**POSTGRADUATE & RESEARCH DEPARTMENT OF CHEMISTRY**

**DWARAKA DOSS GOVERDHAN DOSS VAISHNAV COLLEGE**

**ARUMBAKKAM, CHENNAI- 600 106**

**AUTONOMOUS COLLEGE**

**AFFILIATED TO UNIVERSITY OF MADRAS**

# M.Phil. CHEMISTRY DEGREE COURSE

**CHOICE BASED CREDIT SYSTEM (CBCS)**

**OUTCOME BASED EDUCATION (OBE) SYLLABUS**

**(Full Time & Part Time)**

# REGULATIONS

# SYLLABUS

**(w.e.f 2019 onwards)**

**D.G.VAISHNAV COLLEGE**

**INDEX**

## VISION

To impart value-based quality academia; to empower students with wisdom and to charge them with rich Indian traditions and culture; to invoke the self, to broaden the same towards nation building, harmony and universal brotherhood

## MISSION

To ensure sustained progress and development in imparting quality education, to pioneer new avenues of teaching and research and to emerge as an institution with potential for excellence

**DEPARTMENT OF THE CHEMISTRY**

## VISION

To impart a sound **knowledge** in chemistry to the students that stresses scientific reasoning and problem-solving skills. To equip students with the **skills** required to strengthen their social responsibility and to make them competent in this knowledge-driven society.

## MISSION

| | |
|---|---|
| M1 | To educate students with state-of-the-art curriculum, improvised teaching methodologies and progressive research facilities.<br>To expose students to a breadth of experimental techniques this will transform them into quality chemist. |
| M2 | To produce socially responsible chemist who can contribute more to the industry and to address problems of societal importance.<br>To make the department a thriving center of excellence in teaching, curriculum development and valuable research |
| M3 | To outreach the under-privileged students of the city in the form of workshops, on-line courses, etc that showcase the role of chemistry as central science. |

**Eligibility for admission to M.Phil.**

Pass in M.Sc. Chemistry examination, degree awarded by recognized Indian Universities

**Duration of course**

M.Phil. (one year)

**Eligibility for the award of degree**

Eligibility for the award of degree: Passing of all the subjects (both in internal and ESE) offered by the college for the course.

**PROGRAM EDUCATION OBJECTIVES (PEOs)**

| | |
|---|---|
| **PEO1** | To produce efficient and intellectual research scholar with strong fundamentals in organic, inorganic, physical and analytical chemistry to pursue advanced topics in the field of research, innovation and technology |
| **PEO2** | To make research scholars, capable of attaining employment in teaching, R&D and industry. |
| **PEO3** | To enable research scholars to develop professionally through life-long learning, higher education and other creative entrepreneurial pursuits in their areas of expertise or interest**.** |
| **PEO4** | |
| **PEO5** | |

**PEO TO MISSION STATEMENT MAPPING**

| **MISSION STATEMENTS** | **PEO1** | **PEO2** | **PEO3** | **PEO4** | **PEO5** |
|---|---|---|---|---|---|
| M1 | 3 | 2 | 3 | | |
| M2 | 2 | 2 | 3 | | |
| M3 | 2 | 2 | 3 | | |

**CORRELATION: 3- STRONG 2- MEDIUM 1- LOW**

## PROGRAMME OUTCOMES

**At the completion of the M.Phil. Chemistry program, the scholars of our Department will be able to :**

| S.NO | GRADUATE ATTRIBUTES | PROGRAMME OUTCOMES |
|---|---|---|
| 1. | **Knowledge** | Attain in depth knowledge about the fundamental principles, essential facts, conclusions and applications of chemical and scientific theories in various domains of chemistry. **(PO1)** |
| 2. | **Critical Thinking** | Carry out experiments in the various areas of chemistry. **(PO2)** |
| 3. | **Problem Solving** | Define the background of reaction mechanisms, complex chemical structures, instrumental method of chemical analysis, and separation techniques and apply appropriate techniques for analysing specific problems both qualitatively and quantitatively in laboratories and in industries. **(PO3)** |
| 4. | **Usage of modern tools** | Create data using modern chemical tools and ICT for modeling and analyze the data obtained from sophisticated instruments (like UV-Vis , FTIR, NMR, GCMS, Fluorescence, SEM,TEM and XRD) for chemical analysis **(PO4)** |
| 5. | **Communication** | Develop Skills to evaluate, analyze and interpret the chemical information and data and to communicate effectively within the chemical community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. **(PO5)** |
| 6. | **Life-long Learning** | Demonstrate scholarly attitude to pursue a career in the field of chemical education and research and have the zeal and vision to engage in independent and life-long learning in the broadest context of technological and social change. **(PO6)** |
| 7. | **Ethical Practices and Social Responsibility** | Generate ideas and solutions for green and sustainable chemistry and approach towards planning and execution of research in frontier areas of chemical sciences. **(PO7)** |
| 8. | **Independent and Reflective Learning** | Develop entrepreneurial skills in interdisciplinary and multidisciplinary areas of chemical sciences and its applications and develop a zeal to pursue a career in the field of chemistry.**(PO8)** |

