

Ph.D Programme in Chemistry

Syllabus
2022-2023



DEPARTMENT OF CHEMISTRY
FACULTY OF ARTS, SCIENCE, COMMERCE AND MANAGEMENT

KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University)
(Established under section 3 of UGC Act, 1956)
(Accredited with A+ Grade by NAAC in the Second Cycle)
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DEPARTMENT OF CHEMISTRY
FACULTY OF ARTS, SCIENCE AND HUMANITIES
RESEARCH PROGRAM – Ph.D in Chemistry
(2021–2022 Batch and onwards)

Course Code	Name of the Course	Instruction hours / week	Credits	Maximum Marks (100)
22RCH101	Paper-I: Research Methodology and Pedagogy	4	4	100
22RCH201	Paper-II: Research Publication Ethics	4	4	100
22RCH301	Paper III: Special Paper I – Organic Chemistry	4	4	100
22RCH302	Paper-III: Special Paper II- Nanochemistry			
22RCH303	Paper-III: Special Paper III- Electrochemistry			
22RCH304	Paper-III: Special Paper IV- Environmental Chemistry			
22RCH305	Paper-III: Special Paper V- Organometallic Chemistry of Transition Metals			
22RCH306	Paper- III: Special Paper VI: Polymer Chemistry			
Program Total				

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Part I –Ph.D., CHEMISTRY

22RCH101

Paper-I: Research Methodology and Pedagogy (Effective from the academic year 2021-2022 and onwards)

UNIT I

Research Methodology - Objectives of Research - Types of Research - Criteria for good Research . Defining the Research Problem - Research Design. Dissertation writing- Guidelines for review of literature - Materials and methods, results and discussion. Interpretation of results, presentation of results, summary, presentation of references and appendix.

Use of Computers in Research – Data base Operations like creation – updating – indexing/sorting and searching of data, data entries and analysis, graphical applications.

UNIT II

Data Analysis:

Errors in chemical analysis - classification of errors – determination of accuracy of methods - improving accuracy of analysis - significant figures - mean, standard deviation-comparison of results : “t” test, “f” test, and “chi” square test – rejection of results-presentation of data.

Sampling – introduction – definitions - theory of sampling-techniques of sampling - statistical criteria of good sampling and required size - stratified sampling vs random sampling – minimisation of variance in stratified sampling – transmission and storage of samples.

UNIT III

Definition of problem: Necessity of defining problem, Technique involved in defining a problem. Surveying the available literature. Building up of own literature collection, citation techniques.

Research Design: Subject of study; Place of study; Reason of such study; Type of data required; Method of data collection; Periods of study; Style of data presentation.

Developing a research plan: Research objective; Information’s required for solving the problem; Different methods used to solve a problem.

Publication of Journal Articles: Concept, types of journals, components of a journal article, preparation of the manuscript, from manuscript to publication and online submission.

Submission of Research Proposals: Leading funding agencies in India, Submission of research project proposals with prescribed formats.

UNIT IV

Flame emission and atomic absorption spectroscopy and Fluorometric Analysis:

Types of atomic spectroscopy – emission methods - absorption methods - fluorescence methods - applications of atomic emission spectroscopy – flames and flame spectra.

Fluorescence and phosphorescence –application of fluorometric analysis.

HPLC and Gas Chromatography:

Theory of chromatography - detectors - Application of gas/mass analysis. Principles of high performance liquid chromatography - gradient elution, isocratic elution, sampling detectors for liquid chromatography - quantitative analysis by HPLC.

UNIT V**Pedagogical Methods in Higher Education:**

Objectives and roll of higher education – Important characteristics of an effective Lecture – Quality teaching and learning – Lecture preparation – Characteristics of instructional design – Methods of teaching and learning : Large group – Technique – Lecture, Seminar, Symposium, Team Teaching, Project, Small group Technique – Simulation, role playing Demonstration, Brain storing, case discussion, and assignment, Methods of evaluation – Self evaluation, student evaluation, Diagnostic testing and remedial teaching – Question banking – Electronic media in education: - ‘e’ learning researches – web based learning

References:

