

**SOLAPUR UNIVERSITY,
SOLAPUR**

**M. Sc. II (Sem.-III & IV)
INORGANIC CHEMISTRY SYLLABUS
(Choice Based Credit System-CBCS-True Spirit)**

(w.e.f. June, 2017)

SOLAPUR UNIVERSITY, SOLAPUR
M. Sc. II, INORGANIC CHEMISTRY COURSE SYLLABUS
CHOICE BASED CREDIT SYSTEM (CBCS) (w.e.f. June 2017)

A two-year duration **M. Sc. Inorganic Chemistry** course syllabus has been prepared as per the CBCS semester system. M. Sc. II, SEM-III & SEM-IV Inorganic Chemistry syllabus will be implemented from June 2017. The syllabus has been prepared taking into consideration the syllabi of other Universities, SET, NET, UGC guidelines, and the specific inputs of the Expert Committee Members.

General Structure of the Course:

The course will be of four semesters spread over two academic years. Each semester will have four theory papers of 70 marks for university external examination and 30 marks for internal examination of each semester and two practical's of 70 marks, 30 marks for internal practical of each semester. The distribution of marks is mentioned below

Theory Paper (Semester exam), 16 X 70+30 marks	1600 marks
Practicals (semester end exam.), 8 X 70+30 marks	800 marks
Tutorials for each semester, 4 X 25	<u>100 marks</u>
Total: 2500 marks	

Ratio of marks (Theory: Practical): (73:27)

Semester	Paper Code	Title of the Paper	Semester exam			L	T	P	Credits	
			Theory	IA	Total					
I	Hard core									
		HCT-101	Inorganic Chemistry -I	70	30	100	4		-	4
		HCT-102	Organic Chemistry -I	70	30	100	4		-	4
		HCT-103	Physical Chemistry -I	70	30	100	4		-	4
		Soft Core (Any one)								
		SCT-104A	Analytical Chemistry -I	70	30	100	4		0	4
		SCT-104B	Chemistry in Life Sciences	70	30	100	4		0	
		Practicals								
		HCP-I	Inorganic Chemistry	35	15	50	-	-	2	6
		HCP-I	Organic Chemistry	35	15	50	-	-	2	
		HCP-II	Physical Chemistry	35	15	50	-	-	2	
		Soft core (Any one)								
		SCP-IIA	Analytical Chemistry	35	15	50	-	-	2	2
		SCP-IIB	Analytical Chemistry	35	15	50	-	-	2	
	T-1	Tutorial					25		1	
		Total for 1st semester	420	180	600		25		25	
II	Hard core									
		HCT-201	Inorganic Chemistry -II	70	30	100	4		-	4
		HCT-202	Organic Chemistry -II	70	30	100	4		-	4
		Soft core (Any one)								
		SCT-203A	Physical Chemistry -II	70	30	100	4		-	4
		SCT-203B	Green Chemistry	70	30	100	4		-	
		Open elective (Any one)								
		OET-204A	Instrumental Methods of Analysis	70	30	100	4		-	4
		OET-204B	Medicinal Chemistry -I	70	30	100	4		-	

		Practicals							
	HCP III	Inorganic Chemistry	35	15	50	-	-	2	4
	HCP III	Organic Chemistry	35	15	50	-	-	2	
		Soft core (Any one)							
	SCP IVA	Physical Chemistry	35	15	50	-	-	2	2
	SCP IVB	Physical Chemistry	35	15	50	-	-	2	
		Open elective (Any one)							
	OEP IVC	Analytical Chemistry	35	15	50	-	-	2	2
	OEP IVD	Medicinal Chemistry	35	15	50	-	-	2	
	T-2	Tutorial						25	1
		Total for 2nd semester	420	180	600			25	25

III		Hard core								
	HCT-301	Inorganic Chemical Spectroscopy	70	30	100	4	--	-	4	
	HCT-302	Co-ordination Chemistry- I	70	30	100	4		-	4	
		Soft core (Any one)								
	SCT-303 A	Nuclear Chemistry	70	30	100	4		-	4	
	SCT- 303 B	Separation Science	70	30	100	4		-		
		Open elective (Any one)								
	OET- 304 A	Environmental Chemistry	70	30	100	4		-	4	
	OET- 304 B	Organometallic Chemistry	70	30	100	4		-		
		Practicals								
	HCP –V	Practical HCP	70	30	100	-		-	4	4
	SCP –VI A	Practical SCP	35	15	50	-	-	2	2	
		Open elective (Any one)								
	SCP –VI B	Practical SCP	35	15	50	-	-	2	2	
	OEP- VI C	Practical OEP	35	15	50	-	-	2		
	T-3	Tutorial						25	1	
		Total for 3rd semester	420	180	600			25	25	
IV		Hard core								
	HCT-401	Instrumental Techniques	70	30	100	4	--	-	4	
	HCT-402	Co-ordination Chemistry-II	70	30	100	4		-	4	
	HCT-403	Chemistry of Inorganic Materials	70	30	100	4		-	4	
		Soft Core (Any one)								
	SCT-404A	Applied Inorganic Chemistry	70	30	100	4		-	4	
	SCT-404B	Bioinorganic Chemistry	70	30	100	4		-		
		Practicals								
	HCP –VII	Practical HCP	70	30	100	-		-	4	4
	HCMP-VIII	Major Project/In plant training /Literature Review	70	30	100	-		-	4	4
	T-4	Tutorial							25	1
		Total for 4th semester	420	180	600			25	25	
		Total			2500				100	