**Mapping of POs TO PEOs**

| PEO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **PEO 1** | 3 | 2 | 2 | 2 | 2 | 2 | 1 |
| **PEO 2** | 2 | 2 | 3 | 1 | 2 | 2 | 3 |
| **PEO 3** | 2 | 3 | 3 | 2 | 1 | 1 | 3 |
| **PEO 4** | 3 | 2 | 2 | 2 | 1 | 1 | 2 |
| **PEO 5** | 2 | 2 | 2 | 3 | 2 | 2 | 1 |

3-Strong Correlation 2- Medium Correlation 1- Low Correlation

## PROGRAM SPECIFIC OUTCOMES (PSO's)

| PSO | Upon completion of M.Phil degree programme, the scholars will be able to: |
|---|---|
| PSO1 | Seed the intention for innovative research [PO 1]&[PO5] |
| PSO2 | Gain expertise of well-defined area of research in chemistry [PO 1]&[PO2] |
| PSO3 | Develop innovative methodologies to tackle issues identified and contributing to the development of technological knowledge and intellectual property [PO7] & [PO2} |
| PSO4 | Contribute significant input for scientific growth and to evolve as excellent professionals [PO5] &[PO7] |
| PSO5 | Analyze the impact of new areas of research for global , economic , environmental and societal context [PO3] & [PO4] |
| PSO6 | Develop teaching and learning skills and enhance leadership quality.[PO6] |
| PSO7 | Evolve as best professionals in public sector units BARC/DRDO/CSIR Laboratories[PO6] &[PO7] |

## M.Phil. Course Structure

| SI. No. | Course Components | Subjects | Credits | Hrs. | Max. Marks | |
|---|---|---|---|---|---|---|
| | | | | | CIA | External |
| 1 | Core 1 | Research Methodology | 5 | 3 | 25 | 75 |
| 2 | Core 2 | Instrumental methods of analysis | 5 | 3 | 25 | 75 |
| 3 | Elective 1** | Kinetics and Mechanism | 5 | 3 | 25 | 75 |
| 4 | Elective 2** | Advanced Co-ordination chemistry | 5 | 3 | 25 | 75 |
| 5. | Elective 3** | Synthetic Organic Chemistry | 5 | 3 | 25 | 75 |
| 6. | Elective 4** | Polymer Chemistry | 5 | 3 | 25 | 75 |
| 5 | Core 3 | Project and Viva - Voce | 21 | | | 200* |
| | | Total | 51 | | | |

**Core 1 & 2 compulsory papers**

****Elective 1 -4 (any one Paper) should be taken by the candidate.**

****Elective Papers are to be set by the supervisor concerned.**

* **Project evaluation 150 marks**

**Viva – Voce 50 marks**

# CORE PAPER-1 RESEARCH METHODOLOGY

**LEARNING OBJECTIVES:**

*This course aims to facilitate the approach towards research systematically and present the investigation in a sequential manner.*

**COURSE OUTCOMES:**

At the end of the Course, the Student will be able to:

| | |
|---|---|
| **CO1** | Creating awareness and Visualizing scientific problems. |
| **CO2** | Assessing scientific search engines, scopus, SCI finder, etc. |
| **CO3** | Interpret the acquired data using t-test., Q-test, F-test and analyse using regression analysis |
| **CO4** | Expertising in technical, report and thesis writing and familiarizing with intellectual property informations. |
| **CO5** | Applying software knowledge -Chemdraw, origin etc., and communicating research findings to journals |

**MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**

| **CO/PO/PSO** | PO | | | | | | | PSO | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **CO1** | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO2** | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO3** | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 1 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

**STRONGLY CORRELATED -3, MODERATELY CORRELATED – 2, WEAKLY CORRELATED -1**

| S. NO | CONTENTS OF MODULE | COs |
|---|---|---|
| 1 | **Scientific awareness and selection of research problem**<br>General scientific awareness; Objectives of research-What makes one to do research? Research design - meaning, Need for research, Components of research design, various stages of research - selection of research problem and hypothesis.<br>Basic principles of experimental design-important experimental design-Basic research<br>Possible approaches to be adopted by a researcher; factors affecting quality of research,<br>Problems encountered by researchers in India | **CO1** |
| 2 | **Literature Survey**<br>Primary and secondary sources-reviews, treaties, monographs, patents, current literature search methods, abstraction of research papers, Major secondary sources-bibliography databases, Web as a source of information, searching the web. Literature search using Sci-finder scholar, Scopus. | **CO2** |
| 3 | **Collection of Data**<br>Collection of primary data-observation method, interview method and survey methods, Survey Techniques and Methods – Treatment of data-t-test., Q-test, F-test, significant figures and its importance - sources of error in research data, tests for sound measurement-Techniques of developing measurement tools - Processing and analysis of data-Statistical methods; measures of central tendency - measures of relationship, simple regression analysis, multiple correlation and regression | **CO3** |

