DEPARTMENT OF CHEMISTRY
OSMANIA UNIVERSITY
(Effective from academic year 2023-2024 for Campus, Constituent and Affiliated colleges)

Semester I

	Hrs. /week	internal assessment	Semester exam	Total	Credits
CH101T (*)	3	30 marks	70 marks	100 marks	3
CH102T (*)	3	30 marks	70 marks	100 marks	3
CH103T (*)	3	30 marks	70 marks	100 marks	3
CH104T (*)	3	30 marks	70 marks	100 marks	3
CH151P (IC LAB*)	4			50 marks	2
CH152P (OC LAB*)	4			50 marks	2
CH153P (PC LAB*)	4			50 marks	2
CH154P (AC LAB*)	4			50 marks	2
Total				**600 marks**	**20**

Semester II

	Hrs. /week	internal assessment	Semester exam	Total	Credits
CH201T (*)	3	30 marks	70 marks	100 marks	3
CH202T (*)	3	30 marks	70 marks	100 marks	3
CH203T (*)	3	30 marks	70 marks	100 marks	3
CH204T (*)	3	30 marks	70 marks	100 marks	3
CH251P (IC LAB*)	4			50 marks	2
CH252P (OC LAB*)	4			50 marks	2
CH253P (PC LAB*)	4			50 marks	2
CH254P (ACS LAB*)	4			50 marks	2
Total				**600 marks**	**20**

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M.Sc. CHEMISTRY SYLLABUS

(Effective from academic year 2023-2024 for Campus, Constituent and Affiliated colleges)

SEMESTER –I

Semester-I and Semester-II syllabus is common for all specializations i.e., Inorganic, Organic, Physical, Physical- Organic, Analytical and Pharmacoinformatics.

Paper 1: CH 101 (Inorganic Chemistry)

IC 01: Symmetry of molecules
IC 02: Bonding in Metal Complexes-I
IC 03: Coordination equilibria

IC-01: Symmetry of Molecules: **15 hrs**

Symmetry Operations and Symmetry Elements: Rotational axis of symmetry and types of rotational axes, plane of symmetry and types of planes, improper rotational axis of symmetry, inversion center and identity element. Molecular Point Groups: Definition and notation of point groups. Classification of molecules based on molecular point groups. Systematic assignment of point groups to molecules (flow chart). Exercises in molecular point groups: C_1, C_s, C_i, C_n, C_{nv}, C_{nh}, $C_{\infty v}$, D_n, D_{nh}, D_{nd}, $D_{\infty h}$, S_n (n=even), T_d (CH_4, SiH_4), O_h (SF_6), I_h $B_{12}H_{12}^{2-}$), K_h. Descent and ascent in symmetry with substitution (eg.NH_3, CH_4, PCl_5, ML_6). Symmetry restrictions on dipole moment. Symmetry criteria for optical activity.

IC – 02: Bonding in metal complexes – I: **15 hrs**

Crystal Field Theory: Salient features of CFT. d-orbital splitting patterns in regular octahedral, tetrahedral, square planar, tetragonally distorted octahedral, Jahn-Tellar theorem, trigonal bipyramidal, trigonal planar, pentagonal bipyramidal, and linear geometries. Factors influencing magnitude of Δ_o. Concept of weak field and strong fields. Calculation of crystal field stabilization energies (CFSE's) in six and four coordinate complexes. Applications of CFSE-normal and inverse spinels.

Magnetic properties of transition metal complexes: Types of magnetic behavior. Magnetic susceptibility. Calculation of magnetic moment from magnetic susceptibility. Spin only formula. Quenching of orbital angular momentum. Determination of magnetic moment from Guoy's method. Applications of magnetic moment data for the determination of oxidation states, bond type and stereochemistry. Spin crossover.

IC-03: Coordination Equilibria: **15 hrs**

Solvation of metal ions. Metal complex formation in solution. Binary metal complexes. Stability constants: Types (concentration, Thermodynamic and Conditional), stepwise and overall stability constants and relationships between them. Factors influencing the stability constants - (i) Metal ion effects: charge, size, charge/size IP, crystal field effect (Irving-William's order of stability), Jahn-

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Teller effect. (ii) Ligand effects: Basicity, substituent effect, steric, chelate (size and number of chelate rings), macrocyclic and cryptate effects (crown ethers, cryptands, size match selectivity or concept of hole size and its limitations), macrocycles with pendent groups. Pearson's theory of hard and soft acids and bases (HSAB): Principle and applications. Methods used for the determination of stability constants: pH metric, spectrophotometric and polarographic methods. Ternary metal complexes: Definition, formation of ternary metal complexes, step-wise and simultaneous equilibria with simple examples.

References

1. Chemical applications of group theory, F Albert Cotton, 3rd Edition, Wiley India (2009).
2. Symmetry and Spectroscopy of Molecules, K.Veera Reddy, New Age Int. (P) Ltd. (2002)
3. Symmetry in chemistry, Hans H Jaffe, Milton Archin, Dover publications Inc (2002)
4. Molecular symmetry and group theory, Allen Vincent, 2nd Edition, John Wiley & sons Ltd. (2010)
5. Advanced Inorganic Chemistry, F.A.Cotton & G.Wilkinson, 3rd Edition, Wiley Interscience Publications (1972).
6. Advanced Inorganic Chemistry. F.A.Cotton, G.Wilkinson, C.A.Murillo & M.Bochmann, 6th Edition, Wiley Interscience Publications N.Y (1999).
7. Inorganic Chemistry, J.E. Huheey, K.A.Keiter and R.L.Keiter, 4th Edition, Harper Cottens College Publications (1993).
8. Inorganic Chemistry, Keith F.Purcell and John C.Kotz, Holt-Saunders Int. Edn.London (1977).
9. Principles of Inorganic Chemistry, Puri, Sharma, Kalia, 33rd Edition, Vishal Publications (2022).
10. Metal complexes in Aqueous Solutions, A.E Martell and Robert Hancock, Springer Science (1996)

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Paper-II: CH 102 (Organic Chemistry)

OC-01: Stereochemistry

OC-02: Reaction mechanism-1

OC-03: Conformational analysis (Acyclic systems)

OC-01: Stereochemistry **15 hrs**

Molecular representations: Wedge, Fischer, Newman and Saw-horse formulae, their description and interconversions.

Molecular Symmetry & Chirality: Symmetry operations and symmetry elements (Cn & Sn). Criteria for Chirality. Desymmetrization.

Axial, planar and helical chirality: Axially chiral allenes,spiranes,alkylidene cycloalkanes, chiral biaryls, atropisomerism, buttressing effect, planar chiral ansa compounds and trans-cycloalkenes(upto cyclodecene and their methyl analogues), helically chiral compounds and their configurational nomenclature

Relative and absolute configuration: Determination of configuration by chemical correlation methods.

Racemisation and resolution techniques: Racemisation; mechanism Via carbocation, carbanion and free radical. Resolution by direct crystallization, diastereoisomer salt formation chiral chromatography and asymmetrictransformation.

Determination of configuration in E, Z-isomers: Spectral and Chemical methods of configuration determination of E,Z isomers. Determination of configuration in aldoximes and ketoximes.

OC-02: Reaction mechanism-I **15 hrs**

Determination of reaction mechanism: Introduction: product isolation, isolation, detection and trapping of intermediates, addition of suspected intermediate-von Richter rearrangement. Use of isotopes, isotope effects, and crossover experimentds. Use of IR and NMR in the investigation of reaction mechanism

Electrophilic addition to carbon carbon double bond: Stereoselective addition to carbon carbon double bond; *anti* addition: Bromination and epoxidation followed by ring opening. *Syn* addition : OsO_4 and $KMnO_4$.

Elimination reactions Elimination reactions E2, E1, E1CB mechanisms. Orientation and stereoselectivity in E2 eliminations. Pyrolytic *syn* elimination and α-elimination, elimination Vs substitution.

Nucleophilic Aromatic substitution: Aromatic Nucleophilic substitution: $S_N1(Ar)$, S_N2 (Ar),and benzyne mechanisms and evidence.

OC-03: Conformational analysis (acyclic systems) **15hrs**

Conformational isomerism: Introduction to the concept of dynamic stereochemistry. Conformational diastereoisomers and conformational enantiomers. Conformational nomenclature: Conventional method, limitations, Klyne-Prelog terminology. Study of conformations in, dihaloethanes, halohydrin, ethylene glycol, 2,3-dihalobutanes, butane-2, 3-diol, amino alcohols

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and 1,1,2,2-tetrahalobutanes.

Conformations of unsaturated acyclic compounds: Propylene, Acetaldehyde and Butanone

Physical methods for conformational Analysis: Use of dipole moment, UV, IR and NMR, spectral methods in conformationalanalysis.

Conformational affects on the stability and reactivity of acyclic diastereoisomers: Steric and stereoelectronic factors-examples. Conformation and reactivity (E2 eliminations, NGP, Stereochemistry-Rearrangements). The Curtin – Hammett principle.

References

1. Stereochemistry of carbon compounds by Ernest L.Eliel and Samuel H. Wilen
2. Stereochemistry of organic compounds- Principles and Applications by D. Nasipuri
3. Advanced Organic Chemistry by Jerry March
4. Mechanism and Structure in Organic Chemistry S. Mukerjee
5. Organic chemistry by Jonathan Clayden, Nick Greeves and Stuart Warren
6. Organic Reactions and their mechanisms by P.S.Kalsi
7. Stereochemistry: Conformation & Mechanism by P S Kalsi

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Paper-III: CH 103 (Physical Chemistry)

PC-01: Thermodynamics

PC-02: Electrochemistry

PC-03: Quantum Chemistry-I

PC-01: Thermodynamics **(15 hrs)**

Third law of thermodynamics. Evaluation of absolute entropies from heat capacity data for solids, liquids and gases. Standard entropies.

Gibbs equations for non-equilibrium systems. Material equilibrium. Phase equilibium. Clausius-Clapeyron equation. Conditions for equilibrium in a closed system. The chemical potential. Chemical potential of ideal gases. Ideal-gas reaction equilibrium-derivation of equilibrium constant. Temperature dependence of equilibrium constant-the van't Hoff equation.

Solutions: Partial molar properties-significance. Variation of chemical potential with T and P. Gibbs-Duhem equation-derivation and significance.

Ideal solutions. Thermodynamic properties of ideal solutions. Mixing quantities. Vapour pressure - Raoult's law. Thermodynamic properties of ideally dilute solutions. Vapour pressure- Henry's law.

Nonideal systems. Concept of fugacity, fugacity coefficient. Determination of fugacity. Non ideal solutions. Activities and activity coefficients. Standard-state conventions for non-ideal solutions.

Multicomponent phase equilibrium: Vapour pressure lowering, freezing point depression and boiling point elevation

PC-02: Electrochemistry **(15 hrs)**

Electrochemical Cells: Derivation of Nernst equation – problems. Chemical and concentration cells (with and without transference). Liquid junction potential (LJP) – derivation of the expression for LJP – its determination and elimination.

Types of electrodes-Gas electrodes, Metal-metal ion electrodes, reference electrodes, indicator electrode, Ion selective electrodes, Metal-insoluble salt-anion electrodes, Redox electrodes.

Applications of EMF measurements: Solubility product, potentiometric titrations, determination of pH using glass electrode, equilibrium constant measurements. Decomposition potential and its significance. Electrode polarization – its causes and elimination. Concentration over-potential. Concept of activity and activity coefficients in electrolytic solutions. The mean ionic activity coefficient.

Debye-Huckel theory of electrolytic solutions: Debye-Huckel limiting law (derivation not required). Calculation of mean ionic activity coefficient. Limitations of Debye-Huckel theory. Extended Debye-Huckel's law. Theory of electrolytic conductance. Derivation of Debye-Huckel-Onsager equation – its validity and limitations.

PC-03: Quantum Chemistry- I **(15 hrs)**

Wave mechanics and Schrödinger wave equation: Operators- Operator algebra. Commutation of operators, linear operators. Complex functions. Hermitian operators. Operators ∇ and ∇^2. Eigenfunctions and eigenvalues. Degeneracy. Linear combination of eigenfunctions of an operator. Well behaved functions. Normalized and orthogonal functions.

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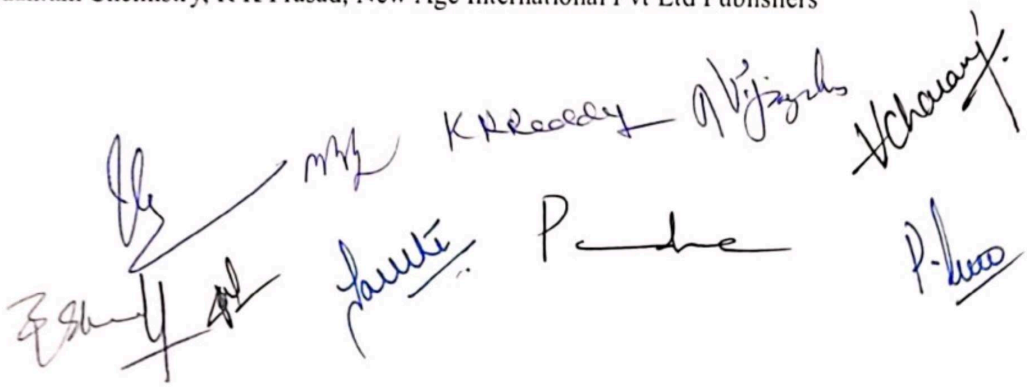
Postulates of quantum mechanics: Physical interpretation of wave function. Observables and Operators. Measurability of operators. Average values of observables. The time dependent Schrodinger equation. Separation of variables and the time-independent Schrodinger equation.

Theorems of quantum mechanics: Real nature of the eigen values of a Hermitian operatorsignificance. Orthogonal nature of the eigen values of a Hermitian operator-significance of orthogonality. Expansion of a function in terms of eigenvalues. Eigen functions of commuting operators-significance. Simultaneous measurement of properties and the uncertainty principle.

Particle in a box- one dimensional and three dimensional: Plots of ψ and ψ^2 -discussion. Degeneracy of energy levels. Calculations using wave functions of the particle in a box, orthoganality, measurability of energy, position and momentum, average values and probabilities. Application to the spectra of conjugated molecules.

References

1. Atkin's Physical Chemistry, Peter Atkins and Julio de Paula, Oxford University press
2. Physical Chemistry, Ira N. Levine, McGraw Hill
3. Physical Chemistry-A Molecular approach, D.A. McQuarrie and J.D. Simon, Viva Books Pvt. Ltd.
4. Molecular Thermodynamics, D.A. McQuarrie and J.D. Simon, University Science Books
5. Introduction to Electrochemistry, S. Glasstone; East-West Press (Pvt.) Ltd.
6. Modern Electrochemistry, J. O. M. Bockris & A. K. N. Reddy, Plenum
7. Principles of physical chemistry, Samuel H. Maron and Carl F. Prutton, Oxford & IBH
8. Physical Organic Chemistry, N. S. Isaacs, ELBS
09. Elementary Quantum Chemistry, F. L. Pilar, McGraw Hill.
10. Quantum Chemistry – D.A. McQuarrie, Viva Publication
11. Quantum Chemistry, Ira N. Levine, Prentice Hall
12. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill
13. Quantum Chemistry, R K Prasad, New Age International Pvt Ltd Publishers



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Paper-IV: CH 104 (Analytical Techniques and Spectroscopy – I)

ASP 01: Techniques of Chromatography & Electronic spectroscopy

ASP 02: NMR spectroscopy-I

ASP 03: Vibrational spectroscopy

ASP-01: Techniques of Chromatography and UV Visible Spectroscopy **15 hrs**

Techniques of Chromatography: Introduction, Classification of chromatographic techniques, differential migration rates, partition ratio, retention time, relation between partition ratio and retention time, capacity factor, selectivity factor. Efficiency of separation - resolution, diffusion, plate theory and rate theory.

