## M.Sc. INORGANIC CHEMISTRY
### SYLLABUS

**FACULTY OF SCIENCE**

**DEPARTMENT OF CHEMISTRY**

**SATAVAHANA UNIVERSITY-KARIMNAGAR**

**UNDER CHOICE BASED CREDIT SYSTEM (CBCS)**

**DEPARTMENT OF CHEMISTRY**

**SATAVAHANA UNIVERSITY - KARIMNAGAR**

**M.Sc., Chemistry**

Under Choice Based Credit System (CBCS)

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**SU – M.Sc., (Inorganic Chemistry) IV Semester**

<table>
<thead>
<tr>
<th>Paper Code</th>
<th>Title</th>
<th>Workload Per Week</th>
<th>Marks</th>
<th>Credits</th>
<th>Duration of the Exams.</th>
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<td>Theory</td>
<td>Practical</td>
<td>Internal</td>
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<tr>
<td>MCHE (IC) 401T</td>
<td>Inorganic Biochemistry IV</td>
<td>4</td>
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<td>20</td>
<td>80</td>
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<tr>
<td>MCHE (IC) 402T</td>
<td>Medicinal Inorganic Chemistry IV</td>
<td>4</td>
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<td>80</td>
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<tr>
<td>MCHE (IC) 403T (E-I) OR MCHE (IC) 403T (E-II)</td>
<td>Supramolecular Chemistry, Biophysical Methods IV (or) Inorganic Material Chemistry IV</td>
<td>4</td>
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<td>80</td>
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<tr>
<td>MCHE (IC) 404T (E-I) OR MCHE (IC) 404T (E-II)</td>
<td>Separation Methods, Green Chemistry and Nanotechnology IV (or) Analytical Techniques and Applied Analysis IV</td>
<td>4</td>
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<tr>
<td>MCHE (IC) 401P</td>
<td>Spectroscopic Techniques &amp; Spectrophotometry IV Lab</td>
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<td>MCHE (IC) 402P</td>
<td>Structural Assignment of Metal Complexes IV Lab</td>
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<td>Student Seminar IV</td>
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<td>18</td>
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*Every student must pass this paper since it is mandatory. However the credits will not included in the Calculation of SGPA and CGPA*
SEMESTER –IV  
(From the academic year 2017-2018 under CBCS)  
Paper- I  
MCHE (IC) 401T: Inorganic Biochemistry

IC-25: Metal ions Interactions with Nucleic acids and their constituents

IC-26: Transport of Electrons and Metal ions

IC-27: Metallo-Enzymes of Iron, Zinc and Nickel

IC-28: Metallo-Enzymes of Cobalt, Copper, Molybdenum and Manganese

IC-25: Metal ions Interactions with Nucleic acids and their constituents  

IC-26: Transport of Electrons and Metal ions  


IC-27: Metallo-Enzymes of Iron, Zinc and Nickel  
*Iron Enzymes:* Structural and Mechanistic Aspects of Cytochrome P450, Cytochrome oxidase, Catalase and Peroxidase - Role of the Metal Ion.

*Zinc Enzymes:* Structural and Mechanistic Aspects of Carbonic Anhydrase, Carboxy Peptidase, Leucin – aminopeptidase, Thermolysin, Alcohol Dehydrogenase - Role of Zinc.

*Nickel Enzymes:* Urease, Hydrogenase and Factor F430: Reactions Catalyzed, Mechanistic Aspects.
IC-28: Metallo-Enzymes of Cobalt, Copper, Molybdenum and Manganese

**Cobalt Enzymes:** Cobalt in Vitamin B12 - Structural Features of Vitamin B12 with reference to coordination of Cobalt - Different Oxidation States of Cobalt - Various forms of Vitamin B12 and Active Enzyme forms - Types of Reactions Catalysed by i) Methyl Cobalamin ii) Deoxyadenosyl Cobalamin - Mechanism of the Methyl Malonyl CoA conversion to Succinyl CoA - Role of the Apoenzyme - Unique features of Cobalt to suit Vitamin B12.

**Copper Enzymes:** Types of Copper in Biological Systems - Structural and Mechanistic Aspects of Superoxide Dismutase, Laccase and Galactose oxidase.

