



(An Autonomous Institution - AFFILIATED TO ANNA UNIVERSITY, CHENNAI)

S.P.G.Chidambara Nadar - C.Nagammal Campus

S.P.G.C. Nagar, K.Vellakulam – 625 701 (Near VIRUDHUNAGAR).

**B.TECH. POLYMER TECHNOLOGY
REGULATION – 2020
AUTONOMOUS SYLLABUS
CHOICE BASED CREDIT SYSTEM
VII TO VIII SEMESTER CURRICULUM AND SYLLABI**

VISION:

To make the Department of Polymer Technology of this Institution the unique of its kind in the field of Research and Development activities in this part of world.

MISSION:

To impart highly innovative and technical knowledge in the field of Polymer Technology to the urban and unreachable rural student folks through Total Quality Education.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

- PEO 1:** Graduates will be technically proficient in Polymer Technology with a commitment to quality, timeliness and compete with confidence in their career
- PEO 2:** Graduates will contribute towards research and professional development and entrepreneurship
- PEO 3:** Graduates will engage in lifelong learning or continuous education opportunities.

PROGRAM OUTCOMES:

After going through the four years of study, the B.Tech Polymer Technology graduates will have the ability to

POs	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/Development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5	Modern tool usage	Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1 : **Polymer industry oriented preparedness:** Reveal an ability to identify careers in polymer technology's domains like, synthesis of polymers, processing and quality with adept skills required to work in polymer technology laboratory or manufacturing facility.

PSO2 : **Higher Education Preparedness:** Demonstrate an ability to appear for competitive examinations to pursue higher studies.

SEMESTER VII

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	PT1701	Polymer Composites	PC	3	3	0	0	3
2	PT1702	Rubber Product Manufacturing	PC	3	3	0	0	3
3	GE1773	Total Quality Management	HS	3	3	0	0	3
4		Professional Elective III	PE	3	3	0	0	3
5		Professional Elective IV	PE	3	3	0	0	3
6		Open Elective II*	OE	3	3	0	0	3
PRACTICALS								
7	PT1711	Computer Aided Mold Design Laboratory -II	PC	4	0	0	4	2
8	PT1712	Polymer Blends and Composites lab	PC	4	0	0	4	2
9	PT1721	Mini project	EEC	4	0	0	4	2
TOTAL				30	18	0	12	24

SEMESTER VIII

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1		Online course-II	OL	3	3	0	0	3
PRACTICALS								
2	PT1821	Project Work	EEC	8	0	0	16	8
TOTAL				11	3	0	16	11

* Course from the Curriculum of other UG programmes.

PROFESSIONAL ELECTIVES (PEs)

PROFESSIONAL ELECTIVE III (SEMESTER VII)

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	PT1731	Biodegradable Polymers	PE	3	3	0	0	3
2	PT1732	Fiber Technology	PE	3	3	0	0	3
3	PT1733	Plastics Packaging Technology	PE	3	3	0	0	3
4	PT1734	Polymer Structure Property Relations	PE	3	3	0	0	3
5	PT1735	Polymers in Civil and Geopolymer	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE IV (SEMESTER VII)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	PT1736	Paints and Surface Coatings	PE	3	3	0	0	3
2	PT1737	Polymers for Aerospace applications	PE	3	3	0	0	3
3	PT1738	Process Instrumentation for Polymer Technologist	PE	3	3	0	0	3
4	PT1739	Specialty Elastomers	PE	3	3	0	0	3
5	PT1740	Tyres and Tubes Technology	PE	3	3	0	0	3

OPEN ELECTIVE II (SEMESTER VII)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
Offered to all discipline								
1	OPT161	Introduction to Macromolecular Science	OE	3	3	0	0	3
2	OPT164	Polymer Processing Technology	OE	3	3	0	0	3
Offered to MECH, MTR, EIE, EEE								
3	OPT162	Introduction to Product Testing	OE	3	3	0	0	3
4	OPT163	Polymer Nanocomposites	OE	3	3	0	0	3

L	T	P	C
3	0	0	3

OBJECTIVES:

- To enable the students to understand the introduction and classification of composites
- To understand the various reinforcements for composites
- To impart the various matrix systems in composites
- To acquire knowledge about various processing methods of composites
- To understand the testing and applications of composites

UNIT I INTRODUCTION TO COMPOSITES 9

Composites- classifications - metal matrix composites, ceramic matrix composites, Polymer matrix composites- Advantages and limitations of polymer matrix composites over MMC and CMC, hybrid composites general properties and applications

UNIT II REINFORCEMENTS FOR COMPOSITES 9

Reinforcements: Properties and applications of - various types of glass fiber, carbon fibers, aramid fibers, boron fibers, natural fibers.

UNIT III MATRIX FOR COMPOSITES 9

Methods of manufacturing- properties, curing characteristics and applications of unsaturated polyesters - vinyl ester -phenol formaldehyde resin-urea formaldehyde resin-melamine formaldehyde resin. epoxy resins, Cyanate esters resins. Polyimide resin

UNIT IV PROCESSING OF COMPOSITES 9

Composites Processing techniques - Hand Lay-Up, Spray- Up, Bag Molding, Resin Transfer Molding (RTM), Filament Winding, Pultrusion, Prepregs, SMC, DMC. Autoclave molding, centrifugal molding

UNIT V TESTING AND APPLICATIONS OF COMPOSITES 9

Mechanics of composites-Fracture and damage mechanics - laminates –delamination -Measurement of physical and mechanical properties: density-fibre volume fraction-void content, test for tensile-compression- flexural in fiber direction.

Applications of Composites: Applications in aerospace, automotive, marine, civil engineering and electrical industry.

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** Familiarize about the introduction and classification of composites
- CO2:** Attain the knowledge of reinforcement mechanism
- CO3:** Explain the matrix for composites
- CO4:** Understand the processing methods of composites
- CO5:** knowledge in testing and applications of composites

TEXT BOOKS

1. Lubin. G., 1982. *Hand Book of Composites*. Van Nostrand Reinhold, New York.
2. Peters. S.T., 1998. *Handbook of Composites*. Chapman & hall. 2nd Edition

REFERENCE BOOKS

1. Hull. D., and Clyne. T.W., 1996. *An introduction to Composite Materials* 2nd Ed., Cambridge.
2. Matthews. F. L., and Rawlings. R.D., 1994. *Composite materials: engineering and science*. Chapman and Hall.
3. Mallick. P.K., 1997. *Composites Engineering Handbook*. Marcel Dekker Inc.
4. Brydson. A., 1995. *Plastics materials*. Butterworth- Heinemann – Oxford

PT1702

RUBBER PRODUCT MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To enable the students to understand the construction and manufacturing of pneumatic tires
- To enable the students to understand manufacturing of belts and hoses
- To acquire knowledge about various processing methods of footwear and sports goods manufacturing
- To enable the students to understand the manufacturing of oil seals and engine mount manufacturing
- To impart knowledge in latex products

UNIT I TYRE MANUFACTURING 9

Tyre- Introduction- functions and requirements– Composition - Various Types – Bias – Belted – Radial – Tubeless Tyre – Tyre Building- Manufacturing methods – moulding & vulcanization.

