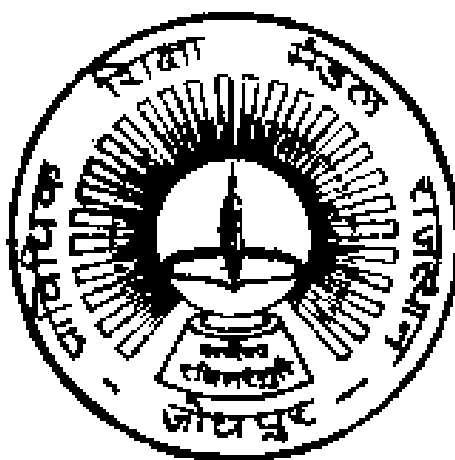


GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN
JODHPUR

SEMESTER SCHEME-2020-21

(SESSION 2021-2022 & ONWARDS)



TEACHING AND EXAMINATION SCHEME
AND SYLLABUS

PLASTIC TECHNOLOGY

(PL)

.....
Curriculum Development Cell
Board of Technical Education, Rajasthan
W-6 Residency Road,
Jodhpur

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN, JODHPUR
TEACHING AND EXAMINATION SCHEME
(SEMESTER SCHEME-2020-21)
FOR DIPLOMA III SEMESTER (PLASTIC TECHNOLOGY) (PL)
SESSION 2021-2022 & ONWARDS

Subject Category	Subject Code	Subjects	Distribution of Time				Distribution of Max. Marks/ Duration							Total Marks	Credits
			Hours per week				End Semester Exam			Internal Assessment					
			L	T	P	Tot	TH	Hrs.	PR	Hrs.	CT	TU/Assi	PR(S)		
PC	PL 3001	Polymer Technology	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	PL 3002	Polymerization Process Engineering	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	PL 3003	Additives and Compounding	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	PL 3004	Plastic Processing-I	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	PL 3005	High Polymer Chemistry	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	PL 3006	Plastic Processing-I Lab	0	0	4	4	-	-	40	3	-	-	60	100	2
PC	PL 3007	Polymerization Process Engineering Lab	0	0	4	4	-	-	40	3	-	-	60	100	2
SI	PL 3008	Summer Internship-I(4 weeks after II sem.)	-	-	-	-	-	-	100	--	--	--	--	100	2
VS	+PL 3333	Anandam (Joy of Giving)	--	--	1	1	--	--	--	--	--	--	100	100	2
		Students Centered Activities	0	0	3	3	--	--	--	--	--	--	--	--	--
		Total Credits	10	5	12	27	300		180		100	100	220	900	23
Grand Total :													900	23	

- | | |
|--|---|
| 1. L : Lecture | 5. PR : Marks for End Semester Exam for Practical |
| 2. T : Tutorial | 6. CT : Marks for class tests (Internal Assessment) |
| 3. P : Practical | 7. TU/Assi : Marks for tutorials/Assignment (Internal Assessment) |
| 4. TH : Marks for End Semester Exam for Theory | 8. PR(S) : Marks for practical and viva (Internal Assessment) |

1. +PL 3333 is same in all branches of Engineering

Student Centered Activities will be graded as A, B, C & D on the basis of attendance and interest of the student in learning.

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN, JODHPUR
TEACHING AND EXAMINATION SCHEME
(SEMESTER SCHEME-2020-21)
FOR DIPLOMA IV SEMESTER (PLASTIC TECHNOLOGY) (PL)
SESSION 2021-2022 & ONWARDS

Subject Category	Subject Code	Subjects	Distribution of Time				Distribution of Max. Marks/ Duration						Total Marks	Credits	
			Hours per week				End Semester Exam			Internal Assessment					
			L	T	P	Tot	TH	Hrs.	PR	Hrs.	CT	TU/Assi			PR(S)
PC	PL 4001	Fiber Technology	2	1	0	3	60	3		20	20	-	100	3	
PC	PL 4002	Plastic Processing –II	2	1	0	3	60	3		20	20	-	100	3	
PC	PL 4003	Fibre Reinforced Plastics	2	1	0	3	60	3		20	20	-	100	3	
PC	PL 4004	Rubber Technology	2	1	0	3	60	3	-	-	20	20	-	100	3
PE	PL 4005	Programme Elective-I PL 40051- Finishing & Decoration of Plastics PL 40052- Advanced Polymerization Process Engineering	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	PL 4006	Plastic Processing-II Lab	0	0	4	4	-	-	40	3	-	-	60	100	2
PC	PL 4007	Fibre Reinforced Plastics Lab	0	0	4	4	-	-	40	3	-	-	60	100	2
PC	PL 4008	Rubber Technology Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
PR	PL 4009	Minor Project	0	0	4	4	-	-	40	3	-	-	60	100	2
AU	+PL 4222	Essence of Indian Knowledge and Tradition	2	0	0	2	-	-	-	-	-	-	-	-	-
VS	+PL 4444	Anandam (Joy of Giving)	-	-	1	1	--	--	--	--	--	--	100	100	2
		Students Centered Activities	0	0	3	3	--	--	--	--	--	--	--	--	--
		Total Credits	12	5	18	35	300	--	160	--	100	100	340	1000	24
		Grand Total :											1000	24	

- | | |
|--|---|
| 1. L : Lecture | 5. PR : Marks for End Semester Exam for Practical |
| 2. T : Tutorial | 6. CT : Marks for class tests (Internal Assessment) |
| 3. P : Practical | 7. TU/Assi : Marks for tutorials/Assignment (Internal Assessment) |
| 4. TH : Marks for End Semester Exam for Theory | 8. PR(S) : Marks for practical and viva (Internal Assessment) |

1. +PL 4222 and +PL 4444 are same in all branches of Engineering

Student Centered Activities will be graded as A, B, C & D on the basis of attendance and interest of the student in learning.

Note: Students will go for 6 Weeks Summer Internship in the Summer Vacations after Fourth Semester. The assessment of the Summer Internship will be done in Fifth Semester

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN, JODHPUR
TEACHING AND EXAMINATION SCHEME
(SEMESTER SCHEME-2020-21)
FOR DIPLOMA V SEMESTER (PLASTIC TECHNOLOGY)(PL)
SESSION 2022-2023 & ONWARDS

Subject Category	Subject Code	Subjects	Distribution of Time				Distribution of Max. Marks/ Duration							Total Marks	Credits
			Hours per week				End Semester Exam				Internal Assessment				
			L	T	P	Tot	TH	Hrs.	PR	Hrs.	CT	TU/Assi	PR(S)		
PC	PL 5001	Engineering Plastics	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	PL 5002	Rheology of Polymers	2	1	0	3	60	3	-	-	20	20	-	100	3
OE	+PL 5100	Open Elective-I +PL 51001- Economic Policies in India +PL 51002- Engineering Economics & Accountancy	3	0	0	3	60	3	-	-	20	20	-	100	3
PC	PL 5003	Testing of Polymers	2	1	0	3	60	3	-	-	20	20	-	100	3
PE	PL 5004	Programme Elective-II PL 50041- Polymer Blends and Alloys PL 50042- Polymer Waste Management	3	0	0	3	60	3	-	-	20	20	-	100	3
PE	PL 5005	Programme Elective-III PL 50051- Advanced Polymer Additives PL 50052- Advanced Engineering Plastics	3	0	0	3	60	3	-	-	20	20	-	100	3
PC	PL 5006	Polymers Testing Lab	0	0	4	4	-	-	40	3	-	-	60	100	2
SI	PL 5007	Summer Internship-II(6 weeks after IV sem.)	-	-	--	--	-	--	100	--	--	--	--	100	3
PR	PL 5008	Major Project	0	0	2	2	-	-	-	-	-	-	-	-	--
VS	+PL 5555	Anandam (Joy of Giving)	--	--	1	1	--	--	--	--	--	--	100	100	2
		Students Centered Activities	0	0	3	3	--	--	--	--	--	--	--	--	--
		Total	15	3	10	28	360		140	-	120	120	160	900	25
Grand Total :													900	25	

- | | |
|--|---|
| 1. L : Lecture | 5. PR : Marks for End Semester Exam for Practical |
| 2. T : Tutorial | 6. CT : Marks for class tests (Internal Assessment) |
| 3. P : Practical | 7. TU/Assi : Marks for tutorials/Assignment (Internal Assessment) |
| 4. TH : Marks for End Semester Exam for Theory | 8. PR(S) : Marks for practical and viva (Internal Assessment) |

1. +PL 51001, +PL51002 and +PL 5555 are same in all branches of Engineering

Student Centered Activities will be graded as A, B, C & D on the basis of attendance and interest of the student in learning.

Note:Major Project will be continued and Assesed in VI Semester

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN, JODHPUR
TEACHING AND EXAMINATION SCHEME
(SEMESTER SCHEME-2020-21)
FOR DIPLOMA VI SEMESTER (PLASTIC TECHNOLOGY)(PL)
SESSION 2022-2023 & ONWARDS

Subject Category	Subject Code	Subjects	Distribution of Time				Distribution of Max. Marks/ Duration							Total Marks	Credits
			Hours per week				End Semester Exam			Internal Assesment					
			L	T	P	Tot	TH	Hrs.	PR	Hrs.	CT	TU/Assi	PR(S)		
HS	+PL 6111	Entrepreneurship and Start-ups	3	1	0	4	60	3	-	-	20	20	-	100	4
OE	+PL 6200	Open Elective-II +PL 62001- Project Management +PL 62002- Renewable Energy Technologies	3	0	0	3	60	3	-	-	20	20	-	100	3
OE	+PL 6300	Open Elective-III +PL 63001- Product Design +PL 63002- Disaster Management	3	0	0	3	60	3	-	-	20	20	-	100	3
AU	+PL 6333	Indian Constitution	2	0	0	2	-	-	-	-	-	-	-	-	0
PC	PL 6001	Design of Dies and Molds	2	0	0	2	60	3	-	-	20	20	-	100	2
PE	PL 6002	Programme Elective-IV PL 60021- Characterisation of Polymers PL 60022- Advanced Rubber Technology	3	0	0	3	60	3	-	-	20	20	-	100	3
PR	PL 6003	Major Project	0	0	6	6	-	-	40	-	-	-	60	100	4
SE	PL 6004	Seminar	1	0	0	1	-	-	-	-	-	-	100	100	1
VS	+PL 6666	Anandam (Joy of Giving)	--	--	1	1	--	--	--	--	--	--	100	100	2
		Students Centered Activities	0	0	3	3	--	--	--	--	--	--	--	--	--
		Total	17	1	10	28	300	--	40	100	100	260	800	22	
Grand Total :													800	22	

- | | |
|--|---|
| 1. L : Lecture | 5. PR : Marks for End Semester Exam for Practical |
| 2. T : Tutorial | 6. CT : Marks for class tests (Internal Assessment) |
| 3. P : Practical | 7. TU/Assi : Marks for tutorials/Assignment (Internal Assessment) |
| 4. TH : Marks for End Semester Exam for Theory | 8. PR(S) : Marks for practical and viva (Internal Assessment) |

1. +PL 6111, +PL 62001, +PL 62002, +PL 63001, +PL 63002, +PL 6333 and +PL 6666 are same in all branches of Engineering

Student Centered Activities will be graded as A, B, C & D on the basis of attendance and interest of the student in learning.

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN JODHPUR
SEMESTER SCHEME-2020-21



III SEMESTER
(SESSION 2021-2022 & ONWARDS)

POLYMER TECHNOLOGY

Course Code	PL 3001
Course Title	POLYMER TECHNOLOGY
Number of Credits	3(L: 2, T: 1, P: 0)
Prerequisites	NIL
Course Category	PC

COURSE OBJECTIVE

Preliminary knowledge of polymer technology is essential to understand the advance subject to plastic technology. This subject covers basic ideas of various types of plastics.

COURSE OUTCOME:

Students will learn about the basic fundamentals of polymers, their properties and applications.

