KAMARAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

(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), Madurai District.

B.TECH. POLYMER TECHNOLOGY

Regulation - 2020

AUTONOMOUS SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

CURRICULUM AND SYLLABI

(III & IV)

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 the world.

Mission of the Department:

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.

Program 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 Polymer Technology graduates will have the ability to

S. No.	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.

KAMARAJ COLLEGE OF ENGINEERING & TECHNOLOGY

(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), Madurai District.

B.TECH. POLYMER TECHNOLOGY

Regulation - 2020

AUTONOMOUS SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

CURRICULUM AND SYLLABI

(III & IV)

SEMESTER III

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	MA1304	Statistics and Partial Differential Equations	BS	3	1	0	4	4
2	PT1301	Fundamentals of Polymer Science	PC	3	0	0	3	3
3	PT1302	Plastics Materials- I	PC	3	0	0	3	3
4	PT1303	Polymer Physics	PC	3	0	0	3	3
5	PT1306	Introduction to Chemical Engineering	ES	3	0	0	3	3
PRACTICAL								
6	PT1311	Polymer Identification and Analysis Laboratory	PC	0	0	4	4	2
7	PT1316	Chemical Engineering Laboratory	ES	0	0	4	4	2
8	HS1321	Interpersonal Skills- Listening and Speaking	EEC	0	0	2	2	1
			TOTAL	**15**	**1**	**10**	**26**	**21**

SEMESTER IV

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	MA1471	Numerical Methods	BS	3	1	0	4	4
2	PT1401	Mould Manufacturing Technology	PC	3	0	0	3	3
3	PT1402	Plastic Processing Technology-I	PC	3	0	0	3	3
4	PT1403	Plastics Materials II	PC	3	0	0	3	3
5	PT1404	Polymer Rheology	PC	3	0	0	3	3
6	PT1405	Rubber Materials	PC	3	0	0	3	3
PRACTICAL								
7	PT1411	Mould Manufacturing Technology Laboratory	PC	0	0	4	4	2
8	PT1412	Polymer Preparation Laboratory	PC	0	0	4	4	2
9	HS1421	An Introduction to Reading and Writing	EEC	0	0	2	2	1
			TOTAL	**18**	**1**	**10**	**29**	**24**

SEMESTER III

MA1304 STATISTICS AND PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	C
3	1	0	4

OBJECTIVES:

- To make the students understand the concept of testing of hypothesis for small and large samples.
- To describe the concept of design of experiments to make the scientific judgements in the Engineering problem.
- To introduce the basic concepts of statistical quality control in the field of Engineering and Technology.
- To introduce the basic concepts of PDE for solving standard partial differential equations.

- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems

UNIT I TESTING OF HYPOTHESIS **12**

Sampling distributions – Statistical Hypothesis – Type I and Type II errors – Tests for single mean and difference of means of large samples (z-test) and Small samples (t-test) – F-test for variance – chi-square test for goodness of fit – independence of attributes – Demo using Excel.

UNIT II DESIGN OF EXPERIMENTS 12

Basic Principles of Experimental Design – Completely randomized design – Randomized block design – Latin square design – 2^2 factorial design – Demo using Excel

UNIT III STATISTICAL QUALITY CONTROL **12**

Control charts for measurements ($\bar{X}$ and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits – Demo using Excel.

UNIT IV PARTIAL DIFFERENTIAL EQUATIONS **12**

Formation of partial differential equations – Solutions of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT V APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS **12**

Dirichlet's conditions – General Fourier series – Half range sine series – Half range cosine series – Classification of PDE – Fourier Series Solutions of one dimensional wave equation – One dimensional equation of heat conduction.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to

CO1	Apply the concept of testing of hypothesis for small and large samples
CO2	Apply the basic concepts of classifications of design of experiments in the field of Engineering and Technology
CO3	Apply the techniques of Statistical quality control in Engineering problems

CO4 Solve various types of partial differential equations

CO5 Apply the Fourier series techniques in solving heat flow and wave equations

TEXT BOOKS:

1. Devore, J L 2017, *Probability and Statistics for Engineering and the Sciences*, Cengage Learning, 9th Edition, Boston
2. Johnson, R A, 2017, *Miller and Freund's Probability and Statistics for Engineers*, Pearson India Education, Asia, 9th Edition, New Delhi.
3. Grewal, B, S, 2014, *Higher Engineering Mathematics*, Khanna Publishers, 43rd Edition New Delhi.

REFERENCES:

1. Milton, J S & Arnold, J C, 2008 *Introduction to Probability and Statistics*, Tata McGraw Hill, 4th Edition, New Delhi.
2. Ross, S M, 2014 *Introduction to Probability and Statistics for Engineers and Scientists*, Elsevier, 5th Edition, New Delhi
3. Spiegel, M R, 2017 Schiller, J, Srinivasan, R A & Goswami, D, *Schaum's Outline of Theory and Problems for Probability and Statistics*, McGraw Hill Education, 3rd Edition, New Delhi.
4. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., 2004 "*Schaum's Outline of Theory and Problems of Probability and Statistics*", Tata McGraw Hill Edition
5. Erwin Kreyszig, 2016 "Advanced Engineering Mathematics ", 10th Edition, John Wiley, India.

PT1301 FUNDAMENTALS OF POLYMER SCIENCE

L	T	P	C
3	0	0	3

OBJECTIVES:

- To enable the students to understand the basic concept of polymer, mechanism and various techniques of polymerization, characterization of polymers by molecular weight, reactions and degradation of polymers

UNIT I BASIC CONCEPTS OF POLYMER 9

Basic concepts of macromolecules – Monomers - Functionality - Classification and Nomenclature of polymers - Types of polymers. Polymer Architectures – Linear- Branched – cross linked Macromolecules. Isomerism in Polymers –structural - stereo-conformational isomerism. Copolymers – statistical - alternating - block and graft copolymers.Step growth polymerization - Mechanism - Kinetics - Bi-functional systems - Poly functional systems.

UNIT II POLYMERIZATION MECHANISMS 9

Introduction-Addition polymerization Mechanism and kinetics of free radical – Cationic – Anionic Polymerisation - Initiator systems - Chain length and degree of Polymerization – Control of molecular weight - Chain transfer - Inhibition Coordination polymerization - Mechanism –Kinetics - Ring opening polymerization-Atom transfer radical-polymerization. Reversible Addition Fragmentation Termination (RAFT).

UNIT III COPOLYMERIZATION MECHANISM 9

Copolymerization –Types of copolymerization- Mechanism and Kinetics of free radical - Ionic copolymerization. Chemistry of copolymerization-monomer and radical reactivity –streric effects-Alteration –polar effects-Q-e scheme.

Determination of Monomer reactivity ratios. Polymerization techniques - Bulk polymerization-Solution polymerization - Suspension polymerization - Emulsion polymerization – Interfacial condensation.

UNIT IV POLYMER MOLECULARWEIGHT 9

Molecular weight- Molecular weight averages - Molecular weight distribution - Unidispersity, polydispersity, Degree of polymerization.

