DEPARTMENT OF CHEMISTRY
ANNA UNIVERSITY, CHENNAI

VISION:

The Department of Chemistry at Anna University shall strive towards attaining world class status and recognition by producing students with sound knowledge, professional skills, high levels of integrity and ethical values. The Department shall provide an outstanding ambience for teaching, research and consultancy. The Department shall perform frontier research and create knowledge base in theoretical and applied chemistry, polymeric and catalytic materials, fuel and energy related processes and materials, environmental chemistry and other transdisciplinary areas of technological importance.

MISSION:

The Department of Chemistry, Anna University shall contribute to the educational, economic and social development:

- By producing postgraduates and Doctorates who are equipped with thorough knowledge in Chemistry, analytical thinking, practical skills and ethics.
- By inspiring the students to be creative thinkers, inspirational role models and citizens with environmental and social consciousness.
- By introducing high quality academic and research programmes in Chemistry and enabling interaction with experts from around the world in the fields of Chemistry.
- By ensuring a supportive ambience in the Department with dynamic leadership and growth opportunities to meet the needs of the students, faculty and staff.
- By promoting the development of technologically and socially relevant processes and products in the fields of catalysis, polymers, corrosion resistance coatings and energy conversion through academic and sponsored research, in collaboration with global research groups.
- By sharing the intellectual resources and infrastructural facilities of the Department of Chemistry among the academic fraternity of the University campus and other Institutions, among the industrial research groups, funding agencies and the Government.
- By facilitating collaborative partnership with industries and other institutions and catalyseinnovation, transfer of technology and commercialization towards fulfilling societal developments.
- By benchmarking the teaching-learning and research processes and their outcomes against the Global standards and improvising on them with a clear view towards continuous development.

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UNIVERSITY DEPARTMENTS

REGULATIONS – 2019

M.TECH. POLYMER SCIENCE AND ENGINEERING

CHOICE BASED CREDIT SYSTEM

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. To provide an interdisciplinary specialization in master degree with emphasis on materials, engineering and fundamentals of polymers and their processing.
2. To produce employable graduates with knowledge and competency in scientific and engineering aspects of polymers, complemented by the appropriate skills and attributes.
3. To impart the fundamental concepts of synthetic resins, composites, engineering plastics, adhesives and conducting polymers and their applications in industries.
4. To gain knowledge on biopolymers, specialty polymers and fibers in engineering applications, analytical testing of polymers and plastic waste management.
5. To provide comprehensive knowledge in the field of polymer science and understanding of the professional practice in polymer industries.

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2. PROGRAMME OUTCOMES (POs)

On successful completion of the two years Polymer Science and Engineering programme our graduates will exhibit ability to

PO	Graduate Attribute	Programme Outcome
1.	Engineering knowledge	Apply the knowledge of engineering specialization to the solution of complex engineering problems in industrial applications.
2.	Problem analysis	Identify, formulate and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3.	Design/development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
4.	Conducting investigations of complex problems	Use research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5.	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering to complex engineering activities with an understanding of the limitations.
6.	The Engineer and society	Conduct themselves to uphold the professional and social obligations, to assess societal, health, safety and cultural issues relevant to the professional engineering practice.
7.	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8.	Ethics	Apply ethical principles and commit to professional ethics, responsibilities along with norms of the engineering practice.
9.	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10.	Communication	Communicate effectively on engineering activities with the engineering community and society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11.	Project management and finance	Demonstrate knowledge understanding of the engineering and management principles and apply these as a member and a leader in a team to manage projects.
12.	Life-long learning	Continue professional development and learning as a life-long activity in the context of technological change.

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4. MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVE WITH PROGRAMME OUTCOMES

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1.	√	√	√					√				
2.								√		√	√	
3.			√	√	√		√	√				
4.				√	√					√	√	√
5.			√						√	√	√	√

5. MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

		Course Name	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
YEAR 1	Semester1	Physics and Chemistry of Macromolecules	√		√		√								√	√		√
		Polymer Reaction Engineering	√		√	√	√								√		√	√
		Polymer Product and Mould Design	√			√	√	√					√		√		√	
		Programme Elective I (one from list of electives)																
		Programme Elective II (one from list of electives)																
		Research Methodology and IPR																
		Audit Course – I (one from list of Audit courses)																
		Polymer Technology Laboratory	√	√			√		√							√	√	√
		Mould Design and Analysis Laboratory	√	√			√						√				√	√
	Semester2	Advanced Characterization Techniques for Polymers		√	√	√		√			√				√			√
		Transport Processes	√		√		√	√							√	√		
		Instrumentation in Polymer Industry	√	√	√	√	√				√				√		√	

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		Advanced Polymer Processing Technology	√	√		√	√						√		√	√		√
		Programme Elective III (one from list of electives)																
		Programme Elective IV (one from list of electives)																
		Audit Course – II (one from list of Audit courses)																
		Polymer Analysis and Characterization Laboratory	√			√	√	√							√	√		
		Polymer Processing and Testing Laboratory	√			√	√	√							√	√		√
		Mini Project with Seminar	√	√					√		√	√						
		Internship/ Training																
	Semester3	Programme Elective V																
		Programme Elective VI																
		Open Elective (one from list of 6 courses)																
		Internship/ Training	√	√					√		√		√					
		Project Phase I	√	√	√	√	√	√	√	√	√	√	√	√				
	Semester 4	Project Phase II	√	√	√	√	√	√	√	√	√	√	√	√				

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CHOICE BASED CREDIT SYSTEM

M.TECH. POLYMER SCIENCE AND ENGINEERING (FT)

CURRICULAM AND SYLLABI FOR I TO IV SEMESTER

SEMESTER I

S. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PL5101	Physics and Chemistry of Macromolecules	PCC	3	0	0	3	3
2.	PL5102	Polymer Reaction Engineering	PCC	3	0	0	3	3
3.	PL5103	Polymer Product and Mould Design	PCC	3	0	0	3	3
4.		Program Elective I	PEC	3	0	0	3	3
5.		Program Elective II	PEC	3	0	0	3	3
6.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	PL5111	Polymer Technology Lab	PCC	0	0	4	4	2
9.	PL5112	Mould Design and Analysis Lab	PCC	0	0	4	4	2
			TOTAL	**19**	**0**	**8**	**27**	**21**

*Audit Course is Optional

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SEMESTER II

S. NO.	CODE NO.	COURSETITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PL5201	Advanced Characterization Techniques for Polymers	PCC	3	0	0	3	3
2.	PL5202	Transport Processes	PCC	3	0	0	3	3
3.	PL5203	Instrumentation in Polymer Industry	PCC	3	0	0	3	3
4.	PL5204	Advanced Polymer Processing Technology	PCC	3	0	0	3	3
5.		Program Elective III	PEC	3	0	0	3	3
6.		Program Elective IV	PEC	3	0	0	3	3
7.		Audit Course –II**	AC	2	0	0	2	0
PRACTICALS								
8.	PL5211	Polymer Analysis & Characterization Lab	PCC	0	0	4	4	2
9.	PL5212	Polymer Processing and Testing Lab	PCC	0	0	4	4	2
10.	PL5213	Mini Project with Seminar	EEC	2	0	0	2	2
11.	PL5311	Internship / Training* (Minimum 4 Weeks)	EEC	-	-	-	-	-
			TOTAL	**22**	**0**	**8**	**30**	**24**
*** Internship / Training , Evaluation during III Semester**								

**Audit Course is Optional

SEMESTER III

S. NO.	CODE NO.	COURSETITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective V	PEC	3	0	0	3	3
2.		Program Elective VI	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
4.	PL5311	Internship / Training (Minimum 4 Weeks)	EEC	0	0	4	4	2
5.	PL5312	Project Phase I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**16**	**25**	**17**

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SEMESTER IV

S. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	PL5411	Project Phase II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

Total Credits: 74

Programme Core Courses (PCC)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	PL5101	Physics and Chemistry of Macromolecules	PCC	3	3	0	0	3
2	PL5102	Polymer Reaction Engineering	PCC	3	3	0	0	3
3	PL5103	Polymer Product and Mould Design	PCC	3	3	0	0	3
4	PL5201	Advanced Characterization Techniques for Polymers	PCC	3	3	0	0	3
5	PL5202	Transport Processes	PCC	3	3	0	0	3
6	PL5203	Instrumentation in Polymer Industry	PCC	3	3	0	0	3
7	PL5204	Advanced Polymer Processing Technology	PCC	3	3	0	0	3
8	PL5111	Polymer Technology Laboratory	PCC	4	0	0	4	2
9	PL5112	Mould Design and Analysis Laboratory	PCC	4	0	0	4	2
10	PL5211	Polymer Analysis and Characterization Laboratory	PCC	4	0	0	4	2
11	PL5212	Polymer Processing and Testing Laboratory	PCC	4	0	0	4	2

PROGRAME ELECTIVE COURSE (PEC)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PL5001	Additives and Compounding of Plastics	PEC	3	3	0	0	3
2.	PL5002	Additive Manufacturing	PEC	3	3	0	0	3
3.	PL5003	Adhesive Science and Technology	PEC	3	3	0	0	3
4.	PL5004	Biopolymers and Biodegradable Polymers	PEC	3	3	0	0	3
5.	PL5005	CAD/CAM Application in Mould/Tool Design	PEC	3	3	0	0	3
6.	PL5006	Conducting Polymers	PEC	3	3	0	0	3
7.	PL5007	Engineering Plastics	PEC	3	3	0	0	3
8.	PL5008	Membrane Technology	PEC	3	3	0	0	3
9.	PL5009	Plastics Mould Manufacturing Technology	PEC	3	3	0	0	3
10.	PL5010	Plastics Waste Management	PEC	3	3	0	0	3
11.	PL5011	Polymer Blends and Alloys	PEC	3	3	0	0	3
12.	PL5012	Polymers for Biomedical Engineering Applications	PEC	3	3	0	0	3
13.	PL5013	Polymers for Packaging Applications	PEC	3	3	0	0	3
14.	PL5014	Polymer Nano-composites	PEC	3	3	0	0	3
15.	PL5015	Reinforced Plastics	PEC	3	3	0	0	3
16.	PL5016	Rubber Technology	PEC	3	3	0	0	3
17.	PL5017	Specialty Polymers	PEC	3	3	0	0	3
18.	PL5018	Synthetic Resins	PEC	3	3	0	0	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	RM5151	Research Methodology and IPR	RMC	2	2	0	0	2

OPEN ELECTIVE COURSES [OEC]*

*(Out of 6 Courses one Course must be selected)

S.NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	OE5091	Business Data Analytics	3	0	0	3	3
2.	OE5092	Industrial Safety	3	0	0	3	3
3.	OE5093	Operations Research	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	3	0	0	3	3
5.	OE5095	Composite Materials	3	0	0	3	3
6.	OE5096	Waste to Energy	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lectur	Tutorial	Practical		
1.	AX5091	English for Research Paper Writing	2	0	0	0	1/2
2.	AX5092	Disaster Management	2	0	0	0	
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0	
4.	AX5094	Value Education	2	0	0	0	
5.	AX5095	Constitution of India	2	0	0	0	
6.	AX5096	Pedagogy Studies	2	0	0	0	
7.	AX5097	Stress Management by Yoga	2	0	0	0	
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0	
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0	

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EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PL5213	Mini Project with Seminar	EEC	2	2	0	0	2
2.	PL5311	Internship/Industrial Training	EEC	4	0	0	4	2
3.	PL5312	Project Phase I	EEC	12	0	0	12	6
4.	PL5411	Project Phase II	EEC	24	0	0	24	12

SUMMARY:

CATEGORY/TYPES OF COURSES	SEMESTER WISE CREDITS				TOTAL CREDITS
	Sem 1	Sem 2	Sem 3	Sem 4	
PCC	13	16	---	---	**29**
PEC	6	6	6	---	**18**
RMC	2	---	---	---	**02**
OEC	---	---	3	---	**03**
AC (Non Credit)	✓	✓	---	---	✓
EEC	---	2	8	12	**22**
Total	**21**	**24**	**17**	**12**	**74**

SYLLABI

SEMESTER I

PL5101	**AND CHEMISTRY OF MACROMOLECULES**	**L T P C**
		3 0 0 3

OBJECTIVES:

- To acquire knowledge in fundamental physical and chemistry of polymers
- To know about the molecular orientation, visco-elastic behaviour.
- To inculcate understanding of Polymer rheology.
- To familiarize the polymerization techniques and its types.
- To understand the thermodynamics of polymer dissolutions.

UNIT I STRUCTURAL PROPERTIES 9

Fundamental concepts of Macromolecules - monomer, polymer classifications - End uses - Functionality - Microstructure. Molecular conformation and configuration- Tacticity - Conformation of an ideal chain-mean square end to end distance-freely jointed and freely rotating chain model, worm like chain model, hindered rotation model - radius of gyration of an ideal chain, Gaussian chain - Crystallinity - Fringed micelle model, Folded chain model. Crystallization kinetics-Avrami model, Ozawa model, Kissinger model and Lauritzen-Hoffman Growth Theory.

UNIT II DEFORMATION AND VISCOELASTICITY 8

Deformation of plastic materials - Yielding of plastic materials -Classification of plastic materials based on stress strain relationship - Viscoelasticity - Voight kelvin model, Maxwell model, Burger model - Deborah number -Molecular theory for viscoelasticity - complex modulus and compliance - WLF equation -TTS curve - Boltzmann superposition principle - Creep and stress relaxation.

UNIT III POLYMER RHEOLOGY 8

Basic concepts of rheology - shear stress, shear strain, shear rate - Newtonian and Non Newtonian fluids - power law - time dependant fluid responses -Viscosity measurements - capillary rheometers - viscometer - types of viscometers - torque rheometers - cup flow and spiral flow tests for determination of flow behaviour - MFI, Melt elasticity.

UNIT IV POLYMERIZATION TYPES AND TECHNIQUES 10

Polymerization techniques and types - Mechanism and kinetics of polymerization- free radical, anionic, cationic polymerization, living polymers and chain transfer agent - Kinetics of step growth polymerization - Carothers equation -Copolymerization and its kinetics - copolymer equation - reactivity ratio - Stereo regular polymerization- Zeiglar Natta catalyst -monometallic mechanism - Polymerization reactions- metathetical – electrochemical - group transfer polymerization and ring opening polymerization.

UNIT V POLYMERIC SOLUTION AND MOLECULAR WEIGHT 10

Thermodynamics of polymer dissolution- entropy and heat of mixing of polymer solution - Hilderbrand equation - Flory Huggins and Flory - Kribaumtheory - solubility parameter - equation of state theory - diffusion coefficient - Polymer fractionation - Molecular weight - number and weight average molecular weight - GPC, light scattering, Osmometry - end group analysis - Mark Howanik equation - Viscosity - Determination - Effect of molecular weight on processing and properties - Polymer degradation - Types.

Attested

TOTAL PERIODS: 45

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OUTCOMES:

CO1 Will be aware of the basics of macromolecules and its structural properties.
CO2 Will know the polymerization and visco-elasticity of plastic materials.
CO3 Will understand basic concepts of polymer rheology.
CO4 Will come to know polymerization techniques and its mechanism.
CO5 Will have knowledge on polymeric solution and molecular weight of polymers.