COURSE CONTENTS**1. INTRODUCTION TO POLYMERS :**

- 1.1 History of polymers
- 1.2 Definition of monomer, polymer, and degree of polymerization
- 1.3 Classification of polymers - plastics, rubbers and fibres
- 1.4 Thermosetts and thermoplastics, their comparison
- 1.5 Hetro, Homo and Copolymer
- 1.6 Reinforced and engineering plastics
- 1.7 Classification of linear, branched and cross linked polymers
- 1.8 Random alternate blocks and graft copolymers
- 1.9 Various natural polymers

2. TYPES OF POLYMERISATION :

- 2.1 Stepwise and addition polymerisation, (free radical, cationic and anionic)
- 2.2 Comparison of step and addition polymerisation

3. POLYMERISATION TECHNIQUES:

- 3.1 Bulk,
- 3.2 Solution,
- 3.3 Suspension
- 3.4 Emulsion.

4. VARIOUS TYPES OF MOLECULAR WEIGHTS OF POLYMERS :

- 4.1 Molecular weight distribution
- 4.2 Determination of molecular weight of polymer by viscometry and osmometry
- 4.3 Introduction to light scattering and ultra centrifuse methods
- 4.4 Effect of molecular weight and viscosity on properties of polymers

5. PHYSICAL STATE OF POLYMERS :

- 5.1 Crystalline and amorphous behaviour
- 5.2 Determination of crystallinity
- 5.3 Thermal transition of polymers
 - 5.3.1 Glass transition temperatures

6. MONOMER, POLYMER CHEMICAL STRUCTURE, PROPERTIES AND APPLICATION OF VARIOUS POLYMERS

- 6.1 Polyethylene
- 6.2 Polypropylene
- 6.3 Polystyrene and HIPS
- 6.4 PMMA
- 6.5 Nylon-6
- 6.6 Phenol Formaldehyde

7. DEGRADATION OF POLYMERS

- 7.1 Introduction
- 7.2 Types of polymer degradation

8. ADVANTAGE OF PLASTICS IN AREAS OF ELECTRICAL, POWER TRANSMISSION, GENERAL HOUSE HOLD, MEDICAL APPLICATIONS ETC.

REFERENCE BOOKS:

- | | |
|--|---------------|
| 1. Text Book of Polymer Chemistry | Billmeyer |
| 2. Physical Chemistry of Polymers | A.Tagor |
| 3. Polymer Science | V.R.Gowariker |
| 4. Properties and structure of polymer | Tobolsky |

SEMESTER SCHEME 2020-21

POLYMERISATION PROCESS ENGINEERING

Course Code	PL 3002
Course Title	POLYMERISATION PROCESS ENGINEERING
Number of Credits	3 (L: 2, T: 1, P: 0)
Prerequisites	Nil
Course Category	PC

COURSE OBJECTIVES:

This subject covers the Chemistry, manufacturing processes, properties, uses and application of various polymers

COURSE OUTCOMES:

Students will learn about the monomer preparation, chemistry and polymerization processes of various polymers.

COURSE CONTENTS:**1. HIGH DENSITY POLYETHYLENE**

- 1.1 Introduction
- 1.2 Monomer Preparation
- 1.3 Chemistry
- 1.4 Polymerization Process
- 1.5 Properties
- 1.6 Applications

2. LOW DENSITY POLYETHYLENE

- 2.1 Introduction
- 2.2 Monomer Preparation
- 2.3 Chemistry
- 2.4 Polymerization Process
- 2.5 Properties
- 2.6 Applications

3. POLYPROPYLENE

- 3.1 Introduction
- 3.2 Monomer Preparation
- 3.3 Chemistry
- 3.4 Polymerization Process
- 3.5 Properties
- 3.6 Applications

4. POLYVINYL CHLORIDE

- 4.1 Introduction
- 4.2 Monomer Preparation
- 4.3 Chemistry
- 4.4 Polymerization Process
- 4.5 Properties
- 4.6 Applications

5. POLYSTYRENE

- 5.1 Introduction
- 5.2 Monomer Preparation
- 5.3 Chemistry
- 5.4 Polymerization Process
- 5.5 Properties
- 5.6 Applications

REFERENCE BOOKS:

1. Manufacture of Plastics Vol I & II
2. Modern Plastics
3. Polymers and Resins
4. Polyolefins Resins Processes
5. Plastic Materials
6. Polymer Technology
7. Engg. Thermoplastics, Properties and Applications
8. Encyclopedia of Polymerisation Engg. and Science
9. Polymer Manufacturing

W. Mayosmith
Harry Barron
Golding
M Sitting
Brydson
Miles &Briston
J.M. Margolis
H.Mark
Radian.

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SEMESTER SCHEME 2020-21

ADDITIVES AND COMPOUNDING

Course Code	PL 3003
Course Title	ADDITIVES AND COMPOUNDING
Number of Credits	3 (L: 2, T: 1, P: 0)
Prerequisites	Nil
Course Category	PC

COURSE OBJECTIVES:

Compounding of plastics needs basic knowledge about common ingredients used in the processes. The formulation of these ingredients directly affects the quality of plastic products.

COURSE OUTCOMES:

Students will learn about the compounding, equipment utilized and various additives used in polymer processing to achieve the desired properties.

COURSE CONTENTS:**1. INTRODUCTION :**

- 1.1 Purpose of compounding
- 1.2 Types of compounding ingredients
- 1.3 Industrial importance of compounding

2. FILLERS AND REINFORCEMENTS :

- 2.1 Introduction
- 2.2 Properties of filled and reinforced plastics
- 2.3 Various types of fillers and reinforcements

3. STABILIZERS:

- 3.1 Light stabilizer
 - 3.1.1 Photo-degradation of synthetic polymers
 - 3.1.2 Mechanism of U.V. stabilization
- 3.2 Heat Stabilizers
 - 3.2.1 Introduction
 - 3.2.2 Heat stabilizers for PVC

4. PLASTICIZERS :

- 5.1 Introduction
- 5.2 Types of plasticizers
- 5.3 Theory, methods and steps in plasticization
- 5.4 Effects of plasticizers on physical properties

5. CONSTRUCTIONAL DETAILS AND WORKING OF MIXING AND BLENDING EQUIPMENTS USED FOR COMPOUNDING

- 5.1 High speed mixer
- 5.2 Internal mixer (banbury mixer)
- 5.3 Ribbon blender
- 5.4 Dry colour blender
- 5.5 Two roll mixing mill
- 5.6 Compounding extruder

REFERENCE BOOKS :

- | | |
|--|---------------------|
| 1. Compounding Materials for the Polymer Industry | John S Dick |
| 2. Plastic Additives Hand book | Gaster & Muller |
| 3. Plasticisers, Fillers and Stabilisers | Ritchie & Critchely |
| 4. Plastic finishing & Decoration | Satas |
| 5. Thermoplastic polymer additives (Theory & Practice) | J T Lutz |

PLASTIC PROCESSING-I

Course Code	PL 3004
Course Title	PLASTIC PROCESSING-I
Number of Credits	3 (L: 2, T: 1, P: 0)
Prerequisites	Nil
Course Category	PC

COURSE OBJECTIVES:

The purpose of this subject is to equip the students with the knowledge of equipment and processes utilized in plastic processing and operational safety.

COURSE OUTCOMES:

Students will learn about the various plastic processing techniques utilized in production of plastic articles and major processes applied in producing consumer goods made of plastic resins.

COURSE CONTENTS:**1. INTRODUCTION TO PROCESSING OF PLASTICS AND VARIOUS TECHNIQUES OF PROCESSING****2. INJECTION MOULDING PROCESSES :**

- 2.1. Introduction
- 2.2. Construction and working of various types of injection moulding machines
 - 2.2.1 Elements of injection moulding machine: Injection unit, Clamping unit, Mould etc.
 - 2.2.2 Nozzles
 - 2.2.3 Plunger and screw types of injection-moulding machine
- 2.3. Moulding Cycle
- 2.4. Moulding Defects and Their Remedies

3. REACTION INJECTION MOULDING

- 3.1 Introduction
- 3.2 Materials Used
- 3.3 Process and Equipment's

4. EXTRUSION:

- 4.1 Introduction
- 4.2 Extruder components
 - 4.2.1 Screw
 - 4.2.2 Barrel
 - 4.2.3 Hopper
 - 4.2.4 Die
 - 4.2.5 Adapter
- 4.3 Cooling and take-off systems
- 4.4 Co-extrusion

5. EXTRUSION PRODUCTS:

- 5.1 Blown Films
- 5.2 Pipe and Tubes
- 5.3 Wire and Cable Coating
- 5.4 Sheets
- 5.5 Profiles

REFERENCE BOOKS :

- | | |
|--|----------------|
| 1. Processing of Thermo Plastic material | Bernhard |
| 2. Extrusion of plastic | Fisher |
| 3. SPI Engg Hand book | Frados |
| 4. Plastic Processing | Radian |
| 5. Plastic Extrusion Tech. | Allan L. Griff |
| 6. Injection moulding | Athale A.S. |
| 7. Moulding of Plastics | N.M. Bekalis |

HIGH POLYMER CHEMISTRY

Course Code	PL 3005
Course Title	HIGH POLYMER CHEMISTRY
Number of Credits	3(L: 2, T: 1, P: 0)
Prerequisites	NIL
Course Category	PC

COURSE OBJECTIVE

The knowledge of this subject is helpful to understand the mechanism of various types of polymerization, quality of the polymers and cost variation of plastic products. This subject also provides a kinetic study of various polymerization techniques and effects of the substituent on polymer properties.

COURSE OUTCOME: Students will learn about the several types of kinetics involved in polymerization reactions

COURSE CONTENTS**1. CONDENSATION POLYMERISATION:**

- 1.1 Concept of functionality
- 1.2 Kinetics of condensation polymerisation
- 1.3 Carother's equation
- 1.4 General conditions of polymerisability

2. ADDITION POLYMERISATION:

- 2.1 Effect of substituents on addition polymerisation
- 2.2 Types of Initiators
- 2.3 Principal kinetics of free radical polymerisation
- 2.4 Inhibition and retardation
- 2.5 Degradation and Chain transfer
- 2.6 Autoacceleration

3. POLYMERISATION DEPOLYMERISATION EQUILIBRIA:

- 3.1 Ceiling temperature
- 3.2 Significance of ceiling temperature in addition polymerization

4. COPOLYMERISATION:

- 4.1 Copolymer equation
- 4.2 Monomer reactivity ratios
- 4.3 Types of co-polymerisation behaviours, block and graft copolymerisation

5. KINETICS OF CATIONIC POLYMERISATION**6. KINETICS OF ANIONIC POLYMERISATION**

- 6.1 Living polymers

REFERENCE BOOKS:

- | | |
|---|-------------------|
| 1. Text Book of Polymer Science | Bill Meyer |
| 2. Principles of Polymerisation | George Odian |
| 3. Polymer Science | V.R.Gowariker |
| 4. Principles of High Polymers, Theory & Practice | Schmidt & Marlies |
| 5. Polymer Chemistry an Introduction | Seymour |
| 6. Polymer Science & Technology of Plastics & Rubbers | P.Ghosh |
| 7. Introductory Polymer Chemistry | G.S.Mishra |
| 8. Text Book of Polymer Science | P.L.Nayak & Lenka |

PLASTIC PROCESSING I LAB.

Course Code	PL 3006
Course Title	PLASTIC PROCESSING I LAB.
Number of Credits	2 (L: 0, T: 0, P: 4)
Prerequisites	Nil
Course Category	PC

COURSE OBJECTIVES:

The purpose of this subject is to equip the students with the knowledge of equipments and processes utilised in plastic processing and operational safety.

COURSE OUTCOMES:

Students will learn about the practical aspects of various plastic processing techniques utilized in production of plastic articles and major processes applied in producing consumer goods made of plastic resins.

