|  |  |
| --- | --- |
|  | |
| M.sc.,  POLYMER CHEMISTRY | |
|  | |
|  | |
|  | |
|  | |
|  | |
|  | |
|  | |
|  | |
|  | |
|  | |
| **SYLLABUS** | |
|  | |
|  | |
|  | |
|  | |
| |  | | --- | | **FROM THE ACADEMIC YEAR**  **2023 - 2024** | |  | | |
|  | |
|  | |
|  | |
|  | |
|  | |
|  | |
|  | |
|  | |
|  | |
|  | |
|  | |
|  | |
|  | |
| **TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI – 600 005** | |
|  | |

|  |  |
| --- | --- |
| **TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION** | |
| **Programme** | **M.Sc. POLYMER CHEMISTRY** |
| **Programme Code** |  |
| **Duration** | **2 years for PG** |
| **Programme Outcomes (Pos)** | **PO1: Problem Solving Skill**  Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.  **PO2: Decision Making Skill**  Foster analytical and critical thinking abilities for data-based decision-making.  **PO3: Ethical Value**  Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.  **PO4: Communication Skill**  Ability to develop communication, managerial and interpersonal skills.  **PO5: Individual and Team Leadership Skill**  Capability to lead themselves and the team to achieve organizational goals.  **PO6: Employability Skill**  Inculcate contemporary business practices to enhance employability skills in the competitive environment.  **PO7: Entrepreneurial Skill**  Equip with skills and competencies to become an entrepreneur.  **PO8: Contribution to Society**  Succeed in career endeavors and contribute significantly to society.  **PO 9 Multicultural competence**  Possess knowledge of the values and beliefs of multiple cultures and  a global perspective.  **PO 10: Moral and ethical awareness/reasoning**  Ability to embrace moral/ethical values in conducting one’s life. |
| **Programme Specific Outcomes**  **(PSOs)** | **PSO1 – Placement**  To prepare the students who will demonstrate respectful engagement with others’ ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.  **PSO 2 - Entrepreneur**  To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.  **PSO3 – Research and Development**  Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.  **PSO4 – Contribution to Business World**  To produce employable, ethical and innovative professionals to sustain in the dynamic business world.  **PSO 5 – Contribution to the Society**  To contribute to the development of the society by collaborating with stakeholders for mutual benefit. |

**Template for P.G., Programmes**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Semester–I** | **Credit** | **Hours** | **Semester-II** | **Credit** | **Hours** | **Semester-III** | **Credit** | **Hours** | **Semester–IV** | **Credit** | **Hours** |
| 1.1. Core-I | 5 | 7 | 2.1. Core-IV | 5 | 6 | 3.1. Core-VII | 5 | 6 | 4.1. Core-XI | 5 | 6 |
| 1.2 Core-II | 5 | 7 | 2.2 Core-V | 5 | 6 | 3.2 Core-VII | 5 | 6 | 4.2 Core-XII | 5 | 6 |
| 1.3 Core – III | 4 | 6 | 2.3 Core – VI | 4 | 6 | 3.3 Core – IX | 5 | 6 | 4.3 Project with viva voce | 7 | 10 |
| 1.4 Discipline Centric  Elective -I | 3 | 5 | 2.4 Discipline Centric  Elective – III | 3 | 4 | 3.4 Core – X | 4 | 6 | 4.4Elective - VI (Industry / Entrepreneurship)  20% Theory  80% Practical | 3 | 4 |
| 1.5 Generic Elective-II: | 3 | 5 | 2.5 Generic Elective -IV: | 3 | 4 | 3.5 Discipline Centric Elective - V | 3 | 3 | 4.5 Skill Enhancement course / Professional Competency Skill | 2 | 4 |
|  |  |  | 2.6 NME I | 2 | 4 | 3.6 NME II | 2 | 3 | 4.6 Extension Activity | 1 |  |
|  |  |  |  |  |  | 3.7 Internship/ Industrial Activity | 2 | - |  |  |  |
|  | **20** | **30** |  | **22** | **30** |  | **26** | **30** |  | **23** | **30** |
| **Total Credit Points -91** | | | | | | | | | | | |

**Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits and Hours Distribution System**

**for all Post – Graduate Courses including Lab Hours**

**First Year – Semester – I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – I | 5 | 7 |
| Core – II | 5 | 7 |
| Core – III | 4 | 6 |
| Elective – I | 3 | 5 |
| Elective – II | 3 | 5 |
|  |  | **20** | **30** |

**Semester-II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – IV | 5 | 6 |
| Core – V | 5 | 6 |
| Core – VI | 4 | 6 |
| Elective – III | 3 | 4 |
| Elective – IV | 3 | 4 |
| Skill Enhancement Course [SEC] - I | 2 | 4 |
|  |  | **22** | **30** |

**Second Year – Semester – III**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – VII | 5 | 6 |
| Core – VIII | 5 | 6 |
| Core – IX | 5 | 6 |
| Core (Industry Module) – X | 4 | 6 |
| Elective – V | 3 | 3 |
| Skill Enhancement Course - II | 2 | 3 |
|  | Internship / Industrial Activity | 2 | - |
|  |  | **26** | **30** |

**Semester-IV**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – XI | 5 | 6 |
| Core – XII | 5 | 6 |
| Project with VIVA VOCE | 7 | 10 |
| Elective – VI (Industry Entrepreneurship) | 3 | 4 |
| Skill Enhancement Course – III / Professional Competency Skill | 2 | 4 |
| Extension Activity | 1 | - |
|  |  | **23** | **30** |

**Total 91 Credits for PG Courses**

**First Year –**

**Semester – I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – I | 5 | 7 |
| Core – II | 5 | 7 |
| Core – III | 4 | 6 |
| Elective – I | 3 | 5 |
| Elective – II | 3 | 5 |
|  |  | **20** | **30** |

**Semester-II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – IV | 5 | 6 |
| Core – V | 5 | 6 |
| Core – VI | 4 | 6 |
| Elective – III | 3 | 4 |
| Elective – IV | 3 | 4 |
| Skill Enhancement Course [SEC] - I | 2 | 4 |
|  |  | **22** | **30** |

**Second Year – Semester – III**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – VII | 5 | 6 |
| Core – VIII | 5 | 6 |
| Core – IX | 5 | 6 |
| Core (Industry Module) – X | 4 | 6 |
| Elective – V | 3 | 3 |
| Skill Enhancement Course - II | 2 | 3 |
|  | Internship / Industrial Activity | 2 | - |
|  |  | **26** | **30** |

**Semester-IV**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – XI | 5 | 6 |
| Core – XII | 5 | 6 |
| Project with VIVA VOCE | 7 | 10 |
| Elective – VI (Industry Entrepreneurship) | 3 | 4 |
| Skill Enhancement Course – III / Professional Competency Skill | 2 | 4 |
| Extension Activity | 1 | - |
|  |  | **23** | **30** |

**Total 91 Credits for PG Courses**

**M.Sc., POLYMER CHEMISTRY**

**I SEMESTER.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **Title of the Course** | **Credits** | **Hours** |
| Core 1 | Structure and Bonding | 5 | 7 |
| Core 2 | Reaction mechanism and Stereochemistry | 5 | 7 |
| Core 3 | Chemical kinetics and Electrochemistry | 4 | 6 |
|  | Chemistry Practicals –I |  |  |
| Elective 1 | Polymers chemistry (mandatory elective) | 3 | 5 |
| Elective 2 | Reagents in Organic Synthesis | 3 | 5 |
|  | Total | 20 | 30 |

|  |  |  |  |
| --- | --- | --- | --- |
| **II SEMESTER** | | | |
| Core 4 | Coordination chemistry | 5 | 6 |
| Core 5 | Reaction mechanism, Rearrangements, Name  reactions, Oxidation and Reduction Reactions | 5 | 6 |
| Core 6 | Quantum chemistry and Analytical techniques | 4 | 6 |
|  | Chemistry Practicals – II |  |  |
| Elective 3 | Physical Chemistry of Polymers (mandatory  elective) | 3 | 4 |
| Elective 4 | Molecular Spectroscopy | 3 | 4 |
|  | NME / Skill Enhancement Course [SEC] | 2 | 4 |
|  | Total | **22** | **30** |

|  |  |  |  |
| --- | --- | --- | --- |
| **III SEMESTER** | | | |
| Core 7 | Inorganic photochemistry, Spectroscopy and  Organometallics | 5 | 6 |
| Core 8 | Spectroscopy, Spectrometry and their applications | 5 | 6 |
| Core 9 | Thermodynamics and Group theory | 5 | 6 |
| Core 10 | Polymer Practicals | 4 | 6 |
| Elective 5 | Polymer physics (mandatory elective) | 3 | 3 |
|  | NME / Skill Enhancement Course [SEC] | 2 | 3 |
|  | Internship / Industrial Activity | 2 | - |
|  | **Total** | **26** | **30** |
| **IV SEMESTER** | | | |
| Core 11 | Photochemistry, Pericyclic reactions, Heterocycles  and Natural products | 5 | 6 |
| Core 12 | Plastics and Rubber technology | 5 | 6 |
|  | Project with Viva voce | 7 | 10 |
| Elective 6 | Applied Polymer Science (mandatory elective) | 3 | 4 |
|  | Skill Enhancement Course – III / Professional Competency Skill | 2 | 4 |
|  | Extension Activity | 1 | - |
|  | Total | **23** | **30** |

**Total Credits -91**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | | **CHE C 401** | **STRUCTURE AND BONDING** | **L** | | **T** | **P** | **C** |
| **Core/Elective/Supportive** | | | **Core** | **4** | | **0** | **0** | **4** |
| **Pre-requisite** | | | Students should know the period table to understanding the physical and chemicals properties of the elements and nature of  bonding. |  | | |  | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:  **CO1.** To understand the physical and chemicals properties of the elements structure of molecules, symmetry of molecular orbitals – in homo and hetero nuclear diatomic systems.  **CO2.** To study band theory of solids and basic principle of electron diffraction.  **CO3.** To understand the preparation, properties and structure of electron deficient compounds and structure of inorganic polymers. | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| **PSO1** | **Understanding** knowledge about physical and chemical properties of periodic  table. | | | | | | K2 | |
| **PSO2** | **Apply** the knowledge about symmetry and overlap of atomic orbital, bond length,  bond order and bond energy. | | | | | | K3 | |
| **PSO3** | Students will be **remember** on fundamentals and structures of p block elements  and principles of diffraction methods. | | | | | | K1 | |
| **PSO4** | **Evaluate** the fundamental knowledge about chemistry of borons and their  classifications. | | | | | | K5 | |
| **PSO5** | **Understand** an idea about types of inorganic polymers and ring systems. | | | | | | K2 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | |
|  | | | | | | | | |
| **UNIT:1** | | **CHEMICAL BONDING** | | | **14 hours** | | | |
| V.B. approach to bonding-Hitler-London, Pauling and Slater refinements, Concept of hybridization and structure of molecules, VSEPR theory shapes of molecules. M.O. approach to covalent bonding  – symmetry and overlap of atomic orbitals – symmetry of molecular orbitals – sigma and pi bonding – energy levels in homo and hetero nuclear diatomic systems – bond length, bond order and bond energy, Application to small molecules such as BeCl2, BCl3 and CCl4, SF4, etc, ionic character in a covalent bond¬ - The concept of multicentre bonding. Pseudo halogens: Structure and bonding in ClF3, BrF3 , BrF5 , IF5, IF7 etc . Oxides and oxyacids of halogens, Bonding in  Noble gas compounds – XeCl2, XeF4, XeOF4, XeF6. | | | | | | | | |
| **UNIT:2** | | **CHEMISTRY OF SOLID STATE: I STRUCTURE** | | | **14 hours** | | | |
| Weak Chemical forces: van der Waals forces, Hydrogen bonding, Close packing of atoms and ions HCP and BCC types of packing voids, radius ratio – derivation – its influence on structures. Lattice energy – Born-Lande equation - Kapustinski equation, Madelung constant. Representative structures of AB and AB2 types of compounds - rock salt, cesium chloride, wurtzite, zinc blende, rutile, fluorite, antifluorite, cadmium iodide and nickel arsenide. Structure of graphite and  diamond. Spinels -normal and inverse types and perovskite structures. | | | | | | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UNIT:3** | | **CHEMISTRY OF SOLID STATE: II DIFFRACTION METHODS** | | **14 hours** |
| Band theory of solids- non-stoichiometry- point defects – linear defects- effects due to dislocations- electrical properties of solids-conductor, insulator, semiconductor-intrinsic-impurity semiconductors-optical properties-lasers and phosphors-elementary study of liquid crystals. Difference between point group and space group – screw axis – glide plane - symmetry elements – relationship between molecular symmetry and crystallographic symmetry – The Concept of reciprocal lattice – X-ray diffraction by single crystal – rotating crystal – powder diffraction. Neutron diffraction: Elementary treatment – comparison with X-ray diffraction. Electron diffraction- Basic principle. Crystal Growth methods: From melt and solution (hydrothermal, Gel  methods). | | | | |
| **UNIT:4** | | **BORON COMPOUNDS AND CLUSTERS** | **14 hours** | |
| Chemistry of boron – boranes, higher boranes, borazines , boron nitrides, hydroborate ions – Preparation, properties and structure, STYX numbers, Wade’s rules. Carboranes- Types such as nido-closo, arachno-preaprtion properties and Structure. Metallocarboranes-a general study. Metal clusters: Chemistry of low molecularity metal clusters only, Structure of Re2Cl8; multiple metal- metal bonds. | | | | |
| **UNIT:5** | | **INORGANIC CHAIN AND CLUSTER COMPOUNDS** | **14 hours** | |
| Types of inorganic polymers, comparison with organic polymers, silanes, higher silanes, multiple bonded systems, silicon nitrides, siloxanes. P-N compounds, cyclophosphazenes and cyclophosphazanes. S-N compounds – S4N4, (SN)x. Isopoly and heteropoly acids – Structure and bonding of 6- and 12 – isopoly and heteropoly anions. Structure of silicates - applications of Paulings rule of electrovalence - isomorphous replacements in silicates – ortho, meta and pyro  silicates – one dimensional, two dimensional and three dimensional silicates. | | | | |
|  | | **Total Lecture hours** | **70 hours** | |
| **Text Book(s)** | | | | |
| 1. | D. E. Douglas, D.H. McDaniel and J. J. Alexander, Concepts and Models in Inorganic  Chemistry, 3rd Ed, 1994. | | | |
| 2. | M. C. Day, J. Selbin, Theoretical Inorganic Chemistry, 2nd Ed, East West Press, 1985. | | | |
| 3. | F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 4th Ed, John Wiley & Sons, 1986. | | | |
| 4. | D.F. Shriver, P.W. Atkins, Inorganic Chemistry, 3rd Ed, 1999. | | | |
| 5. | A.G. Sharpe, Inorganic Chemistry, Pearson Education, 2008. | | | |
|  | | | | |
| **Reference Books** | | | | |
| 1. | N. H. Ray, Inorganic Polymers, Academic Press, 1978. | | | |
| 2. | A. R. West, Basic Solid State Chemistry, John Wiley, 1991. | | | |
| 3. | E. L. Mutteri, Polyhedral Boranes, Academic Press, NY, 19758. | | | |
|  | | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | |
| 1. | Advanced structural inorganic chemistry: DOI: 10.1093/acprof:oso/9780199216949.001.0001 | | | |
| 2. | Diffraction Basics: https://[www.cif.iastate.edu/services/acide/xrd-tutorial/xrd](http://www.cif.iastate.edu/services/acide/xrd-tutorial/xrd) | | | |
| 3. | Electron-deficient compound: https://[www.britannica.com/science/colloid](http://www.britannica.com/science/colloid) | | | |
| 4. | Metal Clusters in Chemistry:  https://onlinelibrary.wiley.com/doi/book/10.1002/9783527618316 | | | |

**MAPPING**-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | M | S | S | M | S | S | S |
| **CO 2** | S | S | S | S | M | S | M | M | S | S |
| **CO 3** | S | S | S | S | M | M | S | M | M | M |
| **CO 4** | M | S | L | S | S | S | S | S | S | S |
| **CO 5** | S | L | S | M | S | S | L | L | L | L |

