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)

SU – M.Sc., (Inorganic Chemistry) III Semester

Paper Code	Title	Workload Per Week		Marks			Credits	Duration of the Exams.
		Theory	Practical	Internal	University	Total		
MCHE (IC) 301T (common paper)	Spectral Techniques III	4	--	20	80	100	4	3 Hrs
MCHE (IC) 302T	Bonding Group Theory and its Applications III	4	--	20	80	100	4	3 Hrs
MCHE (IC) 303T (E-I) (OR) MCHE (IC) 303T (E-II)	Organometallic Chemistry of Transition Metals III (or) Applied Analysis & Green Analytical Chemistry III	4	--	20	80	100	4	3 Hrs
MCHE (IC) 304T (E-I) (OR) MCHE (IC) 304T (E-II)	Photochemistry, Thermal Methods III (or) Nuclear Chemistry & Advanced Analytical Techniques III	4	--	20	80	100	4	3 Hrs
MCHE (IC) 301P	Synthesis and Characterization of Metal Complexes III Lab	--	6	20	80	100	4	4 Hrs
MCHE (IC) 302P	Electro Analytical Techniques III Lab	--	6	20	80	100	4	4 Hrs
	Student Seminar III	2	--	25	--	25	1	1 Hrs
TOTAL		18	12	145	480	625	25	

*Every student must pass this paper since it is mandatory. However the credits will not included in the Calculation of SGPA and CGPA

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SEMESTER –III

(From the academic year 2017-2018 under CBCS)

Paper- I

(Common for all Specializations)

MCHE (SPT) 301 T: Spectral Techniques

SPT-09: 2DNMR techniques and combined applications of UV, IR, ^{1}H NMR, ^{13}C NMR and mass spectroscopy

SPT-10: NQR and Mossbauer Spectroscopy

SPT-11: ORD, Photo Electron and AUGER Electron Spectroscopy

SPT-12: X-ray Spectroscopy & X-ray Diffraction Techniques

SPT-9: 2D-NMR techniques and combined applications of UV, IR, ^{1}HNMR, ^{13}CNMR and mass spectroscopy: (15Hrs)

2D NMR: Principles of 2-D NMR, Classification of 2D-experiments. 2D - J- resolved spectroscopy. Homonuclear and Heteronuclear 2D-J-resolved spectroscopy. Correlation spectroscopy (COSY) Homo COSY (^{1}H-^{1}H COSY), TOCSY (Total Correlation Spectroscopy), Hetero COSY (^{1}H,^{13}C COSY,HMQC), long range ^{1}H, ^{13}C COSY (HMBC), NOESY and 2D- INADEQUATE experiments and Introduction to the analytical approach towards the structure elucidation of simple

Combined applications of UV, IR, ^{1}H NMR, ^{13}C NMR and mass spectroscopy: Organic molecules by combined application of UV, IR, ^{1}H NMR ^{13}C NMR and Mass spectra their applications.

SPT-10: NQR and Mossbauer Spectroscopy (15 Hrs)

Nuclear Quadrupole Resonance: Quadrupole nuclei and quadrupole moments-prolate and oblate nuclear charge distributions-energies of quadrupolar transitions-electric field gradient, coupling constants and splitting

Mossbauer Spectroscopy: Principles, Experimental Considerations and Presentation of the Spectrum - Isomer Shifts – Quadrupole splitting and Magnetic hyperfine splitting - Selection Rules.

Iron Compounds: Low-spin and High-spin Fe(II) and Fe(III) Complexes - π-bonding Effects in Iron complexes - Study of High-spin Low-spin Cross-over c) Diamagnetic and Covalent Compounds - Structural aspects of Iron Carbonyls.Tin Compounds: Tin Halides and Organotin Compounds.

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SPT-11: ORD, Photo Electron and AUGER Electron Spectroscopy: (15 Hrs)

Optical Rotatory Dispersion (ORD) spectroscopy: Optical rotation, circular birefringence, circular dichroism and Cotton effect. Plain curves and Anomalous curves and their applications in determining configuration and in study of conformational changes. Empirical and semiempirical rules-The axial haloketone rule, the octant rule, Helicity rule, Lowe's rule. Application to the study of absolute configuration and conformations of organic molecules.

Photoelectron Spectroscopy: Principle and Instrumentation, Types of Photoelectron Spectroscopy – UPS & XPS, Binding Energies, Koopman's Theorem, Chemical Shifts.