GC: Principle, instrumentation, detectors - TCD, FID, ECD. Derivatization techniques. Programmed temperature gas chromatography. GC analysis of hydrocarbons in a mixture.

HPLC: Principle, instrumentation, detectors- UV detectors, Photodiode array detector, fluorescence detector. HPLC analysis of paracetamol tablets.

UV Visible Spectroscopy: Principle, selection rules, Woodward-Fieser rules. Congugated dienes, trienes and polyenes, Unsaturated carbonyl compounds, Benzene, mono substituted derivative (Ph-R), di-substituted derivative (R-C_6H_4-R′) and substituted benzene derivatives (R-C_6H_4-COR′).

ASP 02: NMR spectroscopy-I **15 hrs**

^{1}H NMR spectroscopy: Magnetic properties of nuclei, principles of NMR spectroscopy. Instrumentation: CW and pulsed FT instrumentation. Equivalent and non-equivalent protons. Homotopic, enantiotopic and diastereotopic protons. Chemical shifts, factors affecting the chemical shifts, electronegativity and anisotropy, shielding and deshielding effects. Signal integration. Spin-spin coupling, vicinal, germinal and long range coupling constants, factors affecting coupling constants. Chemically and magnetically equivalent protons.

Applications of ^{1}H NMR spectroscopy: Reaction mechanisms (cyclic bromonium ion, electrophilic and nucleophilic substitutions, carbocations and carbanions), E, Z isomers, conformation of cyclohexane and decalins, keto-enol tautomerism, hydrogen bonding, proton exchange processes (alcohols, amines and carboxylic acids), C-N rotation. Magnetic resonance imaging (MRI). ^{1}H-NMR of organic molecules and metal complexes: ethyl acetate, 2-butanone, mesitylene, paracetamol, asprin, ethylbenzoate, benzyl acetate, 2-chloro propionic acid, $[HNi(OPEt_3)_4]^+$, $[HRh(CN)_5]$ (Rh I= ½).

ASP 03: Vibrational Spectroscopy **15 hrs**

Interaction of electromagnetic radiation with matter. Factors affecting width and intensity of spectral lines.

IR Spectroscopy: Vibrational energy levels of diatomic molecules, selection rules (derivation not required). Calculation of force constant from vibrational frequency. Anharmonic oscillator. Morse potential energy diagram. Fundamental bands, overtones and hot bands, Fermi Resonance.

Vibration rotation spectra of diatomic and poly atomic molecules: Vibration – rotation spectroscopy, P, Q, R branches. Vibration – rotation spectra of polyatomic molecules – linear, symmetric top and asymmetric top molecules. Principles of FTIR.

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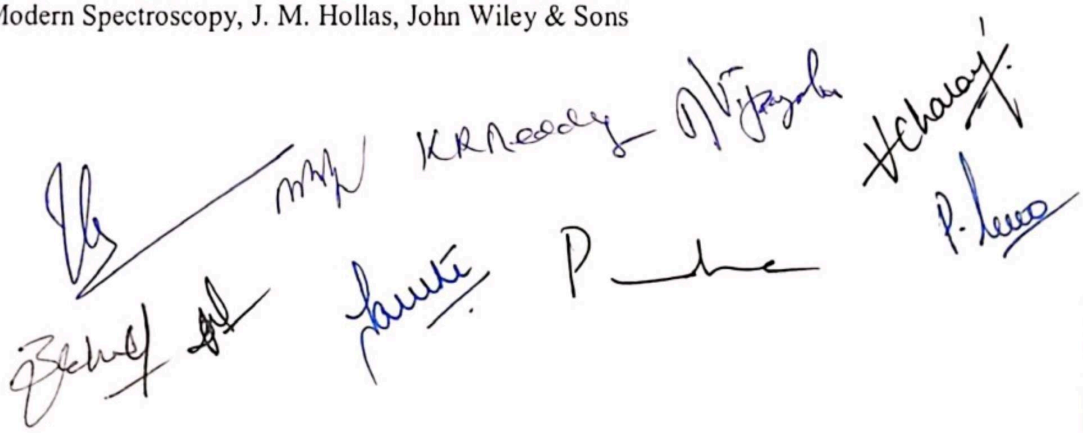
Vibrations of poly atomic molecules: Normal modes of vibration, concept of group frequencies. Characteristics of vibrational frequencies of functional groups; Stereochemical effects on the absorption pattern in carbonyl group, cis-trans isomerism and hydrogen bonding. Isotopic effect on group frequency.

Raman spectroscopy: Classical and quantum theories of Raman effect, Stokes and anti- Stokes lines. Complementary nature of IR and Raman spectra. Pure rotational, vibrational and vibrational – rotational Raman spectra. Selection rules. Depolarization factors of Raman lines and their relevance. Instrumentation and applications of Raman spectroscopy.

References

1. Fundamentals of Molecular Spectroscopy, Banwell and McCash McGraw Hill
2. Introduction to Molecular Spectroscopy, G.M. Barrow, McGrawHill
3. Absorption Spectroscopy of Organic Compounds, J.R. Dyer Prentice-Hall of India Pvt.Ltd
4. Introduction to Spectroscopy, Pavia Lampman Kriz. Cengage learning
5. Pharmaceutical analysis, Watson Elsevier
6. NMR in Chemistry- A multinuclear introduction, William Kemp, Springer
7. Organic Spectroscopy, William Kemp, Palgrave Macmillan
8. Spectroscopy of organic compounds, P.S. Kalsi, New Age International Publishers
9. Structural methods n Inorganic chemistry, E.A.V Ebsworth, John Wiley & Sons.
10. Organic Spectroscopy, LDS Yadav , Springer
11. Elementary Organic Spectroscopy, Y.R. Sharma S. Chand Limited
12. Molecular Spectroscopy by G Arhuldas, PHI Learning Private Ltd. New Delhi.
13. Vibrational Spectroscopy: Theory and Applications, D. N. Sathyanarayana, New Age International
14. Modern Spectroscopy, J. M. Hollas, John Wiley & Sons



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Practicals

Paper CH 151: Inorganic chemistry Lab course **4 hrs/week**

I. Preparation of complexes

1. Hexaammine nickel (II) chloride.
2. Tris (acetylacetanato) manganese(III).
3. Tris(ethylenediamine) nickel(II) thiosulphate.

II. Calibrations

4. Calibration of weights.
5. Calibration of pipettes.
6. Calibration of standard flasks.
7. Calibration of burette.

III. Titrimetric Analysis

8. Estimation of Fe^{2+} by cerimetry
9. Estimation of Ni^{2+} by complexometry (direct titration method)
10. Estimation of Cu^{2+} by complexometry (direct titration method)
11. Estimation of Ca^{2+} by complexometry (substitution titration method)
12. Estimation of Ni^{2+} by complexometry (back titration method)
13. Estimation of Al^{3+} by complexometry (back titration method)

IV. One component Gravimetric Analysis

14. Estimation of Zn^{2+}
15. Estimation of Ba^{2+}

References

1. Text book of Quantitative Inorganic Analysis, 3rd edition, A.I.Vogel, ELBS (1969)
2. Vogel's text book of Quantitative Inorganic analysis, 4th edition, Jeffery etal, ELBS (1988).
3. Vogel's text book of Quantitative Inorganic Analysis, 6th edition, J.Mendham etal, Pearson education ltd (2002).
4. Practical Inorganic chemistry, G.Marr and B.W.Rockett, Van Nostrand Reinhold (1972).
5. Experimental Inorganic/Physical Chemistry – An Investigative integrated approach to Practical Project work, Mounir A.Malati, Woodhead publishing ltd (1999).
6. Advanced experimental Inorganic chemistry, Ayodhya Singh, Campus books international (2006)
7. Practical Inorganic Chemistry, G. Pass & H. Sutcliffe, University science books (1999)

Paper CH 152: Organic Chemistry Lab course **4 hours/ week**

Synthesis of the following compounds:

1 p-Bromoacetanilide
2 p-Bromoaniline,
3 2,4,6- tribromoaniline

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4 1,3,5-Tribromobenzene
5 Tetrahydrocarbazole
6 7-Hydroxy-4-methyl coumarin
7 m-Dinitrobenzene
8 m-Nitroaniline
9 Hippuric acid
10 Azlactone
11 Anthracene-maleicanhydride adduct
12 2,4-Dihydroxyacetophenone
13 Phthalimide
14 Anthranilic acid
15 Methyl-4-nitrobenzoate

References

1. Text book of practical organic chemistry, Vogel
2. Text book of practical organic chemistry, Mann and Saunders.

Paper CH 153 Physical Chemistry Lab course 4 hrs / week

I. Data analysis I: Significant figures, Precision and accuracy

II. Chemical kinetics:

1. Acid-catalyzed hydrolysis of methyl acetate both with 1N HCl
2. Acid-catalyzed hydrolysis of methyl acetate both with 2N HCl
3. Peroxydisulphate-I^- reaction (overall order)
4. Oxidation of iodide ion by hydrogen peroxide-Iodine clock reaction.

III. Conductometry:

5. Determination of cell constant
6. Titration of strong acid vs strong base
7. Titration of weak acid vs strong base
8. Determination of dissociation constant of a weak acid

IV. Potentiometry:

9. Titration of strong acid vs strong base
10. Titration of weak acid vs strong base and determination of dissociation constant of a weak acid.
11. Determination of single electrode potential

V. Polarimetry:

12. Determination of specific rotation of sucrose
13. Determination of specific rotation of glucose
14. Determination of specific rotation of fructose

VI. Adsorption:

15. Adsorption of acetic acid on animal charcoal or silica gel

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References

1. Senior Practical Physical Chemistry B.D. Khosla, V.C. Garg and A. Khosla; R Chand & Co.
2. Experimental Physical Chemistry: V. Athawale and P. Mathur, New Age, International.
3. Practical Physical Chemistry: B. Vishwanathan and P.S. Raghavan, Viva Books.
4. Practical in Physical Chemistry: P.S. Sindhu, Laxmi Publications.
5. Advanced Practical Physical chemistry: J.B.Yadav, Krishna Prakashan Media

Paper CH 154: Analytical Chemistry -I Lab course **4 hrs/week**

I. Applied analysis:

1. Estimation of acetic acid in commercial vinegar by acid base titration method
2. Estimation of iron in cement by dichrometry
3. Estimation of available chlorine in bleaching powder by iodometry
4. Estimation of calcium in calcium tablets by complexometry
5. Estimation of magnesium in talcum powder by complexometry

II. Thin layer chromatography

6. Determination of purity of the compounds prepared in CH 152]
7. Monitoring the progress of chemical reactions for any of the two preparations in CH 152

III. Assay of drugs:

8. Aspirin by acid base back-titration method
9. Ibuprofen by acid base titration method
10. Calcium in calcium gluconate by complexometry

IV. Determination of Physical Properties of Solutions:

11. Determination of molecular weight of a polymer by viscometry
12. Determination of critical solution temperature of phenol-water system
13. Effect of added electrolyte on the CST of phenol-water system

V. Colorimetry

14. Verification of Beer's law and calculation of molar extinction coefficient using $CuSO_4$ solution.
15. Verification of Beer's law and calculation of molar extinction coefficient using $KMnO_4$ solution

References

1. Advanced practical chemistry, R.Mukhopadhyay & P. Chatterjee, NCBA books (2016)
2. Advanced practical inorganic chemistry, Gurdeep Raj, GOEL publishing house (2015)
3. Advanced experimental Inorganic chemistry, Ayodhya Singh, Campus books Int. (2006)
4. Senior Practical Physical Chemistry: B.D. Khosla, V.C. Garg and A. Khosla
5. Advanced Practical Physical Chemistry: J.B.Yadav

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M.Sc. CHEMISTRY SYLLABUS

(Effective from academic year 2023-2024 for Campus, Constituent and Affiliated colleges)

SEMESTER –II

Semester-I and Semester-II syllabus is common for all specializations i.e., Inorganic, Organic, Physical, Physical- Organic, Analytical and Pharmacoinformatics.

Paper-I: CH 201 (Inorganic chemistry)

IC 04: Reaction mechanisms of transition metal complexes

IC 05: Bonding in metal complexes-II

IC 06: Metal clusters ligational aspects of diatomic molecules

IC-04: Reaction mechanisms of transition metal complexes: **15 hrs**

Ligand substitution reactions: Energy profile of a reaction, transition state or activated complex. Types of substitution reactions: (SE, SN, SN^1, SN^2). Langford-Gray classification: A mechanism, D-Mechanism, I-Mechanism I_a, I_d, and Intimate mechanism.

Ligand substitution reactions in octahedral complexes: Aquation or acid hydrolysis reactions, factors affecting acid hydrolysis. base Hydrolysis, conjugate base mechanism, evidences in favour of SN^1CB Mechanism. Substitution reactions without breaking metal-ligand bond. Anation reactions.

Ligand Substitution reactions in square-planar complexes: Mechanism of substitution in square-planar complexes, trans-effect, trans-influence, Grienberg's polarization theory and π - bonding theory, Applications of trans-effect in synthesis of Pt (II) complexes.

Electron transfer reactions (or oxidation-reduction reactions) in coordination compounds: Mechanism of one-electron transfer reactions, atom (or group) transfer or inner sphere mechanism, direct electron transfer or outer sphere mechanism, Factors affecting direct electron transfer reactions, Cross reactions and Marcus-Hush theory.

IC-05: Bonding in Metal Complexes – II: **15 hrs**

Free ion terms and Energy levels: Configurations, terms, states and microstates. Calculation of the number of microstates for p^n and d^n configurations. Vector coupling of orbital angular momenta, spin angular momentum. Spin orbit coupling: L-S (Russel-Saunders) coupling scheme, j-j coupling scheme. Determination of terms for p^1,p^2,d^1 and d^2 configurations of metal ions. Hole formalism. Energy ordering of terms (Hund's rules). Inter – electron repulsion parameters (Racah parameters). Spin-orbital coupling parameters. Effect of weak cubic crystal fields on S,P,D and F terms. Orgel diagrams for (i) d^1, d^4,d^6, d^9 (ii) d^2,d^3,d^7,d^8 (iii) d^5 octahedral and tetrahedral complexes.

IC-06: Metal Clusters and Ligational Aspects of Diatomic molecules **15 hrs**

Metal Clusters: Definition, Factors favouring metal-metal bonding.

