



**MANONMANIAM SUNDARANAR UNIVERSITY -TIRUNELVELI**  
**PG PROGRAMMES**



**OPEN AND DISTANCE LEARNING (ODL) PROGRAMMES**

**(FOR THOSE WHO JOINED THE PROGRAMMES FROM THE ACADEMIC YEAR 2023-2024 ONWARDS)**

**M.Sc. CHEMISTRY**

| <b>Semester</b> | <b>Course</b>                | <b>Title of the Course</b>      | <b>Course Code</b> |
|-----------------|------------------------------|---------------------------------|--------------------|
| IV              | Core XI                      | Coordination Chemistry – II     | SCHM41             |
|                 | Core XII                     | Physical Chemistry – II         | SCHM42             |
|                 | Elective VI                  | Polymer Chemistry               | SCHE41             |
|                 | Skill Enhancement Course III | Scientific Research Methodology | SCHS41             |
|                 | Project                      | Project with Viva-Voce          | SCHR41             |
|                 | Extension Activity           |                                 | SCHX41             |

## COORDINATION CHEMISTRY– II

| UNIT       | Details  |
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| <b>I</b>   | <p><b>Chemistry of organometallic compounds:</b> 18 and 16 electron rule; Structure and Bonding in Metal – olefin complexes (example: Ziese's salt), metal-acetylene and metal-allyl complexes; Metal-cyclopentadienyl complexes – Examples. Synthesis, Structure bonding and reaction of ferrocenes - structure and bonding of beryllocene-covalent versus ionic bonding of beryllocene ;</p> <p><b>Metal Carbonyl complexes:</b> Structure, bonding modes-MO approach of M-CO bonding, <math>\pi</math>-accept or nature of carbonyl group, synergistic effect (stabilization of lower oxidation states of metals); Carbonyl clusters: Low nuclearity and high nuclearity carbonyl clusters—Structures Based on polyhedral skelet on electron pair theory or Wade's rule. Zintlions.</p>   |
| <b>II</b>  | <p><b>Reactions and catalysis of organometallic compounds:</b> Agostic interaction - Oxidative addition, reductive elimination (<math>\alpha</math> and <math>\beta</math> eliminations), migratory insertion reaction and metathesis reaction. Organometallic catalysis: Hydrogenation of olefins (Wilkinson's catalyst), hydroformylation of olefins using cobalt and rhodium catalysts (oxo process), oxidation of olefin (Wacker process), olefin isomerisation, water gas shift reaction, cyclooligomerisation of acetylenes using Reppe's catalysts and Monsanto's acetic acid process. Fischer Tropsch process and synthetic gasoline - Ziegler-Natta polymerization and mechanism of stereo regular polymer synthesis. Hybrid Catalysis: Cluster compound sincatalysis - polymer-supported and phase-transfer catalysis-biphasic-systems.</p>  |
| <b>III</b> | <p><b>Inorganic spectroscopy -I:</b> IR spectroscopy: Effect of coordination on the stretching frequency-sulphato, sulphito, aqua, nitro, thiocyanato, cyano, thiourea, Complexes; Determination of the structure of metal carbonyl Complexes.</p> <p>NMR Spectroscopy: <math>^1\text{H}</math>, <math>^{19}\text{F}</math> and <math>^{31}\text{P}</math> – NMR – applications in structural problems based on number of signals, multiplicity, anisotropy (like <math>\text{H}_3\text{PO}_3</math>, <math>\text{H}_3\text{PO}_2</math>, <math>[\text{HNi}(\text{PPh}_3)_4]^+</math>, <math>\text{SF}_4</math>, <math>\text{TiF}_4</math>, <math>\text{PF}_5</math>, <math>\text{HPF}_2</math>, <math>\text{H}_2\text{PF}_3</math>, <math>\text{PF}_3(\text{NH}_2)_2</math>, <math>\text{P}_4\text{S}_3</math>, <math>\text{P}_4\text{N}_4\text{Cl}_6</math> (<math>\text{NHC}_6\text{H}_5</math>)<math>_2</math>, <math>\text{P}_3\text{N}_3(\text{CH}_3)_2\text{Cl}_4</math>, <math>\text{NF}_3</math>, <math>\text{NF}_2</math>, <math>\text{NH}_3</math> – mer-and fac-<math>\text{Rh}(\text{PPh}_3)_3\text{Cl}_3 \cdot \text{B}^{11}</math> NMR of <math>\text{B}_3\text{H}_8^-</math>. Fluxional molecules (including organo metallic compounds) and study of fluxionality by NMR technique-NMR of paramagnetic molecules-contact shifts. Evaluation of Rate constants-monitoring the course of reaction using NMR.</p> |