| | | |
|---|---|---|
| **4** | **Reporting and thesis writing**<br><br>Structure and components of scientific papers, technical reports and thesis –planning the scientific paper-contents of scientific papers and reports-Illustrations and tables, Plots – diagrams – structures and figures presentation - Preparation of final manuscript /thesis-mechanics of writing a research report-proof reading / correction of research manuscript, style manuals; Bibliography referencing and foot notes etc. Issues related to copyright-reproduction of published materials-royalty - Patenting | **CO4** |
| **5** | **Computer Applications**<br><br>Drawing structures using Chem. Draw - Application of Excel programme for drawing tabular columns – plots – doing simple calculations – Online submission of research articles. | **CO2, CO5 and CO6** |

**References**


1. J.Anderson Durston and pools; THESIS AND ASSIGNMENT WRITING, New Delhi;

Wiley Eastern, 1970

2. Joseph Gibald MLA HAND-BOOK FOR WRITERS OF REASEACH PAPERS

$6^{th}$ edition New Delhi; Affiliated East-west press, 2003

3. T.S.Wilkinson and P.L Bhandarkar, METHODOLOGY AND TECNIQUES OF SOCIAL RESEARCH, Bombay; Himalaya publishing company, 2001

4.Periannan,S.sebastian, SOCIAL RESEARCH METHODOLOGY An introduction Chennai, University of Madras; Department of Christian studies,2003

4. E.Sreedharan-A TEXT BOOK OF HISTORIOGRAPHY 500 B.C to A.D 2000,Bombay, Orient Longman, 2004

# CORE PAPER 2

# INSTRUMENTAL METHODS OF ANALYSIS

**LEARNING OBJECTIVES:**

Students are able to acquire knowledge, information regarding various analytical techniques and tools employed in the industry, quality control labs and research labs. A thorough investigation and analysis could be gained and imparted by a student in analysis in learning these analytical techniques

**COURSE OUTCOMES:**

At the end of the Course, the Student will be able to:

| | |
|---|---|
| **CO1** | The students get useful information on the physical and chemical properties of the chemicals materials and other substances where there will be working upon in a process industry or lab or industries. |
| **CO2** | They acquire information are well equipped on operating any analytical instruments and can carry out any separation techniques which are of upmost important in pharmaceutical and chemical industries. |
| **CO3** | Apart from theoretical knowledge of instrumentation, the students are made to learn visually with hands on experience such that their confidence and morale on handling of instruments is envisaged. |
| **CO4** | In this unit the students learn a complete analysis from characterisation, structural elucidation and detailed information about the organic and inorganic compounds, complexes and materials by various spectroscopic techniques like UV-Visible, IR, NMR, ESR Mossbauer, PES, NQR and Mass spectroscopic methods. |
| **CO5** | The student acquires knowledge about the various physical and chemical changes that varies with extent of mass, temperature, influence of water of hydration, stress and elemental composition through Thermo gravimetric analysis (TGA) Derivative thermo- gravimetric analysis (DTG) Differential thermal analysis (DTA) DSC and Thermometric titrations |

| | |
|---|---|
| **CO6** | The student acquires knowledge about the various electrode systems, significance of residual, migration, diffusion and limiting currents and the role of solvents involved in electro analytical techniques. |
| **CO7** | Detailed information about the measurement of magnetic properties and applications of magnetic materials. |

**MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**

| **CO/PO/PSO** | PO | | | | | | | PSO | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **CO1** | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO4** | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 1 | 2 |
| **CO6** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 1 |

**STRONGLY CORRELATED -3, MODERATELY CORRELATED – 2, WEAKLY CORRELATED -1**

| S. NO | CONTENTS OF MODULE | COs |
|---|---|---|
| 1 | **Purification Techniques:**<br><br>Physical properties - usefulness in analysis and methods of separation prior to analysis – Isolation techniques – extraction - crystallization, sublimation, distillation, different types of distillation techniques – steam distillation – reduced pressure distillation – fractional distillation - Analytical distillation, Thermal hazards of these techniques – chromatography – column, paper, thin layer and gas chromatography – Reaction techniques to include high dilution, vacuum line reactions, reactions aided by azeotropic distillation, recycling pyrolysis, Soxhlet extraction, continuous reactions, reactions at low temperatures, reactions in non-aqueous media and molten salts, micro quantity handling and use of glove box, Special methods in modern chemistry – methods for vacuum sublimation and quasi sublimation, technique and apparatus for reactions in inert atmosphere and under low temperature, working with compressed gases, heating under pressure, chemistry of working with hazardous materials – air/water sensitive, corrosive, toxic, explosive and radioactive materials – use of nitrogen atmosphere and its significance. | **C01, CO2, CO3** |
| 2 | **Spectroscopy:**<br><br>a) Optical spectroscopy –UV, Visible and IR spectroscopy with reference to radiation source, Optical materials, monochromators and detectors, Principles – the design of single beam and double beam spectrophotometers – Application of optical spectroscopy in qualitative and quantitative analysis<br>b) Magnetic Resonance Spectroscopy –Nuclear magnetic and electron magnetic resonance spectroscopy – Basic features of the NMR and ESR spectrometers. NMR: Chemical shift, spin-spin coupling and double resonance. NMR shift reagents – | **CO4** |