REFERENCE

1. V.R. Gowarikar, Polymer Science, 2nd edition, New Age International Pvt Ltd Publishers, 2015
2. Joel R. Fried, Polymer science and technology, 3rd edition, Prentice Hall, 2014.
3. F.W. Billmayer, Text Book of Polymer Science, 3rd edition, John Wiley and sons, New York, 2008.
4. David I. Bower, An introduction to polymer physics, Cambridge University Press, 2002.
5. PremamoyGhosh, Polymer Science and Technology, 3rdedition, McGraw-Hill Publishing Company Limited, New Delhi, 2011.
6. Ulf W.Gedde, Polymer Physics, 1st edition, Kluwer Academic Publishers, 1999.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will be aware of the basics of macromolecules and its structural properties	3	--	3	--	2	--	--	--	--	--	--	--	3	3	--	3
CO2	Will know the polymerization and visco-elasticity of plastic materials	3	--	3	--	2	--	--	--	--	--	--	--	3	3	--	3
CO3	Will understand basic concepts of polymer rheology	3	--	3	--	2	--	--	--	--	--	--	--	3	3	--	3
CO4	Will come to know polymerization techniques and its mechanism	3	--	3	--	2	--	--	--	--	--	--	--	3	3	--	3
CO5	Will have knowledge on polymeric solution and molecular weight of polymers	3	--	3	--	2	--	--	--	--	--	--	--	3	3	--	3
Overall CO		3	--	3	--	2	--	--	--	--	--	--	--	3	3	--	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5102	POLYMER REACTION ENGINEERING	L T P C
		3 0 0 3

OBJECTIVES:

- To acquire knowledge in reaction kinetics and evaluation of reaction rate.
- To familiarize in chemical equilibria and equilibrium constant
- To know about the effect of mixing on kinetics and MWD
- To understand about the design of reactors for various polymerization techniques
- To know about the safety aspects in polymerization reactors.

UNIT I REACTION KINETICS AND EVALUATION OF REACTION RATE 8

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

UNIT II INTRODUCTION TO POLYMERIZATION PROCESSES 9

Micro structural features of polymers and their effect on properties, Classes of polymerizations, Polymerization techniques & polymerization reactors. Important aspects of polymers, polymerization reaction engineering as compared with monomers and their reaction engineering, the effect of mixing on kinetics and MWD.

UNIT III FREE-RADICAL AND STEP-GROWTH POLYMERIZATION 9

Free-radical polymers: properties and applications, FRP mechanisms and kinetics, Controlled radical polymerization, Polymer reaction engineering aspects, Overview of Free-Radical polymerization: Heterogeneous Systems. Polymerization kinetics and modelling, Industrial step growth products, processes and modeling

UNIT IV COORDINATION, SUSPENSION AND EMULSION POLYMERIZATION 10

Polyolefin types: micro-structural classification and analytical techniques, Catalysts for olefin Polymerization, Polymerization kinetics for single- and multiple-site catalysts, Inter- and intra-particle mass and heat transfer resistances, Industrial olefin polymerization reactors, Metallocene polyolefin's reactor, Smith-Ewart Model, Emulsion polymerization reactors, Inverse emulsion polymerization, Mini-emulsion polymerization, Micro-emulsion polymerization, Dispersion polymerization.

UNIT V POLYMERIZATION REACTORS 9

Design of reactors for free radical, step growth polymerization and for copolymerization - polymerization in batch and flow reactors - analysis of rate equation - principle of chemical reactor safety applied to polymerization reactors.

TOTAL PERIODS: 45

OUTCOMES

CO1 Can grasp the idea of chemical equilibria and equilibrium constant
CO2 Will be able to analyze the effects of various process parameters on Kinetics of Polymerization
CO3 Understand the kinetics in heterogeneous polymerization systems.
CO4 Will be able to understand different Polymerization reactors used for production of polymers
CO5 Will be familiar with the design of reactors for free radical and step growth polymerization.

REFERENCE:

1. Octave Levenspiel, “Chemical Reaction Engineering”, 3rd edition, John Wiley & Sons, 1998.
2. AsuaJ. M., Polymer Reaction Engineering, Edited by Blackwell Publishing, 2008.
3. Gupta S. K. and Anil kumar,” Reaction Engineering of Step Growth Polymerization”, Plenum Press, New York 1987.
4. McGreavy,” Polymer Reactor Engineering” Blackie Academic & Professional, Chapman& Hall,1994
5. Dr.Thierry Meyer and Prof. J. Keurentjes “Handbook of Polymer Reaction Engineering”, Wiley-VCH Verlag GmbH & Co. KGaA, 2005.
6. J.A. Biesenberger and D.H. Sebestian, “Principles of Polymerization Engineering”, Wiley,1983.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome														
		PO1	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	PSO 4
CO1	Can grasp the idea of chemical equilibria and equilibrium constant	3	--	3	3	3	-	-	-	-	-	-	-	3		3	2
CO2	Will be able to analyze the effects of various process parameters on Kinetics of Polymerization	3	--	3	3	3	-	-	-	-	-	-	-	3	-	3	2
CO3	Understand the kinetics in heterogeneous polymerization systems	3	--	3	3	3	-	-	-	-	-	-	-	3	-	3	2
CO4	Will be able to understand different Polymerization reactors used for production of polymers	3	--	3	3	3	-	-	-	-	-	-	-	3	-	3	2
CO5	Will be familiar with the design of reactors for free radical and step growth polymerization	3	--	3	3	3	-	-	-	-	-	-	-	3	-	3	2
Overall CO		3	-	3	3	3	-		-	-	-	-	-	3	-	3	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5103 POLYMER PRODUCT AND MOULD DESIGN L T P C

3 0 0 3

OBJECTIVES:

- To learn about the basic concepts of polymer product design.
- To know about the design concepts of mold and die
- To acquire knowledge about the design of extrusion and injection mould dies
- To understand the design concepts in compression and transfer moulding.

UNIT I BASIC CONCEPTS OF PRODUCT DESIGN 9

Mould material selection - polymeric material and its processing effects on performance of parts and its limitation on product design -tooling and cost analysis for product design -polymeric product design concept -design of radii, fillets, ribs and bosses, design of parting line, wall thickness, holes - drilled and tapped holes, taper or draft - design of hinges and snap for boxes - feed system - sprue, runner & gate - ejector system - mould vent - venting method - external & internal undercuts - internal & external thread- threaded holes - assembly - fits & tolerances.

UNITII POLYMERIC PRODUCT DESIGN 9

Structural design of beams, columns, plates, bars, pipes and other structural members - design procedure for polymeric parts - design of plastic structural parts for static and dynamic load - gears and bearings design - design of plastic parts for electrical and optical applications - basic design configuration for elastomeric seals and rings- product design for composites.

UNIT III INJECTION MOLD DESIGN 10

General mould construction - core, cavity, guide pillar,feed system & ejection system and techniques -Two plate mould - Stripper plate mould - three plate mould-single impression and multi- impression - split moulds - finger cam and dog-leg cam actuation mould-inserts - Selection of metal for inserts - side cores and side cavities -split cores- relieving moulding stress around inserts - flow characteristics - injection pressure -injection speed- hold on time- gate freezing - clamping force calculation -temperature control system - cooling system.

UNIT IV EXTRUSION DIE DESIGN 9

Important aspects of die design - basic geometry of die- die land design - die swell - types of extrusion die - film, sheet, pipe, tube, wire/cable coating dies, co-extrusion die - spiral mandrel die, fish tail die, adjustable core die - extrusion die for rubber parts - heating system - temperature control - effect of temperature and pressure on die design.

UNIT V OTHER MOLD DESIGNS 8

Compression mold and transfer mold design - designing of open flash, positive and semi positive mould, pot and plunger - calculation of pressure, projected area, clamping force, flash thickness, bulk factor - blow moulds - types - parison and pinch off design -rotational mould design.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will be familiar with respect to the basic concepts of product design.
CO2 Will able to design mold/die for different molding process.
CO3 Basic knowledge in design aspect for different polymeric materials.
CO4 Will be thorough in the design concepts for various plastic parts by injection moulding
CO5 Knowledge in designing the die for plastic parts by extrusion moulding.

REFERENCE:

1. Harold Belofsky, “Plastics Product Design and Process Engineering”, SPE, HanserPublication, 1995.
2. Sanjay K Nayak, “Fundamentals of Plastics Mould Design”, 1st edition, Mcgraw Hill, New Delhi, 2012.
3. *J.Y.H. Fuh, “Computer-Aided Injection Mold Design and Manufacture”, 1st edition,* CRC-Taylor and Francis group*, 2004.*
4. Dym J.B, “Injection Mould & Moulding, A practical Manual”, 2nd edition, Springer, 1987.
5. Hopmann, Michaeli, “Extrusion dies for plastics and rubbers”, 4th edition, Hanser publication, 2016.
6. Robert A. Malloy, “Plastic Part Design for Injection Moulding”, Hanser Pub., MunichVienna NY, 1994.

Course Articulation Matrix:

Course Outcomes	Statement	Program 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	PSO 4
CO1	Will be familiar with respect to the basic concepts of product design	3	-	-	2	3	2	-	-	-	-	2	-	3	-	3	-
CO2	Will able to design mold/die for different molding process	3	-	-	2	3	2	-	-	-	-	2	-	3	-	3	-
CO3	Basic knowledge in design aspect for different polymeric materials	3	-	-	2	3	2	-	-	-	-	2	-	3	-	3	-
CO4	Will be thorough in the design concepts for various plastic parts by injection moulding	3	-	-	2	3	2	-	-	-	-	2	-	3	-	3	-
CO5	Knowledge in designing the die for plastic parts by extrusion moulding	3	-	-	2	3	2	-	-	-	-	2	-	3	-	3	-
Overall CO		3	-	-	2	3	2	-	-	-	-	2	-	3	-	3	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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RM5151 RESEARCH METHODOLOGY AND IPR

L T P C
2 0 0 2

COURSE OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.

Traditional knowledge Case Studies, IPR and IITs.

TOTAL PERIODS: 30

COURCE OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

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

REFERENCES:

1. Asimov, “Introduction to Design”, Prentice Hall, 1962.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners” 2010

PL5111 **POLYMER TECHNOLOGY LAB** **L T P C**
0 0 4 2

OBJECTIVES:

- To make the student conversant with polymer synthesis and kinetics of polymerization
- To enable students develop their determination of reactivity ratio and molecular weight.
- To know about the importance of fractionation of polymers.
- To understand about the emulsion polymerisation.

UNIT I POLYMERIZATION TECHNIQUES **20**

Polymer synthesis - bulk, solution, emulsion, suspension and slurry polymerization- low and high temperature condensation polymerization, interfacial poly-condensation, thermal and redox initiated polymerizations - kinetics of polymerization - preparation of IPN polymer.

UNIT II PREPARATION OF COPOLYMER AND THERMOSET RESIN **20**

Copolymerization of styrene and MMA - determination of reactivity ratio of MMA - styrene copolymer, preparation of an epoxy resin and unsaturated polyester resin, PF, UF, MF resin - determination of cure of resin - determination of acid value of resin.

UNIT III MOLECULAR WEIGHT DETERMINATION **10**

Determination of Molecular weight - viscometry, end group analysis, GPC, light scattering, osmometry.

UNIT IV FRACTIONATION OF POLYMERS **5**

Fractionation of polymers - Fractional precipitation method - poly-dispersity.

UNIT V EMULSION- PAINT **5**

Emulsion polymerization - paint formulation, coating.

TOTAL PERIODS: 60

OUTCOMES:

CO1 Will gain awareness in synthesis and kinetics of polymers.
CO2 Will be able to methodically discuss fractionation of polymers.
CO3 Practice in the determination of molecular weight for macromolecule
CO4 Will be aware in the synthesis of polymer using different polymerization techniques
CO5 Practical knowledge in the preparation of copolymer and thermoset resin

REFERENCE:

1. Edward A. Colloind, J.Bares and F.W. Billmeyer Jr., “Experiments in Polymer Science”, Wiley Interscience, New York 1973.
2. Wayne R.Sorenson and T.W.Campbell, “Preparative Methods of Polymer Chemistry” 3rd edition, Wiley – Interscience, New York, 2001.
3. Tim A. Oswald Georg Menges, “Material Science of Polymers for Engineers”, HanserPublications, 2012.
4. E.M.McCaffery, “Laboratory Preparation for Macromolecular Chemistry”, McGraw Hill, Kogakush, 1970.
5. Chorng- Shyan Chern, “Principle and Application of Emulsion Polymerization”, John Wiley & Sons, 2008.
6. Stanley Sandler, “Polymer Synthesis and Characterization”, Academic press, 1998.

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Course Articulation Matrix:

Course Outcomes	Statement	Program 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	PSO 4
CO1	Will gain awareness in synthesis and kinetics of polymers	3	2	-	-	3	-	2	-	-	-	-	-	-	3	3	3
CO2	Will be able to methodically discuss fractionation of polymers	3	2	-	-	3	-	2	-	-	-	-	-	-	3	3	3
CO3	Practice in the determination of molecular weight for macromolecule	3	2	-	-	3	-	2	-	-	-	-	-	-	3	3	3
CO4	Will be aware in the synthesis of polymer using different polymerization techniques	3	2	-	-	3	-	2	-	-	-	-	-	-	3	3	3
CO5	Practical knowledge in the preparation of copolymer and thermoset resin	3	2	-	-	3	-	2	-	-	-	-	-	-	3	3	3
Overall CO		3	2	-	-	3	-	2	-	-	-	-	-	-	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5112 MOULD DESIGN AND ANALYSIS LABORATORY L T P C

0 0 4 2

OBJECTIVES:

- To learn about the basics in designing of mould and die.
- To understand the basics in injection mould design
- To know about mould flow simulation and FEA
- To understand about rapid prototyping and PLC

UNIT I BASIC MODELING AND DRAFTING 12

2D drawing and drafting using sketcher workbench (2 drawings) - 3D modeling and drafting using 3D features (3 models) - Assembling and drafting (2 assemblies) - Surface modeling (2 exercises) - 2D and 3D modeling of plastic components using CAD.

UNIT II INJECTION MOULD DESIGN 12

Mold design concept- Fixed clamping plate, cavity plate, back plate, ejector retainer plate, ejector back plate, movable clamping plate, runner, gate, side cores and its assembly -Design calculation for number of cavities, plasticizing rate, clamping force- 2D, 3D designing and modeling of single cavity mould, Multi cavity mould, split mould, finger cam mould.

UNIT III MOULD/DIE DESIGN 12

2D, 3D designing and modeling of compression, transfer moulds - calculation of bulk factor, clamping force, flash thickness allowance - 2D, 3D designing and modeling of blow moulds - calculation of pinch off, head die design, parison dimension- 2D, 3D designing and modeling of extrusion die.

UNIT IV FLOW ANALYSIS 12

Design and process parameter optimization - Mold flow simulation - finite element analysis, meshing - Mold flow analysis- Fill analysis, pack analysis, cool analysis, warp analysis, shrinkage analysis, gate location analysis, runner balance analysis, stress analysis.

UNIT V PRODUCT LIFE CYCLE AND PROTOTYPING 12

Programs on PLC for plastic products (3-5 programs) - Rapid Prototyping and Reverse Engineering.

TOTAL PERIODS: 60

OUTCOMES:

CO1 Will be able to design and develop any type of mold and die for plastic products.
CO2 Will be able to analyse the flow behavior using mould flow analysis
CO3 Will gain knowledge in the designing of complicated parts involved in injection moulding
CO4 Assembly and drafting of components in 2D and 3D models.
CO5 Understanding the concepts of PLC and rapid prototyping

REFERENCE:

1. "Design calculations for Compression moulds", Machinery publications, Yellow series, U.K.
2. Herbert Rees, "Mould Engineering", Hanser publishers, Munich, Vienna N.Y. 1994.
3. Jay Shoemaker, "Moldflow Design Guide: A Resource for Plastics Engineers", Volume10, 1st edition, Mold flow corporation, 2006
4. LaszcoSors and ImreBlazs, "Design of Plastic Moulds and Dies", Elsevier, Amsterdam - Oxford - Tokyo - NY, 1989.
5. "Mould Flow Manual & Part - Adviser Manual" - MOULD FLOW.
6. Max Giordano, Luc Matheiu and Francois Villeneuve, "Product Lifecycle Management - Geometric Variations", Wiley, 2013.

