**UNIVERSITY DEPARTMENTS**

**ANNA UNIVERSITY :CHENNAI 600 025**

**CBCS-REGULATIONS-2015**

**M.TECH. POLYMER SCIENCE AND ENGINEERING**

## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. To provide an interdisciplinary specialization in master degree with emphasis on materials, engineering and fundamentals of polymers and their processing.
II. To produce employable graduates with knowledge and competency in scientific and engineering aspects of polymers, complemented by the appropriate skills and attributes.
III. To impart the fundamental concepts of synthetic resins, composites, engineering plastics, adhesives and conducting polymers and their applications in industries.
IV. To gain knowledge on biopolymers, specialty polymers/rubbers and fibers in engineering applications.
V. To provide comprehensive knowledge on heat and mass transport processes, analytical testing of polymers and plastic waste management.

## PROGRAMME OUTCOMES (POs)

1. In-depth and detailed functional knowledge of the fundamental concepts and experimental methods of science and engineering.
2. To apply and integrate knowledge from four elements i.e., polymer structure, properties, process and performance to solve the industrial problems and also to develop an entrepreneur skill.
3. Knowledge of the topics of inter-disciplinary research, problem identification, formulation and solution in polymer technology.
4. To use the techniques, skills, and modern engineering tools necessary for engineering practice to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
5. Professionally skilled for higher studies in research institutions and to work in polymer industries.

| Programme Educational Objectives (PEOs) | Programme Outcomes (POs) | | | | |
|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 |
| I | ✓ | | ✓ | | |
| II | | | | ✓ | ✓ |
| III | | ✓ | | ✓ | ✓ |
| IV | | | | | ✓ |
| V | | | ✓ | ✓ | |



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| | | | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|---|---|
| YEAR 1 | SEM 1 | Polymer Chemistry | √ | | √ | √ | |
| | | Polymer Process Engineering | √ | √ | √ | √ | |
| | | Science of Polymeric Materials | | √ | √ | √ | |
| | | Synthetic Resins | √ | √ | √ | | |
| | | Elective I | √ | √ | √ | √ | |
| | | Elective II | √ | | √ | √ | |
| | | Polymer Science Laboratory (Practicals) | √ | √ | √ | √ | √ |
| | SEM 2 | Characterization and Testing of Polymers | | √ | √ | √ | |
| | | Instrumentation in Polymer Industry | | √ | √ | √ | √ |
| | | Polymer Process Technology | | √ | √ | √ | √ |
| | | Heat, Mass and Momentum Transport Processes | √ | √ | √ | √ | |
| | | Elective III | √ | √ | √ | | |
| | | Elective IV | √ | √ | √ | | |
| | | Polymer Processing and Testing Laboratory (Practicals) | √ | √ | √ | √ | √ |
| | | Seminar | | √ | √ | √ | √ |
| YEAR 2 | SEM 3 | Engineering Plastics | √ | √ | √ | √ | √ |
| | | Elective V | √ | | √ | √ | √ |
| | | Elective VI | | √ | √ | √ | |
| | | Elective VII | | √ | √ | √ | |
| | | Industrial Training (4 weeks) | | √ | √ | √ | √ |
| | | Project work (Phase I) | √ | √ | √ | √ | √ |
| | SEM 4 | Project Work Phase II | √ | √ | √ | √ | √ |



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**REGULATIONS-2015**

**CHOICE BASED CREDIT SYSTEM**

**I – IV SEMESTER CURRICULUM AND SYLLABUS**

**M.TECH. POLYMER SCIENCE AND ENGINEERING**

## SEMESTER I

| SL. NO. | COURSE CODE | COURSE TITLE | Category | Contact Period | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | PL7101 | Polymer Chemistry | FC | 3 | 3 | 0 | 0 | 3 |
| 2. | PL7102 | Polymer Process Engineering | FC | 3 | 3 | 0 | 0 | 3 |
| 3. | PL7103 | Science of Polymeric Materials | FC | 3 | 3 | 0 | 0 | 3 |
| 4. | PL7104 | Synthetic Resins | FC | 3 | 3 | 0 | 0 | 3 |
| 5. | | Elective I | PE | 3 | 3 | 0 | 0 | 3 |
| 6. | | Elective II | PE | 3 | 3 | 0 | 0 | 3 |
| **LABORATORY** | | | | | | | | |
| 7. | PL7111 | Polymer Science Laboratory | FC | 4 | 0 | 0 | 4 | 2 |
| | | | **TOTAL** | **22** | **18** | **0** | **4** | **20** |

## SEMESTER II

| SL. NO. | COURSE CODE | COURSE TITLE | Category | Contact Period | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | PL7201 | Characterization and Testing of Polymers | PC | 3 | 3 | 0 | 0 | 3 |
| 2. | PL7202 | Heat, Mass and Momentum Transport Processes | PC | 3 | 3 | 0 | 0 | 3 |
| | PL7203 | Instrumentation in Polymer Industry | PC | 3 | 3 | 0 | 0 | 3 |
| 3. | PL7204 | Polymer Process Technology | PC | 3 | 3 | 0 | 0 | 3 |
| 5. | | Elective III | PE | 3 | 3 | 0 | 0 | 3 |
| 6. | | Elective IV | PE | 3 | 3 | 0 | 0 | 3 |
| **LABORATORY** | | | | | | | | |
| 7. | PL7211 | Polymer Processing and Testing Laboratory | PC | 6 | 0 | 0 | 6 | 3 |
| 8. | PL7212 | Seminar | EEC | 2 | 0 | 0 | 2 | 1 |
| | | | **TOTAL** | **26** | **18** | **0** | **8** | **22** |



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## SEMESTER III

| SL. NO. | COURSE CODE | COURSE TITLE | Category | Contact Period | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **THEORY** | | | | | | | | |
| 1. | PL7301 | Engineering Plastics | PC | 3 | 3 | 0 | 0 | 3 |
| 2. | | Elective V | PE | 3 | 3 | 0 | 0 | 3 |
| 3. | | Elective VI | PE | 3 | 3 | 0 | 0 | 3 |
| 4. | | Elective VII | PE | 3 | 3 | 0 | 0 | 3 |
| **LABORATORY** | | | | | | | | |
| 5. | PL7311 | Industrial Training (4 weeks) | EEC | 0 | 0 | 0 | 0 | 2 |
| 6. | PL7312 | Project Work Phase I | EEC | 12 | 0 | 0 | 12 | 6 |
| | | | **TOTAL** | **24** | **12** | **0** | **12** | **20** |

## SEMESTER IV

| SL. NO. | COURSE CODE | COURSE TITLE | Category | Contact Period | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| **PRACTICAL** | | | | | | | | |
| 1. | PL7411 | Project Work Phase II | EEC | 24 | 0 | 0 | 24 | 12 |
| | | | **TOTAL** | **24** | **0** | **0** | **24** | **12** |

**TOTAL CREDITS : 74**

## PROFESSIONAL ELECTIVES (PE)

| SL. NO. | COURSE CODE | COURSE TITLE | Category | Contact Period | L | T | P | C |
|---|---|---|---|---|---|---|---|---|
| 1. | PL7001 | Adhesive Science and Technology | PE | 3 | 3 | 0 | 0 | 3 |
| 2. | PL7002 | Biopolymers and Biodegradable Polymers | PE | 3 | 3 | 0 | 0 | 3 |
| 3. | PL7003 | Composites | PE | 3 | 3 | 0 | 0 | 3 |
| 4. | PL7004 | Computer Aided Design | PE | 3 | 3 | 0 | 0 | 3 |
| 5. | PL7005 | Conducting Polymers | PE | 3 | 3 | 0 | 0 | 3 |
| 6. | PL7013 | Specialty polymers | PE | 3 | 3 | 0 | 0 | 3 |
| 7. | PL7009 | Polymers for Packaging Application | PE | 3 | 3 | 0 | 0 | 3 |
| 8. | PL7006 | Industrial Management | PE | 3 | 3 | 0 | 0 | 3 |
| 9. | PL7007 | Plastics Waste Management | PE | 3 | 3 | 0 | 0 | 3 |
| 10. | PL7010 | Process Instrumentation | PE | 3 | 3 | 0 | 0 | 3 |
| 11. | PL7011 | Reaction Engineering | PE | 3 | 3 | 0 | 0 | 3 |
| 12. | PL7012 | Rubber Technology | PE | 3 | 3 | 0 | 0 | 3 |
| 13. | PL7014 | Synthetic Fibres | PE | 3 | 3 | 0 | 0 | 3 |
| 14. | PL7008 | Polymers for Biomedical Engineering Applications | PE | 3 | 3 | 0 | 0 | 3 |
| 15. | PL7015 | Total Quality Management | PE | 3 | 3 | 0 | 0 | 3 |



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| FOUNDATION COURSE (FC) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Title** | **Category** | **Contact Period** | **L** | **T** | **P** | **C** |
| 1. | | Polymer Chemistry | FC | 3 | 3 | 0 | 0 | 3 |
| 2. | | Polymer Process Engineering | FC | 3 | 3 | 0 | 0 | 3 |
| 3. | | Science of Polymeric Materials | FC | 3 | 3 | 0 | 0 | 3 |
| 4. | | Synthetic Resins | FC | 3 | 3 | 0 | 0 | 3 |
| 5. | | Polymer Science Laboratory | FC | 4 | 0 | 0 | 4 | 2 |

| PROFESSIONAL CORE (PC) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Title** | **Category** | **Contact Period** | **L** | **T** | **P** | **C** |
| 1. | | Characterization and Testing of Polymers | PC | 3 | 3 | 0 | 0 | 3 |
| 2. | | Instrumentation in Polymer Industry | PC | 3 | 3 | 0 | 0 | 3 |
| 3. | | Polymer Process Technology | PC | 3 | 3 | 0 | 0 | 3 |
| 4. | | Heat, Mass and Momentum Transport Processes | PC | 3 | 3 | 0 | 0 | 3 |
| 5. | | Engineering Plastics | PC | 3 | 3 | 0 | 0 | 3 |
| 6. | | Polymer Processing and Testing Laboratory | PC | 6 | 0 | 0 | 6 | 3 |

| Employability Enhancement Courses (EEC) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Title** | **Category** | **Contact Period** | **L** | **T** | **P** | **C** |
| 1. | | Project Work (Phase 1) | EEC | 12 | 0 | 0 | 12 | 6 |
| 2. | | Project Work (Phase 2) | EEC | 24 | 0 | 0 | 24 | 12 |
| 3. | | Seminar Presentation | EEC | 2 | 0 | 0 | 2 | 1 |
| 4. | | Internship in Industry | EEC | 0 | 0 | 0 | 0 | 2 |



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| PL7101 | POLYMER CHEMISTRY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To make the student to acquire knowledge in fundamentals of polymers and bioinorganicpolymers
- To provide exposure to the students about Molecular weight, solubility and fractionation of polymers

**UNIT I BASICS OF POLYMERS AND CHAIN GROWTH POLYMERIZATION 9**

Basics–polymer classifications based on occurrence, types, process, and end uses. Kinetics and mechanism of free radical, cationic, anionic, living polymers and coordination polymerization– Ziegler Natta catalysts-monometallic mechanism–stereo regular polymerization–chain transfer reaction and constant.

