M.Sc. INORGANIC CHEMISTRY
(For students admitted during the academic year 2013-2014)
CURRICULUM AND SYLLABUS

FACULTY OF SCIENCE AND HUMANITIES
SRM UNIVERSITY
SRM NAGAR, KATTANKULATHUR – 603 203
<table>
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<tr>
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### SEMESTER III

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### SEMESTER IV

| xxxxxx      | Elective-3 (List-I)           | 4 | 1 | - | 5  |
| CHET 460    | Career Comprehensive Course*   | 2 | - | - | 2  |
| CPR0435     | Project Work                  | - | - | 12| 12 |
| **Total**   |                               | 6 | 1 | 12| 19 |

**Total number of credits to be earned for the award of degree:** 80

Mode of opting specialization: The number of seats in each specialization course would be up to a maximum of 30% of the total eligible candidates.

**Note:**

* - Continuous Assessment (Full Internals)

L – Lecture Hours, T – Tutorial Hours, P – Practical Hours & C – Credits
### LIST - I (MAJOR SPECIAL ELECTIVES)

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### LIST - II (INTERDISCIPLINARY ELECTIVES)

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INSTRUCTIONAL OBJECTIVES

(i) To study in depth the properties of organometallic compounds

(ii) To gain knowledge in various catalytic processes of organometallic compounds

(iii) To understand the various reactions of organometallic compounds

(iv) To identify the applications of organometallic compounds

UNIT I Introduction
Compounds with transition metal to carbon bonds: classification of ligands, nomenclature, eighteen electron rule; transition metal carbonyls: range of compounds and structure, bonding, vibrational spectra, preparation, reactions; transition metal organometallics: square planar complexes, metal alkyls, metal alkylidenes, metalalkylidyynes and metal arenes.

UNIT II Complexes of Unsaturated Molecules
Synthesis, structure, bonding and reactivity of transitional metal complexes with alkenes, cyclopentadienyl (Metallocenes), Benzenoid, π-allyl, and enylsystems. Complexes with cyclic π donors: Cyclopentadiene, benzene, cycloheptatriene and cyclooctatetraene complexes.

UNIT III Catalytic Processes
Hydrosilation reaction, hydride elimination, abstraction, cyclooligomerisation, olefin isomerisation, ethylene dimerization using RhCl₃ catalyst. FischerTropsch process, water gas shift reaction. Oxidation of Aldehydes, Cyclohexanol, Cyclohexanone, p-Xylene.

UNIT IV Properties and Reactions of Organometallic Compounds
Complex formation, reactions with active oxygen compounds, reactions with halogen, reactions with alkyl halides, acid halides, reactions with oxygen, carbonyls and others. Metal carbonyls, isocyanides and acetylides: 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 V Applications of Organometallic Compounds
Introduction, organometallics in medicine, organometallic compounds in agriculture and horticulture, organometallics in Industry and environmental aspects of organometallic compounds.

Text Books

References
SEMESTER III

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**INSTRUCTIONAL OBJECTIVES**

(i) To educate students on the principles of photochemistry

(ii) To understand the various photochemical properties of transition metal complexes

(iii) To acquire knowledge in charge transfer photochemistry

(iv) To know the various photochemical reactions taking place on solid surfaces

**UNIT I Principles of Photochemistry**

**UNIT II Photochemical Properties of Transition Metal Complexes**
Photo physical process, Photochemical process, Photo substitution reactions, photoredox reactions, Photo rearrangement reaction, Prompt and Delayed Photochemical reactions, Photolysis rules and ligand field theory

**UNIT III Charge Transfer Photochemistry**
Introduction, charge transfer absorption spectra, types of charge transfer excitations and their energy level scheme for charge transfer excitations, Types of reactions observed by charge transfer metal complexes.

**UNIT IV Ligand Field Photochemistry of Transition Metal Complexes**
Photochemistry Cr(III) of complexes: Photo-substitutions, properties of ligand field excited states, Photoaquation reactions, photolysis rule, photoisomerization, photo racemization, photoanation reactions, sensitizer, energy transfer process, Mechanism of photosensitization, photo reactive excited state. The Doublet hypothesis, Role of quartet excited states, Photochemistry of Co(III) complexes: Introduction, energy level diagram, Photoaquations in Co(III) amine, Co(III) cyanide complexes, Fe(II) low spin
complexes, Ru(II) ammine derivative complexes, Photo redox properties of Ce(III) and Ce(IV) complexes, photochemistry of Cu(II) (1,3 diketone) complexes

UNIT V Photochemical Reactions on Solid Surface
Introduction, photo electron transfer mechanism, energy level diagram of solid acceptor and donor levels, Examples of photo catalytic metal/mixed metal oxides and their applications, semiconductor supported metal oxides for photolysis of water, Decomposition of organic pollutants, experimental setup, end product of organic products, carbon dioxide reduction, nitrogen fixations, solar energy conversion and its storage. Chemiluminescence’s in coordination complexes, Thexi state and Franck Condon state.

