SOLAPUR UNIVERSITY, SOLAPUR

M.Sc.-II- INORGANIC CHEMISTRY COURSE SYLLABUS SEMESTER SYSTEM

(w.e.f.June-2015)

The syllabus of M.Sc - Inorganic Chemistry course of two years duration has been prepared as per the semester system (C.G.P.A.). M. Sc. II syllabus is to be implemented from June 2015. The syllabus of M. Sc. Part I was implemented with effect from June 2014. The syllabus has been prepared taking into consideration the UGC guidelines, SET, NET examination syllabus, the syllabus of other universities 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 each for university external examination and 30 marks each for internal examination and two practical courses of 70 marks each for University external examination and 30 marks each for internal practical course. The distribution of marks is as mentioned below.

Theory Paper (Semester Exam),	16 X (70+30) marks	1600 marks
Practicals (Semester End Exam.),	8 X (70+30) marks	800 marks
Seminars for each Semester,	4 X (25 Marks)	100 marks

Total: 2500 marks

M. Sc. Part I* Chemistry (* This course is common for Polymer, Organic, Inorganic, Physical and Analytical Chemistry courses).

Semester I

Theory Courses: Paper No.	**Title of Papers**	**Ext. + Int. = Total**
CH 101	(I) Inorganic Chemistry-I	70+30 = (100 marks)
CH 102	(II) Organic Chemistry-I	70+30 = (100 marks)
CH 103	(III) Physical Chemistry-I	70+30 = (100 marks)
CH 104	(IV) Analytical Chemistry-I	70+30 = (100 marks)

Semester II

Paper No.		**Title of Papers**	**Ext. + Int. = Total**
CH 201	(V)	Inorganic Chemistry-II	70+30 = (100 marks)
CH 202	(VI)	Organic Chemistry-II	70+30 = (100 marks)
CH 203	(VII)	Physical Chemistry-II	70+30 = (100 marks)
CH 204	(VIII)	Analytical Chemistry-II	70+30 = (100 marks)

Practical Course: (Semester End Examination) Practicals P - I to IV for semester I and II Practical Examination will be of 4 days for each semester

P I Chemistry Practical: Sem-I	(70 marks Univ. Exam + 30 Marks Internal Exam)
P II Chemistry Practical: Sem-I	(70 marks Univ. Exam + 30 Marks Internal Exam)
P III Chemistry Practical: Sem-II	(70 marks Univ. Exam + 30 Marks Internal Exam)
P IV Chemistry Practical: Sem-II	(70 marks Univ. Exam + 30 Marks Internal Exam)

M. Sc. Part -II Inorganic Chemistry:

Semester III

Theory Course

Paper No.	Title of Papers	Marks External	Marks Internal	Total Marks
ICH-301 (IX)	Inorganic Chemical Spectroscopy	70	30	100
ICH-302 (X)	Co-ordination Chemistry-I	70	30	100
ICH-303: (XI)	Nuclear Chemistry	70	30	100
ICH-304 (XII) A Elective	Environmental Chemistry	70	30	100
ICH-304 (XII) B Elective	Separation Science	70	30	100
ICH-304 (XII) C Elective	Radiation chemistry	70	30	100
Practical course	Paper-V Paper-VI	70 70	30 30	100 100
Seminar		--	25	25

Semester IV

Paper No.	Title of Papers	Marks External	Marks Internal	Total Marks
ICH-401 (XIII):	Instrumental Techniques	70	30	100
ICH-402 (XIV):	Co-ordination Chemistry-II	70	30	100
ICH-403 (XV):	Chemistry of Inorganic Materials	70	30	100
ICH-404 (XVI) (A): Elective	Applied Inorganic Chemistry	70	30	100
ICH-404 (XVI) (B): Elective	Organometallic Chemistry	70	30	100
ICH-404 (XVI) (C): Elective	Bioinorganic Chemistry	70	30	100
Practical course	Paper-VII Paper-VIII*	70 70	30 30	100 100
Seminar		--	25	25