COURSE CONTENTS:

1. To produce articles on 0.5 OZ hand injection moulding machine
2. To produce articles on 1.0 OZ hand injection moulding machine
3. To produce articles on 1.5 OZ hand injection moulding machine
4. To produce articles on 2.0 OZ hand injection moulding machine
5. To study semi automatic vertical injection moulding machine (capacity 60 grams) and produce articles.
6. To make articles on fully automatic injection moulding machine (capacity 90 grams).
7. To make LDPE blown film on blown film extruder
8. To study Bag cutting and sealing machine and make LDPE Bags of different lengths.
9. To make Diary covers and purse of PVC sheets on high frequency PVC welding machine.
10. Stamping on Plastic Sheets by Hot Stamping Machine

REFERENCE BOOKS :

- | | |
|--|----------------|
| 1. Processing of Thermo Plastic material | Bernhard |
| 2. Extrusion of plastic | Fisher |
| 3. SPI Engg Hand book | Frados |
| 4. Plastic Processing | Radian |
| 5. Plastic Extrusion Tech. | Allan L. Griff |
| 6. Injection moulding | Athale A.S. |
| 7. Moulding of Plastics | N.M. Bekalis |

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POLYMERISATION PROCESS ENGINEERING LAB.

Course Code	PL 3007
Course Title	POLYMERISATION PROCESS ENGINEERING LAB.
Number of Credits	2 (L: 0, T: 0, P: 4)
Prerequisites	Nil
Course Category	PC

COURSE OBJECTIVES:

This subject covers the Chemistry, manufacturing processes, properties, uses and application of various polymers.

COURSE OUTCOMES:

Students will learn about the practical aspects of chemistry and manufacturing processes of various polymers.

COURSE CONTENTS:**PRACTICALS**

1. To identify the given polymers by following methods:
 - 1.1 Visual examination
 - 1.2 Specific gravity test
 - 1.3 Solubility test
 - 1.4 Burning test
 - 1.5 Softening and melting test
 - 1.6 Odour test
 - 1.7 Chemical test
2. To purify the given monomer (Styrene/methyl methacrylate) and to find out its percentage purity
3. To determine specific gravity of the given monomer
4. To determine refractive index of given monomer
5. To prepare polystyrene/PMMA by bulk polyn
6. To prepare polystyrene/PMMA by solution polyn
7. To prepare phenolformaldehyde resins and to determine its gel time
8. To determine K-value and molecular weight of the given polymer by Ostwald viscometer
9. To determine the bulk density of the given polymer
10. To determine the pH value of given monomer with the help of pH meter.

REFERENCE BOOKS:

- | | |
|--|----------------|
| 1. Manufacture of Plastics Vol I & II | W. Mayosmith |
| 2. Modern Plastics | Harry Barron |
| 3. Polymers and Resins | Golding |
| 4. Polyolefins Resins Processes | M Sitting |
| 5. Plastic Materials | Brydson |
| 6. Polymer Technology | Miles &Briston |
| 7. Engg. Thermoplastics, Properties and Applications | J.M. Margolis |
| 8. Encyclopedia of Polymerisation Engg. and Science | H.Mark |
| 9. Polymer Manufacturing | Radian. |

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GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN JODHPUR
SEMESTER SCHEME-2020-21



IV SEMESTER
(SESSION 2021-2022 & ONWARDS)

FIBER TECHNOLOGY

Course Code	PL 4001
Course Title	FIBER TECHNOLOGY
Number of Credits	3(L: 2, T: 1, P: 0)
Prerequisites	NIL
Course Category	PC

COURSE OBJECTIVE

This subject provides the detailed knowledge of production of various synthetic fibres from basic raw materials. This covers the properties, uses, testing of various fibres, which is one of the essential parts of plastic technology.

COURSE OUTCOME:

Students will learn about all processing, properties and applications of all types of fibers that is natural and synthetic

COURSE CONTENTS**1. FIBRES :**

- 1.1 Introduction
- 1.2 Classification
- 1.3 Structural principles of fibre forming polymers
- 1.4 Orientation (X-ray Analysis) and crystallinity of fibres
- 1.5 Effect of orientation on fibre properties

2. VARIOUS TEXTILE TERMS :

- 2.1 Denier
- 2.2 Cotton count
- 2.3 Tex and Millitex
- 2.4 Tenacity
- 2.5 Breaking strength
- 2.6 Elasticity
- 2.7 Percentage elongation
- 2.8 Twist
- 2.9 Moisture content and moisture regain
- 2.10 Crimp

3. FUNDAMENTAL AND GENERAL MANUFACTURING TECHNIQUES OF FIBRES:

- 3.1 Spinning processes - Melt Spinning, Dry Spinning and Wet spinning
- 3.2 General techniques of drawing of fibers
- 3.3 Texturizing of Fibers
- 3.4 Various techniques of Texturizing - False twist, Air texturizing, Gear Crimping, Stuffer box crimping and knife edge, crimping process.

4. FINISHING OF MAN-MADE FIBRES:

- 4.1 Introduction
- 4.2 Various types of finishes- shape retention, firming, softening, water repellent, stain repellent, antistatic soil- release, antimicrobial and fire-resistant finishes.

5. DYEING OF SYNTHETIC FIBRES

- 5.1 Introduction
- 5.2 Basic process

6. CHEMISTRY, MANUFACTURING PROCESS, PROPERTIES AND USES OF FOLLOWING SYNTHETIC FIBRES:

- 6.1 Polyester
- 6.2 Nylon-66

7. ELEMENTARY KNOWLEDGE, PROPERTIES AND USES OF FOLLOWING FIBRES:

- 7.1 Polyvinyl alcohol
- 7.2 Polypropylene

REFERENCE BOOKS :

- | | |
|-----------------------------------|------------------|
| 1. Man-made Fibers Vol. I and II | H. Marks & Atlas |
| 2. Man Made Fibers | Moncrief |
| 3. Production of Synthetic Fibers | A.A. Vaidya |

SEMESTER SCHEME 2020-21

PLASTIC PROCESSING - II

Course Code	PL 4002
Course Title	PLASTIC PROCESSING – II
Number of Credits	3(L: 2, T: 1, P: 0)
Prerequisites	NIL
Course Category	PC

COURSE OBJECTIVES:

The purpose of this subject is to equip the students with the knowledge of equipments and processes utilised in plastic processing and operational safety.

COURSE OUTCOMES:

Students will learn about the processing techniques of different polymers their significance and applications in different fields

COURSE CONTENT**1. BLOW MOULDING :**

- 1.1 Introduction
- 1.2 Types of blow moulding
- 1.3 Hand and Power operated blow moulding
- 1.4 Extrusion blow moulding
- 1.5 Injection blow moulding
- 1.6 Stretch blow moulding
- 1.7 Blow moulding, defects and their remedies.

2. THERMO FORMING :

- 2.1 Introduction
- 2.2 Methods of thermoforming
 - 2.2.1 Pressure forming
 - 2.2.2 Vacuum forming
 - 2.2.3 Plug assist forming
 - 2.2.4 Skin forming
 - 2.2.5 Blister forming
- 2.3 Defects and Remedies

3. ROTATIONAL MOULDING :

- 3.1 Introduction
- 3.2 Types of machines and materials used

4. COMPRESSION MOULDING :

- 4.1 Introduction
- 4.2 Materials used
- 4.3 Moulding cycles
- 4.4 Machineries and equipments used
 - 4.4.1 Hand operated Machines
 - 4.4.2 Semi automatic Machines
 - 4.4.3 Automatic Machines

5. CALENDERING :

- 5.1 Introduction
- 5.2 Basic principles
- 5.3 Material preparations
- 5.4 Types of calender
- 5.5 Calendering variables
- 5.6 Defects and their remedies

6. CASTING :

- 6.1 Introduction

- 6.2 Various casting process
 - 6.2.1 Sheets casting of MMA
 - 6.2.2 Extrusion Casting

7. CONSTRUCTION AND WORKING OF FOLLOWING MACHINES :

- 7.1 Scrap grinder
- 7.2 Bag cutting and sealing machine
- 7.3 Hot stamping machine

REFERENCE BOOKS :

- | | |
|--|--------------|
| 1. Processing of Thermoplastic Materials | Bernhard |
| 2. SPI Engg. Hand Book | Frados |
| 3. Blow moulding | Fisher |
| 4. Plastic Processing | Radian |
| 5. Moulding of Plastics | N.M. Bekalis |
| 6. Plastic Blow Moulding | LEE |

SEMESTER SCHEME 2020-21

FIBRE REINFORCED PLASTICS

Course Code	PL 4003
Course Title	FIBRE REINFORCED PLASTICS
Number of Credits	3(L: 2, T: 1, P: 0)
Prerequisites	NIL
Course Category	PC

COURSE OBJECTIVES:

In certain engineering applications, plastics of greater strength are required, therefore, efforts have been made to reinforce the plastics with fibres. This subject covers the study and manufacturing techniques of such plastics.

COURSE OUTCOMES:

Students will learn about the manufacturing techniques and applications of Fiber Reinforced Plastics (FRP).

COURSE CONTENT**1. INTRODUCTION TO FIBRE REINFORCED PLASTICS****2. PRINCIPLES OF COMPOSITE REINFORCEMENT****3. POLYMERIC MATERIALS FOR THE COMPOSITES**

- 3.1 Thermoplastic materials
 - 3.1.1 PEEK (Polyether ether Ketone)
 - 3.1.2 PEI (Polyether imide)
 - 3.1.3 PI (Poly imide)
- 3.2 Thermosetting Materials
 - 3.2.1 Unsaturated Polyester resin
 - 3.2.2 Epoxy resin
- 3.3 Particular applications of thermoplastic and thermosetting materials (as given in 3.1 and 3.2)
- 3.4 Unsaturated Polyester resins
 - 3.4.1 Types of unsaturated polyester resin and their application
 - 3.4.2 Manufacture of unsaturated polyester resins
 - 3.4.3 Curing of unsaturated polyester resins
 - 3.4.4 Catalysts and accelerators used for curing of unsaturated polyester resins

4. EFFECT OF FIBROUS REINFORCEMENT ON COMPOSITE STRENGTH :

- 4.1 Along Longitudinal
- 4.2 Along transverse
- 4.3 Types of Reinforcements

5. FIBRE GLASS :

- 5.1 Introduction
- 5.2 Production
- 5.3 Glass composition
- 5.4 Properties
- 5.5 Fibre glass forms
- 5.6 Textured yarn

6. HIGH SILICA AND QUARTZ :

- 6.1 Introduction
- 6.2 Forms of high silica and quartz
- 6.3 Thermal and Chemical properties
- 6.4 Applications

7.PROCESSING AND PRODUCTION TECHNIQUES FOR FRP PRODUCTS :

- 7.1 Introduction
- 7.2 Hand lay-up technique
- 7.3 Spray lay-up technique
- 7.4 Bag moulding techniques
- 7.5 Pultrusion
- 7.6 Advantages and disadvantages of each technique

REFERENCE BOOKS:

- | | |
|--|------------------|
| 1. Hand Book of Composites | George Lubins |
| 2. Engineering Material Hand Book Vol. I | Cyril A Dostal |
| 3. Reinforced Thermoplastics | W. V. Titow |
| 4. FRP Technology | Weatherhead R.G. |

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SEMESTER SCHEME 2020-21

RUBBER TECHNOLOGY

Course Code	PL 4004
Course Title	RUBBER TECHNOLOGY
Number of Credits	3(L: 2, T: 1, P: 0)
Prerequisites	NIL
Course Category	PC

COURSE OBJECTIVES:

Knowledge of this subject covers Manufacturing process of various natural and synthetic elastomers which is important part of polymers. This subject also covers properties, uses of rubbers along with processing techniques of rubber articles

COURSE OUTCOMES:

Students will learn about the preparation, properties and applications of natural and synthetic rubbers.

