ANNA UNIVERSITY:: CHENNAI 600 025
AFFILIATED INSTITUTIONS
M.TECH POLYMER SCIENCE AND ENGINEERING
REGULATIONS – 2017
CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

- PEO1: Graduates will be technically adept in Polymer Science & Engineering and acquire up-to-date knowledge and skills for professional success.
- PEO2: Graduates will exhibit appropriate interpersonal skills as demonstrated by effectively working on teams and effectively communicating in the workplace.
- PEO3: Graduates will exhibit a professional work ethic including an interest in personal and professional growth.
- PEO4: Graduates will be aware of how their professional role will impact the global community.

PROGRAMME OUTCOMES (PO)

A graduate of this major should be able to:

a. **Engineering Knowledge**: Select and apply the knowledge, techniques, skills, and modern tools of polymer Science and engineering to broadly defined polymer engineering activities.
b. **Problem Analysis**: Select and apply knowledge of mathematics, science, engineering, and technology to polymer science and engineering problems that require the application of principles and applied procedures or methodologies.
c. **Design/development of solutions**: conduct standard tests and measurements; conduct, analyze, and interpret experiments; and apply experimental results to improve processes.
d. **Conduct investigations of complex Problems**: design systems, components, or processes for broadly defined polymer science and engineering problems.
e. **Modern Tool Usage**: select and apply appropriate techniques, resources and modern polymer science and engineering tools
f. **The Engineer and Society**: understand the need for and engage in self-directed continuing professional development.
g. **Environment and Sustainability:** understand the impact of polymer science and engineering solutions in a societal and global context
h. **Ethics:** demonstrate an understanding of and a commitment to professional and ethical responsibilities, including a respect for diversity
i. **Individual and team work**: function effectively as a member or leader on a technical team.
j. **Communication:** communicate effectively regarding broadly defined polymer science and engineering activities..
k. **Project Management and Finance**: Demonstrate knowledge and understanding of engineering and management principles and apply these to polymer engineering work
l. **Life-long learning:** exhibit a commitment to quality, timeliness, and continuous improvement.

PROGRAMME SPECIFIC OUTCOMES (PSO)

m. **Research:** To apply basic principles of polymer science and engineering in various inter-discipline fields to engage various levels of research activity

n. **Placement and Entrepreneur:** Learn future technologies through acquired foundation skills and knowledge and employ them in industry and business environments

PEO/PO MAPPING

PEO	a	b	c	d	e	f	g	h	i	j	k	l	m	n
PEO 1	✓	✓		✓			✓			✓		✓	✓	✓
PEO 2			✓		✓				✓		✓		✓	✓
PEO 3								✓		✓	✓	✓	✓	✓
PEO 4						✓	✓		✓	✓	✓		✓	✓

SEMESTER COURSE WISE PO MAPPING

Year	Sem	Course Title	a	b	c	d	e	f	g	h	i	j	k	l	m	n
I	I	Polymer Chemistry	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓
		Polymer Processing Technology	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓
		Thermoplastic Materials	✓	✓								✓	✓	✓	✓	✓
		Polymer Additives and Compounding	✓	✓			✓				✓	✓	✓	✓	✓	✓
		Polymer Science Laboratory	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓
		Polymer Processing Laboratory	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓
	II	Characterization and Testing of Polymers	✓	✓		✓	✓				✓	✓	✓	✓	✓	✓
		Polymer Composites	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓
		Polymer Products and Mould and Die Design			✓	✓	✓					✓	✓	✓	✓	✓
		Rubber Technology	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓
		Polymers in Engineering	✓	✓					✓			✓	✓	✓	✓	✓
		Polymer Testing Laboratory	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓
		Seminar	✓		✓		✓				✓	✓	✓	✓	✓	✓
II	III	Project Work (Phase-I)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	IV	Project Work (Phase-II)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

PROFESSIONAL ELECTIVES (PE) MAPPING

Course Title	a	b	c	d	e	f	g	h	i	j	k	l	m	n
Adhesive Science and Technology	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓
Bio Polymers and Biodegradable Polymers	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓
Computer Aided Design			✓	✓	✓	✓				✓	✓	✓	✓	✓
Conducting Polymers	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓
Specialty Polymers	✓	✓					✓			✓	✓	✓	✓	✓
Polymers for Packaging Applications	✓		✓	✓	✓	✓				✓	✓	✓	✓	✓
Industrial Management	✓		✓	✓	✓	✓				✓	✓	✓	✓	✓
Polymer Recycling	✓		✓	✓	✓	✓				✓	✓	✓	✓	✓
Process Instrumentation	✓	✓	L	✓	✓				✓	✓	✓	✓	✓	✓
Reaction Engineering	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓
Synthetic Fibers	✓		✓	✓	✓	✓				✓	✓	✓	✓	✓
Total Quality Management	✓		✓	✓	✓	✓				✓	✓	✓	✓	✓
Polymer Blends and Alloys	✓	✓					✓			✓	✓	✓	✓	✓
Polymer Nanocomposites	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓
Mould Engineering	✓		✓	✓	✓	✓				✓	✓	✓	✓	✓
Thermoplastic Elastomers	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓
Intellectual Property Rights and Copyright Laws	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓

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I TO IV SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER-I

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	PO5101	Polymer Chemistry	PC	3	3	0	0	3
2	PO5102	Polymer Processing Technology	PC	3	3	0	0	3
3	PO5103	Thermoplastic Materials	PC	3	3	0	0	3
4	PO5104	Polymer Additives and Compounding	PC	3	3	0	0	3
5		Professional Elective I	PE	3	3	0	0	3
6		Professional Elective II	PE	3	3	0	0	3
PRACTICALS								
7	PO5111	Polymer Science Laboratory	PC	4	0	0	4	2
8	PO5112	Polymer Processing Laboratory	PC	4	0	0	4	2
			TOTAL	**26**	**18**	**0**	**8**	**22**

SEMESTER-II

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	PO5201	Characterization and Testing of Polymers	PC	3	3	0	0	3
2	PO5202	Polymer Composites	PC	3	3	0	0	3
3	PO5203	Polymer Products and Mould and Die Design	PC	3	3	0	0	3
4	PO5204	Rubber Technology	PC	3	3	0	0	3
5	PO5205	Polymers in Engineering	PC	3	3	0	0	3
6		Professional Elective III	PE	3	3	0	0	3
PRACTICALS								
7	PO5211	Polymer Testing Laboratory	PC	4	0	0	4	2
8	PO5212	Seminar	EEC	2	0	0	2	1
			TOTAL	**24**	**18**	**0**	**6**	**21**

SEMESTER-III

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1		Professional Elective IV	PE	3	3	0	0	3
2		Professional Elective V	PE	3	3	0	0	3
3		Professional Elective VI	PE	3	3	0	0	3
PRACTICALS								
4	PO5311	Project Work (Phase I)	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER-IV

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	PO5411	Project Work (Phase II)	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL CREDITS: 70

PROFESSIONAL ELECTIVES (PE)

SEMESTER-I, PROFESSIONAL ELECTIVE – I

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	PO5001	Polymers for Packaging Applications	PE	3	3	0	0	3
2.	PO5002	Speciality Polymers	PE	3	3	0	0	3
3.	PO5003	Computer Aided Design	PE	3	3	0	0	3

SEMESTER-I, PROFESSIONAL ELECTIVE – II

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	PO5004	Process Instrumentation	PE	3	3	0	0	3
2.	PO5005	Adhesive Science and Technology	PE	3	3	0	0	3
3.	PO5091	Research Methodology	PE	3	3	0	0	3

SEMESTER-II, PROFESSIONAL ELECTIVE – III

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	PO5006	Synthetic Fibers	PE	3	3	0	0	3
2.	PO5007	Bio Polymers and Biodegradable Polymers	PE	3	3	0	0	3