1. J. D. Dick, (1973). Analytical chemistry. McGraw Hill, N.Y. also available in International students edition McGraw Hill, Mogakusha.
2. J.Dyer, (1965), Applications of absorption spectroscopy of organic compounds. Prentice-Hall, Englewood Cliffs, N.J
3. S.M Khopkar,(1998), Basic concepts of analytical chemistry, New Age International, New Delhi
4. B. K. Sharma.(2000),Instrumental methods of chemical analysis, Krishna Prakashan Media, 2000
5. Skoog.D.A and M. West.(2006), Principles of instrumental analysis, Brookes Cole Publishers, Calefornia
6. Willard.H, L. Merrit Jr and A. Dean., Instrumental methods of analysis
16. Vedanayagam, E.G (1989) Teaching Technology for college teachers. New Delhi: Sterling Publishers (P) Ltd.,
17. Rajasekar.S (2005) Computer Education and educational computing. Hyderabad: Neelkamal Publications.
18. Kumar K.L. (1997) Educational Technologies, New Delhi: New age International.

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Part I – Ph.D.,
CHEMISTRY

22RCH201

Paper-II: Research Publication Ethics

(Effective from the academic year 2021-2022 and onwards)

UNIT I

Philosophy and Ethics:

Introduction to Philosophy: Definition, nature and scope, concept, branches - Ethics: Definition, moral philosophy, nature of moral judgments and reactions.

UNIT II

Scientific Conduct:

Ethics with respect to science and research – Intellectual honesty and research integrity – Scientific misconduct: Falsification – Fabrication and Plagiarism (FFP) - Redundant publications: duplicate and overlapping publications – salami slicing - Selective reporting and misrepresentation of date.

UNIT III

Publication Ethics:

Publication Ethics: Definition, introduction and importance - Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. - Conflicts of interest - Publication Misconduct: definition, concept, problems that lead to unethical behavior and vice versa, type - Violation of publication ethics, authorship and contributor ship - Identification of publication misconduct, complaints and appeals - Predatory publishers and journals.

UNIT IV

Publication Misconduct:

Group Discussions: Subject specific ethical issues, FFP, authorship - Conflicts of interest - Complaints and appeals: examples and fraud from India and abroad.

Software tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools

UNIT V

Databases and Research Metrics:

Database : Indexing database - Citation database: Web of Science, Scopus, etc

Research Metrics: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score - Metrics: h-index, g index, i10 index, altmetrics.

UNIT VI

Development of e-content & IP:

Integrated Library Management System (ILMS) : e-journals – e-books – e-shodhsindu – shodhganga – Database - e-content Development - Learning Management System (LMS) – e-PG-Pathshala – CEC (UG) SWAYAM – MOOCs – NPTEL - NMEICT.

IPR: Patent – Copyrights - Trademark – Geographical Indication.

PRACTICE

Open Access Publishing:

Open access publications and initiatives - SHERPA / RoMEO online resource to check publisher copyright & self-archiving policies - Software tool to identify predatory publications developed by SPPU - Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

References:

1. P. Oliver, (2003), The student's guide to research ethics, Open University Press Maidenhead, Philadelphia.
2. H. Zwart, (2010), Tales of Research Misconduct, Springer International Publishing AG.
3. Research Impact, <https://guides.osu.edu/c.php?g=608754&p=4224917>.
4. Diane Elkins et al. (2015). E-Learning Fundamentals: A Practical Guide.
5. Nick Rushby et al. Wiley Handbook of Learning Technology. Wiley Education. Wiley

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Part I– Ph.D., CHEMISTRY

22RCH301

Paper III: Special Paper I – Organic Chemistry

(Effective from the academic year 2021-2022 and onwards)

UNIT I

Theory of Concerted Reactions:

Definitions - molecular orbitals – frontier orbitals – frontier orbital approach – correlation diagrams – the aromatic transition state concept – general rule for pericyclic reactions.

Electrocyclic Reactions:

Definition – thermal electrocyclic reactions – photochemical electrocyclic reactions – metal catalysed electrocyclic reactions.

Cycloadditions:

Introduction – selection rules for thermal polyene cyclo additions – Diels – Alder reaction – The retro diels – alder reaction – 1,3 Dipolar cycloadditions – Retro 1,3 – dipolar additions.

UNIT II

Modern reagents in Organic synthesis:

Sodium cyanoborohydride – osmium tetraoxide – lithium dimethyl copper – thallium trifluoro acetate – sodium hydrogen telluride – silver hexa fluorantimonate – Thiobenzoyl chloride – trichloro silane- vanadium oxytrifluoro – phosphonitrile chloride – ruthenium tetraoxide – barium magnaganate – benzene selenic acid – benzene selenyl bromide/chloride, aluminium chloride/phosphoryl chloride.