**Molybdenum Enzymes:** Biological Roles and Mechanistic Aspects of Nitrogenase, Xanthine oxidase and Sulfite oxidase.

**Manganese Enzymes:** Arginase, Water – oxidase.

**SUGGESTED BOOKS**

2. Biochemistry - Mary K. Campbell. (added these books)
8. Advances in Inorganic Biochemistry, edited by G.L.Eichorn&Marzilli
PAPER II
MCHE (IC) 402T: Medicinal Inorganic Chemistry

IC-29: Metal complexes as Drugs and Anticancer agents
Introduction to Pt(II) chemistry– Thermodynamic and kinetic principles – Cis and Trans influences Thermodynamic and kinetic aspects. Potential binding sites on nucleic acids and their bases and proteins.

IC-30: Metal complexes in Clinical Chemistry

IC-31: Chemical and Photochemical probing of DNA complexes
Chemical probing of DNA complexes: Introduction to footprinting. Chemical probing. Attack on DNA bases a) dimethylsulfate b) diethyal pyrocarbonate c) osmium tetroxide d) aldehydes e) ethyl nitrosourea(ENA) and other chemical probes like tris phenanthroline metal complexes.

Photochemical probes: Psoralens, acridines, UV radition Enzymatic probes
Immobilization of enzymes: Methods and Applications. Platinum Metal Complexes as drugs and anticancer agents: Importance of binding and photoactive metal complexes, ligand dissociation and photoactive metal complexes, ligand dissociation and photosubstitution, photophysics and photochemistry of Ru(II) polypyridyl complexes, Photophysics and photochemistry of Ru(II) polypyridyl complexes, Photophysics in the absence of DNA and in the presence of DNA.

IC-32: DNA binding and molecular pharmacology Interaction of Metallo Pharmaceuticals:
Introduction, concept of intercalating a) classical model b) developments of intercalation model c) quantitative analysis of intercalation. Factors which relate intercalation and...
medicinal activity a) Binding constant b) kinetics c) structural effects and activities d) intercalation and drug action
Specific drugs which bind to DNA by intercalation: a) antipyranosomal drugs b) antimalarial drugs c) antitumor drugs. Non specific interaction in dye binding to DNA and influence of alcohols and amides. Ruthenium: Ru(III), amine complexes: Anti activity, structure activity relationship DNA binding and cleavage-DMSO complexes of Ru(II); DNA interactions of polyaromatic amines-Ru(IV) complexes oxidative DNA cleavage. Rhodium; Rhodium(II) acetate dimer. Anticancer activity, metallocomplexes, chemical correction with antitumor activity, DNA binding and mechanism possibility. Introduction, Structural and chemical properties of streptonigrin and its metal complexes. Evidence for formation of ternary complexes involving DNA and its components. Antitumor activity and mechanism-Metal induced free radical production by organic drugs in relation to their side effects.

SUGGESTED BOOKS

5. Photoreactions of Metal complexes with DNA, A. Krisch – De Mesmacker et al.
PAPER III (Elective-I)
MCHE (IC) 403T (E-1): Supramolecular Chemistry, Biophysical Methods

IC-33: Supramolecular Chemistry
IC-34: Structural aspects of DNA and RNA
IC-35: Spectroscopic analysis of drug/metal complexes binding to nucleic acid
IC-36: CD, ORD, Fluorescence and Enzyme kinetics

IC-33: Supramolecular Chemistry:

Basic Concepts of Host-Guest Complexation (Ionophore Chemistry)


IC-34: Structural aspects of DNA and RNA:


IC-35: Spectroscopic analysis of drug/metal complexes binding to Nucleic acid:

Absorption and Fluorescence Spectra of drug- nucleic acid complexes, salt back titrations interpretation of the data, cooperatively anti cooperatively, the excluded site model, the binding analysis, equilibrium dialysis. Partition analysis, viscosity studies, competitive equilibrium dialysis to assess B & Z DNA binding. Obtaining equilibrium binding isotherms. Competition dialysis to assess base and sequence specificity. Dependence of Kobs on salt concentration, cation effect on Ligand nucleic acid equilibria, Competitive effects of monovalent and divalent cations for binding Record’s polyelectrolyte theory and its importance.
IC-36: CD, ORD, Fluorescence and Enzyme kinetics:

Enzyme kinetics, Michaelis-Menton equation and its treatment, study state kinetic analysis, significance of Km and Kcat, Kcat/Km effect of PH, temperature, substrate concentration. Types of enzyme inhibition.