# S-Strong M-Medium L-Low

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | | **CHE C 402** | **Reaction Mechanism and Stereochemistry** | **L** | **T** | | **P** | **C** |
| **Core**/Elective/Supportive | | | **Core** | **4** | **0** | | **0** | **4** |
| **Pre-requisite** | | | Students to gain knowledge basic concept of symmetry and chirality in the molecules their  spatial arrangement, reactivity of stereoisomers and its reaction mechanism., |  | | |  | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:  **CO1.** To impart advanced knowledge of reaction mechanism, aliphatic nucleophilic substitution, aromatic electrophilic and nucleophilic substitutions. reactive intermediates and stereochemistry of organic compounds.  **CO2.** Students will be expected to gain knowledge basic concept of symmetry and chirality in the molecules their spatial arrangement, properties and reactivity of stereoisomers,  **CO3.**To understand the importance of the configuration of chiral organic compounds which will be useful pharmaceutical industry where chemist works on stereo selective synthesis of compounds | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| **PSO1** | **Understanding** the knowledge about Kinetic and Non kinetic methods of  determining organic reaction mechanisms | | | | | K1 | | |
| **PSO2** | **Apply** the knowledge about Solvent and leaving group effects and neighbouring  group participation (NGP) nucleophlic substitution reaction | | | | | K2& K3 | | |
| **PSO3** | Students will be **remember** on Aromatic Electrophilic and Nucleophilic  Substitutions and study the important name reactions. | | | | | K2 | | |
| **PSO4** | **Evaluate** the fundamentals of an organic reactive intermediates. | | | | | K4 | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PSO5** | **Understand** the chirality, symmetry, R & S nomenclature, Stereospecific and  Stereoselective reactions. | | | K5 |
| **K1** – Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create | | | | |
|  | | | | |
| **UNIT:1** | | **Reaction Mechanism** | **14 hours** | |
| Kinetic and Non kinetic methods of determining organic reaction mechanisms. Isolation and trapping of intermediates, Isotopic labeling studies. Primary Kinetic Isotopic effect. Generation of Kinetic and Thermodynamic enolates. Hammett equation-simple problems and Taft equation. Significance of reaction as well as substituent constants. Ambident nucleophiles such as CN-, NO2-,  phenoxide and ambident dianions.Williamsons ether synthesis. | | | | |
| **UNIT:2** | | **Aliphatic Nucleophilic Substitution** | **14 hours** | |
| Mechanism of nucleophlic substitution reaction: SN1, SN2 and SNi mechanisms. Solvent and leaving group effects and neighbouring group participation (NGP).Substitution at carbonyl, vinylic and bridgehead system. Substitution with ambident nucleophiles- “O” Vs “C”alkylation. Role of LDA, crown ethers and phase transfer catalysts (PTC) in nucleophilic substitution reactions.  Generation of enolates, enolate selectivity (Kinetic Vs Thermodynamic), alkylation of enolates and stereochemistry of enolate alkylation.Mechanism of ester hydrolysis (only Bac2, Aac2 and Aal1). Alkylation of active methylene compounds. Asymmetric alkylation (Evans, Enders and Meyers procedures).Preparation and synthetic utility of enamines, Finkelstein reaction, Wurtz coupling. | | | | |
| **UNIT:3** | | **Aromatic Electrophilic and Nucleophilic Substitutions** | **14 hours** | |
| Aromatic electrophilic substitution: mechanism of nitration, sulfonation, Friedel-Crafts alkylation and acylation reactions. Synthesis of di- and tri-substituted benzenes from benzene or mono- substituted benzenes.Hammett and Hammett-Taft equation. Haworth reaction (for naphthalene), Scholl reaction, Vilsmeier-Haack formylation, Gattermann reaction, Reimer-Tiemann and Bischler- Napieralski reactions.  Aromatic nucleophilic substitution in aryl halides by Meisenheimer complex mechanism and benzyne mechanism.Reactions of aryldiazonium salts.Zeigler alkylation, Vicarious Nucleophlic Substitution (VNS), Chichibabin and Schiemann reactions. | | | | |
| **UNIT:4** | | **Reactive Intermediates** | **14 hours** | |
| Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, carbenoids, benzynes and nitrenes. | | | | |
| **UNIT:5** | | **Stereochemistry** | **14 hours** | |
| Chirality, Symmetry elements, Asymmetric and Dissymmetric chiral molecules. Calculation of number of optical isomers. Stereochemistry of mono and di-substituted cyclopropane, cyclobutane, cyclopentane and cyclohexane.Stereochemistry of tri-substituted cyclopentane, tri-substituted pentane and tetra-substituted hexane.Description of various types of optically active compounds including allenes, cumulenes, spiranes, biphenyls, trans-cyclooctene.  Compounds containing two asymmetric centers; Erythro and threo isomers. Conversion of Fischer projection into perspective forms. Erythro and Threo-Inter conversion of Fischer to Sawhorse and Newman projections.Zig-Zag representation of glucose.Interpretation of homotopic, enantiotopic and diastereotopic atoms and faces.Pro-chiral carbon. Concept of Re- and Si- faces. R & S nomenclature of simple compounds, allenes, spiranes and biphenyls. Stereospecific and | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| Stereoselective reactions. Asymmetric Synthesis-Crams rule and Felkin-Anh model. Conformational analyses of cyclohexane. Di-substitutedcyclohexanes and decalin.. | | | |
|  | | **Total Lecture hours** | **70 hours** |
| **Text Book(s)** | | | |
| 1. | M. B. Smith and Jerry March, Advanced Organic Chemistry, John Wiley & Sons, 5th Ed, 2001. | | |
| 2. | I. L. Finar, Organic Chemistry Vol 2: Stereochemistry and the Chemistry of Natural  product, Dorling Kindersley India (P) Ltd, 2009. | | |
| 3. | Kalsi. P. S, Organic Reactions: Stereochemistry and Mechanism through solved problems, New  Age International (P)Ltd, 4th Ed, 2007. | | |
| 4. | E. L. Eliel and S. H. Wilen, Stereochemistry of Organic Compounds, Wiley India Ed, 2008. | | |
| 5. | M. B. Smith, Organic Synthesis, Academic Press, 3rd Ed, 2011. | | |
| **Reference Books** | | | |
| 1. | F. Carey and R. J. Sundberg, Advanced Organic Chemistry-Part A and B, Springer Science +  Business Media, 5 th Ed, 2007 | | |
| 2. | R. O. C. Norman and J. M. Coxon, Principles of Organic Synthesis, Chapman & Hall, 3rd Ed,  1993. | | |
| 3. | J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Oxford University Press, 2nd Ed, 2012 | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1. | Principles of Organic Synthesis, https://nptel.ac.in/content/syllabus\_pdf/104103110.pdf | | |
| 2. | Basic Principles of Organic Chemistry (Roberts and Caserio) | | |
| 3. | Reagents and Organic reactions – https://nptel.ac.in/content/syllabus\_pdf/104103023.pdf | | |

Mapping- Course Outcome with Programme Specific Outcome

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | M | L | M | M | S | S | S |
| **CO 2** | S | M | M | M | M | L | M | M | S | S |
| **CO 3** | S | M | M | M | M | M | L | M | S | S |
| **CO 4** | L | S | L | M | M | M | M | M | S | S |
| **CO 5** | S | L | S | M | S | S | L | L | S | S |

Note: S-Strong; M-Medium; L-Low

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | | **CHE C 403** | | **Chemical kinetics and Electrochemistry** | **L** | | **T** | | **P** | **C** |
| **Core/Elective/Supportive** | | | **Core** | | **4** | | **0** | | **0** | **4** |
| **Pre-requisite** | | | Knowledge in basic chemical kinetics and electrochemistry and should have studied chemical kinetics and electrochemistry as a subject or part of  a paper in undergraduate programme. | |  | | |  | | |
| **Course Objectives:** | | | | | | | | | | |
| The main objectives of this course are to:  CO1. Provide students with the latest information in the field of chemical kinetics and electrochemistry  CO2. Inculcate advanced knowledge, understanding, and critical judgment appropriate for the application of chemical kinetics and electrochemistry.  CO3. To impart fundamental knowledge about the basic concepts of reaction rate theories and chemical dynamics.  CO4. Explain the processes of primary process, secondary process, photo synthesis, and linear energy transfer  CO5. Explain the theoretical basis of the electrochemical laws, ionic atmosphere and anomalous conductance of non-aqueous electrolytes. Develop practical skills in the use microbiological methodologies, tools and techniques.  CO6. To understand the role of electrical double layer with help of models and equations. | | | | | | | | | | |
|  | | | | | | | | | | |
| **Expected Course Outcomes:** | | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | | |
| **PSO1** | The student will **remember** the basic principles and theories of chemical kinetics and catalysis. | | | | | | | | K1 | |
| **PSO2** | **Understand** the concepts of potential energy surfaces and methods to determine  the fast reactions. | | | | | | | | K2 | |
| **PSO3** | **Demonstrate** the role of Jablonski diagram, to understand the Primary and  Secondary Processes. | | | | | | | | K3 | |
| **PSO4** | **Compare** the different types to Study of fast reactions. | | | | | | | | K4 | |
| **PSO5** | **Assess** role of electrochemistry in Batteries and Fuel cells-Ion selective  electrodes. | | | | | | | | K5 | |
| **PSO6** | Formulate methodologies and develop tools and techniques to Photosynthesis,  solar energy conversions for human welfare. | | | | | | | | K6 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | | | | |
|  | | | | | | | | | | |
| **Unit:1** | | **Chemical kinetics and catalysis** | | | | **14 hours** | | | | |
| Absolute reaction rate theory -Thermodynamic terms-Significance of entropy and volume of activation. Reactions in solution: factors determining reaction rates in solutions, effect of dielectric constant and ionic strength, - Bronsted –Bjerrum equation-Primary and Secondary salt effect, influence of solvent on reaction rates. Acid base catalysis-Bronsted relations, catalytic coefficients  and their determination. Enzyme catalysis and its mechanism, Michaelis-Menten equation, effect of | | | | | | | | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| pH and temperature on enzyme catalysis, Mechanism of enzyme inhibition kinetics of surface reactions- unimolecular reactions-Bimolecular reactions-Langmuir Hinshelwood and Elay-Rideal  mechanism. | | | | |
| **Unit:2** | | **Chemical dynamics** | | **14 hours** |
| Potential energy surfaces-Dynamics of unimolecular reactions-Lindemann Hinshelwood, Rice- Ramsperger- Kassel(RRK) theory.Rice-Ramsperger-Kassel -Marsus (RRKM) theory.  Study of fast reactions by stopped flow techniques- relexation method, flash photolysis and the nuclear magnetic resonance method.  Linear free energy relationship-Hammett equation, Taft equation-Separation of polar, resonance and steric effects. | | | | |
|  | | | | |
| **Unit:3** | | **Photochemistry** | **14 hours** | |
| Jablonski diagram, Primary and Secondary Processes, quantum yield and its determination-chemical actinometer. Excimers and exciplexes-Kinetics of collisional quenching-Stern Volmer equations.Photosensitization, Chemiluminescence. Photosynthesis, solar energy conversions. Semiconductor photo catalysis, lasers.  Radiation Chemistry-linear energy transfer, G-value, dosimeters, radiolysis of water, solvated electrons. | | | | |
|  | | | | |
| **Unit:4** | | **Electrochemistry - I** | **14 hours** | |
| Deviation from ideal behaviour.ion-solvent and ion-ion interactions. Debye-Hückel-Bjerrum model, Ion association and triple ion formations.Expression for the mean activity coefficient.Debye-Hückel limiting law and its applications -Diverse ion effect.Van’t Hoff factor and its relation to colligative properties.Debye-Hückel theory of strong electrolytes.Debye-Hückel length and potential around a central ion, its interpretation. Transport of ions in Solution: Electrolytic conduction- Debye - Hückel-  Onsager treatment of strong electrolytes- ionic atmosphere- Anomalous conductance of non aqueous electrolytes. | | | | |
|  | | | | |
| **Unit:5** | | **Electrochemistry- II** | **14 hours** | |
| Electrical double layer - Electrocapillary phenomena - Surfactants - Lipmann’s equation, Electrokinetic phenomena.Zeta potential and its applications.Structure of electrical double layer – Helmholtz-Perrin, Guoy-Chapmann and Stern models. Butler-Volmer equation for one electron transfer reaction - equilibrium and exchange current densities- and symmetry factor - transfer coefficient.Cyclic voltammetry and Stripping voltammetry - principle – instrumentation- Corrosion and passivation of metals - Pourbaix diagram - Evans diagram –Batteries and Fuel cells-Ion selective  electrodes. | | | | |
|  | | | | |
|  | | **Total Lecture hours** | **72 hours** | |
| **Text Book(s)** | | | | |
| 1. | K. J. Laidler, Chemical Kinetics, Harper and Row, New York, 1987. | | | |
| 2. | A. W. Anderson, Physical Chemistry of Surfaces, Wiley - Interscience, Newyork, 1990. | | | |

|  |  |  |
| --- | --- | --- |
| 3. | | Paula, Peter Atkins and Julio de, Elements of Physical chemistry, 5th Ed, Oxford U. P, 2012. |
| 4. | | John O’M Bockris, Amula K. N. Reddy, and Maria Gamboa–Aldeco, Modern Electrochemistry 2A, 2nd Ed, Kluwer Academic / Plenuim Publishers, NewYork, 2000. |
| 5. | | Mordechay Schlesinger, Modern Aspects of Electrochemistry: Issue 43, Springer, Netherlands, 2009. |
| 6. | | Philip H. Rieger, Electrochemistry ,2nd Edition, 2010. |
| 8. | | G. L. Agarwal, Basic Chemical Kinetics, Tata McGraw Hill, 1990. |
| 9. | | K. J. Laidler, Chemical Kinetics, Tata Mc Graw Hill, 1990. |
| 10. | | Robert J Silbey, Robert A Alberty and Moungi G Bawendi, Physical Chemistry 4th Ed,NJ Hoboken: Wiley, 2015. |
| 11. | | Revise G. W. Castellan, Physical Chemistry, Narosa publishing House, New Delhi, Ed, 2011. |
| 12. | | Gordon. M. Barrow, Physical Chemistry, Tata McGraw Hill Edition, New York, 2011. |
| 13. | | L. R. Puri, Y. R. Sharma and R. S. Pathania, Principles of Physical Chemistry 46th Ed, 2012. |
|  | |  |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | |
| 1 | Chemical kinetics (https://nptel.ac.in/courses/104/101/104101128/) | |
| 2 | History of Chemical kinetics (https:/[/www.int](http://www.intechopen.com/chapters/62152))e[chopen.com/chapters/62152)](http://www.intechopen.com/chapters/62152)) | |
| 3 | Electrochemistry (https://nptel.ac.in/courses/104/106/104106129/) | |
| 4 | Photochemistry (https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/photchem.htm) | |

Mapping- Course Outcome with Programme Specific Outcome

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | M | L | M | M | S | S | S |
| **CO 2** | S | M | M | M | M | L | M | M | S | S |
| **CO 3** | S | M | M | M | M | M | L | M | S | S |
| **CO 4** | L | S | L | M | M | M | M | M | S | S |
| **CO 5** | S | L | S | M | S | S | L | L | S | S |
| **CO 6** | S | M | M | M | M | M | L | M | S | S |

Note: S-Strong; M-Medium; L-Low

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | | CHE C 404 | | **CHEMISTRY PRACTICALS –I** | **L** | **T** | | **P** | **C** |
| **Core/Elective/Supportive** | | | **Core** | | **0** | **0** | | **4** | **4** |
| **Pre-requisite** | | | Knowledge about solubility of mixture of organic and inorganic ions along with basic laboratory skills. | |  | |  | | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:  **CO 1:** To analyze viscosity of the mixtures, heat of neutralization and experiments using phase rule apparatus.  **CO 2:** To identify and confirm the functional groups in organic compounds such as aldehyde, ketone, amines etc. and carry out the separation of organic components from the binary mixture.  **CO 3:** To estimate the quantitative analysis of various inorganic ions such as Cu2+, Ni2+, Fe2+, Zn2+  Mg2+ etc. by gravimetric, titrimetric and redox titrations. | | | | | | | | | |
|  | | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| **PSO1** | Students can **Apply** practical skills to **analyze** viscosity of the mixtures, heat of  neutralization | | | | | | | K3  & K4 | |
| **PSO2** | **Apply** practical skills about identification of functional groups present in the  organic compounds components by chemical and spectral methods. | | | | | | | K3 | |
| **PSO3** | The students will **analyze** separation of two component mixture and identification of compounds and able to determine the presence of functional  groups in a given unknown organic compound. | | | | | | | K4 | |
| **PSO4** | The students will **understand** the quantitative analysis of inorganic mixtures  by gravimetric, titrimetric and colorimetric methods. | | | | | | | K2 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | | |
|  | | | | | | | | | |
| **Physical Chemistry Practicals** | | | | | **60 hours** | | | | |
| 1. Viscosity of mixtures. 2. Cryoscopy, rast and Ebulioscopy. 3. Phase rule - transition temperature, c.s.t., eutectic, compound formation partition. 4. Heat of neutralisation, combustion. | | | | | | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Inorganic Chemistry Practicals** | | | **60 hours** |
| Quantitative analysis of inorganic mixtures by gravimetric, titrimetric and colourimetric methods | | | |
| (Mixtures as met with in common ores and alloys). | | | |
| **Organic Chemistry Practicals** | | | **60 hours** |
| Analysis of two component and three component mixtures separation and characterization with emphasis on characterization by derivatives. | | | |
| **Total Practical hours** | | **180 hours** | |
| **Lab Manuals** | | | |
| 1 | W.G. Palmer, Experimental Inorganic Chemistry, Cambridge University Press,  Cambridge,1965. | | |
| 2 | Vogel’s Text book of quantitative Chemical analysis, G.H. Jaffery, J. Bassett, J.  Mendhan and R.C. Deeny. ELBS,1997. | | |
| 3 | Jeyavathana Samuel, Chemistry Practical Book, G.G.Printers, Chennai, 2012. | | |
| 4 | Vickie.M.Williamson, M.Larry Peck, Lab manual for General Chemistry, Cengage  Learning India Private Limited, New Delhi, 2009. | | |

**MAPPING**-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | S | L | S | S | M | S | S |
| **CO 2** | S | S | S | S | S | M | M | S | S | S |
| **CO 3** | S | S | S | M | M | S | S | M | M | M |
| **CO 4** | M | S | L | S | S | S | S | S | S | S |
| **CO 5** | S | L | S | L | M | S | L | S | L | L |