Course Articulation Matrix:

COURSE OUTCOMES	STATEMENT	PROGRAM 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	PSO 4
CO1	Will be able to design and develop any type of mold and die for plastic products	3	3	-	-	3	-	-	-	2	-	2	-	-	-	3	3
CO2	Will be able to analyse the flow behavior using mould flow analysis	3	3	-	-	3	-	-	-	2	-	2	-	-	-	3	3
CO3	Will gain knowledge in the designing of complicated parts involved in injection moulding	3	3	-	-	3	-	-	-	2	-	2	-	-	-	3	3
CO4	Assembly and drafting of components in 2D and 3D models	3	3	-	-	3	-	-	-	2	-	2	-	-	-	3	3
CO5	Understanding the concepts of PLC and rapid prototyping	3	3	-	-	3	-	-	-	2	-	2	-	-	-	3	3
Overall CO		3	3	-	-	3	-	-	-	2	-	2	-	-	-	3	3

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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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SEMESTER II

PL5201 ADVANCED CHARACTERIZATION TECHNIQUES FOR POLYMERS L T P C

3 0 0 3

OBJECTIVES:

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

UNIT I CHARACTERIZATION TECHNIQUES: 9

Thermal analysis (TGA, DTA, DSC, TMA) - Electron Microscopes (SEM, TEM, AFM) - Chromatography (GC, GPC) - X-ray Diffraction - Structure Identification (IR, NMR) - Melt index and viscosity.

UNIT II THERMAL AND ELECTRICAL PROPERTIES 9

Thermal conductivity - Thermal Expansion - Linear coefficient - HDT - VICAT softening - Brittleness - Temperature - dielectric strength, dielectric constant, dissipation factor - arc resistance.

UNIT III MECHANICAL PROPERTIES, FLAMMABILITY AND HARDNESS 9

Tensile tests - strength, modulus and Elongation - Flexural and compression properties - Impact properties - Types - Izod - charpy, chip and drop impact tests - Flammability test (Non rigid, solid plastics) Hardness tests (Rockwell, Durometer, Barcol).

UNIT IV IGNITION & OPTICAL PROPERTIES AND ANALYTICAL TESTS 9

Ignition Temperature - Oxygen Index Test - Refractive Index, luminous transmittance, haze, density, water absorption, moisture analysis - sieve analysis, crush and burst strength.

UNIT V TESTING OF FOAM PLASTICS, NON DESTRUCTIVE TESTING AND TESTING ORGANIZATIONS 9

Foam properties, rigid, flexible foam - methods of testing - ultrasonic techniques - Testing organization - ASTM, ANSI, NBS, NEMA, NFPA, VL, SPI AND SPE

TOTAL PERIODS: 45

OUTCOME

CO1 Will be able to discuss the characterization techniques of polymers.
CO2 Will be aware of testing of Thermal and electrical properties of polymers.
CO3 Will come to know the mechanical, flammability and hardness test of polymers.
CO4 Will be able to understand ignition, optical and analytical tests of polymers.
CO5 Will be able to learn testing of foam plastics and ultrasonic non-destructive testing of polymers

REFERENCE:

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

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Course Articulation Matrix

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Will be able to discuss the characterization techniques of polymers	-	2	2	3	-	2	-	-	2	-	-	-	3	-	-	3
CO2	Will be aware of testing of Thermal and electrical properties of polymers	-	2	2	3	-	2	-	-	2	-	-	-	3	-	-	3
CO3	Will come to know the mechanical, flammability and hardness test of polymers	-	2	2	3	-	2	-	-	2	-	-	-	3	-	-	3
CO4	Will be able to understand ignition, optical and analytical tests of polymers	-	2	2	3	-	2	-	-	2	-	-	-	3	-	-	3
CO5	Will be able to learn testing of foam plastics and ultrasonic non-destructive testing of polymers	-	2	2	3	-	2	-	-	2	-	-	-	3	-	-	3
Overall CO		-	2	2	3	-	2	-	-	2	-	-	-	3	-	-	3

Attested

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5202	TRANSPORT PROCESSES	L T P C
		3 0 0 3

OBJECTIVES:

- To acquire knowledge on momentum transport process.
- To learn about the solution to equations of motion.
- To understand the basic concepts of heat transfer by conduction and convective process.
- To learn about mass transfer in laminar and turbulent flow.
- To learn about the analogy between heat, mass and momentum transport processes.

UNIT I MOMENTUM TRANSPORT PROCESS **9**

Momentum transport –fluid behavior – overall mass, energy and momentum balances –differential mass, energy and momentum balance-polymeric liquids.

UNIT II SOLUTION TO EQUATIONS OF MOTION **9**

Solution to equations of motion - flow measurement - boundary layer flow – turbulent flow– dimensional analysis applied to momentum transport – design equation for incompressible fluid flow through packed column–fluidization.

UNIT III HEAT TRANSFER BY CONDUCTION PROCESS **9**

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

UNIT IV CONVECTIVE HEAT TRANSFER PROCESS **9**

Convective heat transfer – heat transfer in laminar and turbulent flow- boiling and condensation– design equations for convective heat transfer – heat exchangers.

UNIT V MASS TRANSFER **9**

Mass transfer – molecular diffusion – binary systems – convective mass transfer coefficients – mass transfer in laminar and turbulent flow –design equations for convective mass transfer – analysis between momentum, heat and mass transfer.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will be aware of momentum transport process
CO2 Will be able to know about solution to equations of motion.
CO3 Will be able to methodically discuss heat transfer by conductive and convective process
CO4 Will be familiar with heat exchangers.
CO5 Will understand the importance of mass transfer.

REFERENCE:

1. R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot, “Transport Phenomena”, 2nd edition, John Willey & Sons, 2006.
2. C.J.Geankoplis, “Transport Processes and Unit Operation”, 3rd edition, Prentice Hall,1993.
3. J.R.Welty, C.E. Wicks, G. L. Rorrer and R.E.Wilson, “Fundamentals of Momentum, Heatand Mass transfer”, 5th edition, John – Wiley & Sons, New York, 2007.
4. C.J. Geankoplis, “Transport Processes – Momentum, Heat and Mass”,(Allyn and BaconInc), Boston, USA 1983.
5. Robert Ewald Treybal, Mass-transfer Operations,McGraw-Hill, 1980

Course Articulation Matrix: TRANSPORT PROCESSES

COURSE OUTCOMES	STATEMENT	PROGRAM OUTCOME															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO1	Will be aware of momentum transport process	3	-	2	-	3	2	-	-	-	-	-	-	3	3	-	-
CO2	Will be able to know about solution to equations of motion	3	-	2	-	3	2	-	-	-	-	-	-	3	3	-	-
CO3	Will be able to methodically discuss heat transfer by conductive and convective process	3	-	2	-	3	2	-	-	-	-	-	-	3	3	-	-
CO4	Will be familiar with heat exchangers	3	-	2	-	3	2	-	-	-	-	-	-	3	3	-	-
CO5	Will understand the importance of mass transfer	3	-	2	-	3	2	-	-	-	-	-	-	3	3	-	-
Overall CO		3	-	2	-	3	2	-	-	-	-	-	-	3	3	-	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5203 INSTRUMENTATION IN POLYMER INDUSTRY L T P C

3 0 0 3

OBJECTIVES:

- To make the student familiar with the process variables and their measurement.
- To understand about the use of mathematical analysis of processes
- To acquire knowledge on Computer control and applications.
- To acquaint student with the instrumentation involved in blow moulding
- To understand about instrumentation in extrusion and injection moulding.

UNIT I PROCESS VARIABLES 8

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

UNIT II MEASUREMENT AND CONTROL 10

Measurement and control – Simple systems-first and higher order systems- Design specifications on system time response – feedback control diagram – proportional, integral, derivative and PID controls.

UNIT III MATHEMATICAL ANALYSIS 10

Mathematical analysis of processes and feedback control systems –poles, zeros and system stability-Stability Analysis- Routh's Test-Root locus-frequency response using Bode plot.

UNIT IV COMPUTER CONTROL 8

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

UNIT V INSTRUMENTATION 9

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

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will be familiar with the various process variables and their measurements.
CO2 Will understand about the concepts of first and second order systems
CO3 Will gain knowledge on stability analysis for control systems.
CO4 Will be able to use computer control and its applications effectively.
CO5 Will understand the instrumentation concepts of blow, injection and extrusion moulding

REFERENCE:

1. Steven E. LeBlanc and D.R.Coughanour, "Process Systems Analysis and Control",McGraw Hill Book Co., 3rd Edition, 2009.
2. D.M. Considine, "Process/Industrial Instruments & Controls Handbook", 4th edition, McGraw-Hill Inc., New York (1993).
3. D.V.Rosato, "Blow Moulding Hand book", 2nd edition, Hanser Publications, 2004.
4. Allan L. Griff, "Plastic Extrusion Technology, Reinhold Plastics Applications Series",Krieger publisher,1976.
5. A.Whelan, "Developments in Injection Moulding", Applied SciencePublications,1989.
6. Sidney Levy, "Plastic Extrusion Technology Hand Book", Industrial Press Inc.,NewYork, 1989.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Will be familiar with the various process variables and their measurements	3	3	2	2	3	-	-	-	2	-	-	-	3	-	3	-
CO2	Will understand about the concepts of first and second order systems	3	3	2	2	3	-	-	-	2	-	-	-	3	-	3	-
CO3	Will gain knowledge on stability analysis for control systems	3	3	2	2	3	-	-	-	2	-	-	-	3	-	3	-
CO4	Will be able to use computer control and its applications effectively	3	3	2	2	3	-	-	-	2	-	-	-	3	-	3	-
CO5	Will understand the instrumentation concepts of blow, injection and extrusion moulding	3	3	2	2	3	-	-	-	2	-	-	-	3	-	3	-
Overall CO		3	3	2	2	3	-	-	-	2	-	-	-	3	-	3	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5204 ADVANCED POLYMER PROCESSING TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To learn about the raw materials in the manufacture of various monomers.
- To learn about the specific technology of polymerization for different polymers
- To learn about the advancement in Injection and Blow moulding
- To provide exposure on special moulding techniques.

UNIT I RAW MATERIALS 7

Petroleum, natural gas, biogas and coal sources of monomers - manufacture of acetylene, ethylene, propylene, vinyl chloride, toluene, phenol and styrene.

UNIT II POLYMERIZATION TECHNIQUES 9

Condensation and solution polymerization - melt, interfacial, gas phase - bulk, dispersion, solution, suspension and emulsion - RAFT and ATRP polymerization - specific technology of polymerization - polystyrene, LDPE, HDPE, LLDPE, nylons, butyl rubber, polypropylene, PVC and PET - copolymerization techniques - SBR and ABS.

UNIT III EXTRUSION AND BLOW MOULDING 10

Analysis of flow in extruder - drag flow, pressure flow, leak flow - extruder/die characteristics - screw geometry -basic flow patterns in extrusion die - die exit instabilities - die swell -processing methods based on extruder (granule production, profile production, pipe and corrugated pipe, co extrusion, film blowing, multilayer extrusion) - blow moulding - extrusion and injection stretch blow moulding, advance blow moulding - deep draw double wall blow moulding, press blow moulding, 3 dimensional blow moulding - extrusion coating process (sheet coating and wire covering).

UNIT IV INJECTION MOULDING 9

Injection moulding machines and its components, its types- its process - moulds, multi cavity moulds, mould clamping devices, mould clamping force, disc moulding, injection blow moulding, reaction injection moulding - co injection moulding - two colour injection moulding - gas assisted injection moulding - multi layer injection moulding - liquid injection moulding - counter flow moulding.

UNIT V SPECIAL MOULDING TECHNIQUES 10

Analysis of calendaring, methods of sheet forming - Thermoforming - vacuum forming, pressure forming and matched mould forming - Rotation moulding, processing and analysis of compression moulding, transfer moulding -sintering - solution casting - Sheet molding and dough molding compounds - Processing technology of elastomers - processing of natural and synthetic rubbers - vulcanization, mastication and cyclisation -plastic finishing techniques, powder coating, metallizing.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will be aware in the synthesis of raw materials from petroleum byproducts
CO2 Will know about the specific technology of polymerization for different polymers
CO3 Will be able to discuss methodically the various types of injection moulding
CO4 Will be aware of advancement in the extrusion techniques used for processing polymers.
CO5 Will gain knowledge in the special moulding operations

REFERENCE:

1. John Brydson, “Plastic materials”, 7th edition, Butterworth - Heinamann Ltd., London, 2014.
2. J.A. Biesenberger and H.Sebastian, “Principles of Polymerization Engineering”, Wiley-Interscience Publication, New York, 2004.
3. Charles A.Harper, “Hand book of Plastic Processing”, Willey Publication,2014
4. W.S. Allen & P.N. Baker, “Hand Book of Plastic Technology”, Vol.1, CBS publishers,2009.
5. Myer Kutz, “Applied Plastics Engineering Handbook: Processing, Materials and Applications”, 2nd edition, 2017.
6. Tim A. Osswald Georg Menges, “Material Science of Polymers for Engineers”, Hanser Publications, 2012.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Will be aware in the synthesis of raw materials from petroleum by products	3	2	-	2	3	-	-	-	-	-	2	-	3	3	-	3
CO2	Will know about the specific technology of polymerization for different polymers	3	2	-	2	3	-	-	-	-	-	2	-	3	3	-	3
CO3	Will be able to discuss methodically the various types of injection moulding	3	2	-	2	3	-	-	-	-	-	2	-	3	3	-	3
CO4	Will be aware of advancement in the extrusion techniques used for processing polymers	3	2	-	2	3	-	-	-	-	-	2	-	3	3	-	3
CO5	Will gain knowledge in the special moulding operation	3	2	-	2	3	-	-	-	-	-	2	-	3	3	-	3
Overall CO		3	2	-	2	3	-	-	-	-	-	2	-	3	3	-	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5211 POLYMER ANALYSIS AND CHARACTERISATION LAB L T P C

0 0 4 2

OBJECTIVES:

- To identify the plastics and rubber materials.
- To learn about the electrochemical analysis of polymers.
- To enable the students to interpret the data obtained from DSC and TGA

UNIT I IDENTIFICATION 20

Identification of plastics - PP, PE, polyamide, polyester, PVC, NBR, PS, ABS, PC, IIR, SBR, Thiokol, CR, Butyl rubber, etc.

UNIT II ANALYSIS METHODS 20

MFI, Brookefield viscometer - oxygen index - filler content determination (muffle furnace) - determination of carbon black content - density measurement, electrochemical analysis - cyclic voltammetry, chronopotentiometry, chronoamperometry,

UNIT III INTERPRETATION 20

Surface morphology study – SEM, Interpretation of DSC, TGA, IR and NMR.

TOTAL PERIODS: 60

OUTCOMES:

CO1 Will be able to identify the polymeric materials.
CO2 Will be able to determine the filler and carbon black content
CO3 Will be able to measure the flow property and density
CO4 Will be familiar with the characterization of conducting polymers
CO5 Will have knowledge in the use of SEM

REFERENCE:

1. Dietrich Braun, “Simple Methods for identification of plastics”, 5th edition, 2013.
2. Campbell and J. R. White, “Polymer Characterization Physical Techniques”, Chapmanand Hall, London, 1989.
3. Charles L. Rohn, “Analytical Polymer Rheology”, Hanser Publishers, Munich, 1995.
4. Edith A. Turi, “Thermal Characterization of Polymeric Materials”, 2nd edition 1997.
5. J. Spells, “Characterization of Solid Polymers”, Chapman and Hall, London, 1994.
6. T.R. Crompton, “Characterization of Polymers”, volume 1 and 2, SmithersRapra Technology Limited, 2008.

