic Materials **[12 hrs]**

Forensic toxicology, legal definition of poison and toxinology, human and cattlepoison, and its antidotes. Principle underlying removal of poison from the body and use of antidotes, corrosivepoison and its classification. Common household poisons. Characteristic sign, symptoms, treatment and medicolegal aspects of common household poisons, classifications of poisons according to their mode of action.

Unit- III: Concepts on metal ion toxicity **[12 hrs]**

Metal ion toxicity in man and animals. Introduction, general aspects of Pb(II), Cd(II), and Hg(II), biochemical and physiological effects caused due to Pb(II), Cd(II), and Hg(II) ion toxicity. Detoxifications of this metals using chelating agents.

Unit- IV: Interactions of metal ions and metal complexes **[12 hrs]**

Structure and functions of amino acids, proteins, peptides, enzymes nucleoside, nucleotide and comparative study of structures and functions of these biomolecules. Metal ion binding sites present in amino acids, peptides, proteins,enzymes, nucleoside and nucleotide. Interactions of metal ion and metal complexes with these biomolecules.

Unit – V Physical methods in Bioinorganic chemistry : **[12 hrs]**

A). Electrophoresis method : Types of electrophoresis , principles and applications of capillary electrophoresis , analysis of bands using different methods **B). Centrifugation methods** : Basic principles of sedimentation, types of centrifuges and rotors, types of centrifugations and applications.C). Spectrophotometerics method : UV- visible spectroscopic techniques and their applications.

Books Suggested

1. Inorganic biochemistry – by Guther L. Eicchornvol 1 and 2 volume (Elsevier Scientific Publishing Company Amsterdam 1973, London New York.
2. Pharmacological basis of therapeutic, 5th and 6th edition by –Louis S. Goodman, (Macmillan Publishing company,..INC; New York; Toronto and London)
3. Metal ions in biological system by- Helmut Sigel. Vol. 19 21, 22 - (Marcel Dekker INC, New York and Basel)
4. Metal ions in biological system (Concepts on metal ion toxicity) by Helmut Sigel. Vol.7- (Marcel Dekker INC, New York and Basel)
5. Modi's Medical Jurisprudence and Toxicology 22nd Edition.
6. Parikh's Textbook of Medical Jurisprudence, Forensic Medicine and Toxicology (Six Edi8tion) By C. K. Prikh. (CBS Publishers & distributors 4596/1A 11, Daryagaing New Delhi- 11002
7). Bioinstrumentations – L Veerakumari , MJP publisher Chennai
8). Principles of bioinorganic chemistry – S. J Lippard & J M Berg , Mill Valley californua
9) Elements of BVioinorganic - G N Mukherjii, and Arbinda Das U N Dhur and Sons Pvt. Ltd Kolkatta

M. Sc. Inorganic chemistry Semester -IV

CHEI: 420 Organo transition Metal Chemistry

Period : 60 hrs. **50 Marks**

Unit- I . General Properties of Organotransition Metal Compounds [12 hrs]
Definition, Classification based on the number of coordinated carbon (Hapticity), number of electrons donated by ligands, and type of bonding. Nomenclature, 16, 17, 18 Electron complexes and ligand substitutions, electron counting for common ligands and geometry of organo transition metal compounds.

Unit – II . Alkyl ,aryl Carbene and carbine transition metal compounds. [12 hrs]
General method of synthesis of alkyl and aryl transition metal compounds, (i.e Ti, V, W, Mn, Ir, Co, Fe), Chemical properties, stability and decomposition pathways.

Carbene transition compounds: Types of carbine compounds, properties of carbene ligands, Synthesis of Fischer type carbine compounds, Chemical reaction on coordinated carbine compounds .**Carbyne transition metal compounds :** Synthesis and chemical properties

Unit- III. Transition metal compounds with Unsaturated organic molecules: [12 hrs.]

H^2 alkene transition metal compounds : General methods of the synthesis, Chemical properties: Reaction with nucleophiles and Electrophiles, Structure and bonding (DCD model) **η^2 alkyne transition metal compounds:** Introductions, preparation, chemical properties, Structure and bonding. **η^3 allyl transition metal compounds:** Introduction, Structural verities in allyl transition metal compounds, General methods of preparation, chemical properties, structure and bonding.**η^4 butadiene transition metal compounds:** Introduction, General methods of preparation, reaction on coordinated ligand, structure and bonding. **η^4 Cyclobutadiene transition metal compounds:** Preparation and chemical properties of $(C_4H_4)Fe(CO)_3$, structure and bonding.**η^5Cyclopentadienyl transition metal compounds:** Introduction, classification of η^5- Cyclopentadienyl derivatives, Preparation and chemical properties of $(\eta^5\text{-}C_5H_5)_2Mn$, $(\eta^5\text{-}C_5H_5)Mn(CO)_3$, structure and bonding in Ferrocene.

Unit- IV Organotransition metal compound as catalysts and synthetic reagents [12 hrs]
Activation process: consequent changes in the coordinated ligand reactivity, template effect. **Protection:** Sterric control, facilitation of nucleophilic addition reactions. **Product isolation:** Reductive elimination, β-eliminations, radical formation, alkene or arene displacement by competing ligand, electron transfer from metal atom to an oxidant, release of carbenoid ligands.