SUGGESTED BOOKS

2. Biochemistry - Mary K. Campbell.
3. Notes in Biochemistry - B.D. Hames, N.M. Hoopen & T.D. Houghfon
4. Principles of fluorescence spectroscopes - Lakowiz
5. Fluorescence Quenching theory and applications - Maurice R. Eftink
PAPER III (Elective-II)
MCHE 403T (E-II): Inorganic Material Chemistry

IC-33: Composite Materials
IC-34: Liquid Crystals
IC-35: Explosives and Propellants
IC-36: Fuels and Combustion

IC-33: Composite Materials:


Ceramics: Plasticity of Clays, Whitewares or White-Pottery, Manufacture of White-Pottery, Glazing, Methods of glazing, Earthenwares and Stonewares.

IC-34: Liquid Crystals:

IC-35: Explosives and Propellants:
Explosives: Introduction, Classification of Explosives, Primary Explosives, Low Explosives, High Explosives, Precautions During Storage of Explosives, Blasting Fuses, Manufacture of Important Explosives-Lead azide, Diazonitrophenol (DDNP), Trinitrotoluene (TNT), Nitroglycerine (NG) or Glycerol trinitrate (GTN), Pentaerythritoltrinitrate (PETN) and RDX; Recent uses of Explosives

Propellants: Rocket Propellants - Introduction, Principle of Rocket Propulsion, Classifications of Propellants-Solid propellants, Composite propellants, Liquid Propellants, Mono-propellants, Bipropellants; Differences between Solid propellants and Liquid Propellants

IC-36: Fuels and Combustion:
Introduction, Classification of Fuels, Calorific Value, Characteristics of a Good Fuel, Theoretical Calculation of Calorific value of a Fuel, Coal, Classification of Coal by Rank,

Combustion: Combustion, Mass Analysis from Volume Analysis and Vice Versa, Analysis of Flue Gas

SUGGESTED BOOKS

IC-37: Separation Methods

Solvent extractions: The distribution coefficient, distribution ratio, relation between KD & D, the percent extracted. Solvent extraction of metals-metal chelates, extraction process, analytical separations, solid phase extraction.

Column Chromatography: Retention Parameters, Separation Efficiency, Resolution, Asymmetric factor, Column efficiency, Column performance, HETP, Effective plate number, Van Deemeter Equation,

Gel Exclusion Chromatography: Principle, Stationary phases, Instrumentation, Retention Behavior, Applications.


IC-38: Mixed Ligand Complexes

Definition of mixed ligand complexes (Ternary, Quaternary etc)-methods for quantitative comparison of the corresponding binary and ternary complexes in terms of $\Delta \log K$ and log X- Relative merits and demerit of two approaches and their theoretical origin -Factors responsible for stabilization of mixed lignad complexe. Non covalent interactions (Hydrophobic and stacking interactions). Schiff base information within coordination sphere. Formation of $\pi$-bonds, hydrogen bonding interactions, electrostatic interactions. Applications of mixed ligand complexes in biological systems, catalysis, chemical analysis and environmental fields.

IC-39: Green Chemistry:

Principles and concepts of green chemistry Introduction, sustainable development and green chemistry, atom economy, atom economic reactions, rearrangement reactions, addition reactions, atom uneconomic reactions- substitution reactions, elimination reactions, Wittig reactions. Reducing toxicity, measuring toxicity.

Organic solvents: Environmentally benign solutions: Organic solvents and volatile organic compounds, solvent free systems, super critical fluids- supercritical carbon dioxide and supercritical water. Water as a reagent solvent, water based coatings.

**IC-40 : Nanotechnology:**

*Metal Nanoclusters* – Introduction, Magic numbers, theoretical modeling of nanoparticles, geometric structure, electronic structure, reactivity, fluctuations, magnetic clusters, bulk to nanotransition.