Text Books

References
LIST-I (MAJOR SPECIAL ELECTIVES)
SEMESTER III

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INSTRUCTIONAL OBJECTIVES

(i) To study in depth about the essential elements of life
(ii) To gain knowledge about oxygen carriers
(iii) To understand the basic concepts of enzymes and acquire knowledge about metalloenzymes
(iv) To study in detail about the characterization techniques

UNIT I Introduction
Essential elements in biology, distribution of elements in biosphere, bio-availability, biostability, building blocks of the biosphere; sugars (carbohydrates), fatty acids (lipids), nucleotides (nucleic acids) and amino acids (proteins), Biological importance of water, and the chemistry of biopolymers.

UNIT II Oxygen Storage and Transport
O₂ binding properties of heme (haemoglobin and myoglobin) and non-heme proteins hemocyanin&hemerythrin), their coordination geometry and electronic structure, cooperativity effect, Hill coefficient and Bohr Effect; characterization of O₂ bound species by Raman and infrared spectroscopic methods; representative synthetic models of heme and non-heme systems.

UNIT III Electron Transfer Proteins and Nitrogen Fixation

UNIT IV Enzymes and Metalloenzymes
Enzymes- Nomenclature and classification, chemical kinetics, the free energy of activation and the effects of catalysts, kinetics of enzyme catalyzed reactions-
Michaelis-Menten constant equation- effect of pH, temperature on enzyme reactions, factors contributing to the catalytic efficiency of enzymes.


UNIT V Characterisation Techniques
Physical techniques in bioinorganic chemistry: Brief description of the techniques – UV-Vis, Raman, X-Ray crystallography, paramagnetic NMR and EPR spectroscopy, EXAFS, magnetic susceptibility and electrochemistry

Text Books

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SEMESTER III

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**INSTRUCTIONAL OBJECTIVES**

(i) To study in about material selection and design
(ii) To study in depth about refractories
(iii) To acquire knowledge about biomaterials
(iv) To educate students on the various material characterization techniques

**UNIT I Materials Selection and Design**
Criteria for selection of materials, application of statistics in materials selection, specification of steels, composition, heat treatment, microstructure and properties of ferrous and non-ferrous alloys, ceramics and polymers for light and heavy structural, corrosion resistant, magnetic, electrical and electronic applications, medical implants and prostheses application.

**UNIT II Composite Materials and Adhesives**
Composites Materials:
Adhesives:
Introduction, adhesive action, physical factors influencing adhesive action, chemical factors influencing adhesive action, bonding processes by adhesives.

**UNIT III Ceramics and Refractories**
Ceramics:
Introduction, ceramic materials, structure and polymorphism, synthesis of ceramics, ceramic forming processes, silicates and non-silicate ceramics, structural and functional (electronic, optic) and bio-ceramics.
Refractories:
Principles, properties and strength under load, thermal spalling, chemical properties. Fractures of refractories, corrosion of refractories, different refractory lines, Alumina-silica brick, magnesia refractories, Doloma refractories, carbonaceous refractories,
spinel containing refractories. Manufacture of refractory: Preliminary treatment, Blending and mixing, Forming or moulding, Drying firing, Common refractory bricks.

UNIT IV Biomaterials

UNIT V Materials Characterization Techniques
Materials characterization techniques, principles of different microscopes (optical, electron microscopes, SEM, TEM and AFM) and the preparation of samples, different modes and their applications, thermal methods (TGA and DSC) interpretation of data.

Text Books

References
INSTRUCTIONAL OBJECTIVES

(i) To motivate the students to understand separation and gravimetric techniques.

(ii) To impart knowledge of synthesis and characterization of the inorganic complexes.

(iii) To practice the estimation of metal ions by spectrophotometric methods.

A. Quantitative analysis:
Separation and estimation of mixtures by volumetric and gravimetric methods:

- some typical recommended mixtures are:
  1. Cu-Ni
  2. Cu-Fe
  3. Cu-Zn
  4. Ba-Ca
  5. Ni-Zn.