**UNIT II STEP GROWTH POLYMERIZATION AND COPOLYMERIZATION 9**

Kinetics of condensation polymerization–copolymerization-kinetics–copolymer equation composition of copolymers by NMR–monomer -reactivity ratios and their significance–polymerization reactions- metathetical, electrochemical, Group transfer polymerization and ring opening.

**UNIT III STRUCTURAL PROPERTIES AND REACTION OF POLYMER MOLECULES 9**

Functionality– tacticity of polymer –microstructure– chemical and geometrical structure–ladder, star and telechelic polymers–interpenetrating networks-Polymers-crystalline amorphous nature–crystallizability-effect on properties. Reactions of polymer molecules with specific groups OH, CHO, C=O, COOH and $–NH_2$ and polymer–cross linking, cyclisation–polymer degradation-thermal, mechanical, photo and radiation.

**UNIT I V THERMAL TRANSITION, MOLECULAR WEIGHT AND POLYMER DISSOLUTION 9**

Thermal transitions–TGA, DSC, HDT, MFI.Number, weight and viscosity average molecular weights – polydispersity - molecular weight distribution – determination of molecular weight by GPC and viscometry – polymer dissolution - thermodynamics of polymer dissolution - solubility parameter – fractionation of polymers.

**UNIT V BIO AND INORGANIC POLYMERS 9**

Naturally occurring polymers –starch, proteins, cellulose – Derivatives of cellulose polymers – rayon, cellophane, cellulose acetate, butyrate and nitrate – ethyl cellulose –carboxy methyl cellulose- preparation, properties- application organometallic polymers – co-ordination polymers –polyamides- Inorganic polymers - phosphorous and nitrogen containing polymers –silicones – hybrid polymers – iniferters.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be aware of preparation and properties of polymers at length.
- Will be able to methodically discuss moulding techniques.
- Will develop capacity to characterize polymers and draw a parallel to their properties.

**TEXT BOOK**


1. F.W. Billmayer, Text Book of Polymer Science, 3rd edition, John Wiley and sons, New York, 2002.
2. R.J. Young, Introduction to Polymers, Chapman and Hall Ltd., London, 1999.
3. Gorge Odeon – Principles of Polymerization, 4th edition, McGraw Hill Book Company, New York. 2004.
4. PremamoyGhosh ," Polymer Science and Technology, 2nd edition,McGraw-Hill Publishing Company Limited, New Delhi, 2003.
5. V.R. Gowarikar, Polymer Science, New Age International Pvt Ltd Publishers, 2010.


**REFERENCE BOOKS**


1. ManasChanda, SalilK.Roy," Plastics Technology Hand book ", 2nd edition,Marcel Dekker,New York,1993.
2. H.F.Mark,(Ed)," Encyclopedia of polymer Science & Engineering". John Wiledy& Sons, NewYork, 1989.
3. M.S. Bhatnagar A Textbook of Polymers, Volume 2: Chemistry and Technology of PolymersPublished by S. Chand & Company Ltd. (2010).


| PL7102 | POLYMER PROCESS ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To impart knowledge on mixing devices, extrusion moulding.
- To know the importance of Injection moulding and special moulding techniques. To understand the basic concepts in die design

**UNIT I MIXING DEVICES 9**

Additives and Mixing process, different types of mixing devices - twin drum tumblers, ribbon blenders, Z-blade Mixer, high speed mixer, ball mill, two roll mill, banburymixer, internal mixing and screw mixing – twin screw compounding machines – high temperature and pressure mixing devices – antistatic agents.

**UNIT II EXTRUSION MOULDING 9**

Analysis of flow in extruder – drag flow, pressure flow, leak flow – extruder/die characteristics – basic flow patterns in extrusion die – die exit instabilities – die swell – processing methods based on extruder (granule production, profile production, film blowing, blow moulding, extrusion stretch blow moulding) – extrusion coating process (sheet coating and wire covering).

**UNIT III INJECTION MOULDING 9**

Injection moulding machines and its components - moulds, multi cavity moulds, mould clamping devices, mould clamping force, disc moulding, injection blow moulding, reaction injection moulding.

**UNIT IV SPECIAL MOULDING TECHNIQUES 9**

Analysis of calendaring, methods of sheet forming – Thermoforming – vacuum forming, Pressure forming and matched mould forming – Rotation moulding, Analysis of compression moulding, transfer moulding – Plastic finishing techniques, powder coating, metallizing.

**UNIT V BASIC CONCEPTS IN DIE DESIGN 9**

Types of moulds – ejector system – ejection techniques – mould cooling – CAD / CAM applications

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be aware of different mixing devices, extrusion moulding.
- Will be able to methodically discuss moulding techniques.
- Will understand the basic concepts in die design

**TEXT BOOKS**

1. D.H. Morton-Jones, Polymer Processing, Springer verlaggmbh (2014)
2. Tim A. Osswald Georg Menges "Material Science of Polymers for Engineers", Hanser Publications, 2012.
3. Crawford R.J. Plastics Engineering, Butterworth - Heinemann, 3rd Edition, 2005.

**REFERENCE BOOKS**

1. Richard G.Griskey, Polymer Process Engineering, Chapman and Hall, 1995.
2. Friedhelm Hansen, Plastics Extrusion Technology, 2nd Edition, Hanser Publishers, 1997.
3. Peter Powell, A. Jan IngenHouz, Engineering with Polymers, Stanley Thomas Publishers Ltd., 2nd Edn. 1998.

| PL7103 | SCIENCE OF POLYMERIC MATERIALS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- The objective of this course is introduction to polymer structure, chain structure and mechanical properties.
- To impart knowledge on thermal properties and electrical properties. Students should be conversant with rheological properties.

**UNIT I INTRODUCTION9**

Polymer structure – chain structure – micro structure – crystal structure- crystallinity – determination of crystallinity, size and orientation of crystallites using x-rays-conformation and configuration.

**UNIT II MECHANICAL PROPERTIES 9**

Deformation of plastic materials- classification of plastic materials based on their stress – strain relationship – effect of temperature on deformation-time dependence and viscoelasticity in solid plastics – Boltzmann's superposition principle- dynamic mechanical properties – yielding of plastics–mechanical failure in plastics.

**UNIT III THERMAL PROPERTIES 9**

Enthalpy –melting and crystallization – importance of Tg - factors affecting Tg – determination of Tg – thermal conductivity – thermal expansion and contraction - factors affecting thermal expansion.

**UNIT IV ELECTRICAL PROPERTIES 9**

Electrical properties at low stress and high stress- breakdown mechanisms – electrically conductive plastics – electrical applications of plastics.

**UNIT V RHEOLOGICAL PROPERTIES 9**

Melt flow properties - fundamental concepts of rheology – geometry of flow – rheological

and viscous behavior in simple shear - viscous properties of plastic melts in simple shear – measurement of shear properties – viscometry – types of capillary viscometer – factors affecting shear flow and elongational flow – MFI, melt elasticity.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be aware of preparation and properties of polymers at length.
- Will be able to discuss the properties of polymers.
- Will develop capacity to characterize polymers and draw a parallel to their properties.

**TEXT BOOKS**


1. Birley, Haworth, Batchelor, Physics of Plastics – Processing Properties and Materials Engineering, Hamer Publication, 1992.
2. N.C. McCrum et.al, Principles of Polymer Engineering, 2nd edition Oxford University Press, London, 1997.
3. J.J. Aklonis and J. McKnight, Introduction to Polymer Viscoelasticity, John Wiley and sons, New York, 1983.


**REFERENCE BOOKS**


1. Bever, Encyclopedia of Materials Science and Engg., Volume 7, Pergamon press, London, 1986.
2. L. H. Sperling,"Introduction to physical polymer science, 4th edn, Wiley, 2005.
3. ZehevTadmor, Costas G. Gogos, Principles of Polymer Processing, 2nd Edition, Wiley, 2006.


| PL7104 | SYNTHETIC RESINS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To acquire knowledge on the classification of natural, synthetic polymers and its commercial applications**.**
- To understand the basic concepts of water soluble polymers and its applications in various fields.
- To understand the concepts of thermoplastics and thermosetting resins, the importance of rubbers, fibers and plastics and their engineering applications.

**UNIT I CLASSIFICATION OF POLYMERS 9**

Introduction – Classification of natural, modified and synthetic polymers – effect of structure on properties of polymers — Salient features of plastics-water soluble polymers– classification-functions and properties – starch - dextrinization – modified starches – cellulose and its derivatives- commercial Applications.