Molecular weight determination – Absolute methods: Basic concepts of end group analysis, colligative properties, membrane osmometry, vapour pressure osmometry-light scattering, and Relative methods: Viscometry -gel permeation chromatography

UNIT V REACTIONS OF POLYMERS 9

Chemical reactions of polymers – Addition and substitution reactions - Hydrolysis – Acidolysis –Aminolysis —- cross linking reactions. Polymer degradation – Mechanical degradation – Oxidative degradation – Hydrolytic degradation – Photo degradation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to

CO1	Develop the knowledge in the basic concepts of polymers, their classifications and nomenclature.
CO2	Evaluate the mechanism and kinetics of free radical cationic and anionic polymerization
CO3	Appraise the mechanism and kinetics of copolymer free radical the synthesis techniques for polymer
CO4	Determine the molecular weight of the polymer and understand the techniques used for determination.
CO5	Acquire knowledge about degradation mechanism of polymers and chemical reaction of polymers

TEXT BOOKS:

1. Billmeyer,F.W3rdEdition, 2008.*"Textbook of Polymer Science*", Wiley international publishers.
2. Gowariker, V.R, Viswanathan,N.V, JayadevSreedhar, 2nd edition 2015"*Polymer Science"* – New AgeInternational (P) Ltd, Publishers.
3. Anil kumar and GuptaR K , 2003 *Fundamentals of polymer engineering* Marcel Dekker, Inc

REFERENCES:

1. George Odian, 4thEdition,2004."*Principles of polymerisation*", Wiley international publishers.
2. CowieJM.G., 1991"*Polymers: Chemistry and Physics of Modern Materials*", Blackie, and London
3. Young R.J and .Lovell,P 2nd ed 1991 *"Introduction to Polymers*", Chapman & Hall,.
4. PremamoyGhosh1990, *"Polymer Science and Technology of Plastics and Rubbers*", Tata McGraw- Hill, New Delhi.
5. Painter PC, Coleman MM 2009*Essentials of polymer science and engineering*. DeStech Publications, Lancaster, PA.
6. PremamoyGhosh2011'*Polymer Science and Technology'* Tata McGraw – Hill.
7. Charles E. Carraher Jr. Fourth Edition 2017*Introduction to Polymer Chemistry*, CRC Press.
8. Joel R. Fried, 2014 "*Polymer Science and Technology*", Prentice Hall.
9. Ravve,2012 *A Principles of Polymer Chemistry*, Springer- Verlag New York,.

10. Andrew J. Peacock and Allison Calhoun, 2012*Polymer Chemistry: Properties and Application,* Carl Hanser Verlag GmbH & Company.

.

PT1302 PLASTICS MATERIALS I

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn about the general methods of preparation of individual class of plastics Materials
- To study about the general properties, processing behavior and applications of different class of plastics materials
- To understand about the structure- property relation of different class of plastics materials.

UNIT I INTRODUCTION 9

Basic chemistry of polymers-nomenclature of polymers sources for raw materials. Methods of manufacturing –properties and applications of Natural Polymers - Shellac resin and natural rubber-Cellulosics - Cellulose nitrate, cellulose acetate, cellulose acetate butyrate, Ethyl cellulose and others**.**

UNIT II COMMODITY THERMOPLASTICS-I 9

Preparation- properties - and applications of Polyolefine-Polyethylene- LDPE -LLDPE-HDPE, HMWHDPE- UHMWHDPE - Crosslinked polyethylene- Chlorinated polyethylene –Polypropylene – Homo & Co polymer

UNIT III COMMODITY THERMOPLASTICS-II 9

Preparation - properties - and applications of Vinyl plastics - Polyvinyl chloride, C-PVC, Polyvinyl Acetate, Polyvinylidene chloride, Polyvinyl alcohol. Polystyrene

UNIT IV GENERAL PURPOSE THERMOSETS 9

Preparation - properties - and applications of: Phenol formaldehyde (PF), Amino plastics: Urea formaldehyde (UF) - Melamine formaldehyde (MF), Unsaturated polyesters, Alkyd resins.

UNIT V ENGINEERING AND SPECIALITY THERMOSETS 9

Preparation - properties - and applications of: Epoxy Plastics, Polyurethane (PU) Silicones

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, Students will be able to

CO1 Acquire knowledge on manufacturing, properties and applications of Natural polymers

CO2 Correlate the Olefin polymers manufacturing methods, properties and applications

CO3 Correlate the vinyl polymers manufacturing methods, properties and applications

CO4 Describe the manufacturing methods, properties and applications of general purpose themoset polymers

CO5 Explain the methods of preparation , properties and applications of engineering and speciality polymers

TEXT BOOKS:

1. Brydson, J.A., 1999. *Plastics materials*. Elsevier.
2. Feldman, D. and Barbalata, A., 1996. *Synthetic polymers: technology, properties, applications*. Springer Science & Business Media.

REFERENCES:

1. Olabisi, O. and Adewale, K. eds., 2016. *Handbook of thermoplastics* (Vol. 41). CRC press.
2. Saunders, K.J., 2012. *Organic polymer chemistry: an introduction to the organic chemistry of adhesives, fibres, paints, plastics and rubbers*. Springer Science & Business Media.
3. Rubin, I.I. ed., 1990. *Handbook of plastic materials and technology* (p. 1745). New York: Wiley.
4. Gebelein, C.G., 1993. *Biotechnological Polymers*. Technomic Publishing Co., Lancaster, Pa.

PT1303 POLYMER PHYSICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To make the students understand physical and conformational properties of polymeric materials.
- To know the molecular arrangement in polymers and their orientation under the influence of stress.
- To know the solubility behavior of polymers.

UNIT I FUNDAMENTALS OF POLYMER PHYSICS 9

Potential energy and conformational energy of molecules - conformations and configurations, Tacticity, isomeric states and isomerism in polymers, stereoisomerism, geometric isomerism

Freely jointed and freely rotating chain models -Random coils and average end to end distance - (Derivation only)

UNIT II THERMODYNAMIC PROPERTIES 9

Laws of Thermodynamics - Freely jointed and freely rotating chain models - Entropy and enthalpy- Energy driven and entropy driven elasticity - Thermo elasticity -Thermodynamic treatment - entropic and energetic contributions (Derivation only)

UNIT III POLYMER CRYSTAL FORMATION 9

Amorphous State - Transition temperatures- Glass transition temperature Theory- Factors influencing glass transition Temperature- Crystalline State - polymorphism – Polymer single crystals, lamellae, spherulites – Crystallinity -factors affecting crystallinity -X-ray diffraction.

UNIT IV CHAIN ORIENTATION 9

Chain orientation - Concept of chain orientation - orientation in amorphous and crystalline polymers - Uniaxial and biaxial orientation practical significance – Orientation processes: spinning Process – Optical Properties of polymers – Birefringence, Haze, Transparency.