| | | |
|---|---|---|
| | Applications of NMR spectroscopy in qualitative and quantitative analysis – wide line and FT NMR $C^{13}$ NMR. ESR: Hyperfine splitting – g value – factors affecting the magnitude of 'g' value. Zero field splitting. ESR spectra of organic radicals and transition metal complexes.<br>c) Mossbauer spectroscopy–The Mossbauer effect – nuclei exhibiting Mossbauer effect – experimental techniques – isomer shift, quadrupole splitting – applications.<br>d) Photoelectron Spectroscopy –XPS and UPS- Instrumentation – radiation sources – energy analyzers and detectors – use of XPS and UPS as analytical tools<br>**e)** Mass spectrometry –Mass spectrometer instrumentation – the ion source, mass analysers – detectors – vacuum system – data processing – sample handling – applications of mass spectrometry in quantitative and qualitative analysis. | |
| **3** | **Thermoanalytical methods:**<br>Thermo gravimetric analysis (TGA) Thermo balances Derivative thermo- gravimetric analysis (DTG) Differential thermal analysis (DTA) The DTA apparatus, DSC, DTA Thermometric titrations | **CO5** |
| **4** | **Electroanalytical methods:**<br>a) Voltammetry: Dropping mercury electrode DME – Polarographic analysis – The shape of polarographic wave – Ilkovic equation for diffusion current – significance of half wave potentials - polarographic maxima and their eliminations – instrumentation of polarography – applications in quantitative and qualitative analysis<br>b) Coulometry: Types of coulometric methods - coulometric analysis at constant electrode potentials – titrations involving neutralization, precipitation and complex forming reactions. | **CO6** |

| | | |
|---|---|---|
| **5** | **Magnetic properties:**<br><br>Measurements – different methods – comparison and use in structural elucidation. | **C07** |

**References:**


1. Instrumental methods of analysis, H.H.Willard, L.I. Merrit Jr and J.A.Dean. Affiliated East West Press 1974.
2. Principles of Instrumental Analysis (second edition), D.M.Scoog and D.M.West Holt-Saunders, Japan 1980.
3. Analytical Chemistry R.Gopalan, S.Chand &Co.
4. R.S.Drago, Physical methods in Inorganic Chemistry, Reinhold Ny.1968.
5. E.A.V Ebsworth, D.W.H.Rankin and S.Cradock, Structural methods in Inorganic Chemistry, Blackwell Scientific Publ., 1976.

# ELECTIVE-I

# KINETICS AND MECHANISM

**LEARNING OBJECTIVES:**

**To enumerate on the significance of the thermodynamics and chemical kinetics of the chemical reactions.**

**COURSE OUTCOMES:**

At the end of the Course, the Student will be able to:

| | |
|---|---|
| **CO1** | To understand in detail the classification of chemical reaction |
| **CO2** | To get exposed to different types of solvents and role of green solvents for pollution free environment. |
| **CO3** | To analyze the thermodynamic significance of the chemical reactions. |
| **CO4** | To carry our out fast chemical reactions and isotopic effects. |
| **CO5** | To paraphrase the all the well defined chemical reactions. |

**MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**

| **CO/PO/PSO** | PO | | | | | | | PSO | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |

**STRONGLY CORRELATED -3, MODERATELY CORRELATED – 2, WEAKLY CORRELATED -1**

| S. NO | CONTENTS OF MODULE | COs |
|---|---|---|
| 1 | Empirical treatment of reaction rates – experimental methods: treatment of data – Complex reactions – parallel and consecutive reaction – steady state hypothesis: Theories and comparisons of collision and Transition state theories. Catalysis – homogeneous and heterogeneous catalysis – Acid-Base catalysis – Acidity functions and acidity scales – Enzyme catalysis. | CO1 |
| 2 | Reactions in solutions – Stoichiometry - reaction between ions – reaction between ion and dipole – reaction between dipoles – influence of ionic strength. Solvent effects – polar (protic and dipolar aprotic solvents) and non polar solvents – solvent polarity scales – steric effect | CO2 |
| 3 | Calculation of thermodynamic parameters from kinetic data and their interpretation-isokinetic temperature. | CO3 |
| 4 | Isotope effects – primary and secondary isotope effects – solvent isotope effects.<br>Fast reaction techniques – Flow techniques – Flash photolysis | CO4 |
| 5 | Structural effects – Linear free energy relationship – Hammett and Taft equations – their use in the establishment of mechanism – Acid –base catalysis – Bronsted catalysis- Predicting mechanism based on kinetic data obtained | CO5 |