# S-Strong M-Medium L-Low

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code:** | | **CHE C 405** | | | **COORDINATION CHEMISTRY** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | | | | **Core** | | **4** | **0** | **0** | **4** |
| **Pre-requisite** | | | | Basic knowledge about fundamentals of coordination chemistry, stability of metal complexes, principles of  spectroscopy. | |  | |  | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:  **CO1**. To acquires knowledge about thermodynamics and kinetics stability of metal complexes.  **CO2**. To learn elaborately about various theories of complexes.  **CO3**. To study the electron transfer reactions and mechanism of coordination compounds.  **CO4**. To understand the general concept of catalysis, oxidation and polymerization of olefins. | | | | | | | | | |
|  | | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| **PSO1** | Students will be able to **understand** the stability constant of metal complexes, and recognize the types of isomers in coordination compounds. | | | | | | | K2 | |
| **PSO2** | Students will be **evaluate** to predict/explain the spectral and  magnetic properties of coordination compounds. | | | | | | | K5 | |
| **PSO3** | **Create** knowledge about crystal field theory and MO theory of  coordination compounds. | | | | | | | K6 | |
| **PSO4** | **Apply** knowledge about electron transfer reactions and reaction  mechanism of coordination compounds. | | | | | | | K3 | |
| **PSO5** | Students will be familiarize about **remembering** concepts involved  in the use of organometallic catalysts. | | | | | | | K1 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | | |
|  | | | | | | | | | |
| **UNIT:1** | | | **STABILITY OF COMPLEXES** | | | | **14 hours** | | |
| Stability of complexes- Factors affecting stability of complexes, Thermodynamic aspects of complex formation,Stepwise and overall formation constants, Stability correlations, statistical factors and chelate effect, Determination of stability constant and composition of the complexes: Formation curves and Bjerrum’s half method,Potentiometric method, Spectrophotometric method, Ion exchange method, Polorographic method and Continuous variation method (Job’s method).  Stereochemical aspects- Stereoisomerism in inorganic complexes- Isomerism arising out of ligand distribution and ligand conformation, Chirality and nomenclature of chiral complexes; Application of ORD and CD in the identification of complexes. Macrocyclic ligands- Porphyrins, Corrins, Schiff’s bases, crown ethers, etc. | | | | | | | | | |
|  | | | | | | | | | |

|  |  |  |
| --- | --- | --- |
| **UNIT:2** | **METAL LIGAND BONDING** | **14 hours** |
| Crystal field theory – Splitting of d orbitals under various geometries - factors affecting splitting, CFSE, evidences for CFSE(Structural and thermodynamic effects), spectrochemical series, Jorgensen relation, site preferences, Jahn Teller distortion – Dynamic and Static J.T. effect, Jahn Teller effect and chelation, Application of CFT – Magnetic properties, spectral properties and Kinetic properties, Limitations of CFT, Evidences for M-L overlap.  MOT – MO theory and energy level diagrams concept of Weak and strong fields, Sigma and pi bonding in octahedral, square planar and tetrahedral complexes. Nephlauxetic effect, Magnetic properties of complexes. Comparison of CFT and MOT of bonding in octahedral complexes. | | |
|  | | |
| **UNIT:3** | **ELECTRONIC SPECTRA OF COMPLEXES** | **14 hours** |
| Spectroscopic term symbols for dn ions – derivation of term symbols and ground state term symbol, Hund’s rule, Selection rules – breakdown of selection rules, spin orbit coupling, band intensities, weak and strong field limits – correlation diagram, Energy level diagrams. Orgel diagram for weak field Oh and Td complexes – Splitting of energy level due to Jahn-Teller distortion. Modified orgel diagram – Limitiations of orgel diagram Tanabe–Sugano(T-S) diagrams – Evaluation of Dq and B values for d2 –d8 complexes charge transfer spectra. Complications in band classification between Lf(d-d)  and CT bands. Comparison between d-d bands and CT bands – Numerical problems, Lanthanides and Actinides- Spectral properties. | | |
|  | | |
| **UNIT:4** | **INORGANIC REACTION MECHANISM** | **14 hours** |
| Electron transfer reactions – Inner sphere (ISET) and outer sphere (OSET) electron transfer processes.. Role of bridging ligand with ISET reaction – tunneling transfer – multiple bridging in the activated complex in the ISET process. Complimentary and non complimentary ET reactions. Cross reactions and marcus Hush theory. Reaction mechanism of coordination compounds – Types of ligand substitution reactions – mechanism; Dissociative mechanism (D), Associative mechanism (A) interchange mechanism (I), Labile and Inert complexes. Substitution Reaction in octahedral complexes – general mechanism, general rate law for A,D and I - distinction between D, Id, IA pathways, replacement of coordinated water, mechanism of acid hydrolysis, base hydrolysis – DCB mechanism – direct and indirect evidences in favour of the mechanism. Ligand substitution reactions without cleavage of M-L Bond. Anation Reactions. Substituion in square planar complexes – General mechanism, Trans effect, influences of entering and leaving groups. Application of trans effect – synthesis of isomers of pt(II) complexes – theories of trans effect and cis-trans isomerisation reaction. Application of substitution reactions in the synthesis of Platinum and Cobalt complexes. | | |
| **UNIT:5** | **CATALYSIS** | **14 hours** |
| General principles of catalysis – basic reactions involved in the catalysis by organometallic compounds. Hydrogenation of olefins (Wilkinson’s catalyst) ; Hydro formylation of olefins using Cobalt or Rhodium catalysts (OXO process); oxidation of olefins to aldehydes and ketones (wacker process) Monsanto acetic acid synthesis from methanol. Cyclooligomerisation of acetylene using Ni catalyst (Reppe’s catalyst) Synthetic gasoline by using ZSM-5 catalyst (Fisher-Tropsch and mobil process) polymerization of olefins (Zeigler – Natta Catalyst), polymer bound catalyst. | | |

|  |  |  |  |
| --- | --- | --- | --- |
|  | | **Total Lecture hours** | **70 hours** |
| **Text Book(s)** | | | |
| 1 | F. Basolo and R. G. Pearson, Mechanism of Inorganic reactions, Wiley Eastern,  1967. | | |
| 2 | J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic chemistry-Principles on  structure and reactivity, 4th Ed, Pearson- education, 2002. | | |
| 3 | F. A. Cotton and G. Wilkinson Advanced Inorganic Chemistry, Wiley Eastern, 1988. | | |
| 4 | S. F. A. Kettle, Co-ordination compounds, ELBS, 1973. | | |
| 5 | K. F. Purcell and J. C. Kotz, Inorganic Chemistry, WB Sanders Co, USA, 1977. | | |
| 6 | U.K.Malik, G.D.Tuli, and R.D. Madan, Selected Topics in Inorganic Chemistry,  S. Chand Publication, 2010. | | |
|  | | | |
| **Reference Book(s)** | | | |
| 1. | H. J. Emelius and Sharpe, Modern aspects of Inorganic chemistry, Universal book  stall, New Delhi, 1989. | | |
| 2. | D. F. Shriver, P. W. Atkins and C. H. Longford, Inorganic Chemistry, ELBS, 2nd Ed,  1994. | | |
| 3. | R. B. Heslop and K. Jones, Inorganic Chemistry, Elsevier, 1976. | | |
| 4. | Mechanism of Inorganic reactions - F. Basolo and R. G. Pearson. Wiley, New York  1958. | | |
| 5. | W. E. Addision, Structural Principles of Inorganic Chemistry, Longman, 1961. | | |
|  | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | Stability of complexes:  https://en.wikipedia.org/wiki/Stability\_constants\_of\_complexes | | |
| 2 | Metal ligand bonding: https:/[/www](http://www.york.ac.uk/res/redgroup/redsite/files/metal-).[york.ac.uk/res/redgroup/redsite/files/metal-](http://www.york.ac.uk/res/redgroup/redsite/files/metal-)  ligand%20bonding%202008-9.pdf | | |
| 3 | Inorganic reaction mechanism: <http://www.eolss.net/sample-chapters/c06/e6-100->  09.pdf | | |

**MAPPING**-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | M | L | S | S | L | S | S | M | S | S |
| **CO 2** | S | S | M | S | S | M | M | S | S | S |
| **CO 3** | S | M | S | M | M | S | S | M | M | M |
| **CO 4** | L | S | S | S | S | S | S | S | S | S |
| **CO 5** | S | M | S | L | M | S | L | S | L | L |

# S-Strong M-Medium L-Low

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | | **CHE C406** | **Reaction Mechanism, Rearrangement, Name Reactions, Oxidation and Reduction** | **L** | **T** | | **P** | **C** |
| **Core**/Elective/Supportive | | | **Core** | **4** | **0** | | **0** | **4** |
| **Pre-requisite** | | | Students to acquire knowledge of basics, classification, techniques of polymerization, molecular weight determination and processing  of polymers. |  | | |  | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:  **CO1.** To impart the knowledge of different bond forming reactions.  **CO2.** Students will be expected to gain knowledge name reactions, eliminations, rearrangements.  **CO3.**To understands the importance of oxidation and reductions reactions. | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| **PSO1** | **Understanding** the basics knowledge of carbon-carbon bond forming reactions. | | | | | K1 | | |
| **PSO2** | **Apply** the knowledge and importance of catalyst in the organic reactions. | | | | | K2& K3 | | |
| **PSO3** | Students will be **remember** the molecular rearrangements & name reactions. | | | | | K2 | | |
| **PSO4** | **Evaluate** the fundamentals and the understanding of oxidation and reduction  reactions | | | | | K4 | | |
| **PSO5** | **Understand** the strong back ground in organic reactions will help to get job in  industry. | | | | | K5 | | |
| **K1** – Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create | | | | | | | | |
|  | | | | | | | | |
| **UNIT:1** | | **Addition to carbon-carbon double bond** | | | **14 hours** | | | |
| Electrophilic addition to carbon–carbon double and triple bonds. Nucleophilic addition to carbon–  carbon multiple bonds. Generation and addition of carbenes-Michael addition and Robinson | | | | | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| annulation.  Hydroxylation of olefinic double bonds (OsO4, KMnO4); Woodward and Prevost oxidation. Epoxidation using peracids including Sharpless epoxidation, Ozonolysis.Hydrogenation (homogenous and heterogeneous) and Transfer hydrogenation. Hydration of carbon-carbon double and triple bonds. | | | |
| **UNIT:2** | | **Addition to carbon-oxygen double bond** | **14 hours** |
| Nucleophilic addition to –C=O bond. A study of Mannich, benzoin, Darzen’sglycidic ester, Stobbe and Knovenagel condensation reactions; Wittig, Wittig-Horner olefination reactions; Sulfur and Sulfoniumylides and their reactions, Julia olefination& Peterson alkene synthesis. Asymmetric  reduction of carbonyl functions (Corey’s procedure). | | | |
| **UNIT:3** | | **Elimination** | **14 hours** |
| Elimination reactions: E1, E2, E1cb and Ei-elimination. Conformation of mechanism; solvent, substrate, leaving group effects-Saytzeff’s*Vs* Hoffman elimination; Stereochemistry of E2  eliminations, Elimination in cyclohexane ring system; Mechanism of pyrolytic eliminations. Examples: Chugaev reactions and Cope elimination, Hoffmann degradation and pyrolysis of esters. | | | |
| **UNIT:4** | | **Molecular rearrangements &Name reactions** | **14 hours** |
| A study of mechanism of the following rearrangements: Beckmann, Curtius, Hofmann, Schmidt, Lossen, Wolff, Pinacol, Wagner Meerwin, Demjanov, Dienone-Phenol, Favorski, Benzidine, Claisen, Cope, Sommlet-Hauser, Pummerer and Von-Richter rearrangements.  A study of the following name reactions: Dieckmann cyclization, Hofmann-Loffler Freytag reaction, Mitsunobu reaction, Shapiro reaction, Eschenmoser-Tanabe and Ramburg-Backlund reactions. | | | |
| **UNIT:5** | | **Oxidation and reductions reactions** | **14 hours** |
| Oxidation with Cr (including PCC, PDC, Jones) and Mn (including MnO2 and BaMnO4) reagents; Oxidation with LTA, DDQ and SeO2; Oxidation using DMSO either with DCC or Ac2O or Oxaloyl chloride; Oxidation using IBX and Dess-Martin Periodinane (DMP) reagent.  Reduction with NaBH4, NaCNBH3, Zn(BH4)2 LiAlH4, Li(tBuO)3AlH, DIBAL-H, Red-Al, Et3SiH and Bu3SnH; Reduction using selectrides; Birch reduction. | | | |
|  | | **Total Lecture hours** | **70 hours** |
| **Text Book(s)** | | | |
| 1. | M. B. Smith and Jerry March, Advanced Organic Chemistry, John Wiley & Sons, 5th Ed, 2001. | | |
| 2. | I. L. Finar, Organic Chemistry Vol 2: Stereochemistry and the Chemistry of Natural  product, Dorling Kindersley India (P) Ltd, 2009. | | |
| 3. | V. K. Ahluwalia, Oxidation in Organic Synthesis, CRC Press, 1st Ed, 2012. | | |
| 4. | V. K. Ahluwalia, Reduction in Organic Synthesis, CRC Press, 1st Ed, 2012. | | |
| 5. | M. B. Smith, Organic Synthesis, Academic Press, 3rd Ed, 2011. | | |
| **Reference Books** | | | |
| 1. | F. Carey and R. J. Sundberg, Advanced Organic Chemistry-Part A and B, Springer Science +  Business Media, 5 th Ed, 2007 | | |
| 2. | R. O. C. Norman and J. M. Coxon, Principles of Organic Synthesis, Chapman & Hall, 3rd Ed,  1993. | | |
| 3. | J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Oxford University Press, 2nd Ed,  2012 | | |

|  |  |  |
| --- | --- | --- |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | |
| 1. | Oxidation and reductions reactions: | |
|  | | https://nptel.ac.in/content/storage2/courses/104101005/downloads/LectureNotes/chapter%2013.pdf |
| 2. | | Molecular rearrangements &Name reactions:  https://tmv.ac.in/ematerial/chemistry/kpb/SEM\_IV\_Honours\_Rearrangement%20final.pdf |
| 3. | | Molecular Rearrangements:  file:///C:/Users/DR0983~1.HAR/AppData/Local/Temp/1909250420Rearrangement%20Final-Samim.pdf |

Mapping- Course Outcome with Programme Specific Outcome

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | M | L | M | M | S | S | S |
| **CO 2** | S | M | M | M | M | L | M | M | S | S |
| **CO 3** | S | M | M | M | M | M | L | M | S | S |
| **CO 4** | L | S | L | M | M | M | M | M | S | S |
| **CO 5** | S | L | S | M | S | S | L | L | S | S |