UNIT II BELT AND HOSES MANUFACTURING 9

Belting and Hoses - Conveyor belting, passenger conveyor belting, - Components and Functions – V Belts - Building & Manufacturing- Hose-Types- moulded, machine, handmade- Compounding aspects

UNIT III FOOTWEAR AND SPORTS GOODS MANUFACTURING 9

Footwear and Sports Goods– Footwear Components- sole and heel units –Various manufacturing process- Sports Goods - Tennis Balls – Golf Balls- Tennis rings

UNIT IV OIL SEALS AND ENGINE MOUNT MANUFACTURING 9

Manufacturing, curing of Oil Seals, Gaskets, Engine Mounts, Bridge and railway pads- Rubber to Metal bonding - Good manufacturing practices - Effluent- Control and Treatment- Safety in rubber industry

UNIT V LATEX PRODUCTS MANUFACTURING 9

Latex Products –Dipped goods- rubber band, Gloves, balloon - Manufacturing of Latex Foam Rubber thread, use of latex in cement, adhesives, road rubberisation –Rubber Recycling products.

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** Compare the various types of tyres and its manufacturing process
- CO2:** Suggest suitable rubber composition for making rubber hoses and belts
- CO3:** Demonstrate footwear and sport goods manufacturing techniques
- CO4:** Apply rubber-metal bonding principles for making oil seals and other molded goods
- CO5:** Suggest suitable process for making of latex dipped goods and rubber recycled products

TEXT BOOKS

1. Bhowmick, A. ed., *Rubber products manufacturing technology*, Routledge, 2018
2. Ciesielski, A., *An introduction to rubber technology*. Ismithers Rapra Publishing, 1999
3. Morrell, S.H. and Blow, C.M., 1975. *Rubber technology and manufacture*. Blow, CM, Ed., 1975
4. Mark, J.E., Erman, B. and Roland, M. eds., *The science and technology of rubber*, Academic press, 2013

REFERENCE BOOKS

1. Franta, I. ed., *Elastomers and Rubber Compounding Materials (Vol. 1)*, Elsevier, 2012
2. Morton, M. ed., *Rubber Technology*. Springer Science & Business Media, 2013
3. Gent, A.N., *Engineering with Rubber: How to design Rubber Components*, Carl HanserVerlag GmbH Co KG, 2012.

L	T	P	C
3	0	0	3

OBJECTIVES:

- To enable students to Learn the concepts of quality and quality management, TQM framework, Barriers and Benefits of TQM.
- To enable students to Apply the Principles and techniques of Quality Management for real time
- Understanding the need and importance of quality assurance and certification

UNIT I INTRODUCTION 9

Concept of Quality and Quality Management- Determinants of quality of product & service-Quality vs. Reliability-- Definition of TQM-- Basic concepts of TQM -- TQM Framework- Barriers to TQM –Benefits of TQM.–Gurus of TQM (Brief introduction)- Quality statements – vision, mission, Policy.

UNIT II PRINCIPLES AND PHILOSOPHIES OF QUALITY MANAGEMENT 9

Overview of the contributions of Deming , Juran Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi, Shingeo and Walter Shewhart - Concepts of Quality circle, Japanese 5S principles and 8D methodology.

UNIT III TOOLS AND TECHNIQUES FOR QUALITY MANAGEMENT 9

Quality functions development (QFD) – Benefits, Voice of customer, information Organisation, House of quality (HOQ), building a HOQ, QFD process. Failure mode effect analysis (FMEA) – requirements of reliability, failure rate, FMEA stages, design, process and documentation-Taguchi techniques

UNIT IV STATISTICAL QUALITY CONTROL 9

Juran's concept of quality cost-components of Quality Cost- Statistical Quality Control – Inspection, Sampling, Sample Size, Sampling Plan, AQL, OC curve, Producer Risk, Consumer Risk, AOQ, AOQL, Control Charts & Control Limits – X, R & S charts and their application- causes of variations – Assignable & Random; Runs-Test, Chart-Sensitivity Test and Run-Sum Test; Normal-Distribution curve and concept of Six Sigma

UNIT V QMS- QUALITY MANAGEMENT SYSTEM

9

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation-Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** Ability to apply TQM concepts in a selected enterprise.
- CO2:** Ability to apply TQM principles in a selected enterprise.
- CO3:** Ability to understand Taguchi's techniques, Performance Measures,QFD,HOQ .
- CO4:** Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking.
- CO5:** To confirm quality standards and implementing QMS in business organisation

TEXT BOOKS

1. L. Suganthi & Dr. Anand Samuel, *Total Quality Management*, Prentice Hall, Publications, 2004
2. Dale H.Besterfield, Carol B.Michna,Glen H. Besterfield, MaryB.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, *Total Quality Management*, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013

REFERENCE BOOKS

1. Rose J.E.,*Total Quality Management*, S. Chand & Co., 2016
2. Kiran.D.R, *Total Quality Management: Key concepts and case studies*, Butterworth – Heinemann Ltd, 2016
3. Shridhara Bhat K, *Total Quality Management: Text and Cases*, second edition, Himalaya Publishing House India, 2016

PT1711 COMPUTER AIDED MOLD DESIGN LABORATORY-II

L	T	P	C
0	0	4	2

OBJECTIVES:

- Design of Extrusion die for thermoplastic products
- Design of blow mold for plastic bottles
- Design of compression and transfer mold for thermoset products.

LIST OF EXPERIMENTS

1. Design of convergent and divergent dies for extrusion
2. Design of Extrusion die for plastic pipes
3. Design of Extrusion die for blown films
4. Design of Extrusion die for plastic sheets
5. Design of open flash type compression mold for given product
6. Design of positive type compression mold for given product
7. Design of semi-positive type compression mold for given product
8. Design of plunger type transfer mold for given product
9. Design of pot type transfer mold for given product
10. Design of blow mold for plastic bottle
11. Design of blow mold for plastic containers
12. Design of rotational mold for given product

(Any 8 experiments from above)

TOTAL: 60 PERIODS

EQUIPMENTS NEEDED (FOR 60 STUDENTS)

S.NO.	NAME OF THE EQUIPMENT	QTY.
1	CAD Software License	1 No.
2	Printer	1 No.

OUTCOMES:

- CO1:** Design extrusion die for plastic sheets, films and pipes using CAD software
- CO2:** Design compression mold for thermoset products
- CO3:** Design transfer mold for thermoset products
- CO4:** Design blow mold for bottles and containers
- CO5:** Design of rotational mold for plastic product

L	T	P	C
0	0	4	2

OBJECTIVES:

- Design of Extrusion die for thermoplastic products
- Design of blow mold for plastic bottles
- Design of compression and transfer mold for thermoset products.

