UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY : : CHENNAI 600 025

REGULATIONS - 2013

I TO IV SEMESTERS CURRICULUM AND SYLLABUS (FULL TIME)

M.TECH. POLYMER SCIENCE AND ENGINEERING

SEMESTER I

COURSE CODE	COURSE TITLE	L	T	P	C
THEORY					
PL8101	Polymer Chemistry	3	0	0	3
PL8102	Polymer Process Engineering	3	0	0	3
PL8103	Science of Polymeric Materials	3	0	0	3
	Elective I	3	0	0	3
	Elective II	3	0	0	3
LABORATORY					
PL8111	Polymer Science Laboratory	0	0	4	2
	TOTAL CREDITS	**15**	**0**	**4**	**17**

SEMESTER II

COURSE CODE	COURSE TITLE	L	T	P	C
THEORY					
PL8201	Characterization and Testing of Polymers	3	0	0	3
PL8202	Instrumentation in Polymer Industries	3	0	0	3
PL8203	Polymer Process Technology	3	0	0	3
	Elective III	3	0	0	3
	Elective IV	3	0	0	3
LABORATORY					
PL8211	Polymer Processing and Testing Laboratory	0	0	6	3
PL8212	Seminar	0	0	2	1
	TOTAL CREDITS	**15**	**0**	**8**	**19**

SEMESTER III

COURSE CODE	COURSE TITLE	L	T	P	C
THEORY					
	Elective V	3	0	0	3
	Elective VI	3	0	0	3
	Elective VII	3	0	0	3
LABORATORY					
PL8311	Industrial Training (4 weeks)	0	0	0	2
PL8312	Project work (Phase I)	0	0	12	6
	TOTAL CREDITS	**9**	**0**	**12**	**17**

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SEMESTER IV

COURSE CODE	COURSE TITLE	L	T	P	C
PL8411	Project Work (Phase II)	0	0	24	12
	TOTAL CREDITS	**0**	**0**	**24**	**12**

ELECTIVES FOR M.TECH. (POLYMER SCIENCE AND ENGINEERING)

COURSE CODE	COURSE TITLE	L	T	P	C
PL8001	Adhesive Science and Technology	3	0	0	3
PL8002	Biopolymers and Biodegradable Polymers	3	0	0	3
PL8003	Composites	3	0	0	3
PL8004	Computer Aided Design	3	0	0	3
PL8005	Conducting Polymers	3	0	0	3
PL8006	Engineering Plastics	3	0	0	3
PL8007	Heat, Mass and Momentum Transport Processes	3	0	0	3
PL8008	Industrial Management	3	0	0	3
PL8009	Plastics Waste Management	3	0	0	3
PL8010	Process Instrumentation	3	0	0	3
PL8011	Reaction Engineering	3	0	0	3
PL8012	Rubber Technology	3	0	0	3
PL8013	Synthetic Fibers	3	0	0	3
PL8014	Synthetic Resins	3	0	0	3
PL8015	Total Quality Management	3	0	0	3

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PL8101 **POLYMER CHEMISTRY** **L T P C**
3 0 0 3

OBJECTIVES

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

OUTCOME : THE STUDENT

- 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.

UNIT I FUNDAMENTALS OF POLYMERS 10

Basics – polymer classifications based on- occurrence, types, process, structure and end uses. Polymer microstructure-chemical and geometrical structure - ladder, star and telechelic polymers – interpenetrating networks –tacticity –Polymers- crystalline-amorphous nature-crystallization.- crystallizability-effect on properties - thermal transitions–TGA,DSC ,HDT,MFI.

UNIT II BIO AND INORGANIC POLYMERS 9

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

UNIT III CHAIN POLYMERIZATION 9

Kinetics and mechanism of free radical, cationic, anionic and coordination polymerization – Ziegler Natta catalysts-monometallic mechanism- stereo regular polymerization - chain transfer reaction and constant – living polymers – Alfin catalysts – iniferters.

