ANNA UNIVERSITY, CHENNAI

UNDERGRADUATE CURRICULUM (UNIVERSITY DEPARTMENTS)

Campus: Madras Institute of Technology

Department: Rubber and Plastics Technology

Programme: B.Tech. Rubber and Plastics Technology

Regulations: 2023 (Revised 2024), with effect from the AY 2024 – 25 to all the students of UG Programme.

OVERVIEW OF CREDITS

Sem	PCC	PEC	ESC	HSMC	ETC	OEC	SDC	UC	SLC	Total
I				15			7	1		**23**
II			11	13				1		**25**
III	10		7	4			1			**22**
IV	18						2	3		**23**
V	15	6					4	2		**28**
VI		9			3	3	3	3	1	**22**
VII	10	3			3	3	3			**22**
VIII							8			**8**
Total	53	18	16	32	6	6	28	10	1	**173**
% of Category	**30.64**	**10.40**	**10.40**	**18.50**	**3.47**	**3.47**	**16.18**	**6.36**	**0.58**	

CATEGORY OF COURSES

PCC – Professional Core Course
PEC – Professional Elective Course
ETC – Emerging Technology Course
OEC – Open Elective Course
SLC – Self Learning Course
ESC – Engineering Science Course
HSMC – Humanities Science and Management Course
SDC – Skill Development Course
UC – University Course

For Honours & Minor Degree, please refer the Regulations 2023 (Revised 2024).

SEMESTER – I							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	EN23C01	Foundation English	LIT	2-0-2	4	3	HSMC
2.	MA23C01	Matrices and Calculus	T	3-1-0	4	4	HSMC
3.	PH23C01	Engineering Physics	LIT	3-0-2	5	4	HSMC
4.	CY23C01	Engineering Chemistry	LIT	3-0-2	5	4	HSMC
5.	ME23C01	Engineering Drawing &3D Modelling	LIT	2-0-4	6	4	SDC
6.	ME23C04	Makerspace	LIT	1-0-4	5	3	SDC
7.	UC23H01	தமிழர்மரபு/ Heritage of Tamils	T	1-0-0	1	1	UC
8.	-	NCC/NSS/NSO/YRC		0-0-2	2	-	UC
9.	-	Audit Course–I*	-	-	-	-	UC
				TOTAL CREDITS		**23**	

SEMESTER–II							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	EN23C02	Professional Communication	LIT	2-0-2	4	3	HSMC
2.	MA23C02	Ordinary Differential Equations & Transform Techniques	T	3-1-0	4	4	HSMC
3.	PH23C05	Material Science for Technologists	T	3-0-0	3	3	HSMC
4.	CS23C04	Programming in C	LIT	2-0-4	6	4	ESC
5.	EE23C03	Basics of Electrical and Electronics Engineering	LIT	2-0-2	4	3	ESC
6.	ME23C03	Engineering Mechanics	LIT	3-1-0	4	4	ESC
7.	CY23C06	Physical and Organic Chemistry	T	3-0-0	3	3	HSMC
8.	UC23H02	தமிழரும் தொழில் நுட்பமும் / Tamils and Technology	T	1-0-0	1	1	UC
				TOTAL CREDITS		**25**	

SEMESTER – III							
S. NO	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	MA23C05	Probability and Statistics	T	3-1-0	4	4	HSMC
2.	AE23C01	Solid Mechanics	T	3-1-0	4	4	ESC
3.	RP23301	Engineering Thermodynamics	T	3-0-0	3	3	ESC
4.	RP23302	Introduction to Chemical Engineering	T	3-0-0	3	3	PCC
5.	RP23303	Principles of Polymerization	LIT	3-0-2	5	4	PCC
6.	RP23304	Fluid Mechanics and Polymer Rheology	T	2-1-0	3	3	PCC
7.	RP23305	CAD Modelling Laboratory	L	0-0-2	2	1	SDC
8.	-	Audit Course–II	-	-	-	-	UC
					TOTAL CREDITS	22	

SEMESTER – IV							
S. NO	COURSE CODE	COURSE NAME	COURSE TYPE	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	RP23401	Plastics Materials	LIT	3-0-2	5	4	PCC
2.	RP23402	Rubber Materials	LIT	3-0-2	5	4	PCC
3.	RP23403	Polymer Composites Technology	LIT	3-0-2	5	4	PCC
4.	RP23404	Physical Properties of Polymers	T	3-0-0	3	3	PCC
5.	RP23405	Design of Machine Elements	T	3-0-0	3	3	PCC
6.	-	Skill Development Course I	-	-	-	2	SDC
7.	RP23U01	Standards - Rubber and Plastics Technology	T	1-0-0	1	1	UC
8.	UC23U01	Universal Human Values	LIT	1-0-2	3	2	UC
9.	RP23505	Summer Internship I		0-0-0	0	0	SDC
					TOTAL CREDITS	23	

SEMESTER–V							
S. NO	COURSE CODE	COURSE NAME	COURSE TYPE	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	RP23501	Rubber Processing	LIT	2-0-4	6	4	PCC
2.	RP23502	Plastics Processing	LIT	2-0-4	6	4	PCC
3.	RP23503	Polymer Characterization Techniques	LIT	3-0-2	5	4	PCC
4.	RP23504	Rubber Compounding	T	2-1-0	3	3	PCC
5.	-	Professional Elective I	T	3-0-0	3	3	PEC
6.	-	Professional Elective II	T	3-0-0	3	3	PEC
7.	-	Skill Development Course II	-	-	-	2	SDC
8.	-	Industry Oriented Course I	-	-	-	1	SDC
9.	RP23U02	Perspectives of sustainable development - Rubber and Plastics Technology	T	2-0-2	4	3	UC
10.	RP23505	Summer Internship I		0-0-0	0	1	SDC
				TOTAL CREDITS		**28**	
	OPTIONAL						
11.	RP23D01	Capstone Design Level-I	CDP	0-0-12	12	6	SDC

SEMESTER–VI							
S. NO	COURSE CODE	COURSE NAME	COURSE TYPE	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	-	Professional Elective III	T	3-0-0	3	3	PEC
2.	-	Professional Elective IV	T	3-0-0	3	3	PEC
3.	-	Professional Elective V	T	3-0-0	3	3	PEC
4.	-	Open Elective I	T	3-0-0	3	3	OEC
5.	-	Emerging Technology Course I	T	3-0-0	3	3	ETC
6.	RP23L01	Self-Learning Course	T	1-0-0	1	1	SLC
7.	-	Skill Development Course III	-	-	-	2	SDC
8.	-	Industry oriented course II	-	-	-	1	SDC
9.	UC23E01	Engineering Entrepreneurship Development	LIT	2-0-2	4	3	UC
10.	RP23704	Summer Internship II		0-0-0		0	SDC
				TOTAL CREDITS		**22**	
	OPTIONAL						
11.	RP23D02	Capstone Design Level-II	CDP	0-0-12	12	6	SDC

SEMESTER–VII							
S. NO	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	RP23701	Polymer Testing	LIT	2-0-4	6	4	PCC
2.	RP23702	Tyre Technology	T	3-0-0	3	3	PCC
3.	RP23703	Regulations in Polymer Industries	T	3-0-0	3	3	PCC
4.	-	Professional Elective VI	T	3-0-0	3	3	PEC
5.	-	Open Elective II	T	3-0-0	3	3	OEC
6.	-	Emerging Technology Course II	T	3-0-0	3	3	ETC
7.	-	Industry Oriented Course III	T	1-0-0	1	1	SDC
8.	RP23704	Summer Internship II		-	-	2	SDC
	TOTAL CREDITS					**22**	
	OPTIONAL						
9.	RP23D03	Capstone Design Level - III (Prototyping)	CDP	0-0-12	12	6	SDC

SEMESTER–VIII							
S. NO	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	RP23801	Project Work / Internship cum Project Work	IPW	0-0-16	16	8	SDC
	TOTAL CREDITS					**8**	

TOTAL CREDITS: 170

Verticals (Minimum 6)

S.No	V1 ADVANCED RUBBER TECHNOLOGY	V2 ADVANCED PLASTICS TECHNOLOGY	V3 SPECIALTY POLYMERS	MINOR DEGREE (for other Depts.) POLYMER TECHNOLOGY
1	Latex Science and Technology	Engineering and High Performance Plastics	Polymers in Electrical and Electronics Applications	Polymer Science
2	Rubber Product Design	Advanced Plastics Processing	Polymers in Automobile Industry	Properties of Polymers
3	Rubber Product Manufacture	Plastics in Packaging Technology	Multiphase Polymer Systems	Plastics Technology
4	Thermoplastic Elastomers	Plastics Product Design	Adhesives, Paints and Surface Coatings	Rubber Technology
5	Advanced Tyre Technology and Sustainability	Design and Manufacture of Moulds and Dies	Polymer Nano Composites	Polymer Composites
6	Rubber Recycling and Circular Economy	Analysis and Testing of Polymer Composites	Green Composites	Polymer Recycling
7	Rubber Analysis and Reverse Engineering	Plastics Waste Management	Natural and Bio Based Polymers	Rubber and Plastics Testing

V1 ADVANCED RUBBER TECHNOLOGY						
S. No.	COURSE CODE	COURSE NAME	COURSE TYPE	L-T-P	CREDITS	CATEGORY
1.	RP23001	Latex Science and Technology	T	3-0-0	3	PEC
2.	RP23002	Rubber Product Design	T	3-0-0	3	PEC
3.	RP23003	Rubber Product Manufacture	T	3-0-0	3	PEC
4.	RP23004	Thermoplastic Elastomers	T	3-0-0	3	PEC
5.	RP23005	Advanced Tyre Technology and Sustainability	T	3-0-0	3	PEC
6.	RP23006	Rubber Recycling and Circular Economy	T	3-0-0	3	PEC
7.	RP23007	Rubber Analysis and Reverse Engineering	T	3-0-0	3	PEC

V2 ADVANCED PLASTICS TECHNOLOGY						
S. No.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE**	**L-T-P**	**CREDITS**	**CATEGORY**
1.	RP23008	Engineering and High Performance Plastics	T	3-0-0	3	PEC
2.	RP23009	Advanced Plastics Processing	T	3-0-0	3	PEC
3.	RP23010	Plastics in Packaging Technology	T	3-0-0	3	PEC
4.	RP23011	Plastics Product Design	T	3-0-0	3	PEC
5.	RP23012	Design and Manufacture of Moulds and Dies	T	3-0-0	3	PEC
6.	RP23013	Analysis and Testing of Polymer Composites	T	3-0-0	3	PEC
7.	RP23014	Plastics Waste Management	T	3-0-0	3	PEC

V3 SPECIALTY POLYMERS						
S. No.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE**	**L-T-P**	**CREDITS**	**CATEGORY**
1.	RP23015	Polymers in Electrical and Electronics Applications	T	3-0-0	3	PEC
2.	RP23016	Polymers in Automobile Industry	T	3-0-0	3	PEC
3.	RP23017	Multiphase Polymer Systems	T	3-0-0	3	PEC
4.	RP23018	Adhesives, Paints and Surface Coatings	T	3-0-0	3	PEC
5.	RP23019	Polymer Nano Composites	T	3-0-0	3	PEC
6.	RP23020	Green Composites	T	3-0-0	3	PEC
7.	RP23021	Natural and Bio Based Polymers	T	3-0-0	3	PEC

MINOR DEGREE (for other Depts.) POLYMER TECHNOLOGY						
S. No.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE**	**L-T-P**	**CREDITS**	**CATEGORY**
1.	RP23022	Polymer Science	T	3-0-0	3	PEC
2.	RP23023	Properties of Polymers	T	3-0-0	3	PEC
3.	RP23024	Plastics Technology	T	3-0-0	3	PEC
4.	RP23025	Rubber Technology	T	3-0-0	3	PEC
5.	RP23026	Polymer Composites	T	3-0-0	3	PEC
6.	RP23027	Polymer Recycling	T	3-0-0	3	PEC
7.	RP23028	Rubber and Plastics Testing	T	3-0-0	3	PEC

ADDITIONAL COURSES TO BE PRESCRIBED FOR DIPLOMA LATERAL ENTRY STUDENTS

S. NO.	COURSE CODE	COURSE NAME	L-T-P	CREDITS	CATEGORY
1.	ME23C01	Engineering Drawing & 3 D Modelling	2-0-4	4	ESC
2.	CY23C06	Physical and Organic Chemistry	3-0-0	3	BSC

ADDITIONAL COURSES TO BE PRESCRIBED FOR B.SC. LATERAL ENTRY STUDENTS

S. NO.	COURSE CODE	COURSE NAME	L-T-P	CREDITS	CATEGORY
1.	ME23C01	Engineering Drawing& 3 D Modelling	2-0-4	4	ESC
2.	CS23C04	Programming in C	2-0-4	4	ESC

	LIST OF EMERGING TECHNOLOGY COURSES					
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE**	**L-T-P**	**CREDITS**	**CATEGORY**
1.	RP23E01	Emerging Technologies in Polymer Recycling	T	3-0-0	3	ETC
2.	RP23E02	Polymer Membranes	T	3-0-0	3	ETC
3.	RP23E03	Polymers in Additive Manufacturing	T	3-0-0	3	ETC
4.	RP23E04	Polymers in Energy Storage Systems	T	3-0-0	3	ETC
5.	RP23E05	Polymers in Bio Medical Engineering	T	3-0-0	3	ETC

LIST OF SKILL DEVELOPMENT COURSES						
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE**	**L-T-P**	**CREDITS**	**ATEGORY**
1.	RP23S01	Quality Management in Polymer Industries	T	2-0-0	2	SDC
2.	RP23S02	Data Analytics for Polymer Industries	T	2-0-0	2	SDC
3.	RP23S03	Supply Chain Management Tools	T	2-0-0	2	SDC
4.	RP23S04	Safety in Chemical Industries	T	2-0-0	2	SDC
5.	RP23S05	Mould Flow and Simulation	T	2-0-0	2	SDC
6.	RP23S06	Plastics Injection Mould Simulation and Analysis	T	2-0-0	2	SDC
7.	RP23S07	Professional Development	T		2	SDC

LIST OF OPEN ELECTIVE COURSES						
S. No.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE**	**L-T-P**	**CREDITS**	**CATEGORY**
1.	RP23901	Polymeric Materials for Engineers	T	3-0-0	3	OE
2.	RP23902	Polymer Properties	T	3-0-0	3	OE
3.	RP23903	Adhesive Joining	T	3-0-0	3	OE

EN23C01 **FOUNDATION ENGLISH** **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To develop students' foundational skills in reading, writing, grammar and vocabulary to enable them to understand and produce various forms of communication.
- To enhance students' proficiency in reading comprehension, narrative and comparative writing.
- To comprehend and analyse descriptive texts and visual images
- To articulate similarities and differences in oral and written forms.
- To improve students' proficiency in reading and writing formal letters and emails.

UNIT I BASICS OF COMMUNICATION **6**

Reading - Telephone message, bio-note; Writing – Personal profile; Grammar – Simple present tense, Present continuous tense, wh-questions, indirect questions; Vocabulary – Word formation (Prefix and Suffix).

LAB ACTIVITY: **6**

Listening – Telephone conversation; Speaking Self-introduction; Telephone conversation – Video conferencing etiquette

UNIT II NARRATION **6**

Reading – Comprehension strategies - Newspaper Report, An excerpt from an autobiography; Writing – Narrative Paragraph writing (Event, personal experience etc.); Grammar – Subject-verb agreement, Simple past, Past continuous Tenses; Vocabulary – One-word substitution

LAB ACTIVITY: **6**

Listening – Travel podcast; Speaking – Narrating and sharing personal experiences through a podcast

UNIT III DESCRIPTION **6**

Reading – A tourist brochure, Travel blogs, descriptive article/excerpt from literature, visual images; Writing –Descriptive Paragraph writing, Grammar – Future tense, Perfect tenses, Preposition; Vocabulary – Descriptive vocabulary

LAB ACTIVITY: **6**

Listening – Railway / Airport Announcements, Travel Vlogs; Speaking – Describing a place or picture description

UNIT IV COMPARE AND CONTRAST **6**

Reading – Reading and comparing different product specifications - Writing – Compare and Contrast Essay, Coherence and cohesion; Grammar – Degrees of Comparison; Vocabulary – Transition words (relevant to compare and contrast)

LAB ACTIVITY: **6**

Listening – Product reviews, Speaking – Product comparison based on product reviews - similarities and differences

UNIT V EXPRESSION OF VIEWS **6**

Reading – Formal letters, Letters to Editor ; Writing – Letter writing/ Email writing (Enquiry / Permission, Letter to Editor); Grammar – Compound nouns, Vocabulary – Synonyms, Antonyms

LAB ACTIVITY: **6**

Listening – Short speeches; Speaking – Making short presentations (JAM)

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment
- Written assessments
- Assignment

Lab assessment
- Listening
- Speaking

External Assessment
- End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- Use appropriate grammar and vocabulary to read different types of text and converse appropriately.
- Write coherent and engaging descriptive and comparative essay writing.
- Comprehend and interpret different kinds of texts and audio visual materials
- Critically evaluate reviews and articulate similarities and differences
- Write formal letters and emails using appropriate language structure and format

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume I by Orient Blackswan, 2022

2. “English for Science & Technology - I” by Cambridge University Press, 2023

REFERENCES

1. “Interchange” by Jack C.Richards, Fifth Edition, Cambridge University Press, 2017.

2. “English for Academic Correspondence and Socializing” by Adrian Wallwork, Springer, 2011.

3. “The Study Skills Handbook” by Stella Cortrell, Red Globe Press, 2019

4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		
CO3										√		√
CO4										√		
CO5										√		√

MA23C01	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To develop the use of matrix algebra techniques in solving practical problems.
- To familiarize the student with functions of several variables.
- To solve integrals by using Beta and Gamma functions.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals.
- To acquaint the students with the concepts of vector calculus which naturally arise in many engineering problems.

UNIT I MATRICES 9+3

Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors- Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

UNIT II FUNCTIONS OF SEVERAL VARIABLES 9+3

Limit, continuity, partial derivatives – Homogeneous functions and Euler's theorem - Total derivative – Differentiation of implicit functions – Jacobians -Taylor's formula for two variables - Errors and approximations – Maxima and Minima of functions of two variables – Lagrange's method of undermined multipliers.

UNIT III INTEGRAL CALCULUS 9+3

Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions-Properties – Evaluation of single integrals by using Beta and Gamma functions..

UNIT IV MULTIPLE INTEGRALS 9+3

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of Solids – Change of variables in double and triple integrals-
Evaluation of double and triple integrals by using Beta and Gamma functions.

UNIT V VECTOR CALCULUS 9+3

Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green's theorem, Stoke's and Gauss divergence theorems (without proofs)– Verification and applications in evaluating line, surface and volume integrals.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students wherever applicable from the content of the course.

General engineering applications / branch specific applications from the content of each units wherever possible will be introduced to students.

Suggested Laboratory based exercises / assignments / assessments :

Matrices

1. Finding eigenvalues and eigenvectors
2. Verification of Cayley-Hamilton theorem
3. Eigenvalues and Eigenvectors of similar matrices
4. Eigenvalues and Eigenvectors of a symmetric matrix
5. Finding the powers of a matrix
6. Quadratic forms

Functions of Several Variables

1. Plotting of curves and surfaces
2. Symbolic computation of partial and total derivatives of functions

Integral Calculus

1. Evaluation of beta and gamma functions
2. Computation of error function and its complement

Multiple Integrals

1. Plotting of 3D surfaces in Cartesian and Polar forms

Vector Calculus

1. Computation of Directional derivatives
2. Computation of normal and tangent to the given surface

OUTCOMES:

CO 1 :Use the matrix algebra methods for solving practical problems.
CO 2 :Use differential calculus ideas on several variable functions.
CO 3 :Apply different methods of integration in solving practical problems by using Beta and Gamma functions.
CO 4 :Apply multiple integral ideas in solving areas and volumes problems.
CO 5 :Apply the concept of vectors in solving practical problems.

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir "'Thomas' Calculus", Pearson Education., New Delhi, 2018.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 45th Edition, New Delhi, 2020.
3. James Stewart, Daniel K Clegg & Saleem Watson "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2023.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.
4. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
6. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

PH23C01 **ENGINEERING PHYSICS** **L T P C**
(Common to all branches of B.E/B.Tech Programmes) **3 0 2 4**

COURSE OBJECTIVES

- To familiarize with crystal structure, bonding and crystal growth.
- To impart knowledge on Mechanics of Materials.
- To impart knowledge of oscillations, sound and Thermal Physics
- To facilitate understanding of optics and its applications, different types of Lasers and fiber optics.
- To introduce the basics of Quantum Mechanics and its importance.

UNIT I CRYSTAL PHYSICS **9+6**

Crystal Bonding – Ionic – covalent – metallic and van der Walls's/ molecular bonding. Crystal systems - unit cell, Bravais lattices, Miller indices - Crystal structures - atomic packing density of BCC, FCC and HCP structures. NaCl, Diamond, Graphite, Graphene, Zincblende and Wurtzite structures - crystal imperfections- point defects - edge and screw dislocations – grain boundaries. Crystal Growth – Czocharalski method – vapor phase epitaxy – Molecular beam epitaxy- Introduction to X-Ray Diffractometer.

1. Determination of Lattice parameters for crystal systems.
2. Crystal Growth – Slow Evaporation method
3. Crystal Growth Sol – Gel Method

UNIT II MECHANICS OF MATERIALS **9+6**

Rigid Body – Centre of mass – Rotational Energy - Moment of inertia (M.I)- Moment of Inertia for uniform objects with various geometrical shapes. Elasticity –Hooke's law - Poisson's ratio - stress-strain diagram for ductile and brittle materials – uses- Bending of beams – Cantilever - Simply supported beams - uniform and non-uniform bending - Young's modulus determination - I shaped girders –Twisting couple – Shafts. Viscosity – Viscous drag – Surface Tension.

4. Non-uniform bending -Determination of Young's modulus of the material of the beam.
5. Uniform bending -Determination of Young's modulus of the material of the beam
6. Viscosity – Determination of Viscosity of liquids.

UNIT III OSCILLATIONS, SOUND AND THERMAL PHYSICS **9+6**

Simple harmonic motion - Torsional pendulum –- Damped oscillations –Shock Absorber -Forced oscillations and Resonance –Applications of resonance.- Waves and Energy Transport –Sound waves – Intensity level – Standing Waves - Doppler effect and its applications - Speed of blood flow. Ultrasound – applications - Echolocation and Medical Imaging. Thermal Expansion – Expansion joints – Bimetallic strip – Seebeck effect – thermocouple -Heat Transfer Rate – Conduction – Convection and Radiation.

7. Torsional pendulum-Determination of rigidity modulus of wire and moment of inertia of the disc
8. Melde's string experiment - Standing waves.
9. Ultrasonic interferometer – determination of sound velocity and liquids compressibility

UNIT IV OPTICS AND LASERS **9+6**

Interference - Thin film interference - Air wedge- Applications -Interferometers–Michelson Interferometer –- Diffraction - CD as diffraction grating – Diffraction by crystals -Polarization - polarizers –- Laser – characteristics – Spontaneous and Stimulated emission- population – inversion - Metastable states - optical feedback - Nd-YAG laser, CO_2 laser, Semiconductor laser - Industrial and medical applications - Optical

Fibers – Total internal reflection – Numerical aperture and acceptance angle – Fiber optic communication – Fiber sensors – Fiber lasers.

10. Laser - Determination of the width of the groove of the compact disc using laser.

    Laser Parameters
    Determination of the wavelength of the laser using grating
11. Air wedge -Determination of the thickness of a thin sheet/wire
12. Optical fibre - Determination of Numerical Aperture and acceptance angle

    -Determination of bending loss of fibre.
13. Michelson Interferometer (Demonstration)

UNIT V QUANTUM MECHANICS 9+6

Black body radiation (Qualitative) – Planck's hypothesis – Einstein's theory of Radiation - Matter waves–de Broglie hypothesis - Electron microscope – Uncertainty Principle – The Schrodinger Wave equation (time-independent and time-dependent) – Meaning and Physical significance of wave function - Normalization - Particle in an infinite potential well-particle in a three-dimensional box - Degenerate energy states - Barrier penetration and quantum tunneling - Tunneling microscope.

14. Photoelectric effect – Determination of Planck's constant.
15. Black Body Radiation (Demonstration)
16. Electron Microscope (Demonstration)

TOTAL: 75 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1: Understand the significance of crystal structure and bonding. Learn to grow crystals.
CO2: Obtain knowledge on important mechanical and thermal properties of materials and determine them through experiments.
CO3: Conceptualize and visualize the oscillations and sound.
CO4: Grasp optical phenomenon and their applications in real life.
CO5: Appreciate and evaluate the quantum phenomenon.
CO6 Develop skill set to solve engineering problems and design experiments.

TEXT BOOKS:

1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 10th Edition, 2015.
3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.
4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.

REFERENCES:

1. R. Wolfson, Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D. Kleppner and R. Kolenkow. An Introduction to Mechanics, McGraw Hill Education, 2017.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1		1							
CO2	3	2	1	1								
CO3	3	2	1	1								
CO4	3	2	1	1	1							
CO5	3	2	1	1	1							
CO6	3	2	1	2								

CY23C01 **ENGINEERING CHEMISTRY** **L T P C**
3 0 2 4

UNIT I WATER TECHNOLOGY

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD, BOD, and heavy metals. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, Calgon, and carbonate treatment. External conditioning – demineralization. Municipal water treatment (screening, sedimentation, coagulation, filtration, disinfection-ozonolysis, UV treatment, chlorination), Reverse Osmosis – desalination.

PRACTICAL:

- Estimation of HCl using Na_2CO_3 as the primary standard
- Determination of alkalinity in the water sample.
- Determination of hardness of water by EDTA method.
- Determination of DO content of water sample by Winkler's method.

UNIT II NANOCHEMISTRY

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties (optical, electrical, mechanical, magnetic and catalytic). Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro-spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Applications of nanomaterials – medicine including AYUSH, automobiles, electronics, and cosmetics.

PRACTICAL:

- Preparation of nanoparticles by Sol-Gel method/sonication method.
- Preparation of nanowire by Electrospinning.
- Study of morphology of nanomaterials by scanning electron microscopy

UNIT III CORROSION SCIENCE

Introduction to corrosion – chemical and electrochemical corrosions – mechanism of electrochemical and galvanic corrosions – concentration cell corrosion-soil, pitting, inter-granular, water line, stress and microbiological corrosions-galvanic series-factors influencing corrosion- measurement of corrosion rate. Electrochemical protection – sacrificial anodic protection and impressed current cathodic protection. Protective coatings-metallic coatings (galvanizing, tinning), organic coatings (paints). Paints: Constituents and functions.

PRACTICAL:

- Corrosion experiment-weight loss method.
- Salt spray test for corrosion study.
- Corrosion prevention by electroplating.
- Estimation of corroded Iron by Potentiometry/UV-visible spectrophotometer

UNIT IV ENERGY SOURCES

Electrochemical cell, redox reaction, electrode potential – oxidation and reduction potential. Batteries – Characteristics; types of batteries; primary battery (dry cell), secondary battery (lead acid, lithium-ion battery) and their applications. Emerging energy sources – metal hydride battery, hydrogen energy, Fuel cells – H_2-O_2 fuel cell. Supercapacitors –Types and Applications, Renewable Energy: solar heating and solar cells. Recycling and disposal of batteries.

PRACTICAL:

- Study of components of Lead acid battery.
- Measurement of voltage in a photovoltaic cell.
- Working of H_2 – O_2 fuel cell

UNIT V POLYMER CHEMISTRY

Introduction: Functionality-degree of polymerization. Classification of polymers (Source, Structure, Synthesis and Intermolecular forces). Mechanism of free radical addition polymerization. Properties of polymers: Tg, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index (Problems). Techniques of polymerization: Bulk, emulsion, solution and suspension. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring. Polyamides, Polycarbonates and Polyurethanes – structure and applications. Recycling of polymers.

PRACTICAL:

- Determination of molecular weight of a polymer using Ostwald viscometer.
- Preparation of a polymer.
- Determination of molecular weight by Gel Permeation Chromatography.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

CO1: To demonstrate knowledge of water quality in various industries and develop skills in analyzing water quality parameters for both domestic and industrial purposes.

CO2: To identify and apply fundamental concepts of nanoscience and nanotechnology for engineering and technology applications, and to develop skills in synthesizing nanomaterials and studying their morphology.

CO3: To apply fundamental knowledge of corrosion protection techniques and develop skills to conduct experiments for measuring and preventing corrosion.

CO4: To study the fundamentals of energy storage devices and develop skills in constructing and experimenting with batteries.

CO5: To recognize and apply basic knowledge of different types of polymeric materials and develop skills in preparing and determining their applications for futuristic material fabrication needs.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., “Engineering Chemistry”, 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. Dara S.S., “A Textbook of Engineering Chemistry”, Chand Publications, 2004.
4. Laboratory Manual - Department of Chemistry, CEGC, Anna University (2023).

REFERENCES:

1. Schdeva M.V., “Basics of Nano Chemistry”, Anmol Publications Pvt Ltd, 2011.
2. Friedrich Emich, “Engineering Chemistry”, Medtech, 2014.
3. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, “Polymer Science” New AGE International Publishers, 2009.
4. Vogel’s Textbook of Quantitative Chemical Analysis (8th edition, 2014).

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	3	-	-	-	-	-
CO2	3	-	2	-	2	-	3	-	-	-	-	-
CO3	3	3	2	-	2	-	3	-	-	-	-	-
CO4	3	3	-	-	-	-	3	-	-	-	-	-
CO5	3	-	-	-	-	-	3	-	-	-	-	-
Avg	3	3	-	-	-	-	3	-	-	-	-	-

1’ = Low; ‘2’ = Medium; ‘3’ = High

ME23C01	ENGINEERING DRAWING AND 3D MODELLING	L	T	P	C
		2	0	4	4

COURSE OBJECTIVES

After successful completion of this course, the students will be able to:

1. Understand and use the engineering curves in engineering applications and projection techniques to construct conic curves, points and lines.
2. Develop skills in projecting surfaces and solids and create 2D models using CAD software.
3. Develop skills in 3D projection and 3D modeling of simple parts manually as well as using CAD software.
4. Understand and apply sectioning techniques to solids and assemble components.
5. Develop skills in lateral surface development and sheet metal design.

INTRODUCTION

Manual drawing tools (Mini Drafter, Set Squares, Protractor, Compass, and different grades of pencil). **'**BIS' specifications and rules of Engineering Drawing – Arrows (2H thin line body, HB Filled head and L:W = 3:1 ratio), lettering (Digital fonts, font sizes pertaining to usage and representation), types of line and their syntax (Drawing based – Continuous thin & thick, dashed, dashed dotted and Application based – extension, dimensioning, construction, projection, reference, axis, section, hatching, and break lines), scaling (up, down and equal), and dimensioning. Placing and positioning the 'A3' size drawing sheet over the drawing table. Principal planes and projection, Division of line and circle in to equal parts, and construction of polygons

UNIT i: ENGINEERING CURVES, PROJECTION OF POINTS AND LINES 6+12

Construction of conic curves with their tangent and normal – ellipse, parabola, and hyperbola by eccentricity method

Construction of special curves with their tangent and normal – cycloid, epicycloid, and involute

Projection of points and I angle projection of lines inclined to both principal planes by rotating line method and trapezoidal rule – marking their traces.