UNIT III

Stereochemistry, Conformational Analysis & Retrosynthetic analysis:

Stereoselective, stereospecific and regiospecific reactions – stereoselectivity in carbonyl addition- Cram's rule – configuration – conformation – torsional strain – Vander waals strain – gauche interaction – allylic strain – conformation analysis of acyclic molecules.

Retrosynthetic Analysis of Simple Organic compounds:

Retrosynthetic analysis of mono & difunctional open chain target molecules and monocyclic target molecules.

UNIT IV

Chromatography: Theory, Instrumentation & application in the chemical analysis of column, paper, thinlayer, ion-exchange, Gas chromatography (GC) and High Pressure Liquid Chromatography (HPLC).

Natural products:

Extraction, Isolation and structural elucidation (using spectroscopic methods) of terpenes, steroids, alkaloids and phenolic compounds.

UNIT V

Problem solving:

Solving the structure of simple organic molecules on the basis of UV, IR, NMR & Mass spectral data. (restricted to organic compound compounds having 12 carbon atoms).

References:

1. Agarwal O.P, (2004). Natural Product Chemistry, Vol. I, Goel Publishing House, Meerut
2. Agarwal O.P, (2004). Natural Product Chemistry, Vol. II, Goel Publishing House, Meerut
3. Mackie R.K. and D.M.Smith, 1982. " Guide book to Organic Synthesis", ELBS,
4. Reagents for Organic synthesis – Feiser & Feiser Vols. I – XII.
5. Silverstein and Webster, 1998. "Spectrometric Identification of Organic Compounds", 6thEd., Wiley
6. Skoog D.A.and D.M.West, (2004).Fundamentals of Analytical Chemistry, 8th Edition, Thomson book store, Singapore
7. Usharani S., (2002). Analytical Chemistry, Mac Millan India Ltd., Chennai

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Part I– Ph.D.,

22RCH302

CHEMISTRY

Paper-III: Special Paper II-Nanochemistry

(Effective from the academic year 2021-2022 and onwards)

UNIT I

Size and Shape of Nanomaterials:

Introduction to nanomaterials, Properties of materials & nanomaterials, role of size in nanomaterials, nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, quantum wells, conductivity and enhanced catalytic activity compared to the same materials in the macroscopic state.

UNIT II

Chemical Routes for Synthesis of Nanomaterials:

Chemical precipitation and co-precipitation; Metal nanocrystals by reduction, Sol-gel synthesis; Microemulsions or reverse micelles, melle formation; Solvothermal synthesis; Thermolysis routes, Microwave heating synthesis; Sonochemical synthesis; Electrochemical synthesis; Photochemical synthesis, Synthesis in supercritical fluids.

UNIT III

Nanostructures:

Zero-, One-, Two- and Three- dimensional structure, Size control of metal Nanoparticles and their properties: Optical, Electronic, Magnetic properties; Surface plasmon Resonance, Change of bandgap; Application: catalysis, electronic devices.

UNIT IV

Structural Characterization:

X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM).

UNIT V

Carbon nanostructures:

Introduction. Fullerenes, C60, C80 and C240 nanostructures. Properties & applications (mechanical, optical and electrical). Functionalization of carbon nanotubes, reactivity of carbon nanotubes. Nanosensors: Temperature sensors, smoke sensors, sensors for aerospace and defence. Accelerometer, pressure sensor, night vision system, nano tweezers, nano-cutting tools, integration of sensor with actuators and electronic circuitry biosensors.

References:

- 1.T. Pradeep, (2007). Nano: The Essentials, Tata McGraw-Hill, New Delhi.
2. G. Cao, (2004). Nanostructures and Nanomaterials – Synthesis, Properties and Applications, Imperial College Press, London.

3. C. N. R. Rao, A. Muller and A. K. Cheetham, (2004). The Chemistry of Nanomaterials, Volume 1, Wiley –VCH Verlag GmbH & Co. KgaA, Weinheim.
4. G. A. Ozin, A. C. Aresnault, and L. Cadematriri, (2008). Nanochemistry: A chemical approach to nanomaterials, RSC Publishing.
5. Ray F. Egerton, (2005). Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AFM, Springer Publishing.