Photoelectron Spectra of Simple Molecules: N_2, O_2, F_2, CO, HF, NH_3 and H_2O - Vibrational Structure of PES Bands, Potential energy curves, Interpretation of Vibrational spectral data for ionized (M^+) species, Prediction of Nature of Molecular Orbitals. ESCA in qualitative analysis.

AUGER Electron Spectroscopy: Principles, Instrumentation and Applications.

SPT-12: X-ray Spectroscopy & X-ray Diffraction techniques: (15 Hrs)

X-ray fluorescence (XRF) spectra: Absorption techniques, Absorption edge fine structure (AEFS spectra) and extended X-ray absorption fine structure (EXAFS) spectra Basic Theory, Applications, Instrumentation.

X-ray diffraction: Bragg condition. Miller indices. Experimental methods of X-ray diffraction. Laue method and Debye-Scherrer method. Primitive and nonprimitive unit cells. Index reflections. Identification of unit cells from systematic absences in diffraction pattern. Structure factor and its relation to intensity and electron density. Description of the procedure for an X-ray structure analysis. Typical examples, Advantages and Limitations of X-ray Diffraction.

Electron Diffraction by Gases: Principles - Radial Distribution Curves - Interpretation of Results for simple gas phase molecules-Advantages and Limitations.

Neutron Diffraction: Principles - Application in Hydrogen Bonding Studies - Combined use of X-ray and Neutron Diffraction Studies - Advantages and Limitations.

SUGGESTED BOOKS

1 Spectroscopic identification of organic compounds by R.M.Silverstein. G.C.Bassler and T.E.Morrill.
2 NMR-A multinuclear introduction by William Kemp.
3 Principles of Instrumental analysis, Skoog, Holler and Nieman, Harcourt Asia PTE Ltd.
4 Principles of Instrumental Analysis, Skoog and Leary, Saunders College Publishing.
5 International series of Monographs, Vol. **53**: Photoelectron Spectroscopy, Edited by D. Beckerand D. Betteridge 1972.
6 Sructural methods in inorganic chemistry, E.A.V. Ebsworth.
7 Modern Spectroscopy, J. M. Hollas, John Wiley & sons.
8 Fundamentals of Molecular Spectroscopy, Banwell & McCash.

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9 Introduction to Molecular Spectroscopy, G. M. Barrow, McGraw Hill.

10 Molecular Spectroscopy, J. D. Graybeal, McGraw Hill.

11 Basic principles of Spectroscopy, R. Chang, McGraw Hill.

12 Physical Methods in Chemistry, R. S. Drago, Saunders College.

13 NMR Spectroscopy: Basic principles, concepts and applications in chemistry, H. Gunther, John Wiley & sons.

14 Introduction to Magnetic Resonance, A. Carrington & A.D. Maclachalan, Harper & Row.

15 NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R. V. Parish, Ellis Harwood.

16 NMR basic principles - Atta-ur-Rahman.

17 Two dimensional NMR Spectroscopy-Applications for chemists and biochemists, edited by W. R. Croasmun & R. M. K. Carlson, VCH.

18 X-ray diffraction procedures for polycrysralline and amorphous materials, H. P. Klug & L. E. Alexander, John Wiley.

19 Physical Chemistry, Ira N. Levine, McGraw Hill.

20 Atkin's Physical Chemistry, P. Atkins & Julio de Paula, Oxford University Press.

21 Organic spectroscopy by William Kemp.
22 Spectroscopic methods in organic chemistry by D.H. Williams and I. Fleming.
23 Practical Pharmaceutical Chemistry by A. H. Beckett and J.B. Stenlake.

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PAPER II

MCHE (IC) 302 T: Bonding, Group Theory and its Applications

IC-13: Group Theory, Normal mode analysis and Spectral Activity

IC-14: MOT of Metal Complexes

IC-15: Electronic Spectroscopy of Metal Complexes

IC-16: Infrared (IR) and Raman Spectroscopy

IC-13: Group Theory, Normal Mode Analysis and Spectral Activity

Subgroups-Classes of Symmetry Elements. Representation of Symmetry Elements: Simple Matrices, Block-Factorization, Matrix Representation of *E, C_n, S_n, i and* σ Elements - Representation of Point Groups: Reducible and Irreducible Representations, Character of a Matrix and a Representation, Properties of Irreducible Representations, Construction of Character Tables for some simple Point Groups – Mulliken Symbolism for Irreducible Representations - Standard Reduction Formula – Direct Products.