L = Lecture T = Tutorials P = Practical
4 Credits of Theory = 4 Hours of teaching per week
2 Credit of Practical = 4 hours per week
HCT = Hard core theory,
SCT = Soft core theory,
HCP = Hard core practical
SCP = Soft core practical,
OET = Open elective theory,
OEP = Open elective practical,
HCMP = Hard core main project

Nature of Examination:

Each semester will have theory external examination of four papers of 70 marks each (2.5 hrs. duration). The practical examination of Semesters I to IV will be conducted at the end of the each Semester. Duly certified copy of laboratory record must be produced at the time of examination.

Practical Examination of M. Sc. II

The practical examination will be of 3 days for each semester.

Practical experiments:	60
Oral	05
Journal:	05

Project work / In-plant training Report:

60**+10 marks for presentation

** The valuation of project/ In plant training report to be done by both external and internal examiners at the time of examination. Valuation of Tutorials is to be done in each semester by the teaching faculty involved in organic chemistry course.

Nature of question paper (M. Sc. II):

Time: 2.5 hours

Maxi Marks 70

Instructions

1. Attempt 05 questions.
2. Section I (question 1) is compulsory
3. Attempt any two questions from section II and any two questions from section III.
4. Answers to all 05 questions (from section I, II, III) should be written in the one and the same answer book.
5. All questions carry equal marks.
6. Figures to the right indicate full marks.
7. Use of log tables and calculators is allowed.

Question Paper
Section I

Q 1. Answer the following (14 sub-questions) Marks 14 (1 x 14)
Multiple choice / fill in the blanks / define the term / True-False, predict the product, provide the reagent and conditions etc.

Sub-questions (i) to (xiv)

Section II

Q 2. a) ---- ----- Marks 07
b) ----- Marks 07

Q 3. a) ---- ----- Marks 07
b) ----- Marks 07

Q 4. a) ---- ----- Marks 07
b) ----- Marks 07

Section III

Q 5. a) ---- ----- Marks 05
b) ----- Marks 05
c) ----- Marks 04

Q 6. a) ---- ----- Marks 05
b) ----- Marks 05
c) ----- Marks 04

Q 7. Write short notes on (any three) Marks 14
a) -----
b) -----
c) -----
d) -----

N.B. In sections II and III, the sub-questions (a, b, and c) in a given question should be from different topics of the syllabus.

At least 25 % questions should be problem oriented, where-ever possible, in view to train students for the SET/NET/GATE and other competitive examinations. These questions should test the understanding of candidate rather than the memory. The question paper should cover all the Units included in the syllabus of the respective paper and the weightage of the questions should correspond to the number of lectures allotted to the respective Units / Topics.

M. Sc. Part II (Inorganic Chemistry)

SEMESTER-III

Paper Code-HCT-301: Inorganic Chemical Spectroscopy

[60 Lectures]

[4 credits]

Unit-I

Group Theory

[15]

Molecular symmetry, elements of symmetry and symmetry operations, Products of operation, point group, classification of Molecules into point group, reducible and irreducible representation, the great Orthogonality theorem, character table, symmetry aspects of Molecular orbitals.

Unit-II

Electronic absorption Spectroscopy

[15]

Term symbols, energies of atomic and Molecular transitions, Selection rule, Morse potential energy diagram, electronic transitions, polarized absorption spectra. Nature of absorption spectra, nature of absorption spectra of transition metal complexes, Orgel diagram, Tanabe Sugano diagram and charge transfer spectra.

Unit-III

[15]

A] Infrared and Raman Spectroscopy

[9]

Molecular vibrations, force constants, Molecular vibrations and absorption of Infrared radiations Raman Spectroscopy, polarized Raman lines, Use of symmetry considerations to determine the no. of lines in IR and Raman Spectra, Spectra of gases, applications of Raman and Infrared spectroscopy. Selection rule in Inorganic structure determinations, Hydrogen bonding and infrared spectra, metal ligand and related vibrations.

B] Microwave spectroscopy

[6]

Basic concept, rotation spectra of simple inorganic compounds, Classification of molecules, rigid rotor model, effect of isotopic substitution on transition frequencies & intensities non rigid rotor, stark effect nuclear and electron spin interaction and effect of external field. Applications of Micro wave Spectroscopy.

Unit-IV

[15]

A] Nuclear Magnetic Resonance Spectroscopy

[8]

Principle Instrumentation of NMR, the chemical shift, mechanism of electron shielding and factors contributing to the magnitude of chemical shift. Local & remote effect, spin-spin splitting, applications of spin coupling to structural determination, double Resonance techniques. The contact and Pseudo contact shifts Factors affecting nuclear relaxation, an overview of NMR of metal nuclear with emphasis on ^{195}Pt & ^{119}Sn NMR.