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CHEMISTRY

Paper-III: Special Paper III-Electrochemistry

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UNIT I

Introduction and Principles:

Definition –Cost of corrosion-importance of corrosion studies-classification of corrosion-expressions for corrosion rate. Electrochemical principles of corrosion : Faraday's laws –Types of electrochemical cells formed in corrosion process. thermodynamic principles of corrosion : Electrochemical series/ standard electrode potentials and thermodynamic corrosion theory-Galvanic series of metals and alloys and limitations.

Forms of corrosion (Definition –cause and effects): Galvanic –Crevice –Pitting -Intergranular – Selective leaching –Erosion-Stress-Hydrogen damage.

UNIT II

Kinetics of Corrosion:

Importance –Graphical presentation of kinetic data –exchange current density –different types of polarization of electrodes.Activation polarization and Tafel plots –Mixed potential theory – Application of electrode kinetics to experimental observations-Faradic impedance and corrosion.

UNIT III

Kinetics of Passivity:

Introduction-electrochemical behaviour of active/passive metals-Flade potentials-criteria for selecting a metal exhibiting passivity-effects of various factors on electrochemical behaviour and corrosion rate of metal exhibiting passivity-measured versus theoretical anodic polarization behaviour-Theories of passivity.

UNIT IV

Monitoring of Corrosion:

Determination of corrosion and corrosion inhibition parameters-Non-electrochemical methods:Coupon-Electrical resistance-Gasometric methods:Electrochemical methods: Polarisation-Galvanostatic-Potentiostatic –Potentiodynamic-AC impedance-Hydrogen permeation.

UNIT V

Corrosion control:

Metals and alloys-metal purification-non metallic-cathodic and anodic protection – comparison.Alteration of environment : Changing the medium –use of inhibitors-classification of inhibitors –mechanism of inhibition-Coating (Elementary ideas only).

References:

1. Herbert H.Uhlig and Winston Review. R. (1984). Corrosion and Corrosion control (An introduction to corrosion science and engineering) ,Third Edition, A Wiley Interscience Publication, New York.
2. Mars Fontana G. (1984).Corrosion Engineering, Third Edition, Mc.Graw Hill Book Company, Singapore.
3. Mercer A.D. (1985).Test methods for corrosion inhibitors , J. Corr.Science,85.
4. Raj Narayan.P. (1983).An introduction to metallic corrosion and its prevention ,Oxford and IBH Publishing C., New Delhi.
5. Schmitt G. (1984). Application of inhibitors for acid media ,Corros.J, 73.

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Part I– Ph.D.,
CHEMISTRY

22RCH304

Paper-III: Special Paper IV-Environmental Chemistry

(Effective from the academic year 2021-2022 and onwards)

UNIT I

Chemistry of Water and Waste water:

Basic principles and their significance with special reference to colour, turbidity, alkalinity, acidity, chemical coagulation, hardness, water softening, disinfection, residual chlorine and chlorine demand, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, nitrogen, phosphate, sulphate, gas analysis, enzymes, factors affecting enzyme activity, biochemistry of carbohydrates, proteins, fats and oils under aerobic and anaerobic conditions, detergents and their degradation, composition and characteristics of sewage.

UNIT II

Chemistry of air pollutants-I:

Introduction, definition, classification of air pollutants, effect of air pollutants on man, materials, animals and plants, ambient air quality standards, harmful concentrations, geographical and meteorological factors in air pollution control, measurement of gas flows, volume, quantity and velocity.

UNIT III

Chemistry of air pollutants-II:

Methods of sampling, particulate collection by liquid scrubbing, centrifugal spray scrubbers, venturi scrubbers, foam scrubbers; field sampling techniques such as deposition, absorption, filtration, condensation, adsorption, adhesion, electrostatic precipitation, thermal precipitation, analysis of air pollutants such as particulates sulphur dioxide, carbon monoxide, oxides of nitrogen, hydrogen sulphide, etc., control measures.

UNIT IV

Chemistry of solid wastes:

Chemistry of composting: mechanism involved in the decomposition of organic materials like hemicellulose, proteins, carbohydrates, food materials, organic insecticides, farm wastes, etc., by aerobic and anaerobic processes.