UNIT V POLYMER SOLUTIONS 9

Polymer solutions - Terms and definitions, types of solutions - Hilderbrand approach, Flory Huggins theory - Thermodynamic view of miscibility, upper critical solution temperature (UCST), lower critical solution temperature (LCST) - solubility parameter, determination of solubility parameter of polymers - theta conditions.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, Students will be able to

CO1 Understand the relationship between structure and properties of polymers and will be familiar with various techniques for the study of the size of polymers

CO2 Interpret the response of polymer towards temperature and understand the theories that support their behavior

CO3 Understand the amorphous and crystalline nature of polymers, their influence on properties and methods of determining them

CO4 Acquire knowledge of polymers behavior under orientation and various methods of orientation for the improvement in properties of polymers

CO5 Describe the various theories of polymers in solution and that importance in various applications

TEXT BOOKS:

1. Lewis, D. and Glasstone, S., 1960. *Elements of physical chemistry*. Macmillan.
2. Gedde, U.L.F., 1995. *Polymer physics*. Springer Science & Business Media.

REFERENCES:

1. Ulf W. Gedde, 2001. *Polymer Physics*, Springer – Science Business Media, B.V. 1st Edition.

..

PT 1306 INTRODUCTION TO CHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide the basic fundamentals in the field of chemical engineering.
- To impart the thorough knowledge in fluid flow behavior.
- To gain the ideas in the field of heat transfer operation
- To learn the principles in Mass transfer operations

UNIT I Fluid Flow 9

Newtonian and Non-Newtonian fluids – Continuity Equation - Bernoulli's theorem-Hagen Poisuille equation, Measurement of fluid flow- Orificemeter, Venturimeter and Pitot tube.

UNIT II MECHANICAL OPERATIONS 9

Properties of solids - Laws of crushing, Crushers - Grinders – Screen Analysis - Equipment for screening, Cyclones and Hydro cyclones.

(Basic principles and equipment description only. Mathematical consideration not required)

UNIT III HEAT TRANSFER 9

Modes of heat transfer; Heat transfer by conduction - Fourier's law, conduction across composite walls. Heat transfer by natural & forced convection – Heat Exchangers - Co current, Counter current, Shell & tube heat exchangers.

(Basic principles and equipment description only. Mathematical consideration not required)

UNIT IV MASS TRANSFER 9

Principles of diffusion, theory of diffusion, Two film theory and mass transfer coefficients Humidification – operation, Equipment's - cooling towers and spray chambers - Drying - Principles and definitions. Rate of batch drying- Equipment for drying.

(Basic principles and equipment description only. Mathematical consideration not required)

UNIT V UNIT OPERATIONS 9

Absorption - Principle and equipment (packed towers and plate columns). Distillation – flash distillation, and Binary distillation. Industrial equipment for distillation Adsorption - Principle and equipment for adsorption.

(Basic principles and equipment description only. Mathematical consideration not required)

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to

CO1	Demonstrate the flow meters used in process industries and apply fluid flow behavior in polymer processing.
CO2	Operate different size reduction equipments and screening Operations
CO3	Compare the conduction, convection and Radiation modes of heat transfer.
CO4	Apply the theories behind the mass transfer operations.
CO5	Demonstrate the concept of distillation equipment in Polymer industries.

TEXT BOOKS:

1. Shri Gavhane, K.A., 2015. *"Unit Operations I & II",* NiraliPrakashan Publication.
2. McCabe, W.L., Smith, J.C. and Harriott, P., 2014. *Unit operations of chemical engineering* (Vol. 7). New York: McGraw-hill.
3. Richardson, J.F. and Harker, J.H., 2020. *Coulson and Richardsons Chemical Engineering*.

REFERENCES:

1. Badger, W.L, Banchero, J.T., 2002. *"Introduction to Chemical Engineering"*, McGraw-Hill, UK, 1st Edition.
2. Felder, R.M., Rousseau, R.W. and Bullard, L.G., 2020. *Elementary principles of chemical processes*. John Wiley & Sons.
3. Serth, R.W. and Lestina, T., 2014. *Process heat transfer: Principles, applications and rules of thumb*. Academic press.
4. Bergman, T.L., Incropera, F.P., DeWitt, D.P. and Lavine, A.S., 2011. *Fundamentals of heat and mass transfer*. John Wiley & Sons.
5. Welty, J., Rorrer, G.L. and Foster, D.G., 2020. *Fundamentals of momentum, heat, and mass transfer*. John Wiley & Sons.

PT1311 POLYMER IDENTIFICATION AND ANALYSIS LAB

L	T	P	C
0	0	4	2

OBJECTIVES:

- To identify and analyze a polymer by chemical analysis

LIST OF EXPERIMENTS

Part –A Identification

1. Identification of Rubbers: NR, SBR, BR, IR, IIR, EPDM, CR, NBR, Hypalon, Thiokol,Silicone.
2. Identification of Plastics: PE, PP, PS, PVC, PVA, PF, UF, MF, Polyester
3. Identification of Thermoplastic Elastomers: SIS, SBS, SEBS, Hytrel

(Any six polymer samples in Part –A)

Part –B Determination / Analysis

1. Quantitative estimation of the following monomers: Aniline, Phenol, Acetone, Ethyl Acetate, Formaldehyde, Acrylonitrile, Urea, Glycol, Methyl methacrylate
2. Determination of molecular weight by viscosity method and end group analysis.
3. Estimation of Polymers: Acrylonitrile content of NBR, Chlorine content of CR, Rubber hydrocarbon content of NR.
4. Analysis of Polymer Compounds: Iodine value of rubber compounds, Carbon black content, Free sulphur content, Total inorganic content, Silica content
5. Determination of physical properties - boiling point using standards techniques,
6. Determination of physical properties - melting point, refractive index, specific gravity of polymer materials
7. Determination of Melt flow index of polymer materials.
8. Determination of water soluble matter in given pigment.
9. Determination of solubility of a given polymer in different solvents
10. Determination of viscosity of a resin by Ford Cup or Brook field viscometer.
11. Determination of gel time of a thermoset materials at a given temperature

(Any four experiments in Part –B)

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to

CO1 Identify a polymer by chemical analysis

CO2 Analyze a physical properties of polymer.

CO3 Estimate the quantity of monomers

CO4 Determine the solubility of polymers

CO5 Determine the gel time of thermoset materials

REFERENCES:

1. Sandler, S.R ,Karo, W,BonesteelJ and Pearce E.M, 1998 *Polymer Synthesis andCharacterization: A Laboratory Manual,* Elsevier.
2. Braun, D ,CherdonH and Ritter,H, 2013*Polymer Synthesis: Theory and Practice*, Springer Science.
3. Kuruvilla Joseph and Gem Mathew,2004,*Advanced Practical Polymer Chemistry*, Polymer Publications.
4. Dietrich Braun. 5th edition, 2005*Simple Methods for Identification of Plastics,*Hanser Publications.
5. Siddaramaiah, 2007 "*Practicals in Polymer Science*", CBS Publishers & Distributors, New Delhi.
6. Crompton T R, Vol. 1, 2008, *Characterisation of Polymers.* vol.1, SmithersRapra Technology Limited.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No.	Description of Equipment	Quantity Required
1.	Bunsen Burner	15
2.	Electronic Balance	1
3.	Thermostatic Water bath	2
4.	Melting Point Apparatus	1
5.	Retort Stand	15
6.	Polymer Samples and Glassware	15
7.	Burette	15
8.	Pipette	15
9.	Funnel	15

.