Lab exercises: Study exercise – Introduction to Sketching (or) Drawing, and modification tools in CAD software (AutoCAD, CREO, CATIA, Solid Works, Inventor, Fusion 360)

Activities based learning: Identification of the curves used in the application given in the flash card, demonstration of the instantaneous centre of rotation of governors with respect to angle of inclination of the arms of the governors

UNIT II PROJECTION OF SURFACES & SOLIDS, AND 2D MODELING 6+12

Projection of surfaces inclined to both the principal planes – polygonal, trapezoidal, rhomboidal and circular

Projection of solids – prisms, pyramids, and axisymmetric solids when the axis inclined to both the principal planes – freely hanging – contour resting condition on either of the planes by rotating object method

Lab exercises: Construction of basic sketches – lines, circle, polygon, spline curves, coils, along with dimensioning. Familiarizing with geometric constraints and their types

Activities based learning: Making the solids using cardboards, shadow mapping and contour drawing at different orientation of the solids using torches,

UNIT III 3D PROJECTION OF SOLIDS AND 3D MODELING OF SIMPLE PARTS 6+12

Free hand sketching – I & III angle projections of engineering parts and components Isometric projection of combination of solids – prisms, pyramids, axisymmetric solids, frustum Perspective projection of prisms, pyramids and axisymmetric solids by visual ray method

Lab exercises: 3D Modeling and 2D drafting of machine parts

Activities based learning: Flipped classroom for Free hand sketching, Jig saw activity for Isometric projection, arts and crafts for perspective view

UNIT IV SECTION OF SOLIDS AND SECTIONED DRAFTING OF ASSEMBLED COMPONENTS 6+12

Section of simple and hollow solids – prisms, pyramids and axisymmetric solids, solids with holes/ slots when the section plane perpendicular to one principal plane and inclined to other principal plane ('On the axis' and 'from the axis' conditions)

Application based – section of beams (I, T, L, and C), section of pipe bracket, wood joints, composite walls, shells, flange of a coupling and other similar applications

Lab exercises: Assembly of parts with respect to engineering constraints, and sectioned drafting of assembled components

Activities based learning: Making of mitered joint in wood, sectioning the beams in different angles of orientation and identifying the true shape

UNIT V LATERAL SURFACE DEVELOPMENT AND SHEET METAL DESIGN 6+12

Lateral surface development of sectioned solids when the section plane perpendicular to VP and inclined to HP.

Application based – construction of funnel, chimney, dish antenna, door latch, trays, AC vents, lamp shade, commercial packaging boxes with respect to sectioning conditions and other similar applications

Lab exercises: Sheet metal design and drafting, drafting of coils, springs and screw threads

Activities based learning: Fabrication of funnels, chimney, lamp shade, boxes using card boards, ply woods, acrylics

Total: 90 Hours

Note: Activities based learning should not be covered in the regular class hours. It should be given as assignments to the group of maximum 3 members
Question pattern suggestion: Part – A (Either or type) (5 × 16 = 80) & Part – B (Compulsory) (1 × 20 = 20)

COURSE OUTCOME:-
After successful completion of the course, the students will be able to:
CO1: Construct and identify different types of conic curves and special curves, and project the points and lines pertaining to engineering applications
CO2: Project and visualize surfaces and solids in different orientations and utilize the CAD tools for designing.
CO3: Create and draft accurate 3D models and 2D drawings of machine parts manually as well as using CAD softwares
CO4: Determine the true shape of a sectioned solid and draft the assemble parts accordingly
CO5: Develop lateral surfaces of sectioned solids and design sheet metal components

TEXTBOOKS:

1. Engineering Drawing" by N S Parthasarathy and Vela Murali

2. Engineering Drawing and Graphics with Auto CAD" by Venugopal K

REFERENCE BOOKS:

1. "Basic Engineering Drawing: Mechanical Semester Pattern" by Mehta and Gupta
2. "Engineering Drawing" by Basant Agrawal and C M Agrawal
3. "Engineering Drawing With Auto CAD" by B V R Gupta
4. "Engineering Drawing" by P S Gill
5. "Engineering Drawing with an Introduction to AutoCAD" by Dhananjay Jolhe
6. "Engineering Drawing" by M B Shah
7. "Fundamentals of Engineering Drawing" by Imtiaz Hashmi
8. "Computer Aided Engineering Drawing" by S Trymbaka Murthy
9. "CAED : Computer Aided Engineering Drawing for I/II Semester BE/Btech Courses" by Reddy K B
10. "Computer-Aided Engineering Drawing" by Subrata Pal

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2		1				3	1		3	3	3	2
2	3	3	2		2				3	2		3	3	3	2
3	3	3	3	1	2				3	3		3	3	3	2
4	3	3	3	1	3				3	3		3	3	3	2
5	3	3	3	1	3				3	3		3	3	3	2

ME23C04	MAKERSPACE	L	T	P	C
		1	0	4	3

COURSE OBJECTIVES:

1. To practice the usage of various tools towards assembly and dis-assembly of different items / equipment.
2. To make simple part / component using welding processes.
3. To train on the basic wiring practices of boards, machines, etc.
4. To provide a hands-on experience on the use of electronic components, equipment, sensors and actuators.
5. To expose to modern computer tools and advanced manufacturing / fabrication processes.

LIST OF ACTIVITIES **1L,4P**

(A). Dis-assembly & Assembly Practices

i. Tools and its handling techniques.

ii. Dis-assembly and assembly of home appliances – Grinder Mixer Grinder, Ceiling Fan, Table Fan & Washing Machine.

iii. Dis-assembly and assembly of Air-Conditioners & Refrigerators.

iv. Dis-assembly and assembly of a Bicycle.

(B). Welding Practices

i. Welding Procedure, Selection & Safety Measures.

ii. Power source of Arc Welding – Gas Metal Arc Welding & Gas Tungsten Arc Welding processes.

iii. Hands-on session of preparing base material & Joint groove for welding.

iv. Hands-on session of MAW, GMAW, GTAW, on Carbon Steel & Stainless Stell plates / pipes, for fabrication of a simple part.

(C). Electrical Wiring Practices

i. Electrical Installation tools, equipment & safety measures.

ii. Hands-on session of basic electrical connections for Fuses, Miniature Circuit Breakers and Distribution Box,

iii. Hands-on session of electrical connections for Lightings, Fans, Calling Bells.

iv. Hands-on session of electrical connections for Motors & Uninterruptible Power Supply.

(D). Electronics Components / Equipment Practices

i. Electronic components, equipment & safety measures.

ii. Dis-assembly and assembly of Computers.

iii. Hands-on session of Soldering Practices in a Printed Circuit Breaker.

iv. Hands-on session of Bridge Rectifier, Op-Amp and Transimpedance amplifier.

v. Hands-on session of integration of sensors and actuators with a Microcontroller.

vi. Demonstration of Programmable Logic Control Circuit.

(E).Contemporary Systems

i. Demonstration of Solid Modelling of components.

ii. Demonstration of Assembly Modelling of components.

iii. Fabrication of simple components / parts using 3D Printers.

iv. Demonstration of cutting of wood / metal in different complex shapes using Laser Cutting Machine.

TOTAL: 75 Periods (15 Lecture + 60 Practical)

COURSE OUTCOMES:

Upon the successful completion of the course, students will be able to:

CO1: Assemble and dis-assemble various items / equipment.
CO2: Make simple parts using suitable welding processes.
CO3: Setup wiring of distribution boards, machines, etc.
CO4: Utilise the electronic components to fabricate a simple equipment, aided with sensors and actuators.
CO5: Take advantage of modern manufacturing practices.

REFERENCES:

1. Stephen Christena, Learn to Weld: Beginning MIG Welding and Metal Fabrication Basics, Crestline Books, 2014.
2. H. Lipson, Fabricated - The New World of 3D Printing, Wiley, 1st edition, 2013.
3. Code of Practice for Electrical Wiring Installations (IS 732:2019)
4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Oxford University Press, 7th ed. (Indian edition), 2017.
5. Mazidi, Naimi, Naimi, AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson India, 1st edition 2013.
6. Visualization, Modeling, and Graphics for Engineering Design, D.K. Lieu, S.A. Sorby, Cengage Learning; 2nd edition.

UC23H01 **தமிழர் மரபு** **L T P C**
1 0 0 1

அலகு I **மொழி மற்றும் இலக்கியம்**: **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II **மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**: **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III **நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்**: **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV **தமிழர்களின் திணைக் கோட்பாடுகள்**: **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V **இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு**: **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International

Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H01 **HERITAGE OF TAMILS** **L T P C**
1 0 0 1

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as aClassical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

NCC Credit Course Level 1*

UC23P01	**(ARMY WING) NCC Credit Course Level - I**	**L T P C** **2 0 0 2**

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour 'Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P02	**(NAVAL WING) NCC Credit Course Level – I**	**L T P C** **2 0 0 2**
NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P03	**(AIR FORCE WING) NCC Credit Course Level – I**	**L T P C** **2 0 0 2**
NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

EN23C02 PROFESSIONAL COMMUNICATION L T P C
2 0 2 3

COURSE OBJECTIVES:

- To read and comprehend different forms of official texts.
- To develop students' writing skills in professional context.
- To actively listen, read and understand written and oral communication in a professional context.
- To comprehend and analyse the visual content in authentic context.
- To write professional documents with clarity and precision

UNIT I CAUSE AND EFFECT 6

Reading – Newspaper articles on Social and Environmental issues; Writing – Instructions, Cause and effect essay; Grammar - Modal verbs; Vocabulary – Cause and effect, Idioms

LAB ACTIVITY: 6

Listening and Speaking – Listen to news reports and summarise in oral form.

UNIT II CLASSIFICATION 6

Reading – An article, social media posts and classifying based on the content; Writing – Definition, Note making, Note taking (Cornell notes etc.) and Summarising; Grammar – Connectives; Vocabulary – Phrasal verbs

LAB ACTIVITY: 6

Listening and speaking: Social interaction (Conversation including small talk)

UNIT III PROBLEM AND SOLUTION 6

Reading – Visual content (Tables/charts/graphs) for comprehension; Writing - Problem and Solution Essay; Grammar – If conditionals; Vocabulary – Sequential words.

LAB ACTIVITY: 6

Listening – Group discussion; Speaking – Participating in a group discussion

UNIT IV REPORT 6

Reading – Formal report on accidents (industrial/engineering); Writing – Industrial Accident report; Grammar – Active and passive voice, Direct and Indirect speech; Vocabulary – Numerical adjectives.

LAB ACTIVITY: 6

Listening / watching – Television documentary and discussing its content, purpose etc.

UNIT V JOB APPLICATION AND INTERVIEW 6

Reading - Job advertisement and company profile; Writing – Job application (cover letter and CV) Grammar – Mixed Tenses; Vocabulary – Collocations related to work environment

LAB ACTIVITY: 6

Listening – Job interview; Speaking – Mock interviews

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment

Written assessments

Assignment

Lab Assessment

Group discussion (Peer assessment)

Listening

External Assessment

End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- To apply appropriate language structure and vocabulary to enhance both spoken and written communication in formal contexts.
- Comprehend different forms of official documents
- Write professional documents coherently and cohesively.
- Interpret verbal and graphic content in authentic context
- Analyse and evaluate verbal and audio visual materials.

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume 2 by Orient Blackswan, 2022

2. “English for Science & Technology - II” by Cambridge University Press, 2023.

REFERENCES:

1. “Communicative English for Engineers and Professionals” by Bhatnagar Nitin, Pearson India, 2010.

2. ”Take Off – Technical English for Engineering” by David Morgan, Garnet Education, 2008. 3. “Advanced Communication Skills” by Mathew Richardson, Charlie Creative Lab, 2020.

4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		√
CO3										√		√
CO4										√		√
CO5										√		√

MA23C02	ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORM TECHNIQUES	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To acquaint the students with Differential Equations which are significantly used in engineering problems.
- To make the students to understand the Laplace transforms techniques.
- To develop the analytic solutions for partial differential equations used in engineering by Fourier series.
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic.
- To develop Z- transform techniques in solving difference equations.

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 9+3

Homogeneous linear ordinary differential equations of second order -superposition principle - general solution- Particular integral - Operator method - Solution by variation of parameters - Method of undetermined coefficients - Homogeneous equations of Euler–Cauchy and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

UNIT II LAPLACE TRANSFORMS 9+3

Existence theorem - Transform of standard functions – Transform of Unit step function and Dirac delta function – Basic properties - Shifting theorems - Transforms of derivatives and integrals – Transform of periodic functions - Initial and Final value theorem - Inverse Laplace transforms- Convolution theorem (without proof) – Solving Initial value problems by using Laplace Transform techniques.

UNIT III FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Computation of harmonics.

UNIT IV FOURIER TRANSFORMS 9+3

Fourier integral theorem – Fourier transform pair - Fourier sine and cosine transforms – Properties – Transform of elementary functions – Inverse Fourier Transforms - Convolution theorem (without proof) – Parsevals's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 9+3

Z-transform – Properties of Z-transform – Inverse Z-transform – Convolution theorem – Evaluation of Inverse Z transform using partial fraction method and convolution theorem - Initial and final value theorems – Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

Ordinary differential equations

1. Symbolic computation of linear ordinary differential equations
2. Solving System of simultaneous linear differential equations using ODE SOLVER

Laplace transforms

1. Symbolic computation of Laplace transform and Inverse Laplace transform
2. Plotting Laplace transforms

Fourier Series

1. Symbolic computation of Fourier Coefficients
2. Computation of harmonics
3. Plotting truncated Fourier Series

Fourier Transform

1. Symbolic computation of Fourier Transforms
2. Plotting truncated Fourier Transforms

Z – transform

1. Symbolic computation of Z-Transforms

OUTCOMES:

CO1 :Solve higher order ordinary differential equations which arise in engineering applications.
CO2 :Apply Laplace transform techniques in solving linear differential equations.
CO3 :Apply Fourier series techniques in engineering applications.
CO4 :Understand the Fourier transforms techniques in solving engineering problems.
CO5 :Understand the Z-transforms techniques in solving difference equations.

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 45th Edition, New Delhi, 2020.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.

REFERENCES:

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008
2. Greenberg M.D., “Advanced Engineering Mathematics”, Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”,Narosa Publications, 5 th Edition, New Delhi, 2017.
4. Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
5. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO 1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 5 :	3	3	2	3	1	2	1	1	1	1	1	3

PH23C05	MATERIALS SCIENCE FOR TECHNOLOGISTS (Rubber and Plastics Technology)	L T P C 3 0 0 3

OBJECTIVES

- To make the students to understand the basics of phase diagrams and various crystal growth techniques.
- To equip the students to have a knowledge on different types of electron theory, basics of applied quantum mechanics and about superconductors.
- To introduce the importance of semiconducting materials, physics of semiconducting materials and applications of semiconductors in device fabrication.
- To familiarize the students to magnetic materials, theory and types of magnetizations, dielectric materials and their application.
- To provide the students a sound platform towards learning about advanced materials and their applications.

UNIT I ` MATERIALS PREPARATION AND PROCESSING 9

Gibbs phase Rule – Phase Diagram – One component and multi component systems – Eutectic – peritectic – Eutectoid – Peritectoid – Invariant reactions – Lever Rule – Nucleation – homogeneous and heterogeneous nucleation – Free energy of formation of a critical nucleus – Nucleation rate – Experimental techniques of crystal growth – Czochralski, Bridgman, Flux, Solution, Vapour, Sol-gel - Hydrothermal – Epitaxy.

UNIT II CONDUCTING MATERIALS 9

Classical free electron theory of metals – quantum free electron theory - particle in a three dimensional box – degenerate state - electrons in a metal - Fermi distribution function – Density of energy states – effect of temperature on Fermi energy, Superconducting Phenomena, Properties of superconductors – Meissner effect and Isotope effect. Type I and Type II superconductors, High Tc superconductors – Magnetic levitation and SQUIDS.

UNIT III SEMICONDUCTING MATERIALS 9

Origin of band gap in solids (qualitative) - Concept of effective mass of electron and hole – Carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – Variation of Fermi level with temperature – electrical conductivity – Band gap determination – Carrier concentration in n-type and p-type semiconductors (derivation) – Variation of Fermi level with temperature and impurity concentration – Compound semiconductors – Hall effect – Determination of Hall coefficient – Solar cells – LED and photodiode.

UNIT IV MAGNETIC AND DIELECTRIC MATERIALS 9

Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites, Giant Magneto Resistance, Electronic, Ionic, Orientational and space charge polarization – Internal field and deduction of Clausius Mosotti equation – Dielectric loss – Different types of dielectric breakdown – Classification of insulating materials and their applications – Ferroelectric materials.

UNIT V NEW MATERIALS AND APPLICATIONS 9

Introduction to Ceramics and its applications - Ceramic Fibres - Fibre reinforced Plastics – Fibre reinforced Metal – Metallic glasses – Shape memory alloys – Copper base alloys – Nickel – Titanium alloys - Sensors and Actuators – Range - Accuracy Determination –- Photo detectors, Bio-sensors, Scintillation detectors (Position sensitive) – Renogram – Computed Tomography Scan (CT Scan) - Magnetic Resonance Imaging (MRI) - Performance and Reliability testing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students shall be able to

CO1: Acquire knowledge of phase diagrams and important crystal-growing techniques.
CO2: Familiarize with conducting materials, and properties and applications of superconductors.
CO3: Gain knowledge of semiconducting materials based on energy level diagrams, its types, and temperature effects. Also, fabrication methods for semiconductor devices will be understood.
CO4: Realize with theories of magnetic materials, and understand the dielectric behavior of insulating materials and ferroelectric materials.
CO5: Familiarize with ceramics, FRP, shape memory alloys and important technological applications.

TEXT BOOKS:

1. Raghavan, V. “Physical Metallurgy: Principles and Practice”, Phi Learning (2009).
2. Balasubramaniam, R. “Callister's Materials Science and Engineering”, Wiley India Pvt. Ltd. (2014).
3. Palanisamy P.K., “Materials Science” , Scitech (2013).

REFERENCES:

1. Raghavan, V. “Materials Science and Engineering”, Printice Hall of India (2007).
2. Shackelford, J.F. “Introduction to Materials Science for Engineers”. Pearson India (2006).
3. Donald Askeland. “Materials Science and Engineering”, Brooks/Cole (2010).
4. Smith, W.F., Hashemi, J. and R.Prakash. “Materials Science and Engineering”,Tata Mcgraw Hill Education Private Limited (2014).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1							
CO2	3	3	2	2	1							
CO3	3	3	2	2	1							
CO4	3	3	2	2	1							
CO5	3	3	2	2	1							

CS23C04 **PROGRAMMING IN C** **L T P C**
2 0 4 4

UNIT I BASICS OF C PROGRAMMING 6+12

Introduction to programming paradigms –- Structure of C program - C programming: Data Types - Constants - Keywords - Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements - Decision making statements - Switch statement.

PRACTICALS

1. Designing programs with algorithms/flowchart
2. Programs for i/o operations with different data types

SUGGESTED ACTIVITIES:

- EL - Programs using integer type, arithmetic operators and basic input/output.
- EL - Programs using other data types and operators.
- EL: Programs using else-if, switch

UNIT II LOOP CONTROL STATEMENTS AND ARRAYS 6+12

Iteration statements: For, while, Do-while statements, nested loops, break & continue statements - Introduction to Arrays: Declaration, Initialization - One dimensional array -Two dimensional arrays – Searching and sorting in Arrays – Strings – string handling functions - array of strings

PRACTICALS

1. Programs using various operators
2. Programs using decision making and branching statements
3. Programs using for, while, do-while loops and nested loops.
4. Programs using arrays and operations on arrays.
5. Programs implementing searching and sorting using arrays
6. Programs implementing string operations on arrays

SUGGESTED ACTIVITIES:

- EL: Programs using while, for,do-while, break, continue, enum.
- EL - Programs using arrays and operations on arrays.
- EL - Programs implementing string operations on arrays.
- EL - Programs using functions.

UNIT III FUNCTIONS AND POINTERS 6+12

Modular programming - Function prototype, function definition, function call, Built-in functions – Recursion – Recursive functions - Pointers - Pointer increment, Pointer arithmetic - Parameter passing: Pass by value, Pass by reference, pointer and arrays, dynamic memory allocation

PRACTICALS

1. Programs using functions
2. Programs using recursion
3. Programs using pointers & strings with pointers
4. Programs using Dynamic Memory Allocation

SUGGESTED ACTIVITIES:

- EL - Programs using recursion.
- EL - Programs using pointers and arrays, address arithmetic.
- EL - Programs using Dynamic Memory Allocation, two dimensional arrays and pointers.
- EL - Programs using Pointers and strings.

UNIT IV STRUCTURES AND UNION 6+12

Storage classes, Structure and union, Features of structures, Declaration and initialization of structures, array of structures, Pointer to structure, structure and functions, typedef , bit fields , enumerated data types, Union.

PRACTICALS

1. Programs using Structures
2. Programs using Unions
3. Programs using pointers to structures and self-referential structures.

SUGGESTED ACTIVITIES:

- EL - Programs using structures and arrays.
- EL - Programs using Pointers to structures, Self-referential structures.

UNIT V MACROS AND FILE PROCESSING 6+12

Preprocessor directives – Simple and Conditional macros with and without parameters - Files - Types of file processing: Sequential and Random access – File operations – read, write & seek.

PRACTICALS

1. Programs using pre-processor directives & macros
2. Programs to handle file operations
3. Programs to handle file with structure

SUGGESTED ACTIVITIES:

- EL - Programs using file operations in real-world applications

TOTAL: 90 (30+60) PERIODS

TEXT BOOKS:

1. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.

REFERENCE BOOKS:

1. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013.
2. Ashok N Kamthane, Programming in C, Pearson, Third Edition, 2020
3. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016.
4. Paul Deitel and Harvey Deitel, "C How to Program with an Introduction to C++", Eighth edition, Pearson Education, 2018.
5. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C"' McGraw-Hill Education, 1996.
6. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", 1st Edition, Pearson Education, 2013.

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Write simple C programs using basic constructs.
CO2: Design searching and sorting algorithms using arrays and strings.
CO3: Implement modular applications using Functions and pointers.
CO4: Develop and execute applications using structures and Unions.
CO5: Illustrate algorithmic solutions in C programming language using files.

Total Hours: 90 (30+60)

CO-PO MAPPING

CO	PO1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO1 1	PO12	PSO 1	PSO 2	PSO 3
1	2	3	1	3	2	1	-	-	-	2	-	3	1	2	2
2	2	1	1	3	2	1	-	-	-	-	-	3	1	2	2
3	2	2	1	3	2	1	-	-	3	-	3	3	1	2	2
4	2	1	1	3	2	1	-	-	3	-	3	3	1	2	2
5	2	3	1	3	2	1	-	-	-	2	3	3	1	2	2

1 - low, 2 - medium, 3 – high

EE23C03	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		2	0	2	3

UNIT-I BASIC ELECTRICAL CIRCUITS **6**

Basic Elements: R,L,C- DC Circuits: Ohm's Law - Kirchhoff's Laws –Mesh and Nodal Analysis(Only Independent Sources). AC Circuits: Average Value, RMS Value, Impedance Instantaneous Power, Real Power, Reactive Power and Apparent Power, Power Factor-Steady state Analysis of RL,RC and RLC circuits.

UNIT II AC AND DC MACHINES 6

Magnetic Circuit Fundamentals -DC Machines - Construction and Working Principle, Types and Application of DC generator and Motor, EMF and Torque Equation.

AC Machines: Principle, Construction, Working and Applications of Transformer -Three phase Alternator - Three Phase Induction Motor.

UNIT III ANALOG AND DIGITAL ELECTRONICS 6

Operation and Characteristics of electronic devices: PN Junction Diodes, Zener Diode and BJT Applications: Diode Bridge Rectifier and Shunt Regulator.

Introduction to Digital Electronics: Basics Logic Gates-Flip Flops.

UNIT IV SENSORS AND TRANSDUCERS 6

Solenoids, electro-pneumatic systems, proximity sensors, limit switches, Strain gauge, LVDT, Piezo electric transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

UNIT V MEASUREMENTS AND INSTRUMENTATION 6

Functional Elements of an Instrument, Operating Principle of Moving Coil and Moving Iron Instruments,Power Measurement, Energy Meter, Instrument Transformers - CT and PT, Multimeter-DSO - Block Diagram Approach.

TOTAL 30

LAB COMPONENET:

1. Verification of ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Load test on Single Phase Transformer.
4. Load test on 3 Phase Induction Motor.
5. Uncontrolled diode bridge Rectifiers.
6. Application of Zener diode as shunt regulator.
7. Verification of truth table of logic gates and flip flops.
8. Characteristics of LVDT.
9. Three phase power measurement using two wattmeter method.
10. Study of DSO.

COURSE OUTCOMES:

Students will be able to

CO1 Compute the electric circuit parameters for simple circuits.
CO2 Understand the working principles and characteristics of electrical machines.
CO3 Understand the basic electronic devices.
CO4 Understand the basic operating principles of sensors and transducer.
CO5 Understand the operating principles measuring devices

TEXT BOOKS:

1. Kotharai DP and Nagarath IJ, “Basic Electrical and Electronics Enigneering”, McGraw Hill Education, Second Edition, 2020.
2. Bhattacharya SK, “Basic Electrical and Electronics Engineering”, Pearson Education, Second Edition, 2017.

REFERENCES:

1. Mehta V.K. & Mehta Rohit, “Principles of Electrical Engineering and Electronics”, McGraw Hill Education, Second Edition, 2020.
2. Mehta V.K. & Mehta Rohit, “Principles of Electrical Machines”, S. Chand Publishing, second edition 2006.
3. Albert Malvino & David Bates, “Electronic principles”, McGraw Hill Education, Seventh Edition, 2017.

Mapping COs and POs:																
COs	**Pos**												**PSOs**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	1														
CO2	2	1														
CO3	2	1														
CO4	2	1														
CO5	2	1														
Avg	2	1														

ME23C03	ENGINEERING MECHANICS	L T P C
		3 1 0 4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Determining the resultant forces acting on a particle in 2D and 3D and for applying methods of equilibrium on a particle in 2D and 3D.
- Evaluating the reaction forces for bodies under equilibrium, for determining the moment of a force, moment of a couple, for resolving force into a force-couple system and for analyzing trusses
- Assessing the centroids of 2D sections / center of gravity of volumes and for calculating area moments of inertia for the sections and mass moment of inertia of solids.
- Evaluating the frictional forces acting at the contact surfaces of various engineering systems and for applying the work-energy principles on a particle.
- Determining kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

UNIT I STATICS OF PARTICLES 9+3

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

UNIT II EQUILIBRIUM OF RIGID BODIES AND TRUSSES 9+3

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections – Analysis of Trusses – Method of Joints and Method of Sections.

UNIT III DISTRIBUTED FORCES 9+3

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration.

Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration , Polar Moment of Inertia , Radius of Gyration of an Area , Parallel-Axis Theorem , Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates , Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV FRICTION AND WORK PRINCIPLES 9+3

The Laws of Dry Friction. Coefficients of Friction, Angles of Friction, Wedges, Wheel Friction. Rolling Resistance, Ladder friction. Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact, Method of Virtual Work - Work of a Force, Potential Energy, Potential Energy and Equilibrium.

UNIT V DYNAMICS OF PARTICLES AND RIGID BODIES 9+3

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of

Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods – Kinematics of Rigid Bodies and Plane Kinetics.

TOTAL : 60 Periods

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. To determine the resultant forces acting on a particle in 2D and 3D and to apply methods of equilibrium on a particle in 2D and 3D.
2. Evaluate the reaction forces for bodies under equilibrium, to determine moment of a force, moment of a couple, to resolve force into a force-couple system and to analyze trusses
3. Assess the centroids of 2D sections / center of gravity of volumes and to calculate area moments of inertia for the sections and mass moment of inertia of solids.
4. Evaluate the frictional forces acting at the contact surfaces of various engineering systems and apply the work-energy principles on a particle. evaluate the kinetic and kinematic parameters of a particle.
5. Determine kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

TEXT BOOKS:

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 12th Edition, 2019.
2. Vela Murali, “Engineering Mechanics-Statics and Dynamics”, Oxford University Press, 2018.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3									3		
2	3	3	2	3									3		
3	3	3	2	3									3		
4	3	3	2	3									3		
5	3	3	2	3									3		
Avg	3	3	2	3									3		

CY23C06 PHYSICAL AND ORGANIC CHEMISTRY L T P C
3 0 0 3

OBJECTIVE:

- To familiarize with chemical kinetics, catalysis, electrochemistry, corrosion.
- To make the students learn the mechanism of various chemical reaction.
- To develop knowledge of preparation methods of diamine.

UNIT I CHEMICAL KINETICS AND CATALYSIS 9

Chemical kinetics – order – molecularity – rate of reaction – activation energy – catalysis – surface science – application of catalysis – phase rule and phase diagrams- colligative properties of solutions

UNIT II ELECTRO CHEMISTRY / CORROSION 9

Electro chemistry – electrochemical series – transport numbers and ionic mobility – buffer indicators – redox reaction – potentiometric, conductometric, polarographic studies – galvanic cells – electrolysis – thermodynamic parameters.

UNIT – III STRUCTURE OF ORGANIC COMPOUNDS 9

Bonding in organic compounds- structure – property relationships – electronic effects like inductive, mesomeric, electronic and hyper conjugation effects – free radicals, carbo cations, carbanions, elementary ideas about stereo chemistry.

UNIT – IV DETAILS OF REACTION MECHANISMS 9

Free radical substitution, Electrophilic addition, aromatic electrophilic substitution, Nucleophilic additions, condensation reactions, nucleophilic substitutions in aliphatic and aromatic compounds, cyclo addition, rearrangements, uses of these reactions in polymer preparation.

UNIT – V ORGANIC SUBSTANCES OF IMPORTANCE TO POLYMET TECHNOLGY 9

Amines, important of heterocyclic compounds- furan, thiophene, pyrrole, quinoline, iso quinoline, imidazole, thiazoles, diisocyanates, epichlorohydrin, fluoro alkenes, acrylonitrile. Diamines, dicarboxylic acids, polyhydric alcohols. Aromatic and aliphatic amines, amino acids andproteins.

TOTAL: 45 PERIODS

COURSE OUTCOME:

On completion of the course, the students will be able to:

1. Understand the principles of chemical kinetics and catalysis, including reaction rates, activation energy, and the role of catalysis in chemical reaction.
2. Explain the fundamentals of electrochemistry and corrosion, including redox reaction, electrolysis, and the thermodynamics of electrochemical systems.
3. Analyse the structure of organic compounds and their properties, including electronic effects and stereochemistry.
4. Describe the mechanism of various organic reactions, including substitution, addition, and rearrangement reaction, and their applications in polymer preparation.
5. Identify and evaluate the importance of various organic compounds in polymer technology, including amines, hetrocyclic compounds, diisocyanates, and amino acids.

TEXT BOOK

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press,6th Ed., (2006).
2. Puri, Sharma &Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 47thEdn., 2017.
3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017.
4. Advanced Organic Chemistry, 2nd Edition, Arun Bahl & B S Bahl, S. Chand Publisher,2012.

REFERENCE BOOK

1. Glasstone, S and D.Lewis, “Elementsof Physical Chemsitry”. Macmillan, 1995.
2. Maron and C.F. Pruton Chemistry “Physical Chemistry” Macmillan, 1990.
3. Morrison and Boyd, “Organic Chemistry”. Prentice Hall, 1992.
4. Finar I.L., “Textbook of Organic Chemistry”. ELBS, 1996.