LIST OF EXPERIMENTS

1. Miscible binary system (solution and melt mixing)
2. Immiscible binary system (solution and melt mixing)
3. Compatibilised binary system (solution and melt mixing)
4. Blending of NR with SBR, BR and EPDM.
5. Preparation of Continuous Fiber reinforced Polymer Composites using Hand Lay up technique.
6. Preparation of Continuous Fiber reinforced Polymer Composites using Compression molding technique.
7. Preparation of Dis-Continuous Fiber reinforced Polymer Composites using Hand Lay up technique
8. Preparation of Dis-Continuous Fiber reinforced Polymer Composites using Compression molding technique
9. Preparation of thermoplastic fiber composites using compression moulding
10. Preparation of compression moulded random fiber composites based on thermosets
11. Preparation of compression moulded bidirectional fiber composites based on thermosets
12. Preparation of compression moulded unidirectional fiber composites based on thermosets
13. Preparation of compression moulded random fiber composites based on elastomers
14. Preparation of compression moulded unidirectional fiber composites based on Elastomers
15. Casting

(Any 8 experiments from above)

TOTAL: 60 PERIODS

EQUIPMENTS NEEDED (FOR 60 STUDENTS)

S.NO.	NAME OF THE EQUIPMENT	QTY.
1	Compression moulding machine	1 No.
2	Mould for Hand lay up	1 No.

OUTCOMES:

- CO1:** Prepare the miscible binary system
- CO2:** Illustrate the immiscible and compatibilised binary systems
- CO3:** Develop Continuous and discontinuous fiber composites
- CO4:** Manufacture the unidirectional and random fiber composites
- CO5:** Make the composite using casting process

PT1721

MINI PROJECT

L	T	P	C
0	0	4	2

OBJECTIVES:

To enable the students to

- Demonstrate a sound technical knowledge of their project topic
- Analyze a problem with an in depth literature review in the selected domain
- Train the students in preparing project reports and to face reviews and viva voce examination

Each student will be assigned a project involving theoretical literature review on issues related to Polymer Technology. Continuous internal assessment marks for the project will be given during project review meeting. The student has to prepare and present a project report based on literature review at the end of the semester and give a presentation about the work done. End semester examination mark will be based on viva voce examination.

TOTAL: 60 PERIODS

OUTCOMES:

- CO1:** Identify challenging engineering problems to propose project based solutions
- CO2:** Build critical thinking and analytical decision making capabilities to find solution by formulating proper methodology
- CO3:** Design and development of solution relevant to the problem.
- CO4:** Analyze the design/experimental results
- CO5:** Conduct literature Survey to gain knowledge about the recent technological advancements.

PT1821

PROJECT WORK

L	T	P	C
0	0	16	8

OBJECTIVES:

To enable the students to

- Develop the ability to solve specific problem right from its identification and literature review till the successful solution of the same
- Train the students in preparing project reports and to face reviews and viva voce examination
- To inculcate the habit of working in teams.

Each student will be assigned a project involving some design and fabrication work as well as theoretical and experimental studies on issues related to Polymer Technology. Continuous internal assessment marks for the project will be given during project review meeting. The student has to prepare and present a detailed project report at the end of the semester and give a presentation about the work done. End semester examination mark will be based on viva voce examination.

TOTAL: 240 PERIODS

OUTCOMES:

- CO1:** Identify challenging engineering problems to propose project based solutions
- CO2:** Build critical thinking and analytical decision making capabilities to find solution by formulating proper methodology
- CO3:** Design and development of solution relevant to the problem.
- CO4:** Analyze the design/experimental results
- CO5:** Demonstrate the conclusion based on analysis and recommend solution to potential engineering problems.

L	T	P	C
3	0	0	3

OBJECTIVES:

- To enable the students to understand the method to develop biodegradable polymers
- To get knowledge on need of biodegradable polymer.
- To enrich various testing methods used for analyzing the biodegradability.

UNIT I CHEMISTRY AND BIOCHEMISTRY OF POLYMER DEGRADATION 9

Introduction, enzymes - enzyme nomenclature - enzyme specificity - physical factors affecting the activity of enzymes - enzyme mechanism, Chemical degradation initiates biodegradation, Hydrolysis of synthetic biodegradable polymers.

UNIT II PARTICULATE STARCH BASED PRODUCTS 9

Development of Technology, Current objectives, relative starch technology, Manufacture of master batch, Conversion technology - processing precautions - moisture and temperature - rheological considerations, cyclic conversion process, physical properties of products - sample preparation - physical testing methods

UNIT III BIOPOLYESTERS 9

Introduction, History, biosynthesis, Isolation - solvent extraction - sodium hypo chloride digestion, enzymatic digestion, Properties - crystal structure - nascent morphology, degradation-Intracellular biodegradation - extra cellular biodegradation - thermal degradation - hydrolytic degradation - environmental degradation

UNIT IV RECYCLING TECHNOLOGY FOR BIODEGRADABLE PLASTICS 9

Introduction, conventional recycling - recycling problems, degradable complicate recycling- polyethylene/starch film, reprocessing polyethylene/cornstarch film scrap - learning to reprocess PE/S - Calcium oxide moisture scavenger - temperature control - accounting for pro-oxidant - handling PE/S repro - economics of in-plant recycling, Using PE/S repro – comparative study of PE/S repro on film properties, recycling other degradables.

UNIT V **TEST METHODS & STANDARDS FOR BIODEGRADABLE** **9**
PLASTICS

Introduction, defining biodegradability, criteria used in the evaluation of biodegradable polymers, choosing the most appropriate methodology, description of current test methods -screening test for ready biodegradability, tests for inherent biodegradability, tests for simulation studies, - petri dish screen -environmental chamber method - soil burial tests

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** Ability to apply TQM concepts in a selected enterprise.
- CO2:** Ability to apply TQM principles in a selected enterprise.
- CO3:** Ability to understand Taguchi's techniques, Performance Measures,QFD,HOQ .
- CO4:** Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking.
- CO5:** To confirm quality standards and implementing QMS in business organisation

TEXT BOOKS

1. Griffin, G.J., *Chemistry and technology of biodegradable polymers*, Blackie Academic and Professional, 1994

REFERENCE BOOKS

1. Bastioli, C. ed., *Handbook of Biodegradable Polymers*. Walter de Gruyter GmbH & Co KG, 2020
2. Lendlein, A. and Sisson, A. eds., *Handbook of Biodegradable Polymers: Isolation, Synthesis, Characterization and Applications*, John Wiley & Sons, 2011
3. Ebnesajjad, S. ed., *Handbook of biopolymers and biodegradable plastics: properties, processing and applications*. William Andrew, 2012

4. Perrin, D.E. and English, J.P., *Handbook of Biodegradable Polymers*, Domb AJ, 1997
5. Thakur, V.K., Thakur, M.K. and Kessler, M.R., *Handbook of Composites from Renewable Materials, Biodegradable Materials* (Vol. 5), John Wiley & Sons, 2017

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn about the selection of fiber forming polymers
- To learn about the production technologies of synthetic fibres such as melt spinning, wet spinning, dry spinning, texturing and stretching methods; colouration techniques of fibres.
- To learn about fibre drawing process, modification and testing fibre

UNIT I CRITERIA FOR FIBRE FORMING POLYMERS 9

Development of synthetic - commercial synthetic fibres, Raw materials manufacture. DMT, TPA, MEG, caprolactum, adipic acid, hexamethylene diamine, acrylonitrile, polymerisation - types of polymers - criteria for fibre forming polymers - production of polyethylene terephthalate polymer - polyamides - production of nylon 66 polymer - nylon 6 polymer.