**References:**


1. J.Rajaram & J.C.Kuriacose,1993, Kinetics and mechanism of chemical transformations, Mac Millon India Ltd.
2. K.J.Laidler, 1987, Chemical kinetics, Harper and Row, New York
3. P.W.Atkins, 1990, Physical Chemistry, Oxford
4. W.J.Moore, 1972, Physical Chemistry, Orient Longman, London
5. R.G.Frost and Pearson,1981, Kinetics and mechanism, Wiley, New York

# ELECTIVE 2

# ADVANCED COORDINATION CHEMISTRY

**LEARNING OBJECTIVES:** *The objective of the course is to equip the students to Application of coordination compounds Qualitative analysis, Electron Transfer reactions, Structural evidence from electronic spectra. IR spectral assignments of co-ordinated ligands in Metal complexes and differentiation of isomers, intramolecular rearrangements studies by NMR, NMR of paramagnetic transition metal ion complexes, Photosensitized reactions of Chromium, Cobalt and Platinum. synthesis of macrocyclic ligands and macrocycles.*

**COURSE OUTCOMES:**

At the end of the Course, the Student will be able to:

| | |
|---|---|
| **CO1** | Able to understand different types of electron transfer reaction (one electron transfer reaction and direct electron transfer reaction ) and factors affecting them. |
| **CO2** | To understand the d-orbital splitting pattern in different geometries like octahedral, tetrahedral, tetragonal distorted and square planar, can predict coordinated ligands |
| **CO3** | Be able to use NMR spectra to determine the structures of compounds, given other information such as a molecular formula and Magnetic property of the inorganic complex |
| **CO4** | Discuss the importance of the configuration of chiral inorganic compounds, including those with no chiral centre, in relation to chemical and physical properties. |
| **CO5** | To understand metal ions take part in biological system and their concentration effect and physiological effect on biological system. |
| **CO6** | Gain hands on experience and knowledge about the synthesis of metal complexes of different shapes and different bi and tri nuclear complexes |

**MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**

| CO/PO/PSO | PO | | | | | | | PSO | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **CO1** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| **CO2** | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO6** | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |

**STRONGLY CORRELATED -3, MODERATELY CORRELATED – 2, WEAKLY CORRELATED -1**

| S. NO | CONTENTS OF MODULE | COs |
|---|---|---|
| 1 | **Theories of coordination compounds and Mechanisms of Electron Transfer Reactions**<br><br>Molecular orbital theory and Angular overlap model. Inner sphere and Outer sphere Electron Transfer reactions, Nuclear tunneling in electron transfer, Marcus- Hush Theory. | **CO1** |
| 2 | **Spectroscopy I**<br><br>Determination of Electronic structure and Geometry of coordination compounds<br><br>**Electronic Spectroscopy:** Crystal field spectra and effect of distortion on the d-orbital energy levels. Structural evidence from electronic spectra. Evaluation of Dq and B values in Cr (III), Co(III) $O_h$ and Ni(II) $O_h$ complexes and in tetragonally distorted Copper (II) complexes. | **CO2** |

| | | |
|---|---|---|
| | **Infrared and Raman Spectroscopy:** Structural diagnosis by IR & Raman Spectra – IR spectral assignments of co-ordinated ligands in Metal complexes and differentiation of isomers (CN/ NC, OCN/NCO, SCN/NCS, $NO_2$/ONO) Resonance Raman Spectroscopy.<br><br>**Mossbauer Spectroscopy:** Quadrupole and Magnetic interaction, Mossbauer spectroscopy and applications | |
| **3** | **Spectroscopy II**<br><br>**Nuclear Magnetic Resonance spectroscopy:** Application of spin-spin coupling to inorganic structural determination, NMR Spectra of quadrupolar nuclei, intramolecular rearrangements studies by NMR, NMR of paramagnetic transition metal ion complexes – Lanthanide shift reagents<br><br>**Electron Spin Resonance Spectroscopy:**<br><br>Hyper fine and Zero filed effect on the spectra-Ligand field interpretation of the 'g'and A tensors, Nuclear quadrupole interaction, survey of EPR spectra of first row transition metal ions.<br><br>**Nuclear Quadruopole Resonance Spectroscopy**: Effect of magnetic filed on the spectrum, Relationship between electric filed gradient and molecular structure, structural elucidation of inorganic and coordination compounds | **CO3** |
| **4** | **Study of chiral co-ordination compounds by ORD and CD, Magnetic behavior and Photochemistry:**<br><br>Study of co-ordination compounds by EXAFS & LEED spectra. Magnetic Susceptibility and electronic states of co-ordination compounds. Photo substitution and photo isomerisation of Cr(III), Fe, Ru, Co complexes. | **CO4** |