**UNIT II WATER SOLUBLE POLYMERS 9**

Synthetic water soluble polymers, preparation, properties and applications of polyvinyl alcohol – polyvinylpyrrolidone – polyacrylic acid and its homolog's – polyacrylamide – polyethylene oxide – polyethylene mine. Application of water soluble polymers in pharmaceuticals – cosmetics – textiles – paper – detergents and soaps – paint – flocculation – beverages – polyelectrolyte's.

**UNIT III THERMOPLASTIC RESINS 9**

Thermoplastic resins – polyolefins – vinyl polymers – poly vinyl chloride-polystyrene – PMMA – SAN – PAN - Teflon – polyamides – polycarbonates and their applications.

**UNIT IV THERMOSETTING RESINS** **9**

Thermosetting resins – phenolic resins – aminoplast – UF- MF - polyesters – alkyd resins– epoxies – bisphenol-A and cycloaliphatic based epoxy resins -polyurethanes andpolyureas – silicone resins.

**UNIT V RUBBERS AND FIBERS** **9**

Elastomers – natural rubber – vulcanization - synthetic rubbers - butyl- SBR neoprene.Application of synthetic resins as fiber – commodity plastics – sheets and film – foam – packaging – biodegradable and engineering applications.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be aware of classification of polymers
- Will develop capacity to appreciate the applications of natural and synthetic polymers.

**TEXT BOOKS**

1. J.A. Brydson, Plastics Materials, Newness - Elsevier, Seventh Edn, London, 2014.
2. R.L. Davidson and S. Marshall, Water Soluble Resins, Van-Nostrand Reinhold, New York, 1988.

**REFERENCE BOOKS**

1. R.B. Seymour and C.E.Carraher, Jr., Polymer Chemistry – An Introduction, Marcel Dekker Inc., New york, 2010.
2. Maurice Morton, Rubber Technology, Van Nostrand Reinhold, New York, 2002.

| PL7111 | POLYMER SCIENCE LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVE**

- To make the student conversant with polymer synthesis, kinetics of polymerization.
- To enable students develop their determination of reactivity ratio and molecular weight.
- To know the importance of fractionation of polymers.

**UNIT I POLYMERIZARION TECHNIQUES** **15**

Polymer synthesis – bulk, solution, emulsion, suspension and slurry polymerization- lowand high temperature condensation polymerization, interfacial polycondensation, thermal and redox initiated polymerizations.

**UNIT II KINETICS OF POLYMERIZATION** **10**

Kinetics of polymerization – dilatometry, gravimetry.

**UNIT III CHARACTERIZATION OF POLYMERS** **10**

Determination of reactivity ratio of MMA – styrene copolymer – characterization by TGA, TMA, NMR and IR.Crystallinity of polymers – X-ray diffraction study.

**UNIT IV MOLECULAR WEIGHTS DETERMINATIONS** **15**

Determination of Molecular weight,Molecular weight determination – viscometry, end group analysis, GPC, light scattering, osmometry.

**UNIT V FRACTION OF POLYMERS 10**

Fractionation of polymers – Fractional precipitation method – polydispersity

**TOTAL: 60 PERIODS**

**OUTCOME**

- Will gain awarenessin synthesis and kinetics of polymers.
- Will be able to methodically discuss fractionation of polymers.
- Will develop capacity to characterize polymers and draw a parallel to their properties.

**TEXT BOOKS**

1. E.M.McCaffery, Laboratory Preparation for Macromolecular Chemistry, McGraw Hill, Kogakush 1970.

**REFERENCE BOOKS**

1. Edward A. Colloind, J.Bares and F.W. Billmeyer Jr., Experiments in Polymer Science, Wiley Interscience, New York 1973.
2. Wayne R.Sorenson and T.W.Campbell, Preparative Methods of Polymer Chemistry 3rd edition, Wiley – Interscience, New York, 2001.
3. Tim A. Oswald Georg Menges "Material Science of Polymers for Engineers", Hanser Publications, 2012.

**PL7201 CHARACTERIZATION AND TESTING OF POLYMERS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To pass on knowledge on characterization tests, thermal and electrical properties.
- To learn mechanical properties and flammability, optical properties and analyticaltests.
- To provide exposure to understand the testing of foam plastics and testing organizations.

**UNIT I CHARACTERIZATION TESTS 9**

TGA, DTA, DSC, TMA, XRD, SEM, AFM, TEM, IR, NMR, GC, GPC melt index and viscosity.

**UNIT II THERMAL AND ELECTRICAL PROPERTIES 9**

Heat deflection temperature, Vicat softening temperature, thermal conductivity thermal expansion, brittleness temperature – dielectric strength dielectric constant, dissipation factor, resistance.

**UNIT III MECHANICAL PROPERTIES AND FLAMMABILITY 9**

Tensile tests, compressive properties, impact properties, deformation, brittleness abrasion resistance hardness tests – incandescence resistance, ignition properties, oxygen index, surface burning characteristics.

**UNIT IV OPTICAL PROPERTIES AND ANALYTICAL TESTS 9**

Refractive index, luminous transmittance, haze, density, water absorption, moisture analysis,sieve analysis, crush and burst strength.

**UNIT V TESTING OF FOAM PLASTICS AND TESTING ORGANIZATIONS 9**

Foam properties, rigid and flexible foam - testing methods - ASTM, ANSI, NBS, NEMA, NFPA, UL, SPI and SPE.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be aware of characterization tests, thermal and electrical properties.
- Will be able to appreciate optical properties and analytical tests.
- Will get an idea about testing of foam plastics and testing organizations.

**TEXT BOOKS**


1. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.
2. Vishu Shah, Hand book of Plastics Testing and Failure Analysis, 3rd Edition, John-Willey &Sons, New York, 2007.


**REFERENCE BOOKS**


1. B. Sivasankar, Engineering Chemistry, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2012
2. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastics, Allied Publishers Pvt. Ltd., New Delhi, 2003
3. A. Ya. Malkin, A.A. AskaDsky, V.V. Koverica Experimental methods of polymers, Mir Publishers, Moscow, 1998.
4. Iver, Mead and Riley, Hand book of Plastic test methods, Illith Publishers, New York, 1982.


**PL7202 HEAT, MASS AND MOMENTUM TRANSPORT PROCESSES**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To acquire knowledge on momentum transport process and solution to equations of motion.
- To understand the basic concepts of heat transfer by conduction process and convective heat transfer process.
- To know the importance of mass transfer.

**UNIT I MOMENTUM TRANSPORT PROCESS** **9**

Momentum transport –fluid behavior – overall mass, energy and momentum balances – differential mass, energy and momentum balance-polymeric liquids.

**UNIT II SOLUTION TO EQUATIONS OF MOTION** **9**

Solution to equations of motion - flow measurement - boundary layer flow – turbulent flow– dimensional analysis applied to momentum transport – design equation for incompressible fluid-flow through packed column–fluidization.

**UNIT III HEAT TRANSFER BY CONDUCTION PROCESS** **9**

Heat transfer – steady state conduction – unsteady state conduction – numerical and graphical methods in analysis of heat conduction.

**UNIT IV CONVECTIVE HEAT TRANSFER PROCESS** **9**

Convective heat transfer – heat transfer in laminar and turbulent flow- boiling and condensation – design equations for convective heat transfer – heat exchangers.

**UNIT V MASS TRANSFER** **9**

Mass transfer – molecular diffusion – binary systems – convective mass transfer coefficients – mass transfer in laminar and turbulent flow –design equations for convective mass transfer – analysis between momentum, heat and mass transfer.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be aware of momentum transport process and solution to equations of motion.
- Will be able to methodically discuss heat transfer process.
- Will understand the importance of mass transfer.

**TEXT BOOKS**

1. R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot, Transport Phenomena, (Second Edition) John Willey & Sons, 2006.
2. C.J.Geankoplis, Transport Processes and Unit Operation, (Third Edition) Prentice Hall, 1993.

**REFERENCE BOOKS**

1. J.R.Welty, C.E. Wicks, G. L. Rorrer and R.E.Wilson, Fundamentals of Momentum, Heat and Mass transfer, John – Wiley & Sons, New York, 2007.(Fifth Edition).
2. C.J. Geankoplis, Transport Processes – Momentum, Heat and Mass(Allyn and Bacon Inc), Boston, USA 1983.

| PL7203 | INSTRUMENTATION IN POLYMER INDUSTRY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To make the student familiar with the process variables, measurement and control etc.,
- To understand the use of mathematical analysis of processes, etc., and Computer control and applications.
- To acquaint the student with Instrumentation in blow moulding etc.,

**UNIT I PROCESS VARIABLES** **9**

Process variables such as temperature, pressure, flow etc. and their measurements.Examples in polymer processing in moulding, extrusion.

**UNIT II MEASUREMENT AND CONTROL** **9**

Measurement and control – Simple systems-first and higher order systems- Design specifications on system time response – feedback control diagram – proportional, integral, derivative and PID controls.

**UNIT III MATHAMATICAL ANALYSIS** **9**

Mathematical analysis of processes and feedback control systems –poles, zeros and system stability-Stability Analysis- Routh's Test-Root locus-frequency response using Bode plot.

**UNIT IV COMPUTER CONTROL** **9**

Computer control and application – mathematical concepts of discrete variables analysis and multivariable processes and other control methods as feed forwardcontrol, ratio control and internal model control etc.

**UNIT V INSTRUMENTATION** **9**

Instrumentation in blow moulding, extrusion and injection moulding and control systems.

**TOTAL : 45 PERIODS**

**OUTCOME**

- Will be familiar with the process variables, measurement and control etc.,
- Will be able to use computer control and its applications effectively.
- Will develop capacity to use moulding techniques.