COURSE CONTENT**1. SOURCES AND HISTORY OF NATURAL AND SYNTHETIC RUBBER.****2. AGING OF RUBBER.****3. PRODUCTION OF DIFFERENT GRADES OF NATURAL RUBBER FROM LATEX:**

- 3.1 Smoke sheet
- 3.2 Pale creep

4. SYNTHETIC RUBBER :

- 4.1 Definition
- 4.2 Classification
- 4.3 Scope
- 4.4 Advantages over natural rubber

5. CHEMISTRY, PROPERTIES, PREPARATION OF VARIOUS SYNTHETIC RUBBERS SUCH AS :

- 5.1 SBR
- 5.2 Nitriles
- 5.3 Butyl
- 5.4 Neoprene
- 5.5 Polysulfide

6. CHEMISTRY, PROPERTIES AND USES OF SYNTHETIC RUBBERS SUCH AS :

- 6.1 Hypalon
- 6.2 Ethylene propylene

7. MASTICATION OF RUBBERS**8. PROCESSING OF RUBBER.****9. DIFFERENT INGREDIENTS :**

- 9.1 Fillers
- 9.2 Accelerators
- 9.3 Activators
- 9.4 Softners
- 9.5 Vulcanizing Agents
- 9.6 Age resisters

10. VULCANIZATION OF RUBBERS**11. FABRICATION OF CELLULAR RUBBERS AND RUBBER ARTICLES SUCH AS:**

- 12.1 V-Belts

- 12.2 Conveyor belts
- 12.3 Hoses
- 12.4 Tyres

12. RECLAIMING OF RUBBER:

- 13.1 Processes
- 13.2 Advantages
- 13.3 Applications

REFERENCE BOOKS :

- | | |
|---|------------------------|
| 1. Natural Rubbers Science & Technology | Roberts |
| 2. Chemistry & Technology of Rubber | Morton |
| 3. Polymer Chemistry of Synthetic Elastomers Vol I & II | Kennedy |
| 4. Rubber Technology & Manufacture | C. M. Blow |
| 5. Synthetic Rubber | G.B. Bhitby, C.D.Davis |
| 6. Rubber Materials & Their Compounds | J. A. Brydson |

SEMESTER SCHEME 2020-21

FINISHING AND DECORATION OF PLASTICS

Course Code	PL 40051
Course Title	FINISHING AND DECORATION OF PLASTICS
Number of Credits	3 (L: 2, T: 1, P: 0)
Prerequisites	Nil
Course Category	PE

COURSE OBJECTIVES:

Finishing and decoration plays important role after processing of plastics. Finishing operation is essentially required to give final shape and decoration to enhance the aesthetics of the article.

COURSE OUTCOMES:

Students will learn about the various finishing/machining operations required after producing plastic articles and different types of coating and printing technique suitable to plastic substrate.

COURSE CONTENTS:**1. SURFACE ANALYSIS :**

- 1.1 Introduction
- 1.2 Leveling and surface defects
- 1.3 Surface analysis techniques : light microscopy, scanning electron microscopy
- 1.4 Surface modification by washing, solvent cleaning, abrasion, flame treatment, corona discharge

2. SURFACE FINISHING :

- 2.1 Deflashing
- 2.2 Filing
- 2.3 Tumbling
- 2.4 Grinding and sanding
- 2.5 Polishing
- 2.6 Ashing
- 2.7 Buffing

3. MACHINING OF PLASTICS :

- 3.1 Introduction
- 3.2 Drilling and reaming
- 3.3 Tapping and threading
- 3.4 Laser machining

4. EMBOSSING :

- 4.1 Introduction
- 4.2 Cast embossing
- 4.3 Pressure embossing
- 4.4 Roll embossing

5. SURFACE COATING AND PRINTING :

- 5.1 Spray painting
- 5.2 Screen-printing
- 5.3 Gravure printing
- 5.4 Flexographic printing
- 5.5 Pad printing
- 5.6 Electrostatic printing
- 5.7 Vacuum Evaporation Metallizing

REFERENCE BOOKS

- | | |
|-------------------------------------|---------|
| 1. Plastic Finishing and Decoration | D.Satas |
| 2. S.P.I. Engg. Handbook | Frados |

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ADVANCED POLYMERISATION PROCESS ENGINEERING

Course Code	PL 40052
Course Title	ADVANCED POLYMERISATION PROCESS ENGINEERING
Number of Credits	3 (L: 2, T: 1, P: 0)
Prerequisites	Nil
Course Category	PE

COURSE OBJECTIVES:

This subject covers the Chemistry, manufacturing processes, properties, uses and application of various polymers

COURSE OUTCOMES:**COURSE CONTENTS:**

Chemistry, Monomer Preparation, Various Polymerization Processes, Flow Sheet, Properties and Application of Following Polymers :

1. CELLULOSE ACETATE

- 1.1 Introduction
- 1.2 Chemistry
- 1.3 Polymerization Process
- 1.4 Properties
- 1.5 Application

2. CELLULOSE NITRATE

- 2.1 Introduction
- 2.2 Chemistry
- 2.3 Polymerization Process
- 2.4 Properties
- 2.5 Application

3. EPOXY RESIN

- 3.1 Introduction
- 3.2 Monomer Preparation
- 3.3 Polymerization Chemistry
- 3.4 Polymerization Process
- 3.5 Properties
- 3.6 Application

4. PHENOL FORMALDEHYDE

- 4.1 Introduction
- 4.2 Monomer Preparation
- 4.3 Polymerization Chemistry
- 4.4 Polymerization Process
- 4.5 Properties
- 4.6 Application

5. CHEMISTRY, PROPERTIES AND APPLICATIONS OF FOLLOWING POLYMERS:

- 5.1 HIPS
- 5.2 NYLON 6
- 5.3 Nylon 6,6
- 5.4 Silicon
- 5.5 PMMA
- 5.6 Urea Formaldehyde
- 5.7 Melamine Formaldehyde

REFERENCE BOOKS:

- | | |
|--|----------------|
| 1. Manufacture of Plastics Vol I & II | W. Mayosmith |
| 2. Modern Plastics | Harry Barron |
| 3. Polymers and Resins | Golding |
| 4. Polyolefins Resins Processes | M Sitting |
| 5. Plastic Materials | Brydson |
| 6. Polymer Technology | Miles &Briston |
| 7. Engg. Thermoplastics, Properties and Applications | J.M. Margolis |
| 8. Encyclopedia of Polymerisation Engg. and Science | H.Mark |
| 9. Polymer Manufacturing | Radian. |

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SEMESTER SCHEME 2020-21

PLASTIC PROCESSING-II LAB

Course Code	PL4006
Course Title	PLASTIC PROCESSING-II LAB
Number of Credits	2(L: 0, T: 0, P: 4)
Prerequisites	NIL
Course Category	PC

COURSE OBJECTIVES:

In certain engineering applications, plastics of greater strength are required, therefore, efforts have been made to reinforce the plastics with fibres. This subject covers the study and manufacturing techniques of such plastics.

COURSE OUTCOMES:

Students will learn about the mold preparation and molding techniques of different Plastics materials.

PRACTICALS TO PERFORMED

1. To produce hollow container/bottle by hand blow moulding machine.
2. To produce articles by hand operated 10 tons compression moulding press.
3. To study the operation of semi-automatic compression moulding press (35 tons capacity)
4. To grind the waste plastics on scrap grinder and to find out its efficiency.
5. To colour the plastic granules by Dry colour Blender.
6. To prepare glass reinforced polyester articles by hand lay up technique.
7. Stamping on plastic sheets by hot stamping machine.
8. Fabrication of acrylic sheets items.
9. To print on plastic articles by screen printing method.

REFERENCE BOOKS :

- | | |
|--|--------------|
| 1. Processing of Thermoplastic Materials | Bernhard |
| 2. SPI Engg. Hand Book | Frados |
| 3. Blow moulding | Fisher |
| 4. Plastic Processing | Radian |
| 5. Moulding of Plastics | N.M. Bekalis |
| 6. Plastic Blow Moulding | LEE |

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FIBER REINFORCED PLASTICS LAB

Course Code	PL 4007
Course Title	FIBER REINFORCED PLASTICS LAB
Number of Credits	2(L: 0, T: 0, P: 4)
Prerequisites	NIL
Course Category	PC

COURSE OBJECTIVES:

In certain engineering applications, plastics of greater strength are required, therefore, efforts have been made to reinforce the plastics with fibres. This subject covers the study and manufacturing techniques of such plastics.

COURSE OUTCOMES:

Students will learn about the manufacturing and mold preparation techniques and applications of Fiber Reinforced Plastics (FRP).

LIST OF PRACTICALS TO BE PERFORMED

1. To determine the size, shape, orientation and GSM of Chopped Strand Mat.
2. To study the construction of FRP molds of Chair with the help of various materials of construction.
3. To study the construction of FRP molds of Flower pot Chair with the help of various materials of construction.
4. To study the application of mold release agents.
5. To study the filler mixing process in the unsaturated polyester resin.
6. To study the gel time and pot life of the Gelcoat resin with MEKP curing agent.
7. To study the gel time and pot life of the unsaturated polyester resin with MEKP curing agent.
8. To produce a mold of two wheeler Helmet with help of POP material.
9. To produce a FRP chair by using unsaturated polyester resin, chopped strand Mat by hand lay-up technique.
10. To produce a FRP flower pot by using unsaturated polyester resin, chopped strand Mat by hand lay-up technique.

REFERENCE BOOKS:

- | | |
|--|------------------|
| 1. Hand Book of Composites | George Lubins |
| 2. Engineering Material Hand Book Vol. I | Cyril A Dostal |
| 3. Reinforced Thermoplastics | W. V. Titow |
| 4. FRP Technology | Weatherhead R.G. |

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RUBBER TECHNOLOGY LAB

Course Code	PL 4008
Course Title	RUBBER TECHNOLOGY LAB
Number of Credits	1(L: 0, T: 0, P: 2)
Prerequisites	NIL
Course Category	PC

COURSE OBJECTIVES:

Knowledge of this subject covers testing process of various natural and synthetic elastomers which is important part of polymers.

COURSE OUTCOME:

Students will learn about the characterization techniques of various rubber.

LAB PRACTICES TO BE PERFORMED

1. To determine hardness of given rubber sample by IRHD tester .
2. To determine abrasion resistance of given rubber sample by DIN abrasion tester .
3. To determine hardness of given rubber sample by durometer(Shore-A hardness meter) .
4. To perform heat aging test of given rubber sample.
5. To determine the thickness of given rubber sheet by dial thickness tester
6. To find out the tensile strength & elongation of given rubber sample by tensile testing machine.
7. To find out tear strength /resistance of a given rubber sample by tensile testing machine .
8. To determine the water absorption of given rubber sample .
9. To find out the adhesion strength of rubber to fabric for the given sample .

REFERENCE BOOKS :

- | | |
|---|------------------------|
| 1. Natural Rubbers Science & Technology | Roberts |
| 2. Chemistry & Technology of Rubber | Morton |
| 3. Polymer Chemistry of Synthetic Elastomers Vol I & II | Kennedy |
| 4. Rubber Technology & Manufacture | C. M. Blow |
| 5. Synthetic Rubber | G.B. Bhitby, C.D.Davis |
| 6. Rubber Materials & Their Compounds | J. A. Brydson |

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ESSENCE OF INDIAN KNOWLEDGE AND TRADITION

Course Code	PL 4222(Same in All Branches of Engg.)
Course Title	Essence of Indian Knowledge and Tradition
Number of Credits	0(L-2, T-0, P-0)
Prerequisites	None
Course Category	AU

COURSE CONTENTS:

Basic Structure of Indian Knowledge System:

- (i) वेद,
- (ii) उन्नवेद (आयुर्वेद, धनुर्वेद, गन्धर्ववेद, स्थानतत्त्वआदद)
- (iii) वेदशाखांग (शिक्षा, कलन, ननरुत, व्याकरण, ज्योनतषछथांद),
- (iv) उन्नथाइग (धर्मशास्त्र, र्ीथांसाथा, नुरथाण, तकशास्त्र)
 - Modern Science and Indian Knowledge System
 - Yoga and Holistic Health care
 - Case Studies.

REFERENCES /SUGGESTED LEARNING RESOURCES:

1. V. Sivarama Krishna, " Cultural Heritage of India- Course Material", Bhartiya Vidya Bhavan, Mumbai, fifth Edition, 2014.
2. Swami Jitatanand, " Modern Physics and Vedant", Bhartiya Vidya Bhavan.
3. Fritz of Capra, " The wave of Life".
4. Fritz of Capra, " Tao of Physics".
5. V N Jha, " Tarka sangraha of Annam Bhatta, International" Cinmay Foundation, Velliarnad, Amakum.
6. R N Jha, " Science of Consciousness Psychotherapy and Yoga Practices" Vidya nidhi Prakasham, Delhi, 2016.