Normal Modes analysis & Spectral Activity: Number, Type and Symmetry – Symmetry of Normal Modes of Molecules: Cartesian and Internal Coordinate Methods of Analysis – Normal Mode Analysis of Molecules with C_{nv} (n=2,3), C_{2h}, D_{2h}, T_d and O_h Point Groups – Internal Coordinates and Redundancy (Qualitative concept) – Infrared and Raman Activity of Normal Modes (Infinite Groups Excluded)

IC-14: Molecular Orbital Theory of Metal Complexes

Symmetry Classification of Metal and Ligand Orbitals in Cubic and Non-Cubic Environments: Octahedral, Tetrahedral, Square Planar, Square Pyramidal, Trigonal Bipyramidal Geometries – Concept of Ligand Group Orbitals – Construction of Molecular Orbital Energy Level Diagrams for Octahedral, Tetrahedral and Square Planar Metal Complexes with Sigma (σ) and Pi (л) Bonding Contribution from the Ligands.

IC-15: Electronic Spectroscopy of Metal Complexes

Strength of Crystal Fields – Effect of Weak Crystal Fields on Terms – Ligand Field Term Diagrams: Orgel Diagrams for d^1-d^9 Configurations, Strong Field Configurations: The Method of Descending Symmetry, Correlation Diagrams and Tanabe-Sugano Diagrams for d^2 and d^8 Configurations. Classification of Electronic Spectra for Metal Complexes - Electric Dipole Transitions – Magnetic Dipole Transitions – Selection Rules: Orbital Selection Rules and Spin Selection Rules – Relaxation in Selection Rules – Nature of Electronic Spectral Bands: Band Widths, Band Intensities and Factors Influencing Band Shapes – Jahn-Teller Effect – Spectrochemical Series – Nephelauxetic Effect – Crystal Field Spectra of O_h and T_d Metal Complexes of 3d Metals – Calculation of 10Dq Values, Racah Parameter (B) and Nephelauxetic Ratio (β) – Charge Transfer Spectra.

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IC-16: Infrared (IR) and Raman Spectroscopy

Conditions for Infrared and Raman Spectroscopies – Symmetry Based Selection Rules of Infrared and Raman – Complementary Nature of Infrared and Raman Spectroscopies. Symmetry Requirements for Overtone, Binary and Ternary Combination Bands - Fermi Resonance – Prediction of Diagnostic Fundamentals in Isomers of Metal Complexes – Structure Fitting: Determination of Coordination Sites and Linkage Isomers, Assigning Denticity of Ligands and Distinguishing Isomers of Metal Complexes - Effect of Coordination on Ligand Vibrations: Examples involving Mono, Bi and/or Polydentate Ligands of Oxygen, Sulfur, Nitrogen, Phosphorous, Arsenic, Carbon and Halogen Donors. Application of Resonance Raman Spectroscopy to Structural Elucidation of the active Sites of Heme and Non-Heme Oxygen Carriers.

SUGGESTED BOOKS

1. *Symmetry and Spectroscopy of Molecules*, K. Veera Reddy, Second Edition, New Age International (P) Limited Publishers (2009)
2. *Chemical Applications of Group Theory,* F. A. Cotton, 3rd edition, Wiley NY (1990)
3. *Symmetry and Group Theory In Chemistry*, Mark Ladd, Harwood Publishers, London (2000)
4. *Symmetry Through the Eyes of a Chemist,* I. Hargittai and M. Hargittai, 2nd Edition, Plenum Press, NY (1995)
5. *Molecular Symmetry and Group Theory,* Robert L. Carter, John Wiley & Sons (1998)
6. *Group Theory for Chemists,* G. Davidson, Macmillan Physical Science Series (1991)
7. *Molecular Symmetry,* Schoenland
8. *Electronic Spectroscopy,* A. B. P. Lever
9. *Introduction to Ligand fields,* B. N. Figgis
10. *Infrared and Raman Spectroscopy of Inorganic and Coordination Compounds,* K. Nakamoto
11. *Infrared spectroscopy of Inorganic Compound,* Bellamy

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PAPER III (Elective-I)