**TEXT BOOKS**

1. Steven E. LeBlanc and D.R.Coughanour, Process Systems Analysis and Control, McGraw Hill Book Co., 3rd Edition, 2009
2. Process/Industrial Instruments & Controls Handbook, 4th edition, by D.M. Considine (ed.), McGraw-Hill Inc., New York (1993).
3. D.V.Rosato, Blow Moulding Hand book, Hanser Publications, 2nd revised edition, 2004

**REFERENCE BOOKS**

1. Allan L. Griff, Plastic Extrusion Technology, Reinhold Plastics Applications Series, Krieger publisher,1976.
2. A.Whelan, Developments in Injection Moulding, Applied Science Publications,1989.
3. Sidney Levy, Plastic Extrusion Technology Hand Book, Industrial Press Inc.,NewYork,1989.

| PL7204 | POLYMER PROCESS TECHNOLOGY | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVE**

- To impart knowledge on raw materials and polymerization techniques.
- Students should be conversant with technology of polymerization,polymer processing.
- To provide exposure to the students to understand technology of elastomers.

**UNIT I RAW MATERIALS 9**

Petroleum, natural gas, biogas and coal sources of monomers – manufacture of acetylene, ethylene, propylene, vinyl chloride, toluene, phenol and styrene.

**UNIT II POLYMERIZATION TECHNIQUES 9**

Condensation and solution polymerization – melt,interfacial, gas phase – bulk,dispersion, solution, suspension and emulsion – RAFT and ATRP polymerization - reactors for polymerization.

**UNIT III TECHNOLOGY OF POLYMERIZATION 9**

Specific technology of polymerization – polystyrene, LDPE, HDPE, LLDPE, nylons, butylrubber, polypropylene, PVC and PET – copolymerization techniques –SBR and ABS.

**UNIT IV POLYMER PROCESSING9**

Processing of thermoplastics and thermosetting plastics – compounding – fillers, plasticizers, coupling agents,antidegradants, cross-linking agents, stabilizers, lubricants, colorants, and antioxidants – machines for compounding.

**UNIT V TECHNOLOGY OF ELASTOMERS 9**

Processing technology of elastomers – processing of natural and synthetic rubbers – vulcanization, mastication and cyclisation – calendaring and extrusion techniques – reaction injection moulding – sintering - solution casting – Sheet molding and dough molding compounds.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be aware of raw materials and polymerization techniques.
- Will be able to methodically discuss technology of polymerization and polymer processing.
- Will develop capacity to characterize elastomers and draw a parallel to their properties.

**TEXT BOOKS**

1. John Brydson, Plastic materials, 7th edition, Butterworth – Heinamann Ltd., London, 2014.
2. John Murphy, Additives for Plastics Handbook, 2nd edition, Elsevier Advanced Technology, 2003.

**REFERENCE BOOKS**

1. J.A. Biesenberger and H.Sebastian, Principles of Polymerization Engineering, Wiley-Interscience Publication, New York, 2007.
2. Charles A.Harper , Hand book of Plastic Processing, Willey Publication,2014
3. D.H. Morton and Jones, Polymer Processing, Chapman and Hall, London, 1989.
4. Joel. R. Fried. Polymer Science and Technology,2nd edn, PHI Learning Private Limited, New Delhi-1, 2014.
5. Stephen L. Rosen, Fundamental Principles of Polymeric Materials, 2nd edition, John Wiley and Sons Inc., New York, 2012.
6. W.S. Allen & P.N. Baker, Hand Book of Plastic Technology,Vol.1,CBS publishers,2009.

| PL7211 | POLYMER PROCESSING AND TESTING LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 6 | 3 |

**OBJECTIVE**

- To enable students to knowthe processing of polymers and testing of plastics etc.,
- To know the importance of thermal, electrical and optical properties of thepolymeric materials.
- To understand the basic concepts of Identification**,** characterization, flammability and analytical testing of polymers.

**UNIT I PROCESSING OF POLYMERS 8**

Processing of polymers – principles of compounding and processing for the manufacture of plastics and rubber products- injection, blow and compression moulding, extrusion, calendaring and casting processes.

**UNIT II TESTING OF PLASTICS 8**

Testing of plastics and dry rubber products – mechanical properties – tensile, Flexural, compressive, impact, hardness, abrasion and fatigue resistance tests.

**UNIT III THERMAL PROPERTIES 8**

Thermal properties – thermal conductivity, thermal expansion and brittleness temperature, heat deflection temperature.

**UNIT IV ELECTRICAL PROPERTIES 8**

Electrical properties – dielectric strength, dielectric constant and dissipation factor.Electrical resistance tests - arc resistance.

**UNIT V OPTICAL PROPERTIES 6**

Optical properties – refractive index, transmittance and haze, gloss.

**UNIT VI MATERIAL CHARACTERIZATIO8**

Material characterization tests – thermoplastics – MFI, capillary rheometer test – thermosets – apparent (bulk) density, bulk factor, pourability, viscosity (Brookfield), gel time and peak exothermic temperature.

**UNIT VII FLAMMABILITY TESTS**

Flammability tests – oxygen index test, ignition temperature determination.**6**

**UNIT VIII ANALYTICAL TESTS**

Analytical tests – specific gravity, density, water absorption, moisture analysis.

**UNIT IX ANALYSIS OF PLASTICS 8**

Identification and analysis of plastic and dry rubber materials – chemical and thermal analysis for identification of polymers.

**TOTAL: 90 PERIODS**

**OUTCOME**

- Will be able to develop methods for processing of polymers and testing of plastics etc.
- Will be able to discuss thermal, electrical and optical properties of the polymeric materials.
- Will be able to recognize the basics in analytical testing of polymers.

**TEXT BOOKS**

1. R.P. Brown (Ed), Handbook of Plastics Test Methods, 2nd edition, George Godwin, 1988.
2. W.E. Brown (Ed), Testing of Polymers, Vol. 4, Wiley –Interscience, New York, 1969.
3. J.V. Schmitz (Ed) Testing of Polymers, Vol. 1 –3 , Wiley – Interscience, New York,1968.

**REFERENCE BOOKS**

1. G.C. Ives, J.A. Mead and M.M. Riley, Handbook of Plastics Test Methods, Illith Publishers, London, 1982,
2. J. Haslam, H.A. Willis and D. Squirrell, Identification and Analysis of Plastics. 2nd Edn.,Iliffe Book, Butterworth, London, 1983.

| PL7301 | ENGINEERING PLASTICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To acquire knowledge of polymers meant for electrical, electronics and high temperature applications.
- To impart basic knowledge on polymer blends, alloys and liquid crystals.
- To gain knowledge of polymers in lithography, water treatment and biomedical applications

**UNIT I POLYMERS FOR ELECTRICAL AND ELECTRONICS APPLICATIONS 9**

Engineering plastics – polymers in electrical and electronics industry – electro conducting polymers – polymer batteries – electrets - polymers with piezoelectric, pyroelectric and ferroelectric properties-photo conducting polymers.

**UNIT II POLYMERS FOR HIGH TEMPERATURE APPLICATIONS 9**

Polymers for high temperature resistance– fluoro polymers – aromatic polymers– heterocyclic polymers – polymers as building materials – ultrahigh fibres – aramids – technora – carbon fibres.

**UNIT III POLYMER BLENDS, ALLOYS AND LIQUID CRYSTALS 9**

Polymer blends and alloys. – reinforced plastics – ionic polymers –interpenetrating networks – sequential – simultaneous – full and semi IPN – thermoplastic IPN – liquid crystalline polymers (LCP) – lyotropic and thermotropic liquid crystals – main chain and side chain liquid crystalline polymers–processing of LCP's- applications –ablative plastics.

**UNIT IV POLYMERS IN LITHOGRAPHY AND WATER TREATMENT 9**

Polymers in lithography – photoresist – positive resists – negative resists – solution inhibition resists – image reversal process – Ion exchange resins – polymer membrane – polymer complexes for water treatment.

**UNIT V POLYMERS FOR BIOMEDICAL APPLICATIONS 9**

Polymer for biomedical applications – polymers in dentistry – tissue-adhesives – dialysismembrane – blood oxygenators – bone cement – prostheses – biodegradable sutures – control drug delivery systems.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be able to apply polymers to electrical, electronics and high temperature fields.
- Will understand polymer blends, alloys and liquid crystals.
- Will appreciate the application of polymers in a variety of fields.

**TEXT BOOKS**


1. H.F. Mark (Ed), Encyclopedia of Polymer Science and Engineering, Wiley – Interscience, New York, 1991
2. L.L. Chapoy (Ed), Recent Advances in Liquid Crystalline Polymers, Chapman and Hall, London, 1985.
3. R.W. Dyson, Specialty Polymers, Blackie Academic & Professional, London, (second edition) 1998.


**REFERENCE BOOKS**


1. C.P.Wong, Polymers for Electronic and Photonic Applications, Academic Press, New York, 1993.
2. ManasChanda, Salil K. Roy, Industrial Polymers, Specialty Polymers, and their Applications, CRC Press, 2008.
3. Robert William Dyson, Specialty Polymers, 2nd ed., Springer Verlag, 2011.




| PL7001 | ADHESIVE SCIENCE AND TECHNOLOGY | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVE**

- To bring a sound knowledge of theoretical and technological aspects of mechanism and characterization of adhesives.
- To understand the various types of Adhesives employed in Industries.
- To acquire knowledge of Applications of adhesives in various fields.

**UNIT I ADHESION MECHANISM 9**

Definition and mechanisms of adhesion- mechanical interlocking – inter-diffusion theories – adsorption and surface reaction.Surface topography, surface features and forces,wettingand setting, thermodynamic work of adhesion– influence of constitution onadhesion – interfacial bonding – coupling agents.

