DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD.

DEPARTMENT OF CHEMISTRY

SYLLABUS

M. Sc. Inorganic Chemistry

(Semester III & IV)

Choice Based Credit and Grading System

Effective from : June 2017

The following will be the Choice Based Credit and Grading System structure of revised syllabus for M. Sc. III & IV semester Inorganic Chemistry effective from June 2017.

Semester	**Paper Nos.**	**Title of Paper**	**Teaching (hr)/week**	**Marks**	**Credits**
III- Semester	CHESC-301	Structural elucidation by spectral methods	04	100	04
	CHECI- 302	Bioinorganic and supramolecular chemistry	04	100	04
	CHECI- 303	Applied inorganic chemistry	04	100	04
	CHEEI -304	Chemistry of materials **OR**	04	100	04
	CHEEI -305	Environmental chemistry **OR**	04	100	04
	CHEEI- 306	Solid state chemistry	04	100	04
	CHELI- 307	Laboratory course	06	50	03
	CHELI- 308	Laboratory course	06	50	03
	CHELI- 309	Laboratory course	06	50	03
IV semester	CHECI -401	Nuclear chemistry	02	50	02
	CHECI -402	Photoinorganic chemistry	04	100	04
	CHECI -403	Therapeutic bioinorganic and chemistry of forensic materials	04	100	04
	CHEEI -404	Organo transition Metal Chemistry, **OR**	04	100	04
	CHEEI -405	Polymer chemistry , **OR**	04	100	04
	CHEEI -406	Theoretical and structural inorganic chemistry	04	100	04
	CHEIR - 407	Research Project (Experimental)	24	200	12
	CHEIR - 408	Research Project (Dissertation, Presentation and Seminars)	06	100	06

CHESC-301: Structural elucidation by spectral method

04 Hrs/Week **Credits: 04** **Marks 100**

UNIT-I: Nuclear Magnetic Resonance Spectroscopy (^{1}H NMR) [12hrs]

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}CNuclear Magnetic Resonance Spectroscopy [12hrs]

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

UNIT-III: Mass Spectroscopy [12hrs]

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 [12hrs]

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

UNIT-V [12hrs]

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 diagram 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. FlemmingAbsorption

5. 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

*****

-

CHECI- 302: Bioinorganic and supramolecular chemistry

04 Hrs/Week **Credits : 04** **Marks : 100**

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: Supramolecular chemistry **[12 hrs]**

Basic concepts and principles of supramolecular chemistry, Host-Guest interactions, Molecular Recognition,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: Storage of metals and transport across the membrane **[12hrs]**

The fluid mosaic model of membrane, types of transport and their mechanism, Transport and storage of alkali and alkaline earth metals, Na –K pump, calcium pump. Gibbs-Donnan equilibrium, Iron transport proteins and compounds.

Reference Books:

1. Bioinorganic chemistry -Bertini Ivano, Gray H. B., Lippard S. J. & Valentine J. S.
2. Principles of Bioinorganic chemistry - S. J Lippard & M. J. Berg
3. Inorganic Biochemistry, (Vol.I & II) - 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 Kalasi P. S.
10. Supramolecular organometallic chemistry J. L. Atwood and Jonathava W. steed, Macel Jekkar Publisher
11. Supramolecular Organometallic chemistry -Jean Marie-Lehn.
12. Elements of bioinorganic chemistry - G N Mukharji & Arvind Das

*****

-

CHECI- 303: Applied inorganic chemistry

04 Hrs/Week **Credits: 04** **Marks : 100**

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. 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, NH_3- TPD and CO2- TPD . Applications of zeolite, Zeolite catalyzed reactions, water softening .

Unit-IV: Fundamentals of catalysis **[12 hrs]**

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.