Note: S-Strong; M-Medium; L-Low

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | | **CHE C 407** | | **Quantum chemistry and Analytical techniques** | **L** | **T** | | **P** | **C** |
| **Core/Elective/Supportive** | | | **Core** | | **4** | **0** | | **0** | **4** |
| **Pre-requisite** | | | Knowledge in basic quantum chemistry and should have studied Quantum as a subject or part of a  paper in undergraduate programme. | |  | |  | | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:  CO1. To provide an introduction to the mathematical foundations of quantum chemistry.  CO2. Inculcate advanced knowledge, and understanding, of quantum chemistry for the application of particle in a one dimensional box, particle in a three dimensional box, harmonic oscillator, rigid rotor and hydrogen atom.  CO3. To explain the theoretical basis of the rotational spectroscopy and its applications in rigid rotor and non-rigid rotor.  CO4. To explain the theoretical basis of the vibrational spectroscopy and its applications in harmonic oscillator and an harmonic oscillator.  CO5. To understand the spectroscopies such as Polarography, amperometry, coulometry etc… and its interpertation.  CO6. To highlight the importance of the Surface and Thermal Analysis Techniques and its intertation. | | | | | | | | | |
|  | | | | | | | | | |
| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| **PSO1** | **Recognize** the different types of energy levels are present at quantum level and  derive the equations. | | | | | | | K1 | |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **PSO2** | | **Understand** the applications of quantum chemistry. | | | | | K2 |
| **PSO3** | | **Demonstrate** the role of role of quantum chemistry in rotational and vibrational  spectroscopy. | | | | | K3 |
| **PSO4** | | **Analyze** the different type’s spectroscopic methods and how to interpret them. | | | | | K4 |
| **PSO5** | | **Assess** role of spectroscopy in Surface and Thermal Analysis Techniques. | | | | | K5 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate | | | | | | | |
|  | | | | | | | |
| **UNIT:1** | | | **Quantum Chemistry-I** | | | **14 hours** | |
| Black body radiation-Planck’s quantum theory-Wave particle duality-Uncertainty Principle. Operators-linear, commutation, Hermitian and Hamiltonian operators. Eigen functions and Eigen values-Postulates of quantum mechanics. Derivation of Schrodinger’s time-independent wave  equation and its application to particle in a one dimensional box, particle in a three dimensional box, harmonic oscillator, rigid rotor and hydrogen atom. | | | | | | | |
|  | | | | | | | |
| **UNIT:2** | | | **Quantum Chemistry-II** | | | **14 hours** | |
| Born-Oppenheimer approximation-Hydrogen molecule ion. LCAO-MO and VB treatments of the hydrogen molecule. Antisymmetry and Pauli’s exclusion principle. Slater detrimental wave function, term symbols and spectroscopic states-Russell Saunders coupling. The variation theorem and Perturbation theory. Applications of variation method and perturbation theory to the helium atom.Hybridization-determination of bond angles of sp, sp2 and sp3 hybridizations. Huckel pi electron (HMO) theory and its applications to ethylene, butadiene and benzene. A brief idea of  Hartree and Hartree-Fockself consistent field theory. | | | | | | | |
|  | | | | | | | |
| **Unit:3** | | | **Rotational and vibrational spectroscopy** | | **14 hours** | | |
| Micro wave spectroscopy- Theory- selection rules, –Instrumentation; Energy levels in atoms and molecules- Fourier transformation Rotational spectra of diatomic and polyatomic molecules–P,Q,R branches- effect of isotopic substitution. Non-rigid rotator- Linear molecules.Theory of Rotational Raman spectra.  Vibrational spectra of diatomic molecules – selection rules –overtones, combination and hot bands - Fermi resonance Energy of diatomic molecule, simple harmonic and unharmonic oscillator, rotational character of vibration spectra, Theory of Vibrational Raman spectroscopy-Coherant Antistokes Raman Spectroscopy (CARS). | | | | | | | |
|  | | | | | | | |
| **Unit:4** | | | **Analytical Techniques** | | **14 hours** | | |
| Principles, theory, instrumentation and applications of Polarography, amperometry, coulometry,  EDAX, XPS, AAS, AES, interpretation of spectra-Merits and demerits. | | | | | | | |
|  | | | | | | | |
| **Unit:5** | | | **Surface and Thermal Analysis Techniques** | | **14 hours** | | |
| Principles, theory, instrumentation and applications of SEM, STM, TEM, AFM, ESCA -interpretation of spectra-Merits and demerits.  Principles, theory and applications of TGA, DTA, DSC, DTG. Interpretation of various thermal analysis curves. | | | | | | | |
|  | | | **Total Lecture hours** | **72 hours** | | | |
| **Text Book(s)** | | | | | | | |
| **Reference Books** | | | | | | | |
| 1. | P. W. Atkins, Molecular Quantum Mechanics, Oxford University Press, Oxford, 1983. | | | | | | |
| 2. | I. N. Levine, Quantum Chemistry, Allyn and Bacon, Boston, 1983. | | | | | | |
| 3. | M. W. Hanna, Quantum Mechanics in Chemistry, W.A. Benjamin Inc. London, 1965. | | | | | | |
| 4. | G. M. Barrow, Introduction to Molecular Spectroscopy, McGraw Hill, New York, 1988. | | | | | | |
| 5. | D. A. McQuarrie, Quantum Chemistry, University Science Books, MilValley, California, 1998. | | | | | | |
| 6. | A. K. Chandra, Introduction to Quantum Chemistry, Tata McGraw Hill, 1997. | | | | | | |
| 7. | W. Levine, Quantum Chemistry, Prentice Hall, 1994. | | | | | | |
| 8. | R. K. Prasad, Quantum Chemistry, Wiley Eastern, 1993. | | | | | | |
| 9. | C. F. Banwell, Fundamentals of Molecular Spectroscopy, McGraw Hill, New York, 1966. | | | | | | |
| 10. | D. A. Skoog and D. M. West, Fundamentals of Analytical Chemistry, Holt Rinehart and Winston Publications, IV Edn, 1982. | | | | | | |
| 11. | D. A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Fundamentals of Analytical | | | | | | |
| 12. | Willard, Merit, Dean and Settle, Instrumental Methods of Analysis, CBS Publishers and | | | | | | |
| 13. | R. S. Drago, Physical methods in chemistry, Reinhold, New York, 1968. | | | | | | |
|  | | | | | | | |
|  | QuantumChemistry  (https://[www.uu.se/en/admissions/master/selma/kursplan/?kKod=1KB011)](http://www.uu.se/en/admissions/master/selma/kursplan/?kKod=1KB011)) | | | | | | |
|  | QuantumChemistry (https://nptel.ac.in/courses/104/105/104105128/) | | | | | | |
|  | Molecular Spectroscopy (https://nptel.ac.in/courses/104/101/104101126/) | | | | | | |
|  | Analytical Chemistry (https://nptel.ac.in/courses/104/105/104105084/) | | | | | | |

Mapping- Course Outcome with Programme Specific Outcome

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | M | S | M | S | M | S | L | M | L | L |
| **CO 2** | S | S | L | S | S | M | L | M | L | L |
| **CO 3** | S | M | S | S | S | M | L | S | L | L |
| **CO 4** | S | S | S | S | S | S | M | S | L | L |
| **CO 5** | S | S | S | M | M | L | S | L | L | L |

Note: S-Strong; M-Medium; L-Low

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | | CHE C 408 | | **CHEMISTRY PRACTICALS –II** | **L** | **T** | | | **P** | **C** |
| **Core/Elective/Supportive** | | | **Core** | | **0** | **0** | | | **4** | **4** |
| **Pre-requisite** | | | Knowledge about the preparation of organic compounds and knowledge about common cation and anion. | |  | | |  | | |
| **Course Objectives:** | | | | | | | | | | |
| The main objectives of this course are to:  **CO 1:** To Determine e.m.f., pH, and conductivity using different techniques.  **CO 2:** To identify and confirm the functional groups in organic compounds such as aldehyde, ketone, amines etc. and develop the skill of estimation and extraction of various organic compounds.  **CO 3:** To provide knowledge about the analytical skills by analyzing the given inorganic salt mixture containing two common cations and two rare cations.  **CO4:** To impart knowledge on the quantitative analysis of different metal ions. | | | | | | | | | | |
|  | | | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | | |
| **PSO1** | Students can **Apply** practical skills to **analyze** e.m.f., pH, and conductivity | | | | | | | | K3 &  K4 | |
| **PSO2** | The student able to **understand** the nature of any unknown metal ions. | | | | | | | | K2 | |
| **PSO3** | Acquired skill to **analyze** the presence of microlevel compounds occurring in  crude form in the nature. | | | | | | | | K4 | |
| **PSO4** | **Remembering** the protocol for the preparation of an organic compound by  single and double stage which meets the industrial standards. | | | | | | | | K1 | |
| **PSO5** | **Understand** the basic reaction conditions such as solubility, hydrolysis,  acetylation, bromination, nitration to prepare suitable derivatives. | | | | | | | | K2 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | | | |
| **Physical Chemistry Practicals** | | | | | | | **60 hours** | | | |
| 1. Determination of e.m.f., pH, potentiometric titrations. 2. Determination of conductivity – titrations. 3. Kinetics of ester hydrolysis - inversion of cane sugar. | | | | | | | | | | |
| **Organic Chemistry Practicals** | | | | | | | **60 hours** | | | |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1. About 10 preparations involving two or three stages involving the following   processes, nitration, acylation, halogenation, diazotization, rearrangements, hydrolysis, reduction, alkylation and oxidation.   1. Estimation of phenol, methyl ketones, glucose, nitro, amino, methoxy groups and unsaturation compounds. | | | | | | | | | |
| **Inorganic Chemistry Practicals** | | | | | | | | **60 hours** | |
| 1. Semi micro qualitative analysis of common cation and anion containing the following less familiar elements: Tl, W, Sc, Te, Mo, Ce, Th, Ti, Zr, V, Be, U, Li and Cs. 2. Simple inorganic preparations including some complex compounds. | | | | | | | | | |
| **Total Practical hours** | | | | | | **180 hours** | | | |
| **Lab Manuals** | | | | | | | | | |
| 1 | N. S. Gnana Prakasam, G. Ramamurthy, Organic chemistry Manual, S. Viswanathan Co.,  Ltd. | | | | | | | | |
| 2 | Vogel’s Text book of practical organic chemistry, 5th edition, Prentice Hall, 2008. | | | | | | | | |
| 3 | Raj K Bansal, Laboratory international (p) Ltd, 1996. | manual | of | organic | chemistry, III | | edn, New | | age |
| 4 | Dr. V. V. Ramanujam, Inorganic Semimicro Qualitative Analysis, National Publishing Company, Chennai, 3 rd edition, 1974. | | | | | | | | |

Mapping with Programme Outcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | M | S | M | S | S | S | S | M | S | S |
| **CO 2** | S | S | S | M | M | M | M | S | S | M |
| **CO 3** | M | M | M | S | S | S | S | M | M | S |
| **CO 4** | S | S | S | S | S | S | S | S | S | S |
| **CO 5** | M | S | S | S | L | S | L | S | L | S |

# S-Strong M-Medium L-Low

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code:** | | **CHE C 409** | | | **INORGANIC PHOTOCHEMISTRY, SPECTROSCOPY AND ORGANOMETALLICS** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | | | | **Core** | | **4** | **0** | **0** | **4** |
| **Pre-requisite** | | | | Basic knowledge about principles of photo chemistry, photo electron spectroscopy, IR, Raman and NMR spectroscopy. Also, fundamentals of organometallic  chemistry. | |  | |  | |
| **Course Objectives:** | | | | | | | | | |
| The main objectives of this course are to:  **CO1.** To learn origin and principles of photo chemistry and photo electron spectroscopy.  **CO2.** To get knowledge about properties of nuclear chemistry and application of radioisotopes in agriculture, industry and medicine.  **CO3.** To acquire skill to determine the functional groups present in unknown molecules using vibrational (IR), Raman spectra and NMR spectroscopy.  **CO4.** To study the introduction about the ESR and Mössbauer spectroscopy. Also, gain knowledge about zero field and hyperfine splitting.  **CO5.** To gain knowledge about EAN rule and reactions of organometallic compounds. | | | | | | | | | |
|  | | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| **PSO1** | Students will be able to **understand** principles of photo chemistry and photo electron spectroscopy for homo and heteronuclear diatomic molecules. | | | | | | | K2 | |
| **PSO2** | Student will be **remember** about principles of nuclear chemistry and  their application of radioisotopes in agriculture, industry and medicine | | | | | | | K1 | |
| **PSO3** | Students will be familiarize on **applying** the principles of IR**,** Raman  and NMR spectroscopy to inorganic compounds. | | | | | | | K3 | |
| **PSO4** | Student will be **understand** the concept of ESR spectroscopy and prediction of spectra of inorganic compounds. | | | | | | | K2 | |
| **PSO5** | **Create** knowledge about important types of reactions in organometallic  compounds. | | | | | | | K6 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | | |
|  | | | | | | | | | |
| **UNIT:1** | | | **INORGANIC PHOTO CHEMISTRY AND PHOTO ELECTRON SPECTROSCOPY** | | | | **14 hours** | | |
| Unimolecular charge-transfer photochemistry of cobalt(III) complexes – mechanism of CTTM,  photoreduction – ligand-field photochemistry of chromium(III) complexes – Adamson’s rules, | | | | | | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| photoactive excited states, V-C model – photophysics and photochemistry of ruthenium – polypyridine complexes, emission and redox properties. Photoelectron Spectroscopy  PES - Theory, Types, origin of fine structures - shapes of vibrational fine structures – adiabatic and vertical transitions, PES of homonuclear diatomic molecules ( N2, O2) and heteronuclear diatomic molecules (CO, HCl) and polyatomic molecules (H2O, CO2, CH4, NH3) – evaluation of vibrational constants of the above molecules, Koopman’s theorem- applications and limitations. | | | |
|  | | | |
| **UNIT:2** | **NUCLEAR AND RADIATION CHEMSITRY** | **14** | **hours** |
| Properties of nucleus – different types of nuclear forces , Nuclear structure and nuclear stability, Nuclear models- – liquid drop model, shell model of nucleus, Radioactivity and nuclear reactions, nuclear reactions induced by charged particles – Q value – nuclear reaction cross section, significance and determination – theory of nuclear fission, nuclear fusion, stellar energy. Hot atom chemistry, Nuclear fission and fusion reactors. The interaction of nuclear radiations with matter. Radiation hazards and therapeutics. Detectors and their principles. Tracer Application of  radioisotopes in agriculture, industry and medicine. Isotope dilution and radio-activation methods of analysis. | | | |
|  | | | |
| **UNIT:3** | **APPLICATIONS OF IR, RAMAN AND NMR SPECTROSCOPY TO INORGANIC COMPOUNDS** | **14** | **hours** |
| IR spectroscopy- Introduction, selection rules, stretching frequency of some inorganic ions- effect of coordination on the stretching frequency- sulphato, carbonato, sulphito, aqua, nitro, thiocyanato, cyano, thiourea, DMSO complexes.  Raman spectroscopy – Introduction, combined applications of IR and Raman spectroscopy in the structural elucidation of N2O, ClF3, NO3-,ClO4, metal carbonyls.  NMR spectroscopy- Introduction, structural assessment of simple inorganic compounds, applications of 1H, 15N,19F, 31P-NMR spectroscopy in structural problems, fluxional molecules, quadrupolar nuclei- effect in NMR spectroscopy, shift reagents- applications. | | | |
|  | | | |
| **UNIT:4** | **ESR AND MÖSSBAUER SPECTROSCOPY** | **14** | **hours** |
| ESR spectroscopy-Introduction, presentation of esr spectra g and A parameters, spin densities, Mc- Connel relationship, factors affecting the magnitude of g and A. Zero field splitting, Kramer’s degeneracy, esr spectra of V(II), Mn(II) Fe (II), Co (II), Ni(II), Cu (II) complexes, bis(salicylaldimine)copper (II) , [(NH3)5Co-O2-Co(NH3)5]5+.  Mössbauer spectroscopy –Introduction, principle, instrumentation, recoil energy, Doppler effect, number of MB signals, isomer shift, quadrupole splitting, magnetic hyperfine splitting- applications to 57Fe, 119Sn and 129I compounds. | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UNIT:5** | | **ORGANOMETALLIC CHEMISTRY** | **14** | **hours** |
| Types of organometallic compounds on the basis of the nature of M-C bond. EAN rule: 18e- and 16e- rules – determinator of oxidation state, configuration, coordination number of the metal centre  – Types and application 18e- / 16e- rules. Carbonyls – isolated concept.- Structure of carbonlys (simple and polynuclear) Nitrosyls – bridging and terminal nitrosyls, bent and linear nitorsyls. Dinitrogen compounds donors – Alkyl and Aryl – preparation and properties; chain carbon donors – olefins, acetylene and allyl complexes – synthesis, structure and bonding; cyclic carbon donors – (metallocene) – synthesis, structure and bonding. Important types of reactions of organometallic compounds – substitution – electrophilic and nucleophilic attack on ligands; carbonylation and decarbonylation; oxidative addition and reductive elimination, insertion and deinsertion(elimination). Template synthesis of macrocyclic ligands. | | | | |
|  | | **Total Lecture hours** | **70 hours** | |
| **Text Book(s)** | | | | |
| 1 | R. S. Drago, Physical methods in inorganic chemistry; Affiliated East-West Press Pvt. Ltd.,  New Delhi, 2012. | | | |
| 2 | H. J. Arniker, Essentials of Nuclear Chemistry, 2nd Ed, Wiley Eastern Co, 1987. | | | |
| 3 | F. A. Cotton and G. Wilkinson Advanced Inorganic Chemistry, Wiley Eastern,1988. | | | |
| 4 | C. N. Banwell, Fundamentlas of molecular spectroscopy 4th edition, McGraw Hill Education,  Noida, 1994. | | | |
| 5 | E. A. V. Ebsworth, Structural Methods in Inorganic Chemistry, 3rd Ed ELBS, Great Britain,  1987. | | | |
| 6 | K. F. Purcell and J. C. Kotz, Inorganic Chemistry, WB Sanders Co, USA, 1977. | | | |
|  | | | | |
| **Reference Book(s)** | | | | |
| 1. | R. S. Drago, Physical methods in chemistry; Saunders college publications, Philadelphia,  1992. | | | |
| 2. | G. Friedlander, J. W. Kennedy and J. M. Miller, Nuclear and Radiochemistry, Wiley, 1964. | | | |
| 3. | H. Kaur – “Spectroscopy”, 3rd Ed., Pragati Prakasan Publications, Meerut, 2006. | | | |
|  | | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | |
| 1 | https:/[/www.univi](http://www.univie.ac.at/zbph/broda/dokumente/160-Nuclear_Chemistry.pdf)e[.ac.at/zbph/broda/dokumente/160-Nuclear\_Chemistry.pdf](http://www.univie.ac.at/zbph/broda/dokumente/160-Nuclear_Chemistry.pdf) | | | |
| 2 | https:/[/www.r](http://www.researchgate.net/publication/241812474_Handbook_of_Raman_Spectroscopy)e[searchgate.net/publication/241812474\_Handbook\_of\_Raman\_Spectroscopy](http://www.researchgate.net/publication/241812474_Handbook_of_Raman_Spectroscopy) | | | |
| 3 | https:/[/www.r](http://www.researchgate.net/publication/277433957_NMR_Spectroscopy_in_Inorganic_Ch)e[searchgate.net/publication/277433957\_NMR\_Spectroscopy\_in\_Inorganic\_Ch](http://www.researchgate.net/publication/277433957_NMR_Spectroscopy_in_Inorganic_Ch)  emistry\_Iggo\_Jonathan\_A | | | |

**MAPPING**-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | M | S | S | S | L | S | S | L | S | S |
| **CO 2** | S | S | S | S | S | M | S | S | S | S |
| **CO 3** | M | M | M | M | M | S | M | M | M | M |
| **CO 4** | S | S | S | S | S | S | S | S | S | S |
| **CO 5** | S | L | L | L | M | S | L | M | L | L |