**UNIT II CHARACTERIZATION OF ADHESIVES 9**

Principle of fracture mechanics, peel, lap sheen and butt tensile tests. Pull out of an extendable fibre, various testing and evaluation of adhesives, energy dissipation – plasticity – strength of elastomers.

**UNIT III INDUSTRIAL ADHESIVES 9**

Inorganic adhesives.Principle of compounding – role of resins – fillers – antioxidants – accelerator systems.

**UNIT IV ADHESIVE TYPES 9**

Adhesive from natural origin - animal glues – casein – starch – cellulosic and bio adhesives.Synthetic adhesives -phenolic resin, epoxy, polysulphide, polyurethane, polyvinyl acetate, polyvinyl alcohol, polyvinyl acetal, acrylics, high temperature silicone adhesives. Water based – pressure sensitive – hot -melt adhesives – anaerobic adhesives.

**UNIT V APPLICATIONS OF ADHESIVES 9**

Adhesives for building construction, medical use, automobile industry bonded and coated abrasives – fabrics, cyanoacrylate based adhesives, bonding technology for textile, metal, plastics, wood, paper and glass.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be able to attain the basic knowledge of adhesives.
- Will be able to comprehend the utility of adhesives in industry.
- Will develop capacity to apply adhesives in various fields.

**TEXT BOOKS**

1. W. A. Lees, Adhesives in engineering design, Springer Verlag, Berlin, 1984.
2. D.M. Brewis and D. Briggs, Industrial adhesion problems, Wiley-Interscience Publication, New York, 1985.

**REFERENCE BOOKS**

1. A. J. Kinloch, Adhesion and Adhesive Science and Technology, Springer, 1987.
2. I Skeist, 3rd Edition, Handbook of Adhesives, Van Nostrand Reinhold, New York, 1990
3. A.V. Pocius, Adhesion and Adhesives Technology, Hanser, 2002
4. P. Ghosh, Adhesives and Coatings Technology, Tata-McGraw-Hill Publishing Company Limited, New Delhi, 2008.



| PL7002 | BIOPOLYMERS AND BIODEGRADABLE POLYMERS | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVE**

- To acquire knowledge on synthetic biodegradable polymers and its applications.
- To gain knowledge on principles of biodegradation and disposal of municipal waste.
- To study about the biopolymers and their structures.

**UNIT I SYNTHETIC BIODEGRADABLE POLYMERS 9**

Biodegradable polymers - poly -caprolactone- modified poly -caprolactone copolymer with ester, amide and urethane linkages, polyglycolate, polymandelic acid. Copolymer of 1,4- butanediol with adipic acid and sebacic acid, polyalkylene tartrate cellulose block copolymers -

biodegradable polyamides –copolymers of - amino acid (glycine, serine ), -aminocaproic acid. Benzyl substituted urethane – polyester urea – polyamide urethane - synthesis and properties. polyglutamic acid, bacterial polyesters. Applications – agriculture, medicine, packaging.

**UNIT II PRINCIPLES OF BIODEGRADATION 9**

Biodegradation -introduction – modes of biological degradation –enzymaticdegradationof biopolymers (poly saccharides, proteins, nucleic acids) and syntheticpolymers - microbial degradation of synthetic polymers.

**UNIT III DISPOSAL OF MUNICIPAL WASTE 9**

Disposal ofsolid municipal waste by biodegradation – composting(bioreactors)- deposition in landfills – microbial decomposition processes in anaerobic rubbish dumps. Ideal bioreactors – stirred tank reactor – batch and continuous operations – Fed - Batch operation - plug flow reactor.

**UNIT IV BIOPOLYMERS 9**

Biopolymers - introduction – functions – cotton, wool, paper, rubber, collagen hyaluroran-melanin for UV protection –Applications.

**UNIT V STRUCTURE OF BIOPOLYMERS9**

Proteins, nucleic acids and polysaccharides – the macromolecular structure and biological functions of polymers- primary, secondary, tertiary and quaternary structure of polymers – structure maintenance and transmission of the biological information- structure and enzymatic activity – mechano structural function of biopolymers- viruses and phages – living macromolecules.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be concerned for environment by synthesizing synthetic biodegradable polymers.
- Will be able to methodically discuss importance of waste management.
- Will develop capacity to comprehend biopolymers and their application.

**TEXT BOOKS**


1. J.Guillet, Polymers and Ecological problems, Plenum Press, New York, 1973.
2. W.Schnabel, Polymer Degradation – Principles and Practical Applications, Hanser International, 1982.


**REFERENCE BOOKS**


1. L.L.Hench, E.C. Ethridge, Biomaterials – An Interfacial Approach, Biophysics and Biotechnology Series, Vol 4, Academic Press, New York, 1982.
2. Jens Nielsen, John Villadsen and Gunnar liden, Bioreaction Engineering Principles, 3rd ed, Springer. 2011.
3. Charles Gebelein, Biotechnological Polymers: Medical, pharmaceutical and industrial applications, CRC press,1993.




Attested

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| PL7003 | COMPOSITES | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVE**

- To acquire a knowledge of various types of composites and its advantages and needs.
- To understand the various types of fiber materials and its applications for making composites.
- To understand the knowledge of various resins materials used in processing of composites and the basic destructive and non-destructive testing of composites

**UNIT I CHARACTERISTICS OF COMPOSITES 9**

Characteristics, advantages, and need of composites – Classification – particulate, fibrous, laminated, advanced and hybrid composites, CCCs, nanocomposites.Predicting properties of Fiber-Reinforced composites.

**UNIT II MATERIALS 9**

Fibers: Glass –Types (E,S&C),roving, yarns, CSM, surface mats, preforms, woven and non-woven fabrics - Three dimensional fabrics (woven, knitted and braided); Carbon – PAN and Pitch based - HT, HM and IM; Aramid – Kevlar, Technora HM-50; Production, properties and applications. Natural fibers. Surface treatments. Resins:Thermosets - Unsaturated polyester, epoxy, vinyl ester, silicones & polyimides – production, properties and applications; Thermoplastics - Examples, Comparison with thermosets. Prepregging techniques. Properties and applications.

**UNIT III PROCESSING OF COMPOSITES 9**

Different types of molds- DMC, SMC and prepregs. Hand & Spray layup- RTM, Bag, autoclave, centrifugal and compression molding processes,pultrusion, Vacuum infusion, filament winding and sandwich construction

**UNIT IV TESTING OF COMPOSITES 9**

Fiber volume fraction, tensile, shear, compressive, flexural, thermo elastic and off – axis responses of lamina and laminates - notched strength – fracture toughness-nondestructive testing.

**UNIT V NANOCOMPOSITES 9**

Introduction: Nanoscale Fillers – Clay, POSS, CNT, nanoparticle fillers; Processing into nanocomposites; Modification of interfaces; Properties. Applications.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be conversant with knowledge of various types of composites and its advantages and needs.
- Will be able to know various types of fiber materials and its applications for making composites.
- Will understand the knowledge of various resins materials used in processing of composites and the basic destructive and non-destructive testing of composites

**TEXT BOOKS**


1. George Lubin, Stanley T. Peters , Handbook of Composites, Chapman & Hall, 1998.
2. BorZ.Jang, Advanced Polymer composites, ASM International, USA, 1994.
3. Donald F. Adams, Leif Carlsson A Carlsson, R. Byron Pipes Experimental Characterization of advanced composite materials, Third Edition, CRC Press , 2002.
4. Richard M. Christensen, Mechanics of composite materials, Dover Publications, New York, 2005.

**REFERENCE BOOKS**


1. Mel M. Schwartz,Composite Materials: Processing, fabrication, and applications, Prentice Hall PTR, 1997
2. M.C.Gupta and A.P.Gupta, Polymer Composites, New Age International Publishers, 2007.
3. Nanocomposite Science and Technology. Edited by P.M. Ajayan, L.S. Schadler, P.V. Braun 2003 , WILEY-VCH Verlag GmbH Co. KGaA, Weinheim.
4. Polymer matrix nanocomposites, processing, manufacturing, and application: An overview, F. Hussain, M.Hojjati, M. Okamoto, R.E. Gorga, J. Comp. Mater., 40, 1511-1575 (2006)


| PL7004 | COMPUTER AIDED DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To impart knowledge on Computer graphics fundamentals and Interactive computer programming.
- The students should be conversant with Computer animation and Mechanical assembly.
- To introduce Proto typing, process planning and CAD CAM integration**.**

**UNIT I COMPUTER GRAPHICS FUNDAMENTALS 9**

Graphic primitives – transformations – graphic standards – representation of curves – surface and solid modeling.

**UNIT II INTERACTIVE COMPUTER PROGRAMMING 9**

Requirements of interactive programming – types of interactive programming- objective oriented programming – development of interactive programme in languages like auto LISP etc. – applications.

**UNIT III COMPUTER ANIMATION 9**

Conventional animation – computer animation – animation requirements – animation types – animation techniques – design application

**UNIT IV MECHANICAL ASSEMBLY 9**

Assembly modeling – mating conditions – representation schemes –assembling-sequences – assembly analysis.

**UNIT V PROTOTYPING, PROCESS PLANNING AND CAD CAMINTEGRATION 9**

Basics of prototyping - principles and planning –basics of process planning and CAD CAM integration.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be able to appreciate incorporation of computers in chemistry.
- Will be able to use computers as a tool in solving chemistry related problems.
- Will be able to create programs for direct use in problem solving.

**TEXT BOOKS**


1. Donald Hearn and M. Pauline Baker, Computer Graphics, Prentice Hall, Inc.1997.
2. Ibrahim Zeid, CAD / CAM – Theory and Practice, McGraw Hill, International Edition, 1998


**REFERENCE BOOKS**


1. Mikell, P. Grooves and Emory W.Zimmers Jr., CAD / CAM Computer – Aided Design and Manufacturing, Prentice Hall Inc., 1995.

| PL7005 | CONDUCTING POLYMERS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To acquire a knowledge of chemistry on conducting polymers and itsconductivity.
- To understand the basic concepts of synthesis, processing and applications of conducting polymers.
- To impart knowledge on spectral, morphological,thermal, mechanical and electrochemical characterization of conductive polymers.