3.	PO5008	Conducting Polymers	PE	3	3	0	0	3

SEMESTER-III, PROFESSIONAL ELECTIVE – IV

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	PO5071	Thermoplastic Elastomers	PE	3	3	0	0	3
2.	PO5072	Polymer Nanocomposites	PE	3	3	0	0	3
3.	PO5009	Polymer Blends and Alloys	PE	3	3	0	0	3

SEMESTER-III, PROFESSIONAL ELECTIVE – V

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	PO5010	Reaction Engineering	PE	3	3	0	0	3
2.	PO5011	Industrial Management	PE	3	3	0	0	3
3.	PA5071	Polymer Recycling	PE	3	3	0	0	3

SEMESTER-III, PROFESSIONAL ELECTIVE –VI

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	PO5072	Total Quality Management	PE	3	3	0	0	3
2.	PO5012	Mould Engineering	PE	3	3	0	0	3
3.	PO5073	Intellectual Property Rights and Copyright Laws	PE	3	3	0	0	3

Professional Core (PC)

S. No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PO5101	Polymer Chemistry	PC	3	3	0	0	3
2.	PO5111	Polymer Science Laboratory	PC	4	0	0	4	2
3.	PO5102	Polymer Processing Technology	PC	3	3	0	0	3
4.	PO5103	Thermoplastic Materials	PC	3	3	0	0	3
5.	PO5104	Polymer Additives and Compounding	PC	3	3	0	0	3
6.	PO5112	Polymer Processing Laboratory	PC	4	0	0	4	2
7.	PO5201	Characterization and Testing of Polymers	PC	3	3	0	0	3
8.	PO5202	Polymer Composites	PC	3	3	0	0	3
9.	PO5203	Polymer Products and Mould & Die Design	PC	3	3	0	0	3
10.	PO5204	Rubber Technology	PC	3	3	0	0	3
11.	PO5205	Polymers in Engineering	PC	3	3	0	0	3

12.	PO5211	Polymer Testing Laboratory	PC	4	0	0	4	2

Employability Enhancement Courses (EEC)

S. No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PO5212	Seminar	EEC	2	0	0	2	1
2.	PO5311	Project Work (Phase I)	EEC	12	0	0	12	6
3.	PO5411	Project Work (Phase II)	EEC	24	0	0	24	12

PO5101 **POLYMER CHEMISTRY** **L T P C**
3 0 0 3

OBJECTIVE

- To make the student to acquire knowledge in fundamentals of polymers, bio and inorganic polymers.
- To impart knowledge in chain polymerization, Step growth polymerizations and copolymerization.
- To provide exposure to the students about Molecular weight, solubility and fractionation of polymers.

UNIT I FUNDAMENTALS OF POLYMERS 9

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.

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 organo metallic 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 - new polymerization concepts and techniques like RAFT, click polymerization, green polymerization concepts

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- mathematical, electrochemical, GTP and ring opening.

UNIT V MOLECULAR WEIGHT, SOLUBILITY 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.

TOTAL : 45 PERIODS

OUTCOME

- Will be aware of preparation and properties of polymers as related to the arrangement of chains in them.
- Will understand the utility of bio and inorganic polymers
- Will appreciate the complexities arising out of polydispersity in polymers

REFERENCES

1. F.W. Billmeyer, Text Book of Polymer Science, 3rd edition, John Wiley and sons, New York, 2002.
2. Gorge Odeon – Principles of Polymerization, 4th edition, McGraw Hill Book Company, New York 2004.
3. M.S.Bhatnagar, "A Text Book of Polymers (Chemistry and Technology of Polymers), Vol I, II & III, 1stEdn.,S.Chand and Company, New Delhi, 2007
4. PremamoyGhosh ," Polymer Science and Technology, 2ndedition,McGraw-Hill Publishing
5. R.J. Young, Introduction to Polymers, Chapman and Hall Ltd., London, 1999.

PO5102 POLYMER PROCESSING TECHNOLOGY 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 mould 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-differences between mixing conditions for rubbers and plastics

UNIT II CALENDERING AND EXTRUSION 9

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).-rubber extrusion-hot feed and cold feed extrusion of rubber-calendaring of rubber compounds and PVC pastes -equipment and processes

UNIT III INJECTION MOULDING 9

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

UNIT IV OTHER MOULDING TECHNIQUES 9

Thermoforming – vacuum forming, Pressure forming and matched mould forming – Rotation moulding - Compression moulding- Transfer moulding

UNIT V BASIC CONCEPTS IN MOULD DESIGN 9

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

TOTAL: 45 PERIODS

OUTCOME

- Will be aware of different mixing devices and extrusionOof rubbers and plastics.
- Will be able to methodically discuss injection and other moulding techniques.
- Will understand the basic concepts in mould design

REFERENCES

1. Crawford R.J. Plastics Engineering, Butterworth - Heinemann, 3rd Edition, 2005.
2. D.H. Morton-Jones, Polymer Processing, Springer verlaggmbh (2014)
3. Fried helm Hansen, Plastics Extrusion Technology, 2nd Edition, Hanser Publishers, 1997.
4. Peter Powell, A. Jan IngenHouz, Engineering with Polymers, Stanley Thomas Publishers Ltd., 2nd Edn. 1998.
5. Richard G.Griskey, Polymer Process Engineering, Chapman and Hall, 1995.
6. Tim A. Osswald Georg Menges “Material Science of Polymers for Engineers”, Hanser Publications, 2012.

PO5103	THERMOPLASTIC MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To enable the students to understand the methods of preparation, properties and applications of thermoplastic materials covering i) commodity plastics ii) engineering plastics and high performance plastics.

UNIT I **9**

Preparation, - Properties and applications of polyethylene - LDPE -LLDPE- HDPE, - Crosslinked polyethylene- Chlorinated polyethylene -Polypropylene - Homopolymers - Copolymers.

UNIT II **9**

Preparation, - Properties and applications of poly(vinyl chloride)- Poly (vinylidene chloride)- Poly(vinyl alcohol) - Poly(vinyl acetate)- Chlorinated poly(vinyl chloride)- Plastisols, Poly vinylpyrrolidiene,Polystyrene, HIPS, EPS.

UNIT III **9**

Preparation - properties and applications of Acrylates - Poly (methyl methacrylate)- Polyacrylonitrile. Polyethylene terephthalate - Polybutylene terephthalate - Polyacetals and copolymers – Polycarbonates.

UNIT IV **9**

Preparation, - Properties and applications of Fluoro polymers - Polytetrafluoroethylene, Polychlorofluoroethylene, Thermoplastic polyurethanes, poly ξ–caprolactone and copolymers.

UNIT V **9**

Preparation, properties and applications of High performance Thermoplastic materials PPS, PO, Polysulphone, Polyether Sulphone, PEEK, Polyimide.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will be familiar with manufacturing process of plastic raw polymers-especially commodity and engineering plastics
- Will acquire skills in selecting polymeric materials for specific applications
- Will have basic knowledge about high performance thermoplastics

REFERENCES:

1. J.A.Brydson, “Plastics Materials”, Butterworth- Heinemann - Oxford, 6th Ed., 1995.
2. Feldman.D and Barbalata.A, “Synthetic Polymers”, Chapman Hall, 1996.

PO5104 **POLYMER ADDITIVES AND COMPOUNDING** **L T P C**
3 0 0 3

OBJECTIVES

- To enable students know about various additives like Lubricants, Fillers, Fibres, flame retardants, colorants anti oxidants, UV-stabilizers, plasticizers, anti blocking agents, Nucleating agents, Flow promoters, Anti static agents etc.
- To make them understand the functions of each of these additives, technical requirements, types & mechanism, and their effective evaluation are dealt with in this subject.
- To enable them select suitable plastics material compounding and mixing techniques like two roll milling, internal blender, single / twin screw extruder, etc.