Unit-V: Basic Chemical Calculations: **[12 hrs.]**

Moles**,** Mole fraction, percent composition, weight & volume percent analysis of solid in composition, Material balance involving chemical reaction: Introduction, material balances, Concept of Selectivity, Conversion, and numericals. 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. Molecular Sieves Science and Technology vol I & II, H G Karge , J Weitkamp- Springer
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. Stoichometry (SI Units): B.I. Bhatt & S.M. Vora.
7. Heterogeneous Catalysis and Solid Catalysts , Olaf Deutschmann, Helmut Knozinger, Karl Kochloefl, Thomas Turek, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim
8. Green chemistry and catalysis – Roger A . Sheldon , Isabel Arends , Ulf Hanefeld . Wiley VCH

*****

-

CHEEI- 304: Chemistry of materials

04 Hrs/Week **Credits: 04** **Marks : 100**

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)

*****

-

CHEEI-305: Environmental chemistry

04 Hrs/Week **Credits : 04** **Marks : 100**

Unit-I: Air Pollution **[12 hrs]**

General considerations: polluted air, Types of pollution and units of measurements. Air quality standards, Sampling, Monitoring, Analysis of CO, Sources and sinks of CO pollution, Effects of CO on plants and humans, Control of CO pollution, Analysis of oxides of nitrogen, NOx sources and sinks of NOx pollution, Control of NOx pollution, Hydrocarbons and photochemical smog and its control, Analysis of hydrocarbon in exhaust gasses, Petrol and air, Sulpher di oxide sources, Analysis and control, Acid rain particulates and their effects on human and climate, Control of particulates.

Unit-II: **[12 hrs]**

Water Pollution: Aquatic environment, Water pollutants, Sampling of water and its preservation Trace metals in water, Chemical speciation with special reference to Copper, Lead, Mercury and Arsenic. Water quality standards Water quality parameters.

Oxygen Demanding Wastes: Dissolved oxygen, Biological oxygen demand, Monitoring techniques and methodology with special reference to ammonia, Nitrates, Nitrites, Fluorides, Cyanides, Total hardness, Lead, Cadmium and Mercury. Detection and control of Detergents, oils, Pesticides, Sewage treatment.

Unit-III: **[12 hrs]**

Chemical toxicology : Toxic chemicals in environment, Impact of toxic chemicals on enzymes, Biochemical effects of Arsenic, Cadmium, Lead, Mercury, Carbon monoxide, Sulphur dioxide, Pesticides and Carcinogens.

Soil analysis: Sampling of soil, Determination of water holding capacity, Determination of total nitrogen, phosphorous and sulphur in soil.

Unit-IV: **[12 hrs]**

Industrial pollution: Pollution due to cement industry, Distillery, Pharmaceutical (Drug) industries, Sugar industry, Paper and pulp industries, Thermal power plants, Nuclear power plants, Metallurgical industries, Polymer industries. Recycle, reuse, recovery, disposal, and management of solid industrial waste.

Unit-V: Pesticides and Environmental pollution [12 hrs]

Types of pesticides, , Insecticides and Herbicides . Effect of pesticides, Insecticides and Herbicides on environment , Physicochemical decomposition of pesticides, , Insecticides and Herbicides by soil microorganism and other living organism .

Reference Books:

1. A. K. De, Environmental Chemistry, Wiley Eastern Ltd. New Delhi.
2. S. L. Chopra and J. S. kanwar, Analytical, Agricultural Chemistry, Kalyani Publishers, New Delhi.
3. Environmental chemistry , V P Kudesia , Pragati prakashan , meerut.
4. R. K. Trivedy and P. K. God, Chemical and biological methods for water pollution studies, Environmental publications, co. New Delhi.
5. L. A. Richards, Diagnosis and improvement of saline and alkali soils. Oxford IBH publications co. New Delhi.
6. S. M. Khopkar, Environmentalchemistry, Environmental pollution analysis.
7. M. S. Creos and Morr, Environmental chemical analysis, American publications.
8. M. Sitting, Resources, Recovery and Recycling, Handbook of industrial waste.
9. Standard methods of water and waste water analysis, American public health association Washington D. C.
10. R. Gopalan and AmruthaAnand, "Environmental chemistry laboratory manual Emerald Publication.
11. Standards for water for drinking and other purposes, Beaurau of Indian Standards India.
12. Guideline for drinking water quality recommendations of world health organization, Geneva.
13. B. K. Sharma and H. Kaur, Environmental Chemistry, Guel publishing house Meerut.
14. Thomas G. Spiro and Willian M. Stigliani, Chemistry of environment.
15. Green Chemistry: An Introductory Text, Mike Lancaster, Royal Society of Chemistry,(2002)
16. New Trends in green Chemistry, V.K.Ahluwalia and M. Kidwai, Anamaya Publishers New Delhi, (2004)