* VIII Project work/In-plant / Practical experiments

Nature of Examination: Each semester will have theory University external examination of four papers of 70 marks each (3 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. There will be 70 marks University external practical examination while 30 marks internal examination. The

distribution of marks for each Practical paper -V, VI, VII and VIII will be of 70 marks. Project work / In-plant training / Review Report of 70 marks will be included in P-VIII Whereas distribution of marks for P VIII will be Project work / In-plant training / Review Report + Practical experiments = 70**

** The valuation to be done by both external and Internal examiners at the time of P V-VII practical examination. Valuation of Seminars is to be done by Departmental Faculty involved in Physical Chemistry.

Nature of question paper (for M. Sc. I and II):

Time: 03 hours Max. Marks 70

Instructions:

1. Attempt any 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 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 are 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 No-ICH-301, Inorganic Chemical Spectroscopy

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 pg & 119 sm NMR.

B] Electron & Photo acoustic Spectroscopy [7]

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, Weily eastern
5. Figgis, Introduction to ligand field theory field
6. Schaefer & Gilman: Basic principles of ligand field Theory, J. Wiely
7. P.R. Backer: Molecular symmetry and Spectroscopy A.P.
8. Ferraro Ziomeek, 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. Weily
14. Ferroro: 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 No. ICH-302: Co-ordination Chemistry – I

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. Weily

2. Graddon: Introduction to Coordination Chemistry. J. Weily

3. Drago: Physical methods of Inorganic Chemistry. J. Weily.

4. Graddon: Introduction to coordination Chemistry, Parasmom

5. Lewis and Wilkins: Coordination Chemistry. J. Weily

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 No. ICH 303: Nuclear Chemistry

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 ICH 304 A: Environmental Chemistry (Elective)

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, CO_2, NO_2, SO_2,H_2S, CO_2, analysis of toxic heavy metals, Cd, Cr, As, Pb, Cu, Separation of Co, Cu, Mg, Mn, Fe, analysis of $SO4^{-2}$ P43-, $NO3^{-}$, NO^{2-} analysis of totalcationic 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 No. ICH 304: B Separation Science (Elective)

UNIT-I **[15]**

Solvent Extraction Separation

Principles of solvent extraction, formation of metal complexes, distribution of extractable species, quantitative treatment of extractable equillibria, Methods of extraction, techniques in extraction, application of diketone, hydroxyquinoline, oximes, dithiocarbamates, xanthets, thiols, macrocyclic polythenes and orgao phosphouous 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 one 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 electro chromatography.

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 No. ICH304: C Radiation Chemistry (Elective)

UNIT-I **[15]**

A] Isotopes

Isotope separation, thermodynamic and kinetic isotope effects, isotope exchange reaction kinetics, determination of exchange rate constant, production of radio isotopes.

B] Biological effects of Radiation.

Introduction, genetic and somatic effect on human being, effect of radiation on plants and aquatic Environment

UNIT-II **[15]**

Radiochemical Separation

The need of radiochemical separation techniques, carrier techniques, isotope and nonisotopic carriers, co precipitation and adsorption, ion exchange, solvent extract, electrolytes behavior of carrier free tracer radionuclide.

UNIT-III **[15]**

Principle of tracer chemistry

Application of tracers in physiochemical studies, diffusion studies, isotopic and exchange reactions, tracer in the study of the mechanism of the inorganic chemical reaction, atom transfer & electron transfer mechanisms. Heterogeneous catalysis and surface area measurements, radio carbon dating, tracer studies with tritium, application in metallurgy and preservation of food, geochemical application and hot atom chemistry.

UNIT-IV

Radiation detection and measurements. **[15]**

Ionization current measurements, multiplicative ion collector, methods not based on ion collection, auxiliary Instrumentation and health physical instruments and counting staticsits.