UNIT V

Chemistry of Incineration and Pyrolysis:

Incineration; definition; Incineration of solid waste; combustion characteristics of various inorganic and organic materials; heating values-determination of heating values of combustible liquid and solid wastes; air requirement for combustion; fate of trace constituents such as sulphur during incineration; gaseous pollutants; definition of pyrolysis; chemical changes taking place in organic and inorganic materials during pyrolysis; importance of pyrolysis in the solid waste

disposal; chemistry of recycling of solid waste; recycling and reuse of materials such as paper, plastic, glass, etc.

References:

1. American Public Health Association Inc., New York, (1976). Standard methods for the examination of water and waste water.
2. Hagerty, D.J., J.L. Pavoni and J.E. Heer, (1973). Jr., Solid waste management, Van Nostrand Reinhold Co., New York.
3. Jacobs, M.B., (1960). Chemical analysis of Air pollutants, Interscience, New York.
4. Leithe, W. (1971). Translated by R. Kenor, The analysis of air pollutants, Ann Arbor.
5. Ross, R.D., (1972). Air pollution and Industry, Van Nostrand Reinhold Co., New York.
6. Sawyer, C.N. and P.L. McCarty, (1978). Chemistry of Environmental Engineers, McGraw Hill Publishers.
7. Stern, A.C., Ed., (1968). Air pollution, Vol. 1, 2 and 3, Academic Press, New York.
8. Strauss, W. Ed., (1978). Air pollution control, part 1, 2 and 3, Wiley Interscience, New York.
9. Stumm, W. and J.J. Morgan, (1972). Aquatic Chemistry, Wiley Interscience.
10. Wilson, D.G., (1977). Hand book of solid waste management, Van Nostrand Reinhold Co., New York.

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Part I– Ph.D.,
CHEMISTRY

22RCH305

Paper-III: Special Paper V- Organometallic Chemistry of Transition Metals

(Effective from the academic year 2021-2022 and onwards)

UNIT I

Definition of organometallic compound – 18 electron rule – effective atomic number rule – classification of organometallic compounds – the metal carbon bond types – ionic bond – sigma covalent bond – electron deficient bond – delocalised bond – dative bond – metal carbonyl complexes – synthesis, structure and reactions of metalcarbonyls – the nature of M-CO bonding – binding mode of CO and IR spectra of metal carbonyls – metal carbonyls – metal carbonyl anions – metal carbonyl hydrides– metal carbonyl halides – metal carbonyl clusters – Wades rule and isolobalrelationship – metal nitrosyls – dinitrogen complexes – dioxygen complexes.

UNIT II

Metal alkyl complexes – stability and structure – synthesis by alkylation of metal halides, by oxidative addition, by nucleophilic attack on coordinated ligands – metal alkyl and 18 electron rule – reactivity of metal alkyls – M-C bond cleavage reactions– insertion of CO to M-C bonds – double carbonylation – insertions of alkenes andalkynes – insertions of metals with C-H bonds – alkyldiene and alkyldiyne complexes– synthesis of alkyldiene complexes in low oxidation states and in high oxidationstates – bonding in alkyldiene complexes – synthesis and bonding in alkyldiynecomplexes – reactivity of alkyldiene and alkyldiyne complexes.

Alkene complexes – synthesis of alkene complexes by ligand substitution, by reduction and by metal atom synthesis – bonding of alkenes to transition metals –bonding in diene complexes – reactivity of alkene complexes – ligand substitution –reactions with nucleophiles – olefin hydrogenation – hydrosilation – Wacker process– C-H activation of alkenes – alkyne complexes – bonding in alkyne complexes –reactivity of alkynes – alkyne complexes in synthesis – cobalt catalysed alkyne cycloaddition.

UNIT III

Cyclopentadienyl complexes – metallocenes – synthesis of metallocenes – bonding in metallocenes – reactions of metallocenes – CpFe/Cp₂Fe⁺ couples in biosensors – bent sandwich complexes – bonding in bent sandwich complexes – metallocene halides and hydrides – metallocene and stereospecific polymerization of 1-alkenes –cyclopentadiene as a non-spectator ligand – monocyclopentadienyl (half-sandwich) complexes – synthesis and structures of allyl complexes – arene complexes –synthesis, structure and reactivity of arene complexes – multidecker complexes.