UNIT I INTRODUCTION TO ADDITIVES **9**

Introduction-Technological Requirements-Classification-Chemistry and Mechanism- Selection Criteria-General effect on Properties-Evaluation and functions of additives - Antioxidants-Stabilizers (Heat & UV)-carbon black-its types, manufacture and characteristics- mechanism of reinforcement of a rubber, non black fillers in rubbers

UNIT II ADDITIVES **9**

Plasticizers-Fillers and reinforcements - Impact Modifiers-Lubricants – Antistatic agents-Antiblocking agents - processing aids - Blowing agents- Flame Retardants – Masterbatch-Colourants. –Nucleating agents.

UNIT III ADDITIVES FOR CURING OF RUBBERS 9

Vulcanisation-its importance and effect on rubber properties-vulcanising agents-accelarators, activators, PVI, non sulphur vulcanisation – vulcanisation techniques other than moulding like autoclave curing, microwave curing

UNIT IV MECHANISM OF MIXING 9

mechanism of mixing and dispersion, mixing of solid-solid, liquid-liquid and liquids-solids, dispersive mixing, distributive mixing, mixing entropic measures, mixing indices, scale of segregation and intensity of segregation,

UNIT V COMPOUNDING TECHNIQUES 9

Selection of Polymers and Compounding ingredients- Methods of incorporation of additives into Polymer materials, Compounding of PVC, PE and PP, morphology of filler, compatibilizers – mechanism and theory, filler surface modification and interfacial agents,

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course, the student should be able to

- Will understand about various additives for rubbers and plastics – their needs, their functions and the mechanisms by which they act
- Will understand various compounding techniques used for making different grades of Plastics compounds

REFERENCES

1. R. Gachter and H. Muller, Plastics Additives Hand Book, Hanser Publishers, Munich, 1993.
2. John Murphy, The Additives for Plastics Hand Book, Elsevier Advanced Technology, Oxford, 1996.
3. Jesse Edenbaum, Plastics Additives and Modifiers Hand Book, Chapman & Hall, London,1996.
4. Ica Manas - Zloczower and Zehev Tadmor, Mixing and Compounding of Polymers, Hanser Publications, Munich, 1995.
5. Nicholas P. Cheremisionoff, Polymer Mixing and Extrusion Technology, Marcel Dekker Inc. NewYork, 1995.
6. J.A.Brydson, Plastics Materials, Butterworth Heinemann, Oxford, 1999.

PO5111 POLYMER SCIENCE LABORATORY L T P C
0 0 4 2

OBJECTIVES

- To make the student conversant with polymer synthesis, and appreciate the kinetics of polymerization.
- To enable students understand the methods for determination of molecular weight.
- To make them know the importance of fractionation of polymers.

Experiments on synthesis involving polymerization reactions like

1)Bulk polymerization

2)Emulsion polymerization

3)Suspension polymerization

4)Solution polymerization

5)condensation/interfacial polymerisation

6) determination or reactive ratio for copolymerisation of styrene with MMA

7)TGA, DSC, IR

8)X ray diffraction studies

9)molecular weight and its distribution using viscometry, end group analysis, GPC, osmometry

10) fractionation of polymers

TOTAL: 60 PERIODS

OUTCOME

- Will gain hands on experience on a few polymerization reactions.
- Will be able to methodically discuss the fractionation of polymers.
- Will develop capacity to characterize polymers using IR and thermal analysis.

REFERENCES

1. E.M.McCaffery, Laboratory Preparation for Macromolecular Chemistry, McGraw Hill, Kogakush 1970.
2. Edward A. Colloid, J.Bares and F.W. Billmeyer Jr., Experiments in Polymer Science, Wiley Interscience, New York 1973.
3. Tim A. Oswald Georg Menges “Material Science of Polymers for Engineers”, Hanser Publications, 2012.
4. Wayne R.Sorenson and T.W.Campbell, Preparative Methods of Polymer Chemistry 3rd edition, Wiley – Interscience, New York, 2001.

Equipment needed:

glassware for reactions, GPC, osmometer, Ostwald or Ubbelhode viscometer, DSC,TGA

PO5112 POLYMER PROCESSING LABORATORY L T P C
0 0 4 2

OBJECTIVE

- To enable students to get hands on experience on the processing of polymers
- To make the students understand the basic concepts of Identification**,** characterization, flammability and analytical testing of polymers.

LIST OF EXPERIMENTS

1. Preparation of Blow moulded products
2. Compression moulding of thermoset resin
3. Injection moulding of thermoplastics – Hand, semiautomatic and Fully automatic
4. Extrusion of thermoplastics
5. Compounding of plastics
6. Preparation of FRP laminates
7. Recycling of plastics – Scrap grinder
8. Casting of polymer films
9. Mixng of rubber compounds
10. Compression moulding of rubber compounds
11. Preparation of dry rubber products

(i) Play ball **(ii)** Hawaii sheet **(iii)** M. C sheet(iv)Bottle Caps

12. Preparation of dispersions for compounding of latex
13. Preparation of latex products

(i) Hand Gloves **(ii)** Balloon **(iii)** Rubber band **(iv)** Elastic Thread

(Any Eight experiments)

TOTAL: 60 PERIODS

OUTCOMES

- Will gain practical knowledge in Blow molding, compression molding, Injection molding of Extrusion of polymers
- Will gain knowledge in mixing of plastics and rubbers
- Will gain knowledge in manufacture of a few rubber and plastics products

Equipment required:

Blow moulding machine, Injection moulding machine, extruder, 2 roll mill, rubber curing presses, latex formers, scrap grinder

PO5201	**CHARACTERIZATION AND TESTING OF POLYMERS**	**L T P C**
		3 0 0 3

OBJECTIVE

- To impart knowledge on characterization tests, thermal and electrical properties.
- To enable the student learn about mechanical properties and flammability, optical properties, weathering and analytical tests.
- To provide exposure about testing and standards organizations.

UNIT I CHARACTERIZATIONTESTS 9

Basic principle of TGA, DTA, DSC, TMA, XRD, SEM, TEM, IR

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, arc resistance, surface and volume resistance.

UNIT III MECHANICAL PROPERTIES AND FLAMMABILITY 9

Tensile tests, compressive properties, impact properties, flexural strength, abrasion resistance hardness tests, shear strength –ignition properties, oxygen index

UNIT IV OPTICAL PROPERTIES AND ANALYTICAL TESTS 9

Refractive index, haze, gloss, density, water absorption, moisture analysis, sieve analysis, apparent density, melting point

UNIT V CHEMICAL , WEATHERING PROPERTIES AND TESTING ORGANIZATIONS 9

Weathering properties: Accelerated weathering test - Outdoor weathering test - Chemical properties: Immersion test - Stain resistance test - Solvent stress cracking resistance - Environmental Stress Cracking Resistance (ESCR) - ASTM, ANSI, 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 and standards organizations.

REFERENCES

1. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastics, Allied Publishers Pvt. Ltd., New Delhi, 2003
2. A. Ya. Malkin, A.A. AskaDsky, V.V. Koverica Experimental methods of polymers, Mir Publishers, Moscow, 1998.
3. B. Sivasankar, Engineering Chemistry, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2012
4. Iver, Mead and Riley, Hand book of Plastic test methods, Illith Publishers, New York, 1982.
5. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.
6. Vishu Shah, Hand book of Plastics Testing and Failure Analysis, 3rd Edition, John-Willey & Sons, New York, 2007.