B. Inorganic complex preparation and characterization:

1. tris-triphenylphosphine copper(I) nitrate
2. tris-acetylacetono iron (III)
3. cisandtrans-dichlorobis (ethylenediamine) cobalt (III) chloride
4. bispyridine iodide nitrate
5. trans-bisglycinato copper(II)
6. Prussian blue
7. Tetrammine copper(II)
8. Hexamine cobalt(II) chloride
9. Hexamine nickel(II) chloride

C. Spectrophotometric estimation:(any three)

- Cu, Mn, Ni, Fe, V, Cr, Co.

General scheme for distribution of marks in practical examination

- Time: 6 h (One day Examination)
- Marks: 50 (External) + 50 (Internal)

Quantitative analysis (A) : 20 Marks
Preparation (B) : 10 Marks
Record : 10 Marks
Viva-Voce : 10 Marks
Internal : 50 Marks
Total : 100 Marks
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LIST-II (INTERDISCIPLINARY ELECTIVES)

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INSTRUCTIONAL OBJECTIVES

(i) To study in detail about toxic and hazardous chemicals
(ii) To gain knowledge about green chemistry
(iii) To understand the basics of clinical health and first aid safety

UNIT I Environmental Management of Toxic and Hazardous Chemicals
Introduction to toxic and hazardous chemicals, Procedure for working with substances that pose flammable or explosive hazards, Incineration of hazardous chemicals. Identification, classification and segregation of industrial toxic/hazardous chemicals, recovery, recycling and reuse of industrially important chemicals.

UNIT II Small Scale Industry and R & D Technology Transfer
Need and scope of small scale, Industry, SSI rules and regulations, Registration, Licensing, Incentives, Factory act, Labor laws, FDA, export-import regulations, and tax benefits, Role of R and D, Functional structure of R&D Unit, Research strategies and manufacturing interface

UNIT III Green Chemistry
Introduction, Twelve principles of Green Chemistry with their explanations and examples; designing a Green Synthesis using these principles; Prevention of Waste/byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/minimization of hazardous/toxic products. Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, and aromatic amines (4-aminodiphenylamine), benzyl bromide, disodium iminodiacetate (alternative to strecker synthesis), citral, ibuprofen, paracetamol.

UNIT IV Clinical Health and First Aid Safety

UNIT V Indian Industrial Scenario and Quality Control in Industries
Survey of Indian chemical industries, Indian mineral resources, ferrous metallurgy, heavy chemical industries, nonferrous metals, fine chemicals and pharmaceuticals, natural products and agro-based chemicals, contribution of fertilizers and pesticide, Quality Control Role, Government standards like ISI, MINAS, Agmark, I. P., D. P., U.S.P concepts of quality and quality control.

Text Books

References
SEMESTER III

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INSTRUCTIONAL OBJECTIVES

(i) To study in detail about ecosystem and biodiversity
(ii) To gain knowledge about the energy resources
(iii) To discuss in detail about various social issues

UNIT I  Energy and Environment

Energy resources and their exploitation, Sun as the source of energy- nature of its radiation, Conventional energy sources: coal, oil, biomass and nature gas, non-conventional energy sources: hydroelectric power, tidal, wind, geothermal energy, solar collectors, photovoltaic, solar ponds, nuclear-fission and fusion, magneto-hydrodynamic power (MHD), Energy use pattern in different parts of the world and its impact on the environment. CO₂ emission in atmosphere.

Mechanism of radiation action on living systems- Stochastic and Non-stochastic effects; delayed effects, radioactivity from nuclear reactors, fuel processing and radioactive waste, hazards related to power plants, terrestrial and non terrestrial radiation, dose from environment and nuclear radiations, ultraviolet radiations, pathway analysis and dose assessment, radiologic age dating, radioactivity risk assessment, criterion for safe exposure.

UNIT II  Ecosystem, Biodiversity and its Conservation

Biodiversity concepts and patterns, microbial diversity, Plant diversity, agrobiodiversity, soil biodiversity, economic value of biodiversity, biodiversity losses. Biodiversity hotspots and their characteristic flora and fauna, threatened plants and animals of India, ecosystem people and traditional conservation mechanisms, Biodiversity Convention and Biodiversity Act, IPRs, national and international programmes for biodiversity conservation.

UNIT III Energy Resources and Maintenance
Renewable and non-renewable energy resources, growing energy need, solar radiation and its spectral characteristics, fossil fuels classification, composition. Physico-chemical characteristics and energy content of coal, petroleum and natural gas. Principle of generation and conservation of conventional and non-conventional energy. Energy from biomass and biogas, an aerobic digestion, energy use pattern and future need projection in different parts of the world, energy conservation policies.