Metal carbonyl clusters: Bonding modes of CO: Terminal and bridging. 18 Valence electron rule and its applications. Classification of carbonyl clusters. Low nuclearity carbonyl clusters: M_3 and M_4 clusters, structural patterns in $M_3(CO)_{12}$ (M=Fe, Ru, Os) and $M_4(CO)_{12}$ (M=Co, Rh, Ir) clusters. High nuclearity carbonyl clusters: M_5, M_6, M_7, M_8 and M_{10} clusters. Polyhedral skeletal electron pair theory

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and Total electron count theory. Capping rule. Structural patterns in $[Ni_5(CO)_{12}]^{2-}$, $[Os_6(CO)_{18}]^{2-}$, $[Os_7(CO)_{21}]$, $[Os_8(CO)_{22}]^{2-}$ and $[Os_{10}C(CO)_{24}]^{2-}$. Metal carbonyl scrambling, stereo chemical non-rigidity in $[Rh_4(CO)_{12}]$ and $[Fe_2(Cp)_2(CO)_4]$.

Boranes and carboranes: Wade's rules, STYX rule.

Metal Nitrosyls: Bonding modes of NO: Terminal (linear, bent) and bridging. Structural aspects of $[IrCl(PPh_3)_2(CO)(NO)]^+$ and $[RuCl(PPh_3)_2(NO)_2]^+$. Stereo chemical control of valence in $[Co(diars)_2(NO)_2]^{2+}$ and $[Co(diars)_2(NO)(SCN)]^+$.

Metal Halide clusters: Major structural types in dinuclear metal-metal systems: Edge sharing bioctahedra, face sharing bioctahedra, tetragonal prismatic and trigonal antiprismatic structures. Structure and bonding in $[Re_2Cl_8]^{2-}$ and octahedral halides of $[Mo_6(Cl)_8]^{4+}$ and $[Nb_6(Cl)_{12}]^{2+}$.

References

1. Inorganic reaction mechanisms, M.L.Tobe & John Burgess, Wesley Longman (1999)
2. Reaction mechanisms in metal complexes, K.Veera Reddy, New age publishers (2020)
3. Mechanisms of Reactions at Transition Metal Sites, Richard A Henderson, Oxford Science Primers, London (1993).
4. Mechanisms of inorganic reactions, F.Basalo & R.G.Pearson, 2nd Edition, John Wiley and sons, New York (1967)
5. Inorganic reaction mechanisms, R.K.Sharma, Discovery publishing house (2007)
6. Advanced Inorganic Chemistry. F.A.Cotton, G.Wilkinson, C.A.Murillo and M.Bochmann, 6th Edition, Wiley Interscience, N.Y (1999)
7. Principles of Inorganic Chemistry, Puri,Sharma, Kalia, 33rd Edition, Vishal Publications (2022).
8. Concise coordination chemistry, R Gopalan & V Ramalingam, Vikas publishing house Pvt Ltd (2008)
9. Selected topics in inorganic chemistry, Wahid U. Malik, G.D. Tuli & R.D. Madan, S.Chand & Co Ltd (1998)
10. Concise Inorganic Chemistry, J.D.Lee, 5th Edition, Chapman & Hall (2016).
    Symmetry and Spectroscopy of Molecules. K.Veera Reddy, New Age International (P) Ltd. 2022.
11. Inorganic Chemistry, J.E. Huheey, K.A.Keiter and R.L.Keiter 4 th Edition Harper Cottens College Publications (1993).
12. The Chemistry of Metal Cluster Complexes. D.F.Shriver, H.D.Kaerz and R.D.Adams (Eds), VCH, NY (1990).

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Paper-II: CH 202 (Organic Chemistry)

OC-04: Reaction mechanism-II and Molecular Rearrangements,

OC-05: Pericyclic reactions-I

OC-06: Photochemistry

OC-04: Reaction mechanism-II and Molecular Rearrangements **15 hrs**

Neighbouring group participation (NGP) : Criteria for determining the participation of neighbouring group. Enhanced reaction rates, retention of configuration, isotopic labeling and cyclic intermediates. NGP involving Halogens, Oxygen, Sulphur, Nitrogen, Aryl. Introduction to nonclassical carbocations; NGP Cycloalkyl groups , σ and π- bonds. (Stereospecific examples of NGP to be covered in conformational analysis)

Reactive Intermediates: Generation, detection, structure, stability and reactions of carbenes and nitrenes.

Molecular rearrangements: Definition and classification. Molecular rearrangements involving 1) electron deficient carbon: Allylic and Wolf rearrangement. 2) electron deficient Nitrogen: Lossen, Curtius and Schmidt 3) electron deficient Oxygen: Baeyer-Villiger oxidation. 4) Base catalysed rearrangements: Benzilic acid, Favourski , Transannular , Sommlett-Hauser and Smiles rearrangement

OC-05 Pericyclic reactions **15 hrs.**

Pericyclic reactions: Introduction, Classification of pericyclic reactions into Electrocyclic, cycloadditions, sigmatropic, ene and chelotropic reactions.

Electrocyclic reactions: con rotation and dis rotation. Electrocyclic closure and opening in 4n and 4n+2 systems.

Cycloaddition reactions: Suprafacial and antara facial additions in 4n and4n+2 cycloadditions.

Sigmatropic reactions: [i, j] Suprafacial and antarafacial shifts, Cope and Claisen rearrangement reactions.

Approaches for the interpretation of mechanism of pericyclic reactions: Aromatic Transition States (ATS)/Perturbation Molecular Orbitals (PMO) approach-Concept of Huckel –Mobius aromatic and antiaromatic transition states. Framing Woodward-Hofmann selection rules for all the pericyclic reactions by ATS approach. Solving problems based on ATS approach.

Molecular orbitals: ethylene, 1, 3-butadiene, 1, 3, 5-hexatriene, allyl cation, allyl radical, pentadienyl cation, pentadienyl radical.

Frontier Molecular Orbital (HOMO-LUMO) approach-concept: Framing Woodward-Hofmann selection rules for all the pericyclic reactions by Frontier Molecular Orbital (FMO) approach. Solving problems based on FMO approach.

Conservation of orbital symmetry: (Correlation Diagrams) approach- for electrocylic and cycloadditions & cycloreversions.

OC-06 Organic Photochemistry **15hrs**

Photochemistry: Introduction, p hotochemistry of π-π* transitions: Excited states of alkenes, cis-trans isomerisation, and photo stationary state. Photochemistry of 1,3-butadiene, di-π methane

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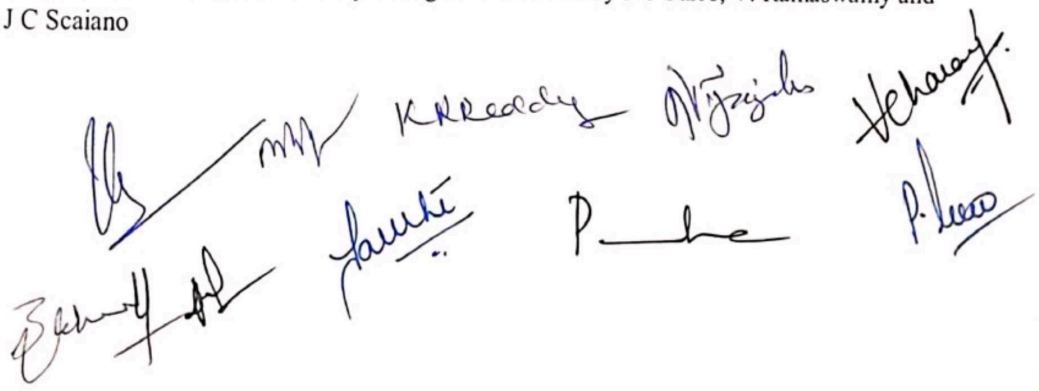
rearrangement. Intermolecular reactions, photocycloadditions, photodimeriastion of simple and conjugated olefins. Addition of olefins to α, β-unsaturated carbonyl compounds. Excited states of aromatic compounds, Photoisimerisation of benzene.

Photochemistry of (n-π*) transitions: Excited states of carbonyl compounds, homolytic cleavage of α- bond, Norrish type I reactions in acyclic and cyclic ketones and strainedcycloalkane diones. Intermolecular abstraction of hydrogen: photoreduction-influence of solvent, nature of hydrogen donor and structure of the substrate.Intramolecular abstraction of hydrogen: Norrish type II reactions in ketones, esters and 1,2diketones, Addition to carbon-carbon multiple bonds, Paterno-Buchi reaction,Photochemistry of nitrites: Barton reaction.

References

1. Stereochemistry of Carbon compounds by Ernest L Eliel / Samuel H. Wilen
2. Stereochemistry of organic compounds – Principles and Applications by D Nasipuri
3. The third dimension in organic chemistry, by Alan Bassindale
4. Stereochemistry: Conformation and Mechanism by P S Kalsi
5. Stereochemistry by V M Potapov
6. Advanced Organic Chemistry by Jerry March
7. Mechanism and Structure in Organic Chemistry S. Mukerjee
8. Maya Shankar Singh, Reactive Intermediates in Organic Chemistry-Structure, mechanism and reactions, Wiley-VCH, 2012.
9. Organic chemistry Vol.I and II by I.L.Finar
10. Comprehensive organic chemistry Vol.5 D.H.R.Barton and W.D..Ollis
11. Pericyclic Reactions - A Textbook: Reactions, Applications and Theory by S. Sankararaman
12. Pericyclic reactions by Ian Flemming.
13. Organic photochemistry by J. M. Coxon and B, Halton
14. Introduction to organic Photochemistry by J. D. Coyle
15. Modern Molecular Photochemistry of Organic Molecules by N J Turro, V. Ramaswamy and J C Scaiano



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Paper-III: CH 203 (Physical Chemistry)

PC-04: Chemical Kinetics and Photochemistry

PC-05: Quantum Chemistry-II

PC-06: Solid State Chemistry:

PC-04: Chemical Kinetics & Photochemistry **(15 hrs)**

Chemical Kinetics: Theories of reaction rates: Collision theory, steric factor. Transition state theory. Hammond's postulate. Thermodynamic formulation of transition state theory. Activation parameters and their significance. The Eyring equation. Unimolecular reactions and Lindamann's theory.

Complex reactions-Opposing reactions, parallel reactions and consecutive reactions (all first order type). Chain reactions-general characteristics, steady state treatment. Example-H_2-Br_2 reaction. Derivation of rate law.

Effect of structure on reactivity-Linear free energy relationships. Hammett and Taft equations-substituent (σ and σ^*) and reaction constant (ρ and ρ^*) with examples. Deviations from Hammett correlations, reasons- Change of mechanism, resonance interaction. Taft four parameter equation.

Photochemistry: The Franck Condon principle. Electronically excited molecules- singlet and triplet states. Radiative life times of excited states-theoretical treatment. Measured life times. Quantum yield. Derivation of fluorescence and phosphorescence quantum yields.

Photophysical processes- photophysical kinetics of unimolecular reactions. Calculation of rate constants of various photophysical processes-problems. Photosensitization. Quenching-Stern-Volmer equation. Introduction to fast reactions- Principle of flash photolysis.

PC-05: Quantum chemistry-II **(15 Hrs)**

Cartesian, Polar and spherical polar coordinates and their interrelations. Schrodinger equation for the hydrogen atom- separation into three equations. Hydrogen like wave functions. Radial and angular functions. Quantum numbers n, l and m and their importance. The radial distribution functions. Hydrogen like orbitals and their representation. Polar plots, contour pots and boundary diagrams.

Many electron systems: Approximate methods. The variation method-variation theorem and its proof. Trial variation function and variation integral. Examples of variational calculations. Particle in a box. Construction of trial function by the method of linear combinations. Variation parameters. Secular equations and secular determinant.

Bonding in molecules: Molecular orbital theory-basic ideas. Construction of MOs by LCAO, H_2^+ ion. The variation integral for H_2^+ ion. Detailed calculation of wave functions and energies for the bonding and antibonding MOs. Physical picture of bonding and antibonding wave functions, energy diagram. The MO wave function and the energy of H_2 molecule MO by LCAO method and Valence bond method (detailed calculations not required)-comparison of MO and VB models.

PC-06: Solid state chemistry **(15 Hrs)**

Electronic properties of metals, insulators and semi-conductors: Electronic structure of solids, Band theory, Fermi level, K space and Brillouin Zones, band structure of metals, insulators and semi-conductors. Electrons, holes and Excitons. The temperature dependence of conductivity of extrinsic semi-conductors. Photo conductivity and photovoltaic effect – p-n junctions.

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Superconductivity: Occurrence of superconductivity. Destruction of superconductivity by magnetic fields – Meissner effect. Types of superconductors. Theories of super conductivity – BCS theory. High temperature superconductors: Structure of defect perovskites. High Tc superconductivity in cuprates. Phase diagram of Y-Ba-Cu-O system. Crystal structure of YBa2Cu3O7-x. Preparation of 1-2-3 materials. Origin of high Tc superconductivity.

Nanoparticles and their applications: Introduction to nanoparticles. Reduced dimensionality in solids: systems with various dimensions -examples.

Preparation of nano particles – top down and bottom up methods. Preparation of nanomaterials- – sol gel methods, chemical vapour deposition method and thermolysis. Characterization of nanoparticles – experimental methods – Powder X-ray Diffraction, Scanning electron microscope (SEM), Transmission Electron Microscopy (TEM), and Atomic Force Microscopy (AFM) (Instrumentation not required). Optical properties of nanoparticles, Applications of nanoparticles.

References

1. Physical Chemistry-A Molecular approach, D.A. McQuarrie and J.D. Simon, Viva Books Pvt Ltd
2. Elements of Physical Chemistry by Peter Atkins and Julio de Paula, Oxford University Press
3. Chemical Kinetics and Reaction Mechanisms, J. H. Espenson, McGraw Hill
4. Chemical Kinetics, K.J. Laidler, McGraw Hill
5. The Physical Basis of Org. Chemistry by Howard Maskill, Oxford Univ. Press (New York)
6. Fundamentals of Photochemistry, K.K.Rohtagi-Mukherji, Wiley-Eastern
7. Molecular Reactions and Photo chemistry by Depuy and Chapman
8. Molecular Photochemistry, N.J. Turro, Benjamin
9. Photochemistry, R.P.Kundall and A. Gilbert, Thomson Nelson
10. Essentials of Molecular Photochemistry by A. Gilbert and J. Baggott, Blackwell Scientific Publications.
11. Organic Photochemistry by J.M.Coxon and B.Halton, Cambridge University press.
12. Introductory Photochemistry by A.Cox and T.J.Kemp. McGraw-Hill, London.
13. Quantum Chemistry, D.A. McQuarrie, Prentice Hall
14. Quantum Chemistry, Ira N. Levine, Prentice Hall
15. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill
16. Quantum Chemistry, R K Prasad, New Age International Pvt Ltd Publishers
17. Elementary Quantum Chemistry, F. L. Pilar, McGraw Hill.
18. Introduction to Solids, Leonid V. Azaroff, Tata McGraw Hill
19. Solid state Chemistry, D.K. Chakrabarthy, New Age International
20. Solid state Chemistry and its aplications, A.R. West, Plenum.
21. Principles of the Solid State, H. V. Keer, New Age International
22. The physics and chemistry of solids by Stephen Elliott, Wiley Publishers.
23. Nanostructured Materials and Nanotechnology, edited by Hari Singh Nalwa, Acad. Press
24. Self-Assembled Nanostructures, Jin Zhang, Zhong-lin Wang, Jun Liu, Shaowei Chen & Gan-Yu-Liu, Kluwer Academic/Plenum
25. Introduction to Nanotechnology, Charles P. Poole Jr, F. J. Owens, Wiley India Pvt. Ltd.