# S-Strong M-Medium L-Low

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | | **CHE C 410** | **Spectroscopy, Spectrometry and their**  **Applications** | **L** | **T** | | **P** | **C** |
| **Core**/Elective/Supportive | | | **Core** | **4** | **0** | | **0** | **4** |
| **Pre-requisite** | | | Students to acquire knowledge of spectroscopic techniques and applications in organic chemistry to structure elucidation of  organic compounds using IR, NMR and Mass Spectra. |  | | |  | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:  **CO1.** To impart the knowledge of different characterization techniques.  **CO2.** Students will be expected to gain knowledge of instrument for characterization of organic comounds.  **CO3.**To understands the importance of elicitation of structure organic compounds. | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| **PSO1** | **Understanding** the basics knowledge of UV, IR, NMR and Mass Spectroscopy. | | | | | K1 | | |
| **PSO2** | **Apply** the knowledge and importance of spectroscopy. | | | | | K2& K3 | | |
| **PSO3** | Students will be **remember** the functional presence and elicitation of structure of  organic compounds. | | | | | K2 | | |
| **PSO4** | **Evaluate** the fundamentals molecular formula of organic compounds using  elemental (CHN) analysis data. | | | | | K4 | | |
| **PSO5** | **Understand** the strong back ground in spectroscopy will help to get job in  industry. | | | | | K5 | | |
| **K1** – Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create | | | | | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
|  | | | |
| **UNIT:1** | | **UV and IR spectra of organic compounds** | **14 hours** |
| Electronic absorption: Beer-Lamberts law, Types of electronic excitation. Chromophore and Auxochrome-Bathochromic and Hypsochromic shift. UV-vis spectra of simple organic compounds such as alkenes, phenols, anilines, carbonyl compounds and 1,3-diketones. Woodward-Fieser rule.  Infrared Spectra: Identification of functional groups in Organic Compounds, Finger print region. Inter and Intramolecular hydrogen bonding. Various factors affecting IR stretching frequencies. | | | |
| **UNIT:2** | | **Nuclear magnetic resonance and their applications** | **14 hours** |
| Origin of NMR spectrum-Nuclear spin states–NMR active nuclei–Nuclear magnetic moment– Larmor equation–Absorption of energy and Resonance–Population density of nuclear spin states.Saturation phenomena–Relaxation mechanisms, Bloch equation (only significance and derivation not required). Comparison of CW and FT instrument–Chemical shift-Standards in NMR– Shielding and Deshielding–Factors affecting chemical shift–electronegativity, hybridization, hydrogen bonding-anisotropic effect–double bond, triple bond, aromatic compounds, carbonyl compounds and annulenes. Spin-spin coupling–splitting origin and rules–factors affecting coupling constant: cis, trans, gem, ortho, meta, para coupling–exchange with deuterium. Vicinity of the proton, Long range coupling, Karplus equation and curve.Two interacting nuclei: AB, AX, AA’BB’, dd, pair of doublet and AB quartet. Three interacting nuclei: AMX, ABX, ABC systems (only pattern is required). Dynamic NMR of DMF, cyclohexane and iodocyclohexane). Double  irradiation/Spin decoupling, Nuclear Overhauser Effect (NOE) and NMR imaging (MRI). | | | |
| **UNIT:3** | | **13C NMR, 19F NMR &31P NMR and 2-D NMR techniques** | **14 hours** |
| 13C NMR–difficulties in recording 13C NMR: Homo nuclear and heteronuclear coupling. Off Resonance decoupled spectrum identification of various types of carbon (functional groups) using 13C NMR. Origin of 13C satellite peaks.Attached Proton Test (APT) &Distortionless Enhancement by Polarization Transfer (DEPT) spectrum (DEPT-45, DEPT-90 and DEPT-135).19F NMR– Precessional frequency and heteronuclear coupling. Identification of organofluoro compounds (CF3CO2Et and CF3CH2OH) using NMR. 31P NMR– Chemical shift and heteronuclear coupling. Identification of organo phosphorous compounds such as (Me)3P, (EtO)3P=O and Ph3P. P-P bond  in NMR. | | | |
| **UNIT:4** | | **Mass spectrometry** | **14 hours** |
| Origin, basics and bloc diagram of Mass spectrum-Various types of Ionization techniques-Stability of Molecular ions, Meta stable ions. Base peaks and Isotope peaks. Fragmentation patterns of organic molecules such as benzenes, phenyl halides, phenols, benzyl alcohols, benzyl halides, aliphatic alcohols, aliphatic as well as aromatic aldehydes, ketones, acids, esters and amides. Fragmentation patterns of aliphatic/aromatic nitro and amine compounds. Fragmentation patterns of heterocyclic compounds (furan, pyrrole and pyridine only). McLafferty rearrangements of organic  molecules. | | | |
| **UNIT:5** | | **Identification of organic compounds using analytical andspectral data** | **14 hours** |
| Determination of molecular formula of organic compounds using elemental (CHN) analysis data. Structural determination of simple organic compounds using UV, IR, NMR and Mass spectral data. | | | |
|  | | **Total Lecture hours** | **70 hours** |
| **Text Book(s)** | | | |
| 1. | William Kemp, Organic Spectroscopy, Macmillan Education UK, 3rd Ed, 1991. | | |
| 2. | D. L. Pavia, G. M. Lampman, G. S. Kriz and J. R. Vyvyan, Introduction to Spectroscopy, | | |

|  |  |
| --- | --- |
|  | 4th Ed, 2009. |
| 3. | Jag Mohan, Organic Spectroscopy Principles & Applications, Alpha Science, International Ltd,  2nd Ed, 2004. |
| 4. | P. S. Kalsi, Spectroscopy of Organic Compounds, New Age International Publishers, 6th Ed,  Reprint, 2005. |
| 5. | M. B. Smith, Organic Synthesis, Academic Press, 3rd Ed, 2011. |
| **Reference Books** | |
| 1. | William Kemp, NMR in Chemistry: A Multinuclear Introduction, MacMillan, 1988. |
| 2. | R. S. Macomber, A Complete Introduction to NMR Spectroscopy, Wiley, 1998. |
| 3. | R. M. Silverstein, F. X. Webster and D. Kiemle, Spectrometric identification of Organic  compounds, Wiley, 7th Ed, 2005. |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
| 1. | Spectroscopy: <http://www.orgchemboulder.com/Spectroscopy/Problems/1.shtml> |
| 2. | Spectroscopy1: https://nptel.ac.in/content/storage2/courses/104106075/Week8/MODULE%2036.pdf |

Mapping- Course Outcome with Programme Specific Outcome

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | M | L | M | M | S | S | S |
| **CO 2** | S | M | M | M | M | L | M | M | S | S |
| **CO 3** | S | M | M | M | M | M | L | M | S | S |
| **CO 4** | L | S | L | M | M | M | M | M | S | S |
| **CO 5** | S | L | S | M | S | S | L | L | S | S |

Note: S-Strong; M-Medium; L-Low

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | **CHE C 411** | | **Thermodynamics and Group theory** | **L** | **T** | | **P** | **C** |
| **Core/Elective/Supportive** | | **Core** | | **4** | **0** | | **0** | **4** |
| **Pre-requisite** | | Knowledge in basic thermodynamics and group theory and should have studied theromodynamics as  a subject or part of a paper in undergraduate programme. | |  | |  | | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:  CO1. To provide students with the latest information in the field of thermodynamics and group theory.  CO2. To Inculcate advanced knowledge, understanding, for the application of group theory. CO3. To explain the concepts of partial molar properties.  CO4. To explain the laws of the thermodynamics and its applications. CO5. To develop skills in determining point group for the molecules. CO6. To highlight the role of group theory in spectroscopy. | | | | | | | | |
|  | | | | | | | | |
| **Expected Course Outcomes:** | | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| On the successful completion of the course, student will be able to: | | | | | |
| **PSO1** | **Recognize** the concepts of partial molar properties. | | | | K1 |
| **PSO2** | **Understand** the laws of the thermodynamics and its applications. | | | | K2 |
| **PSO3** | **Demonstrate** the role of statistical thermodynamics in linking quantum and classical  mechanics. | | | | K3 |
| **PSO4** | **Evaluate** the different types of symmentry elements and operations and its use in  point groups. | | | | K4 |
| **PSO5** | **Assess** role of group theory in spectroscopy. | | | | K5 |
| **PSO6** | **Formulate** methodologies to determine representations of vibrational modes in non-  linear molecules. | | | | K6 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | |
|  | | | | | |
| **Unit:1** | | **Thermodynamics and non-ideal systems** | | **14 hours** | |
| Concepts of Partial Molar Properties-Partial Molar Free Energy and Partial Molar Volume.Gibbs- Duhem equation, Chemical potential-Variation of chemical potential with temperature and pressure, Van’t Hoff isotherm. Fugacity–Determination of fugacity of gases by graphical method-Variation of  fugacity with temperature and pressure -Lewis Randal rule-Duhem-Margules equation. Determination of activity and activity coefficient of non-electrolyte (e.m.f method)-Excess functions. | | | | | |
|  | | | | | |
| **Unit:2** | | **Irreversible thermodynamics** | | **14 hours** | |
| Nernst heat theorem-Third law of thermodynamics-Applications of third law-Entropy change- Calculation of absolute entropies-Apparent exceptions to third law- Non-equilibrium thermodynamics- Basic concepts-Forces and fluxes-Entropy of irreversible processes-Entropy production-Clausius inequality-Phenomenological equations-Onsager reciprocity relations-Coupled reactions. The principal of microscopic reversibility, the Onsager reciprocal relations – verification. Entropy production- rate of  entropy production, entropy production in chemical reactions. | | | | | |
|  | | | | | |
| **Unit:3** | | **Statistical thermodynamics** | **14 hours** | | |
| Objectives of statistical thermodynamics, Concept of distributions, Types of ensembles. Thermodynamic probability, Most probable distribution Law- Classical statistics-Maxwell-Boltzmann (MB) statistics-Quantum statistics-Bose-Einstein (BE) and Fermi-Dirac (FD) statistics-Derivation of distribution function-MB, BE and FD statistics-comparison-Partition functions-Translational, rotational,  vibrational and electronic partition function –Calculation of thermodynamic parameters and equilibrium constants in terms of partition function; Debye and Einstein heat capacity of solids. | | | | | |
|  | | | | | |
| **Unit:4** | | **Group theory-I** | **14 hours** | | |
| Symmetry elements; symmetry operations, Abelian group-point groups-determination of point group- Group multiplication table - Matrix representation of symmetry operations-Similarity transformations; Space groups of crystals-Mulliken symbols-reducible and irreducible representations; Symbols and rules of irreducible representations-reduction formula-direct product representation; Great orthogonality  theorem; character table-construction of character tables C2v, C3v and D2h. | | | | | |
|  | | | | | |
| **Unit:5** | | **Group theory-II** | **14 hours** | | |
| Applications of group theory- Determination of representations of vibrational modes in non-linear  molecules such as water, ammonia, BF3, CH4 and XeF4.Determination of Hybrid orbitals in non-linear | | | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| molecules – Examples: H2O, NH3, BF3, CH4 and XeF4. SALC procedure-evaluation of energies and molecular orbitals for systems like ethylene and butadiene.Selection rules for spectral transitions.  Electronic spectra of formaldehyde and ethylene. | | | | |
|  | | | | |
|  | | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | | |
| 1. | | A. Walton, Molecular and Crystal Structure Models, Ellis Horwood, Chichester, 1978. | | |
| 2. | | A. R. West, Solid State Chemistry and its applications, John Wiley and Sons, New York, 1984. | | |
| 3. | | M. C. Gupta, Statistical Thermodynamics, Wiley Eastern, New Delhi, 1990. | | |
| 4. | | J. Rajaram and J. C. Kuriacose, Irreversible Thermodynamics, Lal Nagin Chand, New Delhi,  1989. | | |
| 5. | | S. Glasstone, Thermodynamics for Chemists, Affiliated East West Press, New Delhi, 1960. | | |
| 6. | | R. P. H. Gasser and W. G. Richards, Introduction to Statistical Thermodynamics, World  Scientific, Singapore, 1995. | | |
| 7. | | P. W. Atkins, Physical Chemistry, Oxford University Press, Oxford, 1990. | | |
| 8. | | R. A. Alberty and R. J. Silbey, Physical Chemistry, John Wiley and Sons, New York, 1992. | | |
| 9. | | V. Ramakrishnan and M. S. Gopinathan, Group theory in Chemistry, Vishal Publications, 1988. | | |
| 10. | | J. Rajaram and J. C. Kuriacose, Thermodynamics for Students of Chemistry, Lal Nagin Chand,  New Delhi, 1986. | | |
| 11. | | F.A. Cotton, Chemical Application of Group Theory, John Wiley and Sons Inc. New York,  1971. | | |
| 12. | | K.V. Raman, Group theory and its applications to Chemistry, Tata McGraw-Hill Publishing  Company, 1990. | | |
|  | |  | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | |
| 1 | Classical to statistical Thermodynamics (https://nptel.ac.in/courses/104/103/104103112/) | | | |
| 2 | Thermodynamics (https://nptel.ac.in/courses/127/106/127106135/) | | | |
| 7 | Symmetry and Group Theory (https://nptel.ac.in/courses/104/106/104106128/) | | | |

Mapping- Course Outcome with Programme Specific Outcome

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | S | M | S | S | S | S | S | S | L |
| **CO 2** | S | S | S | S | S | S | M | S | S | S |
| **CO 3** | S | S | S | S | S | S | S | S | M | S |
| **CO 4** | M | S | S | S | S | S | S | L | S | S |
| **CO 5** | S | S | S | S | M | S | S | S | S | S |
| **CO 6** | S | M | S | S | S | M | M | S | S | M |

Note: S-Strong; M-Medium; L-Low

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | | **CHE C 412** | **Polymer Practical** | **L** | **T** | | **P** | **C** |
| **Core**/Elective/Supportive | | | **Core** | **0** | **0** | | **4** | **4** |
| **Pre-requisite** | | | Students to acquire knowledge of basics, classification, techniques of polymerization and molecular weight determination of  polymers. |  | | |  | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:  **CO1.** To impart the acquire knowledge of laboratory techniques of polymer preparations.  **CO2.** Students will be expected to gain knowledge basic concept and molecular weight determination of polymers.  **CO3.**To understands the kinetics of polymerization process. | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| **PSO1** | **Understanding** the **b**asics knowledge and classification polymers | | | | | K1 | | |
| **PSO2** | **Apply** the knowledge and importance of catalyst in the polymerization. | | | | | K2& K3 | | |
| **PSO3** | Students will be **remember** basic concept and molecular weight determination  of polymers. | | | | | K2 | | |
| **PSO4** | **Evaluate** the fundamentals of the understanding and necessary of different  polymer process. | | | | | K4 | | |
| **PSO5** | **Understand** the strong knowledge in polymer practical will help to get job in  industry. | | | | | K5 | | |
| **K1** – Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create | | | | | | | | |
|  | | | | | | | | |
| **UNIT:1** | | **Polymer preparations** | | | **14 hours** | | | |
| 1. Polymer preparation in bulk 2. Polymer preparation by solution method 3. Polymer preparation by emulsion method 4. Polymer preparation by suspension | | | | | | | | |
| **UNIT:2** | | **Polycondensation Polymerization** | | | **14 hours** | | | |
| Preparation of polyurethane foams | | | | | | | | |
| **UNIT:3** | | **Interfacial and Condensation Polymerization techniques** | | | **14 hours** | | | |
| Nylon-66 preparation and Glyphthal Ester formation. | | | | | | | | |
| **UNIT:4** | | **Kinetics of addition polymerization** | | | **14 hours** | | | |
| Initiator and monomer variation in Kinetics of polymerization of acrylamide. | | | | | | | | |
| **UNIT:5** | | **Polymer Characterizations** | | | **14 hours** | | | |
| 1. IR and NMR spectra of polymers 2. Determination of molecular weight of polymer by viscosity 3. Thermal analysis of polymers | | | | | | | | |
|  | | **Total Lecture hours** | | | **70 hours** | | | |
|  | |  | | |  | | | |

|  |  |
| --- | --- |
| **Text Book(s) and Reference Books** | |
| 1. | Lab manual for polymer chemistry- UNOM Polymer Science. |
| 2. | Introductory to Polymer Chemistry, GS Misra V.R.Gowariker, N.V.Viswanathan and JayadevSreedhar,  New Age International P Ltd., Publishers, 1986 |
| 3. | Seymour/Carraher’s Polymer Chemistry, 6th Ed. Marcel Dekker, 2005. |
| 4. | Polymer: Science & Technology, Joel R.Fried, Prentice-Hall of India Private Ltd, New Delhi,  2000 |
| 5. | Principles of Polymer Systems, Fourth Edition, Ferdinand Rodriguez, Taylor, Francis, 1996 |
|  | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
| 1. | Polymers: https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod16.pdf |
| 2. | Introduction to polymers:  https://nitsri.ac.in/Department/Chemical%20Engineering/M3 Polymer\_Technology.pdf |
| 3. | Polymers: https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/polymers.htm#polmr1 |

Mapping- Course Outcome with Programme Specific Outcome

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | M | L | M | M | S | S | S |
| **CO 2** | S | M | M | M | M | L | M | M | S | S |
| **CO 3** | S | M | M | M | M | M | L | M | S | S |
| **CO 4** | L | S | L | M | M | M | M | M | S | S |
| **CO 5** | S | L | S | M | S | S | L | L | S | S |