PT1316 CHEMICAL ENGINEERING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To impart knowledge in the field of flow measuring instruments
- To learn the fundamental flow analysis of heat exchanger.
- To understand the knowledge in different size reduction equipments.

LIST OF EXPERIMETS

1. To determine the pipe friction using Flow through rough and smooth pipes.
2. To determine the efficiency of pump using Centrifugal pump.
3. To determine the coefficient of discharge of orifice meter.
4. To find the efficiency of Air compressor
5. To Calibrate the rotameter
6. To find the Pressure drop in packed bed
7. To study the concept of Fluidization by using fluidized bed
8. To determine the coefficient of discharge of Venturi meter
9. To find the Thermal conductivity of solids.
10. To find overall heat transfer coefficient of the Heat exchanger
11. To find the Stefan-Boltzman constant
12. To find the new surface area created by Jaw crusher
13. To find the critical speed of Ball Mill
14. To find the Screening efficiency.
15. To separate the component by Simple distillation
16. To separate the component by using steam distillation
17. To find the Particle size and Surface area of filler particles.

(Any Nine Experiments)

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to

CO1 Demonstrate the different flow meters used in process industries.

CO2 Operate the different size reduction equipments such as Jaw crusher and ball mill.

CO3 Apply the knowledge in the field of various screens used in process industries.

CO4 Demonstrate the parallel and counter flow arrangements of Heat exchanger.

CO5 Apply the knowledge in mass transfer operations like simple and steam

distillation.

REFERENCES:

1. Shri Gavhane, K.A., 2015. *"Unit Operations I & II",* NiraliPrakashan Publication.
2. McCabe, W.L., Smith, J.C. and Harriott, P., 2014. *Unit operations of chemical engineering* (Vol. 7). New York: McGraw-hill.
3. Richardson, J.F. and Harker, J.H., 2020. *Coulson and Richardsons Chemical Engineering*.

.

HS1321 INTERPERSONAL SKILLS - LISTENING AND SPEAKING

L	T	P	C
0	0	2	1

OBJECTIVES:

- Equip students with the English language skills required for the successful undertaking of academic studies with primary emphasis on academic speaking and listening skills.
- Provide guidance and practice in basic general and classroom conversation and to engage in specific academic speaking activities.
- Improve general and academic listening skills
- Make effective presentations..

UNIT I LISTENING AS A KEY SKILL 6

Listening as a key skill- its importance- speaking – give personal information – ask for personal information – express ability – enquire about ability – ask for clarification - Improving pronunciation– pronunciation basics –– stressing syllables and speaking clearly – intonation patterns – conversationstarters: small talk

UNIT II LISTEN TO A PROCESS INFORMATION 6

Listen to a process information- give information, as part of a simple explanation –– taking lecture notes – preparing to listen to a lecture – articulate acomplete idea as opposed to producing fragmented utterances - compare andcontrast information and ideas from multiple sources- converse with reasonable accuracy overa wide range of everyday topics.

UNIT III LEXICAL CHUNKING 6

Lexical chunking for accuracy and fluency- factors influence fluency, deliver a five-minuteinformal talk – greet – respond to greetings – describe health and symptoms – invite and offer –accept – decline – take leave – listen for and follow the gist- listen for detail.

UNIT IV GROUP DISCUSSION **6**

Being an active listener: giving verbal and non-verbal feedback – participating in a groupdiscussion – summarizing academic readings and lectures conversational speech listening toand participating in conversations – persuade- negotiate disagreement in group work.

UNIT V GROUP & PAIR PRESENTATIONS **6**

Formal and informal talk – listen to follow and respond to explanations, directions and instructions in academic and business contexts – strategies for presentations and interactive communication – group/pair presentations

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to

CO1	Develop their communicative competence in English with specific reference to listening
CO2	Prepare conversation with reasonable accuracy
CO3	Apply lexical Chunking for accuracy in speaking
CO4	Demonstrate their ability to communicate effectively in GDs
CO5	Explain directions and instructions in academic and business contexts

TEXT BOOKS:

1. Brooks,Margret,2011, *Skills for Success. Listening and Speaking. Level 4,* Oxford University Press,Oxford.
2. Richards, C, Jack& David Bholke,2010, *Speak Now Level 3,*Oxford University Press, Oxford.

REFERENCES:

1. Bhatnagar, Nitin&MamtaBhatnagar,2010, *Communicative English for Engineers andProfessionals,* Pearson, New Delhi.
2. Hughes, Glyn & Josephine Moate,2014, *Practical English Classroom,* Oxford University Press, Oxford.
3. Vargo, Mari,2013, *Speak Now Level 4*, Oxford University Press, Oxford.
4. Richards, C, Jack,2006,*Person to Person (Starter)*, Oxford University Press, Oxford.
5. Ladousse, Gillian Porter,2014, *Role Play*. Oxford University Press, Oxford.

WEBSOURCES:

1. https://www.cambridge.org/elt/blog/wp-content/uploads/2019/10/Learning-Language-in-Chunks.pdf
2. https://english.eagetutor.com/english/628-how-to-greet-your-boss-people-in-office.html
3. https://www.groupdiscussionideas.com/group-discussion-topics-with-answers/
4. https://www.bbc.co.uk/worldservice/learningenglish/business/talkingbusiness/unit3presentations/1opening.shtml

SEMESTER IV

MA1471 **NUMERICAL METHODS**

L	T	P	C
3	1	0	4

OBJECTIVES:

- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals in real life situations.
- To impart the knowledge of various techniques of differentiation and integration.
- To compute the solution of differential equation with initial and boundary conditions.
- To understand the knowledge of finding the solution for the boundary value problems in Partial Differential Equations using finite difference methods.

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 12

Solution of algebraic and transcendental equations: Fixed point iteration method – Newton Raphson method – Solution of linear system of equations: Gauss elimination method – Pivoting – Gauss Jordan method – Inverse of a matrix by Jordan Method – Iterative methods of Gauss Jacobi and Gauss Seidel – Dominant Eigen value of a matrix by Power method.

