

M. Sc. – II
Inorganic Chemistry
Syllabus
Semester – III

Papers		No. of Lectures
CH-326	Organometallic compounds of Transition metals & Homogeneous catalysis	[60]
CH-330	Coordination Chemistry, Magnetism & Reaction Mechanism	[60]
CH-331	Structural Methods in Inorganic Chemistry	[60]
CH-332	Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life	[60]

Semester – IV

CH-430	Inorganic Solids & heterogeneous catalysis	[60]
CH-431	Materials Science	[60]
CH-445	Inorganic Applications in Industry, Biotechnology & Environmental Chemistry	[60]

SEMESTER - III

CH-326

Organometallic compounds of Transition metals & Homogeneous catalysis

- A.** Synthesis and properties of organometallic compounds with i) carbonyl
ii) hydrocarbyl iii) Phosphines iv) nitrosyl ligands [18 L]
- B.** Fluxionality of organometallic compounds [4 L]
- C.** Organometallic compounds as electrophiles, nucleophiles, activating agents,
protecting agents, redox agents [8 L]
- D.** Organometallic compounds, Environment, Agriculture & Medicine [6 L]
- E.** Homogeneous Catalysis:
- I:** General introduction to Homogeneous catalysis, explanation of Tollman's
catalytic cycle [4 L]
- II:** Following processes should be taught with examples from each process.
i) Oxo process ii) Monsanto Process iii) Wacker Process iv) Epoxidation
v) Use of Reppe's catalysis vi) Heck reactions vii) Suzuki coupling [20 L]

Reference Books:

1. Organometallic chemistry by R. C. Mehrotra and A. Singh, 1992, Wiley Eastern Ltd.
 2. Inorganic chemistry by Butler, Harrod, 1989, Benjamin / Cummins Pub. Co.
 3. Principles of organometallic chemistry 2nd Edn. P. Powell, 1988, Chapman and Hall.
 4. Organometallic compounds –Morris sijn. IVY Publication house
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CH-330

Coordination Chemistry, magnetism & Inorganic Reaction Mechanism

Coordination Chemistry, magnetism

- A.** Recapitulation of CFT concepts [4 L]
- B.** Theories of magnetism, Exchange model [6 L]
- C.** Magnetism of monomeric & polymeric coordination compounds [10 L]

D. Study of mixed valence compounds, their magnetic behaviour [10 L]

Inorganic Reaction Mechanism

A. Types of Mechanism [2 L]

B. Substitution in square planar & octahedral complexes [4 L]

C. Electron transfer reactions of coordination compounds [4 L]

D. Inner & outer sphere reactions [5 L]

E. Photochemical reactions [5 L]

F. Oxidative addition, reductive elimination, insertion reactions [5 L]

G. Isomerisation [5 L]

Reference books:

Coordination Chemistry & Magnetism

1. Inorganic chemistry, Principle of Structure and Reactivity, 4th Edn. J. E. Huhey, E. A. Keiter, R. L. Keiter (1993), Addison Wesley Publishing Co.
2. Elements of Magnetochemistry, 2nd Edn., R. L. Datta & A. Syamal (1993) Affiliation, East-Wiley Press (p) ltd.
3. Magnetism and Transition Metal Complexes, F. E. Mabbs and D. J. Machin (1973) Chapman and Hall, London.
4. Coordination Chemistry, Bannerjee (1993), Tata McGraw Hill Publishing Co. New Delhi.
5. Physical Methods for Chemists 2nd Edn., R. S. Drago (1992).

Inorganic Reaction Mechanisms

1. Inorganic Chemistry by Shriver and Atkins. 3rd Edn (1999) Oxford University Press.
2. Mechanism of Inorganic Reactions, by Basalo & Pearson (1977), Wiley Eastern Ltd.
3. Inorganic Reaction Mechanism by M. L. Tobe (1972), Thomas Nelson & Sons.

CH-331

Structural Methods in Inorganic Chemistry

A. Resonance techniques such as NMR, ESR, Mossbauer, NQR & cyclic voltammetry [35 L]

B. Non resonance techniques such as XRD, Thermo-gravimetric analysis (TG, DTA, DSC). [15 L]

C. Introduction, Principle and applications of X-ray Photoelectron Spectroscopy, Auger Photoelectron Spectroscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), [10 L]