UNIT II FIBRE PRODUCTION METHODS 9

Production of acrylic fibres - polypropylene - production of other fibres - PVC fibres - PVA fibres - Aramid fibres - Melt spinning - Polymer feed - melt spinning equipment - high speed spinning - spin draw processes - crystallization method - melt spinning of PET & PP staple fibres - wet and dry spinning comparison. Spin finishes - functions of spin finish - methods of application of spin finish - spin finish for polyester staple fibres - spin finish for texturing process - effect of spin finish on dyeing.

UNIT III FIBRE DRAWING PROCESSES 9

Stretching or drawing - conditions of drawing - machines for draw warping - texturing - false twist process - draw texturing- staple fibre production, melt spinning - drawing, heat setting - crimping in fibre line - production of melt spin staple fibre - polyester tops for wool blending - Mass coloration and tow dyeing of polyester, nylon, acrylic - polypropylene - dyeing in loose fibre and yarn forms of polyester, nylon, acrylic, PP, other synthetic fibres - loose fibre dyeing.

UNIT IV MODIFIED SYNTHETIC FIBRES 9

Modified synthetic fibres - modified polyester, Nylon, PP, acrylics - Hydrophilic - Hollow -Low pilling - flame retardant- bicomponent fibres - Dyeability of synthetic fibres

UNIT V TESTING OF YARN AND FIBRES

9

Quality control - testing raw material - testing polymers - testing yarns & fibres - waste utilisation of polyester - nylon 6 - 66 - acrylics - PP- Energy conservation - pollution control.

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** Ability to apply TQM concepts in a selected enterprise.
- CO2:** Ability to apply TQM principles in a selected enterprise.
- CO3:** Ability to understand Taguchi's techniques, Performance Measures, QFD, HOQ .
- CO4:** Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking.
- CO5:** To confirm quality standards and implementing QMS in business organisation

TEXT BOOKS

1. Vaidya, A.A., *Production of Synthetic Fibres*. Prentice-Hall of India Private Limited, 1988
2. Fourné, F., *Synthetic Fibers: Machines and Equipment, Manufacture, Properties*, Hanser, 1999
3. Gupta, V.B. and Kothari, V.K. eds., *Manufactured Fibre Technology*. Springer Science & Business Media, 2012

REFERENCE BOOKS

1. Mishra, S.P., *A Text Book Of Fibre Science and Technology*, New Age International, 2000
2. Brody, H., *Synthetic Fibre Materials*, Longman, 1994
4. Burkinshaw, S.M., *Chemical Principles of Synthetic Fibre Dyeing*, Springer Science & Business Media, 1995

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce the need and importance of plastic packaging.
- To provide knowledge of various packaging materials
- To impart knowledge on flexible rapid packaging
- To impart knowledge of rigid packaging
- To develop knowledge of various standards for testing
- To provide understanding on testing of packaging materials

UNIT I SELECTION CRITERIA FOR PACKAGING MATERIALS 9

Introduction to plastics packaging: functions of packaging, Types of packages, advantages of plastic packaging, special requirements of food and medical packaging,. Packaging as a system: Elements, approach, package, design, relation criteria for packaging materials, packaging equipment checklist, Major packaging plastics Introduction - PE, PP, PS, PVC, polyesters, PVA, EVA, PA, PC, ionomers & fluoro polymers

UNIT II CONVERSION PROCESS FOR PACKAGING MATERIALS 9

Conversion process - Compression & transfer for moulding, Injection moulding, Blow moulding, Extrusion, roto moulding, thermoforming. Lamination: wet lamination, dry lamination, heat or thermal lamination, extrusion lamination, hot melt or wax lamination, metallizing, Shrink wrapping, Pallet & stretch wrapping. Printing processes such as letter press, flexography, lithography, Gravure, silk screen, ink jet printing, hot die stamping and gold blocking

UNIT III PROCESS FOR FLEXIBLE PACKAGING 9

Extrusion, film and flexible packaging - co extrusion (cast film & sheet, Blown film, Multi layer film & sheet coatings, coextrusions laminations, , pouching, sealing (heat sealing, pressure sealing, adhesive sealing, solvent sealing and adhesive sealing,, evaluation of seals in flexible packages, advantages of flexible packaging - flexible packaging products.

4. A.S. Athayle, *Handbook of packaging plastics*, Multi-Tech publishing co, First edition, 1999

REFERENCE BOOKS

1. Selke. S.E.M., *Plastics Packaging – Properties, Processing and Applications*, John Culter, 2010
2. Hannay. F., *Rigid Plastics Packaging – Materials, Processes And Applications*, Rapra Publications, 2002
3. Paine. F.A., *Fundamentals of Packaging Technology*, Blackie & Sons Publication, 1967
4. Barnetson., *Plastics Materials for Packaging*, Rapra Publications, 1996

L	T	P	C
3	0	0	3

OBJECTIVES:

- The structure of polymers and prediction of polymer properties
- The relationship between polymer structure and properties such as mechanical, thermal, electrical, optical and chemical properties

UNIT I STRUCTURE AND PROPERTIES OF POLYMERS 9

Linear, branched, crosslinked, and network polymers-Homochain and hetero atomic chain polymers - Copolymers and its types- Linear and cyclic arrangement - Prediction of polymer properties, group contribution techniques, topological techniques- Volumetric properties - molar volume, density, Van der Waals volume - Coefficient of linear thermal expansion and volumetric thermal expansion -Pressure volume temperature (PVT) relationship

UNIT II MECHANICAL PROPERTIES 9

Stress-strain properties of polymers - Effect of polymer structure on modulus of elasticity, tensile strength, flexural strength, impact strength, fracture toughness - Crazeing in glassy polymers - Ductile brittle transition. Effect of additives on mechanical properties of polymers - Creep, stress relaxation, and fatigue

UNIT III THERMODYNAMIC AND TRANSITION PROPERTIES 9

Transition temperature in polymers, glass transition (T_g), melt transition (T_m), relationship between T_g and T_m - upper and lower glass transition, Prediction of T_c , T_g and T_m of polymers by group contributions.

Calorimetric properties - Heat capacity, specific heat, latent heat of crystallization and fusion, enthalpy and entropy.

UNIT IV ELECTRICAL AND OPTICAL PROPERTIES 9

Effect of polymer structure on dielectric constant, dissipation factor, and loss factor - effect of frequency of voltage and temperature on dielectric properties - Prediction of molar polarization and effective dipole moment. Effect of additives - Factors affecting the electrical conductivity of polymers.

3. Samuels. R.J., *Structured Polymer Properties*. John Wiley & Sons. New York, 1974
- 4.. Ku. C.C., Liepins.R.,*Electrical Properties of Polymers*. Hanser Publications, Munich, 1987

REFERENCE BOOKS

1. Babu, G.S., *An introduction to soil reinforcement and geosynthetics*, Universities Press, 2006
2. Provis, J.L. and Van Deventer, J.S.J. eds., *Geopolymers: Structures, Processing, Properties and Industrial Applications*, Elsevier, 2009

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OBJECTIVES:

- To learn the various polymer resins and synthesis
- Outline significance of fundamentals of paint science
- To know the various pigments and solvents for paints
- To know the various additives for paints
- To learn the particle size measurements and application of paints
- To know the mechanical properties of paints and coating

UNIT I ORGANIC FILM FORMERS 9

Fundamentals of paint science, reflection, refraction, diffraction, colour science, additive colour mixing, gloss, specular gloss, bloom gloss, surface uniformity, hiding power, chromaticity diagrams for colour measurements.