UNIT II INTERPOLATION AND APPROXIMATION

12

Interpolation with unequal intervals: Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines – Difference operators and relations – Interpolation with equal intervals: Newton's forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION

12

Approximation of derivatives using interpolation polynomials – Numerical integration: Trapezoidal rule – Simpson's 1/3 rule – Simpson's 3/8 rule – Romberg's Method – Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 12

Single step methods: Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge-Kutta method for solving first order equations – Multi step methods: Milne's and Adam's predictor and corrector methods for solving first order equations

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 12

Finite difference methods for solving second order two-point linear boundary value problems – Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

TOTAL: 60 PERIODS

OUTCOMES:

Upon successful completion of this course, students will be able to

CO1 Compute numerical solutions to system of linear equations, algebraic, transcendental equations and Eigen value problems.

CO2 Construct approximate polynomial to represent the data and find the intermediate values of unknown function using interpolation

CO3 Apply numerical methods to find the values of differentiation and integration.

CO4 Solve the partial and ordinary differential equations with initial and boundary conditions by using numerical techniques.

CO5 Solve using finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain and one dimensional heat and wave equation.

TEXT BOOKS:

1. Burden, R.L and Faires, J.D 2016, *Numerical Analysis*, 9th Edition, Cengage Learning.
2. Grewal, B.S., and Grewal, J.S. 2015, *Numerical Methods in Engineering and Science*, Khanna Publishers, 10th Edition, New Delhi.

REFERENCES:

1. Brian Bradie, 2007, *A Friendly Introduction to Numerical Analysis*, Pearson Education, Asia, New Delhi.
2. Gerald. C. F. and Wheatley. P. O. 2006, *Applied Numerical Analysis*, Pearson Education, Asia, 6th Edition, New Delhi.
3. Kandasamy, P, Thilagavathy, K, & Gunavathy, K 2014, *Numerical Methods*, 3rd Edition Reprint, S. Chand & Co. Ltd., New Delhi.
4. Mathews, J.H. 1992, *Numerical Methods for Mathematics, Science and Engineering*, 2nd Edition, Prentice Hall.
5. Sankara Rao. K. 2007, *Numerical Methods for Scientists and Engineers*, Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi.
6. Sastry, S.S 2015, *Introductory Methods of Numerical Analysis*, PHI Learning Pvt. Ltd, 5th Edition, New Delhi.

.

PT1401 MOULD MANUFACTURING TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To make the students to acquire knowledge in basic machining operations
- To impart knowledge in EDM and Electroforming process
- To make the students to acquire knowledge in measuring instruments

UNIT I FUNDAMENTALS OF MOLD MAKING 9

Mold Making: selection of materials for mold making, Mechanism of metal cutting, types of tools, influence of tool angles, Cutting fluids. Applications of basic machining operations Turning, Cylindrical Grinding, Surface Grinding & Vertical Milling in mould making

UNIT II ELECTRICAL DISCHARGE MECHINING 9

Electrical discharge machining – Principle, Types of EDM - Die Sinking & Wire Cut EDM, Machining Process, Requirements of dielectric fluid, Applications of EDM in mold making.

UNIT III ELECTRO FORMING PROCESS 9

Electroforming for mold manufacturing - discussion of the process, materials for electroforming, design & materials for models, machining for electroformed mold cavities, Advantages, Disadvantages & Applications.

UNIT IV HOBBING AND CHEMICAL TEXTURING 9

Hobbing for mold cavity making - Discussion of the hobbing process, elements of hobbing, materials used for cavity, lubrication, and depth of hobbing, advantages and disadvantages. Surface Texturing of molds – Chemical Texturing, Process description, Advantages-Limitations of chemical texturing.

UNIT V METOROLOGY AND INSPECTION 9

Metrology and inspection: Vernier caliper, Micrometer, Vernier height gauges, Surface plate, Slip gauges, Sine Bar, Rockwell Hardness, Optical profile projectors and Optical flat-Applications of measuring instruments in mould making

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to

CO1 Apply the basic machining operations to make mould parts

CO2 Demonstrate the working principles and applications of EDM

CO3 Apply Electroforming principle for making mould cavities

CO4 Apply hobbing and surface texturing principles to make mold parts

CO5 Demonstrate the applications of measuring instruments in mould making

TEXT BOOKS:

1. KlusStokhert (Edt.), *Mold making handbook for Plastic Engineers*, Hanser Publishers, 2nd edition, 1998.
2. Hmt, H.M.T., 2001. *Production technology*. Tata McGraw-Hill Education.
3. Donaldson, C., LeCain, G.H., Goold, V.C. and Ghose, J., 2012. *Tool design*. Tata McGraw-Hill Education.

REFERENCES:

1. Chang, T.C. and Wysk, R.A., 1997. *Computer-aided manufacturing*. Prentice Hall PTR
2. R.G.W.Pye, *Injection Mold Design*, East West Press Pvt. Ltd., New Delhi.3rd Edition, 1983.
3. Stoeckhert&Menning, *Mold making handbook*, 2nd edition, Carl HanserVerlag GmbH & Company KG, 2013.
4. W.A.J Chapman, *Workshop Technology Part 2*, Taylor & Francis Group, 2016.
5. Menges, G., Michaeli, W. and Mohren, P., 2013. *How to make injection molds*. Carl HanserVerlag GmbH Co KG.

..

PT1402 PLASTIC PROCESSING TECHNOLOGY-I

L	T	P	C
3	0	0	3

OBJECTIVES:

- To make the students to acquire knowledge in injection moulding techniques
- To impart knowledge in blow moulding and thermoforming process
- To make the students to acquire knowledge in ancillary equipments

UNIT I INJECTION MOULDING - I 9

Introduction to polymer processing - Plastics processing techniques - Injection moulding Process description- Theory of injection moulding - moulding cycle.

Injection unit: Construction of Injection unit - Types of Injection unit –Plunger type, Two stage preplasticating type & Reciprocating screw type- Barrel-Nozzle-Non return valve.

Design features of screw - Screw design & Nomenclature – Feed zone, Compression zone and Metering zone Types of screw- General purpose screw-PVC screw.

UNIT II INJECTION MOULDING - II **9**

Injection molding Clamping unit - Classification–Toggle type- Hydraulic type-Hybrid clamping- Tie Barless clamping- All electric injection moulding machine-Merits and Demerits- Classification and functions of moulds - Microprocess control.

Calculation of clamping tonnage - Shot capacity – Injection rate - Plasticizing capacity. Moulding defects causes and Remedies

UNIT III BLOW MOULDING **9**

Blow moulding – Fundamentals of the process, complete blow moulding operation, Extrusion blow moulding – Classification - Intermittent type: Reciprocating screw & Accumulator head EBM - Continuous type: Shuttle, Rotary & Vertical type EBM.

Injection blow molding, Injection stretch blow moulding, start-up and shut-down procedures, parison programming, parison swell, cutting devices, moulding defects - causes and remedy.

UNIT IV THERMOFORMING **9**

Thermoforming – Basic process, thermoforming materials, stretching and wall thickness distribution, Methods of forming: simple vacuum forming, drape forming, pressure forming, free forming, snap back forming, matched mold forming and plug assist forming.