Course Articulation Matrix

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Will be able to identify the polymeric materials	3	-	-	2	3	2	-	-	-	-	-	-	3	3	-	-
CO2	Will be able to determine the filler and carbon black content	3	-	-	2	3	2	-	-	-	-	-	-	3	3	-	-
CO3	Will be able to measure the flow property and density	3	-	-	2	3	2	-	-	-	-	-	-	3	3	-	-
CO4	Will be familiar with the characterization of conducting polymers	3	-	-	2	3	2	-	-	-	-	-	-	3	3	-	-
CO5	Will have knowledge in the use of SEM	3	-	-	2	3	2	-	-	-	-	-	-	3	3	-	-
Overall CO		3	-	-	2	3	2	-	-	-	-	-	-	3	3	-	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5212 POLYMER PROCESSING AND TESTING LAB L T P C

0 0 4 2

OBJECTIVES:

- To enable the students to learn about testing of polymers using various standards.
- To gain practical knowledge about molding techniques.
- To learn about mixing operations.

UNIT I MECHANICAL TESTING 15

UTM- tensile, compression, flexural - Impact test- Izod/Charpy - Abrasion resistance and hardness test.

UNIT II ELECTRICAL AND OPTICAL TESTING 10

Dielectric test and arc resistance test - Light transmittance and Opacity - gloss.

UNIT III PRODUCT TESTING 10

Bottle testing - drop impact, Pipe testing - hydrostatic pressure (Burst strength) -Woven sack and film testing - UTM, dart impact.

UNIT IV PROCESSING 15

Injection molding**-** Compression molding**-** Extrusion- pipe, films, rods -Blow molding - FRP - Hand lay up process.

UNIT V MIXING/BLENDING 10

Two roll mill- Banbury mixer- ribbon blender.

TOTAL PERIODS: 60

OUTCOMES:

CO1 Will able to troubleshoot the processing flaws.
CO2 Will able to assure the quality of plastic parts by using various testing.
CO3 Will gain knowledge on specifications of testing devices.
CO4 Will be familiar with plastic products testing
CO5 To acquire knowledge on various testing standards.
.

REFERENCE:

1. R.P. Brown, “Hand Book of Plastics Test Methods”, George Godwin Ltd., London,1981
2. Vishu Shah, “Hand Book of Plastics Testing Technology”, John Wiley & Sons. Inc. New York, 1998.
3. Brycle, D.M., “Plastics Injection Moulding”
4. Schwartz & Goodman., “Plastics Materials & Processing”
5. Levy, Sydney and Carley, James F., “Plastics Extrusion Technology Hand Book”, 2nd edition, Industrial Press Inc., Newyork 1989.
6. James. L White and Sug Hun Bumm, “Polymer Blend compounding and Processing”, Encyclopedia of Polymer blends, Volume: 2, Processing First Edition 2011.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will able to troubleshoot the processing flaws	3	-	-	2	3	2	-	-	-	-	-	-	3	2	-	3
CO2	Will able to assure the quality of plastic parts by using various testing	3	-	-	2	3	2	-	-	-	-	-	-	3	2	-	3
CO3	Will gain knowledge on specifications of testing devices	3	-	-	2	3	2	-	-	-	-	-	-	3	2	-	3
CO4	Will be familiar with plastic products testing	3	-	-	2	3	2	-	-	-	-	-	-	3	2	-	3
CO5	To acquire knowledge on various testing standards	3	-	-	2	3	2	-	-	-	-	-	-	3	2	-	3
Overall CO		3	-	-	2	3	2	-	-	-	-	-	-	3	2	-	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5001 ADDITIVES AND COMPOUNDING OF PLASTICS L T P C
3 0 0 3

OBJECTIVES:

- To know about various additives like Antioxidants, Metal deactivators Lubricants, Fillers, fibres, flame retardants, colourants, anti-oxidants, Antistatic agents etc.
- To understand the functions of each of these additives, technical requirements,
- To learn about the additive types, mechanism and their effective evaluation.

UNIT I INTRODUCTION 11

Introduction to additives- Classification of additives- need and function of additives-Antioxidants-structure, auto oxidation of synthetic polymers, Mechanism, requirements and testing- Metal Deactivators – Mechanism of inhibition, requirements, structural classes and testing – Light Stabilizers – Photo oxidation scheme, Mechanism of stabilization and testing – Plasticizers-theories of plasticizing – lubrication theory, solvation theory, thermodynamic theory, polarity theory –Nucleating agents - Lubricants – Anti sliping agent – Antistatic agent – antiblocking agents – blowing agent – flame retardant – toughening agent.

UNIT II COLORANTS AND COLORING TECHNOLOGY 9

Optical principles and phenomena – Metamerism, Dichroism – General properties, Colorants – White pigment, Black colorants, Inorganic colorants – Oxidic colored pigments, hydroxyl pigments, sulfidic pigments, chromates – Organic colored pigmets- azo pigments, non azo pigments – Coloring technology – Selection criteria, Dispersion, break down, wetting, distribution, cohesive forces- coloration techniques – Coloration with pigment powders, coloration with pigment concentrates.

UNIT III FILLERS AND REINFORCEMENT 9

Theories and action of fillers and reinforcement- properties of filled and reinforced plastics – Economical importance – Description of filler and reinforcements – Calcium Carbonate, Dolomite, Silicates, Talc, Kaolin, Mica, Feldspar, Wollastonite, metal and metal oxides Carbon, carbon black, graphite, basalt fiber, carbon fiber, sisal fiber, boron fiber, electrically conducting fillers.

UNIT IV COMPOUNDING TECHNIQUES 7

Selection criteria of polymers and compounding ingredients - General objectives - possibilities and limitations of mixing and compounding-Principle of mixing and compounding - Methods of incorporation of additives into polymer materials.

UNIT V COMPOUNDING EQUIPMENTS 9

Mixing and mixing equipment's. Principles- Operating characteristics- Machine construction-Specifications -Process control systems and working details of Batch mixers and continuous mixers - High speed mixer -Two roll mill-Banbury Mixer-Ribbon blender - twin drum tumbler -Z blade mixer - Planetary mixers-Single Screw extruder-Twin Screw extruder.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will able to know the basics of additives and its influence on polymeric materials
CO2 Will learn about various additives used in polymeric industries
CO3 Will identify the required additive for specified properties.
CO4 Will grasp idea about colourant and colouring technology.
CO5 Will able to identify the suitable compounding techniques and equipments.

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REFERENCE:

1. R. Gachter and H.Muller, “Plastics additive handbook”, 4th edition, Hanser publications, 1993
2. Manas-Zloczower, “Mixing and Compounding of Polymers”, 2nd edition, Hanser Publications, 2009.
3. J.A.Brydson, “Plastics Materials”, 8th edition, Butterworth Heinemann, Oxford, 2016.
4. Mascia; L, “The Role of Additives in Plastics”, John Wiley & Sons, 1974
5. Ernest W. Flick, “Plastics Additives”, vol - 2, 1st edition, William Andrew, 2001.
6. Murphy John, “Additives for Plastics Handbook”, 2nd edition, Elsevier Science, 2001.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will able to know the basics of additives and its influence on polymeric materials	3	-	3	2	2	-	-	-	-	-	-	-	3	3	-	3
CO2	Will learn about various additives used in polymeric industries	3	-	3	2	2	-	-	-	-	-	-	-	3	3	-	3
CO3	Will identify the required additive for specified properties	3	-	3	2	2	-	-	-	-	-	-	-	3	3	-	3
CO4	Will grasp idea about colourant and colouring technology	3	-	3	2	2	-	-	-	-	-	-	-	3	3	-	3
CO5	Will able to identify the suitable compounding techniques and equipments	3	-	3	2	2	-	-	-	-	-	-	-	3	3	-	3
Overall CO		3	-	3	2	2	-	-	-	-	-	-	-	3	3	-	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5002 **ADDITIVE MANUFACTURING** **L T P C**

3 0 0 3

OBJECTIVES:

- To educate students with fundamental and advanced knowledge in the field of additive manufacturing technology for plastics products.
- To learn about the additive manufacturing process.
- To understand the design concepts in additive manufacturing.

UNITI INTRODUCTION **9**

Introduction to Additive Manufacturing (AM)- AM evolution, Reverse engineering- Distinction between AM & CNC machining, Advantages of AM; AM process chain – Mathematical model for AM - Selection of AM technologies using decision methods – AM process plan.

UNIT II ADDITIVE MANUFACTURING (AM)TECHNOLOGIES **12**

Powder based, droplet based, extrusion based - Object Stereolithography - Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins - Solid Ground Curing (SGC)- Fused deposition Modeling (FDM) - Laminated Object Manufacturing (LOM) - Selective Laser Sintering (SLS) -Laser Engineered Net Shaping (LENS) - Shape Deposition Manufacturing (SDM) - Ballistic Particle Manufacturing (BPM).

UNIT III MATERIAL SCIENCE FOR AM **6**

Multi-functional and graded materials in AM - Role of solidification rate - Evolution of non-equilibrium structure - structure property relationship.

UNIT IV DESIGN FOR AM **9**

DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Support Removal, parts hollowing, Undercuts inclusion and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.

UNIT V APPLICATIONS AND POST PROCESSING **9**

Direct processes; Rapid prototyping, Rapid tooling, Rapid manufacturing – Indirect processes; Indirect prototyping, indirect tooling, indirect manufacturing - Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries. Post processing of AM parts: Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Ability to choose a suitable Additive Manufacturing (AM) method.
CO2 Ability to face the research challenges associated with AM and its data processing tools.
CO3 Ability to understand the concepts of AM, AM technologies.
CO4 Will acquire knowledge on selection of materials for AM
CO5 Will able to learn about AM process plan including building strategies and post processing.

REFERENCE:

1. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Proto-typing, Rapid Tooling Rapid Manufacturing”, Hanser publications, 2012.
2. Chua, C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and applications”, 2nd edition, World Scientific Publishers, 2010
3. Gibson, I., Rosen, D.W. and Stucker, B., “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
4. Kamrani, A.K. and Nasr, E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
5. Adedeji B. Badiru, Vhance V. Valencia , David Liu, " Additive Manufacturing Handbook " CRC Press, 2017

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Ability to choose a suitable Additive Manufacturing (AM) method	3	-	2	2	3	-	-	-	-	-	-	-	3	2	-	3
CO2	Ability to face the research challenges associated with AM and its data processing tools	3	-	2	2	3	-	-	-	-	-	-	-	3	2	-	3
CO3	Ability to understand the concepts of AM, AM technologies	3	-	2	2	3	-	-	-	-	-	-	-	3	2	-	3
CO4	Will acquire knowledge on selection of materials for AM	3	-	2	2	3	-	-	-	-	-	-	-	3	2	-	3
CO5	Will able to learn about AM process plan including building strategies and post processing	3	-	2	2	3	-	-	-	-	-	-	-	3	2	-	3
Overall CO		3	-	2	2	3	-	-	-	-	-	--	-	3	2	-	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5003 **ADHESIVE SCIENCE AND TECHNOLOGY** **L T P C**

3 0 0 3

OBJECTIVES:

- To bring a sound knowledge of theoretical and technological aspects ofmechanism and characterization of adhesives.
- To understand the various types of Adhesives employed in Industries.
- To acquire knowledge of Applications of adhesives in various fields.

UNIT I ADHESION MECHANISM **9**

Definition and mechanisms of adhesion- mechanical interlocking – inter-diffusion theories – adsorption and surface reaction. Surface topography, surface features and forces, wetting and setting, thermodynamic work of adhesion– influence of constitution on adhesion – interfacial bonding – coupling agents.

UNIT II CHARACTERIZATION OF ADHESIVES **9**

Principle of fracture mechanics, peel, lap sheen and butt tensile tests. Pull out of an extendable fibre, various testing and evaluation of adhesives, energy dissipation – plasticity – strength of elastomers.

UNIT III INDUSTRIAL ADHESIVES **9**

Inorganic adhesives. Principle of compounding – role of resins – fillers – antioxidants –accelerator systems.

UNIT IV ADHESIVE TYPES **9**

Adhesive from natural origin - animal glues – casein – starch – cellulosic and bio adhesives. Synthetic adhesives -phenolic resin, epoxy, polysulphide, polyurethane, polyvinyl acetate, polyvinyl alcohol, polyvinyl acetal, acrylics, high temperature silicone adhesives. Water based – pressure sensitive – hot -melt adhesives – anaerobic adhesives.

UNIT V APPLICATIONS OF ADHESIVES **9**

Adhesives for building construction, medical use, automobile industry bonded and coated abrasives – fabrics, cyanoacrylate based adhesives, bonding technology for textile, metal, plastics, wood, paper and glass.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will be able to attain the basic knowledge of adhesives.
CO2 Will be able to comprehend the utility of adhesives in industry.
CO3 Will develop capacity to apply adhesives in various fields
CO4 Will know the various testing methods for adhesives.
CO5 Will acquire knowledge on various material used for adhesives.

REFERENCE:

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

Course Articulation Matrix

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will be able to attain the basic knowledge of adhesives	3	-	3	-	3	2	-	-	-	-	-	-	3	3	-	3
CO2	Will be able to comprehend the utility of adhesives in industry	3	-	3	-	3	2	-	-	-	-	-	-	3	3	-	3
CO3	Will develop capacity to apply adhesives in various fields	3	-	3	-	3	2	-	-	-	-	-	-	3	3	-	3
CO4	Will know the various testing methods for adhesives	3	-	3	-	3	2	-	-	-	-	-	-	3	3	-	3
CO5	Will acquire knowledge on various material used for adhesives	3	-	3	-	3	2	-	-	-	-	-	-	3	3	-	3
Overall CO		3	-	3	-	3	2	-	-	-	-	-	-	3	3	-	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5004 BIOPOLYMERS AND BIODEGRADABLE POLYMERS L T P C

3 0 0 3

OBJECTIVES:

- To acquire knowledge on synthetic biodegradable polymers and its applications.
- To gain knowledge on principles of biodegradation and disposal of municipal waste.
- To study about the biopolymers and their structures.
- To judge the materials based on its nature which can be used for the composting process.
- To design reactors for efficient decomposing bio polymers.
- To appraise the property of the synthetic polymers using proper blend of biopolymers.

UNIT I SYNTHETIC BIODEGRADABLE POLYMERS 9

Definition of Biopolymers and types of biopolymers - polyglycolate, polymandelic acid, polyglutamic acid, poly -caprolactone- copolymer with ester, amide and urethane linkages, Copolymer of 1,4- butanediol with adipic acid and sebacic acid - biodegradable polyamides – copolymers of - amino acid (glycine, serine), - aminocaproic acid.– polyester urea – polyamide urethane - synthesis and properties, bacterial polyesters. Applications – agriculture, medicine, packaging.

UNIT II PRINCIPLES OF BIODEGRADATION 9

Biodegradation -introduction – Biodegradable polymer classes- Natural biodegradable polymer, Synthetic biodegradable polymer and modified naturally biodegradable polymer. Non-biological and biological degradable polymer. Measuring of biodegradation of polymers - Enzyme assays, Plate test, Respiratory test, Natural environment, Field trial, Gas evolution test (CO_2 & CH_4). modes of biological degradation – enzymatic degradation of biopolymers (poly saccharides, proteins, nucleic acids) and synthetic polymers – microbial degradation of synthetic polymers.

UNIT III DISPOSAL OF MUNICIPAL WASTE 9

Disposal of solid municipal waste by biodegradation – composting (bioreactors) - deposition inlandfills – microbial decomposition processes in anaerobic rubbish dumps. Ideal bioreactors– stirred tank reactor – batch and continuous operations – Fed - Batch operation - plug flow reactor.

UNIT IV BIOPOLYMERS 9

Biopolymers - introduction – functions – cotton, wool, paper, rubber, collagen, hyaluroran melanin for UV protection – Surface Modification of Biomaterials for Improved Functionality: Enhancement of biocompatibility by the use of Corona discharge and plasma processes. Surface coatings Silver/silver oxide silicone hydrogels UV curable systems PC coatings Heparin loaded systems.