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| <p style="text-align: center;"><b>IV</b></p> | <p><b>Inorganic spectroscopy-II:</b> EPR spectroscopy: Hyper fine splitting–Factor affecting magnitude of g-values-Zero field splitting and Kramers’ degeneracy-Application of EPR in the study of transition metal complexes based on number of signals, multiplicity, anisotropy <math>[\text{Cu}(\text{bpy})_3]^{2+}</math>, <math>[\text{Cu}(\text{Phen})\text{Cl}_2]</math>, <math>[(\text{NH}_3)_5\text{Co}-\text{O}_2-\text{Co}(\text{NH}_3)_5]^{5+}</math>, <math>\text{Co}_3(\text{CO})_9\text{Se}</math>, <math>\text{Co}_3(\text{CO})_9\text{Rh}</math>, <math>[\text{CoF}_6]^{4-}</math>, <math>[\text{CrF}_6]^{3-}</math>, <math>\text{VO}(\text{acac})_2</math>, <math>[\text{VO}(\text{H}_2\text{O})_6]^{2+}</math>, <math>[\text{Fe}(\text{CN})_5\text{NO}]^{2-}</math>, <math>[\text{Ni}(\text{H}_2\text{O})]^{2+}</math>, and <math>\text{CuCl}_2 \cdot 2\text{H}_2\text{O}</math>. (bis(salicylaldimine) copper(II), <math>[(\text{NH}_3)_5\text{Co}-\text{O}_2-\text{Co}(\text{NH}_3)_5]^{5+}</math> Applications in predicting the covalent character of M-L bond and Jahn-Teller distortion in Cu(II) complexes. EPR spectroscopy of metallo bio molecules: Copper and iron proteins. Mossbauer spectroscopy–Mossbauer effect, Recoil energy, - Mossbauer active nuclei, Doppler shift, Isomer shift, quadrupole splitting and magnetic interactions. Applications of Mössbauer spectra to Fe and Sn compounds / complexes, Structural elucidation and bioinorganic application of iron-sulfur protein</p> |
| <p style="text-align: center;"><b>V</b></p>  | <p><b>Photoelectron Spectroscopy:</b> Theory, Types, origin of fine structures–shapes of vibrational fine structures–adiabatic and vertical transitions, PES of homo nuclear diatomic molecules (<math>\text{N}_2</math>, <math>\text{O}_2</math>) and hetero nuclear diatomic molecules (<math>\text{CO}</math>, <math>\text{HCl}</math>) and polyatomic molecules (<math>\text{H}_2\text{O}</math>, <math>\text{CO}_2</math>, <math>\text{CH}_4</math>, <math>\text{NH}_3</math>). Koopman’s theorem- applications and limitations. Shake-up and Shake-off process. Optical Rotatory Dispersion –Principle of CD, MCD and ORD; <math>\Delta</math> and <math>\lambda</math> isomers in different Cobalt (III) complexes, Assignment of absolute configuration using CD and ORD techniques.</p>   |
| <p><b>Recommended Text</b></p>               | <ol style="list-style-type: none"> <li>1. JE Huheey, EA Keiter, RL Keiter and OK Medhi, Inorganic Chemistry–Principles of structure and reactivity, 4th Edition, Pearson Education Inc., 2006</li> <li>2. GL Meissler and DA Tarr, Inorganic Chemistry, 3rd Edition, Pearson Education Inc., 2008</li> <li>3. D. Bannerjee, Co-ordination Chemistry, TATA Mcgraw Hill, 1993.</li> <li>4. BD Gupta and AK Elias, Basic Organometallic Chemistry: Concepts, Syntheses and Applications, University Press, 2013.</li> <li>5. F.A. Cotton, G. Wilkinson.; C.A. Murillo; M. Bochmann, Advanced Inorganic Chemistry, 6th ed.; Wiley Inter-science: New York, 1988.</li> <li>6. H. Kaur Spectroscopy, Pragati Prakashan, 8<sup>th</sup> edition, 2023.</li> <li>7. B.P. Straughan and S. Walker, Spectroscopy, Chapman and Hall Ltd, 1<sup>st</sup> edition 1976.</li> <li>8. S. F. A. Kettle, Physical inorganic chemistry A Coordination chemistry approach, Springer-Verlag Berlin Heidelberg GmbH, 1<sup>st</sup> edition 1996.</li> <li>9. Asim K Das and Mahua Das, Fundamental concepts of inorganic chemistry, 1<sup>st</sup> eBook edition, <b>Volume 4, 5 &amp; 7</b>, CBS publishers and distributors PVT Ltd, 2019.</li> <li>10. Jagdamba Singh, Mritunjay D Padey, Jaya Singh, Spectroscopy of Inorganic compounds, New age international publishers, 1<sup>st</sup> edition, 2021.</li> </ol>   |