Note: S-Strong; M-Medium; L-Low

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | **CHE C 413** | | **Photochemistry, Pericyclic reactions, Heterocycles and Natural products** | **L** | **T** | | **P** | **C** |
| **Core/Elective/Supportive** | | **Core** | | **4** | **0** | | **0** | **4** |
| **Pre-requisite** | | Knowledge in basics of the photochemistry and should have studied photochemistry in  undergraduate programme. | |  | |  | | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:  CO1. To provide students with the latest information in the field of photochemistry and pericyclic reactions.  CO2. To Inculcate advanced knowledge, understanding, for the different approaches of pericyclic reactions.  CO3. To explain one heteroatom and two heteroatom based heterocyclic compounds  CO4. To explain the isolation, synthesis and structural elucidation of terpenoids, steroids, and alkaloids. | | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | | | | |
| **Expected Course Outcomes:** | | | | | |
| On the successful completion of the course, student will be able to: | | | | | |
| PSO 1 | Recognize the different types of photochemical reactions. | | | | K1 |
| PSO 2 | Understand the different approachs like FMO, Correlation diagram, Huckel0 Mobius, and perturbation molecular approach of pericyclic reactions. | | | | K2 |
| PSO 3 | Apply the selection rules and able to find out the seterochemistry of electrocyclic reactions, cycloadditions and Sigmatropic reactions. | | | | K3 |
| PSO 4 | Compare one heteroatom and two heteroatom heterocyclic compounds. | | | | K4 |
| PSO 6 | Formulate methodologies for isolation, synthesis and structural elucidation of terpenoids, steroids, and alkaloids. | | | | K6 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K6** – Create | | | | | |
|  | | | | | |
| **Unit:1** | | **ORGANIC PHOTOCHEMISTRY** | | **14 hours** | |
| Principles of Photochemistry and Photochemical reactions: Norrish type I & II reactions. Paterno- Büchi reaction; Photochemistry of enones and dienones: [2 + 2] photochemical cycloaddition; Photo  Fries, di-π methane, oxa & aza di-π methane rearrangements. | | | | | |
|  | | | | | |
| **Unit:2** | | **ORBITAL SYMMETRY & PERICYCLIC REACTIONS** | | **14 hours** | |
| Selection rules (Woodward and Hoffmann rules) and stereochemistry of electrocyclic reactions, cycloadditions and Sigmatropic reactions-FMO approach, Correlation diagram approach, Huckel-  Mobius approach and perturbation molecular orbital approach. | | | | | |
|  | | | | | |
| **Unit:3** | | **HETEROCYCLES AND THEIR REACTIVITY** | **14 hours** | | |
| Structure, synthesis and their reaction of the following systems; a) One heteroatom -Pyrrole, Furan, Thiophene, Pyridine; b) Benzo fused Heterocycles - Indole, Quinoline;  c) Two heteroatom - Pyrazole, Imidazole, Pyrimidine, Pyrazine. | | | | | |
|  | | | | | |
| **Unit:4** | | **NATURAL PRODUCTS: TERPENOIDS & STEROIDS** | **14 hours** | | |
| Terpenoids: Isolation and classification - general methods to elucidate the structure of terpenoids - methods of structure elucidation and synthesis as applied to zingiberine - eudesmol - caryophyllene - abietic acid - santonin - biosynthesis of terpenes.  Steroids: Structural elucidation of cholesterol – erogosterol- vitamin-D – equilenin – estrone - progesterone, Stigmasterol, Steriod harmones, androsterone, testosterone, biosynthesis of steroids – Structure - Synthesis of bile acids. | | | | | |
|  | | | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Unit:5** | | | **NATURAL PRODUCTS: ALKALOIDS** | **14 hours** |
| Structural elucidation and biosynthesis of dictamnine – chinconine – morphine – reserpine –  aeronycine – cocaine – lysergic acid and nicotine. | | | | |
|  | | | **Total Lecture hours** | **72 hours** |
| **Text Book(s)** | | | | |
| 1. | | J. A. Joule and K. Mills, Heterocyclic Chemistry, John Wiley, 5th Ed, 2010. | | |
| 2. | | R. K. Bansal, Heterocyclic Chemistry, New Age International (P) Ltd, 5th Ed, 2014. | | |
| 3. | | Charles A. Depuy and Orville L. Chapman, Englewood Cliffs, Molecular reactions and Photochemistry, New Jersey: Prentice-Hall, 1972. | | |
| 4. | | Jagdamba Singh and Jaya Singh, Photochemistry and Pericyclic Reactions, New Age International (P) Ltd, 3rd Ed, 2012. | | |
| 5. | | Sunil Kumar, Vinod Kumar and S. P. Singh, Pericyclic Reactions: A Mechanistic and Problem Solving Approach, Academic Press (Elsevier), 2016. | | |
| 6. | | Sankararaman, S, Pericyclic Reactions: A Text Book: Reactions, Applications and Theory, Wiley-VCH, 2005. | | |
| 7. | | I. L. Finar, Organic Chemistry Vol 1 & 2, Dorling Kindersley India (P) Ltd, 2009. | | |
| 8. | | Koji Nakanishi, Toshio Goto and Shô, Itô, Natural Product Chemistry, Vol. I, Academies Press, 1974. | | |
| 9. | | A. Newman, Chemistry of Terpenes and Terpenoids, Academic Press, 1972. | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | |
| 1 | Organic Photochemistry (https://nptel.ac.in/courses/104/106/104106077/) | | | |
| 2 | Heterocyclic chemistry (https://nptel.ac.in/courses/104/105/104105034/) | | | |
| 6 | Terpenoids (https:/[/www.int](http://www.intechopen.com/chapters/62573))e[chopen.com/chapters/62573)](http://www.intechopen.com/chapters/62573)) | | | |
| 7 | Alkaloids (https:/[/www.int](http://www.intechopen.com/chapters/66742))e[chopen.com/chapters/66742)](http://www.intechopen.com/chapters/66742)) | | | |

Mapping- Course Outcome with Programme Specific Outcome

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | M | L | M | M | S | S | S |
| **CO 2** | S | M | M | M | M | L | M | M | S | S |
| **CO 3** | S | M | M | M | M | M | L | M | S | S |
| **CO 4** | L | S | L | M | M | M | M | M | S | S |
| **CO 6** | S | L | S | M | S | S | L | L | S | S |

Note: S-Strong; M-Medium; L-Low

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code:** | | CHE C 414 | | | PLASTICS AND RUBBER  TECHNOLOGY | **L** | **T** | **P** | | **C** |
| **Core/Elective/Supportive** | | | | **Core** | | **4** | **0** | **0** | | **4** |
| **Pre-requisite** | | | | Knowledge in Polymer Science | | **Syllabus**  **Version** | |  | | |
| **Course Objectives:** | | | | | | | | | | |
| Objectives of this course is to give basic knowledge about the following aspects of polymer technology to the students:   1. Different additives used for polymers. 2. Compounding of plastics and rubber materials. 3. Manufacturing processes used to produce different plastics and rubber moldings. 4. Chemistry, manufacturing methods and properties of some common plastic and rubber materials. | | | | | | | | | | |
|  | | | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | | |
| **CO1** | **Understand** the importance of variety of additives required to modify  different properties of polymers. | | | | | | | | K2 | |
| **CO2** | **Remember** the knowledge about additives, **understand** the requirement and **apply** the knowledge to prepare polymer with a  particular recipe for production of particular article. | | | | | | | | K1 K2  K3 | |
| **CO3** | Acquires knowledge about production (**create)** of some important  common plastic materials and able to **remember** their properties. | | | | | | | | K1  K6 | |
| **CO4** | **Understand** the basics of rubber chemistry and manufacturing of  different rubber moldings. | | | | | | | | K1 | |
| **CO5** | Acquires knowledge about production (**create)** of some important  common rubber materials and able to **remember** their properties. | | | | | | | | K1  K6 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | | | |
|  | | | | | | | | | | |
| **UNIT-1** | | | ADDITIVES | | | | **14 hours** | | | |
| Additives for plastics - fillers - plasticisers - lubricants and flow promoters - anti aging additives - flame retarders - colourants - blowing agents - cross linking agents - uv-  stabilisers. | | | | | | | | | | |
| **UNIT-2** | | | PROCESSING TECHNIQUES | | | | **14 hours** | | | |
| Processing techniques for plastics - injection moulding - compression moulding - blow moulding - rotational moulding - extrusion - calendering. | | | | | | | | | | |
| **UNIT-3** | | | SOME COMMON PLASTICS | | | | **14 hours** | | | |
| Manufacture and properties of polyethylene - polypropylene - polystyrene - polyacrylonitrile  - polymethyl methacrylate - polyesters - polycarbonate - polyamide - polyimide - polyurethane - polyureas - polyvinyl acetate - polyvinyl chloride – polytetrafluoroethylene - polyvinyl carbazole - thermosetting resins. | | | | | | | | | | |
| **UNIT-4** | | | RUBBER CHEMISTRY AND TECHNOLOGY | | | | **14 hours** | | | |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Introduction to rubber chemistry - Natural rubber - Outlines of rubber processing - Mastication, Compounding ingredients, Mixing, Moulding, Extrusion,Calendering and Vulcanisation - Properties of vulcanized rubbers - Manufacturing of rubber based articles  and its applications. | | | | | | | | | |
| **UNIT-5** | | SOME COMMON RUBBERS | | | | | **14 hours** | | |
| Manufacture, properties and applications of Isoprene, Butyl, Butadiene, Chloroprene, EPDM, Thiokol and Silicon rubbers. | | | | | | | | | |
| **Total Lecture hours** | | | | | | | **70 hours** | | |
| **Text Book(s)** | | | | | | | | | |
| 1 | Polymer Chemistry, Sebastian koltzenburg, Michael Maskos and Oskar Nuyken,  Springer, 2017. | | | | | | | | |
| 2 | Polymer Science, V.R.Gowariker, N.V.Viswanathan and Jayadev Sreedhar,  New Age International P Ltd., Publishers, 1986. | | | | | | | | |
| 3 | Seymour/Carraher’s Polymer Chemistry, 6th Ed. Marcel Dekker, 2005. | | | | | | | | |
| 4 | Polymer Science & Technology, Joel R.Fried, Prentice-Hall of India Private Ltd,  New Delhi, 2000. | | | | | | | | |
| 5 | Principles of Polymer Systems, Fourth Edition, Ferdinand Rodriguez, Taylor, Francis,  1996. | | | | | | | | |
| **Reference Book(s)** | | | | | | | | | |
| 1. | Plastics materials, J.A.Blrydson, Butterworth, 1982. | | | | | | | | |
| 2. | Synthetic rubbers, D.C.,Blkacley,l Applied Science Publishers, London, 1983. | | | | | | | | |
| 3. | Rubber Technology, Maurice Morton, Third Ed., Von Nostrand Reinhold, NY, 1982. | | | | | | | | |
| 4. | Rubber Technology  Butterworths,1982. | | and | Manufacture, Second | Ed. | Ed. | By | C.M | Blow, |
| 5. | Advances in Polymer Latex Technology, Vikas Mittal, Nova Science Publishers, Inc.  UK, 2012. | | | | | | | | |
|  | | | | | | | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | | | | | | |
| 1 | [https://www.plastictoday.com](https://www.plastictoday.com/) and https://rubberworld.com | | | | | | | | |

**MAPPING**-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | S | L | S | S | M | S | S |
| **CO 2** | S | S | S | S | S | M | M | S | S | S |
| **CO 3** | S | S | S | M | M | S | S | M | M | M |
| **CO 4** | M | S | L | S | S | S | S | S | S | S |
| **CO 5** | S | L | S | L | M | S | L | S | L | L |

**S-Strong M-Medium L-Low**

# ELECTIVE, SOFT SKILL & INTERNSHIP COURSES OFFERED FOR THE DEPARTMENT/SCHOOL

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | | **CHE E401** | **Polymer Chemistry** | **L** | **T** | | **P** | **C** |
| Core/**Elective**/Supportive | | | **Elective** | **4** | **0** | | **0** | **4** |
| **Pre-requisite** | | | Students to acquire knowledge of basics, classification, techniques of polymerization, molecular weight determination and processing  of polymers. |  | | |  | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:  **CO1.** To impart the knowledge of basics, classification, techniques of polymerization,  **CO2.** Students will be expected to gain knowledge basic concept of molecular weight determination and processing of polymers.  **CO3.**To understands the importance of different polymer process. | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| **PSO1** | **Understanding** the **b**asics knowledge and classification polymers | | | | | K1 | | |
| **PSO2** | **Apply** the knowledge and importance of catalyst in the polymerization. | | | | | K2& K3 | | |
| **PSO3** | Students will be **remember** and learn various techniques involve polymer  synthesis, its use in daily life. | | | | | K2 | | |
| **PSO4** | **Evaluate** the fundamentals of the understanding and necessary of different  polymer process. | | | | | K4 | | |
| **PSO5** | **Understand** the strong back ground in polymer technology will help to get job  in industry. | | | | | K5 | | |
| **K1** – Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create | | | | | | | | |
|  | | | | | | | | |
| **UNIT:1** | | **Development of Polymer Science** | | | **14 hours** | | | |
| Classification of polymers based on sources, method of polymerization and its properties. | | | | | | | | |
| **UNIT:2** | | **Vinyl Polymerization** | | | **14 hours** | | | |
| Addition (Vinyl) polymerization: Free radical polymerization -Mechanism and kinetics of free radical addition polymerization. Ionic polymerization - Types of ionic polymerization, common features, mechanism and kinetics of ionic polymerizations. | | | | | | | | |
| **UNIT:3** | | **Special Polymerization techniques** | | | **14 hours** | | | |
| Coordination polymerization (Ziegler-Natta polymerization), Ring opening and Ring-opening metathesis polymerizations. | | | | | | | | |
| **UNIT:4** | | **Condensation Polymerization** | | | **14 hours** | | | |
| Step (condensation) polymerization, Carothers equation, mechanism and kinetics of condensation polymerization. | | | | | | | | |
| **UNIT:5** | | **Polymerization processes** | | | **14 hours** | | | |
| Bulk, solution, suspension and emulsion polymerization with examples. Melt, solution and interfacial polycondensations. | | | | | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
|  | | **Total Lecture hours** | **70 hours** |
| **Text Book(s) and Reference Books** | | | |
| 1. | Text Book of Polymer Science, Fred W.Billmeyer, Jr., John Wiley & Sons, 1994. | | |
| 2. | Polymer Science, V.R.Gowariker, N.V.Viswanathan and JayadevSreedhar,  New Age International P Ltd., Publishers, 1986 | | |
| 3. | Seymour/Carraher’s Polymer Chemistry, 6th Ed. Marcel Dekker, 2005. | | |
| 4. | Polymer: Science & Technology, Joel R.Fried, Prentice-Hall of India Private Ltd, New Delhi,  2000 | | |
| 5. | Principles of Polymer Systems, Fourth Edition, Ferdinand Rodriguez, Taylor, Francis, 1996 | | |
|  | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1. | Polymers: https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod16.pdf | | |
| 2. | Introduction to polymers:  https://nitsri.ac.in/Department/Chemical%20Engineering/M3 Polymer\_Technology.pdf | | |
| 3. | Polymers: https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/polymers.htm#polmr1 | | |

Mapping- Course Outcome with Programme Specific Outcome

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | M | L | M | M | S | S | S |
| **CO 2** | S | M | M | M | M | L | M | M | S | S |
| **CO 3** | S | M | M | M | M | M | L | M | S | S |
| **CO 4** | L | S | L | M | M | M | M | M | S | S |
| **CO 5** | S | L | S | M | S | S | L | L | S | S |