Classification based on polymeric resin, emulsion, oil and alkyd paints, acrylic paints, epoxy coatings, polyurethanes, silicones, formaldehyde based resins, chlorinated rubbers, acrylics, hydrocarbon resins. Fluoropolymers, vinyl resins, Classification based on application. appliance finishes, automotive finishes, coil coatings, can coatings, marine coatings, aircraft finishes.

UNIT II PIGMENTS FOR PAINTS 9

Paint components, pigments, pigment properties, different types, selection, dispersion and colour matching of pigments, solvents, different types, paint preparation, formulation, factors affecting pigment dispersion, preparation of pigment dispersion, manufacture, extenders, solvents, different types, solvent properties, oil, driers, resins, diluents, additives affecting viscosity, interfacial tension, chemical reactions, living micro organisms. Effects on viscosity – evaporation of solvent from cavity - Flashpoint – Toxicity, enamel, varnish.

UNIT III ADDITIVES FOR PAINTS 9

Anti-corrosive Pigments – Antifoams – Antisettling agent – Antiskinning agents – Can corrosive inhibitors – Dehydrates – Dispersion aids – Driers – Flash corrosion inhibitors – floating and flooding additives – Reodorants – UV absorbance.

Properties such as floating, silking, cratering, foaming, skinning, flame retardance, slipresistance and storage stability, surface cleaning methods, chemical conversion treatments, paint application, brushing, dip coating, flow coating, roller coating, spray painting, electro deposition, chemiphoretic deposition.

UNIT IV APPLICATIONS OF PAINTS AND COATINGS 9

Application of coating – Coating for building – Automotive parts – Automotive refinish paints -General industrial paints – Painting of ships. Mechanism of film formation, physical drying, oxidative drying, chemical drying, Adhesion properties of coatings, factors affecting adhesive bond, thermodynamics of adhesion, testing of paint materials, destructive methods, nondestructive methods

UNIT V MECHANICAL PROPERTIES OF PAINTS AND COATINGS 9

Factors affecting coating properties, film thickness, film density, internal stresses, pigment volume concentration (PVC), different methods used for film preparation, Mechanical properties and optical properties of coatings, ageing properties, effect of rheological behaviour on paint performance. Determination of mechanical properties of coating – Transient method – Dynamic method –Hardness test – Flexibility – Impact test – Acoustic emission – Durability test

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** Understand the various polymerization techniques for different resins
- CO2:** Specify the effects of pigments in paints
- CO3:** Classify the additives in paints.
- CO4:** Mention the impact of the particle sizing methods and various application of coatings
- CO5:** Explain the mechanical properties of paints and coating

TEXT BOOKS

1. LambourneR and Strivens,T.A., *Paint and Surface Coating: Theory and Practice*, William Andrew Publishing, Second Edition,1993
2. Arthur.A.Traction, *Coatings materials and surface coatings*, CRC Press, 2007

3. Rodger Talbert, *Paint Technology Handbook*, CRC Press, London, 2008

REFERENCE BOOKS

1. Swaraj Paul, *Surface coating: Science and Technology*, Wiley, 1996
2. R. Lambourne, *Paint and Surface Coatings-Theory and Practice* 1987
3. Lambourne and Strivens, *Paint and Surface Coatings*, Elsevier, 1999
4. Z. Wicks et al, *Organic Coatings Science and Technology*, John Wiley & Sons, 2007
5. Turner, *Introduction to Paint Chemistry and Principles of Paint Technology*, Springer, 2014
6. Lewis, P.A *Pigment Handbook: Properties and economics*, Wiley, 1988

PT1737 POLYMERS FOR AEROSPACE APPLICATIONS

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OBJECTIVES:

- To impart the knowledge of various types resins used for the manufacturing of air craft parts.
- To understand the various types of fiber materials and its applications for making Composites.
- To understand the knowledge of various manufacturing methods for making aircraft composites.
- To impart the knowledge by incorporating carbon nanotubes for aerospace applications.

UNIT I AERO SPACE GRADE POLYMERS - THERMOSET 9

Epoxies - diglycidylether of bisphenol - A resins, epoxy - novalacs, cycloaliphatic epoxies, thermoset polyurathenes - Thermoset polyimides - Bismaleimides (BMIs) - Cyanate esters (CEs) – Benzoxazines - Phthalonitriles.

UNIT II AERO SPACE GRADE POLYMERS - THERMOPLASTIC 9

Polyetheretherketone (PEEK) - Polyphenylsulfone (PPSU) - Polyetherimide (PEI) - Polyetherketoneketone (PEKK) - Polybenzimidazole (PBI) - Polyphenylene sulfide (PPS)

UNIT III FIBERS FOR AEROSPACE APPLICATIONS 9

Carbon fibres- precursors and production, properties; carbon/carbon composites- production, properties and applications; Sic fibre – Sic/Sic composites – Boron Fibre – Graphite Fibre – Ceramic Fibres.

UNIT IV MANUFACTURING OF COMPOSITES IN AEROSPACE 9

Contact moulding, compression moulding, vacuum bag/autoclave moulding, rotational moulding, resin transfer moulding (RTM), tape wrapping, filament winding, pultrusion, expanding bladder moulding.

UNIT V CARBON NANO TUBES IN AEROSPACE 9

Carbon nanotube (CNT), structure of CNT, synthesis of CNT, electronic, vibrational, mechanical and optical properties of CNT; applications of CNT.

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** Demonstrate different types of thermoset resins used for the manufacture of aircraft parts.
- CO2:** Demonstrate different types of thermo plastic resins used for the manufacture of aircraft parts.
- CO3:** Differentiate the Carbon and SIC synthetic fibres utilized for aerospace applications.
- CO4:** Apply various manufacturing methods for producing aircraft parts.
- CO5:** Implement Carbon Nano Tubes In Aerospace Applications.

TEXT BOOKS

1. Lubin, G., *Handbook of Composites*, Springer Science & Business Media, 2013
2. Peters, S.T. ed., *Handbook of composites*. Springer Science & Business Media, 2013
3. Zhang, S. and Zhao, D. eds., *Aerospace materials Handbook*. CrC Press, 2012

REFERENCE BOOKS

1. Jawaid, M. and Thariq, M.eds., *Sustainable Composites for Aerospace Applications*, Woodhead publishing, 2018
2. Irving, P.E. and Soutis, C. eds., *Polymer composites in the Aerospace Industry*. Woodhead Publishing, 2019
3. Cantor, B., Assender, H. and Grant, P. eds., *Aerospace materials*. CRC Press, 2015
4. Gao, F. ed., *Advances in Polymer Nanocomposites: Types and applications*. Elsevier, 2012
5. Mouritz, A.P., *Introduction to Aerospace Materials*, Elsevier, 2012

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OBJECTIVES:

- To learn the basic concepts of measurements system and transducers
- To understand the basics knowledge on temperature, pressure measuring devices.
- To acquire the knowledge on the flow measurement and vibration measurement devices .