SEMESTER SC

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN JODHPUR
SEMESTER SCHEME-2020-21



V SEMESTER
(SESSION 2021-2022 & ONWARDS)

ENGINEERING PLASTICS

Course Code	PL 5001
Course Title	ENGINEERING PLASTICS
Number of Credits	3(L: 2, T: 1, P: 0)
Prerequisites	NIL
Course Category	PC

COURSE OBJECTIVES:

This subject provides the knowledge of those plastics which are generally used in engineering operations. This subject covers chemistry, processing, properties and applications of various engineering plastics.

COURSE OUTCOME:

Students will learn about types of engineering plastics and their applications under load conditions

COURSE CONTENTS**1. POLY ETHYLENE TEREPHTHALATE [PET]:**

- 1.1 Introduction
- 1.2 Chemistry
- 1.3 Processing
- 1.4 Properties
- 1.5 Applications

2. POLY BUTYLENE TEREPHTHALATE [PBT] :

- 2.1 Introduction
- 2.2 Chemistry
- 2.3 Properties
 - 2.3.1 Mechanical properties
 - 2.3.2 Thermal properties
 - 2.3.3 Creep resistance
 - 2.3.4 Electrical properties
- 2.4 Processing
- 2.5 Applications

3. POLYCARBONATE [PC] :

- 3.1 Introduction
- 3.2 Chemistry
- 3.3 Properties
 - 3.3.1 Physical and Mechanical properties
 - 3.3.2 Thermal and Chemical properties
 - 3.3.3 Electrical properties
- 3.4 Processing
- 3.5 Applications

4. ACETALS :

- 4.1 Introductions
- 4.2 Chemistry
- 4.3 Properties
 - 4.3.1 Physical and Mechanical properties
 - 4.3.2 Electrical properties
 - 4.3.3 Thermal properties
 - 4.3.4 Chemical properties
- 4.4 Processing
- 4.5 Application

5. POLYSULFONE :

- 5.1 Introduction
- 5.2 Chemistry
- 5.3 Properties

- 5.3.1 Mechanical properties
- 5.3.2 Stability
- 5.3.3 Environmental stress cracking resistance
- 5.3.4 Electrical properties
- 5.3.5 Flammability

6.POLYETHER ETHER KETONE [PEEK] :

- 6.1 Introduction
- 6.2 Chemistry
- 6.3 Properties
 - 6.3.1 Physical properties
 - 6.3.2 Mechanical properties
 - 6.3.3 Electrical properties
 - 6.3.4 Chemical resistance
- 6.4 Applications

7.ACRYLONITRILE – BUTADIENE - STYRENE [ABS] :

- 7.1 Introduction
- 7.2 Chemistry
- 7.3 Properties
- 7.4 Processing
- 7.5 Applications

8.PROPERTIES AND APPLICATION OF FOLLOWING SPECIALITY PLASTICS :

- 8.1 Thermoplastic polyurethane[TPU]
- 8.2 Liquid crystal polymers[LCPs]
- 8.3 Polytetrafluoroethylene[PTFE]

REFERENCE BOOKS :

- 1. Engg. Thermoplastics, Properties & Applications J.M.Margolis
- 2. Plastic Materials J.A.Brydson

SEMESTER SCHEME 2020-21

RHEOLOGY OF POLYMERS

Course Code	PL 5002
Course Title	RHEOLOGY OF POLYMERS
Number of Credits	3(L: 2, T: 1, P: 0)
Prerequisites	NIL
Course Category	PC

COURSE OBJECTIVES:

The flow behavior & the process parameters of molten polymer can be understood through Rheological study of polymers. The student can be able to choose the processing techniques for a particular polymer. Students can also understand the internal structure of polymers through characterization methods.

COURSE OUTCOMES:

Students will learn about the flow characteristics and stress-strain deformation of viscoelastic fluids

COURSE CONTENTS:**1. POLYMER RHEOLOGY**

- 1.1. Introduction:
- 1.2. Definition,
- 1.3. Advantages and
- 1.4. Application

2. POLYMER SOLUTION

- 2.1. Introduction,
- 2.2. preparation
- 2.3. significance

3. DIFFERENCE BETWEEN REGULAR AND POLYMER SOLUTIONS**4. FLOW CHARACTERISTICS OF FLUIDS:**

- 4.1. Introduction
- 4.2. Newtonian flow
- 4.3. Non-Newtonian flow

5. VISCOELASTIC FLUIDS:

- 5.1. Introduction
- 5.2. Time-dependent fluids and
- 5.3. Time-independent fluids

6. MECHANICAL MODELS OF VISCOELASTIC FLUIDS:

- 6.1. Introduction
- 6.2. Maxwell model and
- 6.3. Voigt Model

7. RELAXATION PHENOMENON OF VISCOELASTIC FLUIDS**8. RETARDATION PHENOMENON OF VISCOELASTIC FLUIDS****REFERENCE BOOKS:**

- | | |
|--|---------------------------|
| 1. Principle of High Polymers, Theory & Practice | Schmidt & Marlies |
| 2. Properties & Structure of Polymers | Tobolsky |
| 3. Polymer Science & Engg. | Wilkinson |
| 4. Polymer Melt Rheology | F. N. Gogabell |
| 5. Mechanical Testing of Plastics | S. Turner |
| 6. Testing Polymers | J. V. Schemitz & Browen |
| 7. Properties & Testing of Plastic Materials | A. E. Leves & J. A. Rhys. |

8. Hand Book of Plastic Test Methods
9. Hand Books of Plastics Testing Technology

Ives, Mead & Reley
Vishu Shah

SEMESTER SCHEME 2020-21

ECONOMIC POLICIES IN INDIA

Course Code	PL 51001 (Same in All Branches of Engg.)
Course Title	Economic Policies in India
Number of Credits	3 (L:3, T:0, P:0)
Prerequisites	NIL
CourseCategory	OE

COURSE LEARNING OBJECTIVES:

The objective of this course is to familiarize the students of different streams with the basic concepts, structure, problems and issues concerning Indian economy.

CO1	Understand Indian economics policy, planning strategies
CO2	It will enable to students to comprehend theoretical and empirical development across countries and region for policy purposes
CO3	Development Economics as a discipline encompasses different approaches to the problems of unemployment, poverty, income generation, industrialization from different perspectives
CO4	Able to identify the problems and capable to decide the application for future development
CO5	Analyze economic issues and find solutions to complex economic problems and take correct economic judgment

COURSE CONTENTS:**1. BASIC FEATURES AND PROBLEMS OF INDIAN ECONOMY:**

- 1.1. Economic History of India;
- 1.2. Nature of Indian Economy
- 1.3. Demographic features and Human Development Index,
- 1.4. Problems of Poverty, Unemployment, Inflation, income inequality, Blackmoney in India.

2. SECTORAL COMPOSITION OF INDIAN ECONOMY:

- 2.1. Issues in Agriculture sector in India,
- 2.2. land reforms
- 2.3. Green Revolution
- 2.4. agriculture policies of India,

3. INDUSTRIAL DEVELOPMENT,

- 3.1. Small scale and cottage industries,
- 3.2. Industrial Policy,
- 3.3. Public sector in India,
- 3.4. Service sector in India.

4. ECONOMIC POLICIES:

- 4.1. Economic Planning in India,
- 4.2. Planning commission v/s NITI Aayog,
- 4.3. Five Year Plans,
- 4.4. Monetary policy in India,
- 4.5. Fiscal Policy in India,
- 4.6. Centre state Finance Relations,
- 4.7. Finance commission in India

- 4.8. LPG policy in India

5. EXTERNAL SECTOR IN INDIA

- 5.1. India's foreign trade value composition and direction,
5.2. India Balance of payment since 1991,
5.3. FDI in India,
5.4. Impact of Globalization on Indian Economy,
5.5. WTO and India.

REFERENCE BOOKS:

1. Dutt Rudder and K.P.M Sunderam (2017). Indian Economy .S Chand & Co.Ltd. New Delhi.
2. Mishra S. K & V. K Puri (2017). Indian Economy and Its Development Experience. Himalaya Publishing House.
3. Singh, Ramesh, (2016): Indian Economy, Tata-McGraw Hill Publications, New Delhi.
4. Dhingra, I.C., (2017): March of the Indian Economy, Heed Publications Pvt. Ltd.
5. Karam Singh Gill, (1978): Evolution of the Indian Economy, NCERT, NewDelhi
6. Kaushik Basu (2007): The Oxford Companion to Economics of India ,Oxford University Press.

SEMESTER SCHEME 2020-21

ENGINEERING ECONOMICS & ACCOUNTANCY

Course Code	PL 51002 (Same in All Branches of Engg.)
Course Title	Engineering Economics & Accountancy
Number of Credits	3 (L:3, T:0, P:0)
Prerequisites	NIL
Course Category	OE

COURSE OBJECTIVES

- To acquire knowledge of basic economics and facilitate the process of economic decision making.
- To acquire knowledge on basic financial management aspects.
- To develop the basic skills to analyze financial statements.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Understand the macro-economic environment of the business and its impact on enterprise
CO2	Understand cost elements of the product and its effect on decision making
CO3	Prepare accounting records and summarize and interpret the accounting data for managerial decisions
CO4	Understand accounting systems and analyze financial statements using ratio analysis
CO5	Understand the concepts of financial management and investment

COURSE CONTENTS**1. INTRODUCTION:**

- 1.1. Managerial Economics;
- 1.2. Relationship with other disciplines;
- 1.3. Firms: Types, objectives and goals;
- 1.4. Managerial decisions;
- 1.5. Decision analysis.

2. DEMAND & SUPPLY ANALYSIS:

- 2.1. Demand;
 - 2.1.1. Types of demand;
 - 2.1.2. Determinants of demand;
 - 2.1.3. Demand function;
 - 2.1.4. Demand elasticity;
 - 2.1.5. Demand forecasting;
- 2.2. Supply;
 - 2.2.1. Determinants of supply;
 - 2.2.2. Supply function;
 - 2.2.3. Supply elasticity.

3. PRODUCTION AND COST ANALYSIS:

- 3.1. Production function;
- 3.2. Returns to scale;
- 3.3. Production optimization;
- 3.4. Least cost input; Iso quants;
- 3.5. Managerial uses of production function;
- 3.6. Cost Concepts;

- 3.6.1. Cost function;
- 3.6.2. Types of Cost;
- 3.6.3. Determinants of cost;
- 3.6.4. Short run and Long run cost curves;
- 3.6.5. Cost Output Decision;
- 3.6.6. Estimation of Cost.

4. PRICING:

- 4.1. Determinants of Price;
- 4.2. Pricing under different objectives and different market structures;
- 4.3. Price discrimination;
- 4.4. Pricing methods in practice;
- 4.5. Role of Government in pricing control.

5. FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT):

- 5.1. Balance sheet and related concepts;
- 5.2. Profit & Loss Statement and related concepts;
- 5.3. Financial Ratio Analysis;
- 5.4. Cash flow analysis;
- 5.5. Funds flow analysis;
- 5.6. Comparative financial statements;
- 5.7. Analysis & Interpretation of financial statements;
- 5.8. Investments;
- 5.9. Risks and return evaluation of investment decision;
- 5.10. Average rate of return;
- 5.11. Payback Period;
- 5.12. Net Present Value;
- 5.13. Internal rate of return,

REFERENCE BOOKS:

- 1. Mc Guigan, Moyer and Harris, 'Managerial Economics; Applications, Strategy and Tactics', Thomson South Western, 10th Edition, 2005.
- 2. Prasanna Chandra. 'Fundamentals of Financial Management', Tata Mcgraw Hill Publishing Ltd., 4th edition, 2005.
- 3. Samuelson. Paul A and Nordhaus W. D., 'Economics', Tata Mcgraw Hill Publishing Company Limited, New Delhi, 2004.
- 4. Paresh Shah, 'Basic Financial Accounting for Management', Oxford University Press, New Delhi, 2007.
- 5. Salvatore Dominick, 'Managerial Economics in a global economy'. Thomson South Western, 4th Edition, 2001.