**UNIT I ELECTROCHEMISTRY OF CONDUCTING POLYMERS 9**

Electrochemistry of electronically conducting polymers-source of electronic conduction in polymers – solitons, polarons and bipolarons – Doping – Measurement of conductivity – Vander Pauw technique – factors affecting conductivity.

**UNIT II SYNTHESIS, PROCESSING AND APPLICATIONS OF CONDUCTING POLYMERS 9**

Synthesis of conducting polymers – chemical, electrochemical and enzymatic methods – Synthesis, processing methods and applications of polyacetylene, polyaniline, polypyrrole, polythiophene and poly-paraphenylene based conducting polymers.

**UNIT III ELECTROCHEMICAL CHARACTERIZATION OF CONDUCTINGPOLYMERS 9**

Electro-analytical techniques – cyclic voltammetry, chronoamperometry and chrono-coulometry

**UNIT IV SPECTRAL AND MORPHOLOGICAL CHARACTERIZATION OF CONDUCTING POLYMERS 9**

FTIR, UV-vis, Raman, XRD, SEM, TEM and NMR

**UNIT V MECHANICAL AND THERMAL CHARACTERIZATION OFCONDUCTING POLYMERS 9**

UTM, Dilatometry, TGA, DTA, DSC and DMA

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will get a basic idea about conducting polymers.
- Will be able to synthesis conducting polymers.
- Will be able to characterize and analyse the properties of conducting polymers.

**TEXT BOOKS**


1. T.A. Skotheim, R.L. Elsenbaumer and J.R. Reynolds, Hand book of Conducting Polymers – 2nd Edn, Revised and enlarged, Marcel DekkerInc., New York, 2007.
2. J.M. Margolis (Ed.), Conducting Polymers and Plastics, Springer, 2011.


**REFERENCE BOOKS**


1. R.B. Seymour, edr.,Conductive Polymers", Plenum Press, New York, 1981.
2. B. Wessling, Electronic Properties of Conjugated Polymers, Vol.3, Springer, Berlin, 1989.
3. H.G. Kiess (Edr.), Conjugated Conducting Polymers, Springer, Berlin, 1992. D.S.Soane and Z. Martynenko (Eds.), Polymers in Microelectronics, Elsevier, Amsterdam, 1989.

| PL7013 | SPECIALTY POLYMERS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To make the student to acquire knowledge in polymers for special application.
- To provide exposure to the students about advanced polymeric materials.

**UNIT I LIQUID CRYSTALLINE POLYMERS (LCPS) 9**

Concept of liquid crystalline (LC) phase, liquid crystalline polymers and their classification.theories of liquid crystallinity, characteristics of LC state and LCPs, synthesis, structure property relationship, rheology of liquid crystalline polymers, blends of LCPs, self reinforced composites, applications of LCPs.

**UNIT II CONDUCTING POLYMERS 9**

Theory of conduction, semi conductors and conducting polymers, band theory, requirements for polymer to work as conductor, types of conducting polymers - intrinsic and extrinsic, doping of polymeric systems, Mechanism of conducting polymers- Polyaniline, Polyacetylene, Polypyrole, organometallic polymers – Photo conducting polymers- Polymers with Piezzo, ferro and pyro electric properties.

**UNIT III HEAT RESISTANT POLYMERS 9**

Requirements for heat resistance, determination of heat resistance, synthesis, structure-property relationships, applications of heat resistant polymers like polyamides, polyimides and its derivatives, polyquinolines, polyquinoxalines, Polymers for high temperature resistant-PBT, PBO, PBI, PPS, PPO, PEEK, Fluro polymers, aromatic polymers and heterocyclic polymers.

**UNIT IV PHOTOSENSITIVE POLYMERS AND POLYMERS AS COATING ADDITIVES 9**

Photosensitive polymers - synthesis, curing reactions, applications in various fields. Photo resist for semiconductor fabrication. Membranes, their types, methods of casting and their applications. Polymer as coating additives - types, synthesis, requirements for polymer to work as coating additives and applications

**UNIT V POLYMERS IN MISCELLANEOUS SPECIALTY APPLICATIONS 9**

Polymers in agricultural applications: green houses, mulches, control release of agricultural chemicals, seed coatings, etc., polymers in construction and building applications, polymer concrete, polymeric materials used in telecommunication and power transmission applications, polymer composites in aerospace and other light weight applications, polymers in cosmetics

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be aware of preparation and properties of speciality polymers
- Will be able to methodically discuss application of speciality polymers.
- Will develop capacity to characterize polymers and draw a parallel to their properties.

**TEXT BOOKS**


1. ManasChanda, Salil K. Roy, Industrial Polymers, Specialty Polymers, and their Applications, CRC Press, 2008
2. Faiz Mohammad, Specialty Polymers: Materials and Applications, I.K. International Pvt Ltd, 2008
3. H.F.Mark,(Ed),” Encyclopedia of polymer Science & Engineering”. John Wiledy&Sons,
4. New Yorik, 1989.Matrin.T. Goosey,” Plastics for Electronics”, Elsevier,Applied Science, 1985.

**REFERENCE BOOKS**


1. Robert William Dyson, Speciality Polymers, 2nd ed., Springer verlag, 2011
2. .ManasChanda, SalilK.Roy," Plastics Technology Hand book ", 2nd edition,Marcel Dekker, New York,1993.
3. Johannes Karl Fink, Hand book of Engineering and Specialty Polymers, John Wiley & Sons, Vol.2, 2011
4. Norio Ise, IwaoTabushi, An Introduction to Speciality Polymers, Cambridge University Press, 1983 food applications.


| PL7009 | POLYMERS FOR PACKAGING APPLICATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- The objective of this course is introduction to packaging application using polymers
- To impart knowledge on packaging application
- Students should be conversant with packaging materials

**UNIT I POLYMERIC MATERIALS FOR PACKAGING APPLICATION 9**

Major polymers used for packaging- Evaluation of the following polymers for packaging Applications- polyethylene , EVA, EAA, lonomers, LDPE ,HDPE, LLDPE, metallocene polymer, PP,PVC, PVDC, PS, PVOH, EVOH, nylon, polyester, polycarbonate, fluoropolymers, ABS, acrylonitrile

**UNIT II METHODS OF PROCESSING OF PACKAGING 9**

Adhesives, heat sealing types, sealing method, extrusion blown film and cast film and sheet co extrusion, surface treatment testing and evaluation of films, flexible packaging, pouches, bulk and heavy duty bags, thermoforming, thin sheet thermoforming, blow moulding, extrusion and injection blow moulding, foams, cushioning and distribution packaging thermoplastic

**UNIT III POLYMERS FOR BIO BASED FOOD 9**

Edible and biobased food packaging materials, edible film and coating, Polysaccharide based coatings, Lipid based coatings, Protein based coating, First, Second and third biobased packaging materials. permeability of thermoplastic polymers, multilayer films, processing, deteriorative reaction in foods, enzyme reactions, chemical reactions, physical change, biological change, shelf life of foods, factors controlling shelf life.

**UNIT IV POLYMERS FOR MEDICAL APPLICATION 9**

Polymer used in pharmaceutical products-polymers in packaging and medical prosthetics. Bioderadable polymers in medical field-Polymers application in medical devices.Polymers used in drug delivery. Environmental friendly microbial polymers, Polyhydroxyalkanoates(PHAs) for Packaging and biomedical applications

**UNIT V ATMOSPHERE PACKAGING FOR FOODS ANDOTHER INNOVATIONS 9**

Asceptic packaging of foods, sterilization of packaging materials, packaging of microwavable foods, Active and intelligent packaging, modified atmospheric packaging, packaging of fresh foods, horticultural products, dairy products, cereal, snack foods and confectionary, packaging of beverages, comparison of polymer packaging with paper, metal and glass materials, printing processes, safety and legislative aspect of packaging.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be aware of processing methods of polymers used for packaging applications
- Will develop capacity to understand polymers employed in various fields
- Will be able to discuss the application of polymers in packaging field

**TEXT BOOKS**


1. Gordon.L Robertson, Food Packaging, Taylor and Francis (2006)
2. SajidAlavi, Sabu Thomas, K. P. Sandeep, NandakumarKalarikkal, Jini Varghese,
3. SrinivasaraoYaragalla, "Polymers for Packaging Applications, 2014 by Apple Academic
4. Press
5. John R. Wagner, Jr., Crescent Associates, Inc., Rochester, Multilayer Flexible Packaging.
6. lsevier 2009
7. S.Ebnesajiod,W.Andrew Plastic films in food packaging, PDL ,2012.


**REFERENCE BOOKS**


1. ManasChanda, Salil K.Roy," Plastics Technology Hand book ", 2nd edition, Marcel Dekker,New York,1993.
2. H.F.Mark,(Ed)," Encyclopedia of polymer Science & Engineering". John Wiledy&Sons,New Yorik, 1989.


| PL7006 | INDUSTRIAL MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To acquire knowledge on man power planning, motivation and productivity.
- To learn the Industrial relations, public policies, leadership and management in the trade union.
- To understand the basic concepts of dynamics of conflict and collaboration and also on Workers participation and management**.**

**UNIT I MAN POWER PLANNING** **9**

Need – objectives – planning for future – manpower planning process- projecting manpower supply and demand at organizational level – developing manpower strategy - recruitment selection and induction – process of recruitment – selection tests – placement induction – orientation – training and development – training – management development – retraining – evaluation of training programme.