Classification of thermoforming machines –Sheet fed –Roll fed- Shuttle type-Rotary type-Ferris wheel type-Inline theromoformer-Advantages-Disadvantages-Trouble shooting

UNIT V ANCILLARY EQUIPMENTS FOR PROCESSING **9**

Ancillary equipments for processing – Need of predrying - moisture content- Dryer - Types of Dryers - Tray Dryer— Hopper dryer – Hopper loader – Vacuum hopper loader - Granulator - 3 blade, 4 blade granulator - Mould temperature controller – Chilling plant – Colour blender - Magnetic grills.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to

CO1 Illustrate injection moulding principles and screw designs for making of plastic products

CO2 Demonstrate the different types of clamping unit in injection molding machine

CO3 Apply blow molding principles to make plastic bottles and containers

CO4 Apply thermoforming principles to make thermoplastic products

CO5 Illustrate the ancillary equipments used for plastics processing

TEXT BOOKS:

1. Muccio, E.A., 1994. *Plastics processing technology*. ASM international.
2. Rosato, D.V. and Rosato, M.G., 2012. *Injection molding handbook*. Springer Science & Business Media.
3. Crawford, R.J. and Martin, P.J., 2020. *Plastics engineering*. Butterworth-Heinemann.

REFERENCES:

1. Agassant, J.F., Avenas, P., Carreau, P.J., Vergnes, B. and Vincent, M., 2017. *Polymer processing: principles and modeling*. Carl HanserVerlag GmbH Co KG.
2. Baird, D.G. and Collias, D.I., 2014. *Polymer processing: principles and design*. John Wiley & Sons.
3. Lafleur, P.G. and Vergnes, B. eds., 2014. *Polymer extrusion*. John Wiley & Sons.
4. Thomas, S. and Yang, W. eds., 2009. *Advances in polymer processing: from macro-to nano-scales*. Elsevier.
5. Tadmor, Z. and Gogos, C.G., 2013. *Principles of polymer processing*. John Wiley & Sons.
6. Cheremisinoff, N.P. and Cheremisinoff, P.N., 1996. *Handbook of applied polymer processing technology* (Vol. 31). CRC Press.

PT1403 PLASTICS MATERIALS II

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn about the general methods of preparation of individual class of plastic materials
- To study the general properties, processing behavior of plastics materials.

- To provide the knowledge in applications of different class of plastics materials.

UNIT I ENGINEERING PLASTICS & ITS APPLICATIONS - I 9

Preparation- properties - and applications: Styrene copolymers – High Impact Polystyrene (HIPS), Acrylonitrile Butadiene Styrene (ABS), Styrene acrylonitrile (SAN), Acrylic plastics – Polymethyl Methacrylate, Polyacrylonitrile , Ethylene Vinyl Alcohol (EVA).

UNIT II ENGINEERING PLASTICS & ITS APPLICATIONS – II 9

Preparation- properties - and applications: **Polyamides** - Nylons 6, (6,6), (6,10), 11, 12, **Polyesters** – Polyethylene terephthalate, polybutylene terephthalate, Polycarbonate, Polyacetals.

UNIT III HIGH PERFORMANCE PLASTICS - I 9

Preparation - properties - and applications: Aromatic ether - Polypheneylene oxide (PPO), Aromatic thioether - Polyphenylenesulphide (PPS), Polysulfone, Aromatic polyamides

UNIT IV HIGH PERFORMANCE PLASTICS - II 9

Preparation - properties - and applications: Polyimides (PI) Polyamideimide (PAI), Polyimidazoles, Fluoropolymers – Polyvinyl fluoride (PVF), Polyvinylidene fluoride (PVDF), Polytetrafluoroethylene (PTFE), Polychlorotrifluoroethylene (PCTFE).

UNIT V WATER SOLUBLE POLYMERS AND BIO DEGRADABLE POLYMERS 9

Preparation- properties and applications of Biodegradable polymers - poly ξ–caprolactone - polylactic acid- Bacterial polyhydroxyalkonates.– polyvinylpyrrolidone – polyacrylic acid and its homolog's – polyacrylamide –polyethylene oxide – polyethylene amine-Polyvinyl alcohol

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, Students will be able to

CO1 Acquire knowledge on manufacturing, properties and applications of special purpose polymers

CO2 Correlate the structure and properties of engineering polymers

CO3 Acquire skill in selection of suitable polymers for specific applications based on

its properties

CO4 Describe the manufacturing methods, properties and applications of high performance polymers

CO5 Acquire knowledge on methods of preparation , properties and applications of water soluble and biodegradable polymers

TEXT BOOKS:

1. Brydson, J.A., 1999. *Plastics materials*. Elsevier
2. Rubin, I.I. ed., 1990. *Handbook of plastic materials and technology* (p. 1745). New York: Wiley.
3. Manas Chanda, Salil.K.Roy, 1993 *"Plastics Technology Hand book",* 2nd edition, Marcel Dekker, New York.
4. Matrin.T.Goosey, 1985. "*Plastics for Electronics",* Elsevier, Applied Science
5. R.W. Dyson, 1998 *"Specialty Polymers*", Chapman & Hall, 2nd edition.

REFERENCES:

1. Rosato, D.V. and Rosato, D.V., 2004. *Reinforced plastics handbook*. Elsevier.
2. De Carvalho, A.J.F., Curvelo, A.A.S. and Agnelli, J.A.M., 2001. A first insight on composites of thermoplastic starch and kaolin. *Carbohydrate Polymers*, *45*(2), pp.189-194.
3. Birley, A.W., 2012. *Plastics materials: properties and applications*. Springer Science & Business Media
4. Harper, C.A. and Petrie, E.M., 2003. *Plastics materials and processes* (pp. 557-559). John Wiley & Sons.
5. Birley, A.W., 2012. *Plastics materials: properties and applications*. Springer Science & Business Media.
6. Hebbert, M., 1982. The Gospel According to FJO. *Built Environment (1978-)*, *8*(4), pp.219-223.
7. Biron, M., 2018. *Thermoplastics and thermoplastic composites*. William Andrew.

.

PT 1404 POLYMER RHEOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide understanding about the mechanical behavior of polymeric materials.
- To impart knowledge in rheological behavior of polymer melts.

- To equip with the knowledge about the function of various rheometers.
- To apply the fundamentals of polymer rheology in different processing applications.

UNIT I MECHANICAL BEHAVIOUR OF POLYMERIC MATERIALS 9

Introduction to Rheology – Types of mechanical deformation – Elastic materials – Viscous materials – Viscoelasticity – effect of rate of strain, temperature and time on mechanical behaviour of polymeric materials – creep – stress relaxation

UNIT II FLOW PROPERTIES OF POLYMER MELT 9

Fluid flow – types of fluid flow –Newtonian and Non Newtonian fluids – laminar flow of Newtonian fluids - viscosity of polymer melts – shear thinning and shear thickening – zero-shear rate viscosity –– power law – die-swell and melt fracture – Weissenberg effect.