MCHE (IC) 303 T (E-1): Organometallic Chemistry of Transition Metal Complexes

IC-17: Mono, Di, Tri and Tetra hapto Complexes

IC-18: Penta, Hexa, Hepta and Octa hapto Complexes

IC-19: Catalytic Role of OTMC-I

IC-20: Catalytic Role of OTMC-II

IC-17: Mono, Di, Tri and Tetra hapto Complexes

Nomenclature and Classification based on the number of Coordinated Carbons (hapticity) and number of electrons donated by the Ligand. η1 – Complexes : General methods of Preparation – Bonding of Ligand to Metal :α and β Interaction – Thermodynamic Stability and Kinetic Lability of η1 Complexes –Tertiary Phosphine – Transition Metal Alkyl and Aryl Complexes of Ni, Pd and Pt – Ortho-effect – Bonding in Metal – Carbene and Carbyne Complexes. η2 – Complexes: General methods of preparation of Metal – Alkene Complexes – Structure and Bonding in η2 Complexes – Factors affecting the stability of Metal-Olefin bond – Trans Effect – Rotation of Olefin around Metal-Olefin Bond. η3 - Complexes : Metal-Allyl Complexes – General Preparative Routes – Structure and Bonding in η3 Allyl Complexes – Fluxionality – Reactions of η3 Allyl Complexes. η4 Complexes Structure and Bonding in η4 Complexes – Butadiene and Cyclobutadiene Complexes and their Reactivity.

IC-18: Penta,Hexa,Hepta and Octa hapto Complexes

η5 – Complexes: Classification and General methods of Preparation – Bis (η5-cyclopentadienyl) metal complexes (Metallocenes) – Ferrocene : Structure and Bonding – Reactions of Ferrocene – Mechanism of Electroplilic substitution – Friedel Crafts acylation, alkylation, nitration, halogenation and Metallation Reactions.

η6 Complexes: Metal –Arene Complexes – Dibenzenechromium – Preparation, Structure and Bonding in Bis(arene)-Metal Complexes – Reactions. η7 Complexes: Preparation, Structure and Reactions of η7 – C_7H_7 Complexes. η8 Complexes: C_8H_8 as a Ligand – Cyclooctatetraene Complexes – Preparation, Structure and Bonding in Uranocene.

IC-19: Catalytic Role of OTMC-I

Oxidative addition and Reductive Elimination : Stereochemistry and Mechanism of Oxidative Addition – Insertion Reactions – Hydrogenation of Olefins –Transfer Hydrogenation – Hydrosilation of Olefins – Isomerisation of Olefins – Ziegler –Natta Polymerization of Olefins – Oligomerization of Butadiene Alkene Metathesis.

Oxidation of Olefins to Carbonyl Compounds – Oxidation of Hydrocarbons to Alcohols and Acids – Oxidation of Aldehydes.

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IC-20: Catalytic Role of OTMC- II

Reactions of Carbon monoxide and Hydrogen : Hydroformylation – Carbonylation –Syngas-Water gas shift Reaction (WGS) – Reactions of Syngas. Applications of Metal Clusters in Catalysis: Hydroformylation of Ethylene using $[HRu_3 (CO)_{11}]$ – , Hydrogenation of Olefins. Use of $[Fe_6C (CO)_{16}]$ as a model for Fischer – Tropsch process. Recent Developments in Homogenous Catalysis: Phase Transfer Catalysis (PTC) – Homogeneous Transition Metal Catalyzed Reactions under Phase Transfer Conditions: Hydrogenation. Bio Catalysis : Enzyme Analogue Catalysis : Introduction, Examples of Enzymatic Conversions, Reduction of >C=O and >C=C< bonds, Templates: Introduction, Metal Cations as Templates , Covalent molecules as Templates, External and Internal Templates – Homogeneous Catalysts and their Heterogenization or Immobilization by Aqueous Catalysis.

SUGGESTED BOOKS

1. *Organometallics*-A Concise Introduction, Ch.Eischeinbroich and Salzer-VCH

2. *Organotransition Metal Chemistry Fundamental Concepts and Applications*, John Akio Yamamato, Wiley & Sons.