## PHYSICAL CHEMISTRY - II

| UNIT             | Details  |
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| I                | Wave particle duality, Uncertainty principle, Particle wave and Schrodinger wave equation, wave function, properties of wave function. Properties of wave function, Normalized, Orthogonal, ortho normal, Eigen values, Eigen functions, Hermiti an properties of operators. Introduction to quantum mechanics-black body radiation, photoelectric effect, hydrogen spectrum. Need for quantum mechanics, Postulates of Quantum Mechanics, Schrodinger wave equation, Time independent And time dependent  |
| II               | <b>Quantum models:</b> Particle in a box-1D, two dimensional and three-dimensional, degeneracy, application to linear conjugated molecular system, free particles, ring systems. Harmonic Oscillator- wave equation and solution, anharmonicity, force constant and its significance. Rigid Rotor-wave equation and solution, calculation of Rotational constants and bond length of diatomic molecules.   |
| III              | <b>Applications to Hydrogen and Poly electron atoms:</b> Hydrogen atom and hydrogen like ions, Hamiltonian-wave equation and solutions, radial and angular functions, representation of radial distribution functions. Approximation methods-variation methods: trial wave function, variation integral and application to particle in 1D box. Perturbation method - first order applications. Hartree-Fock self-consistent field method, Hohenberg-Kohn theorem and Kohn-Sham equation, Helium atom-electron spin, Pauli exclusion principle and Slater determination.  |
| IV               | <b>Group theory:</b> Groups, subgroups, symmetry elements, operations, classification-axial and non-axial. Dihedral point groups- $C_n$ , $C_{nh}$ , $D_n$ , $D_{nh}$ , $D_{nd}$ , $T_d$ and $O_h$ . Matrix representation and classes of symmetry operations, reducible irreducible and direct product representation. The Great orthogonality theorem – irreducible representation and reduction formula, construction of character table for $C_{2v}$ , $C_{2h}$ , $C_{3v}$ and $D_{2h}$ point groups.  |
| V                | <b>Applications of quantum and group theory:</b> Hydrogen Molecule-Molecular orbital theory and Heitler London (VB) treatment, Energy level diagram, Hydrogen molecule ion; Use of linear variation function and LCAO methods. Electronic conjugated system: Huckel method to Ethylene butadiene, cyclopropenyl, cyclo butadiene and Benzene. Applications of group theory to molecular vibrations, electronic spectra of ethylene.  |
| Recommended Text | <ol style="list-style-type: none"> <li>1. R.K. Prasad, Quantum Chemistry, New Age International Publishers, New Delhi, 2010, 4th revised edition.</li> <li>2. F. A. Cotton, Chemical Applications of Group Theory, John Wiley &amp; Sons, 2003, 2<sup>nd</sup> edition.</li> <li>3. A. Vincent, Molecular Symmetry and Group Theory. A Programmed Introduction to Chemical Applications, John and Willy &amp; Sons Ltd., 2013, 2<sup>nd</sup> Edition.</li> <li>4. T. Engel &amp; Philip Reid, Quantum Chemistry and Spectroscopy, Pearson, New Delhi, 2018, 4<sup>th</sup> edition.</li> <li>5. G. K. Vemulapalli, Physical Chemistry, Prentice Hall of India Pvt. Ltd. 2001. 6. D.A. McQuarrie, Quantum Chemistry, Viva Books PW.Ltd, 2013, 2<sup>nd</sup> edition.</li> </ol> |