PO5202 POLYMER COMPOSITES L T P C
3 0 0 3

OBJECTIVES

- To impart knowledge of various types of composites and its advantages and needs.
- To make the student 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 INTRODUCTION AND ADDITIVES OF COMPOSITES 9

Introduction – Advantages, Characteristics, of composites – Classification – particulate, fibrous, laminated, and hybrid composites, Additives for Composites - Catalysts - - Accelerators - Coupling Agents - Fillers - Toughening Agents

UNIT II MATRIX MATERIALS 9

Classification -Matrix Resins **-** Unsaturated Polyester - Vinyl Ester - Epoxy- Phenol Formaldehyde - Urea Formaldehyde - Melamine Formaldehyde Resin - Properties and Applications

UNIT III REINFORCEMENT MATERIALS 9

Fibre Reinforcements - Glass – Types - CSM – Surface Mats - Performs - Woven and Non Woven Fabrics - Carbon - Aramid Fibre - Boron Fibres - Natural Fibres – Cellulose

UNIT IV PROCESSING OF COMPOSITES 9

DMC, SMC and Prepregs - Hand and Spray Layup - RTM - Bag - Autoclave - Centrifugal and Compression Molding Processes - Filament Winding - Pultrusion Sandwich Construction

UNIT V TESTING AND APPLICATION OF COMPOSITES 9

Testing of Composites - Tensile, Impact, Compression and Flexural Strength- Non Destructive testing for Composites - Application of FRP Products

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 fibers and matrix materials and their applications in making composite products.
- Will understand the knowledge of various processing operations for composites and the basic destructive and non-destructive testing of composites

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 Press , 2002.
3. George Lubin, Stanley T. Peters , Handbook of Composites, Chapman & Hall, 1998.

4. M.C.Gupta and A.P.Gupta, Polymer Composites, New Age International Publishers, 2007.
5. Mel M. Schwartz,Composite Materials: Processing, fabrication, and applications, Prentice Hall PTR, 1997
6. Polymer matrix nanocomposites, processing, manufacturing, and application: An overview,

PO5203 POLYMER PRODUCTS AND MOLD AND DIE DESIGN L T P C
3 0 0 3

OBJECTIVES

- To impart the knowledge on design factor involved in a polymer product manufacture.
- To understand the behavior of polymer product
- To impart the knowledge on design of mold and die for polymer products.

UNIT I **9**

Introduction to structure and physical properties of polymers, stress - strain behaviour of polymers, effect of fillers on properties of polymers, stress analysis of polymers, structural design of beams, plates and other structural members

UNIT II **9**

Design procedure for plastic parts- Basic Principles-Shrinkage-Flash lines- suggested Wall thickness-Draft-Tolerance-Moulded holes-threads-radius- moulded hinges-integral hinge-snap fits - product design thumb rules - case studies

UNIT III **9**

Gear Design materials strength and durability, moulded vs cut plastics gear inspection assembly and operation. Bearings: Self lubricated plastic materials rubber bearing, type of bearings, designers check list. Elastomeric ring seals - basic configurations, design method, design consideration static and dynamic seals.,

UNIT IV **9**

introduction of Injection Moulds - Methodical Mould Design – Calculation related to-number of Cavities, Clamping force, shot weight, Selection of Injection Moulding Machine, Layout of Cavities in multi-impression Mould, Feed Systems - Design of Runners & gate, Ejection Systems, Cooling Systems, Venting.

UNIT V **9**

Types of compression moulding process-Determination of number of cavities-design of mould cavity, design of loading chamber-Transfer mould design- Extrusion die design-Construction features of an extruder, solid die-wire and cable die- Pipe die.

TOTAL: 45 PERIODS

OUTCOME

By the end of this course, students will be able to

- Demonstrate the ability to design rubber and plastics products

- Analyze design data for different polymer products
- Understand the principles of mould and die design for plastics products

REFERENCES

1. Edward Miller, “Plastics Products Design Hand Book”, Marcel Dekker,
2. Laszlo Sors and ImreBalazs, “Design of Plastics Moulds and Dies”, Elsevier, Amsterdam Oxford - Tokyo - NY, 1989.
3. P.S.CRACKNELL and R.W DYSON, “Hand Book of Thermoplastics - Injection Mould Design”, Chapman & Hall, 1993.
4. S.Levy&J.H.Dubois, “Plastic Product Design Engineering Hand Book”, Van Nostrand Reinhold Co., New York, 1977.

PO5204 RUBBER TECHNOLOGY L T P C

3 0 0 3

OBJECTIVE

- To acquire knowledge in the Fundamentals of Rubbers and various Rubbery polymers.
- 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 - 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 GENERAL PURPOSE RUBBERS 6

Preparation, properties and uses of : Natural rubber, SBR, BR, IR

UNIT III SPECIAL PURPOSE RUBBERS 12

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, and thermoplastic elastomers

UNIT IV MANUFACTURE OF TYRE AND TUBES 9

Tyres – functions, requirements – basic design reinforcing systems –construction –-testing – Defects and remedial measures - tube manufacture– compounding for tyre and tube.

UNIT V BELTING, HOSES AND FOOTWEAR 9

Manufacturing methods of Belting and hoses – conveyor, transmission (V and flat) belting. braided and hand–built hoses, footwear

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 properties of rubbers and their product manufacture.

REFERENCES

1. A.K. Bhowmick and H.L.Stephens, Hand Book of Elastomers, Marcel Dekker, New York, 1988.
2. B. Kothandaraman, Rubber Materials, Ane Books Pvt. Ltd., New Delhi, 2008.
3. C.M.Blow and C.Hepburn, "Rubber Technology and Manufacture", 2nd Edn., Butterworths, London, 1982.
4. J. A. Brydson, Plastic Materials, Elsevier Publishers Group, 2014
5. J.M. Martin, W.K.Smith, Handbook of Rubber Technology, Vol. 1 & 2, CBS Publishers & Distributors, 2004
6. M.Morton, Rubber Technology, Van Nostrand Reinhold, 1987.

PO5205 POLYMES IN ENGINEERING 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 – aramide – 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

Student Will be able to

- understand the uses polymers in electrical, electronics and high temperature fields.
- understand polymer blends, alloys and liquid crystals.
- appreciate the application of polymers in a variety of fields like water treatment, stereo lithography and biomedical areas

REFERENCES

1. C.P.Wong, Polymers for Electronic and Photonic Applications, Academic Press, New York, 1993.
2. H.F. Mark (Ed), Encyclopedia of Polymer Science and Engineering, Wiley – Interscience, New York, 1991
3. L.L. Chapoy (Ed), Recent Advances in Liquid Crystalline Polymers, Chapman and Hall, London, 1985.
4. ManasChanda, Salil K. Roy, Industrial Polymers, Specialty Polymers, and their Applications, CRC Press, 2008.
5. R.W. Dyson, Specialty Polymers, Blackie Academic & Professional, London, (second edition) 1998.
6. Robert William Dyson, Specialty Polymers, 2nd ed., Springer Verlag, 2011.

PO5211 POLYMER TESTING LABORATORY L T P C
0 0 4 2

OBJECTIVE

- To enable students to know the testing of rubbers and plastics,
- To enable them understand 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.

MECHANICAL PROPERTIES

Mechanical properties –

1. Tensile
2. Flexural
3. compressive
4. impact strength

5. hardness
6. abrasion resistance

THERMAL PROPERTIES

Thermal properties

7 Vicat softening temperature and heat deflection temperature

8 brittleness temperature

ELECTRICAL PROPERTIES

9 dielectric strength

10 Electrical resistance test

11 arc resistance.

OPTICAL PROPERTIES

12 refractive index

13 transmittance, haze, gloss.

MATERIAL CHARACTERIZATION TESTS

MFI, thermosets – apparent (bulk) density, bulk factor, pourability, specific gravity, gel time and peak exothermic temperature, water absorption.

TOTAL: 60 PERIODS

OUTCOME

Student will be able

- to practically determine thermal, electrical and optical properties of the polymeric materials.
- to recognize the basics in analytical testing of polymers.

REFERENCES

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

Equipment needed:

UTM, impact tester, abrasion resistance testing equipment(Pico or Tager abraders), electrical equipment for supplying high voltages, electrodes etc, prism and other optical equipment for measuring refractive index etc, MFI tester, bulk density tester, specific gravity measuring equipment

PO5212 **SEMINAR** **L T P C**
0 0 2 1

The seminar power point presentation shall be fundamentals oriented and advanced topics in the appropriate branch of engineering with references of journal papers. Presentation is to be planned for duration of 15 minutes including a question answer session of five minutes. The marks will be awarded based on the presentation of the seminar.