3. Homogeneous Catalysis by Metal Complexes, M M Taqui Khan and A E Martel

4. Applied Homogenous Catalysis with Organo Metallic Compounds Vol I & II, Boy Cornills and W A Herrmann – VCH

5. Organometallic Compounds, G E Coates, M C H Green, K Wade vol II

6. Advanced Inorganic Chemistry, Cotton and Wilkinson, V & VI Ed

7. Symmetry and spectroscopy, K Veera Reddy

8. Homogenous catalysis, G W Parshall, John Wiley & Sons, New York

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PAPER III (Elective-II)

MCHE (IC) 303 T (E-II): Applied analysis and Green Analytical Chemistry

IC-17: Enzyme catalysis- Analytical applications

IC-18: Forensic Chemical Analysis

IC-19: Green Analytical Chemistry

IC-20: Advanced Separation Techniques

IC-17: Enzyme catalysis- Analytical applications

Basic principles, Catalysis – measurement of catalytic reactions, Nonspecificity of catalysts, types of reactions catalyzed. Enzyme catalysis, enzyme kinetics, properties of enzymes, enzyme inhibitors and activators, enzyme specificity, Determination of enzymes and enzyme substrates. Example of enzymatic analysis: Dehydrogenase reactions, Substrate determinations: Glucose, Uric acid. Immobilized enzymes. Evaluation methods.

IC-18: Forensic Chemical Analysis

Contact traces – Analysis of soil, fiber and paint evidence in forensic work. Analysis of narcotic drugs and psychotropic substances (opiates, cannabinoids, barbiturates, benzodiazepines, amphetamimes with one example each and LSD) by colour / micro crystal tests, chromatographic methods (TLC, GC, and LC) and spectroscopic methods (UV-Vis, IR, MS and GC-MS). Analysis of explosives and explosion residues (Low explosive residues – cations and anions; High explosive residues – RDX) by spot tests, chromatographic methods (TLC, GC AND GCMS) and spectroscopic methods (UV-Vis, IR, MS and GC-MS). Analytical toxicology – extraction techniques for dugs and pesticides – analytical techniques

inforensic toxicology for alcohols, drugs and pesticides involving spot tests (TLC, GC & LCMS). Interpretation of analytical data – court testimony.

IC-19: Green Analytical Chemistry

Green Analytical Chemistry: Concepts and trends "Greening" Sample Treatment: Reduced and solvent- free sample preparation methodologies, alternative solvents, energy saving procedures. Green Instrumental Analysis: Assessment of analytical methods for "Greenness", greening flow injection analysis, chemical sensors, liquid green chromatography.

IC-20: Advanced Separation Techniques

Separations by extractions: Solid phase extraction- Principle, methodology, applications. Solvent extraction of flow injection analysis. Applications to extractions of metal ions by chelating agents (Dithiazone, 8-hydroxy quinoline and cupferron). Organic reagents in Inorganic analysis – Theoretical basis for the use of organic reagents in inorganic analysis. Extraction of metal ions by the use of organic reagents – acetylacetone, thionyl-trifluoroacetone, tri-n-octyl phosphine oxide.

Affinity and chiral chromatography – Principle, technique, Instrumentation and applications.

Size Exclusion Chromatography – Principles of gel – filtration Chromatography, Instrumentation, retention behavior, resolution, selection of gel type, applications,

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Ion exclusion – Principle and applications.

Supercritical fluid chromatography (SFC) – Instrumentation of SFC, stationary and mobile phases used in SFC, Detectors, Advantages of SFC. Technique and applications of SFC.

GC-FT-IR: Instrumentation, Principles and Applications

SUGGESTED BOOKS

1. Analytical Chemistry - Gary D. Christian, 6th ed. John Wiley and sons. Inc, New York,1994.
2. Kinetics methods of analysis – Marck & Rekniz Vol25
3. Practical Pharmaceutical Chemistry, A.H. Beckett et al, 3rd ed. – Vol. 1 & Vol. 2 CBS Publishers & distributors, 1986.
4. Green Analytical Chemistry: Theory & Practice, Miguel De La Guardia, Sergio Armenta, Elsevier
5. Green Analytical Chemistry, Mihkel Koel, Mihkel Kaljurand, RSC Publishing

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PAPER- IV (Elective-I)

MCHE (IC) 304 T (E-I): Photo Chemistry, Thermal Methods

IC-21: Photo Chemistry of Metal Complexes

IC-22: Thermal Methods

IC-23: AAS, AES, ICP-AES

IC-24: Ionization Methods

IC-21: Photo Chemistry of Metal Complexes

Energy, Structure, Electron Distribution and Chemical reactivity of Electronically Excited states of Coordination Compounds. Photochemistry of Cr(III) and Co(III) metal complexes .

Photochemistry of $Cr(CO)_6$,$Mn_2(CO)_6$ and $Fe(CO)_5$.

Sharp line phosphorescence of Ruthenium Bipyridyl and Ortho-phenanthroline Complexes.