| | | |
|---|---|---|
| | Photo induced electron transfer, cleavage of metal–metal bond in poly nuclear complexes, Pulse radiolysis- Radiolysis of complexes of Cobalt, Iron, Ruthenium and Copper. Photosensitized reactions of Chromium, Cobalt and Platinum. | |
| **5** | **Electro chemical methods of studying co-ordination compounds, Inorganic biochemistry and Synthesis of novel coordination compounds:**<br><br>DC and Pulse polargraphy and cyclic Voltammetry, Electrochemical synthesis of complexes, thin layer electro chemistry.<br><br>The oxygen carriers-hemoglobin and myoglobin, synthetic oxygen carriers. Copper proteins-type I, type II, and type III copper. Electron transfer reagnets-cytochromes and iron sulphur proteins. Nitrogen fixation. Chelate therapy. Application of spectroscopy in the study of bio-inorganic systems.<br><br>Design and synthesis of compartmental ligands and bio-nuclear complexes. Template synthesis, synthesis of macrocyclic ligands and macrocycles. | **CO5, CO6** |

REFERENCES


1. R.S.Drago, Physical methods in Inorganic Chemistry, Reinhold Ny.1968.
2. E.A.V Ebsworth, D.W.H.Rankin and S.Cradock, Structural methods in Inorganic Chemistry, Blackwell Scientific Publ., 1976.
3. M. C. Shrivers, P. W. Atkins, C H Langford, Inorganic Chemistry, OUP, 1990.
4. F. Basolo and Pearson, Mechanism of Inorganic Reactions, Wiley, New York, 1967.
5. R.B.Heslop and K.Jones, Inorganic Chemistry, Elseiver Scientific Publ., 1976.
6. H.A.O.Hill and P.Day, Physical methods in ADVANCED Inorganic Chemistry, John Wiley, 1968.
7. C.N.R.Rao, J.R.Ferraro, Spectroscopy in inorganic Chemistry, Vol I and II, Academic Press, 1970.
8. Purcell, K.F. and Kotz, J.C., - Inorganic Chemistry, WB Saunders Co., USA (1977)
9. J.E. Huheey, 1993, Inorganic Chemistry - Principles, Structure and Reactivity; IV Edition, Harper Collins, NY.

10. F.A. Cotton and G. Wilkinson, 1988, Advanced Inorganic Chemistry - A Comprehensive Text, V. Edition, John Wiley & Sons.
11. R.V. Parish , NMR, NQR, EPR, and Mossbauer Spectroscopy in Inorganic Chemistry. Ellis Horwood Limited. 1990.
12. N.J.Turro. Modern Moleular Photochemistry, Benjamin, Cummings, Mento Park, California 1978
13. Fundamentals of Photochemistry, Wiley Eastern Ltd., K.K.Rohatgi Mukherjee.
14.A.W.Adamson and P.Fleischauer Concepts of Inorganic Photochemistry, Wiley, 1975.
15. A.B.P. Lever, Inorganic electronic spectroscopy, II edition. Publishing company, Amsterdam, 1984.16.

# Elective -3
## SYNTHETIC ORGANIC CHEMISTRY

**LEARNING OBJECTIVES:**

**Objectives:**

1. To know the methods of synthetic strategies and its applications
2. To apply the knowledge of chemical reactions in organic synthesis

**COURSE OUTCOMES:**

At the end of the Course, the Student will be able to:

| | |
|---|---|
| **CO1** | Design and develop strategy in organic synthesis |
| **CO2** | Demonstrate various methodologies in asymmetric synthesis |
| **CO3** | Explain the importance of silicon and Boron in organic synthesis |
| **CO4** | Outline the different types of redox reactions that can be employed in organic synthesis |
| **CO5** | Interpret the knowledge of organic synthesis in selected organic reactions |

**MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**

| **CO/PO/PSO** | PO | | | | | | | PSO | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO6** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