TESTING OF POLYMERS

Course Code	PL 5003
Course Title	TESTING OF POLYMERS
Number of Credits	3 (L: 2, T: 1, P: 0)
Prerequisites	Nil
Course Category	PC

COURSE OBJECTIVES:

For checking quality of the manufactured plastic materials, physical and chemical methods of testing are required. The students having knowledge of Testing will prove useful in the industrial atmosphere.

COURSE OUTCOMES:

Students will learn about the properties through characterization methods.

COURSE CONTENTS:**1. Mechanical Properties and Testing:**

- 1.1 Tensile strength
- 1.2 Impact strength (Izod, Charpy and Falling Dart)
- 1.3 Hardness (Shore A and Shore D)
- 1.4 Abrasion resistance
- 1.5 Burst strength
- 1.6 Tear strength

2. Thermal Properties and Testing:

- 2.1 Softening point
- 2.2 Heat distortion temperature (HDT)

3. Electrical Properties and Testing:

- 3.1 Dielectric strength
- 3.2 Arc resistance
- 3.3 Volume and surface resistivity

4. Optical Properties and Testing:

- 4.1 Light transmittance
- 4.2 Haze

5. Flammability Test:

- 5.1 Introduction
- 5.2 Flammability Test
- 5.3 Oxygen Index
- 5.4 Smoke Generation Test

REFERENCE BOOKS

- | | |
|--|--------------------------|
| 1. Mechanical Testing of Plastics | S. Turner |
| 2. Testing Polymers | J.V. Schemitz & Browen |
| 3. Properties & Testing of Plastic Materials | A.E. Leves & J. A. Rhys. |
| 4. Hand Book of Plastic Test Methods | Ives, Mead & Reley |
| 5. Hand Books of Plastics Testing Technology | Vishu Shah |

POLYMER BLENDS AND ALLOYS

Course Code	PL 50041
Course Title	POLYMER BLENDS AND ALLOYS
Number of Credits	3(L: 3, T: 0, P: 0)
Prerequisites	NIL
Course Category	PE

COURSE OBJECTIVES:

Study of this subject is helpful in understanding various types of specialty polymer mixtures having engineering application

COURSE OUTCOMES:

Students will learn about the blending techniques of different polymers their significance and applications in different fields

COURSE CONTENT**1. POLYMER BLEND AND ALLOYS:**

- 1.1 Introduction
- 1.2 Definition
- 1.3 Significance

2. EFFECT OF MOLECULAR STRUCTURE ON POLYMER- POLYMER INTERACTIONS.**3. MISCIBLE AND IMMISCIBLE BLENDS:**

- 3.1 Definition
- 3.2 Properties
- 3.3 Applications

4. CHARACTERISATION OF BLENDS BY :

- 4.1 Light scattering
- 4.2 Electron microscopy
- 4.3 Glass Transition studies

5. PHYSICAL & MECHANICAL BEHAVIOUR OF POLYMER BLENDS.**6. COMPATIBILIZERS :**

- 6.1 Introduction
- 6.2 Types

7. POLYMER BLENDS PREPARATION:

- 7.1 Melt mixing
- 7.2 Solution blending
- 7.3 Latex mixing
- 7.4 Machines & Equipments used

8. COMMERCIALY AVAILABLE POLYMER BLENDS:

- 8.1 Composition
- 8.2 Properties
- 8.3 Uses

9. THERMOPLASTIC ELASTOMERS :

- 9.1 Introduction
- 9.2 Properties
- 9.3 Application
- 9.4 Types

REFERENCEBOOKS:

1. PolymerBlends& Alloys
2. PolymerBlendsVol.1&2

L.H.Sperling
PaulNewnan

SEMESTER SCHEME 2020-21

POLYMER WASTE MANAGEMENT

Course Code	PL 50042
Course Title	POLYMER WASTE MANAGEMENT
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	PE

COURSE OBJECTIVES:

The objective of this subject is to create awareness among the students about the pollution aspects related to the Plastic Solid Waste Disposal by Plastic Waste Incineration, Reusability and Reprocessing of Plastics and Biodegradation of Plastics.

COURSE OUTCOMES:

Students will learn about plastic waste disposal and their effective utilisation to protect the environment from plastic waste hazards.

COURSE CONTENTS:**1. INTRODUCTION**

- 1.1 Sources and Types of Waste
 - 1.1.1 Industrial Source
 - 1.1.2 Domestic Sources
 - 1.1.3 Medical Sources
 - 1.1.4 E-Plastic Waste
- 1.2 Plastic Waste and Its Hazards
- 1.3 Plastic Cycle

2. WASTE SEPARATION

- 2.1 Separation of Paper/Plastics Mixtures
 - 2.1.2 Processes Involving Application of Heat
 - 2.1.3 Wet Separation Process
 - 2.1.4 Electrodynamic Separation
- 2.2 Separation of Plastics from Plastic-Coated Fabric
- 2.3 Separation of Mixtures of Plastics

3. DEGRADATION OF PLASTIC WASTE

- 3.1 Introduction
- 3.2 Biodegradation
- 3.2 Photodegradation

4. RECYCLING OF PLASTIC WASTE

- 4.1 Primary Recycling
 - 4.1.1 Degradation of Thermoplastics due to Repetitive Processing
 - 4.2.2 Industrial Practice: Granulators, Cryogenic Grinding and Processing Low Bulk Density Plastics Waste
- 4.2 Secondary Recycling
 - 4.2.1 Various Technical Approaches
 - 4.2.2 Mechanical Reworking
 - 4.3.3 Chemical Modification
 - 4.3.4 Co-extrusion and Co-Injection Moulding
 - 4.3.5 Use of Waste Plastics as Fillers
- 4.3 Tertiary Recycling
 - 4.3.1 Pyrolysis
 - 4.3.2 Chemical Decomposition
- 4.4 Quaternary Recycling: Energy from Plastics Waste

5. DISPOSAL OF WASTE PLASTICS WITHOUT RECOVERY OF VALUE

- 5.1 Incineration without the Recovery of Energy
- 5.2 Landfill

REFERENCE BOOKS:

- 1. Plastics Waste Recovery of Economic Value
- 2. Plastic Waste Management: Processing Disposal
- 3. Polymer Waste Management

Jacob Leidnert
Natamai Subramanian Muralisrinivasan
Johannes Karl Fink

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SEMESTER SCHEME 2020-21

ADVANCED POLYMER ADDITIVES

Course Code	PL 50051
Course Title	ADVANCED POLYMER ADDITIVES
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	PE

COURSE OBJECTIVES:

Compounding of plastics needs basic knowledge about common ingredients used in the processes. The formulation of these ingredients directly affects the quality of plastic products.

COURSE OUTCOMES:

Students will learn about the compounding, equipment utilized and various additives used in polymer processing to achieve the desired properties.

COURSE CONTENTS:**1. ANTI OXIDANTS :**

- 1.1 Introduction
- 1.2 Types of antioxidants
- 1.3 Auto-oxidation action
- 1.4 Physical and chemical requirements

2. METAL DEACTIVATORS:

- 2.1 Introduction
- 2.2 Mechanism of inhibition by metal deactivators
- 2.3 Stabilization of polyolefins in contact with copper

3. CHEMICAL BLOWING AGENTS :

- 3.1 Introduction
- 3.2 Various types of blowing agents
- 3.3 Extrusion of foamed P.E.
- 3.4 Expandable P.S. beads

4. COLOURANTS :

- 4.1 Introduction
- 4.2 Pigments and dyes
- 4.3 General properties of coloured plastics
- 4.4 Various types of colourants such as titanium dioxide, carbon black, etc.

5. INTRODUCTION TO FOLLOWING ADDITIVES:

- 5.1 Lubricants
- 5.2 Processing Aids
- 5.3 Flame Retardants
- 5.4 Antistatic agents

REFERENCE BOOKS :

- | | |
|--|---------------------|
| 1. Compounding Materials for the Polymer Industry | John S Dick |
| 2. Plastic Additives Hand book | Gaster & Muller |
| 3. Plasticisers, Fillers and Stabilisers | Ritchie & Critchely |
| 4. Plastic finishing & Decoration | Satas |
| 5. Thermoplastic polymer additives (Theory & Practice) | J T Lutz |

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ADVANCED ENGINEERING PLASTICS

Course Code	PL 50052
Course Title	ADVANCED ENGINEERING PLASTICS
Number of Credits	3(L: 3, T:0, P: 0)
Prerequisites	NIL
Course Category	PE

COURSE OBJECTIVES:

This subject provides the knowledge of those plastics which are generally used in engineering operations. This subject covers chemistry, processing, properties and applications of various engineering plastics.

COURSE OUTCOME:

Students will learn about types of engineering plastics and their applications under load conditions

COURSE CONTENTS**1. POLYPHENYLENESULFIDE (PPS)**

- 1.1 Introduction
- 1.2 Chemistry
- 1.3 Properties
- 1.4 Processing techniques
- 1.5 Applications

2. POLYPHENYLENE OXIDE [PPO] :

- 2.1 Introduction
- 2.2 Chemistry
- 2.3 Properties
 - 2.3.1 Physical properties
 - 2.3.2 Electrical properties
 - 2.3.3 Flammability
 - 2.3.4 Chemical properties
- 2.4 Processing
 - 2.4.1 Injection moulding
 - 2.4.2 Extrusion
 - 2.4.3 Thermoforming
- 2.5 Applications

3. POLYETHER IMIDE [PEI] :

- 3.1 Introduction
- 3.2 Chemistry
- 3.3 Properties
- 3.4 Processing
- 3.5 Applications

4. POLY IMIDES [PI] :

- 4.1 Introduction
- 4.2 Chemistry
- 4.3 Properties
- 4.4 Processing
 - 4.4.1 Processing problems and improvements
 - 4.4.2 Processing methods
- 4.5 Applications
 - 4.5.1 Composite applications
 - 4.5.2 Mechanical applications
 - 4.5.3 Film and fibres
 - 4.5.4 Adhesives
 - 4.5.5 Electrical applications

5. FILLED POLYMERS [POLYMERS FILLED WITH MICA, TALC AND CALCIUM CARBONATE]

6. POLYMER CONCRETES AND ADVANCED CERAMICS :

7. PROPERTIES AND APPLICATION OF FOLLOWING SPECIALITY PLASTICS :

- 7.1. Polyamide - imide [PAI]
- 7.2. Polyoxymethylene [POM]
- 7.3. Poly phenylene ether [PPE]
- 7.4. Polyamides [Nylon-6, Nylon-66]

REFERENCEBOOKS:

- 1. Engg. Thermoplastics, Properties & Applications
- 2. Plastic Materials

J.M. Margolis
J.A. Brydson

SEMESTER SCHEME 2020-21

POLYMER TESTING LAB.

Course Code	PL 5006
Course Title	POLYMER TESTING LAB.
Number of Credits	2 (L: 0, T: 0, P: 4)
Prerequisites	Nil
Course Category	PC

COURSE OBJECTIVES:

For checking quality of the manufactured plastic materials, physical and chemical methods of testing are required. The students having knowledge of Testing will prove useful in the industrial atmosphere.

COURSE OUTCOMES:

Students will learn about the properties through characterization methods.