1. Instrumental Methods of Chemical Analysis.(1979) Chatwal-Anand-Himalaya Publishing House.
 2. Laboratory Techniques in Electroanalytical Chemistry edited by P. T. Kissinger and W. R. Heinman(1984)M Dekker vInc.(USA).
 3. Electrochemical Methods, Fundamentals and Applications by A. J. Bard and L. R. Faulkner (1980), John Wiley (NY).
 4. i) Dennis H. Evans, Journal of Chemistry, Education 60, 290(1983).
ii) P. T. Kissinger, W. R. Hienman, Journal of Chemical Education, 60, 702(1983).
iii) J. J. Van Benschoten, J. of Chemical Education, 60, 772, (1983).
 5. An introduction to Thermogravimetry by C. J. Keatlih an D. Dollimore(1975), Heydon and Sons Ltd.
 6. Thermal Method of Analysis by W. W. Wendlandt, 3rd Edn. 1986 john Wiley(NY).
 7. Thermal Method sof Analysis by P.J. Haines 1995, Blackie Academic and Proffessionals.
 8. Introduction to X-ray powder Diffractometry by R. Jenkins and R. Snyder 1996, Wiley(NY).
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CH-332

Bioinorganic Chemistry:

Inorganic Elements in the Chemistry of Life

A. Structure, functions & biochemistry of enzymes containing following metal ions:

1. Zinc [6 L]
2. Copper [6 L]
3. Nickel [6 L]
4. Manganese: photosynthesis, catalase, peroxidases [6 L]
5. Reactions of Cobalamin [6 L]

At least one model compound of each of the enzyme should be discussed in the class

B. Medicinal Inorganic Chemistry

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| 1. Chemical Nucleases | [12 L] |
| 2. Radiopharmaceuticals | [10 L] |
| 3. MRI contrast reagents | [8 L] |

Metalloproteins & Bioinorganic Medicines

1. Biological Chemistry of Elements. J. J. R. Frausto da Silva, R. J. P. Williams, Chapters 2,12,14, 15, 16, 17.
2. Principles of Bioinorganic chemistry by S. J. Lippard and J. M. Berg, (1994) University Science Books(USA)
3. Bioinorganic chemistry: inorganic elements in the chemistry of life, An Introduction And Guide by Wolfgang Kaim, Brigille Schwederski(1994) John Wiley and Sons.
4. Bioinorganic chemistry, Bestini, Gray, Lippard, Vlentine, 1st South asian Edn.(1980) Viva books pvt.ltd.
5. Comprehensive coordination chemistry Vol.VI
6. Bio-organic chemistry: a Chemical approach to enzyme action 3rd edition.

Semester – IV

CH-430

Inorganic Polymers & Heterogeneous catalysis

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| A. Inorganic Polymers | [18 L] |
| 1. Polycationic & polyanionic compounds | |
| 2. Peroxides, peroxyacids and heteropolyacids | |
| 3. Metal clusters | |
| B. Introduction to heterogeneous catalysis: | [12 L] |
| 1. Basic principles | |
| 2. Classification | |
| 3. Quantitative aspects of adsorption & catalysis | |
| 4. Types of reactors | |
| C. Zeolite and Supported Metal Catalysts | [15 L] |
| D. Nanomaterials as Catalysts: Environment, Organic, Semiconducting | [10 L] |
| E. MCM-41, Clays as catalyst | [5 L] |

Heterogeneous Catalysts and Structural Methods.

1. Encyclopedia of analytical science, Academic Press Vol.1 to 9 1995, Editor Alan Townshend

2. Studies in surface science and catalysts, Vol. 85, 1994, Elsevier science Publications, B. V. pg: 9 to 42. Vol, 137 (2000) pg: 37 to 65.
 3. Verified Synthesis of Zeolite Material, Elsevier Science Pub. (2001) pg: 19 to 100.
 4. Comprehensive Coordination Chemistry Vol. VI
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CH-431

Material Science

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| A. Diffusion in solid and its mechanism | [3 L] |
| B. Solid state reactions and crystal growth | [5 L] |
| C. Imperfection and related phenomenon in solids | [6 L] |
| D. Nanomaterials: | |
| 1. Introduction, types & properties | [4 L] |
| 2. Following nanomaterials should be covered with reference to basic aspects, properties & applications | |
| a. Electronic & optical materials | [10 L] |
| b. Magnetic materials | [8 L] |
| c. Superconducting materials | [6 L] |
| d. Ceramic materials | [6 L] |
| e. Biomaterials | [6 L] |
| f. Nanocomposites | [6 L] |

1. Introduction to Solids, I.V. Azerroff
 2. Principles of solid state, H.V. Keer
 3. Solid state chemistry, N.B. Hannay
 4. Elements of material science, Van Vleck
 5. Electronic structure & chemistry of solids, P.A. Cox
 6. Insight into speciality Inorganic Chemistry, David Thompson
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CH-445

Applications of Inorganic Chemistry in Industry, Biotechnology & Environmental Chemistry