*****

CHEEI-306 : Solid state chemistry

04 Hrs/Week **Credits : 04** **Marks : 100**

Unit-I: Solid state Reactions **[12 hrs]**

General Introduction and principles, classification, Wagner reaction mechanism, Experimental procedures, Co-precipitations as precursor to solid state reaction, Kinetics of solid state reactions, Vapour Phase transport methods, Modification of existing structure by ion exchange and intercalation reactions,- Graphite intercalation compound, transition metal dichalcogenide and other intercalation compounds , Preparation of thin films, methods of characterization of thin films.

Unit-I: Imperfections in solids **[12 hrs]**

Perfect and imperfect crystals, point defects, stoichiometric defects, Schottky and Frenkel defects. Thermodynamics of their formation, color centers. Nonstoichiometric defects, metal excess and metal deficiency defects. Line imperfections, edge dislocation and screw dislocations, Burgers circuits. Surface imperfections, grain boundaries and stacking faults.

Unit-III: Theories of solid state and electronic properties **[12 hrs]**

Free electron theory, Conduction by free electrons, Band theory, refinement to simple band theory, band structure of metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, semiconductor material and their fabrication. **Super conductivity:** conventional super conductors, organic super conductors(organic metals), fullerene, high temperature super conductors, organic charge transfer complexes, Applications

Unit-IV Properties of solid **[12 hrs]**

Optical properties: Luminescence and phosphors, lasers, photoconduction, photoelectric effects**. Magnetic Properties:** Behavior of substances in a magnetic field, classification of magnetic materials, effect of temperature, magnetic domains and hysteresis. **Electrical properties**: Thermoelectric effects, Thomson effects, Peltier effect, seebeck effect, thermocouples, Hall Effect, Dielectric materials, Ferro, Pyro, Piezo electricity and their relations. Applications.

Unit-V Glass and Ceramics **[12 hrs]**

Glass: Introduction, physical and chemical properties of glass. Methods of manufacture of glass, thermodynamics of glass formation, kinetics of crystallization and glass formation, types of glasses, sodalime glass, lead or flint glass, borosilicate glass, glass fiber, aluminosilicate glass, alkali-barium silicate glass, colored glass, opal glass, safety glass, technical glass, glass ceramics, optical (crookes) glass, sealing glass.

Ceramics: Introduction, classification, porous and non-porous materials wastes, clay and its properties, primary and secondary clays. Manufacturing process, glass ceramics.

Reference Books:

1. Solid state chemistry and its applications – A. R. West (John Wiley and sons)
2. Principles of the solid state – H. V. Keer (Wiley Eastern Limited)
3. Material science and engineering – V. Raghavan (prentice hall of India)
4. Principles of electronics – V. K. Mehta (S. Chand and Co.)
5. Engineering Chemistry - P. C. Jain and M. Jain (Shanpat Rai and Sons)
6. Industrial chemistry – B. K. Sharma (Goel Publishing House)
7. The British Glass Website- Types of Glass: http:/wwwbritglass.org.uk.

*****

CHELI-307 : Laboratory course

06 Hrs / Week **Credits : 03** **50 Marks**

I. Prepare and estimate the percentage of metal ion in the metal complex and their spectral studies

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. $[Cu(NH_3)_4]SO_4.H_2O$
8. $[Co(NH_3)_4CO_3]NO_3$
9. $K_3[Cr(CNS)_6]\ 4H_2O$
10. $K_3[Cr(C_2O_4)_3]$
11. $[Cr(urea)_6]Cl_2.3H_2O$