Introduction, principle, Instrumentation and applications of following techniques photo acoustic Spectroscopy (PAS) photo electron Spectroscopy (PES), auger electron Spectroscopy (AES)

Reference books:

1. K. Burger, Coordination Chemistry-experimental methods, Butterworth's
2. R. Drago: Physical method in Inorganic Chemistry, DUSAP.
3. Hill & Day advanced methods in Inorganic Chemistry, J.Weily
4. F.A. Cotton, chemical application of group theory, Wiley eastern
5. Figgis, Introduction to ligand field theory field
6. Schaefer & Gilman: Basic principles of ligand field Theory, J. Wiley
7. P.R. Backer: Molecular symmetry and Spectroscopy A.P.
8. Ferraro Ziomek, Introduction to Group theory, plenum
9. Soctland Molecular symmetry DVN
10. Dorian: symmetry in Chemistry EWAP
11. Hall: Group theory and symmetry in Chemistry MGLt
12. Nakamoto Infrared R Raman Spectra of Inorganic & Coordination compounds J.Weily
13. Nakanisha: Spectroscopy and structure J. Wiley
14. Ferrero: Metal ligand and related vibrations
15. CNR Rao Spectroscopy in Inorganic Chemistry Vol I,II,III
16. Durie: vibrations spectra and structure Vol. I to IV, Elsevier
17. Dudd, chemical Spectroscopy Elsevier
18. Popel : H.N.M.R. Spectroscopy J.Weily
19. R.J. Abraham, J. Fisher and P Loftus Wiley Introduction to NMR spectroscopy.
20. P.K. Bhattacharya: Group Theory & Its Chemical Applications
21. K.V. Reddy: Symmetry & spectroscopy of Molecules.

Paper Code-HCT-302: COORDINATION CHEMISTRY – I

[60 Lectures]

[4 credits]

UNIT-I

Theories of Metal-Ligand bonding [15]

Molecular Orbital treatment, Octahedral (with and without pi bonding) tetrahedral and square planer complexes in a qualitative manner, comparison of theories of bonding, VBT, CFT, LFT and MOT.

UNIT-II

Structural studies of coordination compounds [15]

Compounds of first transition series elements, with respect to their electronic spectra, magnetic & thermal properties (DTA, TGA).

UNIT-III

Magneto Chemistry [15]

Diamagnetic correction, single & multielectron system, types of the magnetic behaviour, Diamagnetism, Para magnetism, Ferro & Ferri, Anti ferro and magnetic interaction, The origin of Para magnetism, Magnetic behavior of complexes, Simplification of Van Velck equation, magnitude of magnetic moments, Determination of magnetic susceptibility by Gouy and faraday method.

UNIT-IV [15]

A] Transition metal complexes & catalysis [8]

Introduction, General Principle, catalysis by transition metal complexes, Hydrocarbons Oxidation by Molecular oxygen, olefin Oxidation, olefin polymerization, olefin hydrogenation, Arene reactions catalyzed by metal complexes, catalysis of condensation polymerization reaction, Current and feature trend in catalysis.

B] Mixed Ligand complexes [7]

Stabilities of ternary complexes, Dynamics of formation of ternary complexes reaction of Coordination ligand in ternary complexes, Mimicking reactions in biological systems, enzyme models, Amino acids ester hydrolysis, peptide synthesis & hydrolysis, Detarbodylation of B keto acids

Reference Books:

1. Jones: Elementary Coordination Chemistry. J. Wiley
2. Graddon: Introduction to Coordination Chemistry. J. Wiley
3. Drago: Physical methods of Inorganic Chemistry. J. Wiley.
4. Graddon: Introduction to coordination Chemistry, Parasmom
5. Lewis and Wilkins: Coordination Chemistry. J. Wiley
6. Msrtel: Coordination Chemistry Vol I, II VNR
7. Earnshaw: Introduction to Magneto Chemistry
8. Mabbs & Machin Magnetism & transition metal complexes Chamman hall
9. Calvin, Magnetic properties of transition metal complexes.
10. L.N. Maley: Magneto Chemistry
11. Datta & Shymlal Elements of Magneto Chemistry
12. Martel & Taqui Khan: homogeneous catalysis with metal complexes Vol.I & II AP.
13. James E. Huheey: Inorganic Chemistry Principles of Structure and reactivity, Harber & Row, Publishers Inc. New York 1972.
14. K.P. Purcell & J.C. Kote: An Introduction to Inorganic Chemistry Holt Sounders, Japan 1980.
15. William L. Jolly: Modern Inorganic Chemistry, Mecgrow Hill USA, 1984
16. F.A. Cotton & R.G. Willkinson: Advanced Inorganic Chemistry.

Paper Code SCT-303 A: NUCLEAR CHEMISTRY

[60 Lectures]

[4 credits]

UNIT-I

Nuclear Structure and Stability [15]

Binding energy, empirical mass equation, The nuclear models, the liquid drop model, the shell model, the Fermi gas model & collective nuclear model, nuclear spin parity & magnetic moments of odd mass numbers nuclei.

UNIT-II [15]

A] Nuclear reaction [8]

Introduction, Production of projectiles, nuclear cross section, nuclear dynamics, threshold energy of nuclear reaction, Coulomb scattering, potential barrier, potential well, formation of a compound nucleus, Nuclear reactions, direct Nuclear reactions, heavy ion induced nuclear reactions, photonuclear reactions.