**STRONGLY CORRELATED -3, MODERATELY CORRELATED – 2, WEAKLY CORRELATED -1**

| S. NO | CONTENTS OF MODULE | COs |
|---|---|---|
| 1 | **DESIGN AND STRATEGY IN ORGANIC SYNTHESIS (15 hours)**<br><br>1.1 Known and unknowns of synthetic systems, analysis of complex and interrelated carbon frame work, precursors, retro synthetic approach.<br>1.2 Yield of synthetic reactions, convergent synthesis.<br>1.3 Functionalisation and interconversion of functional groups-functionalisation of alkanes, alkenes, alkynes, aromatic hydrocarbons, heterocyclic compounds and inters conversion of functional groups<br>1.4 Formation of Carbon-carbon bonds- general strategy, disconnections and synthons, electrophilic and nucleophilic carbon species.<br>1.5 Regiospecific control elements, use of protective groups, activating groups and bridging elements.<br>1.6 Streospecific control elements – functional group a lterations and transportations.<br><br>**ASSIGNMENT 1:** Electrophilic carbon-nitrogen reagents, electrophilic alkenes, Grignard and related organometallic reagents. | **C01** |
| 2 | **ASYMMETRIC SYNTHESIS (10 hours)**<br><br>2.1 Terminology and analytical methods, Strategy and classification of methods, first, Second, third and fourth generation methods. Use of two each of chiral substrates, Chiral auxiliaries, chiral reagents.<br>2.2 Asymmetric catalysis, catalytic asymmetric alkylation, hydrogenation, reactions Catalyzed by enzymes and other proteins.<br>2.3 Organo transition metal chemistry, applications to a symmetric organic synthesis.<br>2.4 Alkylation of active methylene compounds in asymmetric synthesis.<br><br>**ASSIGNMENT 2:** Multistage synthetic routes, asymmetric Diels-Alder reaction, alkylation α to<br>Nitrogen. | **CO2** |

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| **3** | **Silicon and boron in organic synthesis (10 hours)**<br><br>3.1 Properties of bonds to silicon, nucleophilic substitution at silicon, 1,2-rearrangements.<br>3.2 Protection of hydroxyl groups as silyl ethers, silylenol ethers and related silyl ethers,<br>Synthesis of alkenes (Peterson olefination).<br>3.3 Alkynyl-, vinyl- and arylsilanes in organic synthesis, arylsilanes and acylsilanes.<br>3.4 Typical organic synthesis involving organosilicon compounds.<br>3.5 Hydroboration, asymmetric hydroboration, reactions of organoboranes-oxidation,<br>protonolysis, amination, halogenolysis, isomerisation.<br>3.6 Organoboron routes to unsaturated hydrocarbons- synthesis of alkenes, alkynes,<br>diynes, enynes.<br>3.7 Alkylboranes and boron enolates in organic synthesis, double asymmetric induction.<br>3.8 Boronic ester homologation.<br><br>**ASSIGNMENT 3**: Silyl ketene acetals, regioselective electrophilic attack on alkynylsilanes,<br>applications of boron compounds in asymmetric synthesis. | **CO3** |
| **4** | **Redox reactions in organic synthesis (15 hours)**<br><br>4.1 Oxidation of hydrocarbons, alcohols, carbon-carbon double bonds, diols, epoxides.<br>4.2 Enantioselective epoxidation of allylic alcohols, diastereoselective epoxidation,<br>ozonolysis.<br>4.3 Oxidation of ketones – Baeyer-Villiger oxidation, oxidation with thallium (III) nitrate,<br>selenium reagents and intermediates in organic synthesis, lead tetraacetate.<br>4.4 Catalytic hydrogenation, selectivity of reduction,homogeneous hydrogenation, reduction by<br>dissolving metals.<br>4.5 Reduction by hydride transfer reagents – aluminium alkoxides, LAH, sodium borohydride,<br>sodium cycnoborohydride, trialkylborohydrides.<br>4.6 Electrochemical organic synthesis<br><br>**ASSIGNMENT 4:** Wolff-Kishner reduction, desulphurisation of thioacetons, di-imide, lowvalent titanium species. | **CO4** |

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| **5** | **Selected Organic synthesis (10 hours)**<br>Reagents for organic synthesis and their applications - Synthesis of Z-Heneicos-6-en-11-one, Disparlure, Z-Jasmone, helicenes, annulenes, progesterone, cortisone and peptide synthesis. | **CO5** |

**Reference books**


1. R.K.Mackie, D.M.Smith and R.Alan Aitken, Guidebook to organic synthesis, III Edition, Longman Group Limited, 1999.

2. Ireland R.E, Organic synthesis, Prentice Hall India, Goel publishing house, 1990

3. Smith, M.B, Organic synthesis, II Edition, McGraw Hill International, 2002

4. House H.O. Modern Synthetic reactions, W.A. Benjamin Inc, 1972

5. Carruthers, W, Modern Methods of organic synthesis, III edition, Cambridge University Press, 1986.

6. Norman R.O.C., Organic synthesis, Chapman Hall,London, 1980

7. Susan E.Thomas, Organic synthesis, Oxford science publications, 1994.

8. I.L.Finar, Organic synthesis, Longman, 2004.

9. Francis A.Carey and Sundberg, Advanced Organic Chemistry, 5$^{th}$ edition, Tata McGraw-Hill, New York, 2003

10. Smith and Jerry March, March's Advanced Organic Chemistry, John Wiley, 2007.

# ELECTIVE-4

# POLYMER CHEMISTRY

**LEARNING OBJECTIVES:**

1. To know the various polymerization techniques and its significances in polymer chemistry.
2. To apply the knowledge of characterization of prepared polymers.