UNIT IV STEP GROWTH POLYMERIZATIONS AND COPOLYMERIZATION 9

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

UNIT V MOLECULAR WEIGHT, SOLUBILITY AND FRACTIONATION OF POLYMERS 9

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 - 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.

TOTAL : 45 PERIODS

REFERENCES

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. M.S.Bhatnagar, " A Text Book of Polymers (chemistry and Technology of polymers), Vol I, II & III, 1st Edn., S.Chand and Company, New Delhi, 2007.
5. PremamoyGhosh ," Polymer Science and Technology, 2nd edition,McGraw-Hill Publishing Company Limited, New Delhi,2003.

PL8102 POLYMER PROCESS ENGINEERING L T P C
3 0 0 3

OBJECTIVES

- 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

OUTCOME : THE STUDENT

- 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

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, Banbury Mixer, 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

REFERENCES

1. D.H. Morton-Jones, Polymer Processing, Chapman and Hall, London,1989.
2. Crawford R.J. Plastics Engineering, Butterworth - Heinemann, 3rd Edition, 2005.
3. Richard G.Griskey, Polymer Process Engineering, Chapman and Hall, 1995.
4. Friedhelm Hansen, Plastics Extrusion Technology, 2nd Edition, Hanser Publishers, 1997.
5. Peter Powell, A. Jan IngenHouz, Engineering with Polymers, Stanley Thomas Publishers Ltd., 2nd Edn. 1998.

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PL8103 SCIENCE OF POLYMERIC MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVES

- 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.

OUTCOME : THE STUDENT

- 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.

UNIT I INTRODUCTION **9**

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

REFERENCES

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.
4. Bever, Encyclopedia of Materials Science and Engg., Volume 7, Pergamon press, London, 1986.
5. L. H. Sperling,"Introduction to physical polymer science, 4th edn, Wiley, 2005.

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PL8111	POLYMER SCIENCE LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES

- 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.

OUTCOME : THE STUDENT

- Will be aware of 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.

UNIT I **16**

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

UNIT II **10**

Kinetics of polymerization – dilatometry, gravimetry.

UNIT III **14**

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

UNIT IV DeterminationMolecular weight **10**

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

UNIT V **10**

Fractionation of polymers – Fractional precipitation method – polydispersity

TOTAL : 60 PERIODS

REFERENCES

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

PL8201	CHARACTERISATION AND TESTING OF POLYMERS	L	T	P	C
		3	0	0	3

OBJECTIVES

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

OUTCOME : THE STUDENT

- 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.

UNIT I CHARACTERIZATION TESTS 11

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 7

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

TOTAL : 45 PERIODS

REFERENCES

1. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.
2. B. Sivasankar, Engineering Chemistry, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2008.
3. Vishu Shah, Hand book of Plastics Testing and Failure Analysis, 3rd Edition, John-Willey &Sons, New York, 2007.
4. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastics, Allied Publishers Pvt. Ltd., New Delhi, 2003
5. A. Ya. Malkin, A.A. AskaDsky, V.V. Koverica Experimental methods of polymers, Mir Publishers, Mascow, 1998.
6. Iver, Mead and Riley, Hand book of Plastic test methods, Illith Publishers, New York, 1982.

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PL8202	INSTRUMENTATION IN POLYMER INDUSTRIES	L	T	P	C
		3	0	0	3

OBJECTIVES

- 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.,

OUTCOME : THE STUDENT

- 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.

UNIT I **6**

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

UNIT II **10**

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 **10**

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 **9**

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

UNIT V **10**

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

TOTAL : 45 PERIODS

REFERENCES

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

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PL8203	POLYMER PROCESS TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

- 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.

OUTCOME : THE STUDENT

- 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.

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, butyl rubber, polypropylene, PVC and PET – copolymerization techniques – SBR and ABS.