UNIT V STRUCTURE OF BIOPOLYMERS 9

Proteins, nucleic acids and polysaccharides – the macromolecular structure and biological functions of polymers- primary, secondary, tertiary and quaternary structure of polymers –structure maintenance and transmission of the biological information- structure and enzymaticactivity – mechano structural function of biopolymers- viruses and phages – living macromolecules.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will be concerned for environment by synthesizing synthetic biodegradable polymers.
CO2 Will be able to methodically discuss importance of waste management.
CO3 Will develop capacity to comprehend biopolymers and their application.
CO4 Will acquire knowledge on polymer degradation.
CO5 Will gain skill in assessing the bio degradability of polymers.

REFERENCE:

1. J.Guillet, “Polymers and Ecological problems”, Plenum Press, New York, 1973.
2. W.Schnabel, “Polymer Degradation” – Principles and Practical Applications, HanserInternational, 1982
3. L.L.Hench, E.C. Ethridge, “Biomaterials – An Interfacial Approach”, Biophysics andBiotechnology Series, Vol 4, Academic Press, New York, 1982.
4. Jens Nielsen, John Villadsen and Gunnar liden, “Bioreaction Engineering Principles”, 3rd edition,Springer. 2011.
5. Charles Gebelein, Biotechnological Polymers: Medical, pharmaceutical and industrial applications, CRC press,1993.
6. Himadri Panda, Modern Technology of Biodegradable Plastics and Polymers with Bio-Plastics, Starch Plastic, Cellulose Polymers & Others , Engineers India Research Institute, 2015.
7. 7. Manjari Sharma , "Bio-degradable Polymer Compositions Materials and their Structures" Manakin Press 2015.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will be concerned for environment by synthesizing synthetic biodegradable polymers.	2	-	3		2	-	3	2	-	-	-	-	3	2	-	2
CO2	Will be able to methodically discuss importance of waste management.	2	-	3		2	-	3	2	-	-	-	-	3	2	-	2
CO3	Will develop capacity to comprehend biopolymers and their application.	2	-	3		2	-	3	2	-	-	-	-	3	2	-	2
CO4	Will acquire knowledge on polymer degradation	2	-	3		2	-	3	2	-	-	--	-	3	2	-	2
CO5	Will gain skill in assessing the bio degradability of polymers.	2	-	3		2	-	3	2	-	-	-	-	3	2		2
Overall CO		2	-	3		2		3	2	-	-	-	-	3	2		2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

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PL5005 CAD/CAM APPLICATION IN MOULD/TOOL DESIGN L T P C

3 0 0 3

OBJECTIVES:

- To provide knowledge on computer aided design and computer aided manufacturing.
- To learn about CAD/CAM in designing of plastics moulds,
- To understand about CAD/CAM applications in tool designing.

UNIT I INTRODUCTION 9

Basic concepts of CAD - graphic primitives, curve representation, windowing, clipping -shape and size description- parametric programming – interactive programming (LISP) - 2D drafting - 3D modeling- surface and solid modeling - assembly modeling.

UNIT II GRAPHICS AND DATABASE 9

Computer graphics – GKS, Open GL - Concept of Engineering database - Database Management – Data exchange standards – STEP, IGES, CALS.

UNIT III CNC 9

Part programming – G Codes & M Codes- Numerical control(NC), Computer Numerical control(CNC), Direct Numerical Control (DNC) - Working principle of CNC machines –CNC milling, CNC turning, CNC EDM machining- CNC stimulation – CNC interface with CAD.

UNIT IV CAM & FINITE ELEMENT ANALYSIS 9

Introduction to CAM softwares - advanced CAD/CAM technology – Flexible manufacturing system (FMS) – Computer Integrated manufacturing (CIM) – Finite element analysis – nodes and meshes - Types of analysis.

UNIT V MOLD FLOW ANALYSIS 9

Computer aided engineering (CAE) - Introduction to Mould flow analysis- mould flow concepts - analysis sequence -optimizing design and defects - Flow analysis-Thermal analysis - Warpage Analysis - Cooling Analysis - Shrinkage Analysis - Pressure Analysis.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will acquire knowledge on computer aided design and manufacturing for mould designing.
CO2 Will able to learn about basic graphic primitives, 2D drafting and 3D modeling.
CO3 Will have the ability to know about the database management.
CO4 Will learn about CNC, FEM, etc.,
CO5 Will able to analyse mould flow characteristics.

REFERENCES:

1. Chris McMahon and Jimmie Browne “CAD/CAM Principles", "Practice and Manufacturing management “Second Edition, Pearson Education, 1999.
2. Donald Hearn and M. Pauline Baker “Computer Graphics”. 2nd edition, Pearson education India., 2002.
3. Ibrahim Zeid “Mastering CAD CAM” 2nd edition, Tata McGraw-Hill Publishing Co.2007.
4. Jay Shoemaker “Mold flow Design Guide: A Resource for Plastics Engineers”, Volume 10, 4th edition, Hanser, 2006.
5. Radhakrishnan, P. & Subramanyan. S, “CAD/CAM/CIM”, 2nd Edition, New age internationals, 2008.
6. Rao P N, Tiwari N K, Kundra T, “Computer Aided Manufacturing” Tata McGraw Hill 2017.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will acquire knowledge on computer aided design and manufacturing for mould designing	3	-	3	2	3	-	-	-	-	-	2	2	3	-	3	3
CO2	Will able to learn about basic graphic primitives, 2D drafting and 3D modeling	3	-	3	2	3	-	-	-	-	-	2	2	3	-	3	3
CO3	Will have the ability to know about the database management	3	-	3	2	3	-	-	-	-	-	2	2	3	-	3	3
CO4	Will learn about CNC, FEM, etc.,	3	-	3	2	3	-	-	-	-	-	2	2	3	-	3	3
CO5	Will able to analyse mould flow characteristics	3	-	3	2	3	-	-	-	-	-	2	2	3	-	3	3
Overall CO		3	-	3	2	3	-	-	-	-	-	2	2	3	-	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5006 **CONDUCTING POLYMERS** **L T P C**

3 0 0 3

OBJECTIVES:

- To acquire a knowledge of chemistry on conducting polymers and its conductivity.
- To understand the basic concepts of synthesis, processing and applications of conducting polymers.
- To impart knowledge on spectral, morphological, thermal, mechanical and electrochemical characterization of conductive polymers.

UNIT I ELECTROCHEMISTRY OF CONDUCTING POLYMERS **9**

Theory of conduction, semi conductors and conducting polymers, band theory, requirements for polymer to work as conductor, types of conducting polymers - intrinsic and extrinsic - electrochemistry of electronically conducting polymers - source of electronic conduction in polymers - solitons, polarons and bipolarons - doping - measurement of conductivity - Vander Pauw technique - factors affecting conductivity.

UNIT II SYNTHESIS, PROCESSING AND APPLICATIONS OF CONDUCTING POLYMERS **9**

Synthesis of conducting polymers - chemical, electrochemical and enzymatic methods - synthesis, processing methods and applications of polyacetylene, polyaniline, polypyrrole, polythiophene and poly-paraphenylene based conducting polymers.

UNITIII ELECTROCHEMICAL CHARACTERIZATION OF CONDUCTING POLYMERS **9**

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

UNIT IV SPECTRAL AND MORPHOLOGICAL CHARACTERIZATION OF CONDUCTING POLYMERS **9**

FTIR, UV-vis, Raman, XRD, SEM, TEM and NMR.

UNITV MECHANICAL AND THERMAL CHARACTERIZATION OF CONDUCTING POLYMERS

UTM, Dilatometry, TGA, DTA, DSC and DMA. **9**

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will get a basic idea about conducting polymers.
CO2 Will grasp information about conducting mechanisms.
CO3 Will be able to synthesis conducting polymers.
CO4 Will know about the processing methods for conducting polymers**.**
CO5 Will be able to characterize the conducting polymer.

REFERENCE:

1. T.A. Skotheim, R.L. Elsenbaumer and J.R. Reynolds, “Hand book of Conducting Polymers”, 2nd Edition, Revised and enlarged, Marcel DekkerInc., New York, 2007.
2. J.M. Margolis (Ed.), “Conducting Polymers and Plastics”, Springer, 2011.
3. R.B. Seymour, “Conductive Polymers”, 2nd edition Plenum Press, New York, 1981.
4. B. Wessling, “Electronic Properties of Conjugated Polymers”, Vol.3, Springer, Berlin, 1989.
5. H.G. Kiess (Edr.), “Conjugated Conducting Polymers”, Springer, Berlin, 1992.
6. D.S.Soane and Z. Martynenko (Eds.), “Polymers in Microelectronics”, Elsevier, Amsterdam, 1989.

Course Articulation Matrix

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will get a basic idea about conducting polymers	3	-	2	2	3	-	2	-	-	-	-	-	3	3	-	2
CO2	Will grasp information about conducting mechanisms	3	-	2	2	3	-	2	-	-	-	-	-	3	3	-	2
CO3	Will be able to synthesis conducting polymers	3	-	2	2	3	-	2	-	-	-	-	-	3	3	-	2
CO4	Will know about the processing methods forconducting polymers	3	-	2	2	3	-	2	-	-	-	-	-	3	3	-	2
CO5	Will be able to characterize the conducting polymer	3	-	2	2	3	-	2	-	-	-	-	-	3	3	-	2
Overall CO		3	-	2	2	3	-	2	-	-	-	-	-	3	3	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5007	ENGINEERING PLASTICS	L T P C
		3 0 0 3

OBJECTIVES:

- To acquire knowledge of polymers meant for electrical, electronics and high temperature applications.
- To impart basic knowledge on polymer blends, alloys and liquid crystals.
- To gain knowledge of polymers in lithography, water treatment and biomedical applications.

UNIT I POLYMERS FOR ELECTRICAL AND ELECTRONICS APPLICATIONS 9

Engineering plastics - polymers in electrical and electronics industry - electro conducting polymers - polymer batteries - electrets - polymers with piezoelectric, pyroelectric and ferroelectric properties - photo conducting polymers.

UNIT II POLYMERS FOR HIGH TEMPERATURE APPLICATIONS 9

Polymers for high temperature resistance - fluoro polymers - aromatic polymers – heterocyclic polymers - polymers as building materials - ultrahigh fibres - aramids -technora - carbon fibres.

UNIT III IONIC POLYMERS 9

Polymer blends and alloys - Ionic polymers-synthesis, physical properties and applications, Ion-exchange, hydrophilicity, Ionomers based on polyethylene, elastomeric ionomers, Ionomers based on polystyrene, PTFE, Ionomers with polyaromatic backbones, Polyelectrolytes for ion exchange, polyelectrolytes based on carboxylates, polymers with integral ions, polyelectrolyte complexes, Biological and inorganic ionic polymers-- Interpenetrating networks - sequential - simultaneous - full and semi IPN - gradient IPN - thermoplastic IPN.

UNIT IV POLYMERS IN LITHOGRAPHY AND WATER TREATMENT 9

Polymers in lithography - photoresist - positive resists - negative resists - solution inhibition resists - image reversal process - Ion exchange resins - polymer membrane –polymer complexes for water treatment.

UNIT V POLYMERS FOR BIOMEDICAL APPLICATIONS 9

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

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will able to understand about the various types of engineering plastics.
CO2 Will be able to apply polymers to electrical, electronics and high temperature fields.
CO3 Will understand about polymer blends and alloys.
CO4 Will be familiar with the synthesis of IPN.
CO5 Will appreciate the application of polymers in bio-medical field.

REFERENCE:

1. H.F. Mark , “Encyclopedia of Polymer Science and Engineering”, Wiley – Interscience, New York, 3rd edition, 1991.
2. L.L. Chapoy, “Recent Advances in Liquid Crystalline Polymers”, Chapman and Hall, London, 1985.
3. R.W. Dyson, “Specialty Polymers”, Springer netherland, 1998.
4. C.P.Wong, “Polymers for Electronic and Photonic Applications”, Academic Press, New York, 2013.
5. ManasChanda, Salil K. Roy, “Industrial Polymers, Specialty Polymers, and theirApplications”, CRC Press, 2008.
6. Robert William Dyson, “Specialty Polymers”, 2nd edition, Springer Verlag, 2011.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will able to understand about the various types of engineering plastics	3	3	3		2	3	-	-	-	-	-	-	3	-	3	3
CO2	Will be able to apply polymers to electrical, electronics and high temperature fields	3	3	3		2	3	-	-	-	-	-	-	3	-	3	3
CO3	Will understand about polymer blends and alloys	3	3	3		2	3	-	-	-	-	-	-	3	-	3	3
CO4	Will be familiar with the synthesis of IPN	3	3	3		2	3	-	-	-	-	-	-	3	-	3	3
CO5	Will appreciate the application of polymers in bio-medical field.	3	3	3		2	3	-	-	-	-	-	-	3	-	3	3
Overall CO		3	3	3		2	3	-	-	-	-	-	-	3	-	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5008 **MEMBRANE TECHNOLOGY** **L T P C**

3 0 0 3

OBJECTIVES:

- To gain knowledge of technical background on membrane technology.
- To provide wide level of understanding to design membranes.
- To understand the design of membrane modules for water treatment plants**.**

UNIT I INTRODUCTION TO MEMBRANE TECHNOLOGY **9**

Technology overview; Types of membranes; Membrane- separation characteristics; Membrane processes; Membrane modules; Membrane fouling.

UNIT II FUNDAMENTALS OF MEMBRANE TECHNOLOGY **9**

Membrane Transport Theory- Solution diffusion model, Structure- permeability relationships in solution- diffusion membranes, Pore- flow membranes; Membranes and modules- Isotropic membranes, Anisotropic membranes, Metal membranes and ceramic membranes, Liquid membranes, Hollow fiber membranes, Membrane modules; Concentration polarization- Boundary layer film model, Determination of Peclet number, Concentration polarization in liquid separation processes, Concentration polarization in gas separation processes, Cross- flow, co- flow and counter- flow.

UNIT III PROCESSES IN MEMBRANE TECHNOLOGY **9**

Reverse osmosis- Membranes and materials, RO membrane categories, Membrane selectivity, Membrane modulus, Membrane fouling control, Membrane cleaning; Ultra filtration, Microfiltration, Gas separation and Pervaporation- Membrane materials and structure; Characterization, concentration polarization and membrane fouling, Membrane Cleaning, Membranes and modules, System Design, Process design, Applications; Ion exchange membrane processes- Electro-dialysis- Background, Chemistry of ion exchange membranes, Transport in electro dialysis membranes, System design and Applications; Carrier facilitated transport- Introduction, Coupled transport, Facilitated transport.

UNIT IV SUSTAINABLE ROUTE IN PREPARATION OF POLYMERIC MEMBRANES **9**

Polymeric membranes for desalination, water treatment, waste water treatment- Materials, Properties, Preparation techniques; Biomaterials for membranes; Use of non- toxic solvents for membrane preparation and processing; Cost analysis of membrane production- Toxic vs Non-toxic solvents, Possibility of solvent recovery.

UNIT V APPLICATIONS OF MEMBRANBE TECHNOLOGY **9**

Medical applications- Dialysis; Water treatment- Filtration, osmosis, diffusion and separation; Fuel cells, Food and Beverage science- Bottled water, Beer, wine and alcoholic beverages, Fruit juices and maple syrup, Milk and cheese, Vinegar; Composites; Pharmaceutical applications; Biochemical processes; Chemical Industries- Petroleum refining, paint adhesive and solvent recovery; High purity applications- Semiconductor, boiler feed and power industry needs; Mining and Metal processes- Plating processes, Gold and uranium recovery, Recovery of precious metals, Landfill leachate reduction; Nanofiltration.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Ability to gain knowledge on membranes and its technologies.
CO2 Able to learn different types of membranes used in various fields.
CO3 Able to develop new membranes for water treatment processing.
CO4 Able to solve the technical issues related to filtration.
CO5 Gain knowledge in membrane distillation.