(Any two sections from CH-445)

Section A: Applications of Inorganic Materials

1. Electrochemical Applications [9 L]
2. Dyes & pigments: Inorganic pigments, classification, properties, Azo dyes, natural dyes and their interactions with metals [10 L]
3. Composite materials: Synthesis, properties & applications [9 L]
4. Miscellaneous applications [2 L]
Two research papers related to electrochemical applications & natural dye with metal should be discussed in the class

Section B: Environmental Chemistry: Waste Water treatment & analysis

1. Introduction to waste water analysis; Specification of treated wastewater for disposal into surface water Screening chamber, Grit chamber, Oil & grease removal [6 L]
2. Wastewater engineering for biological treatment: Principle, role of micro organisms, ecosystem, designing of biological unit [12 L]
 - a. Stabilisation pond
 - b. Aerated lagoon
 - c. Activated sludge process
 - d. Trickling filters
 - e. Anaerobic treatment
3. Biotechnology & Wastewater Management: Applications of biotechnology for the treatment of a. High strength waste b. primary & secondary sludge c. phenol & cyanide removal [4 L]
4. Energy sources for future: Solar energy, energy from biomass, wind Towers, geothermal etc [4 L]
5. Inorganic metals in environment: Bioaccumulation of toxic metals Lead, mercury, calcium, arsenic [4 L]

Section C: Applications of Inorganic Chemistry in Biotechnology

1. Biotechnology: Introduction [3 L]
2. Living things & Industrial Processes [3 L]
3. Biotechnology & fuels [3 L]
4. Biotechnology & food [7 L]
5. Biotechnology & water [7 L]
6. Biotechnology & health and diseases [7 L]

1. Elements of Biotechnology by p. K. Gupta(2003), Rastogi Publications
2. Environmental chemistry by A. K. Bagio.

3. Principle of environmental chemistry by James Girard. Bartlett publishers
 4. Wastewater engineering, Calf & Eddy
 5. Wastewater treatment for pollution control, Arceivala
 6. Manual on sewage & sewage treatment, Ministry of Works, Delhi
 7. Principles of water quality control, T.H.Y. Tebbut
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Inorganic Chemistry Practical

CH-387

Experiments & computer applications in Inorganic Analysis

A: Analysis of the following samples (any ten)

- a) Ore
- b) Alloy
- c) Cement
- d) Manganese from tea leaves
- e) Vitamin C from Lemon juice (Biological fluid)
- f) fertilizer (PO_4^{3-})
- g) Analysis of Na, K & Ca using Flame photometry
- h) Soil analysis
- i) Ion exchange
- j) Copper from fungicide

B: Statistical Analysis of data obtained from the estimation of following compounds using computational methods

- a) Iron
 - b) Copper
 - c) Nickel
 - d) Cobalt
 - e) Chromium
 - f) Zinc
 - g) Manganese
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CH-388

Practical Course – II

A: Inorganic Instrumental Analysis and computer applications

1. To determine magnetic susceptibility of coordination compounds (two)
2. TGA analysis of coordination compounds (two)
3. Kinetics of aquation of a) Cobalt complex b) iron complex
4. Photochemical reaction – Metal to Ligand charge transfer
5. Table work on analysis coordination compounds using **ANY FOUR Techniques** a) IR b) ESR c) Cyclic voltammetry d) NMR e) XRD
6. Kinetics of dye degradation using CdS nanoparticles
7. Catalytic transfer hydrogenation of nitrobenzene to aniline using a catalyst
8. To study the Metal-DNA interaction spectrophotometrically

The structural analytical data should be analysed using computational methods.

B: Preparation of inorganic compounds (any ten)

- a) NiO b) Nickel ferrite c) Zinc ferrite d) trans-[Co(en)₂Cl₂]Cl
e) K₃[Cr(ox)₃] f) (NH₄)₃[Cr(ox)₃] g) [Cu(acac)₂] h) [Mn(salen)]
i) [Mn(acac)₃] j) [Cu(thiourea)₃]₂SO₄ k) Copper phthalocyanin
l) copper-1,10-phenanthroline
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CH-488

Projects/Extended Practicals in Inorganic Chemistry

A: Preparation and purity of following complexes of

1. DMG
2. 8-hydroxy quinoline
3. Salicyaloxime
4. thiourea

with **Copper, Nickel, Iron, Chromium & Manganese (any three metals)**

B: Structural determination of above complexes using following techniques

- i) UV-Visible spectroscopy ii) Magnetic susceptibility
iii) Thermogravimetric analysis iv) IR v) Solution conductivity

C: Introduction to literature survey