UNIT IV POLYMER PROCESSING 9

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

REFERENCES

1. John Brydson, Plastic materials, 7th edition, Butterworth – Heinamann Ltd., London, 1999.
2. John Murphy, Additives for Plastics Handbook, 2nd edition, Elsevier Advanced Technology, 2003.
3. J.A. Biesenberger and H.Sebastian, Principles of Polymerization Engineering, Wiley- Interscience Publication, New York, 1988.
4. D.H. Morton and Jones, Polymer Processing, Chapman and Hall, London, 1989.
5. Joel. R. Fried. Polymer Science and Technology,2nd edn, PHI Learning Private Limited, New Delhi-1, 2009.
6. Stephen L. Rosen, Fundamental Principles of Polymeric Materials, 2nd edition, John Wiley and Sons Inc., New York, 1993.

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PL8211	POLYMER PROCESSING AND TESTING LABORATORY	L	T	P	C
		0	0	6	3

OBJECTIVES

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

OUTCOME : THE STUDENT

- 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.

UNIT I PROCESSING OF POLYMERS

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

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

UNIT III THERMAL PROPERTIES

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

UNIT IV ELECTRICAL PROPERTIES

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

UNIT V OPTICAL PROPERTIES

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

UNIT VI MATERIAL CHARACTERIZATION

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.

UNIT VIII ANALYTICAL TESTS

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

UNIT IX ANALYSIS OF PLASTICS

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

TOTAL : 60 PERIODS

REFERENCES

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.

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3. J.V. Schmitz (Ed) Testing of Polymers, Vol. 1 –3 , Wiley – Interscience, New York, 1965, 1966, 1968.
4. G.C. Ives, J.A. Mead and M.M. Riley, Handbook of Plastics Test Methods, Illith Publishers, London, 1982,
5. J. Haslam, H.A. Willis and D. Squirrell, Identification and Analysis of Plastics. 2nd Edn.,Iliffe Book, Butterworth, London, 1983.

PL8001 ADHESIVE SCIENCE AND TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES

- 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.

OUTCOME : THE STUDENT

- 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.

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, wetting and setting, thermodynamic work of adhesion – influence of constitution on adhesion – 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

REFERENCES

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.
3. A. J. Kinloch, Adhesion and Adhesive Science and Technology, Springer, 1987.
4. I Skeist, 3rd Edition, Handbook of Adhesives, Van Nostrand Reinhold, New York, 1990
5. A.V. Pocius, Adhesion and Adhesives Technology, Hanser, 2002

6. P. Ghosh, Adhesives and Coatings Technology, Tata-McGraw-Hill Publishing Company Limited, New Delhi, 2008.

PL8002 BIOPOLYMERS AND BIODEGRADABLE POLYMERS L T P C
3 0 0 3

OBJECTIVES

- 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.

OUTCOME : THE STUDENT

- 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.

UNIT I SYNTHETIC BIODEGRADABLE POLYMERS 11

Biodegradable polymers - polyε-caprolactone- modified poly ε-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 α-amino acid (glycine, serine), ε-aminocaproic acid. Benzyl substituted urethane – polyester urea – polyamide urethane - synthesis and properties. γ -polyglutamic acid, bacterial polyesters. Applications – agriculture, medicine, packaging.

UNIT II PRINCIPLES OF BIODEGRADATION 9

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

UNIT III DISPOSAL OF MUNICIPAL WASTE 8

Disposal of solid 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 BIOPOLYMERS

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

REFERENCES

1. J.Guillet, Polymers and Ecological problems, Plenum Press, New York, 1973.
2. W.Schnabel, Polymer Degradation – Principles and Practical Applications, Hanser International, 1982.
3. L.L.Hench, E.C. Ethridge, Biomaterials – An Interfacial Approach, Biophysics and Biotechnology Series, Vol 4, Academic Press, New York, 1982.
4. Jens Nielsen, John Villadsen and Gunnar liden, Bioreaction Engineering Principles, 3rded, Springer. 2011.
5. Charles Gebelein, Biotechnological Polymers: Medical, pharmaceutical and industrial applications, CRC press,1993.

PL8003 COMPOSITES

L	T	P	C
3	0	0	3

OBJECTIVES

- 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.

OUTCOME : THE STUDENT

- Will be aware of preparation and properties of composites.
- Will be able to use fiber materials for making composites..
- Will be able to appreciate the basic destructive and non-destructive testing of composites.