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Paper-IV: CH 204 (Analytical Techniques and Spectroscopy – II) 15 hrs

ASP 04: Electro and Thermal Analytical Techniques

ASP 05: NMR-II and ESR Spectroscopy

ASP 06: Mass spectrometry

ASP- 04: Electro and Thermal Analytical Techniques

Electro analytical techniques: Types and Classification of Electro analytical Methods.

Polarography: Types of polarography: A.C Polarography and D.C Polarography. D.C Polarography: Instrumentation - Dropping mercury electrode, polarogram. Types of Currents: Residual, Migration and Limiting currents. Two and Three electrode assemblies. Ilkovic equation (derivation not necessary) and its consequences. Applications of polarography in qualitative and quantitative analysis. Analysis of mixtures. Application to inorganic and organic compounds. Determination of stability constants of complexes.

Amperometric titrations: Principle, Instrumentation. Types and applications of amperometric titrations. Determination of SO_4^{2-}, metal ions viz., Mg^{2+}, Zn^{2+}, Cu^{2+} and other substances.

Cyclic Voltammetry: Principle, instrumentation, Applications. Cyclic voltammetric study of insecticide parathion. HOMO-LUMO calculations of ferrocene using cyclic voltammetry.

Thermal Analysis:

Introduction, types of thermo analytical methods.

Thermogravimetry: Principle and applications of thermogravimetry- Study of calcium oxalate, calcium sulphate and silver nitrate, Differential thermal analysis: Principle and applications of DTA- Differential thermogram of sulphur,

Differential scanning calorimetry DSC: Principle and application of DSC- determination of glass transition temperatures and heat capacities of PVC and Bakelite.

ASP- 05: NMR-II and ESR Spectroscopy 15 hrs

Multinuclear NMR (^1H, ^{19}F and ^{31}P NMR) and solid state NMR spectroscopy:

First order and non-first order spectra e.g., AX, AX_2, AX_3, A_2X_3, AMX and AB, ABC. Simplification of complex spectra: increased field strength, deuterium exchange, Lanthanide shift reagents and double resonance techniques. Discrimination of enantiomers by use of chiral NMR solvents (CSAs), chiral lanthanide shift reagents and Mosher's acid. Nuclear Overhauser Enhancement (NOE). Fluxional molecules bullvalene, $[\eta^1\text{-}C_5H_5M]$, $[\eta^5\text{-}(C_5H_5)_2Ti\eta^1\text{-}(C_5H_5)_2]$ and $[\eta^4\text{-}C_8H_8Ru(CO)_3]$.

^{19}F NMR spectroscopy: ^{19}F chemical shifts, coupling constants. Applications of ^{19}F NMR involving coupling with ^{19}F, ^1H and ^{31}P: 1,2-dichloro-1,1-difluoro ethane, BrF_5, SF_4, PF_5, ClF_3, IF_5, CF_3CH_2OH.

^{31}P NMR spectroscopy: ^{31}P chemical shifts, coupling constants. Applications of ^{31}P NMR involving coupling with ^{31}P, ^{19}F, ^1H and ^{13}C: ATP, Ph_3PSe, P_4S_3, H_3PO_4, H_3PO_3, H_3PO_2, HPF_2, PF_6^-, PH_3, $[Rh(PPh_3)_3Cl]$ (Rh: I= ½).

Introduction to solid state NMR: Magic angle spinning (MAS). Applications of solid state NMR.

Electron Spin Resonance Spectroscopy: Introduction, principle, instrumentation, selection rules, calculation of 'g'. Study of free radicals.

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ASP - 06: Mass spectrometry **15 hrs**

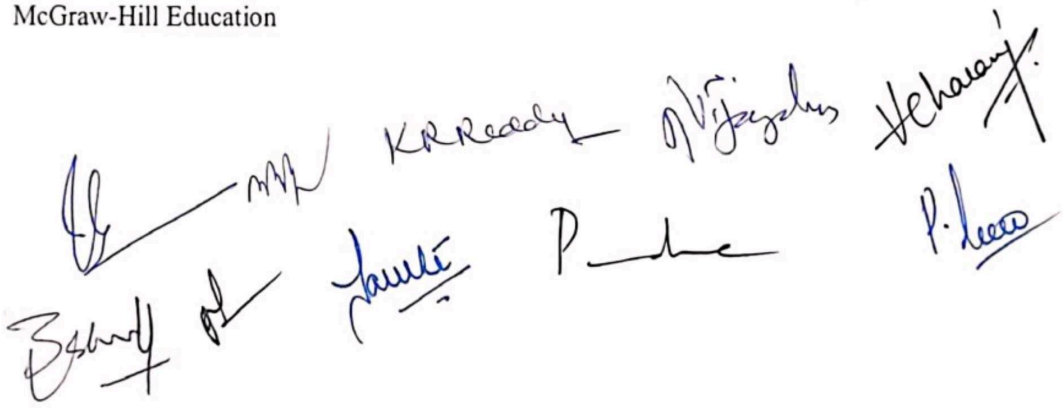
Origin of mass spectrum, principle of EI mass spectrometer. Types of fragments: Odd electron and even electron containing neutral and charged species (even electron rule), Nitrogen rule, isotopic peaks, determination of molecular formula, metastable ion peaks. High resolution mass spectrometry. Salient features of fragmentation pattern of organic compounds including β-cleavage, Mclafferty rearrangement, retro Diels – Alder fragmentation and ortho effect.

Principle of EI, CI, Atmospheric Pressure Ionisation (API), Secondary Ion Mass Spectrometry (SIMS), Electrospray ionization (ESI) and Matrix Assisted Laser Desorption Ionization (MALDI) methods.

Introduction, principle and applications of Gas Chromatography-Mass Spectrometry (GC-MS) and Liquid chromatography-Mass Spectrometry (LC-MS) techniques.

References:

1. Principles of Polarography, Heyrovsky, Elsevier Inc.
2. Principles of Polarography, Kapoor, John Wiley & Sons.
3. Modern Electroanalytical methods, edited by C.C harlot, Elsevier Company.
4. Principles of Instrumental analysis, Skoog, Holler and Nieman, Harcourt Asia PTE Ltd.
5. Analytical Chemistry-An Introduction, Skoog, West, Holler and Crouch, Saunders College Publishing.
6. Principles of Instrumental Analysis, Skoog and Leary, Saunders College Publishing.
7. Spectroscopic identification of organic compounds by R.M. Silverstein and F.X. Webster, John Wiley & Sons
8. Instrumental Methods of Chemical Analysis by B K Sharma, Krishna Prakashan Pvt. Ltd.
9. Instrumental Methods of Analysis by Willard, New York, Van Nostrand
10. Organic spectroscopy by William Kemp, Palgrave Macmillan.
11. NMR-A multinuclear introduction by William Kemp, Springer
12. Spectroscopic methods in organic chemistry by D.H. Williams and I. Fleming McGraw-Hill Education



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Practicals

Paper CH 251: Inorganic chemistry Lab course **4 hours/ week**

I. Preparation of complexes:

1. Mercury tetrathiocyanatocobaltate(II).
2. Chloropentamminecobalt(III) chloride
3. Tetramminecopper(II) sulphate

II. Titrimetric Analysis of two ions in a mixture

4. Estimation of Pb^{2+} and Ca^{2+}
5. Estimation of Zn^{2+} and Mg^{2+}
6. Estimation of Mg^{2+} and Mn^{2+}

III. Analysis of Two component mixtures

7, 8. Separation of Ag^{+} and Ca^{2+} in a mixture and estimation of Ag^{2+} (gravimetric) and Ca^{2+}(volumetric).

9, 10. Separation of Cu^{2+} and Ni^{2+} in a mixture and estimation of Ni^{2+} (gravimetric) and Cu^{2+} (volumetric)

11, 12. Separation of Fe^{3+} and Al^{3+} in a mixture and estimation of Fe^{3+} (volumetric) and Al^{3+}(gravimetric).

IV. Analysis of three component mixtures:

13. Separation of (Ni^{2+} and Cu^{2+}) from Mg^{2+} in the given mixture and estimation of Mg^{2+} gravimetrically

V. Ion exchange methods of analysis:

14. Determination of capacity of an ion exchange resin.
15. Separation of Mg^{2+} and Zn^{2+} on an anion exchange resin and estimation of Mg^{2+} and Zn^{2+}

References

1. Text book of Quantitative Inorganic Analysis, 3rd edition, A.I.Vogel, ELBS (1969)
2. Vogel's text book of Quantitative Inorganic analysis, 4th edition, Jeffery etal, ELBS (1988).
3. Vogel's text book of Quantitative Inorganic Analysis, 6th edition, J.Mendham etal, Pearson education ltd (2002).
4. Practical Inorganic chemistry, G.Marr and B.W.Rockett, Van Nostrand Reinhold (1972).
5. Experimental Inorganic/Physical Chemistry – An Investigative integrated approach to Practical Project work, Mounir A.Malati, Woodhead publishing ltd (1999).
6. Advanced experimental Inorganic chemistry, Ayodhya Singh, Campus books international (2006)
7. Practical Inorganic Chemistry, G. Pass & H. Sutcliffe, University science books (1999)

Paper CH 252: Organic Chemistry Lab course **4 hours/ week**

Identification of organic compounds systematic qualitative analysis:

1. BP / MP, Ignition test, solubility classification
2. Extra elements-N,S & Halogens,(Lassagnine sodium fusion test)
3. p-Nitrobenzoic acid/2-Chloro benzoic Acid

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4. Anisole
5. p- Chlorophenol
6. p-Chloroanilines
7. N-Methyl aniline/N-Ethylaniline
8. N,N-Dimethylaniline
9. Benzamide
10. p-Chloro benzadehyde
11. Acetophenone/ P-Chloro acetophenone,
12. Benzophenone
13. Nitrobenzene
14. Ethylbenzoate
15. Chlorobenzene/ Bromobenzene

References

1. Text book of practical organic chemistry, Vogel
2. Text book of practical organic chemistry, Mann and Saunders.
3. Spectral identification of organic compounds Bassler, Silverstein 5th Edition

Paper CH 253: Physical Chemistry Lab **4hrs /week**

I. Data analysis II: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

II.Distribution:

1. Distribution of I2 between cyclohexane and water
2. Distribution of I2 between cyclohexane and aq.KI solution - calculation of equilibrium constant.

III. Chemical Kinetics:

3. Stoichiometry of Peroxydisulphate - Iodide reaction
4,5. Peroxydisulphate - Iodide reaction: Comparison of strengths of KI solutions by isolation method

IV. Conductometry:

6. Titration of a mixture of strong and weak acids vs strong base
7. Determination of the hydrolysis constant of aniline hydrochloride
8. Determination of solubility product

V. Potentiometry:

9. Titration of Cl^- vs Ag^+ (precipitation titration)
10. Determination of solubility product of sparingly soluble salt

VI. Polarimetry:

11. Inversion of cane sugar catalyzed by 1N HCl
12. Inversion of cane sugar catalyzed by 2N HCl

V. pH metry:

13. Calibration of a pH meter and preparation of phosphate buffers
14. Titration of strong acid vs strong base
15. Titration of weak acid vs strong base and determination of dissociation constant of weak acid

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References

1. Senior Practical Physical Chemistry B.D. Khosla, V.C. Garg and A. Khosla; R Chand & Co.
2. Experimental Physical Chemistry: V. Athawale and P. Mathur, New Age, International.
3. Practical Physical Chemistry: B. Vishwanathan and P.S. Raghavan, Viva Books.
4. Practical in Physical Chemistry: P.S. Sindhu, Laxmi Publications.
5. Advanced Practical Physical chemistry: J.B.Yadav, Krishna Prakashan Media

Paper CH 254: Analytical Chemistry -II & Spectrscopy Lab course **4 hours/ week**

I. Applied analysis:

1. Estimation of alkali content in antacid by acid base titration method
2. Estimation of ascorbic acid in vitamin C by iodometry
3. Estimation of available oxygen in hydrogen peroxide by permanganometry
4. Estimation of calcium in milk by complexometry
5. Determination of hardness of water by complexometry.

II. Spectral analysis: Interpretation of IR, UV, ^{1}H NMR and MS of the following representative compounds

6. An aldehyde
7. An alcohol
8. A carboxylic acid
9. An amine
10. A Ketone

III. Instrumental Analysis:

Conductometry:

11. Titration of a mixture of strong and weak acids vs weak base

Potentiometry:

12. Titration of Fe^{+2} vs $Cr_2O_7^{2-}$ (redox titration)
13. Fe^{2+} vs Ce^{4+} and calculation of formal redox potential of Fe(II)/Fe(III)
14. Fe^{2+} vs MnO_4^- and calculation of formal redox potential of Fe(II)/Fe(III)

pH metry:

15. Titration of a mixture of strong and weak acids vs strong base

References:

1. Vogel's text book of Quantitative Inorganic Analysis, 6th edition, J.Mendham etal, Pearson education ltd (2002)
2. Advanced practical chemistry, R.Mukhopadhyay & P. Chatterjee, NCBA books (2016)
3. Advanced practical inorganic chemistry, Gurdeep Raj, GOEL publishing house (2015)
4. Advanced experimental Inorganic chemistry, Ayodhya Singh, Campus Books International (2006)
5. Senior Practical Physical Chemistry: B.D. Khosla, V.C. Garg and A. Khosla
6. Advanced Practical Physical Chemistry: J.B.Yadav
7. Organic structures from spectra: L. D. Field, S. Sternhell, J. R. Kalman.