Note: S-Strong; M-Medium; L-Low

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | CHE E402 | | **REAGENTS IN ORGANIC SYNTHESIS** | **L** | **T** | | **P** | **C** |
| **Core/Elective/Supportive** | | **Core** | | **3** | **0** | | **0** | **3** |
| **Pre-requisite** | | Knowledge in basic organic reagents and should  have studied organic chemistry as a subject or part of a paper in undergraduate programme. | |  | |  | | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:  CO1. To provide students with the latest information in the field of organic reagents.  CO2. To explain oxidation and reduction reaction using different types of oxidizing and reducing agents.  CO3. To explain the reaction mechanism of the different types of catalyzed organic reactions. CO4. To develop knowledge in molecular rearrangement reactions. | | | | | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | |
|  | | | | | | |
| **Expected Course Outcomes:** | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | |
| PSO 1 | | **Recognize** the different types of organic reagents and their importance. | | | | K1 |
| PSO 2 | | **Understand** the importance of the catalysis and their reactions. | | | | K2 |
| PSO 3 | | **Demonstrate** the role of organic reagents in the molecular rearrangements. | | | | K3 |
| PSO 4 | | **Compare** the different types of catalysts and their importance in organic reactions. | | | | K4 |
| PSO 5 | | **Assess** role of oxidizing and reducing agents in the organic reactions. | | | | K5 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate | | | | | | |
|  | | | | | | |
| **Unit:1** | | | **Functional group transformations using reducing reagents** | | **10 hours** | |
| Functional group transformations using reducing reagents. Use of NaBH4, LiAlH4 and Bu3SnH. | | | | | | |
|  | | | | | | |
| **Unit:2** | | | **Organic reactions using oxidizing reagents** | | **10 hours** | |
| Organic reactions using oxidizing reagents. Woodward and Prevost hydroxylation, osmium tetroxie,  DDQ, Selenium dioxide. | | | | | | |
|  | | | | | | |
| **Unit:3** | | | **Phase transfer catalysts** | **10 hours** | | |
| Phase transfer catalysts, crown ethers and Merrifield resin in organic synthesis, Peterson’s synthesis, | | | | | | |
|  | | | | | | |
| **Unit:4** | | | **Organic reagents - I** | **10 hours** | | |
| Use of the following reagents in organic synthesis. Gilman’s reagent, lithium dimethylcuprate, lithium  diisopropylamide (LDA), dicyclohexylcarbodiimide, trimethylsililyl iodide. | | | | | | |
|  | | | | | | |
| **Unit:5** | | | **Organic reagents - II** | **10 hours** | | |
| Use of 1,3-Dithiane (reactivity umpulong), Wilkinson’s catalyst and baker yeast in organic synthesis. | | | | | | |
|  | | | **Total Lecture hours** | **50 hours** | | |
| **Text Book(s)** | | | | | | |
| 1. | Jerry March, Advanced Organic Chemistry, John Wiley & Sons, 5th Ed, 2001. | | | | | |
| 2. | F. Carey and R. J. Sundberg, Advanced Organic Chemistry-Part A and B, Springer Science + Business Media, 5 th Ed, 2007. | | | | | |
| 3. | M. B. Smith and Jerry March, Advanced Organic Chemistry, John Wiley & Sons, 5th Ed, 2001. | | | | | |
| 4. | J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Oxford University Press, 2nd Ed, 2012. | | | | | |
| 5. | M. B. Smith, Organic Synthesis, Academic Press, 3rd Ed, 2011. | | | | | |

|  |  |  |
| --- | --- | --- |
| 6. | | R. O. C. Norman and J. M. Coxon, Principles of Organic Synthesis, Chapman & Hall, 3rd Ed, 1993. |
| 7. | | Stuart Warren, Organic Synthesis: Disconnection Approach, Wiley India (P) Ltd, 2007. |
| 8. | | V. K. Ahluwalia, Oxidation in Organic Synthesis, CRC Press, 1st Ed, 2012. |
| 9. | | V. K. Ahluwalia, Reduction in Organic Synthesis, CRC Press, 1st Ed, 2012. |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | |
| 1 | Reagents in Organic synthesis (https://nptel.ac.in/courses/104/103/104103111/) | |
| 2 | Reagents in Organic reactions (https://nptel.ac.in/courses/104/103/104103023/) | |

Mapping- Course Outcome with Programme Specific Outcome

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | S | S | S | S | S | S | S | S | S |
| **CO 2** | S | S | S | S | S | S | M | S | S | S |
| **CO 3** | S | S | S | M | S | S | S | S | S | L |
| **CO 4** | S | S | S | S | S | S | S | S | S | S |
| **CO 5** | S | M | S | S | S | S | S | S | M | S |

Note: S-Strong; M-Medium; L-Low

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code:** | | CHE E403 | | PHYSICAL CHEMISTRY OF  POLYMERS (mandatory elective) | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | | | | **Elective** | **3** | **0** | **0** | **3** |
| **Pre-requisite** | | | | Basic knowledge in physical  chemistry and polymers | **Syllabus**  **Version** | |  | |
| **Course Objectives:** | | | | | | | | |
| Objectives of this course is to give basic knowledge about the following aspects of polymers to the students:   1. Terminology of Polymer Science. 2. Different average molecular weights of Polymers. 3. Determination of molecular weights of Polymers. 4. Glass-transition temperature of Polymers. 5. Determination of Glass-transition temperature of Polymers. | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| **CO1** | **Understand** the different terms exclusively used in Polymer Science.  **Analyse and classify** the polymers based on their structures. | | | | | | **K2 K4** | |
| **CO2** | **Recall** the concept of molecular weight simple compounds and to  **Understand** the different average molecular weight of polymers and how it differs from simple organic polymers. | | | | | | **K1 K2** | |
| **CO3** | **Understand** and **able to analyze** molecular weight of polymers using  different chemical and physical methods. | | | | | | **K2 K4** | |
| **CO4** | **Understand** the unique concept **“**Glass-transition temperature” of  Polymers. **Apply** and **Interpret** this value based on structure of the polymer. | | | | | | **K2 K3 K5** | |
| **CO5** | **Able to analyze** glass-transition temperature of polymers using  different physical methods. | | | | | | **K4** | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | |
| **UNIT:1** | | | INTRDUCTION TO POLYMERS | | | **12 hours** | | |
| Terminology – Intermolecular forces and polymer types - Chemical and geometrical  structure of macromolecules. | | | | | | | | |
| **UNIT:2** | | | MOLECULAR WEIGHTS OF POLYMERS | | | **14 hours** | | |
| Concept of average molecular weight - number average, weight average and viscosity average molecular weight - molecular weight distribution - theoretical considerations and empirical distribution model - degree of polymerization and molecular weight - influence  of molecular weight on physical properties. | | | | | | | | |
| **UNIT:3** | | | DETERMINATION OF MOLECULAR WEIGHTS | | | **10 hours** | | |
| Molecular weight determination – end-group analysis, colligative property, light scattering, ultracentrifugation and gel permeation chromatography methods. | | | | | | | | |
| **UNIT:4** | | | GLASS TRANSITION TEMPERATURE | | | **9 hours** | | |

|  |  |  |  |
| --- | --- | --- | --- |
| The glassy state and the glass transition temperature - influencing factors (Main chain structure, side groups, H-bonding, molecular weight, plasticisation, etc.) - glass transition temperature and copolymers - relation between Tg and Tm - importance of glass transition temperature. | | | |
| **UNIT:5** | | DETERMINATION OF GLASS TRANSITION  TEMPERATURE | **5 hours** |
| Determination of glass transition temperature - DSC and DMA methods. | | | |
|  | | **Total Lecture hours** | **50 hours** |
| **Text Book(s)** | | | |
| 1 | Text Book of Polymer Science, Fred W.Billmeyer, Jr., John Wiley & Sons, 1994. | | |
| 2 | Polymer Chemistry, Sebastian koltzenburg, Michael Maskos and Oskar Nuyken,  Springer, 2017. | | |
| 3 | Polymer Science, V.R.Gowariker, N.V.Viswanathan and Jayadev Sreedhar,  New Age International P Ltd., Publishers, 1986. | | |
| 4 | Principles of Polymer Systems, Fourth Edition, Ferdinand Rodriguez, Taylor Francis,  1996 | | |
| 5 | Seymour/Carraher’s Polymer Chemistry, 6th Ed. Marcel Dekker, 2005. | | |
| 6 | Polymer Science & Technology, Joel R.Fried, Prentice-Hall of India Private Ltd, New  Delhi, 2000. | | |
| **Reference Book(s)** | | | |
| 1. | 1. Physical Chemistry of Macromolecules - basic principles and issues, S.F.Sun,  John Wiley & Sons, Inc., 1994. | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
| 1 | [https://nptel.ac.in](https://nptel.ac.in/)  NOC: Introduction to Polymer Physics - NPTEL | | |

**MAPPING**-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | S | L | S | S | M | S | S |
| **CO 2** | S | S | S | S | S | M | M | S | S | S |
| **CO 3** | S | S | S | M | M | S | S | M | M | M |
| **CO 4** | M | S | L | S | S | S | S | S | S | S |
| **CO 5** | S | L | S | L | M | S | L | S | L | L |

# S-Strong M-Medium L-Low

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | | CHE E404 | | **MOLECULAR SPECTROSCOPY** | | **L** | | **T** | | **P** | **C** |
| **Core/Elective/Supportive** | | | **Core** | | | **3** | | **0** | | **0** | **3** |
| **Pre-requisite** | | | Knowledge in basic molecular spectroscopy and should have studied quantum chemistry as a subject or part of a paper in undergraduate  programme. | | |  | | |  | | |
| **Course Objectives:** | | | | | | | | | | | |
| The main objectives of this course are to:  CO1. To provide students with the latest information in the field of molecular spectroscopy.  CO2.To explain the processes of energy level calculation and selection rules of the molecular spectroscopy.  CO3. To explain the theoretical basis of the molecular spectroscopy and spectra in magnetic field.  CO4. Students will be expected to gain knowledge of instrumentation of molecular spectroscopy and for characterization of compounds. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| **Expected Course Outcomes:** | | | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | | | |
| PSO1 | Remember the different types of quantum chemistry energy levels their  importance in molecular spectroscopy. | | | | | | | | | K1 | |
| PSO2 | Understand the instrumentation and characterization of the compounds . | | | | | | | | | K2 | |
| PSO3 | Demonstrate the role of theoretical basis of the molecular spectroscopy and  spectra in magnetic field. | | | | | | | | | K3 | |
| PSO4 | Compare the different types of quantum energy levels and its use in molecular  spectroscopy. | | | | | | | | | K4 | |
| PSO5 | Assess role of magnetic field in NMR and ESR spectroscopy. | | | | | | | | | K5 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate | | | | | | | | | | | |
|  | | | | | | | | | | | |
| **Unit:1** | | **Rotational spectroscopy** | | | | | **10 hours** | | | | |
| classical description of molecular rotation, quantum mechanics of molecular motion, rotational spectra, determination of the bond length from rotational constants, vibrational stretching and vibrational satellites, no-rigid rotor, centrifugal distortion, degeneracies and intensities, Stark effect,  selection rules, rotational spectra of polyatomic molecules. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| **Unit:2** | | **Vibrational spectroscopy** | | | | | **10 hours** | | | | |
| classical description of molecular vibrations, the classical harmonic oscillator, quantum mechanics of molecular vibration, vibrational selection rules, anharmonic vibrations and Morse oscillator, bond dissociation energies and Birge-Sponer plots, calculation of force constants from vibrational spectrum, isotopic shift, rotational structure in vibrational spectra of diatomic molecules, vibrational  selection rules, vibration of polyatomic molecules, normal modes, characteristic group vibrational energies, hydrogen bonds in IR spectra. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| **Unit:3** | | **Electronic Spectroscopy** | | | **10 hours** | | | | | | |
| electronic transition, energy of electronic transition, selection rules, the Franck-Condon principle, | | | | | | | | | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| term symbols for describing atomic and molecular states, Russel Saunders spin-orbit coupling, selection rules of electronic transition, absorption intensity, probability of light absorption, an  electronic spectrum, classification of electronic transition, d-d and CT transitions. | | | | |
|  | | | | |
| **Unit:4** | | | **Raman & Photoelectron spectroscopy** | **10 hours** |
| Description of Raman scattering, Rayleigh scattering, Stokes and anti-Stokes scattering , polarizability of the molecules, Placzek theory, selction rules for rotational Raman spectra of diatomic molecules, rotational Raman spectra, vibrational Raman spectra, Raman spectra of polyatomic molecules.  the photoelectric effect, UV photoelectron spectroscopy UPES, X-ray photoelectron spectroscopy XPES, electron binding energy, ESCA, Auger electron spectroscopy. | | | | |
|  | | | | |
| **Unit:5** | | | **Spectra in magnetic field** | **10 hours** |
| NMR – the Stern-Gerlach’s experiment, nuclear spin angular momentum, the magnetic moment of a nucleus, the nuclei in a magnetic field, the Larmor frequency, the chemical shift, electronic shielding of nuclei, the chemical shift scale, the spin-spin coupling, the spin-spin coupling constant, spin-spin splitting, molecular structure from NMR spectra.  EPR Spectroscopy – paramagnetic species, electron spin, magnetic properties of the electron and selected particles, magnetogyric ratio, electron spin–orbit couplings, energy levels and allowed EPR transitions. | | | | |
|  | | | **Total Lecture hours** | **50 hours** |
| **Text Book(s)** | | | | |
| 1. | | William Kemp, Organic Spectroscopy, Macmillan Education UK, 3rd Ed, 1991. | | |
| 2. | | P. S. Kalsi, Spectroscopy of Organic Compounds, New Age International Publishers, 6th Ed, Reprint, 2005. | | |
| 3. | | R. M. Silverstein, G. C. Bassler and T. C. Morrill, Spectrometric identification of Organic compounds, John Wiley, 5th Ed, 1991. | | |
| 4. | | R. M. Silverstein, F. X. Webster and D. Kiemle, Spectrometric identification of Organic compounds, Wiley, 7th Ed, 2005. | | |
| 5. | | William Kemp, NMR in Chemistry: A Multinuclear Introduction, MacMillan, 1988. | | |
| 6. | | R. S. Macomber, A Complete Introduction to NMR Spectroscopy, Wiley, 1998. | | |
| 7. | | Jag Mohan, Organic Spectroscopy Principles & Applications, Alpha Science International Ltd, 2nd Ed, 2004. | | |
| 8. | | C. F. Banwell, Fundamentals of Molecular Spectroscopy, McGraw Hill, New York, 1966. | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | |
| 1 | Quantum Chemistry (https://nptel.ac.in/courses/104/106/104106083/) | | | |
| 2 | Molecular spectroscopy (https://nptel.ac.in/courses/104/101/104101126/) | | | |
| 7 | NMR spectroscopy (https://nptel.ac.in/courses/104/108/104108078/) | | | |

Mapping- Course Outcome with Programme Specific Outcome

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | S | M | S | S | S | M | S | S | S |
| **CO 2** | S | S | S | S | M | S | L | L | S | S |
| **CO 3** | S | S | S | S | S | M | S | S | S | M |
| **CO 4** | S | M | S | M | M | S | L | M | L | S |
| **CO 5** | S | M | L | S | L | L | S | S | S | S |

Note: S-Strong; M-Medium; L-Low

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course**  **code:** | | CHE E405 | | POLYMER PHYSICS  (mandatory elective) | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | | | **Elective** | | **3** | **0** | **0** | **3** |
| **Pre-requisite** | | | Knowledge in Polymer Science | |  | |  | |
| **Course Objectives:** | | | | | | | | |
| Objectives of this course is to give basic knowledge about the following aspects of polymers to the students:   1. Origin of physics aspects of polymers. 2. Solution properties including confirmation and thermodynamics of dissolved polymer chain and viscosity of polymer solutions. 3. Elasticity of rubbers. 4. Viscoelasticity of polymers. 5. Mechanical properties of polymers. | | | | | | | | |
|  | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| **CO1** | **Understand** how to make polymer solutions and how the structural  features of polymers affecting their solubility. | | | | | | **K2** | |
| **CO2** | **Recall** the confirmation of simple compounds and to **Recall** the concept of solubility, and thermodynamics of solutions. Also, the students will be able to **apply** their knowledge to **evaluate** the size  of the polymer (coil) chain in solution. | | | | | | **K1 K3 K5** | |
| **CO3** | **Understand** flow properties and relationship between molecular weight and viscosity of polymers. The students will also **able to understand** the basic requirement for a polymer to be used as  elastomer. | | | | | | **K2** | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO4** | | **Understand conceptually** new theory to describe the viscoelasticity of polymers. And, able to a**pply** and **Interpret** the  viscoelasticity experimental data. | | | **K2 K3 K4** |
| **CO5** | | **Able to analyze** characterization results of physical and  mechanical properties of polymers. | | | **K4** |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | |
|  | | | | | |
| **UNIT:1** | | | POLYMER SOLUTIONS | | **10 hours** |
| Physical aspects of polymer solutions: Criteria for polymer solubility - conformations of dissolved polymer chains - thermodynamics of solutions. | | | | | |
| **UNIT:2** | | | SOLUTION VISCOSITY | | **10 hours** |
| Solution viscosity and molecular weight – intrinsic viscosity and molecular size (theory of  frictional properties) - fractionation of polymers by solubility. | | | | | |
| **UNIT:3** | | | BASICS OF RHEOLOGY OF POLYMERS | | **10 hours** |
| Rheology of polymers: Viscosity - expression for Newtonian and non-Newtonian fluids, flow measurement (melt flow index) – dependence of melt viscosity on molecular weight  and temperature - kinetic theory of rubber elasticity. | | | | | |
| **UNIT:4** | | | VISCOELASTICITY | | **10 hours** |
| Rheology of polymers: Viscoelasticity description, theories and models. | | | | | |
| **UNIT:5** | | | PROPERTRIES OF POLYMERS | | **10 hours** |
| Physical and Mechanical propertries of polymers: Stress- strain properties, fatigue, impact strength, tear resistance, hardness and abrasion resistance – Thermal property  (flammability) – Electrical properties. | | | | | |
|  | | | **Total Lecture hours** | **50 hours** | |
| **Text Book(s)** | | | | | |
| 1 | Text Book of Polymer Science, Fred W.Billmeyer, Jr., John Wiley & Sons, 1994. | | | | |
| 2 | Polymer Chemistry, Sebastian koltzenburg, Michael Maskos and Oskar Nuyken,  Springer, 2017. | | | | |
| 3 | Polymer Science, V.R.Gowariker, N.V.Viswanathan and Jayadev Sreedhar, New Age  International P Ltd., Publishers, 1986. | | | | |
| 4 | Principles of Polymer Systems, Fourth Edition, Ferdinand Rodriguez, Taylor Francis,  1996. | | | | |
| 5 | Seymour/Carraher’s Polymer Chemistry, 6th Ed. Marcel Dekker, 2005. | | | | |
| 6 | Polymer Science & Technology, Joel R.Fried, Prentice-Hall of India Private Ltd, New  Delhi, 2000. | | | | |
| **Reference Book(s)** | | | | | |
| 1. | Physical Chemistry of Macromolecules - basic principles and issues, S.F.Sun, John Wiley & Sons, Inc., 1994. | | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | | |
| 1 | [https://nptel.ac.in](https://nptel.ac.in/)  NOC: Introduction to Polymer Physics - NPTEL | | | | |