B] Nuclear fission [7]

Liquid drop model of fission, fission barrier and threshold, fission cross section, mass energy and charge distribution of fission products, symmetric and Asymmetric fission, decay chains and delayed neutrons.

UNIT-III [15]

A] Reactor Theory - [10]

Nuclear fission as a source of energy, Nuclear chain reacting systems, critical size of a reaction, research reactors, graphite moderated, heterogeneous, enriched uranium reactors, light water moderated, heterogeneous, enriched uranium reactors, water boilers enriched aq. Homogeneous reactors, Thermonuclear reactors, gamma interactions, shielding and health protection. Reactors in India.

B] Nuclear Resources in India [5]

Uranium and Thorium resources in India and their extractions, Heavy water manufacturing in India.

UNIT-IV

Elements of Radiation Chemistry [15]

Radiation Chemistry, Interaction of radiation with matter, Passage of neutrons through matter, Interaction of gamma radiation with matter, Units for measuring radiation absorption, Radiolysis of water, Free radicals in water radiolysis, Radiolysis of some aqueous solutions

Reference Books:

1. Friedlander, Kennedy and Miller, Nuclear and Radio Chemistry: John Wiley
2. B.G. Harvey, Nuclear Chemistry
3. Hassinsky: Translated by D.G. Tuck, Nuclear Chemistry and its application: Addison Wiley
4. B.G. Harvey, Introduction to Nuclear Physics and Chemistry
5. Maeclefort: Nuclear Chemistry: D.Van Nostrand
6. An N.Nesmeyannoy: Radiochemistry: Mir
7. Jacobs et al: Basic Principles of nuclear Science and Reactors, V.Nost & EWAP
8. N.Jay: Nuclear Power Today Tomorrow: ELBS
9. Kenneth: Nuclear Power Today, Tomorrow: ELBS
10. Essentials of Nuclear Chemistry, H.J. Arnikar, John Wiley
11. Nuclear and Radiation Chemistry: B.K. Sharma, Krishna Publication
12. A Introduction to Nuclear Physics: R. Babber. And Puri

Paper Code SCT-303 B: Separation Science

[60 Lectures]

[4 credits]

UNIT-I [15]

Solvent Extraction Separation

Principles of solvent extraction, formation of metal complexes, distribution of extractable species, quantitative treatment of extractable equilibria, Methods of extraction, techniques in extraction, application of diketone, hydroxyquinoline, oximes, dithiocarbamates, xanthenes, thiols, macrocyclic polyethylenes and organo phosphorous compounds in solvent extraction. Separation of nonmetals and metals.

UNIT-II [15]

Chromatographic separation techniques

Extraction chromatography, theoretical aspects of extraction chromatography, correlation between solvent extraction and extraction chromatography, techniques in extraction chromatography, chromatographic inert support, stationary phases, use of extraction chromatography for separation of fission products.

UNIT-III [15]

Ion exchange separation

Fundamental properties of ion exchangers, theories of ion exchange, exchange capacity, screening effect, penetration of electrolytes into the ion exchange resins, sorption of complex ions, ion exchanges equilibrium, column operation, theory of break through curves, elution steps, use of non aqueous solvents in ion exchange separation, application of ion exchange separation in determination of total salt concentration, removal of interfering ions, separation of anions and metals.

UNIT-IV [15]

A] Separation by electrolysis [8]

Basic principles, over potentials, electrogravimetry, constant current electrolysis, separation with controlled electrode potentials, constant voltage electrolysis, potential buffers, and physical characteristics of metal deposits, internal electrolysis, electrography, electrophoresis, and electrochromatography.

B] Gas Chromatography [7]

Principles of gas chromatography, plate theory of gas chromatography, Instrumentation for gas chromatography, working gas chromatography, application of gas chromatography, programmed temperature chromatography, flow programming chromatography, gas-solid chromatography, and hyphenated techniques in chromatography Problems.

Recommended Books:

1. Solvent extraction in analytical A chemistry by G.H. Morrison, F. Frieiser, John Wiley & Sons, NY.
2. Ion exchange and solvent extraction of metal compounds by Y. Macros, A.S.Kertes, Wiley, Interscience.
3. Solvent extraction Chemistry, Selkine and alegagawa.
4. O.Samuelson, Ion exchange separation in Analytical Chemistry, J.Wiley & Sons.
5. A.I.Vogel, A Text Book of quantitative Inorganic Analysis, Longmann Green.
6. D.A. Skoog & D.M. West, Fundamentals of Analytical Chemistry - Holy Rinchart.
7. G.W. Ewing, Instrumentation Methods of Chemical Analysis, McGraw Hills.
8. S.M. Khopkar, Basic Concepts of Analytical Chemistry.
9. D. Ambrose and B.A. Amborse, As chromatography.

Paper code OET- 304 A: ENVIRONMENTAL CHEMISTRY

[60 Lectures]

[4 credits]

UNIT-I [15]

A] Air Pollution [8]

Sources and sinks of gases pollutants, classification & effects of air pollutants on living and nonliving things, Air pollution problems in India, pollution problems in industrial area, global air pollution problems, green house effect, acid rain, ozone depletion and their consequences on Environment. Major air pollution disasters.