II . Estimation

1. Separation and estimation of Zn(II) and Cd(II) from given mixture using Amberlite IRA 400 anion exchange resin
2. Separation and estimation of Zn(II) and Mg(II) from given mixture using Amberlite IRA 400 anion exchange resin
3. Determine the Total hardness of water by using EDTA
4. Determine the percentage of chlorine from bleaching powder using Volhard method
5. Determination of iron content from given sample by using 8- hydroxyquinoline as extractant

Reference Books:

1. A Text book of Quantitative Inorganic Analysis; A. I. Vogel
2. Practical inorganic chemistry; Pass Geoffrey and haydn Sutcliffe.
3. Advance Inorganic Analysis – S K Agarwala, Keemti Lal , Pragati Prakashan
4. Advanced Practical inorganic chemistry; Gurudeep Raj.
5. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House

Scheme of marking

I. Preparation of complexes	25 Marks
II. Estimation	15 Marks
III. Journal and viva voce	10 Marks

*****

CHELI-308 : Laboratory course

06 Hrs / Week **Credits : 03** **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, λmax. by job's method, mole ratio and slope ratio method.
3. Determine the $_{P}$Ka of Methyl red indicator

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 Glycine by using irrivaing Rossotgi method. by P^H metric
3. Determine the metal ligand stability constant of copper benzoate 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.

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.

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

Reference Books

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

Scheme of marking

1. Experiment - I	25 Marks
2. Experiment- II	15 Marks
3. Record book and Viva Voce	10 Marks

*****

-

CHELI-309 : Laboratory course

06 Hrs / Week **Credits : 03** **50 Marks**

I. Magneto chemistry : at least 05 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

II. Alloy analysis :

1. Solder alloy analysis
2. Brass alloy analysis
3. Bronze alloy analysis.
4. Copper nickel alloy

III. Ore analysis : Any 03

1. Analysis of dolomite ore
2. Analysis of calcite ore
3. Analysis of Haematite ore
4. Analysis of bauxite ore.

Scheme of marking

1. Analysis of ore/Alloy	25 Marks
2. Magneto chemistry	15 Marks
3. Journal and Viva Voce	10 marks

*****

-

CHECI-401: Nuclear chemistry

02 Hrs/Week **Credits : 02** **Marks: 50**

Unit-I: Nuclear particles and its properties [06 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,

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 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.

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.

*****

CHECI: 402 Photoinorganic chemistry

04 Hrs/Week **Credits: 04** **Marks : 100**

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

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 complexes. Excited states of organic ligand ection rules for electronic transitions. **Charge transfer photochemistry** :Introduction, charge transfer absorption spectra, types of charge transfer excitations and their energy level. Types of reactions observed by CTTM, Models of photoredox system.

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

Photochemistry Cr(III) of complexes : properties of ligand field excited states, Photo-substitutions reaction ,Photo aquation reactions, photolysis rule , photoisomerization , photo recimization, photoanation reactions, photo reactive excited state, doublet hypothesis, role of quartet excited states. Sensitizer, mechanism of photo sensitization, photosensitized aquation reaction. Photochemistry of Co(III) complexes : Energy level diagram, Photoaquations in Co(III) amine, Co(III) cynide complexes. Photochemistry of Fe(II) low spin complexes, Ru(II) amine derivative complexes, Photo redox properties of (Ru(III) complexes.

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

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 . Semiconductor supported metal oxides for Photolysis of water. Decomposition of organic pollutants, experimental setup and photo degradation end product of organic moieties.

Reference Books :

1. Concepts of Inorganic Photo chemistry, W. Adamson
2. Photochemistry of Coordination Compound – V. Balzani and Carassiti , Acdemic press London & New York
3. Inorganic spectroscopy , A. B. P. Lever
4. Inorganic Chemistry, J. E. Huhey
5. Fundamental of Photochemistry, Rohatgi Mukherjee
6. Charge Transfer Excitation of Coordination compounds. Generation of reactive intermediate – A Vogler and H Kunkely
7. Metal complex Sensitizers in dye sensitized solar cells, Coord. Chem . Review , Andre Sarto Polo et al , 238, 1343-1361, **2004**
8. Metal centered ligand field excited state : Their roles in the design and performance of transition metal based photochemical moleculesar device , Paul S Wagenkecht and Peter C Ford , Coord. Chem. Review, 255, 591, **2011.**
9. 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**