Energy transfer Spin Correlation energy levels in the energy Transfer Systems;$[Ru(bipy)_3]^{2+}$ $[Cr(CN)_6]^{3-}$. Metal Sensitizers and Quenchers - Electron Relay.

Photochemical Hydrogen production by oxidative quenching of $[Ru\ (bipy)_3]^{2+}$* by Methyl Viologen.

IC-22: Thermal methods

Thermogravimetry, Differential Thermal Analysis and Differential Scanning Calorimetry, instrumentation. Methodology of TG, DTA and DSC.

Thermomechanical analysis, Dynamic mechanical analysis. Application of TGA, study of oxalates and chromates.

Determination of Glass transition, Heat capacity determination, Characterization of polymer blends.

Problems of based on decomposition path way and % composition.

Thermometric titrimetry – theory, instrumentation, applications.

IC-23: AAS, AES ICP-AES and ICP-MS

Atomic Absorption Spectroscopy (AAS): Principles of AAS, Instrumentation – flame AAS and furnace AAS, resonance line sources, sensitivity and detection limits in AAS, interferences – chemical and spectral, evaluation methods in AAS and application in qualitative and quantitative analysis.

Atomic Emission Spectroscopy (AES): Principles of AES, Instrumentation, evaluation methods, Application in quantitative analysis.

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Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP-AES): Limitations of AES, Principles of plasma spectroscopy, plasma as an excitation source. Inductively coupled plasma source, ICP-AES – Instrumentation. Application of ICP-AES, Comparison with AAS.

ICP-MS: Instrumentation, principles, Quantitative analysis and applications.

IC-24: Ionization Methods

Quantitative mass spectrometry: Introduction and Principles; Calibration and Internal Standards; Selected ion monitoring – Selecting ions for monitoring, sensitivity and specificity; Application based on gas chromatography/mass spectrometry-Analysis of metabolite of drug Imipramine.

Metastable ions and Mass Spectrometry: Origin of metastable ions, the usefulness of metastable ions. Mass Spectrometry / Mass Spectrometry (Tandem Mass Spectrometry. Ion cyclotron resonance spectrometers and Ion traps for MS/MS.

Photo Electron Spectroscopy: X-ray photoelectron spectroscopy (ESCA): X-ray photoelectron spectra of atoms - Ar, Kr and Xe. Applications of ESCA in quantitative analysis.

Valence Electron photoelectron spectroscopy (UV- PES): UV-PES spectra of F_2, Cl_2, Br_2, I_2, CO, HF, NH_3 and H_2O. Comparison of bonding capabilities of CO, N_2 and CS towards metals. Comparison of binding energies in isoelectronic series- Ne, HF, H_2O, NH_3 and CH_4.

Photo electronic spectra of transition metal carbonyls and metal halides.

PES of ferrocene and dibenzene chromium.

SUGGESTED BOOKS.

1. Concepts of Inorganic PhotoChemistry A.W. Adamson and P. D. Fleschaner,Wiley.
2. Inorganic Photochemistry, Journal of Chemical Education, Vol 60. No 10, 1983.
3. Progress in Inorganic Chemistry Vol 30 ed :S.J.Lippard.
4. Coordination Chemistry Reviews Vol 39 1981,p121
5. Photochemistry of Coordination compounds V.Balzani and Carassiti,academic presss.
6. Elements of inorganic Photochemistry G.J.Ferrendi,Wiley,
7. Structure and Bonding Vol 49 1982.
8. Principles of Instrumental Analysis, Skoog, Holler and Nieman.
9 . Instrumental Techniques for Analytical Chemistry, Frank Settle.
10. Principles of Analytical Chemistry, M. Valcarcel.
11. Solid State Chemistry and its Applications, *West.*
12. Introduction to Solids, Azaroff.

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13. Solid State Chemistry, D.K. Chakrabarthy

14. Physical Methods in Chemistry, R. S. Drago

15. Physical Methods in Advanced Inorganic Chemistry, Hill and Day.

16. Instrunmental Methods of Analysis, Sixth edition, CBS Publishers, Willard, Merrit, Dean, and Settle.

17. Mass spectrometry for Chemists and Biochemists, Robert A.W Johnstone and Molcolm. E. Rose second Edn.

18. Chemical structure and Bonding, R.L. Decock and H.B. Gray.

19. Physical methods for Chemists, Russell S. Drago second edition, Saunders College publishing 1992.

20. Structural methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H Rankin and S. Craddeck, ELBS.

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PAPER-IV: (Elective-II)