B] Water pollution [7]

Types, sources and classification of water pollutants, Industrial water pollution, constituents of aquatic Environment, oxygen contents of water and aquatic life, oxygen electrode, and its use, mercury pollution and estimation of organomercurials, industrial water, Effects of water pollutants on life and Environment.

UNIT-II [15]

A] Method of control of air pollution

[8]

Method of control of air pollution, electrostatic precipitation wet & dries scrubber, filters, gravity and cyclonic separation, Adsorption, absorption and condensation of gaseous effluent

B] Method of control of water pollution [7]

Water and waste water treatment, aerobic and anaerobic, aeration of water, principle of coagulation, flocculation, softening, disinfection, demineralization and fluoridation.

UNIT-III [15]

Sampling & analysis of air and water pollutants.

a) Methods of sampling gaseous, liquid and solid pollutants, analysis of CO, CO₂, NO₂, SO₂, H₂S, CO₂, analysis of toxic heavy metals, Cd, Cr, As, Pb, Cu, Separation of Co, Cu, Mg, Mn, Fe, analysis of SO₄²⁻, PO₄³⁻, NO₃⁻, NO₂⁻ analysis of total cationic and anionic burdens of water.

b) Pesticide, residue analysis soil pollution, Sources of pesticides residue in the Environment, pesticides degradation by natural forces, effect of pesticide residue on life, Analytical techniques for pesticides residue analysis.

UNIT-IV [15]

A] Radiation pollution-classification & effects of radiation, effects of ionizing radiation on man, Effects of non ionizing radiation on life, radioactivity and Nuclear fallout, protection and control from radiation.

B] Environmental toxicology

Chemical solutions to environmental problems biodegradability, principles of decomposition better industrial processes, Bhopal gas tragedy, Chernobyl, three mile island, sewozo and minamata disasters.

Reference Books:

1. Environmental Pollution, A.K. De
2. Air Pollution, Wark & Werner
3. Environmental Pollution Control in Process Industries, S.P. Mahajan
4. Environmental Pollution, B.K. Sharma & H.Kaur
5. Introduction to Air Pollution, P.K. Trivedi
6. Environmental Pollution Analysis, S.M. Khopkar
7. A Text Book of Environmental Pollution: D.D. Tyagi, M. Mehre
8. Environmental Pollution Engineering and Control, C.S. Rao
9. Chemical in the Environment, Satake & M. Midu
10. Environmental Sciences, E.G. Engel
11. Environmental Chemistry, B.K. Sharma & H.Kaur

Paper code OET- 304 B: Organometallic Chemistry

[60 Lectures] [4 credits]

UNIT-I [15]

A] Methyl derivatives of metals [8]

Structures, bonding, classification of methyl derivatives of metals, cleavage of metal carbon bonds, thermochemical consideration.

B] Catalytic processes: [7]

Carbonylation, hydrogenation, isomerisation of olefins, olefin oxidation, oligomerization, polymerization.

UNIT-II [15]

Organometallic synthesis

Radicals + metals, carbonyls, olefins complexes, addition of metal hydrides to unsaturated carbons, addition of metal alkyls to unsaturated hydrocarbons, substitution reactions, Hydrocarbons + metal Organometallic + metal, metallation, metal halogen exchange reactions, Mercuration & related covalent metallation reactions of Organometallic compounds with metal salts, reactions of bimetallic compounds and halides, ligand exchange reactions of diazoalkanes with metal hydrides and halides, addition of M-OR to C=c, electrolyte reduction using metal cathode, decarboxylation.

UNIT-III [15]

A] Properties of reactions of Organometallic compounds [8]

Complex formation, reactions with active oxygen compounds, reactions with halogen, reactions with alkyl halides, acid halides, reactions with oxygen, carbonyls and others.

B] Metal carbonyls, isocyanides and acetylides. [7]

Preparation, structure, reactions of metal carbonyls with alkyl halides, reactions of metal carbonyls with metal alkyls, cyanides and isocyanides complexes, acetylide complex adduct formation. Complexes: 2,3,4,5,6 and 7 electron donor carbametallic compounds, aromaticity of cyclopentadienyls.

UNIT-IV

Techniques of Organometallic Chemistry [15]

Methods of synthetic chemistry, vacuum techniques, inert atmosphere, nonaqueous media, handling and hazards of organometallic.

Reference Books:

1. Paulson, Organometallic Chemistry -Arnold.
2. Rochow, Organometallic Chemistry - Reinhold.
3. Zeiss, Organometallic Chemistry - Reinhold.
4. Advances in Organometallic Chemistry A.P.