TOTAL: 30 PERIODS

PO5311 **PROJECT WORK (PHASE I)** **L T P C**
0 0 12 6

Project report: To be prepared in proper format decided by the University. The report may include the aspects of the literature review. Members of a project group shall prepare and submit the report.

A comprehensive oral Viva-voce examination will be conducted to assess the student's, depth of understanding in the specified field of engineering and technology..etc.

An internal and external examiner is appointed by the University for the Conduct of viva voce University examination.

PO5411 **PROJECT WORK (PHASE II)** **L T P C**
0 0 24 12

Project report: To be prepared in proper format decided by the University. The report shall record all aspects of the work. Members of a project group shall prepare and submit the report.

A comprehensive oral Viva-voce examination will be conducted to assess the student's intellectual achievement, depth of understanding in the specified field of engineering and technology etc.

An internal and external examiner is appointed by the University for the Conduct of viva voce University examination

PO5001 **POLYMERS FOR PACKAGING APPLICATIONS** **L T P C**
3 0 0 3

OBJECTIVE

- To impart knowledge on packaging materials and applications.

UNIT I **POLYMER PACKAGING MATERIALS** **9**

Introduction to Packaging – Functions of packaging – Major packaging materials viz.
Polyolefins, Polystyrene, Polyvinylchloride, Polyesters, Polyamides (Nylons), Polycarbonate and Newer materials such as High Nitrile polymers, Polyethylene Naphthalate (PEN), Polyetherimide (PEI) and LCP – Properties and Applications in Packaging.

UNIT II CONVERSION TECHNOLOGY-I 9

Extrusion – Blown film, cast film, sheet, multi-layer film and sheet, lamination, stretch and shrink wrap and heat sealing – Injection moulding for manufacturing of packaging products – Blow moulding – Extrusion blow moulding, Injection blow moulding and Stretch blow moulding

UNIT III CONVERSION TECHNOLOGY-II 9

Thermoforming – Vacuum forming, Drape forming, Snap-back vacuum forming, Plug assisted vacuum forming, Pressure forming, Matched mould forming, Scrap less thermoforming, Skin pack and blister packs, Thermoform/fill/seal systems (TFFS). Advantages and disadvantages of thermoforming. Printing – Flexographic printing, Rotogravier printing, Pad printing, Hot stamping,

UNIT IV PERFORMANCE EVALUATION OF PACKAGING PRODUCTS 9

Mechanical properties – Tensile properties, Impact properties, Tear strength, Burst strength, Co-efficient of friction, Blocking, Orientation and shrinkage. Optical Properties – Clarity, Haze and gloss. Barrier Properties – Oxygen transmission, Water vapour transmission rate – Migration.

UNIT V ENVIRONMENTAL CONSIDERATION 9

Plastic waste – Classification, Segregation, Sorting and Waste Management viz. source reduction, reuse/repair, recycling related to packaging films and containers.

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

REFERENCES

1. Gordon L. Robertson, Food Packaging Principles and Practice, Marcel Dekker, Inc., New York 1993.
2. John R. Wagner, Jr., Crescent Associates, Inc., Rochester, Multilayer Flexible Packaging. Elsevier 2009
3. Louis T. Manzione, Plastic Packaging of Microelectronic Devices, Van NostrandReinhold, New York, 1990.
4. S.Ebnesajiod,W.Andrew Plastic films in food packaging, PDL ,2012.

PO5002 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, blends of LCPs, applications of LCPs.

UNIT II CONDUCTING POLYMERS 9

Theory of conduction, band theory, requirements for polymer to work as conductor, types of conducting polymers -doping of polymeric systems, Polyaniline, Polyacetylene, Polypyrrole, 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

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, 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

TOTAL: 45 PERIODS

OUTCOME

- Student will be aware of preparation and properties of speciality polymers
- Student will be able to methodically discuss application of speciality polymers.
- Student will appreciate the uses of polymers for speciality applications

REFERENCES

1. Faiz Mohammad, Specialty Polymers: Materials and Applications, I.K. International Pvt Ltd, 2008
2. H.F.Mark, (Ed)," Encyclopaedia of polymer Science & Engineering". John Wiley & Sons, New York, 1989.
3. Johannes Karl Fink, Hand book of Engineering and Specialty Polymers, John Wiley & Sons, Vol.2, 2011
4. Manas Chanda, Salil K. Roy, Industrial Polymers, Specialty Polymers, and their Applications, CRC Press, 2008
5. ManasChanda, SalilK.Roy," Plastics Technology Hand book ", 2nd edition,Marcel Dekker, New York,1993.

6. Matrin.T. Goosey," Plastics for Electronics", Elsevier, Applied Science, 1985.
7. Norio Ise, IwaoTabushi, An Introduction to Speciality Polymers, Cambridge University Press, 1983 food applications.
8. Robert William Dyson, Speciality Polymers, 2nd ed., Springer verlag, 2011

PO5003 COMPUTER AIDED DESIGN L T P C
3 0 0 3

OBJECTIVE

- To impart knowledge on Computer graphics fundamentals and Interactive computer programming.
- To 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 CAM INTEGRATION 9

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

TOTAL: 45 PERIODS

OUTCOME

- Will be able to appreciate the uses of computers in chemistry.
- Will be able to use computers as a tool in solving industrial problems.

.**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.

PO5004 **PROCESS INSTRUMENTATION** **L T P C**
3 0 0 3

OBJECTIVES

- To make the student learn about temperature 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**

Introduction-Classification of temperature measuring device – thermocouple-Resistance thermometers- thermistor-radiation pyrometry-Total radiation pyrometers - optical pyrometers

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

Pressure –manometers, bourdan tube –bellow diaphragam, Venturi, Orifice & nozzle meters, Pitot tube, turbine type meters, hot wire anemometer, magnetic flow meters. Level measurement: float level meters & electrical conductivity meters

UNIT III PHYSICAL PROPERTY MEASUREMENT **9**

Measurement of Density and specific gravity – Measurement of viscosity thermal conductivity measurement-Measurement of viscosity

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**

Recorders-recorder requirements, analog and digital recording instruments, ultraviolet recorder, Null type recorder, single point recorder

TOTAL : 45 PERIODS

OUTCOME

- Student will have a basic understanding of the engineering concepts involved in the chemical industry.
- Student will Know 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.

REFERENCES

1. A.E. Fribance – Industrial Instrumentation Fundamentals, McGraw Hill Co. New York, 1983.
2. Eckman, D.P. – Industrial Instrumentation, CBS publishers 2004(Reprint).
3. Rebert , H. Perry –Chemical Engineering Hand Book, 8thEdn.,McGraw Hill Co.,Inc. New York, 2007.
4. William Dunn, Fundamentals of Industrial Instrumentation and Process Control, cGraw Hill Professional, 2005

PO5005 ADHESIVE SCIENCE AND TECHNOLOGY L T P C
3 0 0 3

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 MECHANISMS 9

Definition and mechanisms of adhesion- mechanical interlocking – inter-diffusion theories – adsorption and surface reaction. Surface topography, surface features and forces, wetting and setting, 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 SYNTHETIC ADHESIVE TYPES 9

Synthetic adhesives -phenolic resin, epoxy, polysulphide, polyurethane, polyvinyl alcohol, acrylics, high temperature silicone adhesives. Water based– hot -melt adhesives – anaerobic adhesives.

UNIT V APPLICATIONS OF ADHESIVES 9

Adhesives for building construction, medical use, automobile industry bonded and coated abrasives – fabrics, 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.

REFERENCES

1. A.V. Pocius, Adhesion and Adhesives Technology, Hanser, 2002
2. D.M. Brewis and D. Briggs, Industrial adhesion problems, Wiley-Interscience Publication, New Y ork, 1985.
3. I Skeist, 3rd Edition, Handbook of Adhesives, Van Nostrand Reinhold, New York, 1990
4. J. Kinloch, Adhesion and Adhesive Science and Technology, Springer, 1987.
5. P. Ghosh, Adhesives and Coatings Technology, Tata-McGraw-Hill Publishing Company Limited, New Delhi, 2008.
6. W. A. Lees, Adhesives in engineering design, Springer Verlag, Berlin, 1984.