REFERENCES:

1. Baker, R. W.,“Membrane technology”. Kirk-Othmer Encyclopedia of Chemical Technology, 2000.
2. Singh, R. “Membrane technology and engineering for water purification: application, systems design and operation”. Butterworth-Heinemann.2014
3. Nunes, S. P., & Peinemann, K. V. (Eds.). “Membrane technology: in the chemical industry”. John Wiley & Sons. 2006
4. Drioli, E., Giorno, L., & Fontananova, E. (Eds.). “Comprehensive membrane science and engineering”. Elsevier.2017.
5. Figoli, A., & Criscuoli, A. (Eds.). “Sustainable Membrane Technology for Water and Wastewater Treatment”. Springer.2017
6. Uemura, T., & Henmi, M. (2008). Thin-film composite membranes for reverse osmosis. “Advanced membrane technology and applications”, 1-19.

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Course Articulation Matrix

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Ability to gain knowledge on membranes and its technologies	3	2	-	2	-	-	-	-	-	-	2	-	3	3	-	2
CO2	Able to learn different types of membranes used in various fields	3	2	-	2	-	-	-	-	-	-	2	-	3	3	-	2
CO3	Able to develop new membranes for water treatment processing	3	2	-	2	-	-	-	-	-	-	2	-	3	3	-	2
CO4	Able to solve the technical issues related to filtration	3	2	-	2	-	-	-	-	-	-	2	-	3	3	-	2
CO5	Gain knowledge in membrane distillation	3	2	-	2	-	-	-	-	-	-	2	-	3	3	-	2
Overall CO		3	2	-	2	-	-	-	-	-	-	2	-	3	3	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5009 PLASTICS MOULD MANUFACTURING TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To develop knowledge about the mould manufacturing process.
- To impart knowledge on mould materials, metal cutting tools, CNC.
- To learn the basics of mold assembly, product dimension and precision.

UNIT I MATERIALS 9

Mould materials for mould making and for various mould elements - ferrous, non ferrous, steel, aluminum, copper, magnesium alloys, bronze - factors considered for selection of material in mold making - standards for mould materials - heat treatment for mould materials - annealing, hardening, quenching, nitriding, carburizing, carbonitriding, tempering - advance heat treatment for mould materials.

UNIT II TOOLING 9

Metal cutting tools - tool angle - single and multipoint cutting tool - cutting fluids - mechanism of metal cutting -tool materials - coated tool materials - machining operations -lathe - turning, shaping, planning, drilling, grinding-milling - horizontal, vertical, universal milling - boring -hobbing - engraving - pantograph.

UNIT III CNC & RAPID TOOLING 9

Introduction of NC and CNC -programming - G and M code - CNC machines- CNC EDM (wire EDM), CNC Milling, CNC Lathe- CNC machining and turning center - rapid vs conventional tooling - mould element development using rapid tooling- application of rapid tooling.

UNIT IV MOULD FINISHING AND ASSEMBLY 9

Polishing of mould - polishing tools - electrosonic polishing - surface texturing of moulds - photochemical etching - nickel and chromium plating - fitting and assembly of mould elements - check list for mould assembly - mould maintenance.

UNIT V INSPECTION 9

Dimension and tolerance - accuracy and precision - working principle and application of measuring instruments used in tool room - micrometer, surface plates, angle plates, squares, vernier height gauges, depth gauges, slip gauges, dial gauges, surface roughness measurement - hardness testing - comparators - optical profiles projectors, tool makers microscope -optical flats.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will able to understand the mould manufacturing techniques.
CO2 Will have the ability to select the material for mould depending upon application and processing.
CO3 Will know about the metal cutting tools, CNC based tool room machineries and its application in mould manufacture.
CO4 Will gain knowledge on different inspection techniques
CO5 Will acquire the concepts of mould maintenance.

REFERENCE:

1. Klus Stokhert (Edt.), “Mold making handbook for Plastic Engineers”, HanserPublishers, NY, 2nd edition 1998.
2. HMT “Production Technology”, *Tata McGraw-Hill*(India), 1998.
3. Sanjay K. Nayak, “Plastics Mould Technology”, Vol -1 and 2, CIPET Publications, 2007.
4. P.C.Pandey & H. S. Shah, “Modern Machining” Processes, TMH, 1981.
5. Jain R K, “Engineering Metrology”, 19th Edition, Khanna Publishers, 2005.
6. Peter Jones, “The Mould Design Guide”, Smithers Rapra TechnologyLtd., 2008.

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Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will able to understand the mould manufacturing techniques	-	3	3	2	-	2	-	-	2	-	-	-	3	-	-	3
CO2	Will have the ability to select the material for mould depending upon application and processing	-	3	3	2	-	2	-	-	2	-	-	-	3	-	-	3
CO3	Will know about the metal cutting tools, CNC based tool room machineries and its application in mould manufacture	-	3	3	2	-	2	-	-	2	-	-	-	3	-	-	3
CO4	Will gain knowledge on different inspection techniques	-	3	3	2	-	2	-	-	2	-	-	-	3	-	-	3
CO5	Will acquire the concepts of mould maintenance	-	3	3	2	-	2	-	-	2	-	-	-	3	-	-	3
Overall CO		-	3	3	2	-	2	-	-	2	-	-	-	3	-	-	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5010 **PLASTICS WASTE MANAGEMENT** **L T P C**

3 0 0 3

OBJECTIVES:

- To make the student familiar with the polymer wastes and primary and secondary recycling.
- To acquaint the student with tertiary and quaternary recycling, recycling of plastics.
- To introduce to students with recycling of plastics.
- To make the students to rate nature of plastic waste suitable for a particular recycling
- To make them construct new efficient recycling techniques for recent category of waste.
- To make them appraise the existing methods of recycling with environmental concern.

UNIT I POLYMER WASTES **9**

Sources of plastics waste – definitions - generation of industrial plastic waste - plastic in solid waste; Separation of components in municipal refuse - separation process specific to plastics legal aspects.

UNIT II PRIMARY AND SECONDARY RECYCLING **9**

Primary recycling – degradation of plastics – industrial practice; Secondary recycling –approaches to secondary recycling – mechanical reworking of plastic waste – chemicalmodification of mixed plastic waste – co-extrusion and co-injection moulding – waste plastics as fillers.

UNIT III TERTIARY AND QUATERNARY RECYCLING **9**

Tertiary recycling – chemicals from plastics waste – pyrolysis chemical decomposition of plastic waste; Quaternary recycling energy from plastics waste – incinerator – effect of plastics on the incineration process – plastics as land refill- blending of plastics waste with asphalt.

UNIT IV CHALLENGES IN PLASTICS RECYCLING **9**

Recycling of plastics – surface refurbishing; Plastics aging – environmental aging – thermalaging – weathering – chemical degradation – ionizing radiation – wear and erosion;Biodegradation – biodegradable plastics – photodegradable plastics.

UNIT V RECYCLING PROCESSES **9**

Specific recycling processes –PET reprocessing – polyolefines – polystyrene – PVC – acrylics; Thermosets – PURS – phenolics – polyesters – epoxy resins – melamine and urea resins – recycling technologies.

TOTAL PERIODS:45

OUTCOMES:

CO1 Will be aware of plastics waste management.
CO2 Will able to gain knowledge on concepts of recycling plastics.
CO3 Will develop techniques for recycling of plastics.
CO4 Will acquire knowledge on concepts of degradation.
CO5 Will understand the concern for environment and develop skills to address the same.

REFERENCE:

1. Nabil Mustafa, “Plastics Waste Management: Disposal, Recyling and Reuse”, MarcelDekker Inc., New York, 1993.
2. R. J. Ehrig, “Plastic recycling: Products and Processes”, Hanser Publishers, New York, 1992.
3. Jacob Leidner, “Plastic waste: Recovery of Economic Value”, Marcel Dekker Inc., New York,1982.
4. John Scheirs, “Plastics Recycling”, John Wiley and Sons, New York, 1998.
5. Ann Christine, Albertsson and Samuel J. Huang, “Degradable Polymers: Recycling ofPlastics”, Marcel Dekker Inc., New York, 1995.
6. Muralisrinivasan Natamai Subramanian, Plastics Waste Management: Processing and Disposal, Smithers Rapra technology Ltd, 2016.
7. Soil Degradable Bioplastics for a Sustainable Modern Agriculture edited by Mario Malinconico , Springer, 2017.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will be aware of plastics waste management.	2	-	-		2	3	3	3	-	-	-	-	3	3	2	2
CO2	Will able to gain knowledge on concepts of recycling plastics.	2	-	-		2	3	3	3	-	-	-	-	3	3	2	2
CO3	Will develop techniques for recycling of plastics.	2	-	-		2	3	3	3	-	-	-	-	3	3	2	2
CO4	Will acquire knowledge on concepts of degradation.	2	-	-		2	3	3	3	-	-	-	-	3	3	2	2
CO5	Will understand the concern for environment and develop skills to address the same.	2	-	-		2	3	3	3	-	-	-	-	3	3	2	2
Overall CO		2	-	-		2	3	3	3	-	-	-	-	3	3	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5011 **POLYMER BLENDS AND ALLOYS** **L T P C**
3 0 0 3

OBJECTIVES:

- To develop knowledge on polymeric blends and alloys.
- To learn about compatabilizers and high performance blends
- To understand about the characterization of polymer blends.

UNIT I INTRODUCTION **9**

Polymer blends and alloys - an introduction - Need for making polymer blend - selection criteria - classification of polymer blends- mechanism of mixing and dispersion - extensive, intensive mixing, solid-solid, solid- liquid, liquid- liquid - thermodynamic law of miscibility - Advantages of blending.

UNITII COMPATABILIZATION&CRYSTALLIZATION **9**

Compatabilization - methods and mechanism of compatibilization- compatabilizer - compatabilization by reactive blending - principle of phase equilibria calculations -mechanism of phase separation - Mixing theories- Flory Huggins, Gaslattice model- Crystallization of polymer blend -Interpretation of polymer/polymer interactions.

UNITIII PREPARATION TECHNIQUES AND RHEOLOGY OF POLYMER BLENDS **9**

Blend preparation technique – Solvent blending, Latex blending, Melt blending, Mechanical mixing, mechano-chemical mixing, In situ polymerization – Flow behavior of polymer blends – flow behavior of miscible and immiscible polymer blends – complex flow - visco-elastic response of polymer blends.

UNIT IV LCP POLYMER BLENDS **9**

High performance polymer blends- LCP blends – LCP/Polyester blends, LCP/Polyolefin blends, LCP/Polyethersulfone blend, LCP/thermoplastic polyimide blend, LCP/LCP blends.

UNIT V CHARACTERIZATION OF POLYMER BLENDS **9**

Fourier transformed Infrared Spectroscopy (FTIR) – X-Ray Diffraction (XRD), Microscopic Techniques - Optical microscopy - Electron Microscopy: scanning electron microscopy - Transmission electron microscopy, Thermal analysis Differential scanning calorimeter, Glass transition temperature, Light scattering - X Ray Scattering Technique.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will able to prepare blends of various polymers for different applications.
CO2 Will acquire knowledge on miscibility behaviour based on thermodynamics.
CO3 Will able to gain knowledge concepts of techniques involved in polymer blend preparation.
CO4 Gain knowledge about solubility parameter and compatibility of blends
CO5 will be familiar with the phase separation and rheology of polymer blends and alloys.

REFERENCE:

1. D.R. Paul, “Polymer Blends”, volume 2, John Wiley & sons, edition, 2000
2. L.A.Utracki, “Commercial Polymer Blends”, Chapman & Hall, London, 1998.
3. RP. Singh, C.K. Das, S.K. Mustafi, “Polymer Blends and Alloys an overview”, Asian Books Pvt. Ltd.,1st edition, New Delhi- 2002.
4. Muralisrinivasan Natamai Subramanian, “Polymer Blends and Composites - Chemistry and Technology”, Scrivener Publishing LLC, 2017.
5. Gabriel O. Shonaike, George P. Simon, “Polymer Blends and Alloys”, CRC Press. 1999.
6. Lloyd M. Robeson, “Polymer Blends: A Comprehensive Review”, Hanser, 2007.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will able to prepare blends of various polymers for different applications	3	2	3	-	-	-	2	-	2	-	-	-	3	3	-	2
CO2	Will acquire knowledge on miscibility behaviour based on thermodynamics	3	2	3	-	-	-	2	-	2	-	-	-	3	3	-	2
CO3	Will able to gain knowledge concepts of techniques involved in polymer blend preparation	3	2	3	-	-	-	2	-	2	-	-	-	3	3	-	2
CO4	Gain knowledge about solubility parameter and compatibility of blends	3	2	3	-	-	-	2	-	2	-	-	-	3	3	-	2
CO5	will be familiar with the phase separation and rheology of polymer blends and alloys	3	2	3	-	-	-	2	-	2	-	-	-	3	3	-	2
Overall CO		3	2	3	-	-	-	2	-	2	-	-	-	3	3	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5012 POLYMERS FOR BIOMEDICAL ENGINEERING APPLICATIONS L T P C

3 0 0 3

OBJECTIVES:

- To acquire a knowledge of various types of biopolymers and their advantages andneeds.
- To understand the various types of bio-materials and their applications for bio-medical engineering.
- To understand the knowledge of various bio-materials used in processing ofcomponents and the basic destructive and non-destructive testing of such biomaterials.
- To organize fabrication of bio-composites in biomedical applications.
- To create biocompatible biomedical devices using suitable biopolymers.
- To evaluate the modification techniques conventionally used for biomedical devices.

UNIT I BIOMATERIALS IN MEDICINE 9

Introduction to classes of materials used in medicine, world-wide market for biomaterials,clinical implications of biomaterials development. Types of materials-inert, toxic, bioactive,natural materials - collagen, biopolymers etc. Introduction to biocompatibility, requirements and standards, cell-material interaction, testing of biomaterials, in vitro assessment, invivoassessment of tissue compatibility, testing of blood-materials interaction, animal models.

UNIT II BIO POLYMERS 9

Polymers as biomaterials, silicones, polyurethanes, polyvinyl chloride, polyethylenes, Ultrahigh molecular weight polyethylene, polyacrylates, polyether ether ketone, water soluble polymers, hydrogels, bio-adhesives, diffusion principles, polymers for controlled drug delivery applications, polysaccharides, poly(orthoesters), polyanhydrides, aminoacid derived polymers, polyphosphazenes, bacterial polyesters etc.

UNIT III COMPOSITES IN BIOMEDICAL APPLICATIONS 9

Concepts of polymer composites, composites - reinforcing systems-fabrication, mechanical properties, dental filling composites, fibrous and particulate composites in orthopedic implants.Biomimetic materials, nanoscale materials/engineering; bioactive/bioresponsive materials, polymer scaffolds, principles of tissue engineering.

UNIT IV MEDICAL DEVICES 9

Medical devices, medical device development, material choice, device design, extracorporealdevices, oxygenators, intravenous catheters, stents, polymeric implants, heart valves, total artificial heart, cardiac pace makers, vascular grafts, artificial kidney, dialysis membranes, hard tissueimplants, orthopedic implants, fracture plates, intramedullary devices, spinal fixation, joint replacements, bone cement, soft tissue replacements, wound dressing, artificial skin, sutures, contact lenses, tissue adhesives, maxillofacial implants, ear and eye implants, controlled drug delivery systems, biosensors, gloves, condoms, urinary catheters, intrauterine systems, cosmetic implants. Regulation and standards for quality, FDA, EU-medical directives, GMP, GLP, ISO, CE marking etc.