UNIT III VISCO ELASTIC BEHAVIOUR 9

Introduction - Static Test – Dynamic Test – Boltzmann superposition principle – Applications of Boltzmann superposition principle – Mechanical models of Viscoelastic systems – Maxwell Model – Voigt-Kelvin Model

UNIT IV MEASUREMENT OF RHEOLOGICAL PROPERTIES 9

Measurements of rheological properties – capillary rheometers – melt flow index – cone and plate viscometrer – torque rheometers – Mooney viscometer – curemeters – Rheo – optical methods – birefringence

UNIT V APPLICATION OF POLYMER RHEOLOGY TO PROCESSING 9

Rheological behaviour of thermoplastics PE, PVC, PS, PP, nylons and PC – Applications of rheology to polymer processing - injection moulding, extrusion and blow moulding.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to

CO1 Demonstrate the rheological behavior of thermoplastic materials

CO2 Analyze the flow properties of polymer melts.

CO3 Critique the influence of rheology on different properties of polymer.

CO4	Explain the function of various rheological instruments and optimize its parameters.
CO5	Apply the theory of rheology in the applications of polymer processing

TEXT BOOKS:

1. Shaw, M.T., 2012. *Introduction to polymer Rheology*. Hoboken, NJ: Wiley.
2. Gupta, B.R., 2005. *Applied Rheology in Polymer Processing*. Asian Books Private.
3. Rudolph, N. and Osswald, T.A., 2014. *Polymer Rheology: Fundamentals and applications*. Carl Hanser Verlag GmbH Co KG.

REFERENCES:

1. Griskey, R., 1995. *Polymer process engineering*. Springer Science & Business Media.
2. Han, C.D., 2007. *Rheology and processing of polymeric materials: Volume 1: Polymer Rheology* (Vol. 1). Oxford University Press on Demand..
3. Gupta, B.R., 2008. *Polymer Processing Technology*. Asian Books.
4. Han, C.D., 2007. *Rheology and processing of polymeric materials: Volume 1: Polymer Rheology* (Vol. 1). Oxford University Press on Demand.
5. MALKIN, A.Y., 2012. Rheology: concepts, methods and applications. prof. dr. Alexander Ya. Malkin, prof. dr. Avraam I. Isayev. 2nd edition: *Toronto:* ChemTec Publishing.

PT1405 **RUBBER MATERIALS**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To gather basic knowledge on structure and properties of natural rubber, synthetic rubber.
- To acquire the knowledge on structure and properties and thermoplastic elastomers.
- To define the reclaim rubber, properties and its applications.

UNIT I **NATURAL RUBBER** **12**

Natural Rubber: Origin – Natural Rubber Latex, tapping, processing, properties and applications – Conversion of Latex into dry rubber – smoked sheet, air dried sheet, crepe rubber -Modifications of Natural Rubber–Applications

UNIT II GENERAL PURPOSE ELASTOMERS 7

Manufacturing, structure, properties, curing and applications of- Polyisoprene, Polybutadiene, SBR, EPDM, Nitrile rubber.

UNIT III SPECIAL PURPOSE ELASTOMERS -I 9

Manufacturing, structure, properties, curing and applications of- Butyl rubber, Halobutyl, Neoprene,CSM, Fluoro elastomer (FKM), Epichlorohydrin, Polysulphide.

UNIT IV SPECIAL PURPOSE ELASTOMERS-II 9

Manufacturing, structure, properties, curing, and applications of-Polyurethane Elastomers, Acrylic rubber, Ethylene Vinyl Acetate, Silicone rubber

UNIT V THERMOPLASTIC ELASTOMERS AND RECLAIMED RUBBERS 9

Basic structure, Manufacture, Morphology, Commercial grades and Applications – Thermoplastic styrene block copolymers, Polyester thermoplastic elastomers, polyamide thermoplastic elastomer, Polyurethane thermoplastic elastomers. Reclaimed rubber - process of reclamation – applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to

CO1	Relate the structure and properties of natural rubber,
CO2	Describe the structure manufacturing, curing , properties and application of synthetic rubbers
CO3	Discuss the structure manufacturing, curing , properties and application of synthetic rubbers
CO4	Explore the structure manufacturing, curing , properties and application of synthetic elastomers.
CO5	Explain the process of reclamation and morphological behaviour of thermoplastic elastomers

TEXT BOOKS:

1. Morton, M., 1999. *Introduction to polymer science*. In Rubber Technology (pp. 1-19). Springer, Dordrecht.
2. Blow, C.M., 1971. *Rubber technology and manufacture*.
3. Hoffman, W., 1989. *Rubber technology handbook*, Hanser. *New York*, p.239.

REFERENCES:

1. Brydson, J.A., 1978. *Rubber chemistry*.
2. Bhowmick, A.K. and Stephens, H. eds., 2000. *Handbook of elastomers*. CRC Press.
3. De, S.K. and White, J.R. eds., 2001. *Rubber technologist's handbook* (Vol. 1). iSmithers Rapra Publishing.
4. Roland, C., 2007. *Rubber technologist's handbook*, vol. 2. Rapra, Shrewsbury, UK.
5. White, J., De, S.K. and Naskar, K., 2009. *Rubber Technologist's Handbook*, Vol. 2. Smithers Rapra, Shawbury, Shrewsbury, Shropshire, p.452.
6. Thomas, S., Chan, C.H., Pothen, L.A., Rajisha, K.R. and Maria, H. eds., 2013. *Natural Rubber Materials: Volume 1: Blends and IPNs* (Vol. 7). Royal society of Chemistry.
7. Gelling, I.R., 1985. *Modification of natural rubber latex with peracetic acid*. Rubber Chemistry and Technology, *58*(1), pp.86-96.
8. Warner, W.C., 1994. *Methods of devulcanization*. Rubber Chemistry and Technology, *67*(3), pp.559-566.
9. Manuel, H.J. and Dierkes, W., 1997. *Recycling of rubber* (Vol. 99). iSmithers Rapra Publishing.

.

.

PT1411 MOULD MANUFACTURING TECHNOLOGY LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

To enable the students to,

- Perform basic machining operations using lathe and shaping machine
- Demonstrate the basic machining operations of milling machine

- Measure dimensions of parts using measuring instruments

LIST OF EXERCISES

1. Exercise on Shaping machine - making stepped block
2. Exercise on Shaping machine - making beveled block
3. Exercise on Horizontal Milling-Gear cutting
4. Exercise on Vertical Milling
5. Exercise on lathe - external thread
6. Exercise on lathe- taper turning
7. Exercise on Surface Grinding.
8. Exercise on Slotting Machine.
9. Grinding of Cutting tools.
10. Study of different types of Cutting tools
11. Measurements using Micrometer, Vernier caliper and Vernier Height gauge and Slip gauge.
12. Measurement of angle using Sine Bar.
13. Application of Dial gauge.
14. DEMOMSTRATION EXPERIMENT: To make a simple mould for hand injection molding machine

(Any 10 experiments from above)

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to

CO1 Perform turning operations using lathe

CO2 Make stepped block and bevelled block using shaping machine

CO3 Perform basic machining operations using milling machine

CO4 Make finishing operations using grinding machine

CO5 Measure dimensions of parts using measuring instruments

TEXT BOOKS:

1. KlusStokhert (Edt.), *Mold making handbook for Plastic Engineers*, Hanser

Publishers, 2nd edition, 1998.