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M.Sc. CHEMISTRY

INORGANIC CHEMISTRY SPECIALISATION
SYLLABUS OF III & IV SEMESTERS
REVISED AS PER NEW (CB) SYLLABUS

FOR STUDENTS ADMITTED FROM THE YEAR 2016 ONWARDS

Osmania University

M.Sc. Chemistry (Inorganic Chemistry)III and IV Semesters Programme
(For the batch admitted during the academic year 2016-2017 under the CBCS pattern)
[Under Restructured CBCS Scheme]

	III Semester			
	Course	**Hours**	**Credits**	**Marks**
CORE	**Paper-I: CH(IC)301T: Bonding, Group Theory and its Applications** IC-09: Group Theory, Normal mode analysis and Spectral Activity IC-10: MOT of Metal Complexes IC-11: Electronic Spectroscopy of Metal Complexes IC-12: IR and Raman Spectroscopy	4	4	100
CORE:	**Paper-II: CH(IC) 302T: Organo Metallic Chemistry of Transition Metal Complexes** IC-13: Mono,Di and Trihapto Complexes IC-14: Tetra, Penta, Hexa, Hepta and Octahapto Complexes IC-15: Catalytic Role of OTMC-I IC-16: Catalytic Role of OTMC-II	4	4	100
ELECTIVE IIIa	**Paper-III: CH(IC) 303T: Analytical Techniques-I** IC-17: Data Handling IC-18: AAS, AES, ICP-AES IC-19: Diffraction Methods IC-20: Advanced Mass spectrometry	4	4	100
ELECTIVE IIIb	**Paper-III: CH(IC)303T: Supramolecular Chemistry, Photochemistry, Green Chemistry and Nanotechnology** IC-21: Supramolecular Chemistry IC-22: Photochemistry of Metal Complexes IC-23: Green Chemistry IC-24: Nanotechnology	4	4	100
ELECTIVE IVa	**Paper-IV:CH(IC) 304T: Analytical Techniques-II** IC-25: Thermal Methods IC-26: Surface Analysis Methods/ Microscopic analysis IC-27: Advanced Separation Techniques IC-28: Optical Methods	4	4	100
ELECTIVE IVb	**Paper-IV: CH(IC) 304T: Nuclear Chemistry, Zeolites, Solid State, and Surface Chemistry** IC-29: Nuclear Chemistry IC-30: Zeolites and Molecular Sieves IC-31: Solid State Chemistry IC-32: Surface Chemistry & Superconductors	4	4	100
LABORATORY COURSE -I	**CH (IC) 351P: Synthesis and Characterization of Metal Complexes**	9	4	100
LABORATORY COURSE –II	**CH (IC) 352P: Electro-Analytical techniques**	9	4	100

	IV Semester			
	Course	**Hours**	**Credits**	**Marks**
CORE	**Paper-I: CH(IC)401T: Molecular Spectroscopy of Inorganic Compounds** IC-33: Multinuclear NMR IC-34: Advanced NMR techniques IC-35:Applications of ESR to Metal Complexes IC-36:Mossbauer Spectroscopy and Nuclear Quadrupole Resonance Spectroscopy	4	4	100
CORE	**Paper-II: CH(IC) 402T: Bioinorganic Chemistry** IC-37: Metal ions Interactions with Nucleic acids and their constituents. IC-38: Transport of Electrons and Metal ions. IC-39: Metallo-Enzymes of Iron, Zinc and Nickel. IC-40:Metallo-Enzymes of Cobalt, Copper Molybdenumand Manganese	4	4	100
ELECTIVE IIIa	**Paper-III: CH(IC)403T: Medicinal Inorganic Chemistry, Spectroscopic Analysis of Drug/Metal Complexes and Applications of Nanomaterials** IC-41: Metal complexes in Clinical Chemistry IC-42:Metal complexes as Drugs and Anticancer agents IC-43:Spectroscopic analysis of drug/metal complexes binding to DNA IC-44: Applications of Nanomaterials	4	4	100
ELECTIVE IIIb	**Paper-III:CH(IC)403T:Analytical Techniques-III** IC-45: Electroanalytical Methods IC-46: Radiochemical Methods IC-47: Fluorimetry, Phosphorimetry, Nephelometry and Turbidimetry IC-48: Industrial Analysis	4	4	100
ELECTIVE IVa **(ID Paper)**	**Paper-IV: CH(ID) 404T: Interdisciplinary Course (Environmental and Applied Analysis)** IC-49 : Clinical and Pharmaceutical Analysis IC-50: Food and Agricultural analysis IC-51: Analysis of Air and Water Pollutants IC-52: Drinking Water and Sewage Water Treatment	4	4	100
ELECTIVE IVb **(ID Paper)**	**Paper-IV: CH(ID) 404T: Interdisciplinary Course (Inorganic Material Chemistry)** IC-49 : Composite Materials IC-50: Liquid Crystals IC-51: Explosives and Propellants IC-52: Fuels and Combustion	4	4	100
LABORATORY COURSE –I	**CH (IC) 451P: Conventional Methods of Analysis**	9	4	100
LABORATORY COURSE –II	**CH (IC) 452P: Spectroscopic Techniques**	9	4	100

M.Sc. INORGANIC CHEMISTRY SPECIALIZATION
SEMESTER-III
PAPER I

CH(IC)301T: Bonding Group Theory and its Applications

IC-09: Group Theory, Normal mode analysis and Spectral Activity
IC-10: MOT of Metal Complexes
IC-11: Electronic Spectroscopy of Metal Complexes
IC-12: IR and Raman Spectroscopy

IC-09: Group Theory, Normal Mode Analysis and Spectral Activity
Properties of a Group-Closure rule, Identity rule, associative rule, inverse rule, Abelian and Non-abelian groups. Classes of Symmetry Elements of a Group: Similarity transformation, properties of conjugate elements, salient features about Classes, Classes of C_{2V}, C_{2h} and C_{3V}. Matrix Representation of Symmetry Elements: Simple Matrices, Matrix addition, subtraction and multiplication, Block-Factorization. Matrix Representation of *E*, C_n, S_n, i and σ Elements. Great Orhogonality Theorem: Reducible and Irreducible Representations, Properties of Irreducible Representations, Construction of Character Tables for C_{2V}, C_{2h} and C_{3V}. Mulliken Symbolism for Irreducible Representations - Standard Reduction Formula.
Use of Character tables for IR & Raman spectroscopy, symmetry based selection rules for IR and Raman activity. Type and Symmetry of Normal Modes and IR and Raman activity of molecules: Cartesian coordinate method of analysis for C_{2V} (eg. H_2O, SF_4), C_3V (NH_3, $POCl_3$), C_{2h} (trans-N_2F_2), D_{3h} (BF_3), Td(SO_4^{2-}), Oh (SF_6). Internal coordinate method of analysis for C_{2V} (H_2O), C_3V (NH_3), Td (SO_4^{2-}).

IC-10: Molecular Orbital Theory of Metal Complexes: Limitations of Crystal Field Theory, Adjustments to the Crystal Field Theory to allow for covalence -Experimental evidences for Metal - Ligand orbital overlap. The Adjusted Crystal Field Theory. Introduction to Molecular Orbital Theory. Symmetry Classification of Metal and Ligand Group Orbitals in Cubic and Non-Cubic Environments: Octahedral, Tetrahedral, Square Planar, Square Pyramidal, TrigonalBipyramidal Geometries – Concept of Ligand Group Orbitals – Construction of Molecular Orbital Energy Level Diagrams -Octahedral Metal Complexes with (i) Sigma (σ), (ii) sigma(σ) &Pi (π) and (iii) sigma (σ), Pi (π) and Pi* (π*) bonding contribution from the Ligands - Tetrahedral Metal Complexes with (i) Sigma (σ) and (ii) sigma(σ) &Pi (π), and Square Planar Metal Complexes with (i) Sigma (σ) and (ii) sigma(σ) &Pi (π) bonding contribution from the ligands - Molecular orbital electron configurations and calculation of Magnetic Moments.

IC-11: Electronic Spectroscopy of Metal Complexes
Classification of Electronic Spectra for Metal Complexes, Selection Rules: Electric Dipole Transitions, Magnetic Dipole Transitions, Orbital Selection Rules, Spin Selection Rules, Relaxation in Selection Rules. Nature of Electronic Spectral Bands: Band Widths, Band Intensities. Factors Influencing Band Shapes: Jahn-Teller Effect, Spectrochemical Series, Nephelauxetic Effect. Orgel Diagrams for d^1-d^9 Configurations, Crystal Field Spectra of O_h and T_d Metal Complexes of 3d Metals. Charge Transfer Spectra. Strong Field Configurations: The Method of Descending Symmetry, Correlation Diagrams and Tanabe-Sugano Diagrams for d^2 and d^8 Configurations. Calculation of 10Dq Values, Racah Parameter (B) and Nephelauxetic Ratio (β).

IC-12: Infrared and Raman Spectroscopy
Conditions for Infrared and Raman Spectroscopies, Direct product – symmetry requirements for overtones, binary and ternary combination bands. Partial Normal mode analysis-Structure Fitting, Determination of Coordination Sites and Linkage Isomers(NO_2^- , SCN^-), Assigning Denticity of

Ligands (SO_4^{2-}, CO_3^{2-}), Prediction of Diagnostic Fundamentals in Isomers of Metal Complexes and Distinguishing Isomers of Metal Complexes. Effect of Coordination on Ligand Vibrations: Examples involving Mono, Bi and/or Polydentate Ligands of Oxygen, Nitrogen, Carbon and Halogen Donors (NH_3, H_2O, Glycine, Carbonyl and halides). Raman effect and molecular structure- CO, HCN, CO_2, N_2O, H_2O. Principles of Resonance Raman Spectroscopy. 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.

PAPER II

CH(IC)302T: Organo Metallic Chemistry of Transition Metal Complexes

IC-13: Mono,Di and Trihapto Complexes
IC-14: Tetra, Penta, Hexa, Hepta and Octahapto Complexes
IC-15: Catalytic Role of OTMC-I
IC-16: Catalytic Role of OTMC-II

IC-13: Mono, Di and Tri hapto Complexes

Nomenclature and Classification based on the number of Coordinated Carbons (hapticity) and number of electrons donated by the Ligand. 16 and 18 electron rules. Electron countingcovalentand ionic models. η^1 – Complexes : General methods of Preparation –Bonding of Ligand to Metal :αand βInteraction and agostic interaction– Stability and decomposition pathways –η^1 Complexes –Tertiary Phosphine – Transition Metal Alkyl and Aryl Complexes of Pt – Ortho-effect – Bonding in Metal – Carbene and Carbyne Complexes. η^2 –Complexes: General methods of preparation of Metal – Alkene Complexes – Structure and Bonding in η^2 Complexes-Zeises salt – 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.

IC-14: Tetra, Penta,Hexa,Hepta and Octahapto Complexes

η4 Complexes: Structure and Bonding in η4 Complexes –Butadiene and Cyclobutadiene Complexes. η5 – Complexes: 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.

η^6Complexes : Metal –Arene Complexes – Dibenzenechromium – Preparation, Structure and Bonding in Bis(arene)-Metal Complexes – Reactions. η^7Complexes : Preparation , Structure and Reactions of η^7 –

C_7H_7 Complexes. η^8Complexes : C_8H_8 as a Ligand – Cyclooctatetraene Complexes – Preparation, Structure and Bonding in Uranocene.

IC-15: 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. Dupont-1,4-hexadiene synthesis.Oxidation of Olefins to Carbonyl Compounds – Oxidation of Hydrocarbons to Alcohols and Acids – Oxidation of Aldehydes, Cyclohexanol, Cyclohexanone, p-Xylene.

IC-16: 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 $[Fe_4C(CO)14]$ 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 theirHeterogenization 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 AkioYamamato, Wiley & Sons.
3.Homogeneous Catalysis by Metal Complexes, M MTaqui Khan and A E Martel
4. Applied Homogenous Catalysis with Organo Metallic Compounds Vol I & II, Boy Cornillsand 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
9. Basic organometallic Chemistry, B.D. Gupta / A. J. Elias

PAPER III

CH(IC) 303T (Elective IIIa): Analytical Techniques - I

IC-17: Data Handling
IC-18: AAS, AES, ICP-AES
IC-19: Diffraction Methods
IC-20: Advanced Mass spectrometry

IC-17: 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-18: AAS, AES, ICP-AES

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.

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.

Flame Photometry: Principle, Theory, Instrumentation and Applications

IC-19: Diffraction Methods

X – ray Diffraction : X –rays and their generation – choice of radiation ; Miller indices, Braggs equation, Experimental methods – Powder and single crystal methods, Indexing the reflections, Systematic absences, Electron density studies by X – rays – Platinum phthalocyanine complex, Silyl acetate, Tetraalkylbiphosphate ; Advantages and limitations of X – ray Diffraction.

Electron Diffraction by gases :Principles , Radial distribution curves- Interpretation of results for $PBrF_2S$, PF_3S, PF_2HS, $HClO_4$, Silylmonothioacetate and Germylmonothioacetate and $HgCl_2$ molecules, Advantages and Limitations

Neutron Diffraction: Principle, Application in Hydrogen bonding studies, combined use of X – ray and Neutron diffraction studies, Advantages and limitations.

IC-20: Advanced Mass spectrometry

Mass Analyzers: Quadruple, Ion traps, Time of flight (TOF) mass analyzers

Mass Spectrometry / Mass Spectrometry: Tandem Mass Spectrometry, Instrumentation, Applications.

Hyphenated Techniques: GC-MS Principle, instrumentation, Interfaces- Direct coupling interface and open split interface. Application based on gas chromatography/mass spectrometry-Analysis of metabolite of drug Imipramine. **LC-MS-** principle, Instrumentation – Interfaces- Moving belt interface, particle beam interface, thermospray interface, Electrospray interface, atmospheric pressure chemical ionization interface.**ICP – MS** - Principle Instrumentation, and Applications.

Matrix-assisted laser desorption/ionization-Time of flight Mass spectrometry (MALDI-TOF-MS): Principle, Matrix, Sample Preparation for MALDI-MS - Dried droplet Crystallization, Thin layer method, Sandwich Crystallization, Instrumentation, Applications

SUGGESTED BOOKS

1. Analytical Chemistry, Gary Christian, VI Ed, John Wiley & Sons Inc, New York.
2. Instrumental Methods of Chemical Analysis, H. Kaur.
3. Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed, Pearson EducationLtd.
4. Principles of Instrumental Analysis, Skoog, Holler and Nieman.
5. Instrumental Techniques for Analytical Chemistry, Frank Settle.
6. Principles of Analytical Chemistry, M. Valcarcel.
7. Solid State Chemistry and its Applications, *West.*
8. Introduction to Solids, Azaroff.
9. Solid State Chemistry, D.K. Chakrabarthy
10. Physical Methods in Advanced Inorganic Chemistry, Hill and Day.
11. Instrumental Methods of Analysis, Sixth edition, CBS Publishers, Willard, Merrit, Dean,and Settle.
12. Mass spectrometry for Chemists and Biochemists, Robert A.W Johnstone and Molcolm. E.Rose, second Edn.
13. Physical methods for Chemists, Russell S. Drago second edition, Saunders Collegepublishing 1992.
14. Structural methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H Rankin and S.Craddeck, ELBS.

15. Mass Spectrometry Basics, Herbert, Christopher G.; Johnstone, Robert A.W., CRC Press.
16. Mass Spectrometry-A Textbook by Jürgen H. Gross, © Springer-Verlag Berlin Heidelberg 2004, Printed in Germany.
17. Matrix-assisted laser desorption/ionization - https://en.wikipedia.org/wiki/Matrix-assisted_laser_desorption/ionization

PAPER III

CH(IC) 303T (Elective IIIb): Supramolecular Chemistry, Photochemistry, Green Chemistry and Nanotechnology

IC-21: Supramolecular Chemistry
IC-22: Photochemistry of Metal Complexes
IC-23: Green Chemistry
IC-24: Nanotechnology

IC-21: Supramolecular Chemistry

Host – Guest chemistry: Definition and different types of host and guests with examples – types of non-covalent interactions – binding constants of host guest complex and thermo dynamics involved in it – designing principles of host.

Cation guest binding – binding between metal cations and macro cycles – chelate and cryptate effects – relationship between cavity size of host and cation radius and stability of resultant complexes – binding of macro cycles having secondary binding sites.

Anion guest binding – different hosts for anionic guests capable of binding through electro static interactions, hydrogen bonds, lewis acidic hosts – enhancement of binding strength using more than non-covalent interactions.

Neutral guest binding – binding of neutral guest using hydrogen bonding, π - π stacking, hydrophobic effect and charge transfer interactions – simultaneous binding of cation and anion guests – cascade approach, individual binding sites and zwitter ions approach –present and future applications – phase transfer agents – separation of mixtures – molecular sensors – switches and molecular machinery.