DIGITAL REFERENCE LINK

1. https://www.youtube.com/watch?v=i9TSLa3XNpQ
2. https://www.youtube.com/watch?v=m4MbFsPkVwI&t=883s
3. https://www.youtube.com/watch?v=jX4dEOFwaLQ

CO-PO MAPPING

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3								1					
CO2	3	3								1					
CO3	3		3							1					
CO4			3	3						1					
CO5				3	3					1					
Overall CO	1.8	1.2	1.2	1.2	0.6					1					

UC23H02 **தமிழரும் தொழில்நுட்பமும்** **L T P C**
1 0 0 1

அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்: **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III உற்பத்தித் தொழில் நுட்பம்: **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ்: **3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்
   கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi – 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H02 **TAMILS AND TECHNOLOGY** **L T P C**
1 0 0 1

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period -Type study (Madurai Meenakshi Temple)- Thirumalai NayakarMahal -ChettiNadu Houses, Indo-Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies -Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stonebeads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE ANDIRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of KumizhiThoompuof Chola Period,Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing -KnowledgeofSea -Fisheries – Pearl - Conche diving - Ancient Knowledge ofOcean -KnowledgeSpecificSociety.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்
   கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi – 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

MA23C05	PROBABILITY AND STATISTICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
- To understand the basic probability concepts with respect to two dimensional random variables along with the relationship between the random variables and the significance of the Central Limit theorem.
- To understand the basic concepts of sampling distributions and statistical properties of point and interval estimators.
- To apply the small/ large sample tests through Tests of hypothesis.
- To understand the concept of analysis of variance and use it to investigate factorial dependence.

UNIT I ONE-DIMENSIONAL RANDOM VARIABLES 9+3

Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a random variable.

UNIT II TWO-DIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III ESTIMATION THEORY 9+3

Sampling distributions – Characteristics of good estimators – Method of Moments – Maximum Likelihood Estimation – Interval estimates for mean, variance and proportions.

UNIT IV TESTS OF SIGNIFICANCE 9+3

Type I and Type II errors – Tests for single mean, proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances $-\chi^2$ test for goodness of fit – Independence of attributes.

UNIT V DESIGN OF EXPERIMENTS 9+3

Completely Randomized Design – Randomized Block Design – Latin Square Design – 2^2 factorial design.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

SUGGESTED LAB EXERCISES

1. Data exploration using R
2. Visualizing Probability distributions graphically

3. Evaluation of correlation coefficient
4. Creating a Linear regression model in R
5. Maximum Likelihood Estimation in R
6. Hypothesis testing in R programming
7. Chi square goodness of fit test in R
8. Design and Analysis of experiments with R

OUTCOMES:

CO1: Can analyze the performance in terms of probabilities and distributions achieved by the determined solutions.

CO2: Will be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis.

CO3: Provides an estimate or a range of values for the population parameter from random samples of population.

CO4: Helps to evaluate the strength of the claim/assumption on a sample data using hypothesis testing.

CO5: Equips to study the influence of several input variables on the key output variable.

TEXT BOOKS:

1. Irwin Miller and Marylees Miller, "John E. Freund's Mathematical Statistics with applications", Pearson India Education, Asia, 8th Edition, 2014.
2. Walpole, R.E., Myers R.H., Myres S.L., and Ye, K. "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2024.

REFERENCES:

1. Richard A. Johnson, Irwin Miller, John Freund "Miller & Freund's Probability and Statistics for Engineers", Person Education, 8th Edition, 2015.
2. Ross, S.M. "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier, New Delhi, 5th Edition, 2014.
3. Spiegel, M.R., Schiller, J., Srinivasan, R.A. and Goswami, D. "Schaum's Outline of Theory and Problems for Probability and Statistics", McGraw Hill Education, 3rd Edition, Reprint, 2017.
4. Devore, J.L. "Probability and Statistics for Engineering and the Sciences", Cengage Learning, 9th Edition, 2016.

CO – PO Mapping:

COURSE OUTCOMES	PROGRAMME OUTCOMES											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**P10**	**P11**	**P12**
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

AE23C01	SOLID MECHANICS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

Of this course are

1. Knowledge about the behavior and response of materials under axial loading
2. Familiarization with shear force and bending moment diagrams for beams under various loading and support conditions
3. Familiarization with the different methods of analysis for beam deflection
4. To impart to the student knowledge about the behavior of circular shafts and springs under torsional loading
5. Enable the student understand stress and strain relations and ability to calculate principal stresses and strains in structural members

UNIT I AXIAL LOADING 9+3

Normal Stress and Strain – Mechanical Properties of Materials – Material Constants – Study of Stress-strain Curves of Different Materials – Elasticity & Plasticity – Hooke's Law – Shear Stress and Strain – Allowable Stresses and Allowable Loads – Design for Axial Loads – Thermal Stresses in Bars – Strain Energy – Tapered Bar Analysis – Impact Testing

UNIT II STRESSES IN BEAMS 9+3

Types of Beams, Loads, and Support Reactions – Relationships Between Load, Shear Force, and Bending Moment – Shear-Force and Bending-Moment Diagrams – Beam Curvature – Longitudinal Strain – Normal Stress in Beams – Shear Stresses in a Beam – Beam Design

UNIT III DEFLECTION OF BEAMS 9+3

The Euler-Bernoulli Beam Theory – Differential Equation of the Deflection Curve – Beam Deflection by Integration of Bending-Moment Equation, Shear-Force and Load Equations – Method of Superposition – Moment-Area Theorems and Application – Macaulay's Method – Strain Energy in Beams – Non-Prismatic Beams

UNIT IV TORSION 9+3

Torsional Deformations of a Circular Bar – Non-uniform Torsion – Stresses and Strains in Pure Shear – Angle of Twist & Torsional Rigidity – Transmission of Power by Circular Shafts – Statically Indeterminate Torsional Members – Stress Analysis of a Closed-Coil Helical Spring – Stress Concentration in Torsion – Shaft Design Principle

UNIT V ANALYSIS OF STRESS AND STRAIN 9+3

Stress Components in 2D – Hooke's Law for Plane Stress – Stress Transformation Equations – Principal Stress and Maximum Shear Stress – Mohr's Circle – Strain Components in 2-D & 3-D – Analysis of Strain – Stress-Strain Relations for Linearly Elastic Materials – Elastic Constants – Introduction to Elasticity Approach

TOTAL : 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1 Ability to analyze the behavior of a member under axial loading conditions

CO2 Ability to draw shear force and bending moment for different types of beams under various loading conditions

CO3 Knowledge of how to calculate deflection of beams under various loading conditions

CO4 Knowledge of stress analysis of torsion members and ability to design a torsional

member

CO5 Familiarization with the theoretical analysis of stress & strain and the determination of principal values of stress and strain

TEXTBOOKS:

1.James M. Gere, “Mechanics of Materials”, Cengage, 9th Edition, 2022.

2. R.K Rajput, “Strength of Materials”, S. Chand Ltd, 6th Edition, 2015.

REFERENCES:

1. David Roylance, “Mechanics of Materials”, Wiley, 2nd edition,2002

2.HibbelerR.C, “MechanicsofMaterials”,Pearson,10thEdition,2016.

3. E J Hearn, “Mechanics of Materials”, Butterworth Heinemann, Volume-1, 2007.

4. L.S. Srinath, Advanced Mechanics of Solids, Tata McGraw Hill, 3rd Edition, 2017

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	3	3	2	1				1				3	3	3	3	2
2	3	3	3	2	2			1				3	2	3	3	2
3	3	3	2	2				1				3	3	3	3	3
4	3	2	3	3	3			1				3	3	2	3	3
5	3	2	2	2	3			1				3	3	3	3	3

RP23301	ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for

1. To impart knowledge of basic principles of thermodynamics via real world engineering examples
2. To analyse and evaluate cardinal air standard cycles
3. To analyse and evaluate cardinal Steam power cycles
4. Summarize the governing concepts of Refrigeration and Air conditioning
5. To inculcate various modes of heat and mass transfer related to real time scenarios of thermodynamics applied in engineering practice

UNIT - I BASIC THERMODYNAMICS 9

Systems, closed, open and isolated. Property, state, path and process, quasi-static process, Zeroth low, First law. Steady flow energy equation. Engineering Applications of Steady flow energy equation Heat and work transfer in flow and non-flow processes. Second law, Kelvin-Planck statement – Clausius statement - Concept of Entropy, Clausius inequality, Entropy changes in non- flow processes. Available and Unavailable Energy.

UNIT - II AIR STANDARD CYCLES AND COMPRESSORS 9

Cycle, Carnot cycle, Otto, Diesel, Dual combustion and Brayton cycles. Vapor Power Cycles - Air standard efficiency. Mean effective pressure. Comparison of cycles based on same compression ratio and same heat input.

UNIT - III STEAM AND JET PROPULSION 9

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagram. p-v-T surface Properties of steam, Dryness fraction, Quality of steam-by-steam tables and Mollier chart –Rankine cycle, Work done, Steam rate.

UNIT - IV REFRIGERATION 9

Principles of refrigeration, Vapour compression – Types of VCR system with respect to condition of vapour, Problems, Vapour absorption types, comparison - Co-efficient of performance (COP), Properties of refrigerants.

UNIT - V HEAT AND MASS TRANSFER 9

Modes of heat transfer, Flow through heat- exchangers. -Determination for LMTD for parallel flow and AMTD for counter flow heat exchanger- Thermodynamics applications in heat and mass transfer unit operations.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, the students

CO1	Will demonstrate understanding of the nature of the thermodynamic processes for pure substances of ideal gases
CO2	Will interpret First Law of Thermodynamics and its application to systems and control volumes
CO3	Will solve any flow specific problem in an engineering approach based on basic concepts and logic sequences.
CO4	Will compare and contrast between various types of refrigeration cycles
CO5	Will get exposed to the basics and modes of heat transfer and mass transfer

TEXTBOOKS:

1. Chattopadhyay. P Engineering Thermodynamics", oxford University Press, New Delhi, 2010.
2. Nag.P.K., "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, 2007.
3. Rathakrishnan E., "Fundamentals of Engineering Thermodynamics" Prentice-Hall India, 2005.
4. Ganesan.V, "Thermodynamics: Basics and Applied" McGraw Hill Education (India) Private Limited, 2018.
5. Mc. Cabe, W.L., Smith, J.C., Unit Operations of Chemical Engineering, Mc.Graw Hill. 1993.

REFERENCES:

1. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
2. Holman.J.P., "Thermodynamics", 3rd Ed. McGraw-Hill, 2007.
3. Mathur & Sharma Steam Tables, Jain Publishers, New Delhi.
4. Merala C, Pother, Craig W, Somerton, "Thermodynamics for Engineers", Schaum Outline Series, Tata McGraw-Hill, New Delhi, 2004.
5. Ramalingam K.K. "Thermodynamics", Sci-Tech Publications, 2006

CO-PO Mapping

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	3	3	3	1	1	-	2	2	-	3	3	3
2	3	3	3	3	3	1	1	-	2	2	-	3	3	3
3	3	3	3	3	3	1	1	-	2	2	-	3	3	3
4	3	3	3	3	3	1	1	-	2	2	-	3	3	3
5	3	3	3	3	3	1	1	-	2	2	-	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**-**	**2**	**2**	**-**	**3**	**3**	**3**

RP23302	INTRODUCTION TO CHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamental chemical engineering knowledge like heat and mass transfer, thermodynamics and separation technology in polymer industry

UNIT I HEAT TRANSFER 9

Classification of Unit Operations - Heat transfer – steady state – Fourier law – thermal conductivity – conduction through plane wall – cylindrical wall – convection – forced and natural convection – radiation – unsteady state heat transfer -exchange equipment – double pipe and shell and tube heat exchangers, condensers

UNIT II CHEMICAL THERMODYNAMICS 9

Thermodynamic Systems and variable - work, heat, internal energy, thermodynamic equilibrium, reversible and irreversible processes - Equation of state - First law - closed and open systems Steady flow energy equation. Second law, - Concept of Entropy, isentropic efficiency, Maxwell's relation and fluid properties - application to flow processes

UNIT III MASS TRANSFER 9

Mass Transfer –Material Balance - Principles of diffusion, Fick's law – theory of diffusion, Mass transfer coefficients and film theory Penetration theory. Distillation – Vapour liquid equilibria, Simple distillation, Steam distillation, Continuous binary distillation, Industrial equipment for distillation- industrial boilers

UNIT IV AGITATION AND DRYING 9

Agitation of liquids – Types of impellers, Selection criteria, Power consumption calculations for agitated vessel Absorption – Principle and equipment (packed towers and plate columns). Adsorption – Principles and equipment for adsorption

Drying – Principles and definitions, Rate of batch drying, Equipments for drying. Humidification –dry bulb and wet bulb temperatures, Equipment —- cooling towers, spray chambers

UNIT V SEPARATION PROCESSES 9

Membrane Separation Processes - Separation of gases and liquids, Dialysis, Membranes, liquid – liquid extraction, Pervaporation and reverse osmosis. Size reduction Laws of crushing, Equipment – Classification, Crushers and grinders. Mechanical separations – Screening and screening equipment, Filtration – Principle and filtration equipment, filter media, filter aids, Gravity settlers, Cyclones and hydro cyclones

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Students introduced to various types of unit operation in chemical/ Polymer industries
CO2: Students get an understanding on the basics of thermodynamics, heat and mass transfer mechanism
CO3: Students will apply the principles of thermodynamics, heat and mass transfer in rubber and plastics processing
CO4: Students will able to comprehend the agitation of liquids, absorption and adsorption and machinery used for the process

CO5: To get the overview of equipment used to perform various mechanical operations and problems associated during implementation and applications

REFERENCES:

1. Mc. Cabe, W.L., Smith, J.C., Unit Operations of Chemical Engineering, Mc.Graw Hill. 1993.
2. Badger, W.L., Banchero, J.T., Introduction to Chemical Engineering, Mc.Graw Hill, UK, 1997.
3. Richardson and Coulson, Chemical Engineering, Vol. 1 & vol.2, Asian Books Pvt. Ltd., India. 1996.
4. Chattopadhyay, P., Unit Operations of Chemical Engineering Vol. I and Vol. II, Khanna Publishers, Delhi, 1998.
5. J M Smith, H.C.Van Ness and M.M. Abbott, "Introduction to Chemical Engineering Thermodynamics" 6th edition McGraw Hill, 2001

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2								3	2	2	2
CO2	3	2	2	2								3	2	2	
CO3	3	3	3	3		2	2	1			2	3	3	2	3
CO4	3	3	3	3								3	2	2	2
CO5		3	3	3	2		2					3	2	2	3
Overall CO	**3**	**2.6**	**2.6**	**2.6**	**2**	**2**	**2**	**1**			**2**	**3**	**2.2**	**2**	**2.5**

RP23303	PRINCIPLES OF POLYMERIZATION	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the fundamental of polymers, polymerization mechanism and its manufacturing techniques.

UNIT I NATURAL POLYMERS 9+3

History of Macromolecules - Introduction to Natural Polymers and their structures – Cellulose – Cellulose derivatives – Wood and Paper – Biopolymers and their building blocks - Collagen and gelatin – Leather - Proteins and Nucleic acids – Structure of Natural rubber – Concept of macromolecules – Synthetic Polymers and their classification

Practicals - Preparation of Regenerated cellulose.

UNIT II ADDITION POLYMERIZATION - I 9+9

Monomers and functionality - Polymerization mechanism - Types of initiation – Free radical addition polymerization – Kinetics - Degree of polymerization, Molecular weight and distribution - Chain transfer - Polymerization techniques - Cationic polymerization – Anionic polymerization, Copolymerization – Ring opening polymerization – Industrial applications

Practicals - Bulk polymerization of MMA and styrene monomer, Solution polymerization of Acrylamide monomer , Suspension polymerization of styrene with Dibenzoyl peroxide (DBPO), Emulsion Polymerization of styrene ,Free Radical Copolymerization of MMA and styrene

UNIT III ADDITION POLYMERIZATION – II 9+4

Coordination polymerization – Metallocene catalysts - Living Radical Polymerization – Atom Transfer Radical Polymerization – Stable free radical polymerization (NMP) and RAFT polymerization mechanisms - Group transfer Polymerization – Ring opening metathesis Polymerization - Electrochemical polymerization –Photopolymerization

Practicals- Photo polymerization of PEG-400-diacrylate, Synthesis of Polyaniline

UNIT IV CONDENSATION POLYMERIZATION 9+8

Flory's equal reactivity principle – Kinetics of Polycondensation - Carother's equation – Linear polymers by Polycondensation – Interfacial polymerization – Star polymers and dendrimers - Crosslinked polymers by condensation – Gel point –Examples - Moulding powders - Industrial polymerization techniques

Practicals - Preparation of Phenol-Formaldehyde, UF and MF resins, Preparation of Bisphenol -A based epoxy resin, Preparation of Nylon 6,10

UNIT V POLYMER SOLUTIONS AND MOLECULAR WEIGHTS 9+6

Thermodynamics of polymer solutions - Flory-Huggins Theory – Polymer-Solvent interaction parameter-Solubility parameter-Size and shape of Macromolecules -Viscosity of polymer solutions and melts - Molecular Weight averages and distribution – Molecular weight determination - Osmometry, Light Scattering - Basic Principles

Practicals - Determination of molecular weight of polymers by viscosity method, Gel permeation Chromatography - Study

TOTAL : 45 + 30 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1: Acquire knowledge and hands on experience on polymer synthesis
CO2: Know various addition polymerization mechanisms and techniques.
CO3: Understand coordination polymerization mechanisms and techniques.
CO4: Understand step polymerization and the manufacture of condensation polymers
CO5: Comprehend the solution properties of polymers and molecular weights

REFERENCES:

1. Seymour.R.B., and Carraher.C.E., Jr., Polymer Chemistry, 6th Ed., Marcel Dekker, 2003
2. Gowariker.V.T., Viswanathan.N.V., and Sreedar.J., Polymer Science, 5th edition, 2023
3. Charles E. Carraher , "Polymer Chemistry", 9th Edition, CRC Press, 2016
4. Joel,R.F; Polymer Science and Technology, Eastern Economy Edition, 1999.
5. George Odian , " Principles of Polymerisation", John Wiley& Sons, 2004.
6. Paul . J.Flory, "Principles of Polymer Chemistry" Cornell University Press, 1995.
7. Robert.O.Ebewele, " Polymer Science and Technology," CRC Press, 2000

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	3	1	-	1	2	2	1	2	2	3	2	3
CO2	3	3	3	2	1	1	2	2	2	2	2	2	3	2	2
CO3	3	2	3	2	2	2	2	2	2	2	2	3	3	2	1
CO4	3	2	3	2	2	2	2	2	2	1	2	2	3	2	2
CO5	2	1	2	1	1	1	2	2	1	1	2	2	2	1	2
Overall CO	2.8	2	2.6	2	1.4	1.2	1.8	2	1.8	1.4	2	2.2	2.8	1.8	2

RP23304	FLUID MECHANICS AND POLYMER RHEOLOGY	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

- To understand about the basic properties of fluids, behavior and its measurements

UNIT I FLUID FLOW PHENOMENA **9**

Fluid as a continuum, Terminologies of fluid flow, velocity – local, average, maximum, flow rate – mass, volumetric, velocity field; flow visualization – streamline, path line- laminar and turbulent flows of Newtonian fluids - power law – general treatment of isothermal viscous flow in tubes – Reynolds number-Prandlt number-its significance

UNIT II FLOW MEASUREMENT **9**

Bernoulli's equation–kinetic energy correction factor; head loss; friction factor; major and Minor losses-Flow Meters - general equation for internal flow meters; Orifice meter; Venturimeter; concept of area meters: rotameter; Local velocity measurement: Pitot tube

UNIT III RHEOLOGY **9**

classification of fluids, Newtonian and non Newtonian fluids, shear stress, shear strain and shear rate, shear modulus, bulk modulus, Factors influencing polymer rheology - Zero shear viscosity, Dependence of viscosity with temp, shear stress, shear rate fluid through channel- Viscoelasticity - effect of rate of strain, temperature and time on mechanical behaviour of polymeric materials,

UNIT IV RHEOLOGY OF HETEROGENEOUS SYSTEMS **9**

Suspensions, Emulsions, adhesives, paints and coatings- plastisols and organosols, 3D printing inks and resins

UNIT V MEASUREMENT OF RHEOLOGICAL PROPERTIES **9**

Viscosity and normal stress difference of polymer melts - die- swell and melt fracture - Weissenberg effect - Elongational viscosity, Applications of rheology to polymer processing: Moulding and Shaping operations, Electrospinning and 3 D printing - Capillary rheometers, Cone and plate viscometer, torque rheometers, Mooney viscometer

TOTAL PERIODS = 45

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Appreciate the basic understanding of fluids flow behavior
CO2: Acquire knowledge on flow measurements
CO3: Demonstrate the basic concepts on polymer rheology
CO4: Apply knowledge on rheology of heterogeneous systems
CO5: Relate rheology to polymer processing

TEXT BOOKS

1. Brydson J.A., "Flow properties of polymer melts", Life books, London, 1978.
2. Crawford R.J., "Plastics Engineering", Butterworth - Heinemann, Oxford, 1998
3. R.K. Bansal, "Fluid mechanics and Hydraulic machines", Laxmi Publications (P) Ltd, New Delhi, Ninth Edition 2010 .

REFERENCES

1. Natalie Rudolph and Tim Osswald, “Polymer Rheology: Fundamentals and Applications”, Hanser Publications, 2015
2. Fridtjov Irgens, “Rheology and Non-Newtonian Fluids”, Springer International Publishing, 2013
3. Richard C. Progelhof and James L. Throne, “Polymer Engineering Principles”, Hanser Publishers, New York, 1993.
4. John M. Dealy and Kurt F. Wissburn, “Melt Rheology and its Role in Plastics Processing,” Chapman, London, 1995.
5. Lenk R.S., “Polymer Rheology,” Applied Science, London, 1978.
6. Ferry, J.D.”Viscoelastic Properties of Polymers,” John Wiley & Sons, New York, 1986.
7. Chang Dae Han. “Rheology in Polymer Processing,” Academic Press, New York, 1976

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	2		1				2	3	2	3	2
CO2	3	2	2	2	3						2	3	2	3	3
CO3	3	1										3	3	2	3
CO4		3	3	3	3	2						3	3	3	3
CO5	3	3	3	3	3	2	2				2	3	2	3	3
Overall CO	**3**	**2.4**	**2.5**	**2.5**	**2.75**	**2**	**1.5**				**2**	**3**	**2.4**	**2.8**	**2.8**

RP23305	CAD MODELLING LABORATORY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To impart knowledge to prepare drawings for various mechanical components using any commercially available 2D & 3D modeling softwares

CAD Introduction
Sketcher
Solid modeling – Extrude, Revolve, Sweep and Variational sweep, Loft
Surface modeling –Extrude, Sweep, Trim and Mesh of curves, Free form.
Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.
Assembly – Constraints, Exploded Views, Interference check
Drafting – Layouts, Standard & Sectional Views, Detailing & Plotting

PRODUCTION DRAFTING

Detailed part drawing and assembly drawings (with suitable tolerances, machine symbols, specification of fit).

1. Screw jack
2. Connecting rod Assembly
3. Plummer block
4. Machine vice
5. Stop valve
6. Universal coupling and knuckle joint
7. Hydraulic & Pneumatic Assembly
8. Injection moulding toggle type clamping
9. Polymerization Plant Layout-I
10. Polymerization Plant Layout-II

TOTAL : 30 PERIODS

COURSE OUTCOMES

Students will be able to:

CO1: Describe and identify the parts, to choose the functions and operations of a CAD system and draw up specifications.
CO2: Know the different techniques of graphical representation for simple parts and assemblies
CO3: Apply the current technical drawing rules.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	3	1	-	1	1	1	2	1	3	1	-
CO2	3	3	2	3	3	1	-	1	-	1	1	1	3	1	-
CO3	2	2	3	3	2	-	-	1	1	-	1	1	2	1	-
Overall CO	3	3	3	3	3	1	-	1	1	1	1	1	3	1	-

SEMESTER –IV

RP23401	PLASTICS MATERIALS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To impart knowledge on commodity plastics and its applications

UNIT I INTRODUCTION TO PLASTICS 9+6

Plastics - Classification - Structure - Property relationship (effect on thermal, mechanical,optical, chemical, Barrier & electrical properties)

UNIT II OLEFINIC PLASTICS 9+6

Manufacturing methods - structure / property relationships, processing & applications of PE, PP & Copolymers of PE & PP

Practicals - Identification of olefinic plastics

UNIT 3 STYRENICS & ACRYLICS 9+6

Styrenics: Manufacturing methods – Structure - property relationship, processing &applications of PS, SAN, ABS, HIPS & EPS.

Acrylics: Manufacturing Methods – Structure - property relationship processing &applications of PAN, PMMA & their copolymers

Practicals - Identification of styrenic and acrylic plastics

UNIT 4 PVC RESINS 9+6

Manufacturing, Structure - property relationship, additives for PVC - Processing, applications of pPVC, uPVC, PVC pastes, co polymers of PVC, blends & alloys of PVC, Testing of PVC resin, PVC compounds & Products

Practicals - Identification of vinyl plastics, Determination of K Value of PVC, Sieve analysis for particle size classification (PVC resin)

UNIT 5 ADDITIVES FOR PLASTICS 9+6

Fillers – Antioxidants – Stabilizers – Lubricants- Plasticizers – Toughening Agents – Colourants - Fire Retardants - Coupling Agents - Blowing Agents – UV Stabilizers – Anti Static Agents – Anti blocking Agents – Slip and Anti slip agents – processing aids – mould releasing agents– miscellaneous additives – environmental regulations

Practicals - Determination of ash content in plastics materials and products, DOP absorption for PVC resin, Determination of moisture content of plastic granules, Case study - Life cycle analysis of plastics products

Total Periods = 45+30

COURSE OUTCOMES:

Students will be able to

CO1: Understand the influence of chemical structure on various properties of plastics
CO2: Apply the knowledge of olefinic plastics in commodity products
CO3: Demonstrate the role of styrenics and acrylics in various applications
CO4: Select an appropriate PVC polymer for the required application
CO5: Know the significance of additives for plastics and its environmental implications

REFERENCES

1. Brydson.J.A., Plastics Materials, 7th edition, Elsevier Publication, 1999

2. Athalye & Prakash Trivedi, PVC Tech, Multitech Publishing Co, Bombay,1994.
3. Geoffrey Pritchard, "Plastics Additives", Rapra Technology Ltd, UK, 2005.
4. Kolapo Adewale, Olagoke Olabisi "Hand Book of Thermoplastics", 2nd edition, CRC press, 2016
5. Irvin.I. Rubin, "Hand Book of Plastic Materials and Technology", Wiley Interscience, NY,1990
6.Identification of plastics and rubbers by simple methods, CIPET publications 2002
7.Ashraf S.M, Sharif Ahamed, UfanaRiaz, " A Laboratory Manual of Polymers", I.K International Publishing House Pvt Ltd, 2009

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	2	1	2	2	2	1	2	2	2	3	2	2
CO2	3	3	3	2	1	2	1	1	1	2	2	2	3	2	2
CO3	3	2	1	2		1	2	2	2	1	3	3	3	1	2
CO4	2	2	3	1	1	2	2	2	1	1	2	2	2	2	2
CO5	3	3	3	3	3		2	2	3	2		3	2	3	2
Overall CO	2.8	2.4	2.2	2	1.2	1.4	1.8	1.8	1.6	1.6	1.8	2.4	2.6	2	2

RP23402	RUBBER MATERIALS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the concept of flexible polymer chains, physical and chemical properties and manufacture of rubber

UNIT I INTRODUCTION 9+12

Rubber Elasticity – Requirements for rubber elasticity- flexible chain and Tg - Effect of chemical structure on the properties of rubbers - Natural Rubber Latex, tapping, processing, properties and applications – Conversion of Latex into dry rubber – Properties of dry rubber – Classification based on technical specifications – mastication of NR

Practicals-Determine the TSC,DRC and Total alkalinity of latex, Determine the KOH number of given Latex , Determine the VFA of Latex

UNIT II DIENE RUBBERS 9+15

Modifications of Natural Rubber - Applications - Epoxidised natural rubber – Synthetic polyisoprene - SBR-solution SBR-recent advances in solution SBR – BR-Polyalkenamers and polynorbornene-Nitrile Rubber NBR-PVC blends, Butyl Rubber, halobutyl rubber, Polychloroprene Rubbers

Practicals- Identification of Rubber materials and their products (NR, PBR, NBR, SBR, CR, IIR), Determination the melting point of Accelerators, Determine the Oil absorption number of carbon black, Determine the Iodine Adsorption number of carbon black, Determine the moisture and volatile content of rubber products, Determine the Acetone extraction.

UNIT III SPECIAL PURPOSE ELASTOMERS 9

Ethylene Propylene Rubber and Ethylene – Vinyl acetate copolymers – Elastomers based on modified polyethylene – Acrylate rubbers Polysulphide rubbers- polyether rubbers – selection criteria for the special purpose rubbers for various applications

UNIT IV HIGH PERFORMANCE ELASTOMERS 9+3

HNBR- Fluoro elastomers-VDF based fluoro rubbers-perfluoro rubbers- base resistant rubbers- silicone elastomers- Preparation, structure, properties and applications – liquid silicone rubbers – silicones in medical applications

Practicals- Identification of Rubber materials and their products(Silicone rubber)

UNIT V POLYURETHANES AND THERMOPLASTIC ELASTOMERS 9

Poly urethanes- diisocyanates, polyols and chain extenders – castable PUs-millable PUs Requirements for thermoplastic elastomeric behaviour – SBS and SIS Block copolymers – Thermoplastic Polyurethane elastomers – Thermoplastic-co-polyesters – Thermoplastic elastomers based on Plastic – Rubber Blends – Dynamic Vulcanization

TOTAL PERIODS = 45+30

COURSE OUTCOMES:

Students will be able to

CO1: Differentiate between rubbers, plastics and fibres in terms of Tg
CO2: Relate chemical structure to performance and processing properties of rubbers
CO3: Get knowledge about preparation, properties and uses of various rubbers

CO4: Understand the importance of TPEs, their preparation and properties and uses
CO5: Suggest rubbers for specific end uses.