UNIT IV Solid and Hazardous Waste Management

UNIT V Social Issues

Text Books
References
LIST–I (MAJOR SPECIAL ELECTIVES)

SEMESTER IV

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INSTRUCTIONAL OBJECTIVES

(i) To study in depth about amorphous solids
(ii) To gain knowledge about ceramic and composite materials
(iii) To understand the mechanical properties of materials
(iv) To study the magnetic behavior of compounds

UNIT I Introduction
Crystalline and amorphous solids–crystal systems, point groups, types of close packing: hcp and ccp, packing efficiency, radius ratios; polyhedral description of solids; structure types -NaCl, ZnS, Na₂O, CdCl₂, wurtzite, nickel arsenide, CsCl, CdI₂, rutile and Cs₂O, perovskite ABO₃, K₂NiF₄ and spinels.

UNIT II Amorphous Solids and Semiconductor Devices
Amorphous solid, oxide glasses, chalcogenide glasses, amorphous carbon, graphite, diamond, alkaline graphite compounds.
Diodes, p-n junction, transistor, interstitial and cheverel compound, superconductivity compound, properties of superconductivity compounds.

UNIT III Ceramic and Composite Materials
Ceramic materials-
Definition, types, polarization, polarizibility, electric properties, dielectric properties, piezoelectric, pyroelectric and ferroelectric effect.
Composite materials -
Definition, fiber, concrete, asphalt, wood, several other types of composite material.

UNIT IV Electrical and Optical Conductivity of Solids
Electrical conductivity, origin of valence and conduction band in solids, classification of material, time dependent of conductivity, mobility of charge carriers, metal–metal junction, metal– semiconductor junction, optical properties of material, refractive index, inorganic colored solid, LASER and photoluminescence.
UNIT V Mechanical Properties and Magnetic Behavior of Materials

Mechanical behaviour, mechanical properties, fractures of metal, ductile fracture, brittle fracture, toughness and impact testing.

Introduction to magnetism, behavior of substance in a magnetic field, magnetic moments, diamagnetism, paramagnetism, experimental determinations of susceptibility, ferromagnetism, antiferromagnetism, ferrimagnetism, magnetizations of a ferromagnetic substance.

Text Books


References

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INSTRUCTIONAL OBJECTIVES

(i) To gain knowledge on various toxic metals
(ii) To acquire knowledge on the interactions of metal ions and its complexes
(iii) To identify the various metal complexes as drugs
(iv) To acquire knowledge on the mode of action of various therapeutic drugs

UNIT I Introduction to Metal ion Toxicity
Metal ion toxicity in humans and animals. General aspects of Pb(II), Cd(II), and Hg (II) toxicity, biochemical and physiological effects due to Pb(II), Cd(II), and Hg(II) ion toxicity. Detoxifications using chelating agents.

UNIT II Interactions of Metal Ions and Metal Complexes
Structure and functions of amino acids, proteins, peptides, enzymes, nucleosides, nucleotides and comparative study of structures and functions of these biomolecules. Metal ion binding sites present in amino acids, peptides, proteins, enzymes, nucleoside and nucleotide. Interactions of metal ion and metal complexes with these biomolecules.

UNIT III Metal Complexes as Drugs
Introduction to Pt(II) chemistry— Thermodynamic and kinetic principles – Cis and Trans influences.
Discovery applications and structure-effect relationships. CisPt(NH₃)₂Cl₂ and its mode of action. Drug resistance and DNA repair mechanism.

UNIT IV Bio-Energetics and ATP Cycle
Metal complexes in transmission of energy, chlorophylls, photosystem I and photosystem II in cleavage of water, Model systems.
UNIT V Metal Complexes in Clinical Chemistry


Text Books

2. Helmut Sigel (1973): Metal ions in biological system (Concepts on metal ion toxicity), Vol.7 Marcel Dekker INC, New York and Basel

References

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**INSTRUCTIONAL OBJECTIVE**

(i) To evaluate the subject knowledge and presentation skill of the candidate and to train them for their employability

Courses covered under the syllabus from First Semester to Fourth Semester (including electives) will form the basis for Career Comprehensive Course.
PURPOSE
To undertake research and development in an area related to the program of study

PROJECT
A student is free to pick up a topic for the project at the beginning of Semester III. The student is expected to complete the major literature survey during the Semester III and present a tentative research plan at the end of Semester III. The candidate will do the experimental work during Semester IV under the supervision of a guide and submit the results in the form of a thesis at the end of Semester IV. The project internally will be evaluated by the concerned guide and the end semester assessment by duly appointed examiner(s).

Assessment Tool Weightage

Review I – 50 Marks
Review II – 50 Marks

Internal Mark Distribution

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End semester evaluation:
Student will be allowed to appear in the final viva voce examination only if he / she has submitted his / her project work in the form of project report

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