*****

-

CHECI- 403: Therapeutic bioinorganic and chemistry of forensic materials

04 Hrs/Week **Credits : 04** **Marks : 100**

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: Metals in medicine [12 hrs]

Chelation therapy, Limitation of chelation therapy in metal ion detoxification , Zinc salt in the treatment of sickle cell anemia. Lithium therapy in psychiatric mind disorder, Metals used in diagonosis, radiodiagnostic agent, MRI and X-ray contrast agent , Bismuth and Vanadium compound in medicines, chelation and role of metal complexes in conventional drug resistant malaria

Reference Books

Inorganic biochemistry – Guther L. Eicchornvol 1 and 2 volume (Elsevier Scientific Publishing Company Amsterdam 1973, London New York.

1. Pharmacological basis of therapeutic, 5th and 6th edition by –Louis S. Goodman, (Macmillan Publishing companyNC, New York, Toronto and London)
2. Metal ions in biological system - Helmut Sigel. Vol. l9 21, 22 - (Marcel Dekker INC, New York and Basel)
3. Metal ions in biological system (Concepts on metal ion toxicity) by Helmut Sigel. Vol.7- (Marcel Dekker INC, New York and Basel)
4. Modi's Medical Jurisprudence and Toxicology 22nd Edition.
5. 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
6. Bioinstrumentations – L Veerakumari , MJP publisher Chennai
7. Principles of bioinorganic chemistry – S. J Lippard & J M Berg , Mill Valley California
8. Elements of BVioinorganic - G N Mukherjii, and Arbinda Das U N Dhur and Sons Pvt. Ltd Kolkatta

*****

-

CHEEI- 404: Organo transition metal chemistry

04 Hrs/Week **Credits : 04** **Marks : 100**

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.]

η^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

*****

-

CHEEI-405: Polymer chemistry

04 Hrs/Week **Credits: 04** **Marks : 100**

Unit-I: Fundamentals of Biological Macromolecules [12 hrs]

Chemical bonds in biological systems; Properties of water; Thermodynamic principles in biological systems; Properties and classification of amino acids; Structures of nucleic acids, Protein structure and function, Properties of nucleosides and nucleotides, Composition of nucleic acids, Electrophoresis, Factors affecting on Electrophoretic Mobility; Types of Electrophoresis; Free electrophoresis and Gel electrophoresis; Electrophoresis in genetic analysis; DNA Sequencing and DNA foot Printing.

Unit-II: Macromolecules [12 hrs]

Introduction, Formation of synthetic high polymers classification, Polymerization reactions: Chain and Step. Average molecular weight, Number average weight, Methods of determination of molar masses of polymers; Viscosity, Osmometry, Molar mass of charged macromolecules, Donnan membrane equilibrium, Ultracentrifugation, light scattering, Diffusion.

Unit-III: Chemistry of Polymerization [12 hrs]

Chain polymerization: free radical polymerization, ionic polymerization, co-ordination polymerization, Ziegler-Natta catalysts.

Step Polymerization: polycondensation, polyaddition, ring opening, electro chemical polymerization, group, Transfer polymerization, Polymerization techniques.

Unit-IV: Kinetics of Polymerization [12 hrs]

Free radical chain polymerization, Anionic polymerization, Cationic polymerization, Copolymerization, Free radical copolymerization, Ionic copolymerization, Copolycondensation.

Unit-V: Electronically Conducting Polymers [12 hrs]

Introduction, Theories of electronic conduction; Band theory of conduction, Hopping conduction, Super conduction, Mechanism of conduction, Doping mechanism, p-type, n-type, auto doping, Stimuli sensitive (smart) polymers, pH and temperature sensitive smart polymers, Applications: Photovoltaic devices, Sensors, LED and Solar cells, Electro chemical devices, Batteries etc.