MCHE (IC) 304 T (E-II): Nuclear Chemistry & Advanced Analytical Techniques

IC-21: Nuclear Chemistry

IC-22: Electroanalytical Methods

IC-23: Surface Analysis Methods/ Microscopicanalysis

IC-24: Fluorimetry, Phosphorimetry, Nephelometry and Turbidimetry

IC-21: Nuclear Chemistry

Introduction: The atomic nucleus-elementary particles, quarks, classification of nuclides based on Z and N values, nuclear stability, nuclear potential, binding energy. Nuclear structure: Shell model-salient features, forms of the nuclear potential, magic numbers, filling of orbitals, nuclear configuration, Liquid drop model, Fermi gas model, Collective model and Optical model. Nuclear reactors :- General aspects of reactor design, thermal, fast and intermediate reactors, reactor fuel materials, reactor moderators and reflects, coolants, control materials, shield, regeneration and breeding of fissile matter, types of research reactors. Nuclear reactions, fission and fusion, radio-analytical, Radioactivity, radioactive decay kinetics, Parent-daughter decay-growth relationship-secular and transient equilibria, theories of α, β-, β+ and γ-decay, internal conversion, Auger effect. Radio isotopes & its applications.

IC-22: Electroanalytical Methods

pH-metry: Accuracy of direct potentiometer measurements. The Glass pH electrode – Theory, construction, standard buffers, accuracy of pH measurements, measurements with the pH – meter, pH titration of unknown soda ash.

Electrogravimetry: Basic principles of electrogravimetry, Instrumentation, electrogravimetry determination with constant applied voltage and at constant current. Applications of electrogravimetry. Problems based on effect of concentration on electrode potentials, calculation of theoretical cathode potential at the start of deposition, effect of pH in electrolytic separations.

Coulometry: Basic principles, Types of coulometers, constant current coulometric analysis, coulometric titrations – principle, circuit and cell for coulometry, Application to neutralization, Redox, precipitation, complexometric titrations, Advantages of coulometric titrations and errors. Controlled potential coulometry – Technique & applications of inorganic & organic compounds.

High Frequency Titrations: Introduction, Theory, Instrumentation, Applications, Advantages and disadvantages.

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IC-23: Surface Analysis Methods/Microscopic Analysis

Introduction, types of surface measurements.

Photon Probe Techniques: X-Ray Photoelectron spectroscopy - Principle, Instrumentation, applications.

Electron Probe Techniques: Scanning electron microscopy (SEM) – Principle, Instrumentation, applications. Transmission Electron Microscopy (TEM) - Principle, Instrumentation, applications. Energy Dispersive X-ray Spectroscopy (EDX) - Principle, Instrumentation, applications. Electron Probe X-ray analysis (EPXMA) - Principle, Instrumentation, applications. Auger electron spectroscopy (AES) - Principle, Instrumentation, applications.

Ion Probe Techniques: Rutherford backscattering spectrometry (RBS) - Principle, Instrumentation, applications. Secondary ion mass spectrometry (SIMS) – Fundamental aspects of sputtering, Principle, Instrumentation (static & dynamic), applications

Scanning probe microscopy Techniques: Scanning Tunneling Microscopy – Principle, Instrumentation, applications. Atomic Force Microscopy - Principle, Instrumentation, applications.

IC-24: Fluorimetry,Phosphorimetry, Nephelometry and Turbidimetry

Fluorimetry and Phosphorimetry: Theory of Fluorescence and Phosphorescence- Excited states producing Fluorescence and Phosphorescence. Rates of absorption and emission. Deactivation processes, Variables affecting Fluorescence and Phosphorescence. Types of Photoluminescence spectra for Phenanthrene. Instrumentation – Components of Fluorimeter, Spectroflourimeters and Phosphorimeters. Applications of Fluorimetry - Determination of Inorganic Cations, Fluorimetric reagents. Fluorimetric determination of organic species – Thiamine, Aneurine Hydrochloride, Polycyclic aromatic hydrocarbons. Phosphorimetry- Determination of Aspirin in blood serum. Chemiluminescence-Origin, measurements. Analytical applications- Atmospheric pollutants (Oxides of Nitrogen and Sulphur compounds, Ozone).

Nephelometry and Turbidimetry: Light scattering, principle and theory ofNephelometry and Turbidimetry, Effect of concentration, particle size and wavelength on scattering, instrumentation for Nephelometry and Turbidimetry. Turbidimetric titrations. Applications of Nephelometry and Turbidimetry.