IC-22: Photochemistry 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 $Cr(CO)6$,$Mn_2(CO)_{10}$ and $Fe(CO)_5$.

Structuredphosphorescence 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-23: 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.

Industrial case studies: A brighter shade of green – greening of acetic acid, Vitamin C synthesis –enzyme routes. Polythene manufacture-metallocene catalysis.

IC-24: 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 C_{60}, structure of C_{60} and its crystal, alkali doped C_{60}, superconductivity in C_{60}.
Carbon nanotubes: Fabrication, structure, electrical properties, vibrational properties, mechanical properties.
Nanophase and nanostructured materials: **Micells and Microemulsions -** Formation mechanisms of micelles and microemulsions, the critical Micelle Concentration (CMC) for surfactants, Solubilization and Formation of Microemulsions. **Synthesis of Nanoparticles from W/O Microemulsions:** Preparation of Nanoparticles of Metals, Metal Sulfides, Metal Salts, Metal oxides, Nanowires. **Synthesis of Organic Nanoparticles from O/W Microemulsions:** Styrene Latex NanoParticles, Methylmethacrylate Nanoparticles. Sol -Gel process for the fabrication of Glassy and Ceramic materials.

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
4. Concepts of Inorganic PhotoChemistry A.W. Adamson and P. D. Fleschaner,Wiley.
5. Inorganic Photochemistry, Journal of Chemical Education, Vol 60. No 10, 1983.
6. Progress in Inorganic Chemistry Vol 30 ed :S.J.Lippard.
7. Coordination Chemistry Reviews Vol 39 1981,p121
8. Photochemistry of Coordination compounds V.Balzani and Carassiti,academicpresss.
9. Elements of inorganic Photochemistry G.J.Ferrendi,Wiley,
10. Structure and Bonding Vol 49 1982.
11. Separation Methods - M. N. Sastri, 1st ed., Himalaya Publishers, 1991.
12. Principles of Instrumental Analysis – Skoog, Holler, Nieman, 5th ed., Harcourt CollegePublishers, 1998.
13. Analytical Chemistry - Gary Christian, 6th ed, John Wiley and sons. Inc., New York, sixth edition, 1994.
14.Green Chemistry- An Introductory text by Mike Lancaster- RSC.
15. Green Chemistry: Theory and Practice by John C. Warner Paul T. Anastas.
16. Introduction to nanotechnology by Charles P. Poole Jr, Frank J. Owens- Wiley StudentEdition 2006.
17. Hand Book of Nanophase Materials by A.N. Gold Stein ed,Marcel Decker, New York, 1997, Chapter1
18. Clusters of Transition Atoms" by Morse, Chem. Rev 86, 1049 (1986).
19. Hand Book of Nanostructured materials by P.M. Ajayan, H.S Nalwa, ed, AcademicPress, San Diego, 2000, Vol. 5, Chapter 6.
20. Hand Book of Nanophase and Nanostructured materials, volume I: Synthesis, Zhong Lin Wang, Yi Liu,Ze Zhang.

PAPER IV

CH(IC) 304T (Elective IVa): Analytical Techniques-II

IC-25: Thermal Methods
IC-26: Surface Analysis Methods/ Microscopicanalysis
IC-27: Advanced Separation Techniques
IC-28: Optical Methods

IC-25: Thermal Methods

Thermogravimetric analysis (TGA): Principle, Instrumentation, working function of each component, applications of TGA, Study of oxalates, nitrates and chromates by TGA. Determination of carbon black in polythene.

Differential thermal analysis (DTA): Principle, Instrumentation, Methodology, applications. Differential thermogram of sulphur. TG and DTA of manganese phosphine monohydrate.

Differential scanning calorimetry (DSC): Principle, instrumentation, power compensated DSC instruments and Heat flow DSC instruments, Methodology, DSC experiment calibration and data analysis. Applications determination Glass transition temperatures and heat capacities, problems based on Thermal Techniques:

Thermometric titrations: Principle, apparatus, applications to acid base, precipitation, complexometric, redox and non-aqueous titrations.

Combined thermal instruments: Introduction to TGA/MS and TGA/FTIR, High resolution TGA, Microthermal analysis.

IC-26: Surface Analysis Methods/ Microscopic analysis

Introduction, types of surface measurements.

Photon Probe Tecnhniques: 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-27: 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, **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

IC-28: Optical Methods

CD, ORD and Fluorescence: Optical rotator dispersion and Circular dichorism: Principles - Optical rotation, circular birefringence, circular dichroism and Cotton effect, Octet Rule, Experimental Techniques, Use of CD in the conformational studies of metal complexes, DNA and DNA-metal complexes.Theory and principles of fluorescence spectroscopy. Characteristic of fluorescence emission, Fluorescence life time, quantum yield, Static and dynamic/collisional quenching and comparison.
Fluorescence polarization and polarization spectra of a fluorophore. Application of Fluorescence quenching in general and ligand/drug/metal complex DNA binding studies

SUGGESTED BOOKS

1. Principles of Instrumental Analysis: Holler, Skoog and Ccrouch, 6th edition ,Cengage Learning 2007.
2. Instrumental methods of chemical analysis B.K. Sharma, Goel Publishing House.
3. Instrumental Methods of analysis, Willard Mersritt, Dean and Settle, 7th edition, CBS Publishers 1986.
4. Analytical Chemistry – Gary D. Christian, 6th ed., John Wiley and sons. Inc., New York 1994.
5. Instrumental methods of Analysis - Willard, Merit, Dean, 6th ed., CBS Publishers & distributors, 1986.
6. Hand Book for Instrumental Techniques for Analytical Chemistry, Ed. Frank Settle, Prentice Hall, New Jersey, USA, 1997.
7. Vogel's Text book of Quantitative Analysis – GJ Jeffery, J Bassett et al, 5th ed., Longmann, ELBS Publications, 2000.
8. Principles of fluorescence spectroscopes – Lakowicz.
9. Fluorescence Quenching theory and applications – Maurice R. Eftink.
10. Circular Dichroism Spectroscopes of DNA Methods in Enzymology Vol 211.
11. Tris (Phenanthroline) Metal complexes: probes for DNA Helicity Journal of Biomolecular structure and Dynamics Adenine Press 1983. G.L. Eichorn.8
12. Tris (Phenanthroline) Ru(II) Enantiomers interactions with DNA : Mode and specificity of binding J.B. Chaires. Biochemistry 1993 (32) 2573

PAPER IV

CH(IC) 304T (Elective IVb): Nuclear Chemistry, Zeolites, Solid State, and Surface Chemistry

IC-29: Nuclear Chemistry
IC-30: Zeolites and Molecular Sieves
IC-31: Solid State Chemistry
IC-32: Surface Chemistry & Superconductors

IC-29: 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-30: Zeolites and Molecular Sieves

Introduction to porous materials:

Classification into micro-, meso- and macro porous materials, the origin of pores and its significance, distinction from condensed materials.

Zeolites:

Definition, natural and synthetic zeolite or aluminosilicates, the primary and secondary building blocks, final framework structures, Lowensteins rule, sodalite and other structures, Nomenclature: Atlas of zeolite; structural distinctions, Novel zeolites, examplels of small, medium, large and extra large pore zeolites; general properties and application of molecular sieves.

Characterization of zeolite:

XRD, SEM and other techniques; spectral techniques: FT-IR and solid-state NMR; sorption capacity, surface area by BET method, pore volume and pore structure, the origin of Brönsted and lewis acidity in zeolites, the number and the strength, techniques for the estimation of acidity: adsorption of bases and IR spectra, temperature programmed desorption of bases.

IC-31: Solid State Chemistry

Electronic structure of solids and band theory, Fermi level, K Space and Brillouin Zones.

Structure of ionic Crystals & Compounds: Ionic Crystals with stoichiometry MX, Ionic Crystals with stoichiometry MX_2, spinel structure, perovskite structure. AB [nickel arsenide (NiAs)], AB_2[fluorite (CaF_2) and anti-fluorite structures, rutile (TiO_2) structure and layer structure [cadmium chloride and iodide ($CdCl_2$, CdI_2)].

Crystal Defects and non-stoichiometry:

Classification of Defects: subatomic, atomic and lattice defects in solids; Thermodynamics of vacancy in metals; Thermodynamics of Schottky defects in ionic solids ; Thermodynamics of Frenkel defects in silver halides; Calculation of number of defects and average energy required for defect, Other examples of defect structure; Non-stoichiometry and its classifications.

Preparative method of solids:

Introduction, Ceramic method, microwave synthesis, Precursor method, Hydrothermal method, Chemical vapour deposition (CVD) Method, Chemical vapour Transport, Choosing a method for solids.

Crystal Growth: law governing nucleation; Growth of nuclei; Reaction between two solids; Improving the reactivity of solids; Zone refining method; Crystal growth.

IC-32: Surface Chemistry & Superconductors

Surface Chemistry:

Mechanism of catalytic reactions on the surfaces – diffusion of reactants to the surfaces, adsorption of reactants, reaction within the adsorbed layer, desorption of the products, diffusion of the products away from the surface; The mechanism of chemisorption on metals – The formation of chemisorptions layer, the character and nature of the chemisorption bond, the mechanism of chemisorptions for some gases; Nature of adsorbates on surfaces.

Superconductors:

Discovery of super conductors, Meissner effect, Type I and II conductors, Leavitation, BCS theory and Cooper pairs, High Tc Super Conductors, applications of super conductors.

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 8and 9.
3.Introduction to zeolite science and practice, H. Van Bekkum, E. M. Flanigen, P. A. Jacobs and J. C. Jansen (Elseviver Pub. Amsterdam, 2001)
4.Breck.D.w. Zeolites molecular sieves- Structure, chemistry and use. John Wiley & Sons N.Y. (1974).
5.Solid-State Chemistry an Introduction (2nd Edition) – Lasley Smart and Elaine Moore (Chapman & Hall 1996)
6. Solid State Chemistry- D.K.Chakraborty(New Age International Pvt.Ltd.New Delhi, 2000)
7. Introduction to Soilds-L.V.Azaroff(tata McGraw Hill Publication Ltd. New York)
8. Principles of the Solid State-H.V.Keer(Wiley Eastern Ltd.New Delhi, 1994)
9. Solid state Chemistry –N.B.Hannay(Prentice Hall, New Jersey, 1967)
10.Superconductivity, Joi, Khachan& Stephen Bio Science, -----
11.Chemisorption, B. M. W. Trapnell, Butterworths Scientific Publications, London, 1955.
12.Adsorption on solids, VladimirPonec, ZlatkoKnor, SlavojCerny, Butterworth & Co – publishers, 1974.
13.Catalysis: Principle and Applications, B. Viswanathan, S. Sivasanker, A. V. Ramaswamy, Narosa Publishing House, 2002.

LABORATORY COURSES (III Semester)

Paper CH (IC) 351: Synthesis and Characterization of Metal Complexes

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

1. $VO(acac)_2$
2. $CoCl_2(Py)_2$
3. $Na[Cr(NH_3)_2(SCN)_4]$
4. Prussian Blue, Turnbull's Blue Complexes
5. $K_3[Cr(C_2O_4)_3]$ $3H_2O$: UV, IR, TGA and estimation of oxalate.
6. Solid phase synthesis of trans-bis(glycinato)copper(II): IR, estimation of Cu by iodometry
7. $Fe(acac)_3$: FTIR
8. Cis and trans $[CoCl_2(en)_2]Cl$: conversion of cis to trans and trans to cis by IR.
9. Potassium bis(peroxo)oxo(1,10-phenanthroline)vanadium(V) trihydrate: IR,TGA, estimation of vanadium and peroxide
10. Tetra-butylammoniumhexamolybdate(VI): IR, estimation of Mo
11. MnO_2nano particles; SEM, SEM by adding CTAB

SUGGESTED BOOKS

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

Paper CH (IC) 352: Electro-analytical techniques

I Potentiometry

Potentiometric Titrations and Calculation of End Point Potentials for the following systems:
i) $Fe^{2+}$and VO^{2+} Mixture vs Ce^{4+}
ii) Assay of sulphanilamide
iii) Silver electrode for silver assay
iv) Mixture of halide anions using Silver electrode

II pH-metry

1. Determination of CO_3^{2-} and HCO_3^- in a mixture
2. Determination of the dissociation constants of

(i) Ethylenediamine (en)(H_2 L) (ii) Glycine (HL) (iii) Histidinemonohydrochloride (H_2L)

3. Determination of binary constants of i) Cu(II) -en and (ii) Ni(II) -His iii) Ni(II) – Gly Systems
4. Determination of stability constant of ternary (o-Phen-Ni(II)-His) system - Calculation of Log K.

III Conductometry:

1. Determination of the Composition of Cu(II)-oxine and Cu(II)-EDTA Complexes
2. Interaction of Pyrophosphate with Mg^{2+}, Ca^{2+}, Mn^{2+} and Cu^{2+}
3. Determination of Aspirin with KOH

IV Ion selective electrodes method (Ionimetry)

1. Estimation of fluoride ion in water
2. Estimation of nitrate ion in water
3. Estimation of ammonia in water

V Polarography

1. Determination of $E_{½}$ of Cd^{2+} and Pb^{2+}
2. Verification of Ilkovic equation by using Cd^{2+} solution
3. Determination of Stability Constants of Cd^{2+} and Pb^{2+} complexes

VI Electrogravimetry

1. Determination of Copper and Nickel individually and in a Mixture

SUGGESTED BOOKS

1. A Text Book of Quantitative Inorganic Analysis by A.I.Vogel 3rd Edition Elbs Publication 1969.
2. Vogel's Text Book Of Quantitative Inorganic Analysis Jeffery etal 4th edition Elbs Publications 1988.
3. Vogel's Text Book of Quantitative Chemical Analysis, 6th edition. Pearson Education Ltd 2002.
4. Determination and use of Stability Constants – Martell and Motekaitis VCH Publishers INC 1988.
5. Metal Complexes in Aqueous Solutions A.E.Martell and R.D. Handcock, Plenum Press, New York – 1996.
6. Analytical Chemistry by Gary D.Christian 6th EditionJohnWiley&SonsInc New York 1994.

M.Sc. INORGANIC CHEMISTRY SPECIALIZATION
SEMESTER-IV
PAPER I

CH(IC)401T: Molecular Spectroscopy of Inorganic Compounds

IC-33: Multinuclear NMR
IC-34: Advanced NMR techniques
IC-35:Applications of ESR to Metal Complexes
IC-36:Mossbauer Spectroscopy and Nuclear Quadrupole Resonance Spectroscopy

IC-33: Multinuclear NMR

^{13}C nmr spectroscopy: CW and PFT techniques. Types of ^{13}C nmr spectra: undecoupled, proton-decoupled, single frequency off-resonance decoupled (SFORD) and selectively decoupled spectra. ^{13}C chemical shifts, factors affecting the chemical shifts.