UNIT I INTRODUCTION **8**

Characteristics, advantages, and need of composites – Classification – particulate, fibrous, laminated, advanced and hybrid composites, CCCs, nano composites, flexible composites.

UNIT II MATERIALS **10**

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, 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 NANO COMPOSITES **9**

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

TOTAL : 45 PERIODS

REFERENCES

1. BorZ.Jang, Advanced Polymer composites, ASM International, USA, 1994.
2. Donald F. Adams, Leif Carlsson A Carlsson, R. Byron Pipes Experimental Characterization of advanced composite materials, Third Edition, CRC PressINC, 2003.
3. George Lubin, Stanley T. Peters , Handbook of Composites, Chapman & Hall, 1998.
4. Richard M. Christensen, Mechanics of composite materials, Dover Publications, New York, 2005.
5. Carbon fibers: formation, structure, and properties, Leighton H. Peebles, CRC Press, 1995.
6. Sanjay K. Mazumdar, Composites Manufacturing: Materials, Product, and Process Engineering, CRC Press INC, 2002.
7. Nanocomposite Science and Technology. Edited by P.M. Ajayan, L.S. Schadler, P.V. Braun ,2003 , WILEY-VCH Verlag GmbH Co. KGaA, Weinheim
8. Polymer matrix nano composites, processing, manufacturing, and application: An overview, F. Hussain, M.Hojjati, M. Okamoto, R.E. Gorga, J. Comp. Mater., 40, 1511-1575, 2006

PL8004 COMPUTER AIDED DESIGN

L	T	P	C
3	0	0	3

OBJECTIVES

- 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**.**

OUTCOME : THE STUDENT

- 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.

UNIT I COMPUTER GRAPHICS FUNDAMENTALS **10**

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

UNIT II INTERACTIVE COMPUTER PROGRAMMING **10**

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 **10**

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

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UNIT IV MECHANICAL ASSEMBLY **5**

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

UNIT V PROTOTYPING, PROCESS PLANNING AND CAD CAM INTEGRATION **10**

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

TOTAL : 45 PERIODS

REFERENCES

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

PL8005	CONDUCTING POLYMERS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To acquire a knowledge of chemistry on conducting polymers and its conductivity.
- 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.

OUTCOME : THE STUDENT

- Will get a basic idea about conducting polymers.
- Will be able to synthesise conducting polymers.
- Will be able to characterize and analyse the properties of conducting 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 – van der Pauw technique – factors affecting conductivity.

UNIT II SYNTHESIS, PROCESSING AND APPLICATIONS OF CONDUCTING POLYMERS **12**

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 CONDUCTING POLYMERS **7**

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

Attested

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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 OF CONDUCTING POLYMERS 8

UTM, Dilatometry, TGA, DTA, DSC and DMA

TOTAL : 45 PERIODS

REFERENCES

1. T.A. Skotheim, R.L. Elsenbaumer and J.R. Reynolds, Hand book of Conducting Polymers – 2nd Edn, Revised and enlarged, Marcel Dekker Inc., New York, 2007.
2. J.M. Margolis (Ed.), Conducting Polymers and Plastics, Chapman and Hall, London, 1989.
3. R.B. Seymour, edr.,Conductive Polymers", Plenum Press, New York, 1981.
4. B. Wessling, Electronic Properties of Conjugated Polymers, Vol.3, Springer, Berlin, 1989.
5. H.G. Kiess (Edr.), Conjugated Conducting Polymers, Springer, Berlin, 1992. D.S.Soane and Z. Martynenko (Eds.), Polymers in Microelectronics, Elsevier, Amsterdam, 1989.

PL8006 ENGINEERING PLASTICS

L	T	P	C
3	0	0	3

OBJECTIVES

- To acquireknowledge of polymers meant forelectrical, 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

OUTCOME : THE STUDENT

- 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.

UNIT I POLYMERS FOR ELECTRICAL AND ELECTRONICS APPLICATIONS 10

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 10

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 10

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 10

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 5

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

TOTAL : 45 PERIODS

REFERENCES

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.
4. C.P.Wong, Polymers for Electronic and Photonic Applications, Academic Press, New York, 1993.