UNIT IV

Role of organometallic chemistry in catalysis

Coordinative unsaturation – oxidative addition – addition reactions of specific molecules – hydrogen addition – HX addition – addition of X₂ – addition of RX – addition reactions of Si-H, C-C, C-Si and Si-Si bonds – elimination reactions – β and α eliminations – alkane activation – intramolecular and intermolecular C-H activation – activation of sulphur heterocycles – insertion of carbon monoxide – isocyanide insertion – alkene insertion – alkyne insertion.

UNIT V

Homogeneous catalysis by transition metal complexes

Hydrogenation reactions – reversible cis-dihydro catalysts – monohydride catalysts – hydrogenation of alk-1-ene – asymmetric hydrogenation – role of ruthenium complexes in 2001 Nobel Prize for chemistry – transfer hydrogenations – hydrosilation and hydroboration reactions – water gas shift reaction – reduction of carbon monoxide by hydrogen – hydroformylation of alkenes – alcohol carbonylation – decarbonylation reactions – C-C cross coupling and related reactions – alkene oligomerisations and polymerizations – Zeigler-Natta polymerization – alkene dimerisation and oligomerisations – valence isomerisation of strained hydrocarbons – alkene and alkyne metathesis – oxidations of alkanes and alkenes – oxygen transfer reactions – supported homogeneous and phase transfer catalysis.

References:

1. Bockmann.M,(1996),Organometallics 1, complexes with transition metal-carbon bonds, Oxford science publications, Oxford.
2. Bockmann.M,(1996),Organometallics 2, complexes with transition metal-carbon bonds, Oxford science publications, Oxford.
3. Cotton.F.A, G. Wilkinson, C. A.Murillo and M. Bochmann, (1999).Advanced Inorganic Chemistry, Sixth Edition, John Wiley and sons, Inc, New York.
4. Haiduc.I and J. J. Zuckerman, Walter de Gruyter,Brelin, (1985).Basic organometallic chemistry.
5. Huheey.E, Harpe(1978). Inorganic chemistry – Principles of structure and reactivity, JInternational Edition, Harper and Rone, New York.
6. Huheey J.E, E.A.Keiterand R.L. Keiter, (2000). Inorganic chemistry – Principles of structure and reactivity, Addison-Wesley Publishing Company,New York.

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Part I – Ph.D.,

22RCH306

CHEMISTRY

Paper- III: Special Paper VI: Polymer Chemistry

(Effective from the academic year 2021-2022 and onwards)

UNIT I

Chemistry of Polymerization:

Addition polymerization – Free radical polymerization – Initiation, Propagation and termination – inhibitors and retarders. Ionic polymerization – cationic and anionic-Living polymers. Coordination polymerization – Zeigler – Natta catalysts. Condensation polymerization – Extend of reaction and DP – Carother's equation and its significance. Three dimensional polymerization – cross linking – gel point – Ring scission polymerization.

UNIT II

Kinetics of Polymerization:

Kinetics of free-radical polymerization- Kinetic chain length and DP. Derivation for rate expression and expression for kinetic chain length and hence degree of polymerization. Kinetics of polycondensation with polyester as example. Simple kinetic expression – catalyzed and uncatalyzed polycondensation.

UNIT III

Techniques of Polymerization:

Bulk polymerization – solution polymerization – Suspension polymerization – Emulsion polymerization – Advantages and disadvantages of these techniques – comparison of the above.

UNIT IV

Characterization of Polymers:

Molecular weight determination – Method based on colligative property measurements – cryoscopy – ebullioscopy – osmometry – membrane osmometry- vapour –pressure osmometry – Methods based on viscosity. Measurements – viscometry –Light scattering method – ultracentrifuge technique- End group analysis – GPC method. Thermal methods of analysis in polymers – TGA, DTA, DSC.

UNIT V

Polymer structure and Physical Properties:

Crystalline melting point, Glass transition temperature – Properties involving deformations.

References:

1. Billmeyer, F.W. (1984) A Text Book of Polymer Science, Wiley – Interscience Publication
2. Gowariker V.R Viswanathan. N.V Sreedhar. J (1986) Polymer Science, New Age International (P) Ltd Publishers
3. Odian G. (2004) Principles of Polymerization, Wiley Interscience Publications
4. Cowie J.M.G. (1991) Polymers: Chemistry & Physics of Modern Materials, 2nd ed. Chapman & Hall
5. Arora. M.G Singh M., Yadav M.S (1994) Polymer Chemistry, Anmol Publishers Pvt. Ltd.,