Chemical equivalence and magnetic equivalence. Virtual Coupling and its importance in study of Metal Complexes $[Pd\{P(CH_3)_3\}_2I_2]$. Spin Dilute Systems-Satellites in Pt(II) Complexes cis-$[Pt(PEt_3)_2Cl_2]$, $Sn(CH_3)_4$. NMR Time Scale and its use in studying Stereo chemical Non –rigidity (PF_5, $[Rh(PR_3)_5]^+$, $[Fe\{Cp\}_2(CO)_2]$) -ΔR, the Ring Contribution to ^{31}P Chemical Shifts –Metal and Chelate size on ΔR. Applications of ^1H, ^{13}C, ^{19}F, ^{31}P and ^{15}N to simple inorganic and Coordination Compounds - 1)^1H-NMR: $PtHCl(PEt_3)_2$,$Pt(NH_3)_3(CH_3)_3$, BH_4^-, NH_4^+, CH_3CN, [^{6}h- C_7H_8 $Mo(CO)_3$], [^{7}h-$C_7H_7Mo(CO)_3]^+$, B_2H_6; $^{29}SiH_3SiH_3$, 2)^{19}F: BF_4^-, H_2PF_3 3)^{31}P: $Mo(CO)_3(PPh_3)_3$, [Rh $(PPh_3)_3Cl$] ,trans-$[PtCl_4(PEt_3)_2]$, $^{31}PF_2H(^{15}NH_2)_2$ 4) 13C; [^{4}h $C_8H_8Ru(CO)_3$], $Fe(CO)_5$, $Fe_2(CO)_9$, $Fe_3(CO)_{12}$, $FeICp(CO)_{12}$, [$^{13}C^{15}N$ $Co(DH)_2$Pyridine]. $^{13}C\{^1H\}$ NMR spectrum of σ-bonded C_6H_5 ligand.

IC-34: Advanced NMR techniques

Spin-Lattice (T_1) and Spin-Spin Relaxation (T_2). Spin Echo Polarization Transfer – Spin Echo Measurements. ^{13}C-NMR spectral editing techniques: Attached proton test (APT spectra) by Gated Spin Echo, Cross polarization, INEPT spectra, DEPT spectra (Distortionless enhancement by polarization transfer). INADEQUATE spectra (Incredible Natural Abundance Double Quantum Transfer Experiment).

Two Dimensional NMR: Basic principles, Types of 2-D NMR ;i)J- resolved spectroscopy a)homo and b)Heteronuclear J- resolved spectroscopy ii) Correlation spectroscopy ; Homo nuclear shift correlation spectroscopy (COSY) and Hetero nuclear shift correlation spectroscopy (HETCOR) iii) NOESY(Nuclear Overhauser Enhancement Spectroscopy). HOESY (two dimensional heteronuclear NOE). Advantages of 2-D NMR

IC-35:Applications of ESR to Metal Complexes

Principle- Selection Rules – Instrumentation- Microwavesource (energy bands). Application of ESR to the study of simple free radicals: methyl ($CH_3^{\cdot}$), amine ($NH_2\cdot$), diphenylpicrylhydrazyl,cyclopentadienyl ($C_5H_5^{\cdot}$), hydroxy methyl ($CH_2OH\cdot$) radicals. Zero-Field Splitting (ZFS) - Effective Spin - Orbitally Non-degenerate and Degenerate States. ESR Spectra of d^1-d^9 Transition Metal Complexes with examples. Interpretation of g in cubic, axial and rhombohedral geometries. Factors affecting g values. Calculation of g values with simple examples. Intensities of '$g_\parallel$ and $g_\perp$peaks. Evidence for Metal-Ligand Bond Covalency- Cu(II)- Bis –Salicylaldimine. $[(NH_3)_5\ Co\ O_2\ Co\ (NH_3)_5]^{5+}$, Cu(II)- diethyldithiophosphinate, Vanadyldithiophsphinate, Copper(II) tetraphenylporphyrin, Co(II)- phthalocyanine, $K_2[IrCl_6]$. Interpretation of 'g' and 'A' values from esr spectral data in- i) MnF_6^{4-}, ii) CoF_6^{4-}, and CrF_6^{3-}. ESR spectra of dinuclear Cu (II) complexes.

IC-36 Mossbauer and Nuclear Quadrupole Resonance Spectroscopy

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

Applications

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 and Iron-Sulfur Proteins.

Tin Compounds: Tin Halides and Organotin Compounds.

Iodine Compounds: Isomer Shifts of ^{127}I and ^{129}I - Applications to Alkali metal iodides and Molecular Iodine. Mossbauer spectra of IF_6^- and IF_6^+

Nuclear Quadrupole Resonance Spectroscopy: Principle, nuclear quadrupole resonance experiment, Structural information from NQR spectra- $PFCl_4$, PCl_4Ph, $Ga_2Cl_7^-$ and $TeCl_4$ Interpretation of nuclear quadrupole coupling constants.

SUGGESTED BOOKS

1. Structural Methods in Inorganic Chemistry, E. A. V. Ebsworth, D. W. H. Rankin and
2. S. Craddock, ELBS.
3. Physical Methods in Chemistry, R. S. Drago, W.B. Saunders Co., 1977.
5. Physical Methods for Chemists, Russell S. Drago Second edition, Saunders College Publishing, 1992.
6. Principles of Mossbauer spectroscopy, T. C. Gibb, Chapman and Hall, London, 1976.
7. Mossbauer Spectroscopy, N. N. Greenwood and T. C. Gibb, Chapman and Hall, London, 1971.
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. Physical Methods in Advanced Inorganic Chemistry, Hill and Day
12. Magneto Chemistry, Dutta &Shyamal Oxford Chemistry Primers, Vol 62

PAPER II

CH(IC) 402T: Bioinorganic Chemistry

IC-37: Metal ions Interactions with Nucleic acids and their constituents
IC-38: Transport of Electrons and Metal ions
IC-39: Metallo-Enzymes of Iron, Zinc and Nickel
IC-40: Metallo-Enzymes of Cobalt, Copper, Molybdenumand Manganese

IC-37: Metal ions Interactions with Nucleic acids and their constituents

Nucleic Bases, Nucleosides and Nucleotides. Proton Binding Sites of Nucleic Acid Constituents-Purine and Pyrimidine Bases, Nucleosides and Nucleotides. The covalent structure of polynucleotides, secondary structure of DNA: The double helix anti and syn conformations of nucleotides. B, A, & Z forms of DNA. General Factors that influence Metal Ion Binding Sites in Solution – Specific Metal Ion Binding to Nucleic Bases, Nucleotides and Nucleosides in Solution: Stability of Phosphate- Metal ion complexes, Metal binding Metal Ion Complexes, Metal Binding Sites in Nucleosides, Nucleotide - Metal Ion Interactions - Intramolecular Equilibrium Constant KI, Percentage of Closed Isomers - Outer Sphere and Inner Sphere Isomers of M-ATP Complexes and Metal Ion Nucleic Base Interactions.

Metal-DNA and RNA Interactions: Potential Binding Sites (Elementary Treatment) – Influence of Metal Ions on Stability of Nucleic Acids.

IC-38: Transport of Electrons and Metal ions

Transport of Electrons: Iron-Sulphur Proteins: Rubredoxins and Ferredoxins (2Fe,3Fe, 4Fe, 8Fe Proteins) -High Potential Iron-Sulphur Proteins – Structural andSpectral features of Iron-Sulphur Proteins - Electron-transport by Cytochromes,Azurin and Plastocyanin - Importance of Structures of Azurin and Plastocyanininfacilitating Rapid Electron Transport, acotinase- Fe-S enzyme.
Transport and Storage of Metal Ions: Iron-Transport by Transferrin and Siderophores – Ferritin in Iron Storage - Transport of Na+ and K+ across Cell Membranes by Na^{+}- K^{+} ATPase - Transport of Calcium across Sarcoplasmic Reticulam by Ca^{2+}-ATPase.

IC-39: 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, CarboxyPeptidase,Leucin – aminopeptidase, Thermolysin, Alcohol Dehydrogenase - Role of Zinc.
Nickel Enzymes: Urease, Hydrogenase and Factor F430: Reactions Catalyzed, MechanisticAspects.

IC-40: 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)DeoxyadenosylCobalamin - 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, Xanthineoxidase and Sulfite oxidase.
Manganese Enzymes: Arginase, Water – oxidase.

SUGGESTED BOOKS

1. Biochemistry - Geoffrey L. Zubay.
2. Biochemistry - Mary K. Campbell. (added these books)
3. Bioinorganic Chemistry, Bertini, Gray, Lippard and Valentine, University ScienceBooks, California USA 1994.
4. Principles of Bioinorganic Chemistry, S.J. Lippard and M.Berg University ScienceBooks, California 1994.
5. Biological Chemistry of Elements, J.J.R. Franstodasilva and R.J.P. Williams OxfordUniversity Press 1991.
6. Metal Ions in Biological Systems (Series), Ed. H. Sigel Marcel Dekkar, New York
7. Inorganic Biochemistry, J.A. Cowan, VCH publishers 1993.
8. Advances in Inorganic Biochemistry, edited by G.L.Eichorn&Marzilli
9. Bioinorganic Chemistry, Vol-I edited by G.L.Eichorn.
10. Interactions of metal ions with nucleotides and nucleic acids and their constituents Helmut Sigel Chem. Soc. Rev., 1993,22, 255-267.

PAPER III

CH(IC)403T(Elective IIIa):Medicinal Inorganic Chemistry, Spectroscopic Analysis of Drug/Metal Complexes and Applications of Nanomaterials

IC-41: Metal complexes in Clinical Chemistry
IC-42: Metal complexes as Drugs and Anticancer agents
IC-43: Spectroscopic analysis of drug/metal complexes binding to DNA
IC-44: Applications of Nanomaterials

IC-41: Metal complexes in Clinical Chemistry

Theory and mode of action of therapeutic chelating agents , Single ligand Chelation Therapy – Aminopolycarboxylic acids, Desferrioxamine, pencillamine, triethylenetetramine, Mixed ligand chelation therapy - Metallothionens in detoxification. Role of metal ions in the action of antibiotics: Bleomycin, adriamyacin and tetracyclines. Gold-Containing drugs used in therapy of Rheumatoid arthritis - A therapeutic agent for Menkes disease: Copper-histidine - Anti viral chemotherapy and metal peptide interaction.

IC-42: Metal complexes as Drugs and Anticancer agents

Introduction to Pt(II) chemistry– Thermodynamic and kinetic principles – *Cis*and*Trans* influences – Thermodynamic and kinetic aspects. Steric and electronic tuning of reactivity.
Platinum complexes in cancer therapy: Discovery applications and structure-effect Relationships. Cis-platin(cis$Pt(NH_3)_2Cl_2$) mode of action. Potential binding sites on nucleic acids and their bases and proteins. Drug resistance and DNA repair mechanism.
Physical effects of metal complex: DNA binding, unwinding, shortening and bending of the double helix. Biological consequences of platinum –DNA binding. Organic intercalatorsasdonor – acceptor pairs; Transition metal complexes as donor acceptor pairs. Non classical platinum antitumour agents.

IC-43: Spectroscopic analysis of drug/metal complexes binding to DNA

Introduction to DNA binding studies. Cooperativityanticooperativity, the excluded site model. UV-Vis Absorption Spectroscopy and ligand/drug/metal complex DNA binding studies. Application of Fluorescence quenching in general and ligand/drug/metal complex DNA binding studies. Fluorescence titrations and binding constants. Salt back titrations interpretation of the data, the binding analysis,obtaining equilibrium binding isotherms. Dependence of K_{obs}on salt concentration, cation effects on ligand nucleic acid equilibria, Competitive effects of monovalent and divalent cations for binding. Record's polyelectrolyte theory and its importance. Equilibrium dialysis. Partition analysis, competitive equilibrium dialysis to assess B & Z DNA binding. Competition dialysis to assess base and sequence specificity, viscosity studies. Tertiary structure of DNA, Supercoiled DNA(Form-I), Nicked DNA (Form-II) and Linear DNA(Form-III). DNA cleavage activity with ligand/metal complexes-Analysis by Gel electrophoresis.

IC-44: Applications of Nanomaterials

Nanotechnology in modern technology in relation to electronic, biological, consumer and domestic applications. Energy related application: photo-volatile cells. Energy storage nanomaterials.
Sensors: Agriculture, health and medical, food, security.
Applied nanobiotechnology and nanobiomedical science drug delivery, drug targeting, biosensors, bioimaging, neutron capture therapy.

SUGGESTED BOOKS

1. Bioinorganic Chemistry. Inorganic elements in the Chemistry of life, WolfgangKaim&BrigetteSchwederdki.
2. Bioinorganic Chemistry, Bertini, Gray, Lippard and Valentine, University ScienceBooks, California USA 1994.
3. Handbook of Metal-Ligand interactions in Biological fluid Bioinorganic medicine, Vol – Edt. Guy Berthon.
4. Bioinorganic Chemistry, Rosette M. RoatMalone.
5. Photoreactions of Metal complexes with DNA, A. Krisch – De Mesmacker et al.
6. Drug - Nucleic Acid Interactions, Volume 340 Jonathan B. Chaires, Michael J. WaringAcademicPress,2001.
7. Mechanistic Bioinorganic Chemistry Edited by byH.Holden Thorp and Vincent L. Pecoraro, Chemical Society, Washington DC 1995.
8. Metal Complex -DNA Interactions, Editor(s): Nick Hadjiliadis, EinarSletten, Copyright @ Blackwell Publishing Ltd.
9. Gel Electrophoresis - Principles and basics edited by SamehMagdeldin ISBN 978 - 958 -51-0458-2, 376 pages, Publisher: InTech, April 04, 2012
10. Encylopedia of nanomaterials and nanotechnologies, H. S. Nalva.
11. Nanostructures materials: Processing, Properties and applications, C. C. Kouch, WilliamAndrew publications, New york, 2002.
12. Introduction to nanotechnology, C. P. Poole Jr, F. J. Owens, 2nd edition, Wiley-India,Delhi, 2008.

PAPER III

CH(IC)403T(Elective IIIb):Analytical Techniques -III

IC-45: Electroanalytical Methods
IC-46: Radiochemical Methods
IC-47: Fluorimetry, Phosphorimetry, Nephelometry and Turbidimetry
IC-48: Industrial Analysis

IC-45: 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.

IC-46: Radiochemical Methods

Radioactive nucleotides, Instrumentation – measurement of alpha, Beta particles and Gamma radiation. Radio tracers and tracer techniques, applications of Tracer techniques,

Neutron activation analysis: Neutron sources, interaction of neutrons with matter. Theory of activation methods, Experimental considerations, Nondestructive and destructive methods, applications.

Isotopic dilution analysis: Principles, theory and Applications.

Radiometric titrations: Principle, Procedure, advantages & disadvantages, applications to various types of titrations, problems based on the techniques.

Applications of Radio Chemical Methods in Biology, Agriculture and Environment

IC-47: 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.

IC- 48: Industrial Analysis

Analysis of Ferroalloys: Analysis of steel - Molybdenum, Phosphorous.

Analysis of non- Ferrous alloys: Analysis of Tin, Zinc and Copper in Brass, Bronze. Analysis of Tin and lead in Solder.

Analysis of Cement: Composition of Portland cement, estimation of Aluminium oxide and Ferrous oxide. Determination of Alumina in Cement by Polarography.

Analysis of Oils & Fats: Theory, Melting point of fats, Chemical Characteristics: Saponification value, Iodine value, Thiocyanogen value, ketone or perfume rancidity.

Soaps & Detergents: Composition of Soaps. Determination of low level Surfactants, determination of Germicides in soaps and detergents by photometric method, analysis of phosphates by paper chromatography, determination of detergent alkylates by Mass Spectrometry.