UNIT I MEASUREMENT AND MEASUREMENT SYSTEM 9

Introduction , Significance of measurements , Methods of measurements ,Primary, Secondary and Tertiary Measurements ,Classification of instruments , Function of instruments and measurement system, Application of measurement system , Elements for generalised measurement system, Errors -Types Of Error ,Systematic Errors.

UNIT II TRANSDUCERS 9

Transducers, Electrical Transducers, classification of transducers, characteristic and choice of transducers , factors influencing the transducers, potentiometers LVDT, RVDT, capacitive transducers. optical transducers

UNIT III TEMPERATURE MEASUREMENT DEVICES 9

Classification of temperature measuring device ,Measurement of Resistance Thermometer , Themistor, Thermocouple , Radiation Pyrometer , Principle used for Radiation Temperature Measuring Device ,Total Radiation Pyrometer, Infrared Pyrometer, Optical Pyrometer

UNIT IV PRESSURE MEASUREMENT DEVICES 9

Types of pressure measurement device, manometers, types of manometer, bourdon tube bellow, diaphragm, McLeod gauge, Knudsen gauge, thermal conductivity of gauge , calibration of pressure measuring using dead weight tester.

UNIT V FLOW MEASUREMENT AND VIBRATION MEASUREMENT DEVICES 9

Flow through nozzle ,Electromagnetic flow meter , hot wire anemometer, hot film

transducer, turbine flow meter , vortex meter, laser Doppler anemometer, measurement of angular velocity –mechanical tachometer and electrical tachometer.

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** Discuss the general concept of measurements and measurement system
- CO2:** Classify the types of transducers and its functions.
- CO3:** Express the different temperature measuring devices and its working principles.
- CO4:** Demonstrate the pressure measuring device working principle , and applications.
- CO5:** Construct the flow measuring devices and tachometers

TEXT BOOKS

1. Sawhney, A.K. and Sawhney, P., *A course in mechanical measurements and instrumentation* (Vol. 3, p. 12). Dhanpat Rai, New Delhi, 1995
2. Riley, W.F., McConnell, K.G., Dally, J.W., Dally, J.W. and Dally, J.W., *Instrumentation for engineering measurements*. Wiley, 1993
3. Sirohi, R.S. and Krishna, H.R., *Mechanical measurements*. New Age International, 1991

REFERENCE BOOKS

1. Ghosh, A.K., *Introduction to measurements and instrumentation*. PHI Learning Pvt. Ltd, 2012
2. Klaassen, K.B., 1996. *Electronic Measurement and Instrumentation*. Cambridge University Press, 1996
3. Morris, A.S. and Langari, R., *Measurement And Instrumentation: Theory and Application*, Academic Press, 2012
4. Rajput, R.K., *Mechanical Measurements & Instrumentation*. SK Kataria and Sons, 2009
5. *Purkait, P., Electrical and Electronics Measurements And Instrumentation, McGraw-Hill Education, 2013*

6. *Miller, H.B., Acoustical measurements and instrumentation, The Journal of the Acoustical Society of America, 61(2), pp.274-282, 1977*
7. *Kishore, K.L., Electronic Measurements and Instrumentation. Pearson Education India, 2009*

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OBJECTIVES:

- To impart knowledge on manufacturing, compounding of various specialty elastomers
- To acquire knowledge on processing and curing of various specialty elastomers
- To provide exposure on various applications of specialty elastomers

UNIT I SPECIALITY RUBBER AND THEIR COPOLYMERS 9

Introduction of speciality Rubbers - Silicones (Q) - Introduction, Manufacture - Structure and its influence on properties - Compounding - Fabrication - Curing - General properties - Applications - Copolymers - PMQ, PVLQ, FMQ, FVMQ - Silicones Rubber for medical use

UNIT II CHLORO AND FLUORO ELASTOMERS 9

Chlorosulphonated polyethylene - Introduction - Manufacture - Structure and its influence on properties - Compounding - Curing - Properties - Applications
 Epichlorohydrin - (CO, ECO, ETIR)- Introduction - Manufacture - Structure and its influence on properties - Compounding and Curing-Properties and application
 Fluoro Elastomers (FKM) - Introduction - Manufacture - Structure and its influence on properties - Compounding - Curing - Properties and applications

UNIT III POLYSULPHIDE AND TPU 9

Polysulphides (TM) - Introduction, Manufacture - Cross linked Polyethylene (XLPE) – Polyurethane Rubbers - Introduction Manufacture - Structure and its influence on properties - Compounding - Curing - Properties and applications. Thermoplastic Polyurethanes - Introduction - Manufacture - Structure and its influence on Properties - Compounding - Curing - Properties and applications

UNIT IV ACM and THEIR COPOLYMERS 9

Acrylic Rubber (ACM), Ethylene acrylic copolymers, Introduction, Manufacture- Structure and its influence on Properties - Compounding - Curing - Properties and applications
 Ethylene Vinyl Acetate - Copolymer - Introduction, Manufacture -

Structure and its influence on Properties - Compounding - Curing - Properties and applications

UNIT V CHLORONATED PE AND EPDM 9

Chlorinated Polyethylene - Introduction - Manufacture - Structure and its influence on Properties - Compounding - Curing - Properties and applications. EPM, EDPM - Introduction, Manufacture - Structure and its influence on Properties -Compounding - Curing - Properties and applications.

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** State the fabrication, curing and properties of speciality rubbers and copolymers
- CO2:** Familiarize the chloro and fluoro elastomer used in special application
- CO3:** Apply the knowledge on Structure and its influence on properties of polysulphide and TPU.
- CO4:** Demonstrate the manufacturing and applications of ACM speciality polymer and its types
- CO5:** Apply the compounding and curing characteristics for speciality rubbers like CPE and EPDM

TEXT BOOKS

1. Hoffmann., *Rubber Technology Hand Book*, Hanser Publishers Munich, 1989
2. Anil. K., Bhowmick, & Howard. L. Stephens., *Hand Book of Elastomers, New Development & Technology*, Marcel Decker Inc., New York, 1988

REFERENCE BOOKS

1. Stoyko Fakirov, *Handbook of Condensation Thermoplastic Elastomers.*, John Wiley & Sons, 2006

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OBJECTIVES:

- To make the students to understand the role of rubber in tyre.
- To acquire knowledge on cord reinforced rubber in tyre.
- To familiar in tyre manufacturing and retreading processes
- To provide understanding on tyre testing

UNIT I TYRE COMPONENTS AND STRUCTURE 9

Tyres – Function – Construction – Basic tyre design-Tyre Components and their functions, Tyre Materials, Tyre Nomenclature and Structural Dimensions, Classification of tyres based on applications and its requirements. Tubeless Tyre-Function, Construction, Materials and advantages

UNIT II TYRE CORD REINFORCEMENTS 9

Tyre cords – Physical Properties of tyre-cords- Rayon, Nylon, Polyester, Fibreglass, Aramid, Steel Wire-Cord Processing – Heat Treatment, Adhesive treatment, Bonding systems, Rubber to Cord Mechanism, Tyre Cord Construction, Evaluation of adhesive systems.