**M.Sc. II Practical Courses SEM - III,
Inorganic Chemistry Course - HCP- V to OEP- VI C
[120 Lectures] [8 credits]**

1. Ore Analysis - 3
2. Alloy Analysis - 3
3. Preparation of coordination complexes
4. Ion exchange study of separation of mixtures & estimations
5. Spectrophotometry
6. Separation & estimation of ions using ion exchange chromatography
7. Nephelometry
8. Potentiometry
9. Conductometry
10. Thermal analysis
11. Magnetic properties of transition metal complexes
12. Spectro Fluorimetry
13. Solvent extraction
14. Nuclear chemistry
15. Soil analysis
16. Data analysis

SEMESTER-- IV
Paper Code HCT – 401: Instrumental Techniques

UNIT-I **[15]**

X-ray & neutron diffraction

- a) Fundamentals of x-ray diffraction Theory of x-ray diffraction, diffraction of x-rays by crystals, determination of crystal structure (powder as well as single crystals), Instrumentation, determination of lattice parameters, x-ray intensity calculations and application of x-rays
- b) Introduction to neutron diffraction, theory, Instrumentation and application.

UNIT-II **[15]**

Thermal method of analysis

Thermogravimetry [TG], differential thermal analysis [DTA], differential Scanning calorimetry [DSC], Thermo mechanical analysis [TMA] Instrumentation and application, thermometric titrations.

UNIT-III **[15]**

Mossbauer Spectroscopy

Introduction to Mossbauer effect, recoilless emission & absorption of x-rays, Instrumentation, isomer shift, Quadrupole splitting and hyperfine interactions, application of Mossbauer effect to the investigations of compounds of iron and tin .

UNIT-IV **[15]**

A) Electron spin Resonance [ESR] **[8]**

Principles of ESR, hyperfine splitting in simple systems, Instrumentation, factors affecting G values, applications to inorganic complexes.

B) Nuclear Quadra pole Resonance Spectroscopy [NQR] **[7]**

Introduction, effects of magnetic field on the spectra, relation between electric field gradient and structure, application of NQR.

Recommended Books:

1. Elements of x-ray diffraction, B.D. Cullity, Addison Wisley, 1967.
2. Diffraction Method, Wormald, Oxford University, Press, 1973
3. Standard Method of Chemical Analysis IIIA6th end.
4. Neutron Scattering in Chemistry, Baun, G.E. Butleworth, London, 1971.
5. Mossbauer Spectroscopy, Greenwood N.N., Gibbs T.C., Chapman Hall, 1971.
6. Chemical Application of Mossbauer Spectroscopy, Goldanski V.I & Harber R.H., Academic Press 1968.
7. Spectroscopy in Inorganic Compounds CNR Rao & Ferraro G.R., Academic Press, 1970.
8. Basic Principles of Spectroscopy Cheney R. Mac Grows Hill, 1971.
9. Thermal Method, Wendlandt, W.W. John, Wiley, 1986.

10. Principles of Instrumental analysis, Skoog, III rd edn., Saunders, 1985/

Paper Code HCT –402 : CO-ORDINATION CHEMISTRY-II

UNIT-I [15]

A] Classification of Inorganic reactions, reaction intermediates, order of a reaction and reaction mechanism techniques to follow rate of reactions, liability of complexes and crystal field interpretation.

B] Substitution reaction, reactions of transition metal complexes, kinetics and mechanism of substitution reactions of octahedral complexes, acid hydrolysis, base hydrolysis, kinetics and mechanism of substitution reaction.

UNIT-II [15]

A] Stereo chemical aspects of substitution reaction of Octahedral Complexes,

Stereochemical changes in dissociation (SN2) and displacement (SN2) mechanism through various geometries of coordination compounds. Isomerization and racemisation reactions in octahedral complexes.

B] Substitution reaction of labile transition metal complexes

General discussion of some of the metal complexes, the effect of other bonded liquids on rate, reaction in nonaqueous solvents.

C] Mechanism of atom and electron transfer reactions: Key ideas concerning electron transfer, outer sphere electron transfer and inner sphere electron transfer two electron transfer, $[\text{Co}(\text{CN})_5]_3$ A redox & catalytic reagent.

UNIT-III [15]

Photochemistry: Photochemistry of Coordination compounds, electronically excited states of metal complexes, types of photochemical reactions, substitution reactions, rearrangement reactions, redox reaction, and photochemistry of metallocene.

UNIT-IV [15]

Optical rotation and circular dichroism (CD) curves, their use in Coordination Chemistry, principles, optically active molecules, optically rotatory dispersion, circular dichroism, fundamentals, relationship between optically rotator dispersion (ORD) and circular dichroism (CD) curves.

Recommended Books:

1. F. Basolo & R. Pearson: Mechanism of Inorganic Reactions: A Study of Metal Complexes in Solution.
2. Obe, M.L. Inorganic reaction mechanism, Nelson, London, 1972.
3. Taube, electron transfer reactions of metal complex ions in solution. Academic Press, 1970.
4. K.F. Purcell & J.C. Kotz, An Introduction to Inorganic Chemistry, Holt Sounder, Japan.
5. V. Balzani & V. Cavassiti, Photochemistry of Coordination compounds, AP, London, 1970.
6. K. Burger, Coordination Chemistry Experimental Methods, Butterworth's

7. K.K. Rastogi & Mukharjee, Fundamentals of photochemistry, Wiley eastern
8. J.G. Calverts & J.N. Pitts, Photochemicals of Photochemistry, John Wiley
9. Wells, Introduction to Photochemistry.