*Methods of synthesis:* RF plasma, thermolysis, pulsed laser, chemical methods.

*Carbon nanostructures* - Introduction, carbon molecules, new carbon structures,

*Carbon clusters* - small carbon clusters, discovery of C60, structure of C60 and its crystal, alkali doped C60, superconductivity in C60.

*Carbon nanotubes:* Fabrication, structure, electrical properties, vibrational properties, mechanical properties.

*Applications of carbon tubes:* Field emission and shielding, computer, fuel cells, chemical sensors, catalysis, mechanical reinforcement

Biological Nanostructures: Examples of proteins, micelles and vesicles and multilayer films.

**SUGGESTED BOOKS**

1. Supramolecular Chemistry – concepts and perspectives by Jean-Marie Lehn
2. Principles and methods in Supramolecular chemistry, Hans-Jorg Schneider and A. Yatsimirsky, John Wiley and Sons
3. Analytical Chemistry of Macrocyclic and Supramolecular Compounds, S.M.Khopkar, Narosa Publishing House
9. Elements of inorganic Photochemistry G.J. Ferrendi, Wiley,
14. Green Chemistry- An Introductory text by Mike Lancaster- RSC.
PAPER IV (Elective-II)

MCHE (IC) 404T(E-II): Analytical Techniques and Applied Analysis

IC-37: Data Handling
IC-38: Analysis of Air and Water Pollutants
IC-39: Food and Pharmaceutical analysis
IC-40: Soil and Pesticide Residue analysis

IC-37: Data Handling:
Accuracy, Precision, Types of errors – determinate and indeterminate errors, minimization of determinate errors, statistical validation- statistical treatment of finite data ( mean, median, average deviation, standard deviation, coefficient of variation and variance), significant figures – computation rules, comparison of results – student’s t-test, F-test, statistical Q test for rejection of a result, confidence limit, regression analysis – method of least squares, correlation coefficient, detection limits. Calculations.

IC-38: Analysis of Air and Water Pollutants:
*Analysis of Air Pollutants:* Air quality standards, sampling, analysis of air pollutants-SO\(_2\) (UV-Vis, IR), H\(_2\)S (Spectrophotometry and Non-dispersive IR Spectrophotometry), NO-NOx (Chemiluminescence technique, Colorimetric technique- Saltzman method), CO & CO\(_2\) (IR, AAS & GC), Hydrocarbons (GC, GC-MS), Aromatic hydrocarbons in automobile exhaust, petrol, air, O\(_3\) (Chemiluminiscence & Spectrophotometry), particulate matter analysis.
Objectives of analysis, sampling, preservation and preconcentration methods, physical analysis - colour, odour, temperature, pH, EC, redox potential, total dissolved solids (turbidimetry), Chemical analysis of anions – CN-, Cl-, F-,NO\(_2\)-, NO\(_3\)- (spectrophotometry), SO\(_4^{2-}\), PO\(_4^{3-}\). Determination of BOD, COD, TOC & DO.
Analysis of Toxic Metals: Hg, As, Pb, Cd, Be, Al, Cr (Atomic Absorption Spectroscopy and Spectrophotometry)

IC-39: Food and Pharmaceutical analysis:
*Analysis of Chemical additives:* Division of colour additives (Coal-tar dyes, vegetable colours and mineral colours).
Chemical preservatives and synthetic sweetening agents (organic-ether extractable and non-ether extractable)
Antioxidants: Types of Antioxidants used in foods, Analysis of Butylatedhydroxy toluene (BHT),
Food adulteration: Common adulterants in food, contamination of food stuffs. Microscopic examinations for food adulterants.
Pharmaceutical analysis: Determination of Dicofenc (non-aqueous titration), Calcium in vitamin and Calcium formulations (Complexometry), Sulphanilamide (potentiometry), Pethidine hydrochloride (UV-Vis), Frusemide (UV-Vis), Aspirin, paracetamol, and codein in APC tablets (NMF) Phenobarbitone in tablets (IR), atropine in eye drops (GC), Paracetamol and aspirin in tablets (HPLC) Impurity profiling of Propranolol (GC-MS), famotidine (LC-MS).