UNIT V MODIFICATION TECHNIQUES 9

Surface modification techniques, plasma modifications, coating methods. Sterilization methods, dry heat, steam, ethylene oxide, gamma ray, effect of sterilization on polymers,importance of packaging, shelf-life.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will be aware of preparation and properties of bio-polymers.
CO2 Will attain knowledge on different medical devices and its functions.
CO3 Will be able to use bio-polymeric materials for making components.
CO4 Will be able to appreciate the basic destructive and non-destructive testing of bio-polymeric materials.
CO5 Will gain knowledge in various applications of biopolymers

REFERENCE:

1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons, "BiomaterialScience: An Introduction To Materials In Medicine", (2012)
2. ShishirSinha|Naveen Kumar Navani|Ex. Ed. J.N. GovilNanotechnology "Biomaterials", Vol. 11(2014).
3. Sabu Thomas, Dominique Durand, Christophe Chassenieux, P. Jyotishkumar, "Handbook ofbio-polymer based materials, Technology & Engineering" (2013), John Wiley & Sons.
4. Plackett, D. , "Biopolymers: New Materials for sustainable films & Coatings", John Wiley& Sons, 2011.
5. D.L. Wise et al. Eds., "Encyclopedic handbook of Biomaterials and Bioengineering, PartA. Materials & part B. Applications", Volume 1 &2, Marcel Dekker Inc, BPS 2305
6. John Enderle and Joseph Bronzino, Introduction to Biomedical Engineering, 3rd Edition, Academic press, Elsevier, 2012.
7. W. Mark Saltzman, Biomedical Engineering: Bridging Medicine and Technology, Cambridge University Press, 2009.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will be aware of preparation and properties of bio-polymers.	2	-	2	3	-	3	3	-	-	-	-	-	3	3	2	
CO2	Will attain knowledge on different medical devices and its functions.	2	-	2	3	-	3	3	-	-	-	-	-	3	3	2	
CO3	Will be able to use bio-polymeric materials for making components.	2	-	2	3	-	3	3	-	-	-	-	-	3	3	2	
CO4	Will be able to appreciate the basic destructive and non-destructive testing of bio-polymeric materials.	2	-	2	3	-	3	3	-	-	-	-	-	3	3	2	
CO5	Will gain knowledge in various applications of biopolymers.	2	-	2	3	-	3	3	-	-	-	-	-	3	3	2	
Overall CO		2	-	2	3	-	3	3	-	-	-	-	-	3	3	2	

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5013 POLYMERS FOR PACKAGING APPLICATION L T P C

3 0 0 3

OBJECTIVES:

- The objective of this course is introduction to packaging application using polymers
- To impart knowledge on packaging application
- Students should be conversant with packaging materials
- To make the students assess the suitable polymer for a particular packaging application.
- To make the students propose the appropriate processing method for packaging.
- To make the students to solve the existing problems associated with food packaging.

UNIT I POLYMERS FOR PACKAGING APPLICATION 9

Major polymers used for packaging- Evaluation of the following polymers for packagingApplications- polyethylene , EVA, EAA, lonomers, LDPE ,HDPE, LLDPE, metallocene polymer,PP,PVC, PVDC, PS, PVOH, EVOH, nylon, polyester, polycarbonate, fluoropolymers, ABS,Acrylonitrile.

UNIT II PROCESSING METHODS OF PACKAGING 9

Adhesives, heat sealing types, sealing method, extrusion blown film and cast film and sheet coextrusion, surface treatment testing and evaluation of films, flexible packaging, pouches, bulkand heavy duty bags, thermoforming, thin sheet thermoforming, blow moulding, extrusion andinjection blow moulding, foams, cushioning and distribution packaging thermoplastic.

UNIT III POLYMERS FOR FOOD PACKAGING 9

Edible and biobased food packaging materials, edible film and coating, Polysaccharide basedcoatings, Lipid based coatings, Protein based coating, First, Second and third biobasedpackaging materials. permeability of thermoplastic polymers, multilayer films, processing,deteriorative reaction in foods, enzyme reactions, chemical reactions, physical change,biological change, shelf life of foods, factors controlling shelf life.

UNIT IV POLYMERS FOR MEDICAL APPLICATION 9

Polymer used in pharmaceutical products-polymers in packaging and medical prosthetics.Bioderadable polymers in medical field-Polymers application in medical devices. Polymers usedin drug delivery. Environmental friendly microbial polymers, Polyhydroxyalkanoates (PHAs) forPackaging and biomedical applications.

UNIT V INNOVATIVE FOOD PACKAGING 9

Asceptic packaging of foods, sterilization of packaging materials, packaging of microwavablefoods, Active and intelligent packaging, modified atmospheric packaging, packaging of freshfoods, horticultural products, dairy products, cereal, snack foods and confectionary, packagingof beverages, comparison of polymer packaging with paper, metal and glass materials, printingprocesses, safety and legislative aspect of packaging.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will be aware of processing methods of polymers used for packaging applications
CO2 Will develop capacity to understand polymers employed in various fields
CO3 Will familiarize in testing of plastic packaging.
CO4 Will attain the knowledge on thermoforming packaging process
CO5 Will be able to discuss the application of polymers in packaging field.

REFERENCE:

1. Gordon.L Robertson, “Food Packaging”, Taylor and Francis (2006)
2. SajidAlavi, Sabu Thomas, K. P. Sandeep, NandakumarKalarikkal, Jini Varghese, SrinivasaraoYaragalla, “Polymers for Packaging Applications”, Apple AcademicPress, 2014
3. John R. Wagner, Jr., Crescent Associates, Inc., Rochester, “Multilayer Flexible Packaging”, lsevier 2009
4. S.Ebnesajiod, W.Andrew, “Plastic films in food packaging”, PDL ,2012.
5. ManasChanda, Salil K.Roy,“Plastics Technology Hand book”, 2ndedition, MarcelDekker,New York,1993.
6. H.F.Mark,(Ed), “Encyclopedia of polymer Science & Engineering”. John Wiledy&Sons,New York, 1989.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will be aware of processing methods of polymers used for packaging applications.	2	-	3	-	-	2	3	-	-	-	-	3	3	3	3	-
CO2	Will develop capacity to understand polymers employed in various fields.	2	-	3	-	-	2	3	-	-	-	-	3	3	3	3	-
CO3	Will familiarize in testing of plastic packaging.	2	-	3	-	-	2	3	-	-	-	-	3	3	3	3	-
CO4	Will attain the knowledge on thermoforming packaging process.	2	-	3	-	-	2	3	-	-	-	-	3	3	3	3	-
CO5	Will be able to discuss the application of polymers in packaging field.	2	-	3	-	-	2	3	-	-	-	-	3	3	3	3	-
Overall CO		2	-	3	-	-	2	3	-	-	-	-	3	3	3	3	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5014	POLYMER NANOCOMPOSITES	L T P C
		3 0 0 3

OBJECTIVES:

- To learn about the basis of nano-composites and its applications.
- To attain knowledge on bio based nano composites.
- To understand about the applications of nano-composites

UNIT I NANOCOMPOSITES- AN INTRODUCTION 9

Introduction: Preparation of nanostructured materials- top-down processes, bottom- up processes, template assisted structuring of nanomaterials, ordering of nanostructures; Nanoscale fillers – Clay, POSS, CNT, nanoparticle fillers; Tribology of polymeric nanocomposites; Nano ceramic for Ultra high temperature MEMS; Optimizing nano filler performance in polymers; Preparation techniques; Modification of interfaces; Macromolecules at interface and structured organic films; Processing into nanocomposites; Properties; Applications.

UNIT II NANOSTRUCTURED POLYMER COMPOSITES 9

Carbon nanotube/ nanofiber polymer nanocomposites; Processing, properties, and flow behavior of carbon nanofiber- based polymeric nanocomposites; Rheology in polymer/clay nanocomposites: mesoscale structure development and soft glassy dynamics; Polymer- graphite nanocomposites; Polymer nanocomposite- flammability and flame retardancy.

UNIT III NANO- BIO COMPOSITES 9

Animal based fiber reinforced composites; Biopolymeric nanofibers for tissue engineering; Potential use of poly hydroxyl alkanotes for tissue engineering; A reductionist approach for the molecular and supramolecular structures of elastin; Elastic based polymer nanocomposites; PLA based bio and nanocomposites; Toxicology of bio- nano composites.

UNIT IV SHEAR RHEOLOGY OF NANOFIBER BASED COMPOSITES 9

Introduction; Rheology background; Preparation of suspensions and composites; Rheological characterization- Start-up of steady shear, steady state shear measurements, small amplitude oscillatory shear measurements, measurements of temperature effects; Modeling of CNF suspensions; Modeling of CNF/ PS melt composites- Modeling and simulation methods.

UNIT V APPLICATIONS OF NANOCOMPOSITES 9

Barrier and membrane applications; Composite products based out of flammability resistance; Polymer blend compatibilization; Biomedical applications, Fuel cell applications, Electrical/ electronic applications; Optoelectronics, Sensors; Automotive applications; Tyres; Wound care; Sport goods; Personal protective equipments.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will able to demonstrate the preparation of nanomaterials.
CO2 Will familiarize about the science of nanomaterials
CO3 Will able to attain knowledge on characteristic and properties of polymer nanocomposites.
CO4 Will able to correlate the properties of polymer nanocomposites with appropriate applications.
CO5 Will able to gain knowledge in testing of polymer nanocomposites.

REFERENCE:

1. Kelsall, R., Hamley, I. W.,& Geoghegan, M. , “Nanoscale science and technology”. John Wiley & Sons, 2005.
2. Advani, S. G., “Processing and properties of nanocomposites”, World Scientific Pub.., 2007.
3. Pradeep, T,“Nano The essentials Understanding Nanoscience and Nanotechnology”. 2008.
4. Lau, A. K. T., Hussain, F., & Lafdi, K., “Nano-and biocomposites”. CRC Press, 2009.
5. Peters, S. T, “Handbook of composites”. Springer Science & Business Media, 2013.
6. Agarwal, A., Bakshi, S. R., & Lahiri, D., “Carbon nanotubes: reinforced metal matrix composites”, CRC press, 2013.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will able to demonstrate the preparation of nanomaterials	3	2	-	2	3	-	-	-	-	2	2	2	3	3	-	2
CO2	Will familiarize about the science of nanomaterials	3	2	-	2	3	-	-	-	-	2	2	2	3	3	-	2
CO3	Will able to attain knowledge on characteristic and properties of polymer nanocomposites	3	2	-	2	3	-	-	-	-	2	2	2	3	3	-	2
CO4	Will able to correlate the properties of polymer nanocomposites with appropriate applications	3	2	-	2	3	-	-	-	-	2	2	2	3	3	-	2
CO5	Will able to gain knowledge in testing of polymer nanocomposites	3	2	-	2	3	-	-	-	-	2	2	2	3	3	-	2
	Overall CO	3	2	-	2	3	-	-	-	-	2	2	2	3	3	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5015 **REINFORCED PLASTICS** **L T P C**

3 0 0 3

OBJECTIVES:

- To acquire knowledge of the importance and various types of reinforced plastics and its advantages and needs.
- To become aware of the various types of fibers, resins and other additives materials available for making composites.
- To develop expertise in the various types of moulds, premix moulding compounds and processes used in the processing of composites
- To be conversant with the basic destructive and non-destructive testing of reinforced plastics
- To be familiar with the concept of nano reinforcements, their types , processing of nano reinforced plastics and their applications

UNIT I INRODUCTION **9**

Characteristics, advantages, and need for reinforced plastics – Classification – particulate, fibrous, laminated, PMC, MMC, CMC, advanced, hybrid, braided and carbon matrix composites. Predicting properties of Fiber-Reinforced composites.

UNIT II MATERIALS **9**

Fibers: Glass –Types (E,S&C),roving, yarns, CSM, surface mats, preforms, woven and nonwoven fabrics - Three dimensional fabrics (woven, knitted and braided); Carbon – PAN and Pitch based - HT, HM and IM; Aramid – Kevlar, Technora HM-50; Production, properties and applications. Natural fibers. Surface treatments. Resins : Thermosets - Unsaturated polyester, epoxy, vinyl ester, silicones & polyimides – production, properties and applications; Thermoplastics - Examples, Comparison with thermosets. Properties and applications.

UNIT III PROCESSING OF REINFORCED PLASTICS **9**

Different types of molds - DMC, SMC and prepregs. Hand & Spray layup- Bag, autoclave, centrifugal molding, RTM, Vacuum infusion, pultrusion, filament winding, compression molding process and sandwich construction.

UNIT IV TESTING OF REINFORCED PLASTICS **9**

Fiber volume fraction, tensile, shear, compressive, flexural, thermo elastic and off – axis responses of lamina and laminates - notched strength – fracture toughness - nondestructive testing.

UNIT V NANOMATERIALS REINFORCED PLASTICS **9**

Introduction: Nanoscale Fillers – Clay, POSS, Carbon based nanomaterials, nanoparticle fillers; Processing into nanocomposites; Modification of interfaces; Properties. Applications.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will be conversant with knowledge of various types of composites, its advantages and needs.

CO2 Will come to know of various types of fibers, polymers and other additives materials for making reinforced plastics with different properties.

CO3 Will gain adequate knowledge on all types of processes available to make reinforced plastics products and hence will be able to choose suitable process for the manufacture of composite products.

CO4 Will develop expertise to do the required quality control tests to evaluate the suitability of the reinforced plastics products for various applications.

CO5 Will become aware of the new developments related to synthesis, characterisation and applications in the various types of nanomaterials as reinforcements for polymers.

CO6 Will learn to predict the properties of reinforced plastics theoretically.

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REFERENCE:

1. George Lubin, Stanley T. Peters, Handbook of Composites, Chapman & Hall, 1998.
2. Bor Z. Jang, Advanced Polymer composites, ASM International, USA, 1994.
3. Mel M. Schwartz, Composite Materials: Processing, fabrication, and applications, Prentice Hall PTR, 1997.
4. M.C.Gupta and A.P.Gupta, Polymer Composites, New Age International Publishers, 2007.
5. Leif A. Carlsson, Donald F. Adams, R. Byron Pipes,Experimental Characterization of advanced composite materials, Fourth Edition, CRC Press, 2014.
6. Emmanuel Craig, Nanocomposites: Fundamentals, Technology and Applications 2017, Larsen and Keller Education.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will be conversant with knowledge of various types of composites, its advantages and needs.	3	2	2	2	1				2	1	3	2	2	1	1	2
CO2	Will come to know of various types of fibers, polymers and other additives materials for making reinforced plastics with different properties.	3	2	2	2	1				2	1	3	2	2	1	1	2
CO3	Will gain adequate knowledge on all types of processes available to make reinforced plastics products and hence will be able to choose suitable process for the manufacture of composite products	3	2	2	2	1				2	1	3	2	2	1	3	2
CO4	Will learn to predict the properties of reinforced plastics theoretically	3	2	2	2	1				2	1	3	2	2	1	3	2

CO5	Will develop expertise to do the required quality control tests to evaluate the suitability of the reinforced plastics products for various applications	3	2	2	2	1				2	1	3	2	2	1	3	2
CO6	Will become aware of the new developments related to synthesis, characterisation and applications in the various types of nanomaterials as reinforcements for polymers	3	2	2	2	1				2	1	3	2	2	1	1	2
Overall CO		3	2	2	2	1				2	1	3	2	2	1	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5016 **RUBBER TECHNOLOGY** **L T P C**

3 0 0 3

OBJECTIVES:

- To acquire knowledge in the Fundamentals of Rubber and Specialty Rubbers.
- To know about the Processing of Rubber and Manufacture of tyres and Tubes.
- To impart knowledge on rubbers used in Belting, hoses and Footwear.