Paints& Pigments: Constituents of Paints, Analysis of TiO_2 in Titanium dioxide pigments by XRD. Determination of Zn, Pb in Paint pigments by Polarographic method. Analysis of polyesters, acrylics by Gel permeation chromatography.

SUGGESTED BOOKS

1. Principles and practice of Analytical Chemistry, F.W.Fifield& D Kealey, 5th Ed.Blackwell Science, 2000
2. Principles of Instrumental Analysis: Holler, Skoog and Crouch, 6th education, Cengage Learning 2007.
3. Instrumental methods of chemical analysis B.K. Sharma, Goel Publishing House.
4. Analytical Chemistry: Gary D Christian.6th edition.
5. Principles of Instrumental Analysis - Skoog, Holler, Nieman, 5th ed., Harcourt College Publishers, 1998.
6. Principles and practice of Analytical Chemistry, F.W.Fifield& D Kealey, 5th Ed. Blackwell Science, 2000.
7. Quantitative Chemical Analysis, Daniel C. Harris, 6th Ed. WH Freeman & Co. NewYork, 2003.
8. Analytical Chemistry an Introduction, Crouch, 7th Ed. Saunders College Publishing,2000.

9. Standard methods of Chemical analysis, 6th ed., volumes I to IV. Edited by F.J. Welcher: D. Von NostrnadCo. Inc., Princeton N.J. 1966.
10. Biochemical Methods – S. Sadasivam, A. Manickam, 2nd ed., New Age International (P) Ltd., 1997.

PAPER IV

CH(ID) 404T(Elective IVa): Interdisciplinary Course (ID) (Environmental and Applied Analysis)

IC-49: Clinical and Pharmaceutical Analysis
IC-50: Food and Agricultural analysis
IC-51: Analysis of Air and Water Pollutants
IC-52: Drinking Water and Sewage Water Treatment

IC-49: Clinical and Pharmaceutical Analysis

Clinical analysis: Analysis of Carbohydrates and their significances – Fasting, random and post pandrial glucose tests, Estimation of Glucose in serum. Analysis of lipids and their significances –Test for cholesterol. Analysis of proteins and their significance – Estimation of total protein in serum.
Analysis of Major metabolites and their significance – Determination of Blood urea and Creatinine in urine. Analysis of ions and their significance: Estimation of Na, K, Ca, bicarbonates and phosphate in serum. Analysis of Hormones and their significance-ELISA and RIA.

Pharmaceutical analysis: Determination of Diclofenac (non-aqueous titration), Calcium inVitamin D and Calcium formulations (Complexometry), Sulphanilamide (potentiometry),Pethidine hydrochloride (UV-Vis), Frusemide (UV-Vis), Aspirin,paracetamol and codein in APC tablets (NMR), Phenobarbitone in tablets (IR), pivolic acid indipivefrin eye drops (GC), Assay of hydrocortisone cream. (HPLC).Impurity profiling of Propranolol (GC-MS), famotidine (LC-MS).

IC-50: Food and Agricultural 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) SO_2, Sodium Benzoate, Sorbic acid, Benzoic acid.
Antioxidants: Types of Antioxidants used in foods, Analysis of Butylatedhydroxy toluene (BHT), propyl – gallates (PG), Octylgallates (GO), dodecyl gallates (DG) by TLC & GC.
Food adulteration: Common adulterants in food, contamination of food stuffs. Microscopic examinations for food adulterants.
Analysis of Soil – Determination of pH, conductivity, cation exchange capacity, total organic matter, nitrogen, phosphorous, potassium, S, Ca, Mg, Ca+Mg, Zn, Cu, Fe, Mn, B, Mo, Cd, Cr, Ni, Pb.
Analysis of Fertilizers – Moisture determination by Karl Fischer titration methods. Determination of Ammonical nitrogen and Ammonical nitrate nitrogen. Determination of total phosphates as P_2O_5. Estimation of potassium, Estimation of micronutrients by AAS.
Analysis of Pesticides: Analysis of Organo-chlorine pesticides (Cypermethrin) by Gas Chromatography. Determination of Malathion, Methyl parathion and DDT residues in vegetables and food grains.

IC-51: Analysis of Air and Water Pollutants

Air quality standards, sampling, analysis of air pollutants-SO_2 (UV-Vis, IR), H_2S (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 pre-concentration methods, physical analysis - colour, odour, temperature, pH, EC, redox potential, total desolved solids (turbidimetry), Chemical analysis of anions – CN^-, Cl^-, F^-, NO_2^-, NO_3^- (spectrophotometry), SO_4, PO_4.

Determination of BOD, COD, TOC & DO. Analysis of Toxic Metals: Hg, As, Pb, Cd, Be, Al, Cr (Atomic Absorption Spectroscopy and Spectrophotometry)

IC-52: Drinking Water and Sewage Water Treatment

Hardness: causes, measurement of hardness, units- types of hardness, estimation of temporary and permanent hardness, Alkalinity of water and its estimation.

Treatment of Water for Municipal Supply: Characteristics of potable water/Domestic water, WHO standards, and Indian Standards. Aeration, Sedimentation with coagulation, Filtration, Sterilization and Disinfection: Physical Methods-Boiling, Exposure to Sunlight, Disinfection with UV light, Chemical Methods – Ozonization, Chlorination, Breakpoint chlorination and Dechlorination

Desalination of Brackish Water: Treating saline water: distillation, electrodialysis, reverse osmosis (RO).

Mineral Water and Purified Water: Typical Manufacturing Process, Flow Sheet Diagram of Mineral Water Manufacturing Process, Purified Water-Purification methods-Distillation, Double distillation, Deionization - Co-current deionization, Counter-current deionization, Mixed bed deionization, Demineralization, Uses of purified water- Laboratory use, Industrial uses and other uses; Health effects of drinking purified water

Sewage Water Treatment: Domestic sewage - Physical, Chemical, and Biological Characteristics of Domestic Sewage, Municipal sewage, Sewage Composition and Contaminants, Sewage Treatment - On-Site Sewage Treatment Systems and Off-Site Sewage Treatment Systems

SUGGESTED BOOKS

1. Medical Laboratory Technology – Mukherjee,McGraw Hills,1988.
2. Medical Laboratory Technology – RamnikSood, Medical Publishers Pvt. Ltd., 1999.
3. Biochemical Methods – S. Sadasivam, A. Manickam, 2nd ed., New Age International (P) Ltd., 1997.
4. Practical Pharmaceutical Chemistry, A.H. Beckett et al, 3rd ed. – Vol. 1 & Vol. 2 CBS Publishers & Distributors, 1986.
5. Pharmaceutical Analysis - P. Primoo. CBS Publishers, New Delhi, 1999.
6. Text book of Pharmaceutical Analysis – Kenneth. A. Connors, John Wiley & Sons, 1999.
7. Pharmaceutical Chemistry, Instrumental techniques vol-2, Ed. Lesile. G.Chatten.
8. Pharmaceutical Drug Analysis – Asuthoshkar, Minerva Press, 2001.
9. Handbook of analysis and quality control for fruit and vegetables products – S. Ranganna, 2nd edition, Tata McGraw-Hill Publishing Ltd., 1986
10. Introduction to the Chemical Analysis of Foods, S. Suzanne Neilsen, CBSPublishers, New Delhi, 2002.
11. A Text book of Soil Chemical Analysis – P.R. Hesse, CBS Publications, 1998.
12. Methods of Analysis of Soils, Plants, Water and Fertilizers – Ed, HLS Tandon, FDCO publications, New Delhi, 1999.
13. Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed, Pearson Education Ltd.
14. Environmental Pollution Analysis, S M Khopkar, Wiley Eastern Ltd 1995.
15. Environmental Analytical Chemistry, F W Fifield, P J Haines, Blackie AcademiProfessional.
16. Environmental Chemistry, B K Sharma, Goel Publishing House, Meerut.
17. "A Textbook of Engineering Chemistry", Dr. Y. BharathiKumari and Dr. JyotsnaCherukuri, VGS Publications, First Edison, India, 2009.
18. "Engineering Chemistry", Jain P C and Monica Jain, 15th Edition, DhanpatRai Publishing Company Ltd, New Delhi, India, 2005.
19. Textbook of Engineering Chemistry, C Parameswara Murthy, C V Agarwal, Andra Naidu, BS Publications, Hyderabad, India
20. Water Encyclopedia - Domestic, Municipal, andIndustrialWaterSupply and Waste Disposal, Jay H. Lehr and Jack Keeley, Wiley-Interscience, Published by John Wiley & Sons, Inc., Hoboken, New Jersey.
21. Handbook of Water and Wastewater Treatment Technologies, Nicholas P. Cheremisinoff, PublishedbyButterworth-Heinemann, 225Wildwood Avenue, Woburn, MA 01801-2041
22. Purified water: https://en.wikipedia.org/wiki/Purified_water#Purification_methods

PAPERIV

CH(ID) 404T(Elective IVb): Interdisciplinary Course (ID)
(Inorganic Material Chemistry)

IC-49: Composite Materials
IC-50: Liquid Crystals
IC-51: Explosives and Propellants
IC-52: Fuels and Combustion

IC-49: Composite Materials

Introduction, Advantageous Properties of the Composites, Constituents of Composites, Types of Composites – Fibre-reinforced composites (Glass, carbon, Armid, Alumina reinforced composites), Particulate composites, Layered composites, Processing of Fibre-reinforced Composites, Micromechanics of Fibre and Particle Reinforced Composites, Fabrication of the Composites.

Refractories: Characteristics and Classification of Refractories, Properties of Refractories, Manufacture of Refractories, Common Refractories Bricks – Silica Bricks, Alumina Bricks, Magnesite Bricks, Dolomite Bricks, Carbon Bricks and Chromite Bricks.

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

IC-50: Liquid Crystals

Introduction, Types of Mesophases, Characterization of Liquid Crystals, Physical Properties of Liquid Crystals, Structure of Liquid Crystal forming compounds, Classification of Liquid Crystals-Thermotropic Liquid Crystals and Lyotropic Liquid Crystals, Chemical Properties of Liquid Crystals, Applications with special reference to Display systems, Applications and Importance of Lyotropic Liquid Crystals, Future of Liquid Crystals.

IC-51: 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), Pentaerythritaltetranitrate (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, Bi-propellants; Differences between Solid propellants and Liquid Propellants

IC-52: 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, Analysis of Coal – Proximate analysis and Ultimate analysis, Metallurgical Coke, Types of Carbonization of Coal – Low-temperature and high temperature carbonization, Manufacture of Metallurgical Coke by Beehive oven process, Petroleum, classification of petroleum, Refining of crude oil, Cracking – Thermal cracking, Catalytic cracking- Moving-bed catalytic cracking, LPG as a Fuel, Natural Gas, Producer Gas, Water Gas (or Blue Gas), Non-Conventional Sources of Energy-Solar energy, Solar cells and Uses of solar cells.
Combustion: Combustion, Mass Analysis from Volume Analysis and Vice Versa, Analysis of Flue Gas

SUGGESTED BOOKS

1. "Liquid Crystals, Nature's delicate phase of matter", Peter J Collings, Princeton University Press, 2002
2. "Liquid Crystals: Fundamentals", Shri Singh, World Scientific Publishing Company; 1st edition (November 7, 2002)
3. "Science of Engineering Materials", C.M. Srivastava and C. Srinivasan, Wiley-Eastern Ltd. (1991).
4. "Engineering Chemistry", Jain P C and Monica Jain, 15th Edition, DhanpatRai Publishing Company Ltd, New Delhi, India, 2005.
5. A Text book of Engineering Chemistry", Shashi Chawla" DhanpatRai Publishing Company (P) Ltd., New Delhi, India, 2007.
6. Textbook of Engineering Chemistry, C Parameswara Murthy, C V Agarwal, Andra Naidu, BS Publications, Hyderabad, India.
7. "A Textbook of Engineering Chemistry", Dr. Y. BharathiKumari and Dr. JyotsnaCherukuri, VGS Publications, First Edison, India, 2009

Paper CH (IC) 451: Conventional Methods of Analysis

I. Titrimetry:

1. Determination of Ca^{2+}, Mg^{2+}, CO_3^{2-}, HCO_3^- in soil sample
2. Determination of saponification value, Iodine number, acid value and ester value of an oil sample (5-6 samples and comparative study)
3. Determination of Ascorbic acid in Vit.C tablet by iodometry (2-3 samples)

II Water analysis:

1. Determination of Dissolved Oxygen
2. Determination of COD
3. Determination of residual Chlorine in water by Iodometry
4. Determination of Fluoride by Zirconium Alizarin Method
5. Determination of Sulphate by spectrophotometry, turbidimetry or nephelometry

III Separation Methods

1. Separation of Fe^{3+} and Ni^{2+} 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
4. Separation of Fe^{3+} and Ni^{2+} using strongly basic anion resin.

SUGGESTED BOOKS

1.Chemistry Experiments for Instrumental Methods, Donald T Sawyer WilliamR.Hememan et.al John Wiley & Sons 1984.
2.Analytical Chemistry by Gary D.Christian 6thEditionJohnWiley&Sons Inc New York 1994.
3.A Text Book of Quantitative Inorganic Analysis by A.I. Vogel 3rdEditionElbs Publication 1969.
4.Vogel's Text Book of Quantitative Inorganic Analysis Jeffery etal 4th edition ElbsPublications 1988.
5.Vogel's Text Book of Quantitative Chemical Analysis, 6th edition. Pearson Education Ltd 2002.
6.Analytical Chemistry Theory and Practice by R.M. Verma 3rd Edn.CBS Publishers &Distrbutors1994.
7.Comprehensive Experimental Chemistry by V.K. Ahluwalia et.al New Age Publications 1997.
8. Laboratory hand Book of Instrumental Drug Analysis.by B.G. Nagavi 2ndedn. 1996.

LABORATORY COURSES (IV Semester)

Paper CH (IC) 452: Spectroscopic techniques

I Spectrophotometry

1. Estimation of manganese.
2. Estimation of chromium.
3. Simultaneous determination of Manganese and Chromium in a mixture.
4. Determination of pKa of indicator (methyl orange/ methyl red)
5. Estimation of Nickel.
6. 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

II Colorimetry

1. Determination of blood sugar
2. Determination of blood cholesterol
3. Determination of creatinine
4. Determination of Paracetamol

III Fluorimetry

1. Determination of Riboflavin
2. Determination of Quinine Sulphate.

IV Flame photometry

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

V Atomic Absorption Spectroscopy

1. Determination of i) Fe, ii) Mg, iii) Cu, iv) Pb.

SUGGESTED BOOKS

Text Book of Quantitative Inorganic Analysis Jafferyetal 4th edn. EdnElbs Publication

1. A Text Book of Quantitative Inorganic Analysis by A.I. Vogel 3rd EdnElbs Publication 1969.
2. Quantitative Analysis by Day and Underwood Prentice Hall (India) VI Edn.
3. Analytical Chemistry Thoery and Practice by R.M. Verma 3rd Edn.CBS Publishers & Distrbutors1994.
4. Practical Pharmaceutical Chemistry, A.H. Beckett and J.B. Stenlake 4thedn. CBS publishers, 2001
5. Medical Laboratory Technology – Mukherjee,McGraw Hills,1988