## POLYMER CHEMISTRY

| UNIT       | Details   |
|------------|---|
| <b>I</b>   | <b>Characterization, Molecular weight and its Determination:</b> Primary and secondary bond forces in polymers; cohesive energy, molecular structure, chemical tests, thermal methods, T <sub>g</sub> , molecular distribution, stability. Determination of Molecular mass of polymers: Number Average molecular mass(M <sub>n</sub> )and Weight average molecular mass (M <sub>w</sub> ) of polymers. Molecular weight determination of high polymers by physical and methods.   |
| <b>II</b>  | <b>Mechanism and kinetics of Polymerization:</b> Chain growth polymerization: Cationic, anionic, free radical polymerization, Stereo regular polymers: Ziegler Nattapoly merization. Reactionkinetics. Step Growth polymerization, Degree of polymerization.  |
| <b>III</b> | <b>Techniques of Polymerization and Polymer Degradation:</b> Bulk, Solution, Emulsion, Suspension, solid, interfacial and gas phase polymerization. Types of Polymer Degradation, Thermal degradation, mechanical degradation, photo degradation, Photo stabilizers, Solid and gas phase polymerization.  |
| <b>IV</b>  | <b>Industrial Polymers:</b> Preparation and Properties of fibre forming polymers, elastomeric material. <b>Thermoplastics:</b> Polyethylene, polystyrene, Polyacrylonitrile, Polyvinyl Chloride, Poly tetrafluoro ethylene, nylon and polyester. <b>Thermosetting Plastics:</b> Phenol formaldehyde epoxide resin. <b>Elastomers:</b> Natural rubber and synthetic rubber - Buna - N, Buna-S and neoprene. <b>Conducting Polymers:</b> Elementary ideas, polymeric sulphur nitriles and polyacetylene. Polymethyl methacrylate, polyimides, polyamides, polyurethanes, polyurea, and polyethylene |
| <b>V</b>   | <b>Polymer Processing: Compounding:</b> Polymer Additives: Fillers, Plasticizers, antioxidants, thermal stabilizers, fire retardants and colourants. <b>ProcessingTechniques:</b> Calendaring, diecasting, compression moulding, injection moulding, blowmoulding and reinforcing. Film casting,Foaming, Thermofoaming. <b>Catalysis and catalysts:</b> Polymerization catalysis, catalyst support, clay compounds, basic catalyst, auto-exhaust catalysis, vanadium, heterogeneous catalysis.  |

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| <b>Recommended Text</b> | 1.V.R.Gowariker, <i>PolymerScience</i> , Wiley Eastern, 1995.<br>2.G.S.Misra, <i>Introductory Polymer Chemistry</i> , New Age International (Pvt) Limited, 1996.<br>3.M.S.Bhatnagar, <i>A Text Book of Polymers</i> , vol-I & II, S.Chand & Company, New Delhi, 2004. |
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## Scientific Research Methodology