PL8007	HEAT, MASS AND MOMENTUM TRANSPORT PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVES

- 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.

OUTCOME : THE STUDENT

- 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 ofmass transfer.

UNIT I MOMENTUM TRANSPORT PROCESS 10

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 8

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

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UNIT IV CONVECTIVE HEAT TRANSFER PROCESS 8

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 10

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

REFERENCES

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.
3. 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).
4. C.J. Geankoplis, Transport Processes – Momentum, Heat and Mass(Allyn and Bacon Inc), Boston, USA 1983.

PL8008 INDUSTRIAL MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES

- 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**.**

OUTCOME : THE STUDENT

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

UNIT I MAN POWER PLANNING 12

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 12

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 7

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 7

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.

UNIT V WORKERS PARTICIPATION AND MANAGEMENT 7

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

TOTAL : 45 PERIODS

REFERENCES

1. C.B. Memoria, Personnel Management, Himalaya Publishing Co., Bombay, 1985.
2. Robbins, The Management of Human Resource, Prentics, Hall, New Jersey, 1982
3. C.B. Memoria and S.Memoria, Dynamics of Industrial Relations in India, Himalaya Publishing co., Bombay, 1985
4. H.C. Lucas Jr., Information System Concepts for Management, McGraw Hill, Kogakusha, 1978.

PL8009 PLASTICS WASTE MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES

- 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.

OUTCOME : THE STUDENT

- 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.

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

REFERENCES

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

PL8010 PROCESS INSTRUMENTATION L T P C
3 0 0 3

OBJECTIVES

- 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.

OUTCOME : THE STUDENT

- 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

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 recording instruments, variables of importance to various industries and their measurement.

TOTAL : 45 PERIODS

REFERENCES

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

PL8011 REACTION ENGINEERING L T P C
3 0 0 3

OBJECTIVES

- 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

OUTCOME : THE STUDENT

- 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

UNIT I REACTION KINETICS AND EVALUATION OF REACTION RATE 12

Reaction kinetics – rate equation – elementary, non-elementary reactions – mechanism – temperature dependence of reaction rates – analysis of experimental reactor data – evaluation of reaction rate – integral and differential analysis for constant and variable volume system.

UNIT II REACTORS 9

Ideal reactors – homogeneous reaction systems – batch, stirred tank and tubular flow 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

REFERENCES

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

PL8012 RUBBER TECHNOLOGY **L T P C**
3 0 0 3

OBJECTIVES

- 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.

OUTCOME : THE STUDENT

- 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.

8

UNIT I FUNDAMENTALS OF RUBBER

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

10

UNIT II SPECIALTY RUBBERS

Heat resistant rubbers –polyisobutylene, butyl and EPDM rubbers – solvent/oil resistant rubbers –nitrile, neoprene and chloroprene rubbers, EMA,ACM, EVA – hypalon and chlorinated 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.

8

UNIT III PROCESSING OF RUBBER

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

7

UNIT IV MANUFACTURE OF TYRE AND TUBES

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.

12

UNIT V BELTING, HOSES AND FOOTWEAR

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

REFERENCES

1. M.Morton, Rubber Technology, Van Nostrand Reinhold, 1987.
3. A.K. Bhowmick and H.L.Stephens, Hand Book of Elastomers, Marcel Dekker, New York, 1988.
4. J. A. Brydson, Rubbery Material and their Compound', Kluwer Academic Publishers Group, 2001.
5. C. M. Blow and C.Hepburn, "Rubber Technology and Manufacture", 2rd Edn.,Butterworths, London, 1982.
6. A. Whelan, Injection Moulding Machine, Elsevier Publications, London, 1989.
7. B. Kothandaraman, Rubber Materials, Ane Books Pvt. Ltd., New Delhi, 2008.
8. J.M. Martin, W.K.Smith, Handbook of Rubber Technology, Vol. 1 & 2, CBS Publishers & Distributors, 2004
9. M.Morton, Rubber Technology, Van Nostrand Reinhold, 1987.