**UNIT II MOTIVATION AND PRODUCTIVITY** **9**

Issues in managing people – Maslow's need hierarchy – social needs and productivity – hygiene and motivators – motivational climate – demotivation – cases – performance appraisal – job performance and performance measurement – validity and reliability – methods – problems in Indian context – career planning – responsibility – process of career planning and development – advantages and limitations.

**UNIT III UNION MANAGEMENT PERSPECTIVE** **9**

Approaches to industrial relations – public policies – major events in international issues– perspectives for India – trade with development and functions – growth of trade unions – development – functions – structure – leadership and management in the trade union.

**UNIT IV DYNAMICS OF CONFLICT AND COLLABORATION** **9**

Process of conflict – types of conflict – interpersonal conflict – managing inter group relations and conflict – industrial conflict resolution – consultation- collective bargaining – types of bargaining – new collective bargaining –negotiation skills – trends in collective bargaining.

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**UNIT V WORKERS PARTICIPATION AND MANAGEMENT** **9**

Concept, strategies and practices –models in workers participation management – design and dynamics of anticipative forms – case studies– case study analysis – synthesis

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be able to manage industrial issues effectively.
- Will be concerned about labour laws and policies.

**TEXT BOOKS**

1. C.B. Memoria, Personnel Management, Himalaya Publishing Co., Bombay, 1985.
2. Robbins, The Management of Human Resource, Prentics, Hall, New Jersey, 1982

**REFERENCE BOOKS**

1. C.B. Memoria and S.Memoria, Dynamics of Industrial Relations in India, Himalaya Publishing co., Bombay, 1985
2. H.C. Lucas Jr., Information System Concepts for Management, McGraw Hill, Kogakusha, 1978.

| PL7007 | PLASTICS WASTE MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To make the student familiar with the polymer wastes and primary and secondary recycling.
- To acquaint the student with tertiary and quaternary recycling, recycling of plastics.
- To introduce to students with recycling of plastics.

**UNIT I POLYMER WASTES** **9**

Sources of plastics waste – definitions - generation of industrial plastic waste - plastic in solid waste; Separation of components in municipal refuse - separation process specific to plastics-legal aspects.

**UNIT II PRIMARY AND SECONDARY RECYCLING** **9**

Primary recycling – degradation of plastics – industrial practice; Secondary recycling – approaches to secondary recycling – mechanical reworking of plastic waste – chemical modification of mixed plastic waste – co-extrusion and co-injection moulding – waste plastics as fillers.

**UNIT III TERTIARY AND QUATERNARY RECYCLING** **9**

Tertiary recycling – chemicals from plastics waste – pyrolysis chemical decomposition of plastic waste; Quaternary recycling energy from plastics waste – incinerator – effect of plastics on the incineration process – plastics as land refill- blending of plastics waste with asphalt.

**UNIT IV RECYCLING OF PLASTICS** **9**

Recycling of plastics – surface refurbishing; Plastics aging – environmental aging – thermal aging – weathering – chemical degradation – ionizing radiation – wear and erosion; Biodegradation – biodegradable plastics – photodegradable plastics.

**UNIT V RECYCLING PROCESSES** **9**

Specific recycling processes –PET reprocessing – polyolefines – polystyrene – PVC – acrylics; Thermosets – PURS – phenolics – polyesters – epoxy resins – melamine and urea resins – recycling technologies

**TOTAL:45 PERIODS**

**OUTCOME**

- Will be aware of plastics waste management.
- Will develop techniques for recycling of plastics.
- Will develop concern for environment and develop skills to address the same.

**TEXT BOOKS**

1. Nabil Mustafa, Plastics Waste Management: Disposal, Recyling and Reuse, Marcel Dekker Inc., New York, 1993.
2. R. J. Ehrig, Plastic recycling: Products and Processes, Hanser Publishers, New York, 1992.

**REFERENCE BOOKS**

1. Jacob Leidner, Plastic waste: Recovery of Economic Value, Marcel Dekker Inc., New York, 1982.
2. John Scheirs, Plastics Recycling, John Wiley and Sons, New York, 1998.
3. Ann Christine, Albertsson and Samuel J. Huang, Degradable Polymers: Recycling of Plastics, Marcel Dekker Inc., New York, 1995.

| PL7010 | PROCESS INSTRUMENTATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To learn abouttemperature measurement and pressure, level and flow measurement.
- To acquaint the student physical property measurement in and process chemical analyzer.
- To know the importance of Indicating and recording instruments.

**UNIT I TEMPERATURE MEASUREMENT 9**

Differential expansion and fluid expansion types - resistance thermometers-thermoelectric pyrometers - radiation pyrometers - optical pyrometers- pyrometric cones- ultrasonic thin wire thermometer- location of temperature measuring devices in equipment

**UNIT II PRESSURE, LEVEL AND FLOW MEASUREMENT 9**

Liquid types and spring balanced type pressure measuring devices- manometer and sealed belt types of pressure measuring equipment- pressure transmitters - various types of level measuring equipment - volumetric, variable head meters for flow measurement- variable area meters - velocity and current meters- ultrasonic flow meters - mass meters.

**UNIT III PHYSICAL PROPERTY MEASUREMENT 9**

Density and specific gravity - viscosity and consistency - refractive index analysers - boiling point and flash point analyzers - thermal conductivity measurement - moisture measurement.

**UNIT IV PROCESS CHEMICAL ANALYZER 9**

Chromatographic analyzers, infrared analyzers, ultraviolet and visible radiation analyzers mass spectrometers, electro analytical instruments.

**UNIT V INDICATING AND RECORDING INSTRUMENTS 9**

Measurement to indicator transducers, analog and digital indicating and recordinginstruments, variables of importance to various industries and their measurement.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will have a basic understanding of the engineering concepts involved in the chemical industry.
- Knows the importance of in physical property measurement the industrial operations.
- Can associate the reactions that he has already learnt with the actual process in the industry

**TEXT BOOKS**

1. Eckman, D.P. – Industrial Instrumentation, CBS publishers 2004(Reprint).
2. Rebert, H. Perry –Chemical Engineering Hand Book, 8th Edn.,McGraw Hill Co.,Inc. New York, 2007.

**REFERENCE BOOKS**

1. A.E. Fribance – Industrial Instrumentation Fundamentals, McGraw Hill Co. New York, 1983.
2. William Dunn , Fundamentals of Industrial Instrumentation and Process Control, McGraw Hill Professional, 2005

| PL7011 | REACTION ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To train students in reaction kinetics and evaluation of reaction rate and reactors.
- To make the student conversant with the heat effects in reactors and reactor stability.
- To familiarize chemical equilibria and equilibrium constant to students

**UNIT I REACTION KINETICS AND EVALUATION OF REACTION RATE 9**

Reaction kinetics – rate equation – elementary, non-elementary reactions – mechanism – temperature dependence of reaction rates – analysis of experimentalreactordata – evaluation of reaction rate – integral and differential analysis forconstant and variable volume system.

**UNIT II REACTORS 9**

Ideal reactors – homogeneous reaction systems – batch, stirred tank andtubularflow reactor – design for multiple reactions – choice, yield, conversion, selectivity, reactivity – consecutive, parallel and mixed reactions.

**UNIT III HEAT EFFECTS IN REACTORS 9**

Heat effects in reactors – isothermal and non-isothermal homogeneous systems adiabatic reactors – rates of heat exchange for different reactors –design for constant rate heat input and constant heat transfer coefficient operation – batch and continuous reactors.

**UNIT IV REACTOR STABILITY 9**

Reactor stability – criteria for stability of reactors, limit cycles and oscillating reactions

**UNIT V CHEMICAL EQUILIBRIA AND EQUILIBRIUM CONSTANT 9**

Reaction equilibria – equilibrium in chemically reactive system – evaluation of equilibrium constant – effects of temperature on equilibrium – equilibrium composition evaluation.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will understand reaction kinetics.
- Will be able to comprehend heat effects in reactors and reactor stability.

- Will be aware of different reactors.
- Can grasp the idea of chemical equilibria and equilibrium constant

**TEXT BOOKS**

1. Octave Levenspiel, Chemical Reaction Engineering (3rd Edition), , John Wiley & Sons, 1998
2. J. M. Smith, Chemical Engineering Kinetics, McGraw Hill Inc.,3rd edition, New Delhi, 1981

**REFERENCE BOOKS**

1. Nauman E. Bruce, Chemical Reactor Design, John Wiley & Sons, New York, 1987.
2. H. Scott Fogler**, "**Elements of Chemical Reaction Engineering", (4th Edition) Prentice Hall, 2005.

| PL7012 | RUBBER TECHNOLOGY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To acquire knowledge in the Fundamentals of Rubber and Specialty Rubbers.
- To know about the Processing of Rubber and Manufacture of tyres and Tubes.
- To impart knowledge on rubbers used in Belting, hoses and Footwear.

**UNIT I FUNDAMENTALS OF RUBBER 9**

Criteria for a polymer to behave as a rubber – structure vsTg, chemical, mechanical and electrical properties – polymerization types and techniques involved in production of general purpose rubbers – ozone attack on rubbers– protection against oxidation - antioxidants – network bound antioxidants, vulcanization – mechanism of sulphur cure-effect of crosslink density on properties – role of accelerators, activators – non–sulphur vulcanization systems.

**UNIT II SPECIALTY RUBBERS 9**

Heat resistant rubbers –polyisobutylene, butyl and EPDM rubbers –solvent/oil resistantrubbers –nitrile, neoprene and chloroprene rubbers, EMA,ACM,EVA – hypalon andchlorinated PE – high performance, specialty and modified rubbers – fluorine containing and silicone rubbers, polyurethanes , polyethers, polysulphide, polyalkenomers and thermoplastic elastomers – reclaim, liquid and powdered rubbers, ebonites.

**UNIT III PROCESSING OF RUBBER 9**

Rubber processing – mixing operations – composition, concentration, stabilization, coagulation, open mill mixing, internal and continuous mixers – forming operations – calendaring – extrusion –spreading and moulding operations.