**MAPPING**-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | S | L | S | S | M | S | S |
| **CO 2** | S | S | S | S | S | M | M | S | S | S |
| **CO 3** | S | S | S | M | M | S | S | M | M | M |
| **CO 4** | M | S | L | S | S | S | S | S | S | S |
| **CO 5** | S | L | S | L | M | S | L | S | L | L |

# S-Strong = 3 M-Medium = 2 L-Low=1

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code:** | | CHE E406 | | SPECIALITY POLYMERS | **L** | **T** | **P** | | **C** |
| **Core/Elective/Supportive** | | | **Elective** | | **3** | **0** | **0** | | **3** |
| **Pre-requisite** | | | Knowledge in Chemistry and  Polymer Science | | **Syllabus**  **Version** | |  | | |
| **Course Objectives:** | | | | | | | | | |
| Objectives of this course is to give basic knowledge about the following specialty polymers to the students:  1.Dendrimers and hyperbranched polymers. 2. Non-linear optical and photonic polymers. 3. Liquid crystalline polymers. 4. Conducting polymers and 5. Biodegradable polymers. | | | | | | | | | |
|  | | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| **CO1** | **Remember** basic synthetic organic chemistry and able to **understand**  how to synthesis (**create**) topologically attractive highly branched polymers and their properties in comparison to linear polymers. | | | | | | | **K1 K2**  **K6** | |
| **CO2** | **Recall** basic synthetic organic chemistry and able to **understand** the concept of **NLO**. Also, the students will be able to **apply** their  knowledge for synthesis of polymers with non-linear optical properties and able to **evaluate** such polymers. | | | | | | | **K1 K2**  **K4 K5** | |
| **CO3** | **Remember** basic synthetic organic chemistry and able to **understand** how to synthesis (**create**) polymers with liquid crystalline properties. Also, the students will be able to **understand** applications of such  materials. | | | | | | | **K1 K2 K6** | |
| **CO4** | **Understand** the concept of organic conducting materials. Also, the students will be able to **understand** the synthesis of conducting  polymers and their applications. | | | | | | | **K2** | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CO5** | | **Remember** different degradation methods possible for polymeric materials. Also, able to **understand** the importance of bio degradation and how to prepare bio degradable polymers and how to **analyze** the bio  degradation. | | | | **K1 K2 K4** |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | |
|  | | | | | | |
| **UNIT-1** | | | DENDRIMERS AND HYPERBRANCHED POLYMERS | | **10 hours** | |
| Divergent and convergent synthesis, properties and applications of some common dendrimers. Synthesis, properties and applications of some common hyperbranched  polymers. | | | | | | |
| **UNIT-2** | | | NON-LINEAR OPTICAL AND PHOTONIC POLYMERS | | **10 hours** | |
| Non–linear optical responses – chromophores - poling and characterization. Important  considerations for photonic polymers - temporal stability and applications of photonic polymers. | | | | | | |
| **UNIT-3** | | | LIQUID CRYSTALLINE POLYMERS | | **10 hours** | |
| Classification - criteria for forming liquid crystalline polymers - factors affecting the liquid  crystalline polymers and applications. | | | | | | |
| **UNIT-4** | | | CONDUCTING POLYMERS | | **10 hours** | |
| Conducting mechanisms - requirements for polymer to work as conductor - types of conducting polymers - doping of polymeric systems – polyaniline – polyacetylene -  polyparaphenylene and polypyrrole. | | | | | | |
| **UNIT-5** | | | BIODEGRADABLE POLYMERS | | **10 hours** | |
| Types of biodegradable polymers - chemical degradation - biodegradation and hydrolysis of synthetic biodegradable polymers. | | | | | | |
|  | | | **Total Lecture hours** | **50 hours** | | |
| **Text Book(s) --** | | | | | | |
| **Reference Book(s)** | | | | | | |
| 1 | Photonic polymer systems, D.L.Wise et.al., Marcel Dekker, Inc, NY, 1998. | | | | | |
| 2 | Specialty Polymers, R.W. Dyson, Chapman & Hall, 2nd edition, 1998. | | | | | |
| 3 | Dendrimers and Dendrons, G.R. Newkome, C.N. Moorefield and F. Vogtle, Wiley-  VCH, 2001. | | | | | |
| 4 | Dendrimers and Other Dendritic Polymers, M. J. Fre´chet and Donald A. Tomalia,  John Wiley & Sons Ltd, 2001. | | | | | |
| 5 | Biodegradable Plastics & Polymers, Yoshiharu Doi, Kazuhiko Fukuda (ed.), Elsevier  1994. | | | | | |
| 6 | Conductive Polymers and Plastics, Ed. By James M. Margolis, Chapman and Hall,  NY, 1989. | | | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | | | |
| 1 | <https://www.sciencedirect.com/topics/materials-science/dendrimer> | | | | | |
| 2 | <https://www.sciencedirect.com/topics/materials-science/hyperbranched-polymer> | | | | | |
| 3 | <https://www.sciencedirect.com/topics/engineering/liquid-crystalline-polymer> | | | | | |

|  |  |
| --- | --- |
| 4 | <https://www.sciencedirect.com/topics/materials-science/biodegradable-polymer> |
| 5 | https:/[/www.scienc](http://www.sciencedirect.com/topics/chemistry/nonlinear-optical-material)e[direct.com/topics/chemistry/nonlinear-optical-material.](http://www.sciencedirect.com/topics/chemistry/nonlinear-optical-material) |
| Course Designed By: **All faculty members** | |

**MAPPING**-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | S | L | S | S | M | S | S |
| **CO 2** | S | S | S | S | S | M | M | S | S | S |
| **CO 3** | S | S | S | M | M | S | S | M | M | M |
| **CO 4** | M | S | L | S | S | S | S | S | S | S |
| **CO 5** | S | L | S | L | M | S | L | S | L | L |

# S-Strong M-Medium L-Low

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code:** | | **CHE E 407** | | **APPLIED POLYMER SCIENCE** | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | | | **Core** | | **4** | **0** | **0** | **4** |
| **Pre-requisite** | | | Basic knowledge about the  polymers. | | **Syllabus**  **Version** | |  | |
| **Course Objectives:** | | | | | | | | |
| The main objectives of this course are to:  **CO1.** To make the student to understand the physicochemical properties of polymers.  **CO2.** To acquire knowledge on the use of polymers in adhesive applications.  **CO3.** To uunderstand the knowledge in the physicochemical properties and applications of photonic polymers.  **CO4.** To provide knowledge on the fundamentals and synthesis of liquid crystalline Polymers.  **CO5.** To study properties, classifications and applications of biodegradable and conducting  polymers. | | | | | | | | |
|  | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | |
| **PSO1** | Student will be **understand** the physicochemical properties of  adhesive and their uses. | | | | | | K2 | |
| **PSO2** | Acquired knowledge about **remembering** the non-linear optical and | | | | | | K1 | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | photonic polymers. | | | |  |
| **PSO3** | | Will be **understand** the fundamentals composites, fabrication and their  applications. | | | | K2 |
| **PSO4** | | **Create** knowledge about the properties and types of polymer latex. | | | | K6 |
| **PSO5** | | Student will be **evaluate** the recycling techniques of polymers. | | | | K5 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | |
|  | | | | | | |
| **UNIT:1** | | | **ADHESIVES** | | **7 hours** | |
| The chemistry and physical properties of structural adhesives, pressure sensitive adhesives, rubber based adhesives, contact bond (film) adhesives and hot-melt adhesives | | | | | | |
|  | | | | | | |
| **UNIT:2** | | | **COATINGS** | | **7 hours** | |
| Coating methods, solvent based coatings, role coating, spray coating, high solid coatings, powder coatings, electrodeposition coating, properties and selection | | | | | | |
|  | | | | | | |
| **UNIT:3** | | | **COMPOSITES** | | **7 hours** | |
| Types of composites – types of matrix - polymer-metal and ceramics. Types of reinforcements–glass, carbon and aramide - role of fibre and matrix - constituent and  composite properties – fabrication, application of composites | | | | | | |
|  | | | | | | |
| **UNIT:4** | | | **POLYMER LATEX** | | **7 hours** | |
| Introduction to polymer latex, classification of latex, comparisons and contrasts between polymer latex and polymer solutions, investigation of latex properties. | | | | | | |
| **UNIT:5** | | | **RECYCLING TECHNIQUES** | | **7 hours** | |
| Recycling techniques, size reduction, washing, identification and sorting of plastics, agglomeration, other methods of recycling and waste disposal options, chemical recycling, thermal conversion technologies. | | | | | | |
|  | | | **Total Lecture hours** | | **35 hours** | |
| **Text Book(s)** | | | | | | |
| 1 | Sina Ebnesajjad and Arthur H. Landroc, Adhesives Technology Handbook, Elsevier,  2014. | | | | | |
| 2 | Limin Wu Jamil Baghdachi, Functional Polymer Coatings: Principles, Methods and  Applications, John Wiley & Sons, Inc., 2015. | | | | | |
| 3 | Dr. Sabu Thomas and Dr. Joseph Kuruvilla, Polymer Composites, Wiley VCH, 2012. | | | | | |
| 4 | Vikas Mittal, Advances in Polymer Latex Technology, Nova Science Publishers, Inc.  UK, 2012. | | | | | |
| 5 | Ernst Worrell Markus Reuter, Handbook of Recycling 1st Edition, 2004. | | | | | |
|  | | | | | | |
| **Reference Book(s)** | | | | | | |
| 1. | Roy W. TessGary W. Poehlein , Applied Polymer Science, | | | American Chemical | | |
| Society, Volume 285, . | | | | | |

|  |  |
| --- | --- |
| 2. | Clara D. Craver and Charles E. Carraher, Jr, Applied Polymer Science: 21st Century,  1st Edition, Elsevier Science, 2000. |
| 3. | Raju Francis, Recycling of Polymers: Methods, Characterization and Applications, Wiley‐VCH Verlag GmbH & Co. KGaA, 2016. |
|  | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
| 1 | https://app.knovel.com/web/toc.v/cid:kpRPMCA001/viewerType:toc/ |
| 2 | https://onlinecourses.nptel.ac.in/noc20\_me29/preview |
| 3 | https://adhesives.specialchem.com/online-courses |
|  |  |

**MAPPING**-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | M | S | M | S | M | S | S | M | M | S |
| **CO 2** | S | M | S | S | S | S | M | S | S | S |
| **CO 3** | S | S | S | M | S | M | S | M | S | M |
| **CO 4** | L | S | L | S | L | S | S | S | L | S |
| **CO 5** | S | L | S | L | S | L | L | S | S | L |

# S-Strong M-Medium L-Low

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | | **UOM S121** | | **Excel & Origin Software for Chemist** | **L** | **T** | | **P** | **C** |
| **Core/Elective/Supporti ve** | | | **Supportive** | | **0** | **0** | | **2** | **2** |
| **Pre-requisite** | | | Knowledge in basic computer operating. | | **Syllabu s Version** | | **2020**  **-** | | |
| **Course Objectives:** | | | | | | | | | |
| CO1. The aim of this course is to urge students to understand and study Excel & Origin software. | | | | | | | | | |
|  | | | | | | | | | |
| **Expected Course Outcomes:** | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | |
| **PSO 1** | **Understand** the use of Excel & Origin software for chemistry. | | | | | | | K1 | |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **PSO 2** | | | **Apply** the Excel & Origin software for drawing graphs in physical chemistry data’s. | | | | K2 |
| **PSO 3** | | | **Analyze** the data using single, multiple, 2D, 3D and contour plots. | | | | K3 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | |
|  | | | | | | | |
| **Unit:1** | | | | **EXCEL & ORIGIN SOFTWARE FOR CHEMIST** | | **35 hours** | |
| Basic, drawing of single, multiple, 2D, 3D and contour plots. | | | | | | | |
|  | | | | | | | |
|  | | | | **Total Lecture hours** | **35 hours** | | |
| **Text Book(s)** | | | | | | | |
| 1 | | Greg Harvey. 1994. Excel For Dummies. Wiley. | | | | | |
| 1 | | OriginLab Corporation, 2002. Origin: Scientific Graphing and Analysis Software. | | | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | | | | |
| 1 | Nil | | | | | | |

**MAPPING**-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PS O** | **PS O 1** | **PS O 2** | **PS O 3** | **PS O 4** | **PS O 5** | **PS O 6** | **PS O 7** | **PS O 8** | **PS O 9** | **PS O 10** |
| **CO 1** | S | M | M | S | L | S | S | M | S | S |
| **CO 2** | S | S | S | S | S | M | M | S | S | S |
| **CO 2** | S | S | S | S | S | M | M | S | S | S |

**S-Strong M-Medium L-Low**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code** | **UOM S122** | | **POLYMER TESTING AND CHARACTERISATION** | **L** | **T** | | **P** | **C** |
| **Core/Elective/Supporti ve** | | **Supportive** | | **0** | **0** | | **2** | **2** |
| **Pre-requisite** | | Basic knowledge in polymer testing. | | **Syllabu s Version** | | **2020**  **-** | | |
| **Course Objectives:** | | | | | | | | |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| CO1. To understand different types of polymer characterization. | | | | | | | |
| CO2. To study the physical, mechanical, thermal, optical and electrical properties of polymers. | | | | | | | |
| **Expected Course Outcomes:** | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | |
| **PSO 1** | | | **Understand** the polymer testing and characterization for new polymeric materials. | | | | K1 |
| **PSO 2** | | | **Evaluate** the use of polymeric characterization and understand how polymeric materials behave in practical applications | | | | K6 |
| **PSO 3** | | | **Analyze** the physical, mechanical, thermal, optical and electrical properties of polymers | | | | K3 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create | | | | | | | |
|  | | | | | | | |
| **Unit:1** | | | | **EXCEL & ORIGIN SOFTWARE FOR CHEMIST** | | **35 hours** | |
| Basic, drawing of single, multiple, 2D, 3D and contour plots. | | | | | | | |
|  | | | | | | | |
|  | | | | **Total Lecture hours** | **35 hours** | | |
| **Text Book(s)** | | | | | | | |
| 1 | | Greg Harvey. 1994. Excel For Dummies. Wiley. | | | | | |
| 1 | | OriginLab Corporation, 2002. Origin: Scientific Graphing and Analysis Software. | | | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | | | | |
| 1 | Nil | | | | | | |

**MAPPING**-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/ PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | S | L | S | S | M | S | S |
| **CO 2** | S | S | S | S | S | M | M | S | S | S |
| **CO 2** | S | S | S | S | S | M | M | S | S | S |

**S-Strong M-Medium L-Low**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course code:** | | | **UOM S124** | | | CHEMWINDOW SOFTWARE | **L** | **T** | **P** | **C** |
| **Core/Elective/Supportive** | | | | | **SOFT SKILL** | | **0** | **0** | **2** | **2** |
| **Pre-requisite** | | | | | Knowledge in basic chemistry and chemical structures of  compounds. | |  | |  | |
| **Course Objectives:** | | | | | | | | | | |
| Objective of this course is to motivate and to give hands-on training to the students to learn Chemwindow softw*ar*e a chemist must know. | | | | | | | | | | |
| **Programme Specific Outcomes:** | | | | | | | | | | |
| On the successful completion of the course, student will be able to: | | | | | | | | | | |
| **CO1** | | **Understand** the software. | | | | | | | K2 | |
| **CO2** | | **Apply** their knowledge and able to draw (**create**) structures of common monomers and polymers. Also, the students will be able to  draw (**create**) some complex structures of highly branched polymers. | | | | | | | K3 K6 | |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create | | | | | | | | | | |
|  | | | | | | | | | | |
| **UNIT:1** | | | | Basics of the Chemwindow software. | | | | **10 hours** | | |
| **UNIT:2** | | | | Drawing of linear, branched and highly branched  aliphatic and aromatic structures of common polymers. | | | | **25 hours** | | |
| **Total Lecture hours** | | | | | | | | **35 hours** | | |
| **Text Book(s)** | | | | | | | | | | |
| 1 | NIL | | | | | | | | | |
| **Reference Book(s)** | | | | | | | | | | |
| 1. | Chemdraw version 12.0. | | | | | | | | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | | | | | | | | |
| 1 | NIL | | | | | | | | | |

**MAPPING**-COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PSO 8** | **PSO 9** | **PSO 10** |
| **CO 1** | S | M | M | S | L | S | S | M | S | S |
| **CO 2** | S | S | S | S | S | M | M | S | S | S |

# S-Strong M-Medium L-Low

**UOM I001 Internship – Industrial training**

# M. Sc. Internship Objectives

* Getting familiar with the practical working condition in a specific chemical industry. This concerns the future working situation in industry.
* Getting familiar with the working of the organisation at which the internship is done.
* Applying the knowledge and skills gained during the studies; Getting insight into chemical industryand its problems.
* Carrying out a project under industry and collaborate with different projects.

# M. Sc. Internship Opportunities

* M. Sc. offers rewarding internship opportunities for students.
* Internships provide the chance to gain expressive professional experience while working on projects.
* You will develop your knowledge by working side by side with our internal experts.
* All of our internships are paid positions and relocation and housing support may be available in certain cases.
* Working as an M. Sc., intern is a great first step in making a decision to come to work for

M. Sc., after you finish your educational program.