TEXT BOOK:

1. Kothandaraman B, Rubber Materials, Ane Books, New Delhi, 2007

REFERENCES:

1. Brydson, J.A., Rubber Chemistry, Allied science Publishers, London, 1978.

2. Morton.M., Rubber Technology, Chapman Hall, 1995.

3. Franta, Elastomers and Rubber Compounding materials, Elsevier, 1989.

4. Klingender R.C, Handbook of speciality elastomers, CRC Press, 2008

5. Practicals in Polymer science-Siddramaiah-CBS Publishers and Distributors.2007

6. ASTM Standards, Vol. 8 & 9, ASTM International, 2004.

7.Ashraf S.M, Sharif Ahamed, UfanaRiaz, " A Laboratory Manual of Polymers", I.K International Publishing House Pvt Ltd, 2009

8.Stanley R. Sandler, Wolf Karo, JoAnne Bonesteel, Eli M. Pearce," Polymer Synthesis and Characterization: A Laboratory Manual," Academic Press, 1998

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	1	1	1	1	1	2	3	3	2	1
CO2	3	2	2	1				2	1	1	2	2	3	2	1
CO3	3	2	2	1	1			1	1	1	2	2	3	1	2
CO4	3	2	2	2	2	2	1	1	2	2	2	3	3	2	2
CO5	3	2	2	2	3	3	2	2	2	1	1	1	3	3	2
Overall CO	**3**	**2.2**	**2**	**1.4**	**1.6**	**1.2**	**0.8**	**1.4**	**1.4**	**1.2**	**1.8**	**2.2**	**3**	**2**	**1.6**

RP23403	POLYMER COMPOSITES TECHNOLOGY	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

part knowledge on constituents of polymer composite materials

UNIT I INTRODUCTION **8+2**

Historical Development- Concept of Composite- Basic Definitions and Classifications of Composites - MMC, CMC and PMC- Advantages and Limitations of Composites Materials – Applications of composites Materials - Aircraft and Military Applications, Space Applications, Automotive Applications, Sporting Goods Applications, Marine Applications, Infrastructure

Practicals- Determination of fiber volume fraction of composite laminate, Determination of Density of laminates

UNIT II MATRIX MATERIALS **10+5**

PF, UF and MF Resins – Preparation properties and uses – Moulding powders – Additives Epoxy- Preparation properties and uses Unsaturated Polyester, Vinyl Ester - Cyanate Ester, Furan resins, Polyimides and BMI's - preparation, properties and applications, phthalonitrile resins, Benzoxazine resin - Preparation properties and applications -Thermoplastic Matrices

Practicals- Calculation of gel time, Preparation of prepregs for Polymer Matrix Composites,

UNIT III REINFORCEMENT MATERIALS **9+6**

Reinforcements-Classification-Role and Selection of fibers - Glass fibre -classification, Manufacture and properties, Carbon fibre -classification, Manufacture and properties, Aromatic polyamides ,PE fibres, Boron Fibres, Whiskers, Natural Fibres, Nano fibres

Practicals- Preparation of treated natural fiber Polymer composites, Preparation of discontinuous Fiber-reinforced Polymer Composites

UNIT IV ADDITIVES FOR COMPOSITES **8+5**

Cross linkers, Coupling agents, Sizing agents, diluents, Fillers - particulate, Nano fillers - carbons based, silica based, cellulose based, self-reinforcing composites

Practicals- Preparation of nanofillers reinforced Polymer Composites

UNIT V FABRICATION **10+12**

Hand Layup and Spray up Techniques - Resin Transfer Molding – Reaction Injection Molding -Vacuum Infusion – SMC & BMC - Pressure Injection - Compression Molding- Composite Tooling - Automated tape laying technique &fiber placement - Filament winding – Pultrusion - Thermoplastic Composite manufacturing - Processing of carbon-carbon composites. Post processing - Secondary Adhesive bonding - Joining of Thermoplastic Composites - Composite Repairing - Hole drilling - Environmental protection and sealing - Composite repairing.

Practicals- Fabrication of Polymer Composites using Hand layup Techniques, Fabrication of Polymer Composites using spray up Techniques, Fabrication of Polymer Composites - Compression Molding, Fabrication of Polymer Composites - Vacuum bag Molding

Total Periods = 45+30

COURSE OUTCOMES:

Students will be able to

CO1: Acquire fundamental knowledge on composites, its classification and applications

CO2: Select matrix materials for various applications

CO3: Acquire sound knowledge on fibrous reinforcements

CO4: Select appropriate additives for composite manufacture

CO5: Choose suitable techniques for the manufacture of composites

TEXT BOOKS

1. Mallick P.K., “Fiber reinforced Composites” 3rd edition, Taylor and Francis.2008.

REFERENCES

1. Weatherhead, R., "FRP Technology", Fibre Reinforced Resin Systems, Applied Science Publishers Ltd., London, 1990.
2. Krishan Kumar Chawla, "Fibrous Materials", 2nd edition, Cambridge University Press, 2016
3. Michel Biron, " Thermosets and Composites: Technical Information for Plastics Users, Elsevier Advanced Technology, UK, 2004
4. Ken L. Forsdyke and Trevor F. Starr, "Thermoset Resins "Rapra Technology Limited, Shawbury, Shrewsbury, Shropshire, SY4 4NR, UK, 2002.
5. Debdatta Ratna,"Handbook ofThermoset Resins",iSmithers – A Smithers Group Company , Shawbury, United Kingdom, 2009

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	1	2	1	1	1	2	2	3	2	3
CO2	3	3	3	3	2	1	2	1	1	1	2	2	3	2	3
CO3	3	3	3	3	2	1	2	1	1	1	2	2	3	2	3
CO4	3	3	3	3	2	1	2	1	1	1	2	2	3	2	3
CO5	3	3	3	3	2	1	2	1	1	1	2	2	3	2	3
Overall CO	3	3	3	3	2	1	2	1	1	1	2	2	3	2	3

RP23404	**PHYSICAL PROPERTIES OF POLYMERS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

in knowledge on physical behaviour of polymers and its applications

UNIT I AMORPHOUS AND SEMICRYSTALLINE STATES IN POLYMERS 9

Glassy and rubbery states - Segmental mobility and chain flexibility-glass transition Temperature and its significance - Factors affecting transitions in polymers – Crystallization in polymers-Semicrystalline state - Crystallization from polymer solutions and melts-Crystal nucleation and growth - Degree of crystallinity-Effect of crystallization on polymer properties -Relation between Tg and Tm in semicrystalline polymers – Flow behaviour of polymer melts

UNIT II DEFORMATION AND FAILURE PROPERTIES OF POLYMERS 9

Comparative analysis of polymers with conventional materials - Mechanical properties of Polymers-Flexural strength - Impact strength - Fatigue endurance - Ductile and Brittle failure -Ductile-Brittle transitions - crazing and cracks and their role in fracture in polymers - Creep and Stress relaxation - Boltzmann Superposition principle - Effect of temperature on properties of polymers - viscoelastic properties - Time-Temperature superposition

UNIT III FRICTION AND WEAR IN POLYMERS 9

Introduction to Tribology-Static and Dynamic Coefficients of friction – Factors affecting friction-Friction and wear in Glassy and amorphous polymers – single contacts – multiple contacts – Rolling friction – sliding friction of rubbers and rigid polymers – Solid lubricants – Polymer composites in Friction related applications – Polymers in hip and knee joints - wear - adhesive wear – Cohesive wear –Wear factor - Wear Testing

UNIT IV ELECTRICAL AND OPTICAL PROPERTIES OF POLYMERS 9

Dielectric properties of polymers-Factors affecting dielectric properties-Quantitative relationships-Dielectric relaxations and molecular dynamics in polymers - Dielectric breakdown- Antistatic and conducting polymers - Properties and applications of polyelectrolytes - Piezoelectric properties of polymers - Optical properties of polymers - Reflection - Refraction - Light scattering - Light transfer and Absorption - Birefringence and orientation in polymers - Photoelastic stress analysis

UNIT V BARRIER AND SPECIALITY PROPERTIES OF POLYMERS 9

Barrier properties: Sorption, Diffusion and Permeation - Durability: Thermal stability and photo degradation in Polymers - Flammability Characteristics - magneto-rheological behaviour in polymer systems - properties and applications of hydrogels – Smart polymer systems - Ablative plastics and their applications

TOTAL PERIODS = 45

COURSE OUTCOMES:

Students will be able to

CO1: Classify polymers based on their amorphous and crystalline states
CO2: To demonstrate viscoelastic characteristics of polymers
CO3: Analyze performance of polymers in friction related applications
CO4: Select a material for electrical and optical properties
CO5: Understand durability of polymers and emerging applications

REFERENCES

1. Ulrich Eisele, Introduction to Polymer Physics, Springer – Verlag, New York, 1990.
2. Bill Meyer.F.W. Text Book of Polymer Science, Wiley Interscience Publications, 1994.

3. L.H.Sperling, Introduction to Physical Polymer Science, 4th edition, Wiley Interscience, 2006
4. Gert Strobl, The Physics of Polymers, Springer – Verlag 2010
5. Marianne Gilbert, "Brydson's, Plastics Materials", 8th edition, Elsevier Science 2016.
6. Manas Chanda and Salil K Roy, Industrial polymers, Speciality Polymers and their Applications, CRC Press, Taylor & Francis group, 2009

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	3	1	-	1	-	-	1	2	2	3	2	2
CO2	3	3	3	3	2	-	2	-	2	1	2	2	3	3	2
CO3	3	3	3	3	3	-	3	-	2	1	3	3	3	2	2
CO4	3	3	3	3	2	-	1	-	2	1	3	2	3	2	1
CO5	3	3	3	2	2	-	3	-	3	1	1	2	3	2	2
Overall CO	**3**	**3**	**3**	**3**	**2**	**-**	**2**	**-**	**2**	**1**	**2**	**2**	**3**	**2**	**2**

RP23405	DESIGN OF MACHINE ELEMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the various stresses induced in machine elements and their design in polymer processing machineries.

UNIT I OVERVIEW OF DESIGN AND POLYMER PROCESSING MACHINE ELEMENTS 12

Fundamentals of Engineering Design–Machine components Design, Phases of Design, Design Considerations–Standards and Codes - Selection of Materials – Overview of Polymer processing machines -Various common Elements- Design against Static and Dynamic Load -Factor of Safety- Principal Stresses-Failure modes- Stress Concentration- Stress Concentration Factors-Notch Sensitivity- Variable Stress- Fatigue Failure- Endurance Limit- Design for Finite and Infinite Life- Soderberg and Goodman Criteria.

UNIT II DESIGN OF DETACHABLE AND PERMANENT JOINTS 9

Design of Bolts under Static Load, Design of Bolt with Tightening/Initial Stress, Design of Bolts subjected to Fatigue – Keys -Types, Selection of Square and Flat Keys-Design of Riveted Joints and Welded Joints- Case study related to polymer processing machine.

UNIT III DESIGN OF SHAFTS AND COUPLING 9

Design of Shaft –For Static and Varying Loads, For Strength and Rigidity-Design of Coupling- Misalignments-Types- Flange, Muff and Flexible Rubber Bushed Coupling- Case study of Two Roll Mill roller shaft and Extruder screw shaft subjected to various loads.

UNIT IV DESIGN OF SPRINGS AND BEARINGS 7

Design of Helical Spring-Types, Materials, Static and Variable Loads-Design of Leaf Spring- Design of Journal Bearing -Antifriction Bearing-Types-Life of Bearing, Reliability Consideration, Selection of Ball and Roller Bearings. Case studies related to polymer processing machines.

UNIT V GEAR DESIGN 8

Types of gears - Terminology of gears- Design considerations – strength of gear teeth – Lewis equation —Dynamic tooth load – Design of spur gears – helical gears – herringbone gears – bevel gears and worm gears. Case studies related to polymer processing machines.

Total Periods = 45

COURSE OUTCOMES

CO1: Demonstrate the Engineering Design and various stress induced in various polymer processing machine elements.

CO2: Familiarize with design practice of detachable and permanent joints used in Polymer processing machines.

CO3: Analyze the design process of shaft and coupling used in polymer processing machines.

CO4: Gain the knowledge of design of springs and bearings in polymer processing machines.

CO5: Realize with the design of gear drives in power transmission of Polymer processing machineries.

TEXT BOOKS:

1. Joseph Edward Shigley, Charles R. Mischke " Mechanical Engineering Design", McGraw Hill, International Edition, 1992.

REFERENCES

1. V.B.Bhandari, "Design of Machine Elements", Tata McGraw-Hill Publishing Company Limited, 2003.

2. C.S.Sharma and Kamlesh Purohit, “Design of Machine Elements”, Prentice Hall of India Private Limited, 2003.
3. Robert L.Norton, “Machin Design – An Integrated Approach”, Prentice Hall International Edition, 2000.
4. White.J.L., Rubber Processing Technology Materials, Principles, Hanser Publication, New York, 1995

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	3	2	1	2	2	2	2	2	3	3	2
CO2	2	2	3	3	2	3	1	1	1	1	2	2	2	3	3
CO3	3	3	3	3	3	1	1	1	2	1	2	2	3	3	1
CO4	3	3	3	2	2	2	2	2	1	1	2	2	3	2	2
CO5	3	3	3	2	2	1	1	1	1	1	2	2	3	3	1
Overall CO	2.8	2.8	3	2.4	2.4	1.8	1.2	1.4	1.4	1.2	2	2	2.8	2.8	1.8

RP23U01 STANDARDS - RUBBER AND PLASTICS TECHNOLOGY L T P C
1 0 0 1

MODULE I – OVERVIEW OF STANDARDS 6

Basic concepts of standardization; Purpose of Standardization, marking and certification of articles and processes; Importance of standards to industry, policy makers, trade, sustainability and innovation. Objectives, roles and functions of BIS, Bureau of Indian Standards Act, ISO/IEC Directives; WTO Good Practices for Standardization. Important Indian and International Standards.

MODULE II- STANDARDS FOR RUBBER AND PLASTICS PRODUTCS 9

Standards for testing pipe, bottle, Film, cable and wire, Foam and fiber testing, Engine mount, gaskets, seals, o rings, bridge bearings, metal to rubber bonding,

UC23U01 **UNIVERSAL HUMAN VALUES** **L T P C**
1 0 2 2

COURSE OBJECTIVE:

The objective of the course is four-fold:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Module I: Introduction **(3L,6P)**

Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self-Exploration– Its content and process; 'Natural acceptance' and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practical Session: *Include sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking*

Module II: Harmony in the Human Being **(3L,6P)**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - happiness and physical facility, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health.

Practical Session: *Include sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.*

Module III: Harmony in the Family and Society **(3L,6P)**

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in

society- Undivided Society, Universal Order- from family to world family.

Practical Session*: Include sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives*

Module IV: Harmony in the Nature and Existence (3L,6P)

Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all- pervasive space, Holistic perception of harmony at all levels of existence.

Practical Session: *Include sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.*

Module V: Implications of Harmony on Professional Ethics (3L,6P)

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations, Sum up.

Practical Session: *Include Exercises and Case Studies will be taken up in Sessions E.g. To discuss the conduct as an engineer or scientist etc.*

TOTAL: 45 (15 Lectures + 30 Practicals) PERIODS

COURSE OUTCOME:

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

1. Become more aware of themselves, and their surroundings (family, society, nature);
2. Have more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. Have better critical ability.
4. Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

REFERENCES:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 3rd revised edition, 2023.
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews.
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj - PanditSunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

Web URLs:

1. Class preparations: https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php
2. Lecture presentations: https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php
3. Practice and Tutorial Sessions: https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						1	1	1	3			3
CO2						1	1	1	3			3
CO3						3	3	2	3		1	3
CO4						3	3	2	3		1	3
CO5						3	3	3	3		2	3

SEMESTER –V

RP23501	RUBBER PROCESSING	L	T	P	C
		2	0	4	4

OBJECTIVES

- The course aims to impart the knowledge on various rubber processing machinery construction, operations and rubber product manufacturing process

UNIT I COMPOUNDING AND MIXING OPERATIONS 6+36

Rubber mixing mechanism, mixing machinery - Open mill mixing – Internal mixers – - rotors design and orientations -Comparison Tangential and Intermesh Mixing Technologies- Continuous mixers – Energy Mixing - Factors affecting mixing – Flow behavior of rubber compound, processibility test, common problems in mixing.

t trend in Mixing technologies -Advanced tangential and intermesh type mixing -Tandem Mixing technologies -Silica compound mixing ,Controls on Silanisation, Effect of silanisation on compound properties

Advanced bulk material handling technologies [Powder and liquid]

Practicals-Mastication of NR on two roll mill, Preparation of carbon black filled NR compound, Preparation of carbon black filled SBR & NR blend in Banbury mixer, Preparation of carbon black filled EPDM compound, Preparation of carbon black filled NBR compound, Preparation of silica filled NR/PBR Blend in Banbury mixer, Preparation of carbon black filled IIR compound, Preparation of fumed silica filled silicone compound

UNIT II EXTRUSION 6+12

Extrusion- construction and operations - Screw type – L/D ratio and its influence – Hot and cold feed extruders – Pin barrel extruder – Twin screw extruder – Analysis of rubber flow in extruder screws and dies – Die entry effects – Die exit instabilities - co-extrusion systems -Multiple compound co-extrusion Duplex,Triplex, Quadrplex, Pentaplex(Quintuplex) technologies to meet the latest demands of the product requirements – Temperature Control Units for different zones and different type of compounds -Factors affecting the extrusion process, Die swell and die design concepts for different type of compounds-Understanding of Shrinkage concepts in extrusion line-Extrudate profile(gauge, dimension), Weight measurement techniques and controls-Common problems in extrusions.

Practicals - Extrusion characteristics of a filled rubber mix- NR, SBR, NBR & EPDM compounds

UNIT III CALENDERING 6

Calendering Fabric, Steel,Gum – construction and operations - Roll configurations – Feed systems -Flow patterns in calender banks – Analysis of rubber flow in calender gaps – Calendering operations - Sheeting – Coating – Frictioning – Topping –– Gauge control – Temperature control system –Cooling Systems-Factors affecting the calendaring process,

Roll crown , Roll bending, Roll Cross axis purpose and methods-Concepts of Tension control in various zones of caledering line-Typical Fabric Calendering Line components-Splice press,Festoons,Flexiblizer,Hot cans,Spreading unit,-Typical Steel Calendering Line components -Creel room,Organiser roll,Impression/Groove roll,Festoons-common problems in calendaring process.

UNIT 4 VULCANIZATION TECHNIQUES 6+12

Compression, transfer and injection molding process – Blanks & pre-heating techniques, preparation of surfaces for bonding, common problems in molding. Vulcanization –Batch vulcanization- Autoclaves, Hot

air chambers - curing of hand built up products - Continuous vulcanization - L.C.M. (Liquid Curing Media), Microwave curing, Rotocure, Hot air oven, common problems in curing.

Practicals- Curing Process of Rubber Compound- NR, SBR, NBR, EPDM, IIR & Silicone,, Molding and preparation of H-Pull test specimen, Molding of any two rubber products.

UNIT 5 FINISHING OF RUBBER COMPONENTS 6

Equipment's for flash and spew removal – Cryogenic techniques – Hand trimming – roller trim, buffing, tumbling, punching, grinding, shot blasting, painting, lacquering –- Plant layout design, Plant services, Power transmission, Hydraulics, Heating and cooling systems - automation, Safety systems - Guards, Trip devices, Photoelectric and pressure sensitive devices – Maintenance of guards - man power requirements, Storage and Flow pattern of materials, Energy conservation- Case study.

Total Periods = 30+60

OUTCOME

After completion of this course, the students shall be

CO1: Acquire knowledge on various rubber processing machinery and its operation

CO2: Familiarize with various rubber product forming/shaping process

CO3: Analyze the importance of vulcanization techniques and its parameters

CO4: Acquire knowledge on the flow behavior of rubber in forming and molding process

CO5: Design a plant layout and familiarize with plant services for rubber Product manufacturing

TEXT BOOKS:

1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 201.
3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.
4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.

REFERENCES:

1. Blow.C.M. and Hepburn.C. Rubber Technology and manufacture, Butterworths, 1982.
2. Evans.C.W., Practical Rubber Compounding and processing, Applied Science Publishers, London, 1981.
3. Whelan.A., Injection Moulding Machines, Elsevier, 1989.
4. Stevens.M.J., Extruder Principles and Operations, 2nd edition, Elsevier Applied Science, New York, 1995.
5. White.J.L., Rubber Processing Technology Materials, Principles, Hanser Publication, New York, 1995.
6. Richard F.Grossman,The Mixing of Rubber, Chapman & Hall,1997.
7. Kleemann, Weber, Elastomer Processing, Hansar, 2005.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	1	3	2	2	1	1	2	3	1	2
CO2	2	1	1	1	2	2	2	2	2	1	3	2	3	1	2
CO3	3	2	2	2	2	2	2	2	2	1	2	1	3	2	2
CO4	3	3	3	2	2	2	2	2	1	1	2	2	3	2	2
CO5	1	2	2	2	2	1	2	1	1	1	1	1	1	2	2
Overall CO	2.2	1.8	1.8	1.6	2.0	1.6	2.2	1.8	1.6	1.0	1.8	1.6	2.6	1.6	2.0

RP23502	PLASTICS PROCESSING	L	T	P	C
		2	0	4	4

COURSE OBJECTIVES:

- To enable the students to learn about the various plastics primary and secondary processing techniques, machinery and their key features

UNIT I PLASTICS MASTERBATCHING AND COMPOUNDING 5+6

Basic principles of plastics compounding and masterbatching, Rheology of filled polymer systems - role of additives in plastics processing and product performance

Practicals- Master batch Compounding and Mixing of plastics and their characteristics.

UNIT II INJECTION MOULDING PROCESS 6+20

Principle of injection moulding -Injection screw nomenclature-Technical specifications selection criteria for types of materials and machineries–components of Injection unit- components of clamping unit- Types of clamping systems -Ejection System- Types of nozzles-cavity pressure profile- Common moulding defects, causes and remedies.

Practicals- Semi-Automatic Injection Molding-Plunger Type, Fully Automatic Injection molding technique, Mold study and its maintenance, Scrap grinding for recycling of plastics

UNIT III EXTRUSION AND BLOW MOULDING PROCESS 7+16

Fundamentals of Extrusion Techniques-parts of extruder- flow analysis in Extrusion–film, pipe, sheet, wire and profile extrusions-Twin screw extrusion process-Processing condition-downstream equipments-Trouble shooting of extrusion process - Blow moulding techniques- Types of blow moulding -materials-parison programming-applications- Trouble shooting of blow moulding process - RotationalMoulding-Introduction-principles-process-machineryused-moldprocessparameters –merits and demerits.

Practicals-Extrusion of plastics - Single screw and Twin screw extruder, Single screw - Blown film extrusion process, Fully Automatic blow molding process, Scrap grinding for recycling of plastics

UNIT IV THERMOSET MATERIAL PROCESSING 6+6

Thermoset materials-properties–flow characteristics-Compression moulding process –Types of compression mould- compression moulding cycle, process variables and their effect on product quality-Transfer moulding process- Introduction-principles-Pot type, Plunger type, screw transfer moulding. -causes and remedies of thermoset material processing

Practicals- Compression molding

UNIT V SECONDARY PROCESSING TECHNIQUES 6+12

Thermoforming- types of thermoforming process- process variables – applications –merits and demerits-Calendering- calender roll arrangements- calendering process-process variables applications-merits and demerits -Adhesive bonding –machining –welding of plastics.

Practicals- Thermoforming process, Calendering process, Sample preparation to determine adhesive bond strength

Total Periods = 30+60

COURSE OUTCOMES:

On completion of the course, the students will be able to:

Students will be able to

CO1: Explain the significance of the Rheology in polymer processing

CO2: Acquaint of various parameters to operate injection molding machine.

CO3: Demonstrate the function of Die design during making the products from Extrusion ,blow and rotational moulding process

CO4: Acquired knowledge about flow of thermoset materials and their processing techniques

CO5: Aware of thermoforming, finishing, machining and welding of plastics

TEXT BOOKS:

1. Irwin Miller and Marylees Miller "John E. Freund's Mathematical Statistics with applications", Pearson India Education, Asia, 8th Edition, 2014.
2. Devore, J.L. "Probability and Statistics for Engineering and the Sciences", Cengage Learning, 8th Edition, 2011.

REFERENCES:

1. Milton, J.S. and Arnold, J.C. "Introduction to Probability and Statistics", Tata McGraw Hill, New Delhi, 4th Edition, 3rd Reprint, 2008.
2. Ross, S.M. "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier, New Delhi, 5th Edition, 2014.
3. Spiegel, M.R., Schiller, J., Srinivasan, R.A. and Goswami, D. "Schaum's Outline of Theory and Problems for Probability and Statistics", McGraw Hill Education, 3rd Edition, Reprint, 2017.
4. Walpole, R.E., Myers R.H., Myres S.L., and Ye, K. "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2011.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	2	3	3	3	3	3	2	3	2	2	1	1	2	2	3
CO2	3	3	3	2	2	3	2	3	1	3	1	2	3	3	1
CO3	2	3	3	2	2	2	2	2	1	3	1	2	3	3	1
CO4	2	3	3	3	3	3	2	3		2	1	1	2	2	3
CO5	2	2	2	3	3	2	1	1	1	2	1	1	3	2	3
Overall CO	2.2	2.8	2.8	2.6	2.6	2.6	1.8	2.4	1	2.4	1	1.4	2.6	2.4	2.2

RP23503	POLYMER CHARACTERIZATION TECHNIQUES	L	T	P	C
		3	0	2	4

OBJECTIVES

To impart knowledge on various characterization techniques for polymers

UNIT – I CHEMICAL METHODS **6+6**

Identification of Olefins, Dienes and other vinyl Polymers by Chemical Methods – preliminary examination – Polymer identification through functional group reactions- Analysis of Decomposition products using GC-Pyrolysis, Gas Chromatography- Analysis of antioxidant, process oil and additives in Polymer Compounds

Practicals- Analysis of polymer compound by chemical methods, Analysis of additives used for polymers by chemical methods

UNIT – II SPECTROSCOPIC CHARACTERIZATION OF POLYMERS **10+6**

FTIR and Raman Spectroscopy –Principles - Characterization of Specific functional groups - Group frequencies and Finger Print Regions– Applications in Polymer Blends and alloys - UV – Visible Spectroscopy - Spectrophotometer – Analysis of Cu, Mn, Fe in NR – NMR, XRF, XPS and their applications in Polymer Characterization, ICP- OES

Practicals- Estimation of iron in rubber latex/rubber using UV visible spectroscopy, Characterization of polymers using FTIR

UNIT – III MOLECULAR WEIGHT STUDIES **9+6**

Molecular weight determination - Osmometry, Light scattering, End group analysis, Ultracentrifugation, GPC, HPLC– Separation of Biological macromolecules, Mass Spectroscopy fundamentals- MALDI techniques for polymers

Practicals- Molecular weight determination by end group analysis, Molecular weight and distribution by GPC

UNIT – IV THERMAL ANALYSIS **12+6**

Thermal analysis – Instrumentation – Polymer Identification using Thermal Analysis - Compositional analysis – volatile matter, Rubber, Polymer blends, C-black & ash – estimation – Glass transition – Heat capacity – Thermal history of polymers – Degradation – State of cure studies-Characterization of Mechanical & Dielectric Relaxations in Polymers – Cyclic voltammeter

Practicals- Compositional analysis/Thermal stability of polymer/polymer compound by TGA, Determining the thermal transition in polymers by DSC/DMA

UNIT – V ADVANCED CHARACTERIZATION TECHNIQUES **8+6**

Structural characterization using X-ray diffraction, Optical microscope, SEM, TEM and AFM

Practicals- Determination of % crystallinity/d-spacing of polymers by XRD, Morphological study of polymer blends/composites using SEM, Study of dispersion of fillers/nanofillers in polymer composites/compound using SEM/TEM

TOTAL: 45 + 30PERIODS

COURSE OUTCOMES

Students will be able to

CO1: Identify unknown polymers and polymer products by chemical analysis
CO2: Know the importance of spectroscopic techniques in polymer characterization
CO3: Apply the basic principles in determining molecular weight of polymers
CO4: Use thermal analysis techniques for polymer characterization and product identification
CO5: To learn the basic principles and applications of microscopic techniques

REFERENCES:

1. Hummel D.O.and Scholl F., “Atlas of Polymer and Plastics Analysis”, Vol.2, Carl Hanser Verlag, 1988
2. Craver, C.D. and Provder T., “Polymer Characterization”, ACS Advances in chemistry Series, Volume 227, 1990
3. Vishu Shaw, “Handbook of Plastics Testing and Failure Analysis”, 4th Edition, Wiley Interscience, 2021
4. T. R. Crompton, “Characterisation of Polymers”, Rapra Technology, 2008

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	2	1	2	2	2	3	3	3	3	3
CO2	3	3	3	3	2	2	1	2	3	2	3	3	3	3	3
CO3	3	3	3	3	2	2	1	2	3	2	3	3	3	3	3
CO4	3	3	3	3	2	2	1	2	2	2	3	3	3	3	3
CO5	3	3	3	3	2	2	1	2	3	2	3	3	3	3	3
Overall CO	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2.2**	**1.6**	**3**	**3**	**3**	**3**	**3**

RP23504	RUBBER COMPOUNDING	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

To understand and selection of rubber materials, additives and its compounding techniques to meet the required properties.

UNIT I PRINCIPLES OF RUBBER COMPOUNDING **9**

Technical approach to compound development ASTM D 2000 Call lines, standard practices, compounding for general and specific application, design of rubber compounds, processability, properties, performance and cost

UNIT II ADDITIVES FOR RUBBER COMPOUNDING **9**

Compounding additives, cross linkers, age resistors, reinforcers-carbon blacks and silica fillers-silica reinforcement-importance- coupling agents-principle of their working- silanisation reaction during reinforcement by silica filler- other non black fillers- process enablers, extenders, flexibilisers, thermal aging resistors, special functional additives, homongenisers - Safe handling of various rubber chemicals - environmental regulations.

UNIT III COMPOUNDING OF GENERAL PURPOSE RUBBERS **9**

Hardness specified NR, SBR, compounds for age resistance, compression set resistance, flexural fatigue, abrasion resistance, vibration mounts and isolation pads, bridge bearing, conveyor belting.

UNIT IV COMPOUNDING OF SPECIALTY RUBBERS **9**

Principles and materials for EPDM, CR, halobutyls, nitriles, silicones, fluorocarbon elastomers, chlorosulphonated polyethylenes, polyacrylates, polyurethanes, HNBR, LSR

UNIT V QUALITY CONTROL IN RUBBER COMPOUNDING **9**

Application of QC, statistics on compounding, DOE, traceability, role of specific gravity on end use, sustainability, control and disposal of off-spec compounds, matching of hardness.

Total Periods = 45

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1: Apply the concept of science in various addition, design a formulation for a specific requirement

CO2: Apply basic statistics on compounding and the properties

CO3: Select relevant rubbers for a set of requirements

CO4: Know theoretical background on the role of rubber chemistry and fine chemicals in solvent, thermal, oxidative environments

CO5: Evaluate the costing aspects of compounds- volume, specific gravity and mass balance

TEXT BOOKS:

1. The Mixing of Rubber (ed) by Richard F Grossman, Chapman & Hall, London, UK,1997,
2. "Rubber Technology - Compounding and Testing for Performance", John S Dick, Hanser Publishers, Munich, 2001.
3. Practical Rubber Compounding and Processing, Colin W Evans, Springer 1981.

REFERENCES :

1. "Bayer Handbook on Rubber Technology"
2. R.T. Vanderbilt Company, “The Vanderbilt Rubber Handbook” Volume 9,Vanderbilt,1978
3. Jim R. White, Sadhan K. De, “Rubber Technologist's Handbook”Volume 1, Rapra Technology Limited,

2001
4. Maurice Morton, “Rubber Technology”, Springer Netherlands, e-book, 2013
5. Shrikant P. Athavale, Hand Book of Rubber Formulations, Rubber Technology, Notion Press, 2018

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	2	1	1	1	1	3	3	3	1	1
CO2	3	3	3	2	2	2	1	1	1	1	3	3	3	3	1
CO3	3	3	3	2	2	2	1	1	1	1	3	3	3	1	1
CO4	3	3	3	2	2	2	1	1	1	1	3	3	3	1	3
CO5	3	3	3	2	2	2	1	1	1	1	3	3	3	3	1
Overall CO	3	3	3	2	2	2	1	1	1	1	3	3	3	1.8	1.4

RP23U02 PERSPECTIVES OF SUSTAINABLE DEVELOPMENT – POLYMER INDUSTRIES

L	T	P	C
2	0	2	3

MODULE I – INTRODUCTION **6**

Principles & Historical perspectives, Importance and need for sustainability in engineering and technology, impact and implications. United Nations Sustainability Development Goals (SDG), UN summit – Rio & outcome, Sustainability and development indicators.

MODULE II – ENVIRONMENTAL SUSTAINABILITY **6**

Climate change, Biodiversity loss, Pollution and waste management, Renewable vs. non-renewable resources, Water and energy conservation, Sustainable agriculture and forestry. National and international policies, Environmental regulations and compliance, Ecological Footprint Analysis

MODULE III – SOCIAL & ECONOMIC SUSTAINABILITY **9**

Equity and justice, Community development, Smart cities and sustainable infrastructure, Cultural heritage and sustainability, Ethical considerations in sustainable development.