**COURSE OUTCOMES:**

At the end of the Course, the Student will be able to:

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| **CO1** | To understand in detail about the fundamental terms in polymer chemistry and also their classification. |
| **CO2** | To get exposed to different types of several polymerization techniques. |
| **CO3** | To enumerate the utility of stereoregular polymers and ring opening polymerization in the world of polymer science and technology. |
| **CO4** | To paraphrase the concepts of polymers in solution |
| **CO5** | To get exposed to different types characterization techniques in polymer chemistry. |

**MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES:**

| **CO/PO/PSO** | PO | | | | | | | PSO | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |

**STRONGLY CORRELATED -3, MODERATELY CORRELATED – 2, WEAKLY CORRELATED -1**

| S. NO | CONTENTS OF MODULE | COs |
|---|---|---|
| 1 | **Introduction**<br><br>Definitions, origin, nomenclature, classification of macromolecules; molecular weight (MW) and its distribution; thermal transitions; thermodynamics of polymerization. | CO1 |
| 2 | **Types of Polymerization**<br><br>Reactivity of functional groups; kinetics; molecular weight in open and closed system - Carother's equation; stoichiometric control of MW; cyclization vs. linear polymerization, cross-linking and gel point; process condition; step-copolymerization, examples of step polymers<br><br>**Radical Chain Polymerization**<br><br>Nature of chain polymerization and its comparison with step polymerization; radical vs. ionic polymerizations; structural arrangements of monomer units; kinetics of chain polymerization; molecular weight and its distribution; chain transfer, inhibition, retardation, auto-acceleration; energetic characteristics; techniques of radical polymerization – bulk, solution, emulsion, suspension polymerization; examples of polymers made by radical chain polymerization.<br><br>**Living radical polymerization**<br><br>Theory; nitroxide-mediated polymerization (NMP); atom transfer radical polymerization (ATRP); radical addition-fragmentation transfer (RAFT); others.<br><br>**Ionic chain polymerization**<br><br>Comparison of radical and ionic polymerizations; cationic polymerizations - kinetics, mechanism; anionic polymerization - kinetics, mechanism; living anionic polymerization; examples.<br>**Chain co-polymerization**<br><br>General considerations; types of copolymers, copolymer compositions, reactivity ratio; radical and ionic copolymerizations; examples. | CO2 |
| 3 | **Stereoregular polymerization** | CO3 |

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| | Origin and types of stereoisomerism in polymers; factors influencing stereoregulation; properties of stereoregular polymers; stereospecific ionic polymerizations; coordination polymerization; Ziegler-Natta polymerization, metallocene polymerization; examples<br>Other polymerization processes<br><br>Ring opening polymerization; group transfer polymerization; metathesis polymerization, etc. | |
| **4** | **Polymers in solution**<br><br>Thermodynamics of polymer solutions; Flory-Huggins theory, theta conditions; solubility parameters; fractionation of macromolecules<br><br>**Chain dimensions**<br><br>Freely joined chain; effect of geometric and volume restrictions; frictional properties of macromolecules in dilute solution. | **CO4** |
| **5** | **Characterization of macromolecules**<br><br>Determination of molecular weight - methods for measuring number average, weight average, viscosity average MW; gel permeation chromatography; spectroscopic techniques to determine chemical composition and molecular microstructure.<br><br>**Reaction of macromolecules**<br><br>Reactions with polyolefins, polyenes, pendant groups; polymer degradation - thermal degradation, degradation by catalyst residues, degradation by end groups; mechanism of stabilization - antioxidants and heat stabilizers, catalyst quenchers, end-capping;<br><br>**Polymer properties and supermolecular structure**<br><br>Properties of solid polymers, amorphous and crystalline phases of polymers, structure-property relationship.<br><br>**Special topics/ Newer topics**<br>Naturally occurring polymers, biodegradable, biosynthesis, polymers from bio/renewable resources. | **CO5** |

**REFERENCES**


1. Principles of Polymerization, 4th edn. George Odian, Wiley
2. Introduction to Polymers, 2nd edn. R. J. Young and P. A. Lovell, Nelson Thrones

3. Contemporary Polymer Chemistry, 3rd edn. H. R. Allcock, F. W. Lampe and J. E. Mark, Pearson
4. Polymers: Chemistry and Physics of Modern Materials, J.M.G. Cowie, CRC Press
5. Introduction to Physical Polymer Science, L. H. Sperling, Wiley

**ASSESSMENT PATTERN**

**CIE- Continuous Internal Evaluation (40 Marks)**

| **Bloom's Category** | **ESE** |
|---|---|
| **Marks (out of 50)** | **100** |
| Remember | -- |
| Understand | ---- |
| Apply | 40 |
| Analyze | 40 |
| Evaluate | 10 |
| Create | 10 |

**ESE- Semester End Examination (100 Marks; weightage 60%)**

| **Bloom's Category** | **Weightage %** |
|---|---|
| Remember | -- |
| Understand | -- |
| Apply | 40 |
| Analyse | 40 |
| Evaluate | 10 |
| Create | 10 |