COURSE CONTENTS:

1. To study the tensile strength of the given polymer with the help of tensile testing machine.
2. To study the elongation at break of the given polymer with the help of tensile testing machine.
3. To determine shore A hardness of the given plastics
4. To determine shore D hardness of the given plastics
5. To determine the melt flow Index of the given Polymer by MFI Tester
6. To determine thickness of the given plastic film/sheet by dial thickness gauge
7. To determine Refractive index of the given plastic film/sheet by Abbe Refractometer
8. To determine burst strength of the given plastic film
9. To determine melting point of the given polymer
10. To determine water absorption of the given plastic sample

REFERENCE BOOKS

- | | |
|--|--------------------------|
| 1. Mechanical Testing of Plastics | S. Turner |
| 2. Testing Polymers | J.V. Schemitz & Browen |
| 3. Properties & Testing of Plastic Materials | A.E. Leves & J. A. Rhys. |
| 4. Hand Book of Plastic Test Methods | Ives, Mead & Reley |
| 5. Hand Books of Plastics Testing Technology | Vishu Shah |

GOVERNMENT OF RAJASTHAN
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SEMESTER SCHEME-2020-21



VI SEMESTER
(SESSION 2021-2022 & ONWARDS)

ENTREPRENEURSHIP AND START-UPS

Course Code	PL 6111(Same in All Branches of Engg.)
Course Title	Entrepreneurship and Start-ups
Number of Credits	4 (L-3 , T-1, P-0)
Prerequisites (Course code)	None
Course Category	HS

COURSE LEARNING OBJECTIVES:

1. Acquiring Entrepreneurial spirit and resourcefulness.
2. Familiarization with various uses of human resource for earning dignified means of living.
3. Understanding the concept and process of entrepreneurship-its contribution and role in the growth and development of individual and the nation.
4. Acquiring entrepreneurial quality, competency, and motivation.
5. Learning the process and skills of creation and management of entrepreneurial venture.

LEARNING OUTCOME:

Upon completion of the course, these students will be able to demonstrate knowledge of the following topics:

1. Understanding the dynamic role of entrepreneurship and small businesses
2. Organizing and Managing a Small Business
3. Financial Planning and Control
4. Forms of Ownership for Small Business
5. Strategic Marketing Planning
6. New Productor Service Development
7. Business Plan Creation

COURSE CONTENTS:**1. INTRODUCTION TO ENTREPRENEURSHIP AND START-UPS**

- 1.1. Definitions, Traits of an entrepreneur, Intrapreneurship, Motivation
- 1.2. Types of Business Structures,
- 1.3. Similarities / differences between entrepreneurs and managers.

2. BUSINESS IDEAS AND THEIR IMPLEMENTATION

- 2.1. Discovering ideas and visualizing the business
- 2.2. Activity map
- 2.3. Business Plan

3. IDEA TO START-UP

- 3.1. Market Analysis– Identifying the target market,
- 3.2. Competition evaluation and Strategy Development,
- 3.3. Marketing and accounting,
- 3.4. Risk analysis

4. MANAGEMENT

- 4.1. Company's Organization Structure,
- 4.2. Recruitment and management of talent.
- 4.3. Financial organization and management

5. FINANCING AND PROTECTION OF IDEAS

- 5.1. Financing methods available for start-ups in India
- 5.2. Communication of Ideas to potential investors– Investor Pitch
- 5.3. Patenting and Licenses

6. EXIT STRATEGIES FOR ENTREPRENEURS, BANKRUPTCY, AND SUCCESSION AND HARVESTING STRATEGY

SUGGESTED LEARNING RESOURCES:

S.No.	Title of Book	Author	Publication
1.	The Startup Owner's Manual: The Step by-Step Guide for Building a Great Company	Steve Blank and Bob Dorf	K & S Ranch ISBN-978-0984999392
2.	The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses	Eric Ries	Penguin UK ISBN-978-0670921607
3.	Demand: Creating What People Love Before They Know They Want It	Adrian J. Slywotzky with Karl Weber	Headline Book Publishing ISBN-978-0755388974
4.	The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business	Clayton M. Chris Tensen	Harvard business ISBN:978-142219602

SUGGESTED SOFTWARE/LEARNING WEBSITES:

- a. <https://www.fundable.com/learn/resources/guides/startup>
- b. <https://corporatefinanceinstitute.com/resources/knowledge/finance/corporatestructure/>
- c. <https://www.finder.com/small-business-finance-tips>
- d. <https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-business/>

SEMESTER SCHEME 2020-21

PROJECT MANAGEMENT

CourseCode	PL 62001(Same in All Branches of Engg.)
CourseTitle	Project Management
NumberofCredits	3(L:3,T:0,P:0)
Prerequisites	NIL
CourseCategory	OE

COURSE LEARNING OBJECTIVES

- To develop the idea of project plan, from defining and confirming the project goals and objectives, identifying tasks and how goals will be achieved.
- To develop an understanding of key project management skills and strategies.

COURSE OUTCOMES

At the end of the course, the student will be able to:

CO1	Understand the importance of projects and its phases.
CO2	Analyze projects from marketing, operational and financial perspectives.
CO3	Evaluate projects based on discount and non-discount methods.
CO4	Develop network diagrams for planning and execution of a given project.
CO5	Apply crashing procedures for time and cost optimization.

COURSE CONTENTS**1. CONCEPT OF A PROJECT:**

- 1.1. Classification of projects
- 1.2. Importance of project management
- 1.3. The project Life cycle
- 1.4. Establishing project priorities (scope-cost-time)
- 1.5. Project priority matrix
- 1.6. Work break down structure.

2. CAPITAL BUDGETING PROCESS:

- 2.1. Planning -Analysis-Selection-Financing-Implementation-Review.
- 2.2. Generation and screening of project ideas
- 2.3. Market and demand analysis
- 2.4. Demand forecasting techniques.
- 2.5. Market planning and marketing research process
- 2.6. Technical analysis

3. FINANCIAL ESTIMATES AND PROJECTIONS:

- 3.1. Cost of projects
- 3.2. Means of financing
- 3.3. Estimates of sales and production-cost of production
- 3.4. Working capital requirement and its financing
- 3.5. Profitability project, cash flow statement and balance sheet.
- 3.6. Breakeven analysis.

4. BASIC TECHNIQUES IN CAPITAL BUDGETING:

- 4.1. Non discounting and discounting methods
- 4.2. pay-back period
- 4.3. Accounting rate of return
- 4.4. Net present value
- 4.5. Benefit cost ratio
- 4.6. Internal rate of return.

- 4.7. Project risk.
- 4.8. Social cost benefit analysis and economic rate of return.
- 4.9. Non-financial justification of projects.

5. PROJECT ADMINISTRATION:

- 5.1. Progress payments,
- 5.2. Expenditure planning,
- 5.3. Project scheduling and network planning,
- 5.4. Use of Critical Path Method (CPM),
- 5.5. Schedule of payments and physical progress,
- 5.6. time-cost trade off.
- 5.7. Concepts and uses of PERT
- 5.8. Cost as a function of time,
- 5.9. Project Evaluation and Review Techniques
- 5.10. Cost mechanisms.
- 5.11. Determination of least cost duration.
- 5.12. Post project evaluation.
- 5.13. Introduction to various Project management softwares.

REFERENCE BOOKS

- 1. Project planning, analysis, selection, implementation and review –Prasannachandra–Tata McGraw Hill
- 2. Project Management – the Managerial Process– Clifford F. Gray & Erik W. Larson-McGrawHill
- 3. Project management- David I Cleland- McGraw Hill International Edition, 1999
- 4. Project Management– Gopala krishnan– Mcmillan India Ltd.
- 5. Project Management- Harry – Maylor – Peason Publication

RENEWABLE ENERGY TECHNOLOGIES

Course Code	PL 62002(Same in All Branches of Engg.)
Course Title	Renewable Energy Technologies
Number of Credits	3 (L:3, T:0, P:0)
Prerequisites	NIL
Course Category	OE

COURSE LEARNING OBJECTIVES

- To understand present and future scenario of world energy use.
- To understand fundamentals of solar energy systems.
- To understand basics of wind energy.
- To understand bio energy and its usage in different ways.
- To identify different available non-conventional energy sources.

COURSE OUTCOMES

At the end of the course, the student will be able to:

CO1	Understand present and future energy scenario of the world.
CO2	Understand various methods of solar energy harvesting.
CO3	Identify various wind energy systems.
CO4	Evaluate appropriate methods for Bio energy generations from various Bio wastes.
CO5	Identify suitable energy sources for a location.

COURSE CONTENTS**1. INTRODUCTION:**

- 1.1. World Energy Use;
- 1.2. Reserves of Energy Resources;
- 1.3. Environmental Aspects OF Energy Utilization;
- 1.4. Renewable Energy Scenario in India and around the World;
- 1.5. Potentials; Achievements/ Applications;
- 1.6. Economics of renewable energy systems.

2. SOLAR ENERGY:

- 2.1. Solar Radiation;
- 2.2. Measurements of Solar Radiation;
- 2.3. Flat Plate and Concentrating Collectors;
- 2.4. Solar direct Thermal Applications;
- 2.5. Solar thermal Power Generation
- 2.6. Fundamentals of Solar Photo Voltaic Conversion;
- 2.7. Solar Cells;
- 2.8. Solar PV Power Generation;
- 2.9. Solar PV Applications.

3. WIND ENERGY:

- 3.1. Wind Data and Energy Estimation;
- 3.2. Types of Wind Energy Systems;
- 3.3. Performance; Site Selection;
- 3.4. Details of Wind Turbine Generator;
- 3.5. Safety and Environmental Aspects.

4. BIO-ENERGY:

- 4.1. Bio mass direct combustion;
- 4.2. Bio mass gasifiers;

- 4.3. Bio gas plants;
- 4.4. Digesters;
- 4.5. Ethanol production;
- 4.6. Bio diesel;
- 4.7. Cogeneration;
- 4.8. Bio mass Applications.

5. OTHER RENEWABLE ENERGY SOURCES:

- 5.1. Tidal energy;
- 5.2. Wave Energy;
- 5.3. Open and Closed OTEC Cycles;
- 5.4. Small Hydro Geothermal Energy;
- 5.5. Hydrogen and Storage;
- 5.6. Fuel Cell Systems;
- 5.7. Hybrid Systems.

REFERENCE BOOKS

1. Non-Conventional Energy Sources, Rai. G. D., Khanna Publishers, New Delhi, 2011.
2. Renewable Energy Sources, Twidell, J.W. & Weir, A., EFN SponLtd.,UK,2 006.
3. Solar Energy, Sukhatme. S. P., Tata Mc Graw Hill Publishing CompanyLtd. ,New Delhi, 1997.
4. Renewable Energy, Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, U.K., 1996.
5. Fundamental of Renewable Energy Sources, G N Tiwari and M K Ghoshal, Narosa, New Delhi, 2007.
6. Renewable Energy and Environment A Policy Analysis for India ,NH Ravindranath, U K Rao, B Natarajan, P Monga, Tata McGraw Hill.
7. Energy and The Environment, R A Ristinen and J J Kraushaar, second edition, John Willey & Sons, New York, 2006.
8. Renewable Energy Resources, J W T widell and A D Weir, ELBS, 2006.

PRODUCT DESIGN

CourseCode	PL 63001(Same in All Branches of Engg.)
CourseTitle	Product Design
NumberofCredits	3 (L:3,T:0,P:0)
Prerequisites	NIL
CourseCategory	OE

COURSE LEARNING OBJECTIVES

- To acquire the basic concepts of product design and development process
- To understand the engineering and scientific process in executing a design from concept to finished product
- To study the key reasons for design or redesign.

COURSE OUTCOMES

At the end of the course, the student will be able to:

CO1	Understand the basic concepts of product design and development process.
CO2	Illustrate the methods to define the customer needs.
CO3	Describe an engineering design and development process.
CO4	Understand the intuitive and advanced methods used to develop and evaluate a concept.
CO5	Apply modelling and embodiment principles in product design and development process.

COURSE CONTENTS**1. DEFINITION OF A PRODUCT**

- 1.1. Types of product;
- 1.2. Levels of product;
- 1.3. Product-market mix;
- 1.4. New product development (NPD) process;
- 1.5. Idea generation methods;
- 1.6. Creativity;
 - 1.6.1. Creative attitude;
 - 1.6.2. Creative design process;
- 1.7. Morphological analysis;
- 1.8. Analysis of inter-connected decision areas;
- 1.9. Brain storming.

2. PRODUCT LIFECYCLE;

- 2.1. The challenges of Product development;
- 2.2. Product analysis;
- 2.3. Product characteristics;
- 2.4. Economic considerations;
- 2.5. Production and Marketing aspects;
- 2.6. Characteristics of successful Product development;
- 2.7. Phases of a generic product development process;
- 2.8. Customer need identification;
- 2.9. Product development practices and industry-product strategies.