PL8013 SYNTHETIC FIBRES

L	T	P	C
3	0	0	3

OBJECTIVES

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

OUTCOME : THE STUDENT

- 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.

UNIT I INTRODUCTION TO TEXTILE PROCESS **5**

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

UNIT II MANUFACTURE OF FIBRE FORMING POLYMERS **15**

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

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UNIT III MANUFACTURE OF FILAMENT FIBRE 15

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 5

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 5

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

TOTAL : 45 PERIODS

REFERENCES

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.
3. 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.
4. V.Usenko, Processing of Man-made Fibres, MIR publishers, Moscow, 1985.
5. MenachemLewin and Eli M.Pearce, (Ed), Hand book of Fibre Science and Technology, Vol IV Fibre chemistry, Marcel Dekker Inc., New York, 1985.
6. T.Nakajima, Advanced Fibre Spinning Technology, Wood head, S.B. Leed, 1994.
7. S.B. Warner, Fibre science, Prentice Hall, 1995.

PL8014 SYNTHETIC RESINS

L	T	P	C
3	0	0	3

OBJECTIVES

- 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.

OUTCOME : THE STUDENT

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

UNIT I CLASSIFICATION OF POLYMERS 10

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 10

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 10

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

UNIT IV THERMOSETTING RESINS 10

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

UNIT V RUBBERS, FIBERS AND PLASTICS 5

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

REFERENCES

1. J.A. Brydson, Plastics Materials, Newness - Butterworths, Seventh Edn, London, 1999.
2. R.L.Davidson and S. Marshall, Water Soluble Resins, Van-Nostrand Reinhold, New York, 1988.
3. R.B. Seymour and C.E.Carraher, Jr., Polymer Chemistry – An Introduction, Marcel Dekker Inc., New york, 2006.
4. Maurice Morton, Rubber Technology, Van Nostrand Reinhold, New York, 2002.

PL8015	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To impart knowledge on the theory of quality control**,** quality capability study.
- To introduce knowledge on quality assurance and acceptance, sampling plans and tables.
- To acquaint the students about quality engineering, reliability and maintainability in enterprises management.

OUTCOME : THE STUDENT

- Will develop management skills.
- Will build up concern for quality and its maintenance.

UNIT I 9

Introduction to quality control theory - elements of quality, fundamentals of statistics and probability in quality control –measures of central tendency on-normal distribution – significance tests – difference between means. binomial, Poisson distributions – Thorndike chart – hyper geometric distribution.

UNIT II 9

Control of process quality – principles of control – quality capability analysis – quality capability study – average range method for determining process capability – control of variable quality – characteristics – theory of control charts –control limits- types of control charts – control chart for variables –X and R control charts – control charts for attributes – P. Chart, C. Charts.

UNIT III **9**

Quality assurance and acceptance – acceptance sampling-operating characteristics curve – development of single sampling plan, concept of AQL, LTPD producers and consumers risk – average outgoing quality (AOQ) curve. Other acceptance sampling plans – sampling tables.

UNIT IV **9**

Quality engineering – planning for quality and reliability – quality standards – specification of inspection methods, setting of standard quality levels – introduction to ISO-9000 –design of quality experiments using statistics –analysis of variance.

UNIT V **9**

Reliability and maintainability – definition of reliability, factors affecting reliability – MTTF –MTBF – evaluation of reliability, quality management – organising for quality – economy of quality- techniques of ABC analysis- quality management education – zero defects concept – quality circles concept- applying total quality management in enterprises.

TOTAL :45 PERIODS

REFERENCES

1. A.J. Ducan, Quality Control and Industrial Statistics, Homewood, Illinois, 1959.
2. A.V.Feigenbaum, Total Quality Control, McGraw Hill Co. New York, 1961
3. B.L. Hansen, Quality Control: Theory and Applications, Prentice-Hall, New Jersey, 1966.
4. H. Lal, Total Quality Management –A Practical Approach, 2nd ed,Wiley Eastern, New York, 1990

Attested

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