UNIT III TYRE COMPOUNDING AND MECHANICS 9

tyre compound and fundamental properties –compound development – raw materials for compounding- different tyre components – designing the compound matrix for the reinforced composite. Mechanics of rubber – cord-rubber composite and its properties, failure mechanism of cord reinforced rubbers composites. Inflation pressure – contact area, tyre deflections – design factors and principles. Rolling resistance, friction, mechanical loss on tyre behavior.

UNIT IV TYRE AND TUBE MANUFACTURING 9

Tyre manufacturing – tyre building – green tyre – curing methods – post curing - inflation – finishing. –Retreading – criteria – methods of retreading.

Tubes: Principles of tube design – manufacturing of tubes by extrusion, valve jamming, inflation & curing in presses, tube testing

UNIT V TYRE TESTING AND RECYCLING

9

Tyre Testing – Destructive and Non-destructive Testing of Tyres, Plunger Tests (Breaking energy), Pulley wheel test Field Tract Testing – Braking, Acceleration, mileage, Regulations, Tyre Labelling. Recycling of rubber vulcanizate –Use of recycled rubber

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** Describe the components and classification of tyres
- CO2:** Select the reinforcement with respect to tyre cord
- CO3:** Choose the suitable compounding ingredients for tyre manufacturing
- CO4:** Demonstrate the tyre and tube manufacturing process
- CO5:** Suggest a suitable destructive and non-destructive testing method of tyre

TEXT BOOKS

1. Tom French., *Tyre Technology*, Adam Hilger, 1989
2. James E. Mark, & Burak. Erman., *Science and Technology of Rubber.*, Academic Press, 2005

REFERENCE BOOKS

1. Ridha. R.A., & Theves. M., *Advances In Tyre Mechanics.*, Rapra Technology Limited, 1997
2. Bhowmick. A.K., Hall. M.M., & Benaney. H.A., *Rubber Products Manufacturing Technology.*, Marcel Dekker Inc, New York, 1994

OPT161

**INTROUCTION TO MACROMOLECULAR
SCIENCE**

L	T	P	C
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OBJECTIVES:

- To introduce the fundamentals of polymer chemistry, structure and classification of polymers.
- To impart knowledge about preparation, properties and application of natural polymers
- To impart knowledge about preparation, properties and application of synthetic polymers
- To provide exposure about polymerization methods
- To develop an understanding of molecular weight and solubility of macromolecules.

UNIT I INTRODUCTION TO POLYMERS 9

Introduction to Historical Background of Polymer Science, Various applications of polymers, Raw materials, Market and future of polymers, India in global scenario. Macromolecular concept, structural features of polymers, Basic concepts and terminology like monomers, oligomers, polymers low polymers, high polymers, copolymers, functionality, degree of polymerization, thermoplastics, thermosets, elastomers/rubbers, plastics, fibers, adhesives.

UNIT II NATURAL & INORGANIC POLYMERS 9

Natural Polymers: Chemical & Physical structure, properties, source, applications of polymers such as cellulose, lignin, starch, rosin, shellac, cellulose acetate, butyrate and nitrate – ethyl cellulose – carboxymethyl cellulose
Inorganic polymers - phosphorous and nitrogen containing polymers – silicones - hybrid polymers

UNIT III SYNTHETIC POLYMERS 9

Raw material for synthetic polymers: Manufacturing of various fractions of crude petroleum important for polymer industry for Raw Materials such as ethylene, propylene, butadiene etc. and Brief idea of preparation, properties and application of polyethylene, polypropylene, polystyrene, polyvinyl chloride, Novolac and resol.

UNIT IV POLYMERIZATION MECHANISM 9

Kinetics and mechanism of free radical, cationic, anionic and coordination polymerization - stereo regular polymerization– living polymers comparison of radical cationic and anionic polymerizations. Polycondensation polymerization- and Copolymerization.

UNIT V MOLECULAR WEIGHT 9

Molecular weight types - Molecular weight averages - Molecular weight distribution - Unidispersity, polydispersity, Degree of polymerization. Effect of Molecular weight on processing and properties- Factors affecting molecular weight and molecular weight distribution

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** Describe the components and classification of tyres
- CO2:** Select the reinforcement with respect to tyre cord
- CO3:** Choose the suitable compounding ingredients for tyre manufacturing
- CO4:** Demonstrate the tyre and tube manufacturing process
- CO5:** Suggest a suitable destructive and non-destructive testing method of tyre

TEXT BOOKS

1. Billmeyer, F.W., *Textbook of polymer science*. John Wiley & Sons, 1984.
2. Odian, G., *Principles of polymerization*. John Wiley & Sons, 2004

REFERENCE BOOKS

1. Bhatnagar, M.S., *A Text Book of Polymers (Chemistry and Technology of Polymers), Vol I, II & III*, S.Chand and Company, 2007
2. Gowarikar V.R., *Polymer Science*, NewAge International Pvt. Ltd, 2015
3. Carraher C E,., *Introduction to Polymer Chemistry*, CRC Press, 2017
4. Ravie, A. *Principles of Polymer Chemistry*, Springer-Verlag, 2012

5. Peacock, A.J. and Calhoun, A., *Polymer Chemistry: Properties and Application*. Carl Hanser Verlag GmbH Co KG, 2012
6. Fried; J. R., *Polymer Science and Technology*, Prentice-Hall of India Pvt. Ltd., , 2003
7. Young, R.J. and Lovell, P.A., *Introduction to polymers*. CRC press, 2011
8. Ghosh, P, *Polymer science and technology*. Tata McGraw-Hill Education, 1990

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OBJECTIVES:

- To make the student acquire knowledge on conducting polymers.
- To provide exposure on synthesis of conducting polymers.
- To impart a thorough understanding of doping process of conducting polymers.
- To provide knowledge on properties of conducting polymers.
- To facilitate the students to understand the use of conducting polymers for various applications.

UNIT I STRUCTURAL EVALUATION OF POLYMERS 9

Principles, theories and applications to polymeric systems with suitable illustration of the following techniques: Fourier transform infrared spectrometry, Ultraviolet - visible spectrometry, Nuclear magnetic resonance spectrometry, Mass spectrometry, X-ray diffraction spectrometry, Gas chromatography.

UNIT II THERMAL PROPERTIES OF POLYMERS 9

Glass transition temperature, melting temperature, heat distortion temperature, etc. Sample preparation, standardization, conditioning of sample, processability test, dynamic mechanical analysis, melt flow rate, Vicat softening temperature. Study of a dilatometer. Study of thermo-chemical analysis and differential scanning calorimeter and their applications to polymers with suitable examples

UNIT III ELECTRICAL PROPERTIES 9

Surface volume resistivity, Breakdown voltage, Arc resistance, Tan Delta, etc. The theory behind these phenomena, application to polymers and evaluation.