PO5091 **RESEARCH METHODOLOGY** **L T P C**
3 0 0 3

OBJECTIVES

- To gain insights into how scientific research is conducted.
- To help in critical review of literature and assessing the research trends, quality and extension potential of research and equip students to undertake research.
- To learn and understand the basic statistics involved in data presentation.
- To identify the influencing factor or determinants of research parameters.
- To test the significance, validity and reliability of the research results.
- To help in documentation of research results.

UNIT I INTRODUCTION TO RESEARCH METHODS 9

Philosophy of Science, Evolutionary Epistemology, Scientific Methods, Hypotheses Generation and Evaluation, Code of Research Ethics, Definition and Objectives of Research, Various Steps in Scientific Research, Types of Research; Research Purposes - Research Design - Survey Research - Case Study Research.

UNIT II DATA COLLECTION AND SAMPLING DESIGN 9

Sources of Data: Primary Data, Secondary Data; Procedure Questionnaire- Survey and Experiments – Design of Survey and Experiments - Sampling Merits and Demerits - Control Observations - Procedures – Sampling Errors.

UNIT III STATISTICAL MODELING AND ANALYSIS, TIME SERIES ANALYSIS 9

Probability Distributions, Fundamentals of Statistical Analysis and Inference, Multivariate methods, Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Spectral Analysis, Error Analysis, Applications of Spectral Analysis.

UNIT IV POLYMER RESEARCH 9

Polymer synthesis–structure property relation- characterization- testing- principles and methodology.

UNIT V RESEARCH REPORTS 9

Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report

TOTAL : 45 PERIODS

OUTCOMES

- Ability to critically evaluate current research and propose possible alternate directions for further work
- Ability to develop hypothesis and methodology for research
- Ability to comprehend and deal with complex research issues in order to communicate their scientific results clearly for peer review.

REFERENCES

1. Bendat and Piersol, Random data: Analysis and Measurement Procedures, Wiley Interscience, 2001.
2. C.R. Kothari, Research Methodology Methods and Techniques, 2/e, VishwaPrakashan, 2006.
3. Donald R. Cooper, Pamela S. Schindler, Business Research Methods, 8/e, Tata McGraw-

Hill Co. Ltd., 2006.
4. Fuzzy Logic with Engg Applications, Timothy J.Ross, Wiley Publications, 2nd Ed[d]
5. Genetic Algorithms in Search, Optimization, and Machine Learning by David E. Goldberg.
6. Jenkins, G.M., and Watts, D.G., Spectral Analysis and its Applications, Holden Day, 1986.
7. Richard I Levin amp; David S.Rubin, Statistics for Management, 7/e. Pearson Education, 2005.
8. Shumway and Stoffer, Time Series Analysis and its Applications, Springer, 2000.
9. Simulated Annealing: Theory and Applications (Mathematics and Its Applications, by P.J. van Laarhoven& E.H. Aarts[e]

PO5006 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 learn about 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.

REFERENCES

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. Menachem Lewin 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.
6. A.A.Vaidya, Production of Synthetic Fibres, Prentice Hall of India Pvt. Ltd., New Delhi 1988.
7. 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.

PO5007 BIOPOLYMERS AND BIODEGRADABLE POLYMERS L T P C
3 0 0 3

OBJECTIVE

- To impart knowledge on synthetic biodegradable polymers and its applications.
- To impart knowledge on principles of biodegradation and disposal of municipal waste.
- To make them get a basic knowledge 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, biodegradable polyamides –copolymers of - amino acid (glycine, serine), -aminocaproic acid.– polyester urea – polyamide urethane - synthesis and properties. polyglutamic acid, bacterial polyesters.

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 9

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 9

Proteins, nucleic acids and polysaccharides – 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-

TOTAL: 45 PERIODS

OUTCOME

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

REFERENCES

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

PO5008 CONDUCTING POLYMERS L T P C
3 0 0 3

OBJECTIVE

- 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.

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- mechanism of conduction - 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, 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.

REFERENCES

1. B. Wessling, Electronic Properties of Conjugated Polymers, Vol.3, Springer, Berlin, 1989.
2. H.G. Kiess (Edr.), Conjugated Conducting Polymers, Springer, Berlin, 1992. D.S.Soane and Z. Martynenko (Eds.), Polymers in Microelectronics, Elsevier, Amsterdam, 1989.
3. J.M. Margolis (Ed.), Conducting Polymers and Plastics, Springer, 2011.
4. R.B. Seymour, edr.,Conductive Polymers", Plenum Press, New York, 1981.
5. 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.

PO5071 THERMOPLASTIC ELASTOMERS L T P C
3 0 0 3

OBJECTIVE

- To understand about the different methods of synthesising TPEs and advantages over thermoplastics and elastomers
- To provide a comprehensive overview of different TPEs based on polyolefin, vinyl, styrenic, urethane and polyamides
- To familiarise the student about structure , properties and applications of different TPEs

UNIT I CLASSIFICATION OF THERMOPLASTIC ELASTOMERS 9

Introduction to Thermoplastic Elastomers (TPE) Polyolefin – based thermoplastic elastomers – Block copolymer, Random Block polymers, Graft copolymers, Polyolefin blend TPE's preparation, Properties, processing and applications.

UNIT II THERMOPLASTIC ELASTOMERS FROM CONVENTIONAL POLYMERS 9

Polyvinylchloride based Thermoplastic Elastomers – PVC/Nitrile Rubber blends, PVC/Polyurethane blends. Styrenic Thermoplastic Elastomers – Manufacture, Properties

Applications.

UNIT III POLYURETHANE ELASTOMER 9

Thermoplastic Polyurethane Elastomer – Raw materials, Synthesis, Properties, Processing, Blends and Applications.

UNIT IV POLYAMIDE AND POLYETHER BASED ELASTOMER 9

Polyamides based Thermoplastic Elastomers – Polyamide thermoplastic elastomers, Preparation, properties, and applications. Thermoplastic Polyether ester Elastomers – Synthesis, Properties and applications.

UNIT V THERMO PLASTIC ELASTOMER FROM BLENDS 9

Introduction - Preparation of Elastomer – Plastic blends by dynamic vulcanization, properties and applications. Ionomeric Thermoplastic Elastomers: Synthesis, Properties, and applications of ionomeric elastomers

TOTAL : 45 PERIODS

OUTCOME

At the end of the course, the student should be able to

- differentiate the unique characteristics of different TPEs compared with thermoplastics and elastomers
- be able to select the suitable TPE for the application
- be able to Correlate the structure and properties of different TPEs

REFERENCES

1. Anil K. Bhowmick, Howard L. Stephens, Hand Book of Elastomers New Developments and Technology, Marcel Dekker, Inc., New York, 1988.
2. Benjamin M. Walker, Hand Book of Thermoplastic Elastomers, Van Mostrand Reinhold Company, New York, 1979
3. G.Holden, N.R. Legge, R. Quirk, H.E. Schrolder, Thermoplastic Elastomers – 2nd Edition, Hanser Publishers, Munich, 1996.
4. S.K. De, Anil K. Bhowmick, Thermoplastic Elastomers from Rubber – Plastic Blends, Ellis Horwood, New York, 1990.

PO5072 POLYMER NANOCOMPOSITES L T P C
3 0 0 3

OBJECTIVES

- To gain an understanding of materials commonly used for nano-modification such as nanoclays, carbon nanotubes, etc.
- To study different manufacturing techniques of dispersion of nano particles such as sonication, high shear mixing, centrifugal mixer, twin-screw extrusion.
- To study different manufacturing techniques to produce real-life components
- To understand characterization techniques of these materials using scattering, spectroscopic and microscopic techniques

UNIT I **9**

Definition of nanocomposite, nanofillers, classification of nanofillers, carbon and noncarbon based nanofillers- synthesis and properties of fillers.