Triple bottom line approach, Sustainable economic growth, Corporate social responsibility (CSR), Green marketing and sustainable product design, Circular economy and waste minimization, Green accounting and sustainability reporting.

MODULE IV – SUSTAINABLE MATERIALS **9**

Alternate to single use plastics, Green fillers and reinforcements for polymer materials, Extended Producers Responsibility for polymer products in India - Case study

MODULE V – SUSTAINABILITY PRACTICES **30**

SDG in rubber and plastics industries – Case study, Energy efficiency of rubber and plastics machineries, Safe handling of raw materials- health impacts, Carbon footprint assessment of polymer industries - Case study. LCA of rubber and plastics products - case study.

TOTAL: 60 PERIODS

REFERENCES:

1. Allen, D., & Shonnard, D. R. (2011). Sustainable engineering: Concepts, design and case studies. Prentice Hall.
2. Munier, N. (2005). Introduction to sustainability (pp. 3558-6). Amsterdam, The Netherlands: Springer.
3. Blackburn, W. R. (2012). The sustainability handbook: The complete management guide to achieving social, economic and environmental responsibility. Routledge.
4. Clini, C., Musu, I., & Gullino, M. L. (2008). Sustainable development and environmental management. Published by Springer, PO Box, 17, 3300.
5. Bennett, M., James, P., & Klinkers, L. (Eds.). (2017). Sustainable measures: Evaluation and reporting of environmental and social performance. Routledge.
6. Seliger, G. (2012). Sustainable manufacturing for global value creation (pp. 3-8). Springer Berlin Heidelberg.
7. Stark, R., Seliger, G., & Bonvoisin, J. (2017). Sustainable manufacturing: Challenges, solutions and implementation perspectives. Springer Nature.
8. Davim, J. P. (Ed.). (2013). Sustainable manufacturing. John Wiley & Sons.

RP23505	SUMMER INTERNSHIP I	L	T	P	C
		0	0	0	1

All the students have to undergo practical industrial training of **TWO WEEKS** duration in recognized establishments, at the end of which they have to submit a report. The internal assessment will be based on the report and presentation and the examination marks, on viva voce examination.

2 WEEKS

UC23E01 ENGINEERING ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship
2. Apply process of problem - opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects
3. Analyse market types, conduct market estimation, identify customers, create customer persona, develop the skills to create a compelling value proposition and build a Minimum Viable Product
4. Explore business models, create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture ideas & solutions built with domain expertise
5. Prepare and present an investible pitch deck of their practice venture to attract stakeholders

MODULE – I: ENTREPRENEURIAL MINDSET **4L,8P**

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economies – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Case Analysis: Study cases of successful & failed engineering entrepreneurs - Foster Creative Thinking: Engage in a series of Problem-Identification and Problem-Solving tasks

MODULE – II: OPPORTUNITIES **4L,8P**

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

MODULE – III: PROTOTYPING & ITERATION **4L,8P**

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques.

Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

MODULE – IV: BUSINESS MODELS & PITCHING **4L,8P**

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest Assumptions in Business Model Design – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback

MODULE – V: ENTREPRENEURIAL ECOSYSTEM **4L,8P**

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon the successful completion of the course, students will be able to:

CO1: Develop an Entrepreneurial Mind-set and Understand the Entrepreneurial Ecosystem Components and Funding types

CO2: Comprehend the process of opportunity identification through design thinking, identify market potential and customers

CO3: Generate and develop creative ideas through ideation techniques

CO4: Create prototypes to materialize design concepts and conduct testing to gather feedback and refine prototypes to build a validated MVP

CO5: Analyse and refine business models to ensure sustainability and profitability Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

REFERENCES:

1 Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition

2. Bill Aulet (2024). Disciplined Entrepreneurship: 24 Steps to a Successful Startup. John Wiley & Sons.

3. Bill Aulet (2017). Disciplined Entrepreneurship Workbook. John Wiley & Sons.

4. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business

5. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch

6. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons

7. Marc Gruber & Sharon Tal (2019). Where to Play: 3 Steps for Discovering Your Most Valuable Market Opportunities. Pearson.

SEMESTER VII

RP23701	POLYMER TESTING	L	T	P	C
		2	0	4	4

OBJECTIVES:

- To provide students with knowledge of testing methods, instrument, property evaluations, and their interpretation of polymers.

UNIT I TEST ON POLYMER PROCESSABILITY 6+12

Principles of Testing- ASTM, ISO, DIN and BIS Standards and specification -Tests on raw materials - Melt flow index -Density – Moisture analysis – Tests on thermosets – Spiral flow tests - Bulk factor - Gelation tests - Processing properties of rubber - Scorch and cure parameters – Crosslink density measurements – Techniques and instruments – Types of cure meters – Principles, applications of cure data - Principle and Application

Practicals- Rubber compound testing-Determination of Mooney Viscosity of Raw and Compounded rubber, Determination of Scorch and Cure parameters of Compounded rubber, Demonstration of Rubber Process Analyzer (RPA),

Plastics Testing-Determination of MFI, Bulk density

UNIT II MECHANICAL AND THERMAL TESTING OF POLYMERS 6+20

Tensile strength – Modulus – Hardness of plastics – Flexural strength - Impact strength -– Coefficient of friction – Static and dynamic –Abrasion Test- Heat deflection temperature - Vicat softening point – Thermal expansion - Thermal conductivity - Brittleness temperature test – Rubber vulcanizate properties – Hardness, tear, tensile, compression & shear, abrasion - application of test data.

Practicals- COF determination, Tensile, flexural and compressive testing of plastics, Determination of Impact properties - Izod/Charpy, Thermal property - HDT and VSP, Determination of hardness – Rockwell

Testing of rubber vulcanizates -Hardness, Resilience, Tensile properties, Tear strength, Spring properties, Heat buildup test, H-pull adhesion test, Compression Set Resistance, Abrasion resistance.

UNIT III LONG TERM AND AGEING PROPERTIES OF POLYMERS 6+12

Tests for fatigue loading – creep –stress relaxation- Accelerated weathering test -Outdoor weathering test- testing for microbial resistance – testing for oil and fluid resistance - Water absorption test, Bio degradability test and environmental impact test, Migration test (Food contact applications)

Practicals- Hot air aging Resistance, Swelling Resistance, Fatigue (crack initiation and propagation), Flex to Fatigue test

UNIT IV ELECTRICAL AND OPTICAL TESTING OF POLYMERS 6+12

Resistivity measurements – Dielectric properties - Tracking index – Arc resistance – Refractive index – Birefringence and photoelastic measurements- Gloss – Transmittance – Reflectance – Colour measurement - Gas and Water vapour permeability test – Stain resistance – ESCR – Salt spray test – Flammability test

Practicals- Environmental stress cracking resistance test, Arc Resistance determination, Opacity determination, Determination of electrical properties – LCR, Flammability test of plastics- LOI

UNIT V TESTS ON FINISHED PRODUCTS 6+4

Blow molded polyethylene container – PVC pipes – Rigid Foam - rubber seals & Gaskets – Engine Mount–

PET bottles – Rubber hoses – Conveyor Belt- Non-destructive testing of polymers - X rays, acoustic emission and ultrasonic techniques

Practicals- Dart impact for films

TOTAL PERIODS = 30+60

OUTCOMES:

CO1: To learn the importance of standards and specifications.
CO2: Familiarize about various standard test methods and equipments used in Rubber and Plastics industry.
CO3: To prepare and characterize the product for testing
CO4: Access and analyze the properties and performance of the rubber and plastics products.
CO5: Anticipate and assess life of the compound or product

REFERENCES:

1. Mathur A B, "Testing and Evaluation of Plastics" Allied Publishers (P) Ltd., 2003.
2. Smith, Len, "Language of Rubber," Butterworth- Heinemann Ltd., 1993.
3. Schaefer R, "Dynamic Properties of Rubber (1-8) Series," Rubber World, Vol.211, 1995.
4. Vishu Shaw, "Handbook of Plastics Testing and Failure Analysis", 4th Edition, Wiley Interscience, 2021
5. ASTM Standards Volumes 8 and 9, 2004

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1		1	1	3	1	1	1	2	1		2	1	2	
CO2	2					2	1	1		1		1	1		1
CO3	3	2	2	2	3	2	2	1				2	2	2	2
CO4	3	2	2	2	3	2	2	1	1	1		2	1		
CO5	3	3	3	3	3	3	3	1				2	3	3	2
Overall CO	2.4	2.33	2	2	3	2	1.8	1	1.5	1		1.8	1.6	2.33	1.66

RP23702	TYRE TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the knowledge about the tyre functions, structure, design, manufacturing, testing and performance

UNIT I TYRE FUNCTIONS AND STRUCTURE 9

Tyres – definitions and functions- types of tyres and application requirements -construction-components and their function, tyre geometry, tyre sizes, nomenclature, tyre materials composition – Industry standards-National and International standards-Speed and load ratings.

UNIT II TYRE REINFORCEMENTS 9

Textile tyre cords,terminology, cord construction, cord-to-rubber compound adhesion; Steel wire and cord, mechanism of steel wire-to- rubber adhesion, measurement of adhesion, fatigue and endurance.

UNIT III TYRE TREAD CONSTRCUCTION 9

Tread components and its function,tread pattern design, road adhesion, tyre footprint pressure, tread extrusion contour, tread radius, tread width, Tread groove and venting, tread depth.Compounding design concepts for tread cap for various types of applications-challenges in meeting conflicting tyre performance requirements like rolling resistance, wet grip and tread wear.

UNIT IV TYRE CASING CONSTRUCTION 9

Casing components and construction – Purdy's equation, belt design, inner liner and barrier, ply, sidewall, bead, apex, chafer, shoulder wedge - safety factor for ply and bead constructions.

UNIT 5 TYRE MANUFACTURING,TESTING AND PERFORMANCE 9

Overall Process flow, Tyre Building, Different tyre building systems – Uni stage and Dual stage building systems.,

Tyre Curing - Basic features of tyre curing press for typical tyres- curing medium and curing cycle Indoor tyre testing for legal and performance requirements – tyre dimension, tyre uniformity and balancing, tyre forces and moments, plunger testing, high speed test, endurance, bead seating, Air permeability, Foot print, stiffness, NDT.

Outdoor tyre evaluation – labeling requirements – Ride & Handling, Wet & dry grip, cornering, traction, rolling resistance breaking distance, enveloping, noise, wear, durability

TOTAL PERIODS = 45

COURSE OUTCOMES:

Students will have acquired knowledge in the following:
Basics of tyre function, structure and construction
Various tyre reinforcing materials and its performance
Various components of making a tyre and their functions
Understand the tyre manufacturing and tyre curing process
Important testing and performance properties of tyre and their optimization

REFERENCES:

1. Clark S K, `Mechanics of Pneumatic Tyres 'US Department of Transportation, 1981.
2. Gent A N, Walter J D, `The Pneumatic Tyre' published by NHTSA, DOT, USA, 2005.

3. Setright J K., `Automobile Tyre' Chapman and Hall, 1972.
4. Kovac FrederickJ.,` Technology Forecasting Tyres' The Good year Tire Company,1973.
5. Wake W C., and Wootton D B.,`Textile Reinforcement of Elastomers' Springer, The Netherlands, 2012.
6. Brendan Rodgers,'Tire Engineering An Introduction',CRC Press,2021

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	3	3	3	2	2			1		3	3	3	3
CO2	2	3	3	3	3	2	2			1		3	3		3
CO3	2	3	3	3	3	2	2			1		3	3	3	3
CO4	2	3	3	3	3	2	2			1		3	3	3	3
CO5	2	3	3	3	3	2	2			1		3	3	3	3
Overall CO	2	3	3	3	3	2	2			1		3	3	3	3

RP23703	REGULATIONS IN POLYMER INDUSTRIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the different regulations of raw materials used in polymer industry**.**

UNIT – I INTRODUCTION TO REGULATIONS **9**

Basic Definition, importance of regulations and registrations, Regulatory bodies – national and international

UNIT –II REGULATIONS FOR MEDICAL COMPONENTS **9**

FDA - FFDCA - BIS - Federal regulations for Color additives - consideration in blood bag, catheters, gloves, syringes, silicone implants, ortho and dental implants, sanitary waste; Collection and disposal of medical wastes

UNIT – III GLOBAL TYRE AND NON TYRE PRODCUTS REGULATIONS **9**

New global Tyre standard under consideration- Requirements of ROHS, SVHC, REACH, TSCA, DoT – NHATSA, EU, ECE, Gulf, BIS regulations-Other important international regulations

UNIT – IV REGULATIONS FOR FOOD PACKAGING **9**

Standards -FDA- FSSAI- Food safety and standards (packaging and labelling) regulations- EU regulations- General requirements for the container - BIS standards for PE, PP,PVC, Ionomer resin, PET, Nylon 6, EVA- Packaging requirements for milk and its products, edible oil/fat, fruits and vegetable products, meat products, drinking water; Impact of Microplastics

UNIT – V EXTENDED PRODUCER RESPONSIBILITY (EPR) **9**

Regulations by CPCB and SPCB- Legislations & Regulations with respect to End-of-life (ELT) tyres, plastics packaging and EPR - PWPs-use of recycled plastics

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:
CO 1: Learn the different types of regulations and safety mechanism in polymer industries.
CO 2: Analyze the end of life of various polymer products
CO 3: Know the different types of regulations and materials used in medical components
CO 4:Gain knowledge on the different types of regulations and materials used in food packaging
CO 5: Learn the different types of regulations in tyre and non tyre industries.

REFERENCES:

1. Food safety and standards (Packaging and Labelling) Regulations, 2011
2. European Regulations for Plastics materials on food contact applications, EU Regulations 2011
3. Plastic Waste Management (Amendment) Rules, CPCB, 2022
4. Plastic Waste Management (Amendment) Rules, CPCB 2016
5. Tyre waste management (Amendment) Rules, CPCB, 2022

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	2	3	3	3	3	3	2	1	2	2	2
CO2	1	1	1	1	2	3	3	3	3	3	2	1	2	2	2
CO3	1	1	1	1	2	3	3	3	3	3	2	1	2	2	2
CO4	1	1	1	1	2	3	3	3	3	3	2	1	2	2	2
CO5	1	1	1	1	2	3	3	3	3	3	2	1	2	2	2
Overall CO	1	1	1	1	2	3	3	3	3	3	2	1	2	2	2

RP23704	SUMMER INTERNSHIP II	L	T	P	C
		0	0	-	2

All the students have to undergo practical industrial training of **FOUR WEEKS** duration in recognized establishments, at the end of which they have to submit a report. The internal assessment will be based on the report and presentation and the examination marks, on viva voce examination.

4 WEEKS

TOTAL: 60 PERIODS

SEMESTER VIII

		L	T	P	C
RP23801	**PROJECT WORK / SEMESTER LONG INTERNSHIP**	**0**	**0**	**16**	**8**

Each student will be assigned a project involving some design and fabrication work as well as theoretical and experimental studies on problems related to Rubber and Plastics 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.

(16 h/Week x 15 Weeks)

TOTAL: 240 PERIODS

VERTICAL-I (ADVANCED RUBBER TECHNOLOGY)

RP23001	LATEX SCIENCE AND TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand knowledge on natural rubber latex, processing and manufacturing of latex products.

UNIT – I LATEX CHARACTERISTICS AND CONCENTRATION METHODS 9

Definition of Latex, classification, Latex particle size and distribution, stability and destabilization of latices, Comparison between latices and polymer solution; Natural rubber latex –origin, tapping, bulking and preservation, composition of field latex, properties, preservation, methods of concentrating latex - creaming, centrifuging, & evaporation,– Specification and testing- (National and ISO) for latex grades (ASTM D 1076)

UNIT – II LATEX COMPOUNDING 9

Latex compounding-Ingredients, Preparation of Dispersions, Emulsion, Slurries; Machineries- Ball mill, Pearl mill; Preparation of latex compound and maturation; Prevulcanized latex, MG Latex, -Preparation, properties and application; Evaluation of the latex compound- Chloroform number, swelling index test; Design for latex products formulation.

UNIT – III LATEX DIPPING PROCESS 9

Principle and types of dipping process, Dipping plant design, formers, sequence of operation, post processing; Manufacture of Condoms, Gloves, Catheters, Balloonsformulations, process, specification, testing and troubleshooting.

UNIT – IV LATEX FOAM, SHEETING AND SPRAYING 9

Principle and Manufacture of Foam-Dunlop and Talalay process, Compound design-Process details, Foam properties, testing and defects, foam applications; Latex sheeting; latex binders and carpet backing- Basics and process.

UNIT – V EXTRUSION AND PRODUCTS BASED ON SYNTHETIC LATEX 9

Principle and Manufacture of latex elastic threads; latex tubing; latex casting process specification and testing, defects. Synthetic latex- Types, properties, and application- surface coatings, adhesives, paper industries.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Understand the Natural rubber latex processing
CO 2: Acquire the knowledge on various Latex product manufacturing
CO 3: Familiarize the importance of synthetic latex and its applications
CO 4: Acquire knowledge on latex foam and sheet manufacturing process
CO 5: Demonstrate on latex extrusion process.

REFERENCES:

1. Blackley, D.C., “High Polymer Latices”, Vol 1 and 2, Chapman & Hall, 1997
2. Mausser,R.F., “The Vanderbilt Latex Hand book” 3rdedn.R.T. Vanderbilt Company

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO2	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO3	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO4	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO5	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
Overall CO	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3

RP23002	RUBBER PRODUCT DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enhance the knowledge on designing of rubber components.

UNIT – I DEFORMATION, LOADING AND RESPONSE 9

Basics of rubber elasticity – theories - stress-strain properties - Poisson's Ratio, E, G & K and their relations – long term properties- Geometry and materials on spring constants - metal bonded rubber assemblies- design for spring rates

UNIT – II DESIGN FOR COMBINED DEFORMATION 9

Rubber product in simple shear- axial shear- rotary shear- sleeves- bush for torsion loads- shear spring rates- compression and shear in combination- material selection.

UNIT – III DESIGN FOR DAMPING AND DYNAMIC APPLICATIONS 9

Dynamic mechanical properties and media- hysteresis- heat generation- vibration control- damping- engine mounts, bearings and earthquake resistant bearings- compound design.

UNIT – IV PRODUCT DESIGN FOR FLUID SEALING AND BELTS 9

Rubber in fluid sealing - type of seals- static seals, gaskets- couplings, hose- profile- beltings- conveyor and power transmission- printing rollers, failure mechanism and remedial measures.

UNIT – V PRODUCTS FOR SPECIAL APPLICATIONS 9

Rubber products for specialty applications- defence, aerospace/space - naval fields, biomedical, electrical, polymers in robotics, high temperature applications

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Demonstrate the role of rubber elasticity in product application
CO 2: To learn the rubber application in load bearing, sealing and vibration control
CO 3: The student gets some idea about design aspects of materials and product geometry.
CO 4: Compare the role of rubber hardness and form factor in fatigue life and strength of products.
CO 5: To demonstrate the mold design for rubber products and specific product applications.

REFERENCES

1. Alan N Gent, "Engineering with Rubber", Hanser Verlag, Munich, 2001.
2. Freakley P R and Payne A R, "Theory and Practice of Engineering with Rubber," Applied Science Publishers, London, 1970.
3. Lindley P B, "Engineering Design with Natural Rubber", RAPRA, London, 1974.
4. Gobel E F & Brichta A M, Newnes, "Rubber Springs Design,"Butterworths, London 1974.
5. A D Roberts, "Natural Rubber Science and Technology", OUP, London, 1998
6. Treloar L R G, "The Physics of rubber Elasticity", 3rd Edition, The oxford University press Inc, Newyork 2005.
7. Gunter mennig, Klaus Stoeckhert , "Mold-making Handbook", 3rd Edition, Hanser Publishers, Munich, 2013.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
CO2	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
CO3	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
CO4	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
CO5	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
Overall CO	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3

RP23003	RUBBER PRODUCT MANUFACTURE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enable the students to understand the construction and manufacturing of tyre and non-tyre rubber products.

UNIT – I LATEX PRODUCTS MANUFACTURING 9

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

UNIT – II BELT MANUFACTURING 9

Belting – Types of belt – Conveyor belt - V-belt – synchronous belt – Components and Functions – Building and Manufacturing – Materials - compounding aspects

UNIT – III HOSES MANUFACTURING 9

Hoses – Types of hoses – Types of construction - Components and Functions – Wrapped moulding - Materials - Compounding aspects – Hose Fittings – Finishing operations -– labeling

UNIT – IV 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- Tennikoit rings

UNIT – V 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

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Familiarize in latex product manufacturing process
CO 2: Demonstrate the tyre manufacturing techniques
CO 3: Gain knowledge on manufacturing of belts and hoses
CO 4: Attain knowledge in production of Footwear and sports Goods
CO 5: Acquire skills in manufacturing of oil seals and mounts

REFERENCES

1. Blow. C.M. and Hepburn C, “Rubber Technology and Manufacture”, Butterworths, 1982.
2. C.W. Evans, “Hose Technology”, Elsevier Applied Science Publishers, 1979.
3. Bhowmick, A, “Rubber products manufacturing technology”, Routledge, 2018
4. Ciesielski, A., “An introduction to rubber technology”, Ismithers Rapra Publishing, 1999
5. Mark, J.E., Erman, B. and Roland, M. eds., “The science and technology of rubber”, Academic press, 2013

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO2	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO3	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO4	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO5	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
Overall CO	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3

RP23004	THERMOPLASTIC ELASTOMERS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To understand the morphology, properties and applications of TPEs

UNIT – I INTRODUCTION **9**

Elasticity and elastomers – need for and advantages of thermoplastic elastomers – Phase structure – synthesis-classification of TPE- demand for TPE and its growth

UNIT – II STYRENIC AND OLEFINIC THERMOPLASTIC ELASTOMERS **9**

Preparation, properties, and uses of ABA block type TPEs (SBS, SIS & SEBS) Blending of PE and PP with EPDM, NBR, dynamic vulcanization and its importance

UNIT – III PU, POLYESTER AND POLYAMIDE TPES **9**

Preparation of PUs – soft and hard segments –transitions in TPUs – properties and uses of PUs – polyether-ester TPEs-preparation - crystallization behaviour in the hard phase of polyester TPEs-morphology, properties and uses of polyester TPEs – polyamide-Polyester -properties and uses

UNIT – IV IONOMERS AND RUBBER-PLASTIC BLENDS **9**

NBR/PP blends, nylon/NBR blends-NBR/PVC blends–compatibilization of these blends ionomers-their preparation, properties and uses

UNIT – V RECYCLING AND RECENT DEVELOPMENT OF TPES **9**

Recycling methods-TPE based on recycled plastics and rubber – drivers for the growth of TPE – Trends in technical development- TPE ecosystem- Bio-based TPE products.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Appreciate the differences between conventional and thermoplastic elastomers and Selection of raw polymer (TPE) for the given application

CO2: To learn the preparation and properties of styenic and olefinic based TPEs

CO3: To acquire knowledge on the preparation, properties of PU, Polyester and polyamide based TPEs

CO4: To gain knowledge on the preparation, properties of Ionomer and rubber/plastics blends based TPEs

CO5: Demonstrate the recycling of TPEs

REFERENCES

1. Holden G, Kricheldorf H R, Quirk R P, Thermoplastic Elastomers, 3rd Edition, Hanser,2004

2. Jiri George Drobny, “Handbook of Thermoplastic Elastomers” Elsevier Science, 2014

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	1	3	3	1	2	1	1	2	3	2	3
CO2	3	2	3	2	1	3	3	1	2	1	1	2	3	2	3
CO3	3	2	3	2	1	3	3	1	2	1	1	2	3	2	3
CO4	3	2	3	2	1	3	3	1	2	1	1	2	3	2	3
CO5	3	2	3	2	1	3	3	1	2	1	1	2	3	2	3
Overall CO	3	2	3	2	1	3	3	1	2	1	1	2	3	2	3

RP23005	ADVANCED TYRE TECHNOLOGY AND SUSTAINABILITY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To impart the knowledge about the use of sustainable tyre engineering materials, manufacturing and performance

UNIT – I TYRE MANUFACTURING **9**

Process flow of tyre plants – tyre components- Assembly of components for major types of tyres – types of tyre building systems – uni stage and dual stage building – Tyre curing – curing medium – curing cycle designing concepts – curing bladder design – Radial & circumferential stretch methods – mould cavity design – crown area and pattern design – Quality control features

UNIT-II TYRE PERFORMANCE **9**

Tyre performance- forces & moments - uniformity & balancing parameters – Radial force, radial harmonic, lateral force, conicity, run outs, static balancing, dynamic balancing and couple, ply steer – Factors affecting uniformity & balancing – Tyre design, manufacturing equipment and process parameters – simulations in design process – digital twin

UNIT – III TYRE LONGEVITY IMPROVEMENT TECHNIQUES **9**

Tyre retreading - Criterion for tyre retreading - rubber compounding ingredients – tyre retreading process- Retreading methodology, physical properties of retread compounds, hot and cold curing process, casing repair, cementing, painting - self healing materials – sealants for tubeless tyres - TPMS

UNIT – IV ADVANCEMENTS IN TYRE TECHNOLOGY **9**

Tire modeling – Basics, Brush model for rigid and flexible carcass – Uni tire semi-empirical model – sensing system in intelligent tyre – types of sensors, types of energy harvesting technology – tyre forces estimation system – Machine learning in the tyre industry – algorithms for tyre force measurement, Tyre road friction estimation - data processing and prediction of results.

UNIT – V SUSTAINABILITY IN TYRE INDUSTRY **9**

Sustainable materials and tyre development – scrap tyre derived materials -Recovered carbon black – end-of-life tyres – synthetic rubbers derived from renewable sources – Renewable process aids – Silica derivation from renewable sources – Bio fillers and reinforcements – mass balance approach - bio-based coupling agents – sustainability in processing – Energy optimization in tyre curing, electrical induction heating, waste elimination - case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1 Basics of tyre manufacturing and curing techniques

Understand the sustainability in tyre materials

Evaluate the performance of the tyre

Apply the knowledge to improve life cycle of tyres

Key Technologies involved in tyre evaluations and intelligent systems.

REFERENCES

1. Charlotte Clark, Kenneth Meardon, Dexter Russell “Scrap Tire Technology And Markets” , Noyes Data Corporation , USA, 1993.
2. Nan Xu , Hassan Askari ,Amir Khajepour, “Intelligent Tire Systems” , Springer, Switzerland 2022.
3. Yukio Nakajima , “Advanced Tire Mechanics”, Springer, Singapore, 2019.
4. William J. Bodziak, “Tire Tread And Tire Track Evidence” CRC Press, Boca Raton, 2008.
5. Shulman.V.L , “Tyre Recycling”, Rapra Technology Limited, UK, 2004.

6. Brendan Rodgers, “Tire Engineering An Introduction” CRC Press, Boca Raton, 2021.
7. Ridha.R.A and Theves .M “Advances in Tyre Mechanics”, Rapra Technology Limited, UK 1994.
8. Hans B Pacejka , “Tyre And Vechile Dynamics”, SAE International, 2005.
9. Donald f. Hays and Alan l. Browne , “The Physics Of Tire Traction”, Springer , USA 1974.
10. Tom French , “Tyre Technology”, Adam Hilger, Bristol, 1989.
11. Evans .M .S , “Tyre Compounding for Improved Performance”, Rapra Technology Limited , UK 2002.
12. Bireswar Banerjee , “Tyre Retreading”, Rapra Technology Limited , UK, 2015.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	2	2	1	2	2	3	3	3	3	3
CO2	3	3	3	3	3	2	2	1	2	2	3	3	3	3	3
CO3	3	3	3	3	3	2	2	1	2	2	3	3	3	3	3
CO4	3	3	3	3	3	2	2	1	2	2	3	3	3	3	3
CO5	3	3	3	3	3	2	2	1	2	2	3	3	3	3	3
Overall CO	3	3	3	3	3	2	2	1	2	2	3	3	3	3	3

RP23006	RUBBER RECYCLING AND CIRCULAR ECONOMY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the rubber waste management and recycling techniques.

UNIT – I MANAGEMENT OF END-OF-LIFE RUBBER PRODUCTS 9

Introduction-Tires and Tire Markets, Increasing tire Usage, Management of End-of–Life Tires (ELTs); Challenges and need for rubber recycling - Circular Economy-Reduce, Reuse, Recycle and recover; Landfill Regulations – Economic benefits of Rubber Recycling – Composition of Truck and Passenger tires - Retreading and reclaiming and their limitations.

UNIT – II MECHANICAL RECYCLING OF TIRE 9

Collection and sorting of waste tyres - Shredding, chipping and granulation - Grinding and size reduction machinery-Separation of steel, fabric and other constituents-Methods of size reduction- Ambient, wet, water-jet and cryogenic grinding, Morphology and properties of aggregates and crumb rubber- Energy, Economic and end use considerations

UNIT – III TIRE DERIVED PRODUCTS 9

Used tyres in sea and land erosion control, Artificial sport turfs, Running tracks, Play rounds – Applications of fine powders and granulates, Rubber modified asphalt for road construction-wet and dry methods-Applications of surface modified scrap rubber powder in rubber compounds, Thermoplastic vulcanizates and scrap rubbers in thermosets

UNIT – IV CHEMICAL RECYCLING 9

High Pressure high Temperature Sintering, Solid state shear extrusion - De-vulcanization – Ultrasonic, Chemical, microwave, Thermo-mechanical and mechano-chemical techniques –Applications of de-vulcanized rubber, Flow and cure characteristics, Swelling and crosslink density measurements of de-vulcanized rubber- De-vulcanizing agents

UNIT – V RESOURCE RECOVERY AND FEEDSTOCK RECYCLING 9

Calorific value of tyres, Tyre Pyrolysis, Tyre derived fuel, Energy recovery and use in Cement kilns – Emission control, tyres to energy plants, Case studies – Feed stock recycling of waste tyres, pyrolysis oil, recovered carbon black – Plant designs – Environment and fire safety requirements-Bio and enzymatic degradation of scrap rubber

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Analyze environmental and technological challenges in handling used tyres
CO 2: Demonstrate the size reduction techniques for viscoelastic materials and tires
CO 3: Know the possibilities of innovative products based on recycled rubber
CO 4: Learn the various de-vulcanization techniques
CO 5: Identify the relevance of circular economy through closed loop recycling

REFERENCES:

1. Rubber Recycling, S.K.De, A I Isayev and Klementine Khait, CRC Press, 2005
2. Tyre waste Recycling, Trever M.Letcher, Valerie L.Shulman and Serji Amirkhanian, Academic Press, 2021

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	3	3	3	1	2	3	1	2	3	3
CO2	2	3	3	2	2	2	3	1	2	1	3	2	3	2	2
CO3	2	3	3	3	1	3	3	2	1	1	3	2	3	3	2
CO4	3	3	2	2	1	2	3	2	1	1	2	1	2	3	2
CO5	1	1	2	2	2	1	2	2	2	2	2	2	3	3	2
Overall CO	2.2	2.6	2.4	2	1.6	2.2	2.8	2	1.4	1.4	2.6	1.6	2.6	2.8	2.2

RP23007	RUBBER ANALYSIS AND REVERSE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on the various testing instruments and procedures required by the standards and to comprehend the various rubber compound and product tests.

UNIT – I TESTS ON RAW RUBBERS AND COMPOUNDS 9

Plastimeters – Plasticity Retention Index (PRI) – extrusion rheometers – Torque rheometers – Mooney - Scorch and cure rate – ODR & MDR – Dynamic responses of unvulcanized rubber compounds (RPA) - Tack- Green strength – Bound rubber content.