2. Hmt, H.M.T., 2001. *Production technology*. Tata McGraw-Hill Education.
3. Donaldson, C., LeCain, G.H., Goold, V.C. and Ghose, J., 2012. *Tool design*. Tata McGraw-Hill Education.

REFERENCES:

1. Chang, T.C. and Wysk, R.A., 1997. *Computer-aided manufacturing*. Prentice Hall PTR
2. R.G.W.Pye, *Injection Mold Design*, East West Press Pvt. Ltd., New Delhi.3rd Edition, 1983.
3. Stoeckhert&Menning, *Mold making handbook*, 2nd edition, Carl HanserVerlag GmbH & Company KG, 2013.
4. W.A.J Chapman, *Workshop Technology Part 2*, Taylor & Francis Group, 2016.
5. Menges, G., Michaeli, W. and Mohren, P., 2013. *How to make injection molds*. Carl HanserVerlag GmbH Co KG.

LIST OF EQUIPMENT FOR A BATCH OF 60 STUDENTS:

S. No.	Description of Equipment	Quantity Required
1.	Shaping machine	1 No
2.	Vertical milling machine	1 No
3.	Horizontal milling machine	1 No
4.	Lathe	5 No
5.	Surface grinding machine	1 No
6.	Vernier caliper	1 No
7.	Vernier height gauge	1 No
8.	Vernier Depth Gauge	1 No
9.	Bench grinder	1 No
10.	Micrometer	1 No

.

PT1412 POLYMER PREPARATION LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To impart practical skills in synthesizing various polymers using different polymerization techniques.
- To impart knowledge in identifying suitable method for polymerization of polymer..

LIST OF EXPERIMENTS

1. Preparation of phenol - formaldehyde (Novalac) resin.
2. Preparation of phenol - formaldehyde (Resol) resin.
3. Preparation of Urea formaldehyde resin by condensation method.
4. Preparation of Bisphenol - An epoxy resin.
5. Preparation of polystyrene by bulk polymerization method
6. Preparation of polystyrene by emulsion polymerization method
7. Preparation of acrylonitrile by Solution Polymerization method.
8. Preparation of styrene and methyl methacrylate by copolymerization method.
9. Preparation of Caprolactone by Ring opening polymerization method
10. Preparation of Vinyl acetate by Solution Polymerization method.
11. Sheet casting using methyl methacrylate

    (any 9 experiments)

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to

CO1	Apply the knowledge on synthesis the polymer by condensation technique
CO2	Apply the polymerization techniques like solution and emulsion, interfacial in polymer preparation
CO3	Synthesize industrially used polymers like polystyrene, PMMA and epoxy resin
CO4	Synthesize a copolymer by applying copolymerization technique
CO5	Apply the knowledge on preparation of biodegradable polymer

REFERENCES:

1. Siddaramaiah., 2007., *Practical's in Polymer Science*, CBS Publishers & Distributors.
2. Dietrich Braun., Harald Cherdron., Matthias Rehahn, et al., 2012 "*Polymer Synthesis: Theory and Practice: Fundamentals, Methods, Experiments*", springer ,5th edition.
3. Wayne, R.Sorenson., and Campbell, T.W. *2001*. *Preparative Methods of Polymer Chemistry* 3rd edition, Wiley – Interscience, New York.
4. McCaffery E.M. 1970, *Laboratory Preparation for Macromolecular Chemistry*, McGraw Hill,Kogakush.
5. Collins, E.A., Bares, J. and Billmeyer, F.W., 1973. *Experiments in polymer science.*

.

HS1421 AN INTRODUCTION TO ADVANCED READING AND WRITING

L	T	P	C
0	0	2	1

OBJECTIVES:

The course will enable learners to

- To strengthen the reading skills of students of engineering.
- To enhance their writing skills with specific reference to technical writing
- To develop their critical thinking skills.
- To provide more opportunities to develop their project and proposal writing skills

UNIT I EFFECTIVE READING 6

Reading – Strategies for effective reading-Use glosses and footnotes to aid reading comprehension- Read and recognize different text types-Predicting content using photos and title. Reading-Read for details-Use of graphic organizers to review and aid comprehension.

UNIT II CRITICAL READING 6

Reading– Understanding pronoun reference and use of connectors in a passage- speed reading techniques. Reading– Genre and Organization of Ideas- Reading– Critical reading and thinking- understanding how the text positions the reader.

UNIT III PARAGRAPH WRITING 6

Writing-Plan before writing- Develop a paragraph: topic sentence, supporting sentences, concluding sentence.-Write a descriptive paragraph Writing-State reasons and examples to support ideas in writing– Write a paragraph with reasons and examples- Write an opinion paragraph

UNIT IV ESSAY WRITING 6

Writing– Elements of a good essay - Types of essays- descriptive-narrative- issue-based-argumentative-analytical.

UNIT V EFFECTIVE WRITING 6

Writing– Email writing- visumes – Job application- Report Writing - Project writing-Writing convincing proposals

TOTAL: 30 PERIODS

COURSE OUTCOMES:

CO1 Understand how the text positions the reader

CO2 Develop critical thinking while reading a text

CO3 Develop a descriptive paragraph

CO4 Make use of sentence structures effectively when creating an essay

CO5 Demonstrate proper usage of grammar in writing E-Mails, Job application and project proposals

TEXT BOOKS:

1. Gramer, F, Margot & Colin, S, Ward, 2011, *Reading and Writing (Level 3)* Oxford University Press, Oxford.
2. Debra Daise, CharlNorloff, and Paul Carne, 2011, *Reading and Writing (Level 4)* Oxford University Press: Oxford.

REFERENCE BOOKS:

1. Davis, Jason & Rhonda LIss. 2006 *Effective Academic Writing (Level 3)* Oxford University Press: Oxford.
2. E. Suresh Kumar and et al. 2012, *Enriching Speaking and Writing Skills*, Second Edition, Orient Black swan: Hyderabad.
3. Withrow, Jeans and et al. 2004 *Inspired to Write. Readings and Tasks to develop writing skills*, Cambridge University Press: Cambridge.
4. Goatly, Andrew, 2000 *Critical Reading and Writing*, Routledge: United States of America.
5. Petelin, Roslyn & Marsh Durham, 2004 *The Professional Writing Guide: Knowing Well and Knowing Why, Business & Professional* Publishing: Australia.

WEB RESOURCES:

1. http://learnenglishteens.britishcouncil.org/skills/reading
2. https://learnenglish.britishcouncil.org/skills/reading
3. https://www.readingrockets.org/article/25-activities-reading-and-writing-fun
4. https://linguapress.com/advanced.htm