Unit –V Catalytic processes involving organotransition metal compound: [12 Hrs]
Hydrogenation of alkene using Wilkinson's catalysts, hydrosilation reaction, hydroformulation of alkene (oxo process) Ziegler Natta polymerizations. Fischer Tropsch process, water gas shift reaction. Monsanto process for acetic acid synthesis., Wacker process of oxidation of alkene.

Reference Books:

1. Organo metallic Chemistry, R. C. Mehrotra, & A. Singh
2. Principal and applications of organotransition metal Chemistry, J. P. Collman, L. S. Hegedus, J. R. Norton
3. Inorganic Chemistry , Attkin and Shriver
4. Advanced Inorganic Chemistry, Gurdeep Raj.
5. Inorganic Chemistry, J. E. Huhey

M. Sc. Inorganic chemistry Semester –III & IV

Laboratory course (Inorganic) CHEI - 421

4.5 hrs/week
Max Marks : 50

I. Preparation, estimation of metal ion, UV/IR spectrum of metal complexes to be prepared (any 05)

- **Single step preparation**

1.Tris (thiourea) Copper(II) Sulphate . 2. Bis (thiourea) Zinc (II) sulphate
3. $NH_4[(Cr(III)(C_2O_4)_3]$ 4. [Ni(II) (Salicyldoxime)$_2$]
5. [Copper (II) (Acetyl acetone)$_2$] 6. Manganese (II) Phthalocyanine
7. Mercury(II) Dithizonate

- **Two step preparation : i). Preparation of ligand ii). Preparation of metal complex**

1 Copper(II) complexes of Schiff base derived from salicylaldehyde with aniline/ substituted aniline
2. Cobalt(II) complexes of Schiff base derived from salicylaldehyde with aniline/ substituted aniline
3. Nickel(II) complexes of Schiff base derived from salicylaldehyde with aniline/ substituted aniline
4. Zinc(II) complexes of Schiff base derived from salicylaldehyde with aniline/ substituted aniline
5. Iron(III) complexes of Schiff base derived from salicylaldehyde with aniline/ substituted aniline

II Inorganic composite materials.

1. Preparation and magnetic properties of Zinc ferrite.
2. Preparation and magnetic properties of Cobalt ferrite
3. Preparation and magnetic properties of Nickel ferrite
4. Preparation of $FeTiO_3$and utilization for degradation of methylene blue.
5. Preparation and catalytic applications of sulphated zirconia for acid catalyzed reactions
6. Preparation, characterization of Nickel nano particles.
7. Synthesis of Aluminoslicate zeolite and their catalytic application.

III. Collection of UV Visible, IR , XRD, TGA/DTA Spectrum/pattern analysis inorganic compounds / metal complexes / metaloxides / nanoparticals

Reference Books:

1. Nano technology: Principles and Practices-Sulbha K. Kulkarni
2. A Text book of Quantitative Inorganic Analysis; A. I. Vogel
3. Practical inorganic chemistry; Pass Geoffrey and haydn Sutcliffe.
4. Advanced Practical inorganic chemistry; Gurudeep Raj.
5. Internet Search of UV Visible, IR , XRD, TGA/DTA Spectrum/pattern analysis metal complex/ metal oxides materials

Scheme of marking

1. Preparation of complexes. Single/ two step preparation [20 marks]
2. Preparation of inorganic composite materials/ diffraction data analysis of inorganic compounds [15 marks]
3. UV Visible, IR , XRD, TGA/DTA Spectrum/pattern analysis [10 marks]
4. Record book and viva voce [05 marks]

Laboratory course (Inorganic) CHEI - 422

4.5 hr per week
50 marks

I Spectrophotometer:

1. Estimate the amount of copper and bismuth ions using EDTA, photometric titration method
2. Determine the stability constant, empirical formula, λ max. by job's method, mole ratio and slope ratio method.
3. Determine the pKa of Methyl red indicator
4. Simultaneous determination of MnO^-_4 and $Cr_2O_7^-$
5. Determination of Fe(II) by using O-phenanthroline reagent.

II. P^H metrically

1. Determine the Pk value of benzoic acid by using irrivaing Rossotgi method. by P^H metric method and metal ligand stability constant of its complex.
2. Determine the Pk value of Phthallic acid by using irrivaing Rossotgi methodby P^H metric method and metal ligand stability constant of its complex.
3. Determine the Pk value of Glycine by using irrivaing Rossotgi method. by P^H metric
4. Determine the metal ligand stability constant of copper benzoate complex by pH metric method.
5. Determine the metal ligand stability constant of copper phthalate complex pH metric method.
6. Determine the metal ligand stability constant of copper glycinato complex by pH metric method.

III. Conductometry

1. Analyze the acid mixture hydrochloric acid and acetic acid by conductometric method.
2. Analyze the mixture of copper sulphate, hydrochloric acid and acetic acid by conductometric method.
3. Determine the stability constant and composition/formula of lead oxalate by conductometric method.
4. Determine the solubility and solubility product of sparingly soluble salt by conductometric method.