UNIT II **9**

Properties of various polymer nanocomposites: Nanotube/Polymer Composites, Layered Filler Polymer Composite Processing- Polyamide Matrices, Polyimide Matrices, Polypropylene and Polyethylene Matrices, Liquid-Crystal Matrices, Epoxy and Polyurethane Matrices, Rubber Matrices.

UNIT III **9**

Synthesis of Nanocomposite: Direct Mixing, Solution Mixing, In-Situ Polymerization, In-Situ Particle Processing Ceramic/Polymer Composites, In-Situ Particle Processing Metal/Polymer Nanocomposites, Modification of Interfaces, Modification of Nanotubes, Modification of Nanoparticles. Surface treatment, Composites manufacturing techniques.

UNIT IV **9**

Characterization of Nanocomposites: Particle Size Analysis, Glass Transition and Relaxation, X-ray Diffraction, Scanning Electron Microscopy, Transmission Electron Microscopy, Small-Angle X-Ray Scattering (SAXS), Cone Calorimetry (CC) and Mass Loss Calorimetry (MLC).

Properties of Nanocomposite: Mechanical Properties, Modulus and the Load-Carrying Capability of Nanofillers, Failure Stress and Strain Toughness, Abrasion and Wear Resistance, Permeability, Dimensional Stability Contents, Thermal Stability and Flammability, Electrical and Optical Properties, Resistivity, Permittivity, and Breakdown Strength, Refractive Index, Barrier properties of polymer nanocomposites, Permeation and diffusion models relevant to polymer Nanocomposites, Polymer nanocomposites diffusivity, sorption, permeability. Wear resisting polymer nanocomposites: preparation and properties, Wear performance and mechanisms.

UNIT V **9**

Nanocomposites containing functionalized nanoparticles: Organic and polymer materials for electronics devices such as LED, Photo-voltaics etc.,- Polymer Nanocomposites for Bio-medical application, Photo-oxidation of polymers, Nanoparticles approaches to enhance the lifetime of polymers

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course, the student should be able to

- The student will Know different characterization and testing techniques and interpretation of results
- The student will have a knowledge about different structures and properties of nanocomposites
- The student will have an idea about preparation technologies and applications of nanocomposites

REFERENCES

1. Joseph H. Koo, Polymer Nanocomposites, Processing, Characterization, and Applications, McGraw-Hill 2006
2. L.A. Utracki " Clay-Containing Polymeric Nanocomposites" Rapra Technology Limited, 2004
3. Luigi Nicolis& Gianfranco Carotenuto "Metal -Polymers Nanocompsites" A John Wiley & Sons, Inc Publication 2005
4. P. M. Ajayan, L. S. Schadler, P. V. Braun (Eds) Nanocomposite Science and Technology WILEY-VCH Verlag GmbH Co. KGaA, Weinheim, 2003
5. Y.C. Ke& P. Stroeve " Polymer-Layered Silicate and Silica Nanocomposites- Elsevier, 2005

PO5009 POLYMER BLENDS AND ALLOYS L T P C
3 0 0 3

OBJECTIVES:

- To enable the student learn about the polymer miscibility and polymer interaction in various types of polymer blends and alloys

UNIT I INTRODUCTION 9

Definition for Blends - Alloys and Copolymers - Reason for Blending - Classification of Polymer Blends - Miscible Blends and Immiscible Blends - Phase Equilibria Calculation - Huggins - Flory Theory

UNIT II DETERMINATION OF POLYMER/POLYMER MISCIBILITY 9

Methods of Measurements - Refractive Index - Ultrasonic Velocity - Thermal and Optical Methods - Factors Affects on Miscibility of Polymer Blends - Compatibility - Solubility Parameter - Interaction Parameter.

UNIT III THERMODYNAMICS, CRYSTALLIZATION AND MELTING OF POLYMER BLENDS 9

Introduction - Thermodynamic Principles - Thermodynamics of a Single Component Systems - Phase Separation - Methods of Measurements - Crystallization, Morphological and Melting Behavior of Polymer Blends

UNIT IV COMPATIBILIZED BLENDS AND METHODS OF TOUGHENING 9

Introduction - Types and Role of Compatibilizer - Compatibilization Methods - Mechanism of Compatibilized Blends - Mechanism and Theory of Toughing - Toughening of Thermoplastics

UNIT V RHEOLOGY AND APPLICATIONS OF POLYMER BLENDS AND ALLOYS 9

Introduction - Rheology of Miscible and Immiscible Blends - Applications - Automotive - Electrical and Electronics - Medical - Packaging

TOTAL : 45 PERIODS

OUTCOME:

- demonstrate knowledge and understanding in the blends of various polymers, its solubility parameter, compatibility and phase separation and rheology of Polymer blends and alloys

REFERENCES

1. L. A. Utracki, Polymer blends and alloys, Hanser Publishers, New York, 1979
2. L. A. Utracki, Polymer Blends Hand book, Kluwer academic publishers, UK, 2002
3. L. M. Robeson, Polymer blends Hanser publications, USA, 2007
4. M. J. Folkes, P. S. Hope, Polymer blends and alloys, Springer, London, 2012

PO5010 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 get familiarize with chemical equilibrium constant

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 and tubularflow 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, chemical equilibria and equilibrium constant

REFERENCES

1. H. Scott Fogler**, "**Elements of Chemical Reaction Engineering", (4th Edition) Prentice Hall, 2005.
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. OctaveLevenspiel, Chemical Reaction Engineering (3rd Edition), , John Wiley & Sons, 1998

PO5011 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.

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.

REFERENCES

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

PA5071 POLYMER RECYCLING **L T P C**
3 0 0 3

OBJECTIVES

- To emphasize the fundamentals and importance of plastics recycling.
- To impart the knowledge on various sorting and separation techniques.
- To highlight recycling procedures for commodity and engineering plastics.
- To familiarize rubber recycling procedures.

UNIT I FUNDAMENTALS OF PLASTICS RECYCLING **9**

Need for recycling –Source of Plastic waste – depolymerization - Thermal depolymerization – Ceiling temperature and its importance – Degradation – Biodegradation, Primary, Secondary and Tertiary recycling.

UNIT II RECYCLING OPERTIONS **9**

Sorting and separation techniques – Density based – Optical sorting – Electrostaticsorting – Sorting by melting temperature – Sorting by selective dissolution- sorting of metalcontaminants, size reduction - cutting – Densification – Pulverization – Chemical methods,melt filtration of contamination in recycled plastics – screen changers – filtration requirementsof different recycled plastics.

UNIT III RECYCLING MATERIALS- I **9**

Recycling of PET – PET separation – Melt reprocessing – Chemical reprocessing – Energy recovery – application.HDPE recycling – Application of HDPE recyclate – LDPE recycling – Application of LDPE recycle LDPE – film recycling – Polypropylene recycling – Application of recycled PP – Recycling of polystyrene - Application of Recycled EPS.Nylon recycling – Chemical recycling – Mechanical recycling – applications Depolymerization of PMMA.

UNIT IV RECYCLING MATERIALS- II 9

Recycling of Engineering Thermoplastics – PC – ABS Mechanical and chemical recycling of polyacetals – Uses, recycling of polyurethanes – Physical methods – Chemical methods, Feed stock recycling and energy recovery.

Recycling of Thermoset composites – grinding of SMC – selective chemical degradation of SMC scrap – solvent recycling – pyrolysis – Energy recovery from SMC scrap – Recycling of thermoplastics composites.Recycling of PVC - Separation techniques for PVC and PET – size reduction – melt filtration – Mechanical recycling – chemical recycling – Energy recovery – applications. Feed Stock Recycling – Pyrolysis – kiln / Retort – Fluidized bed – application – Hydrogenation of plastics waste – Gasification – different gasification process – economic aspects – Incineration of plastic waste with energy recovery.