SUGGESTED BOOKS

1. Essentials of nuclear chemistry, 4th edition; H. J. Arniker, NAIL publishers (1995); Chapters 1, 3 and 4.
2. Nuclear and Radioactive chemistry; Friedlander, Kennedy and Miller; Chapters 8 and 9.
3. Principles and practice of Analytical Chemistry, F.W.Fifield& D Kealey, 5th Ed.Blackwell Science, 2000
4. Principles of Instrumental Analysis: Holler, Skoog and Crouch, 6th education, Cengage Learning 2007.

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5. Instrumental methods of chemical analysis B.K. Sharma, Goel Publishing House.

6. Analytical Chemistry: Gary D Christian.6th edition.

7. Principles of Instrumental Analysis – Skoog, Holler, Nieman, 5th ed., Harcourt College Publishers, 1998.

8. Principles and practice of Analytical Chemistry, F.W.Fifield& D Kealey, 5th Ed. Blackwell Science, 2000.

9. Quantitative Chemical Analysis, Daniel C. Harris, 6th Ed. WH Freeman & Co. NewYork, 2003.

10. Analytical Chemistry an Introduction, Crouch, 7th Ed. Saunders College Publishing,2000

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LABORATORY COURSES – III SEMESTER

MCHE (IC) 301 P: Synthesis and Characterization of Metal Complexes

Laboratory preparation and characterization of *3d* transition metal complexes of *tetrahedral*, *square planar* and *octahedral* geometries.

1. $Mn(acac)_3$
2. $VO(acac)_2$
3. $Ni(DMG)_2$
4. $CoCl_2(Py)_2$
5. $[Co(NH_3)_6][Co(NO_2)_6]$
6. *Cis*-$[Co(trien)(NO_2)_2]Cl.H_2O$
7. $Na[Cr(NH_3)_2(SCN)_4]$
8. $TiO(C_9H_6NO)_2.2H_2O$
9. Prussian Blue, Turnbull's Blue Complexes

SUGGESTED BOOKS

1. *Practical Inorganic Chemistry*, G. Marr and B. W. Rockett.
2. Practical Inorganic Chemistry by G.Pass H.Sutchiffe,2nd edn John Wiley & Sons.
3. *Experimental Inorganic/Physical Chemistry,* M. A. Malati, Horwood Publishing, Chichester, UK (1999)

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MCHE (IC) 302 P: Instrumental Methods of Analysis – I

Potentiometry: Potentiometric Titrations and Calculation of End Point Potentials for the following systems:

i) Fe^{2+} vs Ce^{4+}

ii) Fe^{2+} vs $Cr_2O_7^{2-}$

iii) Fe^{2+} vs MnO_4^-

Use of Ion Selective Electrodes:

i) Copper ion electrode for copper assay

ii) Silver ion electrode for silver assay

iii) Analysis of water for anions

pH-metry

1. Determination of the dissociation constants of i) Ethylenediamine (en)(H_2 L) ii) Glycine (HL) iii)Histidinemonohydrochloride (H_2L)
2. Determination of binary constants of i) Cu(II) -en and (ii) Ni(II) -His systems
3. Deterimanation of stability constant of ternary (o-Phen-Ni(II)-His) system - Calculation of ΔLog K.

SUGGESTED BOOKS

- A Text Book of Quantitative Inorganic Analysis by A.I.Vogel 3rd Edition Elbs Publication 1969.
- Vogel's Text Book Of Quantitative Inorganic Analysis Jeffery etal 4th edition Elbs Publications 1988.
- Vogel's Text Book of Quantitative Chemical Analysis, 6th edition. Pearson Education Ltd 2002.
- Determination and use of Stability Constants – Martell and Motekaitis VCH Publishers INC 1988.
- Metal Complexes in Aqueous Solutions A.E.Martell and R.D. Handcock, Plenum Press, New York – 1996.

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MODEL QUESTION PAPER FOR LABORATORY COURSE

1Q. preparation and characterization of 3d transition metal complexes of _ _ _ _ _ _ _ _ _ _ _

2Q. determine equivalence point for the reaction between _ _ _ vs _ _ _ _ using potentiometry.

3Q. determine stability constant/dissociation constant of _ _ _ _ _ _ _ _ using pH metry.

SCHEME OF EVALUATION

Max. Marks: 100

External Assessment	**80 M**
For the 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

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