Reference Books:

1. Cantor, C. R. and Schimmel Biophysical Chemistry Vols. 1-3, W. H. Freeman (1980).

2. Lehninger, A.L., Nelson, D. L. and M. M. Lehninger, Principles of Biochemistry 4th Ed., W. H. Freeman (2004).
3. U. Satyanarayana; Biochemistry.
4. Upadhyay; Biophysical Chemistry.
5. L. Stryer, Biochemistry, 5th Edition, (2002) Freeman and Co. New York.
6. D. Voet, J. G. Voet, Biochemistry 3rd Edition (2004), Wiley International Publication.
7. D. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry 3rd Edition (2002) McMillan North Publication.
8. Polymer Science. By V. R. Gowariker, N. V. Viswnathan, Jayadev Sreedhar.
9. Polymers and Resins. By Brage Golding.
10. Electrical Properties of Polymers. By Tony Blythe and David Bloor.
11. Self doped conducting polymers. By Michael S. Freund and Bhavana Deore.
12. Polymer Science and Technology. By Premamoy Ghosh.

*****

--

CHEEI-406 : Theoretical and structural inorganic chemistry

04 Hrs/Week **Credits : 04** **Marks : 100**

Unit- I: Applications of theoretical models to chemical compounds. [12 hrs]

Valence bond model: theoretical concept of hybridization, construction of wave functions for sp, sp^2, sp^3, dsp^2 and d^2sp^3 hybridizations. Identification of nature of bonds. Application of VSEPER theory to covalent bonded anionic compounds.

Unit- II: Crystal field theory [12 hrs]

Important feature of CFT, crystal field splitting d orbital in octahedral , tetrahedral, square planer and tetragonal complexes, factors affecting 10Dq, application of CFT, CFSE and their uses, limitation of CFT

Unit- III: Molecular orbital Theory [12 hrs]

Basic principles of MOT, linear combination of atomic orbitals, construction molecular orbital wave function of H_2, H_2^+, H_2^- . Molecular orbital energy level diagram of poly atomic molecules (NH_3, BF_3, BeH_2, octahedral and tetrahedral molecules).

Donor acceptor chemistry of NH_3: BF_3, $BF_3 : O(C_2H_5)_2$, $Br_2 : CH_3OH$ adducts. π- Molecular orbitals of planer C_nH_n molecules, HOMO -LUMO energy, correlation of HOMO- LUMO energies with ionization energy, electron affinity, hardness and reactivity of molecules.

Unit-IV: Chemical forces and its importance [12 hrs]

Types of chemical forces, covalent bonding, ionic bonding, dipole-dipole interaction, induced dipole interactions, dipole-induced dipole interactions, with suitable examples, interpretation of hydrogen bonding interactions in common organic compounds , solubility of ionic substances, ion solvent interactions with examples, Polarity of solvent, factors affecting the polarity of solvents, importance of polar and non polar solvent in chemical reactions.

Unit –V: Chemistry of main group elements [12 hrs]

Synthesis, structure and properties of Borazines, phosphazenes and their polymers, Hetrocyclic inorganic systems, Sulfur- nitrogen chain and ring compounds, Xenon compounds, interhalogens compounds, Structural aspect of oxy acid of phosphorous, sulfur, nitrogen and halogens.

Reference Books:

1. Inorganic Chemistry - J E Huhey
2. Concept and models of Inorganic chemistry – Bodil E Douglas and Darl H
3. McDaniel , Oxford & IBH Pub. Co.
4. Inorganic chemistry- Gary L Miessler, Donald A Tarr 3rd Edn
5. Inorganic chemistry – Puri and Shrma
6. Inorganic chemistry – J D Lee
7. Inorganic chemistry- Attken
8. Quantum chemistry and spectroscopy- Engel
9. Physical chemistry - A molecular approach – Donald A Mc Quarrie , John D Simon

*****

--

CHEIR-407 : Research project (Experimental)

24 Hrs/Week	**Credits : 12**	**200 Marks**

*****

CHEIR-408 : Research project (Dissertation, presentation and Seminars)

06 Hrs/week	**Credits : 06**	**100 Marks**