IV. Potentionmetry

1. Determine the redox potential of Fe(II)/Fe(III) system and hence determine the number of electron involved in the system using $K_2Cr_2O_7$ by potentiometric method.
2. Determine the amount of chloride, bromide and iodide in the given sample by potentiometric method.
3. To determine the stability constant of $[Ag(NH_3)_2]^+$ complex by potentiometric method.
4. To determine the stability constant of silver thiosulphate complex by Potentiometric method.

V. Turbidometry

1.Determine the sulphate content of the given sample using turbidometric titration.

VI. Flame photometry:

1. Estimate the amount of sodium/potassium from the given sample

VII. Application of Computer in Chemistry: at least 05 expt

A. Application of Microsoft EXCEL in Chemistry (Attach the printed sheet in your record book)

1. Calculate the excess molar volume of given data 02
2. Calculate the excess viscosity of given data 02
3. Calculate the excess free energy of given data 02
4. Plot graph between x= sinθ Vs Y = Cosθ, θ= 0 - 360^0
5. Plot the Neat labeled graph from given data 06
6. Arrange the data increasing order of trend. 02

Reference Books/ Journals:

1. Systematic experimental physical chemistry – T. K. Chondhekar & S.W. Rajbhoj
2. Experiments in chemistry – D.V. Jahagirdar
3. Textbook of quantitative Inorganic Analysis – IV Edn. J. Bassett, R. C. Denny, G.H.Gefery and J. Mendham
4. Journal of Chemical Engineering Data, India. Journal of Chemistry, Journal of Indian Chemical Society, (Note: Data collection for computer practical)

Scheme of marking

1. Experiment on Spectrophotometer/ P^H meter/ Conductometry / Potentiometer / Turbidometry / Flame photometry [30 marks]
2. Experiment on applications of Excel [15 marks]
3. Record book and Viva Voce [05 marks]

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M. Sc. Inorganic chemistry Semester –III & IV

Laboratory course (Inorganic) CHEI- 423

06 hr per week **50 marks**

I. Magneto chemistry : at least 10 sample

1. Determine the number of unpaired electron in the given sample by Gouy's balance method

Select the sample : Copper sulphate, sodium sulphate, calcium carbonate, potassium ferrocynide, potassium ferricynide, coordination complexes

2. To verify the Weidemann's law using nickel chloride solution and determine number of unpaired electron in it.

II. Alloy analysis : any 02

i. Solder alloy analysis

ii. Stainless steel alloy analysis

iii. Brass and bronze alloy analysis.

iv. Copper nickel alloy

v. Qualitative analysis of soil

III. Ore analysis : 02

i. Analysis of dolomite ore

ii. Analysis of calcite ore

iii. Analysis of Haematite ore

iv. Analysis of bauxite ore.

IV. Analysis of metals in drug sample

i. Analysis of calcium from given drug sample

ii. Analysis of Iron from given drug sample

iii. Analysis of water soluble vitamin forms the given sample.

iv. Determination of number of water molecules present in given samples

v. Analysis of forensic toxic metal ion

Scheme of marking

1. Analysis of Ore/alloy	[25 marks]
2. Experiments on magneto chemistry/ analysis of drug sample, Vitamin, Forensic sample, water in samples	[20 marks]
3. Record book and Viva Voce	[05 marks]

M. Sc. Inorganic chemistry Semester –III & IV

Project work (Inorganic) CHEI - 424

4.5 hrs/week
Max Marks : 50

Tentative topic of Project work

1. Design , synthesis and characterizations of ligands molecules
2. Synthesis and characterizations metal complexes.
3. Preparation of single crystal of metal salts/ metal complexes
4. Synthesis, characterizations and applications of metal nano particles.
5. Synthesis, characterizations and applications of metal oxides / mixed metal oxides of transition/ non transition metals.
6. Synthesis and characterizations of mesoporous materials
7. Designing the assemblies for purification of water using inorganic materials
8. Photodegradation studies of organic pollutants using inorganic catalytic materials
9. Water analysis/ Soil analysis
10. Analysis and utilization of fly ash
11. Preparation and characterization of thin film of semiconductor materials.
12. Application of computer in chemistry.: EXCEL, computational software in chemistry
13. Kinetics of ligand substitution reaction

Scheme of marking

Project work Evaluation : 25 marks

i. Literature survey
ii. Experimental procedures , photographs
iii. Characterizations techniques : Fundamentals principles of respective techniques
iv. Spectrum / images of prepared materials
v. Data analysis / applications of synthesized materials
vi. Conclusion
vii. Reference citations
viii. Holistic response of students (scientific thinking, power of imagination, Punctuality, efforts, curiosity,)

Power point presentation of Project work : 25 marks

i. Self preparation PPT
ii. Skill of presentation
iii. Contents of presentation
iv. Subject knowledge
v. Manuscript preparation/acceptance/publication

Reference : i). Library Work ii). Internet search is compulsory