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 practicals 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 = 100 marks

Total: 2500 marks

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

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<tr>
<th>Semester</th>
<th>Paper Code</th>
<th>Title of the Paper</th>
<th>Semester exam</th>
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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.

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<td>Project work / In-plant training Report:</td>
<td>60**+10 marks for presentation</td>
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** 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.

- 5 -
Unit-I

Group Theory

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

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

A] Infrared and Raman Spectroscopy

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

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

A] Nuclear Magnetic Resonance Spectroscopy

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.
Electron & Photo acoustic Spectroscopy

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.
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
17. Dudd, chemical Spectroscopy Elsevier
18. Popel : H.N.M.R. Spectroscopy J.Weily
20. P.K. Bhattacharya: Group Theory & Its Chemical Applications
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.

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
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
10. L.N. Maley: Magneto Chemistry
11. Datta & Shymlal Elements of Magneto Chemistry
15. William L. Jolly: Modern Inorganic Chemistry, Mecgrow Hill USA,1984
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]
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
6. An N.Nesmeyannoy: Radiochemistry: Mir
8. N.Jay: Nuclear Power Today Tomorrow: ELBS
11. Nuclear and Radiation Chemistry: B.K. Sharma, Krishna Publication
12. A Introduction to Nuclear Physics: R. Babber. And Puri
UNIT-I  
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, xanthets, thiols, macrocyclic polythenes and organophosphorous compounds in solvent extraction. Separation of nonmetals and metals.

UNIT-II  
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  
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  
A] Separation by electrolysis
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
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.
3. Solvent extraction Chemistry, Selkine and alegagawa.
8. S.M. Khopkar, Basic Concepts of Analytical Chemistry.
UNIT-I  
A] Air Pollution  
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  

UNIT-II  
A] Method of control of air pollution  
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  
Water and waste water treatment, aerobic and anaerobic, aeration of water, principle of coagulation, flocculation, softening, disinfection, demineralization and fluoridation.

UNIT-III  
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⁻, P₄₃⁻, 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  
B] Environmental toxicology
Chemical solutions to environmental problems biodegradability, principles of decomposition better industrial processes, Bhopal gas tragedy, Chernobyl, three mile island, sewozio 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
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.
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
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

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

UNIT-III
Mossbauer Spectroscopy

Introduction to Mossabaur 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

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:
2. Diffraction Method, Wormald, Oxford University, Press, 1973
   Press 1968.
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)\textsubscript{5}]\textsuperscript{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:
6. K. Burger, Coordination Chemistry Experimental Methods, Butterworths's
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, Nonstiochiometric defect (structural and thermodynamic aspects) incorporation of stiochometric excess of defects, thermodynamics of Nonstiochiometric phases.

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

B] 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]
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.

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

Reference Books:
4. Hagenmuller, Preparative Methods in Solis State Chemistry
6. N.N. Greenwood: Ionic Crystals, Lattice Defects and Nonstiochiometry (Butterworth's)
9. E.A. Kroger, Chemistry of Imprefect Crystals (Holland)
10. A.R. West, Solid State Chemistry
12. S.O. Pillai Academic press: Solid state physics
UNIT-I

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 metal-carbon 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


UNIT-III

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

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)
12. Solar Energy Rai C.D.
15. Outlines in Chemical Technology Vol I, S.D. Sukla & Pandey G.N.
UNIT-I
Metals in Life Processes
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
Structure and mechanism of hemoglobin, vitamin B\(_{12}\), B\(_{12}\) co-enzyme myoglobin, synthesis of oxygen carriers.
B] Photosynthesis
Complexes of prophyries porphysins ring complexes, redox mechanism.

UNIT-III
A] Nitrogen Fixation
Nitrogen in biosphere, nitrogen cycle, nitrification role of microorganisms, nitrogen fixation in soils
B] Metal poisoning and drug action of Inorganic complexes compounds

UNIT-IV
A] Trace Metals in Plant Life
Micronutrients in soil, role of micronutrients in plant life
B] Biogeochemistry
Biodegradation of minerals bacteria leaching and its applications.

Recommended Books:
2. Ochiai: Bioinorganic Chemistry: Allyn & Bacon Burton
4. Wallace: Decade on synthetic chelating agent in Inorganic plant nutrition, Wallace
5. Williams: Metals in Life
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. Partial 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 geometry (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 & 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.