**IC-40: Soil and Pesticide Residue Analysis:**
Analysis of soils for available Major Nutrients - Estimation of available Nitrogen (Kjeldahl Method), Phosphorus (Olsen’s Method and Bray and Kurtz Method), and Exchangeable Calcium & Magnesium (by EDTA). Soil analysis for Micronutrients - Estimation of Available Zinc, Copper, Manganese and Iron (AAS) - Analysis of Pesticide Residues - Determination of Methyl Parathion Residues in food grains & vegetables (Solvent Extraction and Titrimetry) - Determination of Organochlorine pesticides by Gas Chromatography (Cypermethrin) - Determination of Malathion and DDT Residues in food grains (Spectrophotometry).

**SUGGESTED BOOKS**

2. Fundamentals of Analytical Chemistry, Skoog & West
3. Pharmaceutical Drug Analysis, Ashtoshkar
4. Vogel’s Text Book of Quantitative Chemical Analysis, 6th Ed, Pearson Education Ltd
5. Environmental Pollution Analysis, S M Khopkar, Wiley Eastern Ltd 1995
9. Introduction to chemical analysis of foods, S Suzanna & Nielsen, CBS Publishers & Distributors
MCHE (IC) 401P: Instrumental Methods of Analysis – II

Spectrophotometry
1. Estimation of manganese.
2. Estimation of chromium.
3. Simultaneous determination of Manganese and Chromium in a mixture.
4. Determination of composition of Complex by Job’s Method and Mole ratio Method in the following:
   (i) Cu (II)-EDTA    (ii) Fe (II) - o-Phen

Flame photometry
1. Determination of Na
2. Determination of K
3. Determination of Ca
4. Determination of Li

Separation Methods
1. Separation of Fe3+ and Ni2+ using tri-n-butyl phophite (TBP) from HCl medium (Solvent extraction)
2. Determination of cations by paper chromatography; Co(II), Ni(II) and Cu(II)
3. Separation of Fe(III) and Al(III) by column chromatography

SUGGESTED BOOKS
3. Quantitative Analysis by Day and Underwood Prentice Hall (India) VI Edn.
Structural Assignment of Metal Complexes from Physico-Chemical Data:
A complete characterization of metal complex in terms of its composition, structure and other identification based on the following physico-chemical data for each of the metal complexes will be made:

1. Elemental Analysis and other Physical Characteristics such as Conductivity, Dipole Moment, etc. (where available and applicable)
2. Infrared and Raman Spectra (Chart/Data)
3. NMR Spectra (Charts/Data based on one or more active nuclei)
4. Mossbauer Spectrum (Chart/Data, wherever applicable)
5. ESR Spectrum (Chart/Data, wherever applicable)
6. Electronic and CD/ORD Spectra (Chart/Data, wherever applicable)
7. Magnetic Susceptibility Data (at various temperatures of available)
8. CV and other Electrochemical Data
9. TGA/DTA Profiles
10. Any other Thermodynamic and Kinetic parameters that aid the structural assignment.

Conventional Methods of Analysis
Titrimey:
1. Determination of Ca2+, Mg2+, CO32-, HCO3- in soil sample
2. Determination of Iron & Calcium in Cement
3. Determination of saponification value an oil sample
4. Determination of Iodine value of an oil sample
5. Determination of Calcium in calcium tablets

Water analysis:
1. Determination of residual Chlorine in water by Iodometry
2. Determination of Fluoride by Zirconium Alizarin Method
**SUGGESTED BOOKS**

   Text Book of Quantitative Inorganic Analysis Jafferyetal 4th edn. Edn, Elbs Publication
10. *Quantitative Analysis* by Day and Underwood Prentice Hall (India) VI Edn.
MODEL QUESTION PAPER FOR LABORATORY COURSE

1Q. Estimate the _ _ _ _ by using spectrophotometry/ flame photometry

2Q. Determine the _ _ _ _ from physic chemical data/ using conventional methods of analysis.

SCHEME OF EVALUATION

Max.marks: 100

External Assessment 80 M
For the major experiment & data analysis : 60 marks
Sample submission/Graph : 10 marks
Viva – voce : 10 marks

Internal Assessment 20 M
Day to day work and regularity : 10 marks
Record work : 10 marks