Reference Books.

1. Friendlander, Kennedy & Miller, Nuclear and radio Chemistry, ohm Wiley.
2. B.G. Harvey, Nuclear Chemistry.
3. Haissinsky, Translated by D.G. Tuck, Nuclear physics and Chemistry.
4. Mark lefort, Nuclear Chemistry, D.V. Nostrand.
5. An N.Nesmeyanov, Radiochemistry, Mir.
6. Jacobs, et al, Basic Principles of nuclear science and reactors, V.Nost, EWAP.
7. N.Jay, Nuclear power, today tomorrow, ELBS.
8. Kenneth, Nuclear power, today and tomorrow, ELBS.

9. Essentials of Nuclear Chemistry, J.Arnikar, John Wiley.

10. D.C. Dayal, nuclear physics.

M.Sc. II Practical Courses SEM - III,
Inorganic Chemistry Course ICH – 311 & ICH 312

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 No. ICH - 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

Thermal method of analysis **[15]**

Thermogravimetriy [TG], differential thermal analysis [DTA], differential Scanning calorimetric [DCS], Thermo mechanical analysis [TMA] Instrumentation and application, thermometric titrations.

UNIT-III **[15]**

Mossbauer Spectroscopy

Introduction to Mossabaur effect, recoilless emission & absorption of x-rays, Instrumentation, isomer shift, Quadrapole 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. Mossbaur Spectroscopy, Greenwood N.N., Gibbs T.C., Chapmann 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., Sounders, 1985/

Paper No. ICH-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, $[Co(CN)_5]_3$ A redox & catalytic reagent.

UNIT-III **[15]**

Photochemistry: Photochemistry of Coordination compounds, electronically exited 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. Pearsons: 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 is 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, Butterworths's

7. K.K. Rastogi & Mukharjee, Fundamentals of photochemistry, Wiley eastern

8. J.G. Calverts & J.N. Pits, Photochemicals of Photochemistry, John Wiley

9. Wells, Introduction to Photochemistry.

Paper No ICH: 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, Nonstiochiometric defect (structural and thermodynamic aspects) incorporation of stiochometric excess of defects, thermodynamics of Nonstiochiometric 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 Ferro electricity. 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, langevins theory & paramagnetic susceptibility of solids, ferromagnetism, Domain theory. Hysteresis in magnetism, ferrimagnetisms (ferries) Applications of magnetic materials.

B] Magnetic Materials

I] Structure and Properties of i) Metal and Alloys ii) Transition metal Oxides iii) Spinels iv) Ilmenites v) Perovskite and vi) Magneto-plumbites. 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. Azoroof 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 No. ICH 404 A: Applied Inorganic Chemistry (Elective)

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

Non conventional sources of energy **[15]**

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 MaGraw Hill)

2. Principals 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. Chapmann 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, Sriniwasan 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 No. 404: B Organometallic Chemistry (Elective)

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, mettalation, 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 acetyl ides. **[7]**

Preparation, structure, reactions of metal carbonyls with alkyl halides, reactions of metal carbonyls with metal alkyls, cyanides and isocyanides complexes, acetalynide 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 organ metallic.

Reference Books:

1. Paulson, Organometallic Chemistry -Arnold.

2. Rochow, Organometallic Chemistry - Reinhold.

3. Zeiss, Organometallic Chemistry - Reinhold.

4. Advances in Organometallic Chemistry A.P.

Paper No ICH 404: C Bioinorganic Chemistry (Elective)

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 B_{12}, B_{12} co-enzyme myoglobin, synthesis of oxygen carriers.

B] Photosynthesis [7]

Complexes of prophyries porphysins 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,
Inorganic Chemistry Course ICH – 411 & ICH 412

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 polarogram for determination of half wave potentials and unknown concentration.

7. Calculation of band gap of semiconductors with the help of plots of log & 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.