UNIT – II TESTS ON VULCANIZATES - I 9

Stress-strain relationships – Poisson's Ratio – Data for finite element analysis – Hardness – Tensile stress/strain – Relaxed modulus – Compressive stress/strain – Shear stress/strain – Tear tests – Cutting resistance – adhesion tests – Dispersion test – Ageing tests- Rebound resilience – Compression set

UNIT – III TESTS ON VULCANIZATES - II 9

Principles of dynamic tests – DMA - Heat build-up test – Flex cracking and cut growth resistance test – Friction and wear test – wear mechanism – low temperature properties – Effect of fluids, gases and ozone – Electrical properties – Permeability test.

UNIT – IV TESTS ON RUBBER PRODUCTS 9

Rubber products – chemical analysis – Breaking strength of conveyor belt – Sealability of rubber gaskets and seals – Bursting strength of hoses – Rubber threads – Adhesion strength of coated fabrics – Interfacial strength of rubber-to-metal bonded products.

UNIT – V REVERSE ENGINEERING OF RUBBER PRODUCTS 9

Concept of reverse engineering – Different instrumentation techniques - Applications of DSC, TGA, GCMS, and FTIR in reverse engineering – Case studies- Formula reconstruction – Specific examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Assess the processing properties using rheometer

CO2: Learn the short-term stress-strain behavior of rubber vulcanizates

CO3:Familiarize the importance of synthetic latex and its analyze and interprete the dynamic properties of vulcanizates

CO4: Evaluate the product performance and life prediction of rubber components

CO5: Apply reverse engineering principles and create new formulations

REFERENCES:

1. R P Brown, "Physical Testing of Rubber", 4th edition, Springer, 2006 (e-Copy 2012).
2. John S Dick, "Basic testing of rubber: selecting methods for rubber test program", ASTM International, ASTM Stock number MNL 39, 2003.
3. John S Dick, "Rubber Technology : Compounding and Testing for performance", 2nd Edition, Carl Hanser Verlag, Munich 2009.
4. Saikat Dasgupta, " Reverse Engineering of Rubber Products, Concepts, Tools, And Techniques", Taylor & Francis Group, 2014
5. ASTM Standards Volumes 8 and 9, 2022

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
CO2	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
CO3	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
CO4	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
CO5	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
Overall CO	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2

VERTICAL 2 (ADVANCED PLASTICS TECHNOLOGY)

RP23008	ENGINEERING AND HIGH PERFORMANCE PLASTICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To impart knowledge on properties and applications of plastics in Engineering and high performance applications

UNIT – I ENGINEERING PLASTICS 10

Polyamides, (nylons), modified polyamides, polyesters - PET, PBT, Polyacetals, PC and its blends - Preparation, properties & applications

UNIT – II HIGH TEMPERATURE PLASTICS 10

Fluorine containing Plastics - Preparation, properties & uses of PTFE, PCTFE, PVDF, other high performance plastics like PPO, PPS, polysulphones, PEEK, Polyimides, Polybenzimidazoles, aromatic polyamides - Kevlar, Nomex - Preparation, properties & applications.

UNIT – III SPECIALTY POLYMERS - I 9

Polymers for electronic applications, conducting polymers - Photoresists, polymers in optoelectronics polymers with piezoelectric, pyroelectric & ferroelectric properties, Polymers in telecommunications and power transmission

UNIT – IV SPECIALTY POLYMERS - II 9

Synthetic polymer membranes, ionic polymers, hydrogels and smart polymers, dendritic polymers, shape memory polymers, LCP's, IPN's

UNIT – V POLYMERS FOR BIO MEDICAL APPLICATIONS 7

Bio- compatible and bio degradable polymers, Controlled drug release, tissue engineering, orthopaedic application, dentistry, Biomaterials for Heart Valves and Arteries

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to

CO 1:Select right type of plastics for engineering applications
CO 2: Know the need for high temperature plastics in strategic applications
CO 3: Demonstrate the importance of specialty polymers in the field of electronics
CO 4: Learn the importance of specialty materials in various applications
CO 5: Apply the knowledge of plastics materials in bio medical applications

TEXT BOOKS:

1. ManasChanda, Salil.K.Roy, "Plastics Technology Hand book", 5th edition, CRC Press, New York, 2017.

REFERENCES:

1. R.W. Dyson "Specialty Plastics" 2nd edition, Blackie Academic & Professional,1988
2. James M. Margolis " Engineering. Plastics Handbook" McGraw – Hill, 2006.
3. "Engineering Plastics", Vol.2, ASTM International, 1988.
4. Matrin.T.Goosey, "Plastics for Electronics", Elsevier, Applied Science, 1985.
5. David K. Platt, "Engineering and High Performance Plastics, Market Report", Rapra Technology Limited, 2003.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2	2	3	2	2	2	3	3	3	3	2
CO2	3	2	2	2	2	2	3	2	2	2	3	3	3	3	2
CO3	3	2	2	2	2	2	3	2	2	2	3	3	3	3	2
CO4	3	2	2	2	2	2	3	2	2	2	3	3	3	3	2
CO5	3	2	2	2	2	2	3	2	2	2	3	3	3	3	2
Overall CO	3	2	2	2	2	2	3	2	2	2	3	3	3	3	2

RP23009	ADVANCED PLASTICS PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To familiarize students with the latest plastics processing techniques and machineries

UNIT – I ADVANCED INJECTION MOULDING PROCESS - I 9

Introduction - Co-injection moulding, Two-colour injection moulding process - applications, Gas assisted Injection Moulding - Basic processes and procedures – Moulding aspects -shrinkage and summary. Reaction Injection Moulding (RIM) - Process - Mould – Process Controls – Merits.

UNIT – II ADVANCED INJECTION MOULDING PROCESS – II 9

Multi-layer Moulding, Counter flow moulding, Liquid Injection Moulding processes. Thinwalled moulding, Structural foam moulding - Low pressure and high pressure processes -Merits &demerits.

UNIT – III ADVANCED BLOW MOULDING - I 9

Introduction - Classification of advanced Blow moulding processes - Deep draw Double Wall Blow Moulding Technology - Split moulds- Versatility - Applications. Press Blow Moulding Technology Process - Applications, Three dimensional Blow Moulding Process -Applications.

UNIT – IV ADVANCED BLOW MOULDING – II 9

Stretch blow moulding - Injection stretch blow moulding - Extrusion stretch blow moulding Process - Merits & demerits - Applications. Multi-layer Blow Moulding - Process -Applications.

UNIT – V ADVANCED EXTRUSION PROCESSES 9

Introduction - Profile Extrusion - Material - Process - Process optimization - Cooling Profile applications. Process, downstream equipments - dies and application. Multi-layer film extrusion, co-extruded sheets, Corrugated pipes, profiles.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to

CO1: Learn the gas assisted and co-injection techniques and Product manufacture

CO2: Gain knowledge on thin walled products and foam molding techniques

CO3: Gain knowledge on blow molding and double wall molding techniques

CO4: Know about stretch blow molding process

CO5: Acquire knowledge about advance co extrusion process and product manufacture.

TEXT BOOKS:

1. Crawford RJ., " Plastics Engineering" Elsevier. 2011.

REFERENCES:

1. James F. Stevenson, "Innovation in Polymer Processing Moulding," Hanser Publishers, New York, 1996.
2. Donald V. Rosato, "Injection Moulding Handbook," International Thomson Publishing Company, 1985.
3. Friedhelm Henson, "Plastics Extrusion Technology," Hanser Publishers, New York,1988.
4. Brunt Strong, "Plastics: Materials and Processing, "Prentice-Hall, New Jersey,1996

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO2	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO3	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO4	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO5	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
Overall CO	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3

RP23010	PLASTICS IN PACKAGING TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To impart knowledge on the functions of packaging materials, packaging techniques and its testing

UNIT – I INTRODUCTION TO PACKAGING 9

Definition, functions of packaging, types and selection of package, packaging hazards, interaction of package and contents, materials and machine interface, environmental and recycling considerations-Life cycle assessment; Package design-Fundamentals, factors influencing design, stages in package development.

UNIT – II DIFFUSION AND PERMEABILITY 9

Diffusion-Types of diffusion, Fick's law of diffusion and applications; Diffusion coefficients of gas, liquid and vapour in polymers and packaging films, techniques to measure diffusion coefficient in polymer interface; Polymer permeability, gaseous transport in polymers, permeability measurement.

UNIT – III PACKAGING TECHNIQUES 9

Flexible and Rigid Packaging-Extrusion- Blown film, cast film, multi-layer film and sheet, lamination; Injection moulding; Blow moulding; Thermoforming; Surface treatment for printing and printing processes

UNIT – IV SPECIALITY PACKAGING 9

Aerosol packaging, shrink and stretch wrapping, blister packaging, antistatic packaging, aseptic packaging, active packaging, modified atmospheric packaging, ovenable package, cosmetic package, hardware packaging, food packaging, textile packaging, health care packaging, export packaging.

UNIT – V TESTING OF PACKAGING MATERIALS 9

Package Testing- Mechanical properties – Tensile and tear properties, Impact properties, Burst strength, Stiffness, Crease or flex resistance; Co-efficient of friction, Blocking Orientation and Shrinkage; Optical Properties – Clarity, Haze and gloss; Barrier Properties – Oxygen transmission, Water vapour transmission rate migration; Chemical resistance tests.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to

CO1: Apply and examine the knowledge of properties for selection of packaging materials
CO2: Learn the barrier properties of polymers
CO3: Select between different techniques of packaging
CO4: Acquire knowledge on various smart packaging techniques
CO5: Will familiarize in testing of plastic packaging

REFERENCES:

1. Selke, S. E. M., Culter, J. D. and Hernandez, R. J., "Plastics Packaging: Properties, Processing, Applications and Regulations", Carl Hanser Verlag, USA, 2021
2. A. L. Baner, Otto G. Piringer, "Plastics Packaging" 2nd edition, Wiley, 2008
3. Aaron L Brody Kenneth S Marsh, "Encyclopedia of Packaging Technology", Wiley, 1997.
4. A.S. Athayle, "Handbook of Packaging Plastics", Multi Tech publishing Co, First edition, 1999

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	2	3	1	2	1	2	3	3	3	3
CO2	3	3	3	3	3	2	3	1	2	1	2	3	3	3	3
CO3	3	3	3	3	3	2	3	1	2	1	2	3	3	3	3
CO4	3	3	3	3	3	2	3	1	2	1	2	3	3	3	3
CO5	3	3	3	3	3	2	3	1	2	1	2	3	3	3	3
Overall CO	3	3	3	3	3	2	3	1	2	1	2	3	3	3	3

RP23011	PLASTICS PRODUCT DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the knowledge on the design of some plastics products and composite products.

UNIT – I CONCEPTS IN PRODUCT DESIGN 9

Product design stages, Principles & Methodical approach for Product Design – factors affecting product design -Design Process – Material selection - size, shape and function – use of creep curves and other viscoelastic data in product design - Aesthetics, Ergonomics– Process selection – Safety Factors in Product Design–Product Design Appraisal- Geometric Dimensioning and Tolerances on Product-Design for Manufacture &Assembly (DFMA)

UNIT – II PRODUCT DESIGN FEATURES 9

Wall thickness – variations in wall thickness – suggested wall thickness for various plastics materials – Taper & Draft – Design of radii, fillets, Ribs and bosses- Shrinkage - Fits & Tolerances- External & Internal Undercuts

UNIT – III HOLES & THREADS 9

Moulded Holes & its types - Drilled and tapped holes- Hinges – Types - Design of Integral hinges. Moulded threads – thread types- Inserts – materials – selection of metal for inserts –location of inserts in the part – moulded inserts – pressed in inserts.

UNIT – IV ASSEMBLY FEATURES 9

Part Consolidation-Mechanical Fasteners- Snap Fits Joints- Snap Fit Theory, Annular and Torsional Snap fits, Assembly Procedures and Issues with Snap Fits- Welding –Ultrasonic Welding, Vibration and Hot-Plate Welding, Spin Welding- Bonding - Solvent and Adhesive Bonding-Retention Features-Alignment Features- Orientation-Expansion Differences- Tolerances– Introduction to In-mould Assembly

UNIT – V DESIGN OF COMPOSITES 9

Design Criteria for Composites- Design requirements- functional-safety-reliability –cost effectiveness-Design constraints- factor of safety for uncertainties -design failure criteria- optimization in design. Design for physical, mechanical and functional properties of composites-code of practice of loading on structures-Design of simple structural elements-tension bars-columns-beams-pipes-plates and shells. Design of joints-bolted, joints - bonded joints.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to

CO1: Explain the concepts and features of Plastic Product design.
CO2: Learn the basic concepts of designing with plastics for various loading applications, structural elements and joints.
CO3: Learn about holes & threads mould
CO4: Learn the concepts of assembly features
CO5: Gain knowledge on the concepts of composite product design.

TEXT BOOKS:

1. Robert A. Malloy, “Plastic Part Design for Injection Moulding”, Hanser Publishers, Munich Vienna, New York, 1994.
2. R. D. Beck “Plastics Product Design”, Van Nostrand Reinhold, New York,1980

REFERENCES:

1. Belofsky, H, “Plastics Product Design and Processing Engineering, Hanser Publishers, Munich Vienna New York, 1994.
2. Sidney levy J. Harry Dubois, “Plastics Product Design Engineering Hand Book”, Second Edition, Chapman and Hall Ltd, 1984
3. Paul A. Tres, “Designing Plastic Parts for Assembly”, 2nd Revised Edition, Hanser Publishers, Munich Vienna New York, 1994
4. Alfredo Campo E. “The Complete Part Design Handbook for Injection Molding of Thermoplastics”, Hanser Publishers, Munich, 2006
5. Daniel B. Miracle and Steven L. Donaldson “Composites” Volume 21, ASM Handbook,ASM International, 2001.
6. P.K. Mallick, “Fiber-Reinforced Composites: Materials, Manufacturing, and Design”, Third Edition, CRC Press 2007

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
CO2	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
CO3	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
CO4	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
CO5	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
Overall CO	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3

RP23012	DESIGN AND MANUFACTURE OF MOULDS AND DIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on design and manufacture of moulds and dies for polymer processing.

UNIT – I DESIGN OF INJECTION MOULD 9

Introduction to Mould and Die Mould –function-requirement-mechanical properties- tolerance-basic mould types-Mould construction nomenclature - Injection Mould- properties of mould materials, steels for different mould parts, requirement of heat treatment - Classification of injection molds - Calculation of the number of cavities in injection mould - Feed systems- type of runners-design of runners and runner efficiency - Types of Gates- Design of gates for a different type of plastic materials and geometry – Working of ejection systems – constructional features of ejector grid - Ejector grid lay out – type of ejector elements – various ejection techniques in injection mold – cooling system design

UNIT – II DESIGN OF COMPRESSION, TRANSFER AND EXTRUSION DIES 9

Classification of compression mold - Compression mold materials – design features of different type of compression molds – transfer mould classifications – pot and plunger type – design guidelines for transfer molds - Introduction of extrusion die design - Basic consideration in die design - Constructional features of rod die – Design of pipe dies – inline, crosshead and off-set dies –design of profile dies – design of blown film dies – design of flat film and sheet dies.

UNIT – III CONVENTIONAL MOULD MANUFACTURING METHODS 9

Introduction: material removal processes, types of machine tools –Theory of metal Cutting Chip formation, cutting tool materials, tool wear, tool life, surface finish, cutting fluids- Centre lathe- Various operations Capstan and turret lathes - Reciprocating machine tools: shaper, planer, slotter - Milling : types, milling cutters, operations - Hole making : drilling, Reaming- Grinding process – Cylindrical grinding, surface grinding

UNIT – IV UNCONVENTIONAL MOULD MANUFACTURING METHODS 9

Electric Discharge Machining (EDM)- working Principle. Parameters-Surface Finish and MRR- electrode - Wire cut EDM – Applications. Chemical machining and Electro-Chemical machining - Etchants- Maskant- Techniques of applying maskant- Principles of ECM-Equipment's-Surface Roughness and MRR-Electrical circuit-Process Parameter

UNIT – V NC AND CNC IN MOULD MANUFACTURING 9

Numerical control (NC) machine tools – CNC: types, constructional details, special features – Design considerations of CNC machines for improving machining accuracy – Structural members – Slide ways – Linear bearings – Ball screws – Spindle drives and feed drives. Part programming fundamentals.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to

CO1: Demonstrate the Mould and various concepts in Injection mould.

CO2: Gain knowledge on the Design of Compression, Transfer moulds and Extruder Die.

CO3: Study about various Conventional Machining process in Mould making.

CO4: Learn the various Unconventional methods of manufacturing Mould.

CO5: Study the NC and CNC applications in Mould making

TEXT BOOKS:

1. DuBois J. Harry: Plastics Mold Engineering Handbook (English, Paperback, Springer- Verlag New York Inc.4th Edition November 2013

2. Klus S DuBois J. Harry, Plastics Mold Engineering Handbook (English, Paperback, , Hanser Publishers, NY, 3rd Edition 2013

REFERENCES:

1. Peter Jones, “The Mould Design Guide”, Smithers Rapra Technology Ltd., 2008
2. R.G.W.Pye, Injection Mold Design, East West Press Pvt. Ltd., New Delhi.,2000.
3. Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", volume II, Media promoters and Publishers Private Limited, Mumbai, 2010.
4. Peter Jones, “The Mould Design Guide”, Smithers Rapra Technology Ltd., 2008.
5. W.A.J Chapman, Workshop Technology, Vol I & II, ELBS.
6. Herbert Rees, Mold Engineering, Hanser Publishers, NY.,2002.
7. George Menges & Paul Mohren, How To Make Injection Molds, Hanser Publishers,2001.
8. Douglas M. Bryce, Plastic Injection Molding manufacturing process fundamentals, Society of Manufacturing Engineers, Dearborn, Michigan.,1996.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
CO2	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
CO3	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
CO4	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
CO5	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3
Overall CO	3	3	3	3	2	2	3	1	1	1	2	3	3	2	3

RP23013	ANALYSIS AND TESTING OF POLYMER COMPOSITES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand, test and analyze the properties of fibre reinforcements, polymer matrix materials and commercial composites.

UNIT – I MECHANICS OF COMPOSITE LAMINA 9

Characteristics of a Fiber-Reinforced Lamina - Stress and Strain Transformations in a Thin Lamina under Plane Stress - Isotropic, Anisotropic, and Orthotropic Materials - Fiber–Matrix Interactions in a Unidirectional Lamina – Micro failure Modes under different loading conditions- Elastic Properties of a Lamina –types, Compliance and Stiffness Matrices of Lamina, Coefficients of Linear Thermal Expansion,

UNIT – II MECHANICS OF LAMINATED STRUCTURE 9

Lamination Theory– Assumptions - Laminate Strains - Laminate Forces and Moments - Elements in Stiffness Matrices -Midplane Strains and Curvatures - Lamina Strains and Stresses Due to Applied Loads - Thermal Strains and Stresses -Interlaminar Stresses - Problems

UNIT – III DESIGN OF COMPOSITES 9

Design criteria – Design Allowable – design procedure with composites – Failure predictions of unidirectional lamina – Notched lamina – hole size effect – De-lamination initiation – Finite element analysis in composites – Joint design – Design of tension, compression & torsion member – Design of sandwich beam

UNIT – IV TESTING OF COMPOSITES 9

General mechanical properties – Tension, compression, flexural & shear – Inter-laminar shear strength-fatigue- impact- fracture behavior and damage tolerance – non mechanical test – per ply thickness – constituent content – density – CTE – Thermal conductivity –Diffusivity – Pin bearing strength – non destructive Testing, Case studies for few specific products

UNIT – V COMPOSITES FOR SPECIFIC APPLICATIONS 9

Aircraft radomes - Composite leaf-spring – composite pressure vessel – tubes for space stations truss structure – Boat hull – automotive shaft – Chemical transportation pipe – solid rocket motors- windmill blades – Orthopedic applications .

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to

CO1: Apply basic principles of mechanics to composite lamina

CO2: Apply basic principles of mechanics to laminated structure

CO3: Predict the failure of laminate based on various failure theories.

CO4: Select raw materials for a lamina, chose the proper stacking sequence of laminas,and design a laminated composite structure to best suit specific applications

CO5: Apply knowledge of composite mechanical performance and manufacturing methods to a composites in design/main project

REFERENCES:

1. Weatherhead, R.G., “FRP Technology”, Applied science Publishers Ltd., 2000.
2. Xiao-SuYi, Shanyi Du., “Composite Materials Engineering” Vol.1&2. Springer.
3. Mortensen. A., “Concise Encyclopedia of Composite Materials” Elsevier.

4. ASM Handbook, Vol. 21.
5. Krishan K. Chawla., “Composite Materials Science and Engineering” Springer. 1998.
6. Crawford RJ., “ Plastics Engineering” Elsevier. 2011.
7. Mallick P.K., “Fiber reinforced Composites” Marcel Dekker Inc.1993.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
CO2	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
CO3	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
CO4	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
CO5	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
Overall CO	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2

RP23014	PLASTICS WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To enhance the knowledge about management of the different types of plastic waste generated from different sector by using 4R principle and evaluate their properties for end use applications.

UNIT – I INTRODUCTION TO WASTE MANAGEMENT 9

Sensitizing proper polymer usage and disposal - towards recycling oriented society, Global statistics about plastic pollution–source polymer waste- Plastic waste management hierchy- Legislations related to polymer waste management- Primary, Secondary, Tertiary (feedstock) recycling and Quaternary recycling and incineration - Business opportunities and challenges- Case studies

UNIT – II SORTING & SIZE REDUCTION TECHNIQUES 9

Density based – Optical sorting – Electrostatic sorting – Sorting by melting temperature – Sorting by selective dissolution- sorting of metal contaminants, Cleaning of waste streams, size reduction - cutting – Densification – Pulverization – Chemical methods, melt filtration of contamination in recycled plastics – screen changers – filtration requirements of different recycled plastics.

UNIT – III RECYCLING OF PACKAGING WASTES 9

Recycling of single use plastic waste -HDPE recycling – Application of HDPE recyclate – LDPE recycling – Application of LDPE recyclate – Polypropylene recycling – Application of recycled PP – Recycling of polystyrene - Application of Recycled EPS –PET material Recycling and applications of recycled PET material

UNIT – IV RECYCLING AND RESOURCE RECOVERY 9

Mechanical and chemical recycling of PVC-Recycling of Engineering Thermoplastics – Nylon recycling - PC – ABS & e-wastes - Mechanical and chemical recycling of polyacetals – Uses, recycling of polyurethanes – Physical methods – Chemical methods, Feed stock recycling and energy recovery, Recycling of Thermoset composites –case studies- Recycling of thermoplastics composites-case studies.

UNIT – V LCA AND CIRCULAR ECONOMY 9

Life cycle analysis methods– LCA of PE films, PET bottle, PVC pipes, cables and wires, EPS foam -Intro to circular economy – Importance of EPR - commodity plastics, engineering plastics thermoset material circular economy case studies .

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to

CO1: Comprehend the laws governing polymeric waste management and their environmental impact.
CO2: Identify suitable sorting technique for different plastic waste and improve the quality of recycled product
CO3: Apply the 4 R approach for recycling and reusing of both commercial plastics.
CO4: Used suitable recycling technology for Engineering plastic materials and composites
CO5: Analysis and improve the circular economy

REFERENCES:

1. John Scheirs, “Polymer Recycling Science, Technology and Applications,” JohnWiley & Sons, 1998.
2. Ann Christine Albertson and Samuel J Huang, “Degradable Polymers, Recycling and Plastics,” Marcel Dekker Inc, 1995.
3. Goodship V., (2007) Introduction to plastics recycling, Rapra.
4. Gerald D Andrews and Pallatheri M Subramanian, “Emerging Technologies in Plastics Recycling,” ACS Symposium Series, 513, 1992.

5. Mustafa.N. “Plastics Waste Management Disposal Recycling and Reuse,” Marcel Dekker Inc, 1993.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	3	3	3	2	3	1	3	3	2	2
CO2	2	3	3	2	3	2	2	2	1	2	2	2	2	3	3
CO3	3	2	2	2	3	3	2	2	3	2	2	2	2	2	1
CO4	3	2	2	2	3	3	2	2	1	2	2	1	2	2	1
CO5	3	3	3	2	3	2	3	2	2	2	3	2	1	2	3
Overall CO	2.8	2.4	2.4	2	2.8	2.6	2.4	2.2	1.8	2.2	2	2	2	2.2	2

VERTICAL 3 (SPECIALTY POLYMERS)

RP23015	POLYMERS IN ELECTRICAL AND ELECTRONICS APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To enable the students to learn about the polymers used in electrical applications.

UNIT I INTRODUCTION TO POLYMERS 9

Polymers- Requirements for polymers as insulators, semiconductors and conductors. Design of conjugated polymers for organic electronics - chemical, electrochemical and enzymatic methods - doping - general considerations

UNIT II CONDUCTING/INSULATING POLYMERS AND PROPERTIES 9

Conducting Polymers-properties and applications of PANI, Polythiophene, Polyacetylene and Polypyrole. Photoconducting polymers and its applications. Insulating / Non conducting polymers used in electrical applications -PE, PVC, PF, Aminoplasts, epoxy and other flame retardant polymers. Properties - Electronic properties, electrochemical, electroluminescent properties, electrochromic and electromechanical properties

UNIT III ENERGY HARVESTING POLYMERS 9

Photovoltaic devices - working mechanism and light harvesting materials. Working mechanism and materials for thermoelectric generator, piezoelectric transducer and triboelectric generator-Dielectric Elastomer based Generating systems-energy harvesting using Magneto Rheological Elastomers and fluids

UNIT IV POLYMERIC ENERGY STORAGE DEVICES 9

Supercapacitors – Polymer based electrodes and electrolytes. Lithium ion batteries based on polymers – Polymer as active materials in electrode, polymer as separator and electrolyte.

UNIT V APPLICATIONS 9

Light emitting conjugated polymers - polymer light emitting diodes and electrochemical cells- electret - photoresist - positive and negative photoresist - wire and cable - encapsulation - polymers in optical data storage - optical fibers - corrosion and ESD protection, EMI shielding artificial muscles - electro chromic devices - electromechanical actuators - sensor devices-conductive composites, smart tyres- pressure monitoring systems-3D printing

TOTAL PERIODS = 45

COURSE OUTCOME

The students will be able to

CO1: Relate the properties of polymers for electronics applications

CO2: Select polymers for electrical applications

CO3: Know about polymers used for harvesting solar energy

CO4: Know about polymeric energy storage devices

CO5: Analyze various polymers for electrical applications

TEXTBOOKS

1. J.M. Margolis (Ed.), Conducting Polymers and Plastics, Springer, 2011.

2. R.W Dyson, “Specialty Polymers”, 2nd Edition, Springer, 1998
3. Soane.D.S. and Martynenko.Z., “Polymers in Microelectronics”, Elsevier, Amsterdam, 1989.

REFERENCES

1. Xin Fang, Wei Weng, Huisheng Peng, Xuemei Sun“Polymer Materials for Energy and Electronic Applications”, Elsevier, 2017
2. Hans Kuzmaly, Michael Mehring, Siegmar Roth, “Electronic Properties of Conjugated Polymers,” Springer, Berlin, 2012

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	2	3	3	3	3	1	2	2	2	2	3	2	2
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CO4	3	3	2	3	3	3	3	1	2	2	2	2	3	2	2
CO5	3	3	2	3	3	3	3	1	2	2	2	2	3	2	2
Overall CO	3	3	2	3	3	3	3	1	2	2	2	2	3	2	2

RP23016	POLYMERS IN AUTOMOBILE INDUSTRY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Students will be able to understand and select the applications of different polymers in automobile manufacturing.

UNIT I POLYMER PROPERTIES FOR AUTOMOTIVE APPLICATIONS 9

Identification of plastics / rubber components in automobiles - Function - Selection criteria. Resilience, creep, hysteresis and damping, stability, set and stress relaxation, behaviour in dynamic applications.

UNIT II POLYMERS IN UNDERHOOD APPLICATIONS 9

Functions, materials and requirements for underhood components - Brake fluid reservoir, Rubber seals, hoses, engine mount and cover, air intake manifold, radiator, V belt, battery cases

UNIT III POLYMERS IN INTERIOR AND EXTERIOR APPLICATIONS 9

Functions, materials and requirements for interior components - seating components, dash board components, AC vent assembly, air bags, bumpers, wheel cover, head and tail lamps, door panels, brake pads, pneumatic tyres, weatherproof coatings

UNIT IV POLYMERS IN ELECTRIC VEHICLE 9

Polymers in sensors shield and enclosures -PTFE, PEEK-, nylon brackets –battery separators, coatings and binders- PP, PVDF-insulation materials in EV charging stations – PEI, PI, PTFE, PVC, PEEK

UNIT V RECYCLING AND ENVIRONMENTAL ASPECTS IN AUTOMOBILE 9

Automotive sustainable polymers in exterior and interior applications - Usage of recycled polymers in automobile components - Plastics in automotive end of life - Case studies

TOTAL PERIODS = 45

COURSE OUTCOMES:

Students will be able to

CO1: Gain knowledge on the properties of polymers in automotive applications
CO2: Know the importance of various polymers in underhood applications.
CO3: Acquire knowledge about polymeric materials used in interior and exterior components
CO4: Select the suitable materials for Electric vehicle components.
CO5: Analysis the end of life of various automotive components

REFERENCES:

1. Kalia S., Averous L., (2011) Biopolymers: Biomedical and Environmental Applications, Joseph P. Greene, “Automotive Plastics and Composites”, Elsevier Science, 2021
2. A.N.A. Elliott ,Automotive Application of Polymers II, Elsevier, 1991
3. Rudolf Stauber, Plastics in Automotive Engineering, Exterior Applications, Hanser Publications, 2007
4. Manas Chanda and Salil K Roy, Industrial polymers, Speciality Polymers and their Applications, CRC Press, Taylor & Francis group, 2009
5. Brydson’s, Plastics Materials, 8th edition, Marianne Gilbert Butterworth-Heinemann 2016.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	2	2	2	1	2	2	2	3	3	3
CO2	3	3	3	2	2	2	2	2	1	2	2	2	3	3	3
CO3	3	3	3	2	2	2	2	2	1	2	2	2	3	3	3
CO4	3	3	3	2	2	2	2	2	1	2	2	2	3	3	3
CO5	3	3	3	2	2	2	2	2	1	2	2	2	3	3	3
Overall CO	3	3	3	2	2	2	2	2	1	2	2	2	3	3	3

RP23017	MULTIPHASE POLYMER SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on the blending of different polymers for suitable applications.

UNIT I THERMODYNAMICS OF POLYMER BLENDS 9

Flory – Huggins treatment of polymer mixtures –Phase diagrams and Miscibility gaps - Effect of temperature on the miscibility in polymer solutions and blends - Criteria for Blend miscibility – Polymer – Polymer Interaction Energies – Hydrogen boding systems – Crystalline polymer blends

UNIT II MANUFACTURE OF POLYMER BLENDS 9

Factors influencing Morphology phase stability in blends-Materials, Machine and Processing characteristics-Chemistry of compatibilization-Block and graft copolymers as compatibilizers - Reactive compatibilization – Commercially important Polymer Blends: Structure – Property relationships

UNIT III MORPHOLOGY OF POLYMER BLENDS 9

Continuous & disperse phases – Phase visualization methods – Optical Microscopy, TEM, SEM and AFM – Dispersed phase size and performance properties – Glass transition in Polymers blends and copolymers – Applications of thermal analysis in crystalline polymer blends – Interpenetrating Polymer networks

UNIT IV PERFORMANCE OF POLYMER BLENDS 9

Thermo-mechanical Performance of amorphous – Amorphous and Amorphous- Crystalline blends – Permeability of miscible blends – Barrier materials through control of Blend morphology – Reinforced polymer blends

UNIT V ELASTOMER BLENDS 9

Miscible and immiscible elastomers blends – Thermoplastic vulcanizates – Thermoset – Thermoplastic Blends – Properties of cured Blends – Rubber Toughening of thermosets – Toughening of semi-crystalline plastics – Recycling of polymer blends.