UNIT IV MECHANICAL PROPERTIES 9

Their principles and applications to polymers, Tensile strength, flexural strength, impact resistance, percentage elongation, Griffin theory, tear test, fatigue and wear, hardness, compressive strength time dependant properties like creep, stress, relaxation, etc

UNIT V ENVIRONMENTAL RESISTANCE & OPTICAL PROPERTIES 9

Environmental resistance: Stress cracking, effect of weathering, biological degradation, fire, radiation staining.

Optical properties: Refractive index, gloss, colour matching, haze

Fire test: Ignition of flame and spread, limiting oxygen index, rate of heat release, smoke toxicity test

Adhesion test: Peel test, tension test, shear test.

Microscopy: Scanning electron microscopy, travelling electron microscope.

Identification of polymers using chemical methods

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** Attain the basic knowledge of polymers structural evolution
- CO2:** Demonstrate thermal properties of various polymers
- CO3:** Interpretation the electrical properties of polymers
- CO4:** Analyze the various polymers mechanical properties
- CO5:** Identify the environment needs and test polymers for various applications

TEXT BOOKS

1. Lobo, H. and Bonilla, J.V., *General Introduction To Plastics Analysis*, Plastics Engineering, New York, 68, pp.1-42, 2003
2. Brown, R. ed., *Handbook of Polymer Testing: Physical Methods*. CRC press, 1999

REFERENCE BOOKS

1. Shah, V., *Handbook Of Plastics Testing Technology*, 1988
2. Ives, G.C., Mead, J.A. and Riley, M.M., *Handbook of Plastics Test Methods*, 1971

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OBJECTIVES:

- To understand the basics and chemistry of nano size materials and their synthesis, characterization and applications.
- To equip with the knowledge on the processing of polymer nanocomposites.
- To study the various methods employed for the dispersion of nanomaterials in polymers.
- To provide knowledge in nanocomposite technology

UNIT I INTRODUCTION TO POLYMER NANOCOMPOSITES 9

Introduction to polymer nanocomposites – layered silicates – carbon nanotubes – inorganic nanofillers – polymer filler interfaces – modification of interfaces – ceramic/polymer nanocomposites – metal/polymer nanocomposites – natural nano biocomposites

UNIT II POLYMER - LAYERED SILICATE NANOCOMPOSITES 9

Polymer-layered silicate nanocomposites: types of nanoclays – thermoplastics and thermosets and elastomer matrices. Preparation of polymer-layered silicate nanocomposites – solution – melt mixing – latex mixing methods – techniques for achieving dispersion of nanofillers – intercalation and exfoliation

UNIT III POLYMER - CNT NANOCOMPOSITES 9

Carbon nanotube (CNT) – reinforced polymer nanocomposites: structure of carbon nanotubes – dispersion properties of CNT nanocomposites – interfacial bonding properties – mechanical properties and conductivity of nanotube-polymer nanocomposites.

UNIT IV PROCESSING OF POLYMER NANOCOMPOSITE 9

Processing of polymer nanocomposites – direct mixing – melt mixing – solution mixing – In-situ polymerization – In-situ particle processing – ceramic/polymer composites – metal/polymer nanocomposites – natural nanocomposites

UNIT V APPLICATIONS OF POLYMER NANOCOMPOSITES 9

Applications of polymer nanocomposites: automobiles – aerospace – injection

moulded products – coatings and adhesives – fire retardants – packaging materials – microelectronic packaging – dielectrics – drug delivery – membranes – medical devices and consumer goods

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** Explain the basic principles and types of polymer nanocomposites.
- CO2:** Select the appropriate nanofillers for the synthesis of nanocomposites with a novel polymer to achieve synergistic properties
- CO3:** Analyze and characterize polymer nanocomposites
- CO4:** Select appropriate techniques for processing of polymer nanocomposites.
- CO5:** Gain knowledge applications of polymer nanocomposites.

TEXT BOOKS

1. Chaudhery Mustansar Hussain., Ajay Kumar Mishra., *New Polymer Nanocomposites for Environmental Remediation*, Elsevier publication, 2018.
2. Ahmad Fauzi Ismail., Pei Sean Goh., *Carbon-based Polymer Nanocomposites for Environmental and Energy Applications*. Elsevier publication, 2018
3. Koo.H., *Fundamentals, Properties, and Applications of Polymer Nanocomposites*, 2016
4. Vikas Mittal., *Polymer Nanocomposite Coatings*. Taylor and Francis group, 2014
5. M. Ajayan. M., Schadler. L.S., Braun. P.V., *Nanocomposite Science and Technology*. WILEY-VCH Verlag GmbH, 2003

REFERENCE BOOKS

1. Jyotishkumar Parameswaran Pillai. Nishar Hameed. Thomas Kurian. Yingfeng Yu., *Nanocomposite Materials: Synthesis, Properties and Applications*. Taylor and Francis group, 2017

2. Aravind Dasari. Zhong-Zhen Yu. Yiu-Wing Mai, *Polymer Nanocomposites: Towards Multi-Functionality*. Springer, 2016
3. Rakesh Gupta. K., Elliot Kennel., Kwang-Jea Kim., *Polymer Nanocomposites Handbook*. Taylor and Francis group, 2010
4. Ramanan Krishnamoorti., Richard. A., Vaia., Washington. D.C., *Polymer nanocomposites: synthesis, characterization, and modeling*. American Chemical Society. Oxford University Press, 2002
5. Hussain. F., .Hojjati. M., Okamoto. R.E., *Polymer matrix nanocomposites, processing, manufacturing, and application: An overview*. J. Comp. Mater, 2006

UNIT V CALENDERING

9

Introduction-calender roll arrangements-calendering process-process variables applications-merits and demerits.

Thermoforming: Introduction-various types of thermoforming process- process variables – applications –merits and demerits.

TOTAL: 45 PERIODS

OUTCOMES

- CO1:** Explain the basic principles and types of polymer nanocomposites.
- CO2:** Select the appropriate nanofillers for the synthesis of nanocomposites with a novel polymer to achieve synergistic properties
- CO3:** Analyze and characterize polymer nanocomposites
- CO4:** Select appropriate techniques for processing of polymer nanocomposites.
- CO5:** Gain knowledge applications of polymer nanocomposites.

TEXT BOOKS

1. Whisson, R.R., *Injection Moulding—Theory And Practice*: Irvin I. Rubin John Wiley, New York, 1972
2. Athalye, A.S., *Special Injection Moulding Processes*, Popular Plastics and Packaging, 2007
3. De Zwart, J., *Methods Of Processing Plastics- In Handbook of Precision Engineering*, (pp. 3-57). Palgrave, London, 1971
4. Lee, N.C., *Practical Guide To Blow Moulding*, Smithers Rapra Publishing, 2006

REFERENCE BOOKS

1. Frados, J., *Plastics Engineering Handbook of the Society of the Plastics Industry*, Springer, 1976
2. Chan, I.W., Pinfold, M., Kwong, C.K. and Szeto, W.H., *A review of research, commercial software packages and patents on family mould layout design automation and optimization*, The International Journal of Advanced Manufacturing Technology, 57(1-4), pp.23-47, 2011