**UNIT IV MANUFACTURE OF TYRE AND TUBES 9**

Rubber product manufacture – tyres – functions, requirements – basic design reinforcing systems –construction – manufacture – aero tyres – building and curing of passenger car tyre, truck tyre, four wheeler tyre - testing – Defects and remedial measures - tube manufacture– compounding for tyre and tube.

**UNIT V BELTING, HOSES AND FOOTWEAR 9**

Belting and hoses – conveyor, transmission (V and flat) belting. troughing moulded, braided and hand–built hoses – compounding - footwear and ports goods – hot air vulcanized – compression moulded – direct molded process for shoe bottoming – injection moulded sole and heel units – safety and antistatic foot wear – micro and macrocellular rubbers – expanding rubber by nitrogen gassing and chemical blowing agents– tennicoit rings

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be aware of preparation and properties of rubbers.
- Will be conversant in manufacture and properties of tyres and Tubes.
- Will develop capacity to appreciate the applications of rubber.

**TEXT BOOKS**


1. M.Morton, Rubber Technology, Van Nostrand Reinhold, 1987.
2. A.K. Bhowmick and H.L.Stephens, Hand Book of Elastomers, Marcel Dekker, New York, 1988.
3. J. A. Brydson, Plastic Materials, Elsevier Publishers Group, 2014.


**REFERENCE BOOKS**


1. C. M. Blow and C.Hepburn, "Rubber Technology and Manufacture", 2rd Edn.,Butterworths, London, 1982.
2. A. Whelan, Injection Moulding Machine, Elsevier Publications, London, 1989.
3. B. Kothandaraman, Rubber Materials, Ane Books Pvt. Ltd., New Delhi, 2008.
4. J.M. Martin, W.K.Smith, Handbook of Rubber Technology, Vol. 1 & 2, CBS Publishers & Distributors, 2004
5. M.Morton, Rubber Technology, Van Nostrand Reinhold, 1987.


| PL7014 | SYNTHETIC FIBRES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To introduce the textile process and also teach about manufacture of fibre forming polymers.
- To make the student conversant with the manufacture of filament fibre and Manufacture of Staple fibre.
- To teach Texturization.

**UNIT I INTRODUCTION TO TEXTILE PROCESS 9**

Classification of fibres, yarn manufacture, fabric manufacture, wet processing of textile, testing of textile materials.

**UNIT II MANUFACTURE OF FIBRE FORMING POLYMERS 9**

Polymer production - fibre forming polymers – properties, characterization - production of polyethylene terephthalate (PET), polyester, nylon, polyacrylonitrile and polypropylene.

**UNIT III MANUFACTURE OF FILAMENT FIBRE 9**

Filament fibre manufacture - melt, wet and dry spinning of polymers- spin finishes – functions, constitution and application - post spinning operations – drawing and winding.

**UNIT IV MANUFACTURE OF STAPLE FIBRE 9**

Staple fibre manufacture - production of staple fibres – drawing of tow, heat setting, crimping and cutting - tow to top converters – advantages, principles and working of machines.

**UNIT V TEXTURIZATION 9**

Texturization - introduction, methods, false twist texturing, air jet texturing, comparison.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be up to date with the preliminary preparation of fibers.
- Will have clear understanding of the concept of dyeing.
- Will be familiar the machinery and stages involved in textile processing.



Attested

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**TEXT BOOKS**

1. A.A.Vaidya, Production of Synthetic Fibres, Prentice Hall of India Pvt. Ltd., New Delhi 1988.
2. V.B.Gupta and K.K.Kothari (Ed), Man-made Fibres Production, Processing Structure, Properties and Applications, Vol. I and II, Dept. of Textile Technology, IIT, New Delhi 1988.

**REFERENCE BOOKS**

1. H.F. Mark,S.M.Atlas and E.Cernia (Ed), Man-made Fibres -Science and Technology, Vol . I to III, Interscience publishers, New York, 1987.
2. V.Usenko, Processing of Man-made Fibres, MIR publishers, Moscow, 1985.
3. MenachemLewin and Eli M.Pearce, (Ed), Hand book of Fibre Science and Technology, Vol IV Fibre chemistry, Marcel Dekker Inc., New York, 1985.
4. T.Nakajima, Advanced Fibre Spinning Technology, Wood head, S.B. Leed, 1994.
5. S.B. Warner, Fibre science, Prentice Hall, 1995.

**PL7008 POLYMERS FOR BIOMEDICAL ENGINEERING APPLICATIONS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**OBJECTIVE**

- To acquire a knowledge of various types of biopolymers and their advantages and needs.
- To understand the various types of bio-materials and their applications for bio-medical engineering.
- To understand the knowledge of various bio-materials used in processing of components and the basic destructive and non-destructive testing of such bio-materials.

**UNIT I MATERIALS IN MEDICINE** **9**

Introduction to classes of materials used in medicine, world-wide market for biomaterials, clinical implications of biomaterials development.Types of materials-inert, toxic, bioactive, natural materials - collagen, biopolymers etc. Introduction to biocompatibility, requirements and standards, cell-material interaction, testing of biomaterials, in vitro assessment, in vivo assessment of tissue compatibility, testing of blood-materials interaction, animal models.

**UNIT II BIO POLYMERS** **9**

Polymers as biomaterials, silicones, polyurethanes, polyvinyl chloride, polyethylenes, Ultra high molecular weight polyethylene, polyacrylates, polyether ether ketone, water soluble polymers, hydrogels, bio-adhesives, diffusion principles, polymers for controlled drug delivery applications, polysaccharides, poly(orthoesters), polyanhydrides, aminoacid derived polymers, polyphosphazenes, bacterial polyesters etc.

**UNIT III COMPOSITES IN BIOMEDICAL APPLICATIONS** **9**

Concepts of polymer composites, composites - reinforcing systems-fabrication, mechanical properties, dental filling composites, fibrous and particulate composites in orthopedic implants.Biomimetic materials, nanoscale materials/engineering; bioactive/bioresponsive materials, polymer scaffolds, principles of tissue engineering.

**UNIT IV MEDICAL DEVICES 9**

Medical devices, medical device development, material choice, device design, extracorporealdevices, oxygenators, intravenous catheters, stents, polymeric implants, heart valves, total artificial heart, cardiac pace makers, vascular grafts, artificial kidney, dialysis membranes, hard tissueimplants, orthopedic implants, fracture plates, intramedullary devices, spinal fixation, joint replacements, bone cement, soft tissue replacements, wound dressing, artificial skin, sutures, contact lenses, tissue adhesives, maxillofacial implants, ear and eye implants, controlled drug delivery systems, biosensors, gloves, condoms, urinary catheters, intrauterine systems, cosmetic implants. Regulation and standards for quality, FDA, EU-medical directives, GMP, GLP, ISO, CE marking etc.

**UNIT V MODIFICATION TECHNIQUES 9**

Surface modification techniques, plasma modifications, coating methods. Sterilization methods, dry heat, steam, ethylene oxide, gamma ray, effect of sterilization on polymers, importance of packaging, shelf-life.

**TOTAL: 45 PERIODS**

**OUTCOME**

- Will be aware of preparation and properties of bio-polymers.
- Will be able to use bio-polymeric materials for making components..
- Will be able to appreciate the basic destructive and non-destructive testing of bio-polymeric materials.

**TEXT BOOKS**

1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons, Biomaterial Science: An Introduction To Materials In Medicine, (2012)
2. ShishirSinha|Naveen Kumar Navani|Ex. Ed. J.N. GovilNanotechnology Biomaterials**,** Vol. 11 (2014).

**REFERENCE BOOKS**

1. Sabu Thomas, Dominique Durand, Christophe Chassenieux, P. JyotishkumarHandbook of bio-polymer based materials, Technology & Engineering(2013), John Wiley & Sons.
2. Plackett, D. (2011), Biopolymers: New Materials for sustainable films & Coatings, John Wiley & Sons
3. D.L. Wise et al. Eds., Encyclopedic handbook of Biomaterials and Bioengineering, Part A. Materials & part B. Applications, Volume 1 &2, Marcel Dekker Inc, BPS 2305

**PL7015 TOTAL QUALITY MANAGEMENT L T P C**

**3 0 0 3**

**OBJECTIVE**

To provide comprehensive knowledge about the principles, practices, tools and techniques of Total quality management.

**UNIT I CONCEPTS OF TQM 5**

Philosophy of TQM, Customer focus, organization, top management commitment, team work, quality philosophies of Deming, Crosby and Muller.

**UNIT II TQM PROCESS 12**

QC Tools, Problem solving methodologies, new management tools, work habits, quality circles, bench marking, strategic quality planning.

**UNIT III TQM SYSTEMS 8**

Quality policy deployment, quality function deployment, Standardization, designing for quality, manufacturing for quality.

**UNIT IV QUALITY SYSTEM 10**

Need for ISO 9000 system, Advantages, clauses of ISO 9000, Implementation of ISO 9000, quality costs, quality, auditing, case studies.

**UNIT V IMPLEMENTATION OF TQM 10**

Steps, KAIZEN, 5s, JIT, POKAYOKE, Taguchi methods, case studies.

**TOTAL : 45 PERIODS**

**OUTCOME**

- To under the various principles, practices of TQM to achieve quality
- To learn the various statistical approaches for quality control.
- To understand the TQM tools for continuous process improvement.
- To learn the importance of ISO and Quality systems

**REFERENCES**


1. Rose J. E., “Total quality Management”, Kogan Page Ltd, 1999.
2. Bank, J., “The essence of Total Quality Management”, Prentice Hall of India, 1993.
3. Bonds, G., “Beyond Total Quality Management”, McGraw Hill, 1994.
4. Osada, T., “The 5S’s, The Asian Productivity Organisation”, 1991.