| UNIT       | Details   |
|------------|---|
| <b>I</b>   | <p><b>TO SCIENTIFIC RESEARCH:</b></p> <p>Objectives of research – Types of research – Significance of research. Research methods versus methodology – Research and scientific method – Criteria of good research – Problems encountered by researchers in India. Problem selection – Selection of research problem, sources of research problems, criteria/characteristics of a good research problem, errors in selecting a research problem – project proposal – funding agencies.</p>  |
| <b>II</b>  | <p><b>LITERATURE SURVEY:</b></p> <p>Sources of information, Primary, Secondary, Tertiary sources, Journals, Journal abbreviations, Abstracts – Beilstein-Handbuch and tables of information – Reviews – Current titles – Textbooks – Current contents – General treatises – Monographs and treatises on specific areas – Literature search – Information about a specific compound – Science citation index – Box to locate journals. Introduction to Chemical Abstracts. Online searching, Database, Scifinder, Scopus, Citation Index, Impact Factor.</p>   |
| <b>III</b> | <p><b>WRITING OF RESEARCH REPORT:</b></p> <p>Format of the research report – style of writing the report – references and bibliography. Research paper writing: Types of research papers – Structure of research papers – Research paper formats – Different formats for referencing – ways of communicating research paper – organizing a poster display, giving an oral presentation in seminars/conferences – Making effective presentations using Power Point and Beamer. Research Proposal: Format of research proposal, Individual research proposal and institutional proposal.</p>  |
| <b>IV</b>  | <p><b>PLAGIARISM AND INTELLECTUAL PROPERTY RIGHTS:</b></p> <p>Plagiarism – Introduction, Reason for plagiarism, Types of plagiarism – Plagiarism of words, Patch work plagiarism, Self-plagiarism, Cyber and Digital plagiarism, Accidental plagiarism, Plagiarism of Authorship, Plagiarism of Ideas. Plagiarism policies – IEEE, Springer, Elsevier. Software used for identifying plagiarism. Techniques to avoid plagiarism – Referencing, Paraphrasing. Significance of Intellectual Property Rights. Forms of IPR – Patents, Copyright, Trademarks, Collective marks, Industrial Design. Valuation of IPR, IPR and licensing.</p> |
| <b>V</b>   | <p><b>ADVANCED INSTRUMENTAL TECHNIQUES:</b></p> <p>Principles, techniques and applications: Surface probe microscopy: Atomic force microscopy, Scanning tunnelling microscopy, Scanning electron microscopy, Transmission electron microscopy, HRTEM, Energy Dispersive X-ray analysis (EDX), X-ray photoelectron spectroscopy. X-ray diffraction techniques – Powder and single crystal XRD, principle, techniques and applications.</p>   |

**Recommended Text:**

1. Dr.C.R.Kothari, Research Methodology: Methods and Techniques, New Age International Publishers, 2 nd Edition, New Delhi. 2014.
2. Ranjitkumar, Research Methodology: A Step by Step Guide for Beginners, Pearson Education; 2 nd Edition, 2005.
3. Tanmoy Chakraborty and Lalita Ledwani, Research Methodology in Chemical Sciences: Experimental and Theoretical Approach, Apple Academic Press; 1 st Edition, 2016.
4. Dr.N.Arumugam, Research Methodology, Saras Publication, First Edition, 2016.
5. Vinayak Bairagi and Mousami V. Munot, Research Methodology- A Practical and Scientific approach, CRC Press, 2019.
6. R.Gopalan, P.S.Subramanian and K.Rengarajan, Elements of Analytical Chemistry, Sultan Chand and Sons, New Delhi, 2005.
7. S.M.Khopkar, Basic concepts of analytical chemistry, New age international, third edition 2008.
8. Douglas A.Skoog, Donald M. West, F. James Holler and Stanley R.Crouch, Fundamentals of Analytical Chemistry, ninth edition, 2013.
9. Gary D.Christian, Purnendu K.Dasgupta and Kevin A.Schug, Analytical Chemistry, John Wiley & Sons, seventh edition, 2013.
10. G.R.Chatwal and S.K.Anand, Instrumental Method of Chemical Analysis, Himalaya Publishing house, fifth Reprint, 2016.  
Text Books
11. A.Joseph, Methodology for Research; Theological Publications, Bangalore, 1986.
12. B.E.Cain, The Basis of Technical Communicating, ACS., Washington, D.C., 1988.