UNIT I FUNDAMENTALS OF RUBBER **9**

Criteria for a polymer to behave as a rubber – structure vsTg, chemical, mechanical andelectrical properties – polymerization types and techniques involved in production of generalpurpose rubbers – ozone attack on rubbers– protection against oxidation - antioxidants –network bound antioxidants, vulcanization – mechanism of sulphur cure-effect of crosslinkdensity on properties – role of accelerators, activators – non–sulphur vulcanization systems.

UNIT II SPECIALTY RUBBERS **9**

Heat resistant rubbers –polyisobutylene, butyl and EPDM rubbers –solvent/oil resistantrubbers– nitrile, neoprene and chloroprene rubbers, EMA,ACM,EVA – hypalonandchlorinated PE – highperformance, specialty and modified rubbers – fluorine containing and silicone rubbers,polyurethanes , polyethers& polysulphide.

UNIT III PROCESSING OF RUBBER **9**

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

UNIT IV MANUFACTURE OF TYRE AND TUBES **9**

Rubber product manufacture – tyres – functions, requirements – basic design reinforcingsystems – construction – manufacture – aero tyres – building and curing of passenger car tyre,truck tyre, four wheeler tyre - testing – Defects and remedial measures - tube manufacture–compounding for tyre and tube. Naval and space applications of rubber, Green tyre technology, Intelligent tyres-new generation tyres.

UNIT V BELTING, HOSES AND FOOTWEAR **9**

Belting and hoses – conveyor, transmission (V and flat) belting. troughing moulded, braided andhand–built hoses – compounding - footwear and ports goods – hot air vulcanized – compressionmoulded – direct molded process for shoe bottoming – injection moulded sole and heel units –safety and antistatic foot wear – micro and macrocellular rubbers – expanding rubber bynitrogen gassing and chemical blowing agents– tennicoit rings.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will be aware of preparation and properties of rubbers.
CO2 Will be conversant in manufacture and properties of tyres and Tubes.
CO3 Will develop capacity to appreciate the applications of rubber.
CO4 Will have enriched knowledge about elastomeric materials.
CO5 Will have an update of current trends in rubber processing technology.

REFERENCE:

1.M.Morton, Rubber Technology, Van Nostrand Reinhold, 1987.

2.A.K. Bhowmick and H.L.Stephens, Hand Book of Elastomers, Marcel Dekker, New York,1988.

3. J. A. Brydson, Plastic Materials, Elsevier Publishers Group, 2014.

4.C. M. Blow and C.Hepburn, “Rubber Technology and Manufacture”, 2rdEdn.,Butterworths, London, 1982.

5.B. Kothandaraman, Rubber Materials, Ane Books Pvt. Ltd., New Delhi, 2008.

6. J.M. Martin, W.K.Smith, Handbook of Rubber Technology, Vol. 1 & 2, CBS Publishers & Distributors, 2004.

7. Yuko Ikeda- Atsushi Kato, Yukio Nakajima,Rubber science - A modern approach, 1st edition, 2018.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will be aware of preparation and properties of rubbers	3	-	3	-	-	2	2	-	-	-	2	-	3	3	-	2
CO2	Will be conversant in manufacture and properties of tyres and Tubes	3	-	3	-	-	2	2	-	-	-	2	-	3	3	-	2
CO3	Will develop capacity to appreciate the applications of rubber	3	-	3	-	-	2	2	-	-	-	2	-	3	3	-	2
CO4	Will have enriched knowledge about elastomeric materials	3	-	3	-	-	2	2	-	-	-	2	-	3	3	-	2
CO5	Will have an update of current trends in rubber processing technology	3	-	3	-	-	2	2	-	-	-	2	-	3	3	-	2
Overall CO		3	-	3	-	-	2	2	-	-	-	2	-	3	3	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5017 **SPECIALTY POLYMERS** **L T P C**

3 0 0 3

OBJECTIVES:

- To make the student acquire knowledge on liquid crystalline polymers.
- To provide exposure on conducting and piezoelectric polymers.
- To impart a thorough understanding of heat resistant polymers.
- To provide knowledge on photosensitive polymers and coating additives.
- To facilitate the students to understand the use of polymers for specialty applications.

UNIT I LIQUID CRYSTALLINE POLYMERS (LCPS) 9

Concept of liquid crystalline (LC) phase, liquid crystalline polymers and their classification - theories of liquid crystallinity, characteristics of LC state and LCPs, synthesis, structure property relationship, rheology of liquid crystalline polymers, blends of LCPs, self reinforced composites, applications of LCPs.

UNIT II CONDUCTING POLYMERS 9

Theory of conduction, semi conductors and conducting polymers, band theory, requirements for polymer to work as conductor, types of conducting polymers - intrinsic and extrinsic, doping of polymeric systems, Mechanism of conducting polymers- Polyaniline, Polyacetylene, Polypyrole, organometallic polymers – Photo conducting polymers- Polymers with Piezzo, ferro and pyro electric properties.

UNIT III HEAT RESISTANT POLYMERS 9

Requirements for heat resistance, determination of heat resistance, synthesis, structure-property relationships, applications of heat resistant polymers like polyamides, polyimides and its derivatives, polyquinolines, polyquinoxalines, Polymers for high temperature resistant applications - PBT, PBO, PBI, PPS, PPO, PEEK, Fluro polymers, aromatic polymers and heterocyclic polymers.

UNIT IV PHOTOSENSITIVE POLYMERS AND POLYMERS AS COATING ADDITIVES 9

Photosensitive polymers - synthesis, curing reactions, applications in various fields. Photo resist for semiconductor fabrication. Membranes, their types, methods of casting and their applications. Polymer as coating additives - types, synthesis, requirements for polymer to work as coating additives and applications

UNIT V POLYMERS IN MISCELLANEOUS SPECIALTY APPLICATIONS 9

Polymers in agricultural applications: green houses, mulches, control release of agricultural chemicals, seed coatings, etc., polymers in construction and building applications, polymer concrete, polymeric materials used in telecommunication and power transmission applications, polymer composites in aerospace and other light weight applications, polymers in cosmetics.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Comprehend the importance of rheology of liquid crystalline polymers
CO2 Understand the importance of Polymeric doping systems
CO3 Have knowledge on the use of polymers for high temperature applications
CO4 Identify the application of photoresists and polymeric coatings
CO5 Understand the use of polymers for agricultural, aerospace and telecommunications

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REFERENCES:

1. Manas Chanda, Salil K. Roy, Industrial Polymers, Specialty Polymers, and their Applications, CRC Press, (2009).
2. Faiz Mohammad, Specialty Polymers: Materials and Applications, I.K. International Pvt Ltd, (2008).
3. Matrin.T. Goosey," Plastics for Electronics", Elsevier, Applied Science, (1985).
4. Robert William Dyson, Speciality Polymers, Springer, (2012).
5. Manas Chanda, Salil K.Roy," Plastics Technology Hand book ", 2nd edition, Marcel Dekker Inc, New York, (1993).
6. Johannes Karl Fink, Hand book of Engineering and Specialty Polymers, John Wiley & Sons, Vol.2, (2011).
7. Norio Ise, IwaoTabushi, An Introduction to Speciality Polymers, Cambridge University Press, (1983).

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Comprehend the importance of rheology of liquid crystalline polymers	2	2	2	-	2	-	2	-	-	2	1	2	3	3	2	2
CO2	Understand the importance of Polymeric doping systems	2	2	2	-	2	-	2	-	-	2	1	2	3	3	2	2
CO3	Have knowledge on the use of polymers for high temperature applications	2	2	2	-	2	-	2	-	-	2	1	2	3	3	2	2
CO4	Identify the application of photoresists and polymeric coatings	2	2	2	-	2	-	2	-	-	2	1	2	3	3	2	2
CO5	Understand the use of polymers for agricultural, aerospace and telecommunications	2	2	2	-	2	-	2	-	-	2	1	2	3	3	2	2
Overall CO		2	2	2	-	2	-	2	-	-	2	1	2	3	3	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PL5018 **SYNTHETIC RESINS** **L T P C**
3 0 0 3

OBJECTIVES:

- To acquire knowledge on the classification of natural, synthetic polymers and its commercial applications**.**
- To understand the basic concepts of water soluble polymers and its applications invarious fields.
- To understand the concepts of thermoplastics and thermosetting resins, their importance of rubbers, fibers and plastics and their engineering applications.

UNIT I CLASSIFICATION OF POLYMERS **9**

Introduction – Classification of natural, modified and synthetic polymers – effect of structure on properties of polymers –– Salient features of plastics-water soluble polymers– classification functions and properties – starch - dextrinization – modified starches – cellulose and its derivatives- commercial Applications.

UNIT II WATER SOLUBLE POLYMERS **9**

Synthetic water soluble polymers, preparation, properties and applications of polyvinyl alcohol – polyvinylpyrrolidone – polyacrylic acid and its homolog's – polyacrylamide – polyethylene oxide – polyethylene mine. Application of water soluble polymers in pharmaceuticals – cosmetics –textiles – paper – detergents and soaps – paint – flocculation – beverages – polyelectrolyte's.

UNIT III THERMOPLASTIC RESINS **9**

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

UNIT IV THERMOSETTING RESINS **9**

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

UNIT V RUBBERS AND FIBERS **9**

Elastomers – natural rubber – vulcanization - synthetic rubbers - butyl- SBR neoprene.Application of synthetic resins as fiber – commodity plastics – sheets and film – foam – packaging – biodegradable and engineering applications.

TOTAL PERIODS: 45

OUTCOMES:

CO1 Will be aware of classification of polymers
CO2 Will develop capacity to appreciate the applications of natural and syntheticpolymers.
CO3 Will able to gain knowledge on properties of thermoplastic and thermosetting resin and its trade name.
CO4 Will able to know the preparation of various thermoplastic and thermosetting resins.
CO5 Able to gain knowledge in various rubber and its formulations.

REFERENCE BOOKS

1. J.A. Brydson, "Plastics Materials", Newness - Elsevier, Seventh Edn, London, 2014.
2. R.L. Davidson and S. Marshall, "Water Soluble Resins", Van-Nostrand Reinhold, New York,1988.
3. R.B. Seymour and C.E.Carraher, Jr., "Polymer Chemistry – An Introduction", MarcelDekker Inc., New york, 2010.
4. Maurice Morton, "Rubber Technology", Van Nostrand Reinhold, New York, 2002.
5. Qipeng Guo, "Thermosets, Structure, Properties, and Applications",2nd Edition,Elsevier November 2017.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Will be aware of classification of polymers	3	-	-	-	-	-	2	-	-	-	2	2	3	2	-	2
CO2	Will develop capacity to appreciate the applications of natural and synthetic polymers	3	-	-	-	-	-	2	-	-	-	2	2	3	2	-	2
CO3	Will able to gain knowledge on properties of thermoplastic and thermosetting resin and its trade name	3	-	-	-	-	-	2	-	-	-	2	2	3	2	-	2
CO4	Will able to know the preparation of various thermoplastic and thermosetting resins	3	-	-	-	-	-	2	-	-	-	2	2	3	2	-	2
CO5	Able to gain knowledge in various rubber and its formulations	3	-	-	-	-	-	2	-	-	-	2	2	3	2	-	2
Overall CO		3	-	-	-	-	-	2	-	-	-	2	2	3	2	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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OPEN ELECTIVE COURSES (OEC)

OE5091 **BUSINESS DATA ANALYTICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop– RDBMS versus Hadoop–Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop– Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

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1. VigneshPrajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, UmeshaNayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
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6. A. Ohri, “R for Business Analytics”, Springer, 2012
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	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

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OE5092 **INDUSTRIAL SAFETY** **LT P C**
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING 9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

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

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REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn ,Foundation Engineering Handbook, Chapman & Hall London,2013.
4. Higgins & Morrow , Maintenance Engineering Handbook,Eighth Edition,2008

OE5093 OPERATIONS RESEARCH LT P C
3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method,Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

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

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
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OE5094 COST MANAGEMENTOF ENGINEERING PROJECTS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member,Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES

CO1 – Understand the costing concepts and their role in decision making
CO2–Understand the project management concepts and their various aspects in selection
CO3–Interpret costing concepts with project execution
CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management

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

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE5095 **COMPOSITE MATERIALS** **L T P C**
3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION **9**

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS **9**

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES **9**

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES **9**

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH **9**

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

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

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, WestGermany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
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OE5096 **WASTE TO ENERGY** **L T P C**
3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNITI INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNITIIBIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNITIII BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNITIV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNITV BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

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

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

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AUDIT COURSES (AC)

AX5091 ENGLISHFOR RESEARCHPAPERWRITING L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNITI INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 –Learn about what to write in each section
CO3 –Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

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

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
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AX5092 **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explaina critical understanding of key concepts in disaster riskreduction and humanitarian response.
CO3: Ability to illustratedisaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describean understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to developthe strengths and weaknesses of disaster management approaches

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

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1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
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3. Sahni, Pardeep Et.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS 6

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES 6

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS 6

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

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

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1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
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AX5094	VALUE EDUCATION	L T P C
		2 0 0 0

OBJECTIVES

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

Values and self-development–Social values and individual attitudes. Workethics,Indianvisionofhumanism.Moralandnon-moralvaluation.Standards and principles. Value judgements

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love fornature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.

Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the over all personality.

Suggested reading

1. Chakroborty, S.K.“Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

AX5095	CONSTITUTION OF INDIA	L T P C 2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:

History, Drafting Committee, (Composition &Working)

UNIT II PHILOSOPHYOFTHE INDIANCONSTITUTION:

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

District's Administration head: Role and Importance, • Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION:

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- DiscussthegrowthofthedemandforcivilrightsinIndiaforthebulkofIndiansbeforethe arrival of Gandhi in Indian politics.
- Discusstheintellectualoriginsoftheframeworkofargumentthatinformedtheconceptualization
- of social reform sliding to revolution in India.
- DiscussthecircumstancessurroundingthefoundationoftheCongressSocialistParty[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- DiscussthepassageoftheHinduCodeBillof1956.

Suggested reading

1. TheConstitutionofIndia,1950(BareAct), Government Publication.
2. Dr. S. N. Busi, Dr. B. R.AmbedkarframingofIndianConstitution,1st Edition,2015.
3. M.P. Jain,IndianConstitutionLaw,7th Edn.,Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis,2015.

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AX5096 **PEDAGOGY STUDIES** **L T P C**
2 0 0 0

OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT II INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OFPEDAGOGICALPRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to understand:

- Whatpedagogicalpracticesarebeingusedbyteachersinformalandinformalclassrooms in developing countries?
- What is the evidence on the effectiveness soft he sepedagogical practices, in what conditions, and with what population of learners?
- How can teacher education(curriculum and practicum)and the school curriculum and guidance materials best support effective pedagogy?

Suggested reading

1. Ackers, HardmanF(2001)ClassroominteractioninKenyanprimaryschools,Compare,31(2): 245-261.
2. AgrawalM (2004)Curricular reform in schools: The importance of evaluation, JournalofCurriculumStudies,36(3):361-379.
3. AkyeampongK(2003)TeachertraininginGhana-doesitcount?Multi-siteteachereducationresearchproject(MUSTER) country report 1.London:DFID.
4. Akyeampong K,LussierK, PryorJ, WestbrookJ (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. ChavanM (2003) Read India: Amass scale, rapid, 'learningtoread 'campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

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AX5097 **STRESS MANAGEMENT BY YOGA** **L T P C**
2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do‘s and Don’t’sin life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTEDREADING

1. ‘YogicAsanasforGroupTarining-Part-I”:JanardanSwamiYogabhyasiMandal, Nagpur
2. “Rajayogaorconquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department),Kolkata

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To a waken wisdom in students

UNIT I

Neetishatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses-29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses-71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 -Personality of role model - shrimadbhagwadgeeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad- Bhagwad- Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and man kind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students.

Suggested reading

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.