Paper Code HCT- 403: Chemistry of Inorganic Materials

UNIT-I **[15]**

A] Lattice Defects **[8]**

Introduction to types of Solids, Perfect & imperfect crystals, point defects, Line defect and plane defect defect (definition & explanation of meaning) order & disorder phenomena, thermodynamics of Schottky & Frenkel defect formation, Determination of defect, Nonstoichiometric defect (structural and thermodynamic aspects) incorporation of stoichiometric excess of defects, thermodynamics of Nonstoichiometric phases.

B] Synthesis of Inorganic materials **[7]**

Synthesis of solid state materials using different techniques ceramic techniques, co precipitation techniques, sol gel techniques, precursor techniques, high temperature & high pressure synthesis.

UNIT-II **[15]**

A] Ionic Conductors

Types of ionic conductors, mechanism of ionic conduction, interstitial jumps, vacancy mechanism, diffusion, super ionic conductors, phase transition & mechanism of conduction in super ionic conductors, examples and applications of ionic conductors.

B] Electronic properties of materials

a) Organic semiconductors, examples, properties and application b) Superconductivity, superconductivity in metals, alloys and ceramics materials (mixed oxides) BCS theory, Meissner effect, type I & II superconductors, application Fullerenes as superconductors. c) Dielectric polarization: piezoelectricity and Ferroelectricity. d) Lasers and Masers actions, laser production and application.

UNIT-III **[15]**

A] Magnetic properties of Materials

Introduction, Magnetization, Electron spin and magnetic moment, Theory of diamagnetism, Langevin's theory & paramagnetic susceptibility of solids, ferromagnetism, Domain theory. Hysteresis in magnetism, ferrimagnetism (ferries) Applications of magnetic materials.

B] Magnetic Materials

I] Structure and Properties of i) Metal and Alloys ii) Transition metal Oxides iii) Spinel iv) Ilmenite v) Perovskite and vi) Magneto-plumbite. II] Hard and Soft magnetic materials ,

hysteresis loop and their application in transformer cores, magnetic bubble memory devices for information storage and permanent magnets III] Spin glasses: Formation and characteristics.

UNIT-IV [15]

A] Advanced Inorganic Materials [8]

Nanotechnology and its business applications, Introduction to nanoscale, Potential applications of nanomaterials, Challenges and opportunities scope of nanotechnology, Commercialization scope Nanotechnology research in 21st century, Basic nanotechnology science and chemistry concepts, basic

nanostructures, nanocomposites, Thin films, nanofoam, nanoclusters, smart nanostructures, manufacturing techniques of nanomaterials.

B] Glass, ceramics, Refractory materials [7]

Glassy states, Glass formers and glass modifiers, applications, ceramic structures, mechanical properties, clay products, refractory characterization, properties.

Reference Books:

1. Solid State Chemistry: A.H. Hanny
2. C.N.R. Rao, Solid State Chemistry: Dekker
3. Wilcox: Preparation and Properties of Solid State Materials: Vol I & II, Dekker
4. Hagenmuller, Preparative Methods in Solis State Chemistry
5. Lohn Wulff, The Structure and Properties of Materials Vol. IV, Electronic Properties (Wily Eastern)
6. N.N. Greenwood: Ionic Crystals, Lattice Defects and Nonstiochiometry (Butterworth's)
7. L.V. Azoroo and J.J. Brophy: Electronic Processes in Materials, MacGraw Hills.
8. T.J. Rey et al : The Defect Solid State (Interscience)
9. E.A. Kroger, Chemistry of Imprefect Crystals (Holland)
10. A.R. West, Solid State Chemistry
11. H.V.K Keer, Principles of the Solid State Chemistry, Wiley Eastern.
12. S.O. Pillai Academic press: Solid state physics

Paper Code SCT- 404 A: Applied Inorganic Chemistry

UNIT-I

[15]

a) **Catalysis:** Basic principles, thermodynamics and kinetic aspects, industrial requirements, classification, theories of catalysis, homogeneous & heterogeneous catalysis, reaction catalyzed by transition metal complexes

b) **Organometallic compounds:** Classification of Organometallic compounds based on the nature of metalcarbon bond, bonding in pi-metal complexes, Aromatic character of Ferrocene, Reaction of ferrocene, Inert gas rule.

c) **Zeolites:** synthesis of different zeolites, characterization, determination of surface acidity, shape, selectivity and application.

UNIT-II

Inorganic Polymers

[15]

General properties of Inorganic polymers, Types of inorganic polymers, Phosphorus based network polymers, Sulphur –based polymers, Boron- based polymers, Silicon- based polymers, Natural Co-ordination polymers, Chain coordination polymers.

UNIT-III

[15]

Non conventional sources of energy

a) Alternate source of energy

Solar sources: Photochemical methods, thermodynamic efficiency of energy conversion, energy from solar radiations, transition metal complexes for energy production, solar hydrogen system, photochemical processes at semiconductors electrodes, photo galvanic & Photovoltaic cells based on Inorganic photochemical systems.

b) Geothermal energy

c) Energy from biogas

d) Tidal wind sources

e) Energy from fission and fusion reactions.