TOTAL PERIODS = 45

COURSE OUTCOMES:

Students will be able to

CO1: Learn thermodynamics of polymer miscibility

CO2: Demonstrate the manufacturing of polymer blends

CO3: Identify appropriate polymer combinations for optimum morphology

CO4: Relate morphology of polymer blends with performance properties

CO5: Design compounds and products based on elastomer blends

REFERENCES:

1. Paul, D.R. and Bucknall, C.B., “Polymer Blends”, Volumes I and II, Wiley Interscience, 2000.
2. Utracki, L.A., “Polymer Blends Handbook”, Volumes I and II, Kluwer Academic Publishers, 2002.
3. Riew, C.K. and Kinloch, A.J., “Toughened Plastics I – Science and Engineering”, ACS, Advance in Chemistry Series 233, 1993
4. L.H.Sperling, “Introduction to Physical Polymer Science”, Wiley Interscience, 2006

Course Outcomes	Program outcome and Program Specific Outcome														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO2	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO3	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO4	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
CO5	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3
Overall CO	3	2	3	2	1	3	3	2	1	1	2	3	3	2	3

RP23018	ADHESIVES PAINTS AND SURFACE COATINGS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the concept of adhesion and principles of formulating various polymeric adhesives and paints.

UNIT I FUNDAMENTALS OF ADHESION 8

Adhesives – Fundamentals – types of substrates –mechanisms of setting, adhesive strength – thermodynamics of adhesives – concepts of surface energy, contact angle etc – types of joints – joint selection

UNIT II NON REACTIVE ADHESIVES 10

Natural adhesives like animal glue, casein, starch – rubber based adhesives – NR, SBR, NBR, CR, IIR adhesives – Latex based & solution based – principles behind formulations – Pressure sensitive & hot melt adhesives based on SBS, EVA – polyvinyl acetate & polyvinyl alcohol based adhesives.

UNIT III REACTIVE ADHESIVES 10

Phenolics, epoxies, acrylics, anaerobics, cyanoacrylates – uses of adhesives in civil Engineering, automobile, aerospace, electrical & electronic industries.

UNIT IV SURFACE COATINGS 9

Components of Paints – Preparations formulations, pigment dispersion, drying & film formation mechanisms, types of paints – based on emulsion, oil, alkyds, epoxies, PF, UF etc, Urethanes, Silicones – Primers like chlorinated rubber – applications, powder coatings.

UNIT V SURFACE PREPARATION AND TESTING 8

Surface preparation for adhesion & painting, powder coatings, factors affecting coating properties, barrier properties – rheology & its importance, paint & adhesion performance testing.

TOTAL PERIODS = 45

COURSE OUTCOMES:

Students will be able to

CO1: Learn the concept of adhesion as a joining operation

CO2: Appreciate the physical chemistry of adhesives and paints, mechanisms of setting and development of strength in the joints and coatings

CO3:earn the concepts and mechanism of reactive adhesives

CO4: Apply the principles of formulating various adhesives and paints

CO5: Demonstrate the importance of and methods of surface preparations

REFERENCES:

1. Skiest I ," Hand book of Adhesives ", Van Nostrand Reinhold, 1990.
2. Shields, "AdhesivesHand Book," Elsevier, 2008.
3. Malshe V.C, Sikchi M, "Basics of Paint Technology",Vol 1, ColourPublicatons Pvt Ltd, Mumbai, 2002
4. PhillipeCognard"Handbook of Adhesives and Sealants: Basic Concepts and High Tech Bonding",Elsevier, 2005.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	1	1	2	1	1	1	1	1	1	1	2	3	2	2
CO2	3	1	1	2	1	1	1	1	1	1	1	2	3	2	2
CO3	3	1	1	2	1	1	1	1	1	1	1	2	3	2	2
CO4	3	1	1	2	1	1	1	1	1	1	1	2	3	2	2
CO5	3	1	1	2	1	1	1	1	1	1	1	2	3	2	2
Overall CO	3	1	1	2	1	1	1	1	1	1	1	2	3	2	2

RP23019	POLYMER NANOCOMPOSITES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic knowledge on nanofillers and polymer nanocomposites; its preparation and applications

UNIT I INTRODUCTION 8

Introduction to nano materials, and nanocomposites, Construction of polymer nano-composites, Template - Directed Assembly - Block copolymers and their phase behaviour - Directed assembly of polymer blends - Assembly and transfer of nanoparticles / nanofibers using polymers

UNIT II NANOMATERIALS USED IN POLYMERS 10

Nanofillers in bulk polymers - overview of potential nano structured fillers - types - nanoparticles, nanofibers, nanotubes, nano sheets; surface features and layers and its modification. Techniques used to characterize nano structured materials.

UNIT III CARBON BASED POLYMER NANOCOMPOSITESS AND THEIR APPLICATION 10

Structure of carbon nanotubes, processing methods for nanotube based polymer nanocomposites, nano tube alignment, characterization, properties and applications

UNIT IV PREPARATION AND PROCESSING 9

Mixing techniques and dispersion of nanomaterials in polymer matrix, Preparations of polymer nanocomposites - melt blending, solution blending, latex coagulation, in-situ polymerization, characterization, properties and applications

UNIT V APPLICATIONS 8

Polymers in nano electronics, Magnetic polymer nanocomposites, Wear resisting polymer nanocomposites, Packaging, Bio-medical, surface coatings, etc.

Total Periods = 45

COURSE OUTCOMES:

Students will be able to

CO1: Appreciate the basic understanding of polymer nanocomposites and nano polymer
CO2: Acquire knowledge on in selecting nanofillers and its incorporation in polymer matrix
CO3: Demonstrate the formation of carbon nanotube and carbon allotropes based polymer nanocomposites and their applications
CO4: Learn the different methods of preparation and processing of polymer nano composites
CO5: Learn the applications of polymer nano composites in different segments

REFERENCES:

1. Joseph H.Kao, ”Polymer Nano composites”,McGraw-Hill Pub., 2006.
2. Klaus Friedrich,Stoyko Fakirov andZhong Zhang,“Polymer Composites from Nano to Macro”, Springer2005
3. Rao C N R, A.Muller, & A.K.Cheetham,“The chemistry of Nanomaterials”,Vol1 & Vol2.Wiley-VCH,2005.
4. Yiu-Wing Maiand Zhong-Zhen Yu, “Polymer Nanocomposites”, Woodhead Publishing Limited, 2006
5. B.S. Murty, P. Shankar, Baldev Raj, James Murday,Textbook of Nanoscience and Nanotechnology, Springer, 2013

Course Outcomes	Program outcome and Program Specific Outcome														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
CO2	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
CO3	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
CO4	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
CO5	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2
Overall CO	3	3	3	3	3	2	2	1	2	2	3	3	2	3	2

RP23020	GREEN COMPOSITES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the use of sustainable materials and reinforcement in preparing green composites

UNIT I BIOPOLYMERS 9

Need of Green composites- Classification - Biopolymers from natural origin and mineral origin - isolation – Starch –Cellulose-chitin and chitosan-Lignin- biodegradable polyester - Properties and applications- surface modification - applications -Properties of biocomposites.

UNIT II BIODEGRADATION 9

Biodegradation.- Mechanism of biodegradation (polyesters, PHB, polyamides, polycarbonates, polyvinyl alcohol, polyurethanes and polyethers) factors influencing biodegradation. Types of biodegradable polymers - properties and application.

UNIT III BIO COMPOSITES 9

Natural bio - fibre and nano fillers as reinforcement - Linseed oil, castor oil, cashew nut liquid, soyabean oil ,Bio based PU, green epoxy based thermoset composites- processing-properties-applications

UNIT IV TESTING & CHARACTERIZATION 9

Test methods and standards for bio-degradable plastics - Criteria used in evaluation of biodegradable plastics – Description of current test methods – Scanning test for ready biodegradability - Test for inherent biodegradability - Test for simulation studies- methods for assessing polymer biodegradability.

UNIT V APPLICATIONS 9

Green composites for Automotive applications- Structural applications-Civil applications-biomedical applications- Biopolymer Films – Biodegradable mulching - Biosensors - Functionalized Biopolymer Coatings and Films – Applications of biopolymers in horticulture Food Packaging- Films and coatings in Food Applications present trends and future challenges- LCA for green composites.

TOTAL PERIODS = 45

COURSE OUTCOMES:

Students will be able to

CO1: Appreciate the basic understanding of biopolymers
CO2: Acquire knowledge degradation mechanism of various biopolymers.
CO3: Demonstrate the natural fiber/filler based composites
CO4: Learn the degradability test of bio-composites
CO5: Learn the applications of biocomposites in various fields.

TEXT BOOK:

1. Susheel Kalia, Biodegradable Green Composites,wiley, 2016
2. Arlindo Silva, Georgios Koronis, Green Composites for Automotive Applications, Elsevier Science,2018

REFERENCES:

1. Biodegradable polymers for industrial applications, Ray Smith , Woodhead Publishing Ltd, CRC Press, 2005.

2. Handbook of Biodegradable polymers – Abraham J. Domb, Joseph Kost & David M. Wiseman.
3. Bio-Based Polymers and Composites – Richard P.Wool . Xiuzhi Susan Sun.
4. Green Polymer Materials – Amar Singh Singha and Vijay Kumar Thakur.
5. Natural Fibers, Bio Polymers, and Bio Composites – Amar K.Mohanty, Manjusri Misra and Lawrence T. Drzal.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	2	2	3	3	2	3	3
CO2	3	3	3	3	3	3	3	3	2	2	3	3	2	3	3
CO3	3	3	3	3	3	3	3	3	2	2	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	2	2	3	3	2	3	3
CO5	3	3	3	3	3	3	3	3	2	2	3	3	2	3	3
Overall CO	3	3	3	3	3	3	3	3	2	2	3	3	2	3	3

RP23021	NATURAL AND BIOBASED POLYMERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the need of bio-based and natural polymers

UNIT I INTRODUCTION 9

Need for bio-based polymers in various polymer industries- Case study– Importance of bio-based polymers and circular economy in polymer industries- Challenges in utilizing polymers from renewable sources – End of life option for bioplastics and compostability

UNIT II BIOBASED NATURAL POLYMERS I 9

Biodegradation.- Mechanism of biodegradation. Biobased materials –Properties and applications of Cellulose, starch, chitin, chitosan, xanthan, Pectin, Alginate, Gelatin, Casein, Soy and Whey protein, Collagen, silkworm cocoons

UNIT III BIOBASED NATURAL POLYMERS II 9

Plastics from microorganisms – PHA- Monomers from bio-based sources- Bio-based epoxy and Polyurethane, bio polyesters, Natural fibers in composite – Lignin matrix composites- Bio based plastics from lipids, polyamides from biomass

UNIT IV PROCESSABILITY OF NATURAL AND BIO BASED POLYMERS 9

Challenges in primary processing of bio based polymers – Processing Technology for biopolymers – Practical processing parameters, 3 D processing of bio-based polymers , Bio refinery approach to processing bio-based polymers

UNIT V APPLICATIONS 9

Bio based packaging – importance. Recent trends - Intelligent and Active polymer packaging systems based on Bio-based and natural polymers – Bio based polymers in Medical devices and applications and in textile industries

Total Periods = 45

COURSE OUTCOMES:

Students will be able to

CO1: Appreciate the basic understanding of biobased polymers
CO2: Acquire knowledge on properties of various bio based poymers
CO3: Demonstrate the properties of polymers form bio sources
CO4: Learn the processability of bio polymers
CO5: Learn the applications of natural and biobased polymers in various fields

REFERENCES:

1. Pratima Bajpai , “Biobased Polymers-Properties and Applications in Packaging”, Elsevier Science, (ebook) 2019.
2. Ololade Olatunji, Natural Polymers-Industry Techniques and Applications, Springer International Publishing, 2018
3. Pierfrancesco Cerruti, Valentina Marturano, Veronica Ambrogi, “Sustainability of Polymeric Materials” , De Gruyter, 2020
4. Ada Pui Yan Hung, Alan Kin-tak Lau, “Natural Fiber-Reinforced Biodegradable and Bioresorbable Polymer Composites, Elsevier Science, e book , 2017
5. Christian V. Stevens, “Bio-Based PlasticsMaterials and Applications”, Wiley, 2013
6. Khalid Mahmood Zia, Nadia Akram, Shazia Tabasum, Aqdas Noreen, Muhammad Usman Akbar, “Processing Technology for Bio-Based Polymers- Advanced Strategies and Practical Aspects”, Elsevier Science, e book, 2021

MINOR DEGREE in POLYMER TECHNOLOGY

RP23022	POLYMER SCIENCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of polymer, polymerization techniques, properties and applications.

UNIT I INTRODUCTION TO NATURAL AND SYNTHETIC POLYMERS 9

Small molecules and Macromolecules - Natural Polymers-Cellulose, Biopolymers and Natural Rubber; Synthetic Polymers-Vinyl Monomers, Diene monomers, cyclic monomers, Addition polymers; Monomers with two or more functional groups-Condensation polymers; Difference between monomers and Polymers - Types of Polymer materials-Thermoplastics, Thermosets, Elastomers and fibers

UNIT II SYNTHETIC POLYMERS - ADDITION POLYMERIZATION 9

Free radical Polymerization – Initiation, Propagation, termination, Degree of Polymerization and Molecular weight; Cationic and anionic Polymerization, Coordination polymerization, Ring opening polymerization – Examples using ethylene, isobutylene, styrene, butadiene, propylene, caprolactam; Copolymerization and its Industrial applications

UNIT III SYNTHETIC POLYMERS - CONDENSATION POLYMERIZATION 9

Difunctional and Polyfunctional monomers - polycondensation reactions -Polyesters, Nylons, polycarbonates, Polyurethanes and polypeptides; Crosslinked and Polymers – Phenol, urea and Melamine Formaldehyde resins - Epoxy and unsaturated polyester resins - Moulding powders and Composites

UNIT IV MOLECULAR WEIGHT OF POLYMERS 9

Average Molecular Weights of Polymers – Polymer Fractionation - Number, Weight and Viscosity average molecular weights, Molecular weight distribution; Determination of molecular weights-Solution viscosity, Osmometry, Light Scattering and Gel Permeation Chromatography; Effect of molecular weight and distribution on properties of Polymers

UNIT V STATES OF AGGREGATION IN POLYMERS 9

Classification of Polymers based on states of aggregation, Examples – Amorphous state, Glassy and rubbery states, Semi-crystalline states; Transitions in Polymers - Importance of Glass Transition Temperature and Melting points in polymers Degree of crystallinity and melt viscosity of polymers – Requirements for fiber forming polymers -Liquid crystalline state

TOTAL PERIODS = 45

COURSE OUTCOMES:

Students will be able to:

CO1: Acquire knowledge on fundamentals of polymer materials

CO2: Learn various addition polymerization mechanisms and techniques.

CO3: Gain knowledge on step polymerization and the manufacture of condensation polymers

CO4: Learn importance of molecular weights and its techniques.

CO5: Gain knowledge on transition, cyrstallinity of polymers.

TEXT BOOK:

1. 1 Gowarikar, “Polymer Science”, 3rd edition, New Age International Publisher, 2019
2. Bill Meyor, “Introduction to Polymer Science”, 3rd edition, Wiley India Pvt Ltd, 2007.

REFERENCES:

1. Georgr Odian, “Principles of Polymerization”, 4th edition, Wiley, 2004.
2. Charles E. Carraher Jr., Raymond Benedict Seymour, “Polymer Chemistry”,7th edition, Taylor and Francis, 2008

Course Outcomes	Program outcome and Program Specific Outcome														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	2	1	1	1	1	2	2	2	2
CO2	3	2	2	2	2	1	2	1	1	1	1	2	2	2	2
CO3	3	2	2	2	2	1	2	1	1	1	1	2	2	2	2
CO4	3	2	2	2	2	1	2	1	1	1	1	2	2	2	2
CO5	3	2	2	2	2	1	2	1	1	1	1	2	2	2	2
Overall CO	3	2	2	2	2	1	2	1	1	1	1	2	2	2	2

RP23023	PROPERTIES OF POLYMERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on the basic properties of polymers and its applications

UNIT I SOLUTION PROPERTIES 9

Dissolution of simple molecules and Polymers – Polymer Dissolution, solubility parameter, Effect of Temperature on polymer dissolution – Upper and Lower critical solution Temperatures – Thermodynamics of Polymer solutions and Blends - Emulsions and suspensions–Paints, adhesives, coatings

UNIT II MECHANICAL PROPERTIES 9

Strength Properties – Hardness, Tensile, Flexural and Tear Strength; Comparison with traditional materials- Ductile to Brittle and Brittle to Ductile failures; Fatigue and endurance; Effect of temperature on properties - Viscoelasticity-creep and stress relaxation in polymers; Viscoelasticity under dynamic conditions-Applications of Viscoelasticity-Friction and wear

UNIT III CHEMICAL PROPERTIES 9

Polymer Solubility parameter – Selection of additives; Solvent, fuel and Chemical resistance; Resistance to aging and weathering-Accelerated aging tests, Resistance to Heat, oxygen, Ozone, sunlight, irradiation and Hydrolysis; Flame resistance-Limiting Oxygen index; Chemical reactions of polymers-cross linking, grafting and surface modification reactions

UNIT IV ELECTRICAL AND OPTICAL PROPERTIES 9

Dielectric Properties – Surface and Volume resistivity, Arc resistance, Dielectric constant and dielectric loss, Effect of chemical structure, temperature, Frequency and additives on dielectric properties – Optical properties-Reflection, Refraction, Transmission and absorption of light-Gloss and Haze- Optical applications - Automotive lighting and optical fibers.

UNIT V SPECIALITY PROPERTIES 9

Polymers in packaging - barrier Properties, diffusion, gas permeability; Electroactive polymers - EMI Shielding, conductive coating, conductive polymers, ionic polymers, poly electrolytes, ion-exchange reins, polymer membranes; Agricultural and Biomedical applications of hydrogels; Ablation; Polymers for additive manufacturing

TOTAL PERIODS = 45

COURSE OUTCOMES:

Students will be able to

CO1: Able to learn the solution properties of polymers

CO2: To demonstrate visco-elastic characteristics and mechanical properties of polymers

CO3: Analyze chemical performance of polymers

CO4: Choose a dielectric material for a given set of operating conditions

CO5: Identify polymers for novel applications

REFERENCES

1. L H.Sperling, “Introduction to physical polymer science”, 4th Edition, Wiley Interscience, 2006
2. John Brydson, “Plastics Materials”, , 7th Edition, Butterworth Heinemann,1999
3. Gowarikar, “Polymer Science”, 3rd edition, New Age International Publisher, 2019
4. Charles E. Carraher Jr., Raymond Benedict Seymour, “Polymer Chemistry”,7th edition, Taylor and Francis, 2008
5. D.W. van Krevelen, “Properties of Polymers”, 3rd edition, Elsevier Science, 2003
6. James E. Mark, “Physical Properties of Polymers”, 3rd edition, Cambridge University press, 2004

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
CO2	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
CO3	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
CO4	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
CO5	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
Overall CO	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2

RP23024	PLASTICS TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on plastics materials, processing and its applications

UNIT I INTRODUCTION TO PLASTICS 9

Plastics - Classification - Structure - Property relationship (effect on thermal, mechanical, optical, chemical, Barrier & electrical properties)

UNIT II COMMODITY PLASTICS 9

Manufacturing methods, properties and applications of PE, PP, PVC, PS, ABS, HIPS, SAN, PMMA,PAN

UNIT III ENGINEERING AND HIGH PERFORMANCE PLASTICS 9

Manufacturing methods, properties and applications of Nylon, POM, PC, PET, PBT, PTFE, PEEK, Polyimide, PPS, Polysulphone

UNIT IV PLASTICS COMPOUNDING 9

Compounding principles – Mixing equipments - Fillers - Antioxidants - Stabilizers – Lubricants- Plasticizers – Toughening Agents – Colourants – Fire Retardants – UV Stabilizers – Anti Static Agents – processing aids

UNIT V PLASTICS PROCESSING 9

Injection molding process – extrusion process – blown film extrusion – Blow molding – Compression molding –Rotational molding

Total Periods = 45

COURSE OUTCOMES:

Students will be able to

CO1: Explain the influence of chemical structure on various properties of plastics

CO2: Know various types of commodity plastics

CO3: Demonstrate the role of engineering and high performance plastics in various applications

CO4: Select suitable additive for plastics compounding

CO5: Choose the appropriate technique for manufacturing plastics products

TEXT BOOKS

1. 1 Gowarikar, “Polymer Science”, 3rd edition, New Age International Publisher, 2019
2. Bill Meyor, “Introduction to Polymer Science”, 3rd edition, Wiley India Pvt Ltd, 2007.

REFERENCES

1. Brydson.J.A., Plastics Materials, 7th edition Elsevier Publication, 1999
2. Manas chanda, “Plastics Technology Handbook”5th edition, CRC Press, 2017
3. OlagokeOlabisi, “Hand Book of Thermoplastics”, Marcel Decker, inc., 1997
4. Irvin.I. Rubin, “Hand Book of Plastic Materials and Technology”, Wiley Interscience,NY,1990.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
CO2	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
CO3	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
CO4	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
CO5	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
Overall CO	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2

RP23025	RUBBER TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide the students with basic knowledge on the rubber materials, compounding additives and its processing and vulcanization

UNIT I SCIENCE OF RUBBERS 9

Physics of Rubber Elasticity – Thermodynamics of rubber – Classification of rubbers – Effect of structure on Tg – Effect of chemical structure on the performance properties of rubbers – Effect of structure on processing properties of elastomers

UNIT II RUBBER MATERIALS 9

NR-Tapping latex, Processing of Latex - Dry rubber production (Smoked sheet, air dried sheet, Crepe etc.) - Grading of rubbers-Synthetic rubbers-structure properties-Manufacturing, structure, properties, compounding, curing and applications - Polyisoprene, Polybutadiene, SBR, EPDM, Butyl rubber, Neoprene, Nitrile rubber, Silicone rubber, Fluoroelastomer, Polysulphide rubber, polyurethane rubber, Acrylic rubber,TPEs.

UNIT III COMPOUNDING AND MIXING 9

General principles of rubber compounding – Various compounding ingredients and their classification – Preparation, properties and uses of carbon black – Non-black fillers, plasticizers, accelerators, activators, cross-linking agents – Special purpose additives– Rubber mixing mechanism– Mixing machinery – Two roll mill, Internal mixer

UNIT IV MOLDING AND VULCANISATION 9

Compression, transfer and injection moulding of rubbers – Curing characteristics - Mechanism of crosslinking by different crosslinking agents – Vulcanisation techniques

UNIT V RUBBER PRODUCT MANUFACTURING 9

Manufacturing of Belting, Hoses, Footwear, rubber-to- metal bonded items, sports goods, cellular rubber, and tyres etc.

TOTAL PERIODS = 45

COURSE OUTCOMES:

Students will be able to

CO1: Learn the structure and properties of natural rubber and other synthetic elastomers.

CO2: Demonstrate the basics of rubber compounding and vulcanization and rubber products manufacturing.

CO3: Analyze the properties of rubbers based on their chemical structure and modify it as per property requirement.

CO4: Demonstrate skills to use rubber processing machinery and develop a high-quality rubber compound.

CO5: Apply proper vulcanization mechanism for a particular rubber compound to meet desired product performance

REFERENCES

1. Blow.C.M. and Hepburn.C. Rubber Technology and manufacture, Butterworths, 1982.
2. Evans.C.W., Practical Rubber Compounding and processing, Applied Science Publishers, London, 1981.
3. Whelan.A., Injection Moulding Machines, Elsevier, 1989.
4. Stevens.M.J., Extruder Principles and Operations, Elsevier Applied Science, New York, 1985.
5. White.J.L., Rubber Processing Technology Materials, Principles, Hanser Publication, New York,1995.

6. Richard F.Grossman,The Mixing of Rubber, Chapman & Hall,1997.
7. Kleemann, Weber, Elastomer Processing, Hansar, 2005.
8. John S. Dick, “Rubber Technology: Compounding and Testing for Performance”, Second Edition, Carl Hanser Verlag GmbH & Company KG, 2014.
9. R. B. Simpson, “Rubber Basics”, First Edition, iSmithers Rapra Publishing, 2002.
10. Anil K. Bhowmick, Howard Stephens, “Handbook of Elastomers”, Second Edition, CRC Press, 2000.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
CO2	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
CO3	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
CO4	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
CO5	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2
Overall CO	3	2	3	2	2	1	2	1	1	1	1	2	3	3	2

RP23026	POLYMER COMPOSITES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge in fundamentals and types of composites, properties and applications

UNIT I INTRODUCTION TO COMPOSITES 8

Historical Development- Concept of Composite- Basic Definitions and Classifications of Composites - MMC, CMC and PMC- Advantages and Limitations of Composites Materials – Applications of composites Materials - Aircraft and Military Applications, Space Applications, Automotive Applications, Sporting Goods Applications, Marine Applications, Infrastructure

UNIT II MATERIALS 10

Matrix materials -PF, UF and MF Resins – Preparation properties and uses – Moulding powders – Additives Epoxy-Preparation properties and uses Unsaturated Polyester, Vinyl Ester - Cyanate Ester, Furan resins, Polyimides and BMI's - preparation, properties and applications, phthalonitrile resins, Benzoxazine resin – Preparation properties and applications - Thermoplastic Matrix- Polyether Ether Ketone, PolyphenyleneSulfide, Polysulfone, Thermoplastic Polyimides –

UNIT III FIBROUS REINFORCEMENTS 9

Reinforcements-Classification-Role and Selection of fibers - Glass fibre -classification, Manufacture and properties, Carbon fibre -classification, Manufacture and properties, Aromatic polyamides ,PE fibres, Boron Fibres, Natural Fibres- Additives For CompositesCross linkers, Coupling agents, Fillers -particulate, Whiskers, Nano fillers - carbons based, silica based, cellulose based, self reinforcing composites

UNIT IV FABRICATION 9

Hand Layup and Spray up Techniques - Resin Transfer Molding – Reaction Injection Molding -Vacuum Infusion – SMC& BMC - Pressure Injection - Compression Molding- Composite Tooling - Automated tape laying technique &fiber placement - Filament winding – Pultrusion - Thermoplastic Composite manufacturing - Processing of carbon-carbon composites. Post processing - Secondary Adhesive bonding - Joining of Thermoplastic Composites - Composite Repairing - Hole drilling - Environmental protection and sealing - Composite repairing

UNIT V TESTING OF COMPOSITES 9

General mechanical properties – Tension, compression, flexural & shear – Inter-laminar shear strength-fatigue- impact- fracture behavior and damage tolerance – non mechanical test – per ply thickness – constituent content – density – CTE – Thermal conductivity – Diffusivity – Pin bearing strength – non destructive Testing.

Total Periods = 45

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Acquire fundamental knowledge on composites and its classification and application
CO2: Acquire knowledge about various matrix materials.
CO3: Acquire the knowledge on various reinforcements and additive materials used
CO4: Acquire the knowledge of various techniques involved in manufacturing of composites
CO5: Predict the failure of laminate based on various failure theories

Course Outcomes	Program outcome and Program Specific Outcome														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1	2	1	1	1	1	2	3	3	2
CO2	3	2	3	3	2	1	2	1	1	1	1	2	3	3	2
CO3	3	2	3	3	2	1	2	1	1	1	1	2	3	3	2
CO4	3	2	3	3	2	1	2	1	1	1	1	2	3	3	2
CO5	3	2	3	3	2	1	2	1	1	1	1	2	3	3	2
Overall CO	3	2	3	3	2	1	2	1	1	1	1	2	3	3	2

RP23027	POLYMER RECYCLING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enhance the knowledge about management of the different types of polymer waste generated from different sector by using 4R principle and evaluate their properties for end use applications.

UNIT I INTRODUCTION TO WASTE MANAGEMENT 8

Global statistics about polymer pollution–source polymer waste- Legislations related to polymer waste management–Environment challenges and benefits of recycling- Primary, Secondary, Tertiary (feedstock) recycling and quaternary recycling and incineration

UNIT II PRELIMINARY STEPS FOR POLYMER RECYCLING 10

Density based – Optical sorting – Electrostatic sorting – Sorting by melting temperature – Sorting by selective dissolution- sorting of metal contaminants, size reduction - cutting – Densification – Pulverization – Chemical methods, melt filtration of contamination in recycled plastics – screen changers – filtration requirements of different recycled plastics

UNIT III RECYCLING OF COMMODITY PLASTICS 9

Recycling of one time use plastic waste -HDPE recycling – Application of HDPE recyclate – LDPE recycling – Application of LDPE recycle LDPE – film recycling – Polypropylene recycling – Application of recycled PP – Recycling of polystyrene - Application of Recycled EPS- Mechanical and chemical recycling of PVC.

UNIT IV RECYCLING OF ENGINEERING PLASTICS 9

PET material Recycling and applications of recycled PET material -Recycling of Engineering Thermoplastics – Nylon recycling -PC – ABS & e-wastes - Mechanical and chemical recycling of polyacetals – Uses, recycling of polyurethanes – Physical methods – Chemical methods, Feed stock recycling and energy recovery

UNIT V RUBBER RECYCLING 9

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

TOTAL PERIODS = 45

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Comprehend the laws governing polymeric waste management and their environmental impact.
CO2: Identify suitable sorting technique for different plastic waste and improve the quality of recycled product
CO3: Apply the 4 R approach for recycling and reusing of Commodity plastic materials
CO4: Used suitable recycling technology for Engineering plastic materials
CO5: Learn various mechanical and de-vulcanization techniques for Rubber materials

REFERENCES

1. John Scheirs, “Polymer Recycling Science, Technology and Applications,” JohnWiley & Sons, 1998.
2. Ann Christine Albertson and Samuel J Huang, “Degradable Polymers, Recycling and Plastics,” Marcel Dekker Inc, 1995.
3. Goodship V., (2007) Introduction to plastics recycling, Rapra.
4. Rubber Recycling, S.K.De, A I Isayev and Klementine Khait, CRC Press, 2005
5. Tyre waste Recycling, Trever M.Letcher, Valerie L.Shulman and Serji Amirkhanian, Academic Press, 2021

Course Outcomes	Program outcome and Program Specific Outcome														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	3	3	3	1	3	1	2	3	3	3
CO2	3	2	3	3	2	3	3	3	1	3	1	2	3	3	3
CO3	3	2	3	3	2	3	3	3	1	3	1	2	3	3	3
CO4	3	2	3	3	2	3	3	3	1	3	1	2	3	3	3
CO5	3	2	3	3	2	3	3	3	1	3	1	2	3	3	3
Overall CO	3	2	3	3	2	3	3	3	1	3	1	2	3	3	3

RP23028	RUBBER AND PLASTICS TESTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To gain knowledge on standards, specifications and testing of plastics and rubber materials and products

UNIT I INTRODUCTION 9

Principles of Testing- Standards and specification - ISO and other various standards for Rubber and Plastics Testing - Working Groups- Rubber & Plastics, Difference between test on raw materials and product

UNIT II PLASTICS TESTING- I 9

Melt flow index - Spiral flow tests – Tests on thermosets – Viscosity - Bulk factor – Gelation tests – Flame resistance tests – Tensile strength – Modulus – Hardness of plastics – Flexural strength – Impact strength– Tests for fatigue loading.