UNIT V RUBBER RECYCLING 9

Tyre size reduction – Application of ground Rubber crumb – Filler – Bound Rubber products – Thermoplastics binder – Civil engineering applications – Surface treated crumb rubber – applications – Rubber reclaiming and devulcanization scrap rubber and fuel source (Tyre derived fuel TDF) – Pyrolysis.

TOTAL : 45 PERIODS

OUTCOMES

Students will able to:

- Apply the principles of various methods of recycling and to relate the methods tovarious polymeric materials.
- Understand the need for recycling and classification of recycling methods.
- Sort and separate mixed plastics.
- Recycle domestic and engineering thermoplastics.
- Acquire the knowledge of various techniques for rubber recycling

REFERENCES

1. Ann Christine Albertson and Samuel J Huang, Degradable Polymers, Recycling andPlastics, Marcel Dekker Inc, 1995.
2. Gerald D Andrews and Pallatheri M Subramanian, Emerging Technologies in PlasticsRecycling, ACS Symposium Series, 513, 1992.
3. John Scheirs, Polymer Recycling Science, Technology and Applications, JohnWiley&Sons, 1998.
4. Mustafa.N. Plastics Waste Management Disposal Recycling and Reuse, Marcel DekkerInc, 1993.
5. Randall Curlec, T. and Sujit Das, Plastics Wastes: Management Control, Recycling andDisposal, US Environmental Protection Agency, Noyes Data Corporation, 1991.

PO5072 TOTAL QUALITY MANAGEMENT L T P C

3 0 0 3

OBJECTIVES

- To provide comprehensive knowledge about the principles, practices, tools and techniques of total quality management

UNIT I INTRODUCTION 9

Introduction – Need for quality – Evolution of quality – Definitions of quality – Dimensions of product and service quality – Basic concepts of TQM – TQM Framework – Contributions of Deming, Juran and Crosby – Barriers to TQM – Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention – Costs of quality.

UNIT II TQM PRINCIPLES 9

Leadership – Strategic quality planning, Quality Councils – Employee involvement – Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal – Continuous process improvement – PDCA cycle, 5S, Kaizen – Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUES I 9

The seven traditional tools of quality – New management tools – Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES II 9

Control Charts – Process Capability – Concepts of Six Sigma – Quality Function Development (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000 – ISO 9001-2008 Quality System – Elements, Documentation, Quality Auditing – QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – TQM Implementation in manufacturing and service sectors.

TOTAL: 45 PERIODS

OUTCOMES

- 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. Dale H. Besterfiled, et at., “Total quality Management”, Pearson Education Asia, Third Edition, Indian Reprint, 2006.
2. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 8th Edition, First Indian Edition, Cengage Learning, 2012.
3. Janakiraman. B and Gopal .R.K., “Total Quality Management – Text and Cases”, Prentice Hall (India) Pvt. Ltd., 2006
4. Suganthi.L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006.

PO5012	MOULD ENGINEERING	L T P C
		3 0 0 3

OBJECTIVES

- To select proper materials for mould making
- To understand the need and method of surface treatments
- To acquire the knowledge on mould manufacturing techniques
- To inspect, repair, protect and estimate the moulds

UNIT I MATERIAL FORMOULDS 9

Selection of steels– Properties of steels– common steels used for moulds –strength of materials, calculation of wall thickness for cavity– Insert size–Life of mould Non-ferrous metals for mould construction: Application–Zinc based alloys Aluminium alloys –Beryllium copper Non-metallic materials for mould construction: Advantages and its applications –epoxies-polyester– silicon

UNIT II SURFACE TREATMENT OF MOULD MATERIALS 9

Introduction–Heat treatment process – casehardening – through hardening – nitriding – tips on successful heat treatment – vacuum hardening –cryogenic heat treatment Hard chromeplating – Nickel plating – chemical etching – Mould Polishing techniques

UNIT III MOULD MAKING TECHNIQUES 9

Pantographengraving–Hydrocopying–Jigboring–CNCmachines–CNCLatheCNCMilling–

CNCEDM–Advantages and its Applications – Assembly of moulds– Rapid prototyping

UNIT IV INSPECTION AND QUALITY CONTROL OF MOULDS 9

Introduction to Tool Room measuring instruments – Vernier– Micrometer – Height Gauge–Slip Gauge–Dial Gauge–Measuring tapers and angles – CMM.

UNIT V MOULD COST ESTIMATION, REPAIR AND PROTECTION 9

Procedure for estimating mould cost – General outline – Cost calculation – Basic moulds –Cavity– Basic functional components Special functions etc. Mould Repair and maintenance –scheduling mould maintenance – advantages – storage –corrosion protection – wear and lubrication – special consideration.

TOTAL : 45 PERIODS

OUTCOMES

At the end of the course, the student should be able to

- Identify components of specific products and justify their material selection
- Describe the advantages and disadvantages of the different classes of manufacturing processes
- Describe the manufacturing processes used to fabricate mould components
- understand surface enhancement processes in advanced manufacturing and their applications

REFERENCES

1. CyrilDonaldsonGeorgeH.LecainVCGoold,ToolDesign,TATAMcGraw-Hill,1998.
2. Dominick V. Rosato, Donald V. Rosato, Injection Moulding Hand Book, CBC Publishers&Distributors,1987.
3. Irwin Rubin, Injection Moulded Theory and Practice, Wisely Interscience Publication, 1972.
4. RichardR.KibbeJohnE.Neele,RolandOMeyer,WarranT.White,MachineTool Practices,PrenticeHallofIndiaPvt.Ltd.,1999.
5. Society of Plastics Industry, Plastics Engineering Hand Book, Van Nostrand Reinhold Company, 1945.

PO5073 INTELLECTUAL PROPERTY RIGHTS (IPR) AND COPY RIGHT LAWS L T P C
3 0 0 3

OBJECTIVES

- To know about the intellectual properties, patents, trade marks and design rights
- To understand the procedure for applying patent documentation
- To get information on the industrial design and its projection
- To learn about the procedure for commercialization of intellectual properties

UNIT I **9**

Introduction – Invention and Creativity – Intellectual Property (IP) – Importance –Protection of IPR – Basic types of property (i). Movable Property - Immovable Property and - Intellectual Property.

UNIT II **9**

IP – Patents – Copyrights and related rights – Trade Marks and rights arising fromTrademark registration – Definitions – Industrial Designs and Integrated circuits –Protection of Geographical Indications at national and International levels – Application Procedures..

UNIT III **9**

International convention relating to Intellectual Property – Establishment of WIPO –Mission and Activities – History – General Agreement on Trade and Tariff (GATT) –TRIPS Agreement.

UNIT IV **9**

Indian Position Vs WTO and Strategies – Indian IPR legislations – commitments to WTO-Patent Ordinance and the Bill – Draft of a national Intellectual Property Policy –Present against unfair competition.

UNIT V **9**

Case Studies on – Patents (Basmati rice, turmeric, Neem, etc.) – Copyright and related rights – Trade Marks – Industrial design and Integrated circuits – Geographic indications – Protection against unfair competition.

TOTAL: 45 PERIODS

OUTCOMES

On completion of this paper the student will

- Able to understand the laws and regulation governing the patents, trade marks and copyrights
- Able to know about the procedure for applying patent and copy rights
- Understand the basics of industrial design

- Have detailed knowledge of commercialization of patents and trademarks

REFERENCES

1. Eli Whitney, United States Patent Number: 72X, Cotton Gin, March 14, 1794.
2. Intellectual Property Today: Volume 8, No. 5, May 2001, [www.iptoday.com].
3. Subbaram N.R. “Handbook of Indian Patent Law and Practice “, S. Viswanathan Printers and Publishers Pvt. Ltd., 1998.
4. Using the Internet for non-patent prior art searches, Derwent IP Matters, July 2000.
5. www.ipmatters.net/features/000707_gibbs.html.