UNIT-IV

[15]

Introduction to Nano-materials

Definition and types of nano-materials, Importance of nano-materials, Size dependent properties, various techniques for making nano-materials Applications of nano-materials

Recommended Books:

1. Introduction to Solids- L.V. Azaroff (Tata McGraw Hill)
2. Principles of Materials Science and Engineering- Willams F. Smith (Wiley, 1991)
3. Heterogeneous catalysis 2nd edn., Bond C. Chapman all (1987)
4. The application & Chemistry of catalysis by suitable transition metal complexes Parashall. W. Weily N. 1980.
5. Homo. transition metal catalysis, A general art, Masters C. Chapman and Hall, London 1981.
6. Introduction to the principles of heterogeneous catalysis, Thomas J.M., Thomas W.J. Academic press N.Y. 1967
7. Inorganic polymers: Mark J.F., Allock H.R. West, Prentice hall
8. Inorganic polymers: Ring N.H., Academic Press N.Y. 1978
9. The Inorganic heterocyclic chemistry of sulphur, nitrogen, phosphorous, Heal A.G. Aca, Press N.Y. 1980.
10. Solar energy Principles of thermal collections and storage, Sukhatme S.P., Tata Macgrow Hill New Delhi 1984.
11. Fuel Cells, Bockeris JOM, Srinivasan S. and Mac grow Hills 1969
12. Solar Energy Rai C.D.
13. Energy Resources, Simon A.L. 1975
14. Direct Energy Conversion, Addison Wesley, 1970, All M and Kottani S.
15. Outlines in Chemical Technology Vol I, S.D. Sukla & Pandey G.N.

Paper code SCT- 404 B : Bioinorganic Chemistry

UNIT-I

Metals in Life Processes **[15]**

Na-K-charge carriers & osmotic pressure, relation to sensitivity of nerves and control on muscles, Mg-Ca complexes with nucleic acid, nerve impulse transmission, trigger reaction, Mn, Fe, Co, Cu, Mo, ferridoxins, Zn-super acid catalysis.

UNIT-II

A] Oxygen Carrier Systems **[8]**

Structure and mechanism of hemoglobin, vitamin B₁₂, B₁₂ co-enzyme myoglobin, synthesis of oxygen carriers.

B] Photosynthesis **[7]**

Complexes of porphyrins porphyrins ring complexes, redox mechanism.

UNIT-III

A] Nitrogen Fixation **[8]**

Nitrogen in biosphere, nitrogen cycle, nitrification role of microorganisms, nitrogen fixation in soils

B] Metal poisoning and drug action of Inorganic complexes compounds **[7]**

Metal poisoning, treatment by using chelating agent, mercury, lead & cadmium poisoning & treatment. Platinum complexes in treatment of cancer, metal deficiency and use of metal chelates.

UNIT-IV

A] Trace Metals in Plant Life **[8]**

Micronutrients in soil, role of micronutrients in plant life

B] Biogeochemistry **[7]**

Biodegradation of minerals bacteria leaching and its applications.

Recommended Books:

1. Eichhorn: Inorganic Biochemistry : Vol I , 2 Elsevier
2. Ochiai: Bioinorganic Chemistry: Allyn & Bacon Burton
3. Williams: an Introduction to Bioinorganic Chemistry, C.C. Thomos Spring III
4. Wallace: Decade on synthetic chelating agent in Inorganic plant nutrition, Wallace
5. Williams: Metals in Life
6. Zagic: Microbial Biogeochemistry, Academic press
7. Ahuja: Chemical Analysis of the Environment, Plenum press

**M.Sc. II Practical Courses SEM - IV,
HCP- VII to HCMP – VIII****

[120 Lectures] [8 credits]

1. Ore analysis (Three)
 2. Preparation of coordination compounds (Three) and preparations of mixed metal oxides (two)
 3. Ion exchange chromatography; separation of multicomponent mixtures
 4. Solvent extraction
 5. Spectrophotometry
 6. PH Metry
 7. Conductometry
 8. Polarography
 9. Electrogravimetry
 10. Nuclear and radiochemistry
- B) Interpretation exercises
1. X-ray powder diffraction analysis of cubic compound
 - a. Determination of lattice constants and geometry
 - b. Partical Size
 - c. Density
 2. Interpretation of Mossbaur spectrum with reference to determination of a) isomer shift b) quadruple splitting c) Internal magnetic field d) general comment
 3. Interpretation of IR spectrum with reference to stretching vibration 0-2 C=N, C=O, N-, M-O
 4. Interpretation of NMR spectrum with reference to calculation of chemical shifts and general comments.
 5. Interpretation of absorption spectra for
 - a. Verification of position of ligands in spectrochemical series.
 - b. Determination of gemetry (Octahedral, square planer, tetrahedral) of a given compound.
 - c. Calculation of spectral splitting parameters.
 6. Interpretation of polar gram for determination of half wave potentials and unknown concentration.
 7. Calculation of band gap of semiconductors with the help of plots of log ϵ vs. $10^{3/4}$.

*** Any other relevant experiment may be added.**

****Project or industrial in plant training or literature review articles:**

In the final semester, students have to carry out project either at college laboratory or university laboratory or in any recognized R & D laboratory (Public/Private/Government) or Industry or

Institute of national repute across the country under the guidance of scientist or a post-graduate faculty member. Alternatively the student can undertake the literature review of the articles.