UNIT III PLASTICS TESTING- II 9

Heat deflection temperature – Softening point – Thermal conductivity – Dielectric properties -Resistivity measurements -Tracking index – Arc resistance – Refractive index - Gloss – Transmittance – Reflectance.

UNIT IV TESTS ON RAW RUBBERS AND COMPOUNDS 9

Mooney viscosity, Scorch and cure parameters – Techniques and instruments – Types of cure meters – Principles, applications of cure data -Processability Testing, Principle and Application.

UNIT V TESTS ON RUBBER VULCANIZATES 9

Mechanical properties –Hardness, tear, tensile, compression & shear - application of test data and abrasion. Fatigue – Flex cracking and cut growth – Heat buildup – Principle and applications. Effect of environment – Oxygen, heat, ozone, low temperature and swelling media.

TOTAL PERIODS = 45

COURSE OUTCOMES:

Students will be able to

CO1:Learn the importance of standards and specifications.

CO2:Familiarize about the various tests on raw materials and Product of Plastics.

CO3: Gain the knowledge on various thermal and optical testing on plastics.

CO4: Study the various tests on Rubber Compounds.

CO5:Analyze the various tests on Rubber Vulcanisates.

REFERENCES

1. Brown.R.P. Physical Testing of Rubber, Elsevier, 1986.
2. Testing and Evaluation of Plastics, Mathur A B., Allied Publishers (P) Ltd., 2003
3. Language of Rubber, Smith, Len, Butterworth- Heinemann Ltd., 1993.
4. Schaefer.R. Dynamic Properties of Rubber (1-8) Series, rubber World, Vol.211, 1995.
5. ASTM Standards Volumes 8 and 9, 2003
6. Vishu Shaw, Hand Book of Plastics Technology, 2nd Edition, Wiley Interscience, 1998.

Course Outcomes	Program outcome and Program Specific Outcome														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	3	1	1	1	3	3	3	3	3
CO2	3	3	3	3	3	2	3	1	1	1	3	3	3	3	3
CO3	3	3	3	3	3	2	3	1	1	1	3	3	3	3	3
CO4	3	3	3	3	3	2	3	1	1	1	3	3	3	3	3
CO5	3	3	3	3	3	2	3	1	1	1	3	3	3	3	3
Overall CO	3	3	3	3	3	2	3	1	1	1	3	3	3	3	3

OPEN ELECTIVE COURSES

RP23901	POLYMERIC MATERIALS FOR ENGINEERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To enable engineers get a fundamental knowledge about polymers and their applications

UNIT I POLYMERS – A GENERAL INTRODUCTION 9

Fundamental terminology of polymers – classification of polymers- molecular weight of polymers and its significance – elementary ideas about polymerization – types and techniques

UNIT II PLASTICS 9

Poly olefins – PS, ABS, PVC, PMMA - nylon6 and nylon 66- PET -Polyacetal-polycarbonate, PTFE– PPO,PPS, Polysulphone, PEEK– polyimides– epoxy resins – unsaturated polyester resins

UNIT III RUBBERS AND FIBRES 9

Natural rubber – SBR, BR, EPDM and butyl rubbers – nitrile and polychloroprene rubbers – fluoro rubbers and silicones – polyamide fibres (aliphatic and aromatic)– fibres from polyesters - polyethylene fibre – carbon fibre – glass fibre .

UNIT IV ADDITIVES FOR POLYMERS 9

Need for compounding of rubbers and plastics – compounding ingredients – fillers, processing aids, curatives, anti-oxidants and anti ozonants, fire retardants-blowing agents- colourants

UNIT V SECTOR WISE APPLICATIONS OF POLYMERS 9

Polymers in agriculture - packaging-electronics and electrical engineering – automobile engineering-aerospace - civil engineering -telecommunications-instrumentation-medical

Total Periods = 45

COURSE OUTCOME

Students will be able to

CO1**:**Understand the fundamentals of polymers

CO2**:**Know the properties and applications of plastics

CO3:Understand the properties of elastomers and fibres

CO4:Analyse the need for additives in polymers

CO5:Choose appropriate polymers for specific applications

TEXTBOOK

1. Gowariker V.R, Viswanathan N.V, Sreedhar J-Polymer Science, 3rd Edition,New Age International Publishers, 2019
2. Technical Manual on Plastics Materials, Published by CIPET, 2007
3. Brydson J.A, Plastics Materials, 8th Edition, Marianne Gilbert, Elsevier, 2017

RP23902	ADHESIVE JOINING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To enable the students to

- Understand the importance of adhesive bonding
- Appreciate the applications of adhesives in various sectors

UNIT I INTRODUCTION TO ADHESIVE BONDING AND ITS FUNDAMENTALS 9

History and importance of adhesive bonding – comparison of adhesive bonding with mechanical fastening and welding – scope of adhesive bonding in engineering - adhesion and wetting – forces involved in adhesion

UNIT II THEORY OF ADHESION, CLASSIFICATION OF ADHESIVES 9

Adsorption theory-mechanical interlocking theory- electrostatic theory-diffusion theory- weak boundary layer theory – types of substrates – types of adhesives based on their functions, mechanism of setting etc

UNIT III ADHESIVE AND SEALANT MATERIALS 9

Composition of adhesives – additives used in adhesives - Non reactive adhesives – pressure sensitive adhesives – reactive adhesives

UNIT IV ADHESIVE JOINT DESIGN-SOME PRELIMINARY IDEAS 9

Types of adhesive joints - factors affecting joint strength – methods to improve adhesive joint strength-importance of surface preparation of the substrates

UNIT V APPLICATIONS OF ADHESIVES 9

Aerospace-automobiles-civil engineering – electrical industries – electronics – uses in medical field

Total Periods = 45

COURSE OUTCOME

The students will be able to

CO1**:**Compare and differentiate between adhesive bonding and conventional bonding

CO2**:**Understand the basic mechanism of adhesive bonding

CO3**:**Know about composition of adhesives

CO4**:**Have preliminary ideas on Adhesive Joint design

CO5**:**Choose appropriate adhesives for specific applications

TEXTBOOKS

1. Lucas F.M da Silva, Andreas Ochsner, Robert D.Adams, Handbook of Adhesion Technology - Vol 1 and 2, 2nd Edition, Springer, 2011
2. Irving Skeist, Handbook of Adhesives. Springer, 3rd Edition, Springer, 2012

RP23903	POLYMER PROPERTIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To enable the students to

- Understand the fundamentals of polymers, structure and molecular weight
- Know about Tg and its importance
- Know about mechanical properties of polymers
- Understand the importance of electrical and optical properties of polymers

UNIT I INTRODUCTION 12

History of Macromolecules – Difference between simple organic molecules and macromolecules- Monomers – Functionality – Classifications of Polymers – Natural and synthetic polymers – Structure of natural rubber and proteins. Polymer Dissolution - Difference between simple solutions and polymer solutions – Molecular Weight - Average molecular weight – Degree of polymerization and molecular weight – Molecular weight distribution – Polymer fractionation-Polydispersity – Molecular weight determination. Different methods – Gel Permeation Chromatography – Osmometry, Light Scattering – Basic Principles

UNIT II STATES OF AGGREGATION IN POLYMERS 10

Transitions and segmental mobility in polymers – Glass transition, Tg, and flexibility – Multiple transitions in polymers - Significance of transition temperatures – Semicrystalline polymers – Effect of crystallization on properties of polymers – Factors affecting crystallization crystal nucleation and growth – relationship between Tg and Tm – Relationship between properties and crystalline structure- Melting of polymers – Rheology of Polymer melts

UNIT III DEFORMATION & STRENGTH PROPERTIES OF POLYMERS 10

Polymer structure and Stress – Strain properties – Tensile properties – Flexural strength – Iimpact strength – Fatigue endurance – Hardness tests – Mechanical relaxations in polymers –Effect of temperature on mechanical behaviour of polymers – Visco-elastic properties– Damping characteristics – Crazing in glassy polymers – Role of crazing in fracture – Macroscopical fracture theory – Fracture and microstructure

UNIT IV ELECTRICAL PROPERTIES OF POLYMER 7

Structure-Property relationships – Polar and Nonpolar polymers - charge carriers – Electronic and Orientation Polarization-carrier mobility – Dielectric properties of polymers - Anti static and conductive of polymers –Volume resistivity measurements Molecular theories of dielectric relaxation in polymers – Dielectric breakdown

UNIT V OPTICAL PROPERTIES OF POLYMERS 6

Introduction – Isotropic polymers – Anisotropic polymers – Dichroism – Optical applications of polymers – Transmission – Rheoptical properties and application-Birefringence-Photoelastic effects and Analysis in Polymers

Total Periods = 45

COURSE OUTCOME

The students will be able to

CO1**:**Understand the fundamentals of polymers and molecular weight

CO2**:**Realize the importance of transitions in polymers

CO3**:**Know about deformations in polymers

CO4**:**Choose right type of polymers for electrical insulation purpose

CO5**:**Know the importance of optical properties of polymers

TEXTBOOK

1. Ulrich Eisele, Introduction to Polymer Physics Springer, 2011.
2. Bill Meyer.F.W. Text Book of Polymer Science, 3rd Edition, Wiley Interscience Publications, 2007
3. Seymour.R.B., and Carraher.C.E., Jr., Polymer Chemistry, 6th Edition, Marcel Dekker, 2003

REFERENCES

1. L.H.Sperling, Introduction to Physical Polymer Science, 4th Edition, Wiley Interscience, 2006

EMERGING TECHNOLOGIES

RP23E01	EMERGING TECHNOLOGIES IN POLYMER RECYCLING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To enable the students to

- Know various emerging techniques in the field of polymer recycling

UNIT I NEED FOR THE EMERGING TECHNOLOGY 9

Fundamental issues related difficulty of recycling/upcycling plastic products - Micro plastics from Origin to Impacts -Awareness around single use plastic pollution - concepts of reduce, reuse and recycle - Regulations and practices of polymer recycling - The consequences of the National policy - Social, economic and environmental megatrends - LCA on plastic recycling technologies- Opportunities for recycling in the polymer value chain

UNIT II ADVANCED SEPARATION TECHNOLOGY & PRIMARY RECYCLING 9

Primary and secondary recycling- Secondary mechanical recycling- collection, decontamination- melt and extrusion- Advanced Sorting and Separation Technologies- Near-Infrared (NIR) Spectroscopy - Density Separation Techniques - Mechanical Recycling of Packaging Waste Thermo chemical recycling – Solvolysis and upcycling- Microwave-Assisted Recycling

UNIT III TERTIARY RECYCLING WITH ENERGY RECOVERY 9

Tertiary recycling-Chemical recycling-Energy recovery, Chemical recovery-cracking,Alcoholysis, Hydrolysis- Advances and approaches for chemical recycling of plastic waste- Enzymatic Recycling-Electrochemical Recycling- Thermal recycling-Pyrolysis-Gasification-Hydrogenation- Incineration with energy recovery

UNIT IV RECYCLABLE/UPCYCLABLE HIGH-PERFORMANCE PLASTICS 9

Organic recycling- Development of recyclable/upcyclable high-performance plastics- High-performance thermoplastic resins- Recyclable crosslinked resins with dynamic or reversible bonds- Decomposable thermoset resins

UNIT V SUSTAINABLE AND UPCYCLING OF PLASTIC WASTE 9

Sustainable coating technologies for enhancing the recycling/upcycling efficiency of plastic products- Film coatings made of sustainable and renewable polymers- Development of self-cleaning plastic films- . Upcycling plastic waste into high value-added polymer

Materials- . Biological upcycling to form value-added products- Chemical upcycling to form value-added products

TOTAL PERIODS = 45

REFERENCES

1. Carlos A. Bernardo, Güneri Akovali, Jacob Leidner, L.A. Utracki, Marino Xanthos, “Frontiers in the Science and Technology of Polymer Recycling”, Springer, (e book), 2013
2. Katrina Knauer , “Circular Plastics Technologies-Chemical Recycling”, De Gruyter, (e book), 2024.
3. Raju Francis, “Recycling of Polymers - Methods, Characterization and Applications”, Wiley, 2016
4. Trevor M. Letcher “Plastic Waste and Recycling: Environmental Impact, Societal Issues, Prevention, and Solutions” Academic Press, 2020 **ISBN**: 9780128178812
5. Vimal Katiyar and Joginder Singh” Sustainable Polymers: Opportunities for the Next Decade” Springer Nature,2022

RP23E02	POLYMER MEMBRANES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To enable the students to

- Understand the membrane preparation, materials and its applications

UNIT I INTRODUCTION 9

Membranes - its classification based on materials, structure and morphology, configuration ,separation mechanism - membrane module - structure and properties of polymeric membranes - Theory of liquid/gas transport through membranes – mechanism – diffusion, sorption, selectivity and rejection mechanism

UNIT II POLYMERS FOR MEMBRANES 9

Cellulose based membranes - polypropylene -polyacrylonitrile - PVC - polyamide – polyimide-polysulfone - polyethersulfone- PVDF – poly(styrene divinyl benzene) - Nafion -advanced polymeric membranes, hybrid and composites membranes - regulatory changes and challenges

UNIT III FABRICATION/PROCESSING OF MEMBRANES 9

Solution casting-Phase inversion technique - Template leaching – track etching – Thin film composite (TFC) membranes preparation- interfacial polymerization - solution coating - hollow fiber spinning- Electrospinning - surface modification and functionalization techniques- its significance- foul control and cleaning of membranes

UNIT IV TESTING AND CHARACTERIZATION 9

Testing protocols for polymeric membranes - morphological characteristics- transport properties - mechanical properties- chemical characterization

UNIT V APPLICATIONS OF POLYMERIC MEMBRANES 9

Microfiltration and ultrafiltration, Nano filtration membranes for water purification - Polymeric reverse osmosis and forward osmosis membranes for water desalination - medical applications of membranes - dialysis membranes - Membranes for food and beverages, chemical and textile industries -Industrial effluent treatment - membranes for pervaporation- Membranes for gas separation - Ion exchange membranes - polymeric membranes for fuel cell- energy storage batteries

Total Periods = 45

REFERENCES

1. Sabu Thomas, Anil Kumar S, Runcy Wilson, Soney C. George, “Transport Properties of Polymeric Membranes”, Elsevier, 2017
2. Richard W. Baker, “Membrane Technology and Applications” Wiley, 2004
3. T. deV. Naylor , “Polymer Membranes - Materials, Structures and Separation Performance”, Rapra Technology Limited, 1996.
4. Mahmoud Atef Abdulhamid, “Polymer Membranes -Increasing Energy Efficiency”, De Gruyter, (e book) 2024
5. Chandan Das, Kibrom Alebel Gebru, “Polymeric Membrane Synthesis, Modification, and Applications - Electro-Spun and Phase Inverted Membranes”, CRC Press,(e book) 2018
6. Rajindar Singh, “Membrane Technology and Engineering for Water Purification-

   Application, Systems Design and Operation”, Elsevier, (e book) 2014

RP23E03	POLYMERS IN ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To enable the students to

- Know about the design, manufacture and applications of additive manufacturing

UNIT I INTRODUCTION **9**

Introduction to Additive Manufacturing (AM)- AM evolution- Distinction between AM & CNC machining- Advantages of AM- AM process chain- Conceptualization- CAD- conversion to STL Transfer to AM- STL file manipulation- Machine setup- build -removal and clean up-post processing- Classification of AM processes – Advantages and limitations of AM.

UNIT II DESIGN FOR AM **9**

Motivation- DFMA concepts and objectives- AM unique capabilities- Exploring design freedoms. Design tools for AM- Part Orientation- Removal of Support- Hollowing out part- Inclusion of Undercuts and Other Manufacturing Constraining Features- Interlocking Feature- Reduction of Part Count in an Assembly- Identification of markings / numbers

UNIT III AM AND POLYMER FEEDSTOCK **9**

AM feedstock - Material extrusion - Polymers for material extrusion- Pellet based – bio extrusion - micro extrusion- Print parameters – anisotropy of printed parts –VAT photo polymerization - Material Jetting - Sheet lamination – Powder bed fusion

UNIT IV MATERIALS **9**

PLA – Filled PLA – PLA composites – Properties – PHAs, PCL, Polyamide – Properties – Sustainable hydrogels for AM, ABS, PEEK-Properties. Shape memory polymers and composites for 4D printing

UNIT V APPLICATIONS **9**

3D printed polymer products and composites in Biomedical applications, electronics, aerospace, textiles

Total Periods = 45

REFERENCES

1. Antonio Paesano, “Handbook of Sustainable Polymers for Additive Manufacturing” (e book), CRC Press, 2022
2. Declan M. Devine, “Polymer-Based Additive Manufacturing -Biomedical Applications”, Springer International Publishing (e book), 2019
3. Joanna Izdebska-Podsiadły, Polymers for 3D Printing-Methods, Properties, and Characteristics, Elsevier Science, 2022

RP23E04	POLYMERS IN ENERGY STORAGE SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To enable the students to

- Understand the various polymers used in energy storage systems

UNIT I INTRODUCTION **9**

Energy harvesting and energy storage based on polymers – advantages and challenges -stability, conductivity, temperature tolerance, scaling up.

UNIT II CONDUCTING POLYMERS **9**

Electrochemistry of electronically conducting polymers-source of electronic conduction in polymers - Synthesis of conducting polymers – chemical, electrochemical and enzymatic methods – doping, Processability and applications of acetylene, aniline, pyrrole, thiophene and para – phenylene based conducting polymers.

UNIT III APPLICATIONS OF CONDUCTING POLYMERS **9**

Conducting polymers in microelectronics - EMI shielding and lithography, LED-rechargeable batteries - artificial muscles - electrochromic devices– sensor devices.

UNIT IV STORAGE DEVICES **9**

Photovoltaic device, thermoelectric generator, piezoelectric transducers – Material and working mechanism, Super capacitor, polymer as separator/electrolyte in batteries, polymer as active material in electrode

UNIT V FLEXIBLE DEVICES **9**

Latest development in wearable energy storage devices - Flexible Li-ion batteries based on polymer, Flexible piezo devices, flexible super capacitors.

Total Periods = 45

REFERENCES

1. Skotheim.T.A., Elsenbaumer.R.L. and Reynolds J.R., “Hand book of Conducting Polymers”, 2nd Edn, Marcel Dekker Inc., New York, 1998.
2. Margolis J.M., “Conducting Polymers and Plastics”, Chapman and Hall, London, 1989.
3. Seymour R.B., “Conductive Polymers”, Plenum Press, New York, 1981.
4. Wessling B., “Electronic Properties of Conjugated Polymers,” Vol.3, Springer, Berlin, 1989.
5. Kiess H.G., “Conjugated Conducting Polymers,” Springer, Berlin, 1992.
6. Soane.D.S. and Martynenko.Z., “Polymers in Microelectronics”, Elsevier,Amsterdam, 1989.
7. Xin Fang, Wei Weng, Huisheng Peng, Xuemei Sun “Polymer Materials for Energy and Electronic Applications”, Elsevier, 2017

RP23E05	POLYMERS IN BIOMEDICAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To enable the students to

- Know about the polymers used in biomedical applications

UNIT I INTRODUCTION **9**

Polymer selection criteria for medical applications - physical, chemical property, compatibility requirements

UNIT II MATERIALS **9**

UHMWPE, Silicones, acrylics, PEEK, PLA, PGA, PCL, Chitosan, chitin, NR latex, collagen - Properties

UNIT III BIOMATERIAL BASED DEVICES **9**

Biomaterial based devices - Physical and mechanical requirement of biomedical device materials - polymers in biosensors

UNIT IV POLYMERS IN DENTAL AND ORTHOPEDIC APPLICATIONS **9**

Polymers in dentures - dental implants - dental restorative composites - impression materials- adhesion and bonding aspects in dentistry, Polymeric material for joint repair and total joint replacement - friction and wear properties

UNIT V POLYMERS IN DRUG DELIVERY AND TISSUE ENGINEERING **9**

Drug delivery systems - polymers used - properties- biodegradable polymers, controlled release - mechanism. Hydrogels in encapsulation and tissue engineering - wound dressing – ocular applications- polymeric scaffolds for tissue engineering - polymers in cardiovascular systems

TOTAL PERIODS = 45

REFERENCES

1. A.K. Bajpai, Jaya Bajpai, Rajesh Kumar Saini, Priyanka Agrawal, Atul Tiwari, Smart Biomaterial Devices-Polymers in Biomedical Sciences, CRC Press, (e book) 2016
2. Mike Jenkins, Institute of Materials, Minerals, and Mining,, “Biomedical Polymers”, Elsevier Science, (e book) 2007
3. Shalaby W. Shalaby, Ulrich Salz, Polymers for Dental and Orthopedic Applications, Taylor & Francis, 2007

SKILL DEVELOPMENT COURSES

RP23S01	QUALITY MANAGEMENT IN POLYMER INDUSTRIES	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

To enable the students to

- Learn the various principles and practices of Quality Management

UNIT I INTRODUCTION 6

Introduction - Need for quality - Evolution of quality - Definition of quality. Concept of Quality –different perspectives. Concept of total Quality – Design, inputs, process and output - Attitude and involvement of top management. Customer Focus – customer perception - customer retention. Dimensions of product and service quality. Cost of quality.

UNIT II QUALITY MANAGEMENT PHILOSOPHIES AND PRICIPLES 6

Quality Gurus - Crosby, Deming, Masaaki Imai, Feigenbaum, Ishikawa, Juran, Oakland, Shigeo Shingo, and Taguchi. Concepts of Quality circle, Japanese 5S principles and 8D methodology.

UNIT III STATISTICAL PROCESS CONTROL 6

Statistical Process Control (SPC) – Meaning, Significance. Construction of control charts for variables and attributes. Process capability – meaning, significance and measurement. Six sigma- concepts of process capability. Reliability concepts – definitions, reliability in series and parallel, product life characteristics curve. Total productive maintenance (TMP), Terotechnology. Business process Improvement (BPI) – principles, applications, reengineering process, benefits and limitations.

UNIT IV QUALITY TOOLS AND TECHNIQUES 6

Quality Tools - The seven traditional tools of quality, New management tools. Six-sigma, Bench marking, Poka-yoke, Failure Mode Effect Analysis (FMEA) – reliability, failure rate, FMEA stages, design, process and documentation. Quality Function Deployment (QFD) – Benefits, house of quality. Taguchi - quality loss function, parameter and tolerance design, signal to noise ratio.

UNIT V QUALITY MANAGEMENT SYSTEMS 6

Introduction Quality management systems – IS/ISO 9004:2000 – Quality System –Elements, Documentation guidelines for performance improvements. Quality Audits - QS 9000 – ISO 14000 – Concepts. TQM -culture, framework, benefits, awareness and obstacles. Employee involvement – Motivation, empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal. Supplier - Selection, Partnering, Supplier Rating

TOTAL PERIODS = 30

REFERENCES

1. Dale H.Besterfield, Carol Besterfield-Michna, Glen H. Besterfield, Mary Besterfield -Sacre, Hemant Urdhwareshe, Rashmi Urdhwareshe, Total Quality Management (TQM), Fifth edition, Pearson Education, 2018.
2. Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2010
3. Poornima M.Charantimath, Total Quality Management, Pearson Education, Second Edition, 2011.
4. Douglas C. Montgomory, Introduction to Statistical Quality Control, Wiley Student Edition4th Edition,

Wiley India Pvt Limited, 2008.
5. Indian standard – quality management systems – Guidelines for performance improvement (Fifth Revision), Bureau of Indian standards, New Delhi.
6. Panneerselvam.R, Sivasankaran. P, Quality Management, PHI Learning, 2014.

RP23S02	DATA ANALYTICS FOR POLYMER INDUSTRIES	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

To enable the students to

- Learn the software tools to analyze the data

UNIT I INTRODUCTION TO INFERENTIAL STATISTICS 6

Populations and Samples - Random Sampling - Basics of Probability and Statistics - Introduction to Sampling Distributions - Introduction to Hypothesis Testing - Z-test and its Procedure

UNIT II ADVANCED INFERENTIAL STATISTICS 6

Importance of Hypothesis Tests - One-tailed and Two-tailed Tests - Influence of Sample Size - Introduction to Power and Sample Size - Estimation Techniques - Point Estimate- Confidence Interval

UNIT III T-TEST 6

T-test for One Sample - T-test for Two Independent Samples - T-test for Two Related Samples

UNIT IV ANALYSIS OF VARIANCE (ANOVA) AND CHI-SQUARE TESTS 6

Basics of F-test and ANOVA - Introduction to Multiple Comparisons - Basics of Chi-square Tests

UNIT V BASICS OF PREDICTIVE ANALYTICS 6

Linear Regression - Implementation and Goodness of Fit - Multiple Regression - Basics of Logistic Regression - Introduction to Time Series Analysis

TOTAL: 30 PERIODS

TEXT BOOKS

1. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017
2. Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green Tea Press,2014

RP23S03	SUPPLY CHAIN MANAGEMENT TOOLS	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

To enable the students to

- Understand the importance of and major decisions in supply chain management for gaining competitive advantage.

UNIT I INTRODUCTION **6**

Supply Chain – Fundamentals, Evolution, Role in Economy, Importance, Decision Phases, Enablers & Drivers of Supply Chain Performance; Supply chain strategy; Supply Chain Performance Measures.

UNIT II SUPPLY CHAIN NETWORK **6**

Distribution Network Design – Role in supply chain, Influencing factors, design options, online sales and distribution network, Distribution Strategies; Network Design in supply chain – Role, influencing factors, framework for network design, Impact of uncertainty on Network Design.

UNIT III PLANNING DEMAND, INVENTORY AND SUPPLY **6**

Managing supply chain cycle inventory and safety inventory - Uncertainty in the supply chain, Analyzing impact of supply chain redesign on the inventory, Risk Pooling, Managing inventory for short life-cycle products, multiple item -multiple location inventory management; Pricing and Revenue Management.

UNIT IV LOGISTICS **6**

Transportation – Role, Modes and their characteristics, infrastructure and policies, transport documentation, design options, trade-offs in transportation design, intermodal transportation. Logistics outsourcing – catalysts, benefits, value proposition. 3PL, 4PL, 5PL, 6PL; International Logistics -objectives, importance in global economy, Characteristics of global supply chains, Incoterms.

UNIT V SUPPLY CHAIN INNOVATIONS **6**

Supply Chain Integration, SC process restructuring, IT in Supply Chain; Agile Supply Chains, Legible supply chain, Green Supply Chain, Reverse Supply chain; Supply chain technology trends – AI, Advanced analytics, Internet of Things, Intelligent things, conversational systems, robotic process automation, immersive technologies, Blockchain.

TOTAL PERIODS = 30

REFERENCES

1. Sunil Chopra, Peter Meindl and DharamVirKalra, Supply Chain Management-Strategy Planning and Operation, Pearson Education, Sixth Edition, 2016.
2. Janat Shah, Supply Chain Management – Text and Cases, Pearson Education, 2009
3. Ballou Ronald H, Business Logistics and Supply Chain Management, Pearson Education, 5 th Edition, 2007.
4. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, Tata McGraw-Hill, 2005.
5. Pierre David, International Logistics, Biztantra, 2011.

RP23S04	SAFETY IN CHEMICAL INDUSTRIES	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

To enable the students to

- Learn the basic safety precautions followed in chemical industries

UNIT I INTRODUCTION 6

Safety, Hazard, Risk - Need of safety in chemical industries-Accident loss statistics in chemical industries, Nature of accidents and disasters - Case study

UNIT II TERMINOLOGIES RELATED TO CHEMICAL INDUSTRIES 6

Material Safety Data Sheet (MSDS)- Chemical identity, Chemical Abstracts Service (CAS) number, Health Hazard data, preventive measures, Chemical Hazards and control – Class, label and symbol- dangerous goods symbols and definition - IDLH-Immediately Dangerous to Life & Health, NE - no evidence for existence of IDLH

UNIT III REGULATIONS 6

Safety regulations in chemical industries- National Institute for Occupational Safety and Health (NIOSH), Laws and Regulations that govern the Chemical Process Industry in India, HAZCHEM - Recommended exposure limits (RELs) - rules and regulation for transportations of chemicals- Standards for Personal Protective Equipment **-** REACH for polymer industries

UNIT IV RISKS IN THE POLYMER INDUSTRY 6

NR Latex and ammonia allergy - Rubber Fumes – Health and Safety - General recommendations for handling rubber chemicals and monomers for plastics manufacturing- Handling and usage of MDI, TDI in polyurethane manufacture

UNIT V HAZARD ANALYSIS AND CONTROL 6

(HAZOP) Hazard and Operability Analysis - Process hazard and control, storage hazard and control in chemical industries- Minimizing hazards in process and storage, Emergency Response & Disaster Management Planning in polymer plant – Case study

TOTAL PERIODS = 30

REFERENCES

1. NIOSH Pocket Guide to Chemical Hazards
2. Polymer REACH Consortium, “REACH for the Polymer Industry - A Practical Guide”, Smithers Information Limited (e book), 2012
3. Nicholas P. Cheremisinoff, Hazardous Chemicals in the Polymer Industry, CRC Press, 2017
4. Naesinee Chaiear ,Health and Safety in the Rubber Industry, Rapra Technology Limited, 2001
5. D. C. Allport, D. S. Gilbert, S. M. Outterside , MDI and TDI: Safety, Health and the Environment, Wiley, 2004

RP23S05	MOULD FLOW AND SIMULATION	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

To enable the students to learn tools related to Mold flow analysis

Mould Flow and Simulation

Using any one CAE software the following will be analyzed for any Plastic Processing Mould.

(1) Modeling and Mesh Creation
(2) Creation of Feed system and cooling system
(3) Gate Location Analysis
(4) Fill and Flow Analysis
(5) Cooling Analysis

TOTAL PERIODS = 30

COURSE OUTCOME

The students will be able to
Analyze the flow, fill and cooling characteristics for any one plastic processing mould using any one CAE software

REFERENCES

1. R.G.W.Pye, Injection Mould Design, SPE Publication.
2. P.S.Cracknell and R.W.Dyson, Hand Book of thermoplastics injection mould design, Chapman & Hall, 1993.
3. Herbert Rees, Mould Engineering, Hanser publishers, Munich, Vienna N.Y. 1994.
4. Technical Directory on Design and Tooling for plastics, CIPET, Guindy, Chennai.
5. Design calculations for Compression moulds, Machinery publications, Yellow series, U.K.
6. Mould Flow Manual & Part - Adviser Manual - MOULD FLOW.
7. Laszco Sors and Imre Blazs, Design of Plastic Moulds and Dies, Elsevier, Amsterdam - Oxford - Tokyo - NY, 1989.

RP23S06	PLASTIC INJECTION MOLD SIMULATION AND ANALYSIS	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

To enable the students to have hands-on experience on simulation and analysis software
Plastic Injection Mould Simulation and Analysis

To Analyse the following for any Plastic Injection Mould by any CAE software.

- 1) Gate and Runner Design
- 2) Mould filling
- 3) Mould cooling
- 4) Product Quality and Warpage
- 5) Various machine parameters for Ideal mouldability

TOTAL PERIODS = 30

REFERENCES

1. R.G.W.Pye, Injection Mould Design, SPE Publication.
2. P.S.Cracknell and R.W.Dyson, Hand Book of thermoplastics injection mould design, Chapman & Hall, 1993.
3. Herbert Rees, Mould Engineering, Hanser publishers, Munich, Vienna N.Y. 1994.
4. Technical Directory on Design and Tooling for plastics, CIPET, Guindy, Chennai.
5. Mould Flow Manual & Part - Adviser Manual - MOULD FLOW.
7. Laszco Sors and Imre Blazs, Design of Plastic Moulds and Dies, Elsevier, Amsterdam - Oxford - Tokyo -NY, 1989.