3. PRODUCT DESIGN

- 3.1. Design by evolution;
- 3.2. Design by innovation;
- 3.3. Design by imitation;
- 3.4. Factors affecting product design;
- 3.5. Standards of performance and environmental factors;
- 3.6. Decision making and iteration;
- 3.7. Morphology of design (different phases);
- 3.8. Role of aesthetics in design.

4. INTRODUCTION TO OPTIMIZATION IN DESIGN

- 4.1. Economic factors in design;
- 4.2. Design for safety and reliability;
- 4.3. Role of computers in design;
- 4.4. Modeling and Simulation;
- 4.5. The role of models in engineering design;
- 4.6. Mathematical modeling;
- 4.7. Similitude and scale models;
- 4.8. Concurrent design;
- 4.9. Six sigma and design for six sigma;
- 4.10. Introduction to optimization in design;
- 4.11. Economic factors and financial feasibility in design;
- 4.12. Design for manufacturing;
- 4.13. Rapid Proto typing (RP);
- 4.14. Application of RP in product design;
- 4.15. Product Development versus Design.

5. DESIGN OF SIMPLE PRODUCTS DEALING WITH VARIOUS ASPECTS OF PRODUCT DEVELOPMENT;

- 5.1. Design Starting from need till the manufacture of the product

REFERENCE BOOKS

- 1.Product Design and Development, Karl T. Ulrich and Steven D. Eppinger, Tata McGraw–Hill edition.
- 2.Engineering Design– George E. Dieter.
- 3.An Introduction to Engineering Design methods Vijay Gupta.
- 4.Merie Crawford: New Product management, McGraw-Hill Irwin.
- 5.Chitale A K and Gupta R C, “Product Design and Manufacturing”, Prentice Hall of India, 2005.
- 6.Kevin Otto and Kristin Wood, Product Design, Techniques in Reverse Engineering and New Product Development, Pears on education.

DISASTER MANAGEMENT

Course Code	PL 63002(Same in All Branches of Engg.)
Course Title	Disaster Management
Number of Credits	3 (L: 3, T: 0, P :0)
Prerequisites	NIL
Course Category	OE

COURSE LEARNING OBJECTIVES

Following are the objectives of this course:

- To learn about various types of natural and man-made disasters.
- To know pre and post-disaster management for some of the disasters.
- To know about various information and organizations in disaster management in India.
- To get exposed to technological tools and their role in disaster management.

COURSE OUTCOMES:

- 1.1. After completing this course, student will be:
- 1.2. Acquainted with basic information on various types of disasters
- 1.3. Knowing the precautions and awareness regarding various disasters
- 1.4. Decide first action to be taken under various disasters
- 1.5. Familiarized with organization in India which are dealing with disasters
- 1.6. Able to select IT tools to help in disaster management

COURSE CONTENTS**1. UNDERSTANDING DISASTER**

- 1.1. Understanding the Concepts and definitions of Disaster,
- 1.2. Hazard,
- 1.3. Vulnerability,
- 1.4. Risk,
- 1.5. Capacity–Disaster and Development,
- 1.6. Disaster management.

2. TYPES, TRENDS, CAUSES, CONSEQUENCES AND CONTROL OF DISASTERS

- 2.1. Geological Disasters (earth quakes, land slides, tsunami, mining);
- 2.2. Hydro-Meteorological Di-sasters (floods, cyclones, lightning, thunder-storms, hailstorms, avalanches, droughts, cold and heat waves)
- 2.3. Biological Disasters (epidemics, pest attacks, forest fire);
- 2.4. Technological Disasters (chemical, industrial, radiological, nuclear)
- 2.5. Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters)
- 2.6. Global Disaster Trends
- 2.7. Emerging Risks of Disasters
- 2.8. Climate Change and Urban Disasters.

3. DISASTER MANAGEMENT CYCLE AND FRAME WORK

- 3.1. Disaster Management Cycle
- 3.2. Paradigm Shift in Disaster Management.
- 3.3. Pre-Disaster
- 3.4. Risk Assessment and Analysis,
- 3.5. Risk Mapping,
- 3.6. Zonation and Microzonation,
- 3.7. Prevention and Mitigation of Disasters,
- 3.8. Early Warning System
 - 3.8.1. Preparedness,
 - 3.8.2. Capacity Development;
 - 3.8.3. Awareness.
- 3.9. During Disaster
 - 3.9.1. Evacuation

- 3.9.2. Disaster Communication
- 3.9.3. Search and Rescue
- 3.9.4. Emergency Operation Centre
- 3.9.5. Incident Comm and System
- 3.9.6. Relief and Rehabilitation
- 3.10. Post-disaster
 - 3.10.1. Damage and Needs Assessment,
 - 3.10.2. Restoration of Critical Infra structure
 - 3.10.3. Early Recovery Reconstruction and Redevelopment;
 - 3.10.4. IDNDR, Yokohama Strategy, Hyogo Frame-work of Action.

4. DISASTER MANAGEMENT IN INDIA

- 4.1. Disaster Profile of India
- 4.2. Mega Disasters of India and Lessons Learnt.
- 4.3. Disaster Management Act 2005
- 4.4. Institutional and Financial Mechanism,
- 4.5. National Policy on Disaster Management,
- 4.6. National Guidelines and Plans on Disaster Management;
- 4.7. Role of Government (local, state and national),
- 4.8. Non-Government and Inter Governmental Agencies

5. APPLICATIONS OF SCIENCE AND TECHNOLOGY FOR DISASTER MANAGEMENT

- 5.1. Geo informatics in Disaster Management (RS, GIS, GPS and RS).
- 5.2. Disaster Communication System (Early Warning and Its Dissemination).
- 5.3. Land Use Planning and Development Regulations,
- 5.4. Disaster Safe Designs and Constructions,
- 5.5. Structural and Non Structural Mitigation of Disasters
- 5.6. S & T Institutions for Disaster Management in India

REFERENCES

- 1.Publications of National Disaster Management Authority (NDMA) on Various Templates and Guide lines for Disaster Management
- 2.Bhandani, R. K., An over view on natural & man-made disasters and their reduction, CSIR, New Delhi
- 3.Srivastava, H. N., and Gupta G. D., Management of Natural Disasters in developing countries, Daya Publishers, Delhi
- 4.Alexander, David, Natural Disasters, Kluwer Academic London
- 5.Ghosh, G .K. ,Disaster Management, APH Publishing Corporation
- 6.Murthy, D. B. N., Disaster Management: Text & Case Studies, Deep & Deep Pvt. Ltd.

INDIAN CONSTITUTION

CourseCode	PL 6333(Same in All Branches of Engg.)
CourseTitle	Indian Constitution
NumberofCredits	0 (L:2,T:0;P:0)
Prerequisites(Coursecode)	None
CourseCategory	AU

COURSE CONTENT

1. THE CONSTITUTION –

- 1.1. Introduction
- 1.2. The History of the Making of the Indian Constitution
- 1.3. Preamble and the Basic Structure, and its interpretation
- 1.4. Fundamental Rights and Duties and their interpretation
- 1.5. State Policy Principles

2. UNION GOVERNMENT

- 2.1. Structure of the Indian Union
- 2.2. President– Role and Power
- 2.3. Prime Minister and Council of Ministers
- 2.4. Lok Sabha and Rajya Sabha

3. STATE GOVERNMENT

- 3.1. Governor– Role and Power
- 3.2. Chief Minister and Council of Ministers
- 3.3. State Secretariat

4. LOCAL ADMINISTRATION

- 4.1. District Administration
- 4.2. Municipal Corporation
- 4.3. Zila Panchayat

5. ELECTION COMMISSION

- 5.1. Role and Functioning
- 5.2. Chief Election Commissioner
- 5.3. State Election Commission

SUGGESTED LEARNING RESOURCES:

S.No.	Title of Book	Author	Publication
1.	Ethics and Politics of the Indian Constitution	Rajeev Bhargava	Oxford University Press, New Delhi, 2008
2.	The Constitution of India	B.L.Fadia	Sahitya Bhawan; New edition(2017)
3.	Introduction to the Constitution of India	D D Basu	Lexis Nexis; Twenty-Third 2018 edition

SUGGESTED SOFTWARE / LEARNING WEBSITES:

1. <https://www.constitution.org/cons/india/const.html>
2. <http://www.legislative.gov.in/constitution-of-india>
3. <https://www.sci.gov.in/constitution>
4. <https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/>

DESIGN OF DIES AND MOULDS

Course Code	PL 6001
Course Title	DESIGN OF DIES AND MOULDS
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Nil
Course Category	PC

COURSE OBJECTIVES:

The objective of this subject is to equip the students with the knowledge of different kinds of moulds, their drawing and design of moulded articles. The skill and knowledge of die design and construction is of great importance in plastic processing.

COURSE OUTCOMES:

Students will learn about the basic design concepts of various types of moulds and dies.

COURSE CONTENTS:**1. DESIGN CONCEPTS OF MOULDED ARTICLES:**

- 1.1 Introduction
- 1.2 Shrinkage and Sink marks
- 1.3 Parting lines
- 1.4 Draft/Taper
- 1.5 Radii
- 1.6 Ribs and bosses
- 1.7 Wall thickness
- 1.8 Venting of moulds
- 1.9 Moulded holes

2. DESIGN OF COMPRESSION MOULDS:

- 2.1 Flash type mould
- 2.2 Positive type mould
- 2.3 Landed positive mould
- 2.4 Semi positive mould

3. DESIGN OF TRANSFER MOULDS:

- 3.1 Plunger type Mould
- 3.2 Pot type Mould

4. INJECTION MOULDS :

- 4.1 Single and Multi-cavity moulds
- 4.2 Two-plate and three-plate moulds
- 4.3 Feeding system- sprue, runners and gates

5. EXTRUSION DIES :

- 5.1 General features of extrusion dies
- 5.2 Die design for pipe
- 5.3 Die design for solid rods
- 5.4 Die design for blown film
- 5.5 Die design for wire and cable coating

REFERENCE BOOKS :

1. SPI Engg. Hand book
2. Processing of Thermoplastic Materials
3. Plastic Product Design
4. Plastic Mould Engg.
5. Design of Plastic Moulds & Dies
6. Dies for Plastic Extrusion
7. Injection Mould Design

Frados
Bernhard
Ronald D. Beck
Dubois, Pribble
L. Sors, I Balaze
M.V. Joshi
R.G. W. Pye

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CHARACTERISATION OF POLYMERS

Course Code	PL 60021
Course Title	CHARACTERISATION OF POLYMERS
Number of Credits	3(L: 3, T: 0, P: 0)
Prerequisites	NIL
Course Category	PE

COURSE OBJECTIVES:

The flow behaviour & the process parameters of molten polymer can be understood through Rheological study of polymers. The student can be able to choose the processing techniques for a particular polymer. Students can also understand the internal structure of polymers through characterisation methods. understand the internal structure of polymers through characterisation methods.

COURSE OUTCOMES:

Students will learn about the characterization of polymer properties and get the information about the polymers performance during applications.

COURSE CONTENTS**1.DTA (DIFFERENTIAL THERMAL ANALYSIS):**

- 1.1 Introduction
- 1.2 Methods of analysis
- 1.3 Conclusions of results

2.TGA (THERMO GRAVIMETRIC ANALYSIS):

- 2.1 Introduction
- 2.2 Methods of analysis
- 2.3 Conclusions of results

3.TMA (THERMOMETRIC ANALYSIS):

- 3.1 Introduction
- 3.2 Methods of analysis
- 3.3 Conclusion of results

4. DSC (DIFFERENTIAL SCANNING CALORIMETRY) :

- 4.1 Introduction
- 4.2 Methods of analysis
- 4.3 Conclusions of results

5.GPC (GEL PERMEATION CHROMATOGRAPHY) :

- 5.1 Introduction
- 5.2 Methods of analysis
- 5.3 Conclusions of results

6.IR SPECTROSCOPY :

- 6.1 Introduction
- 6.2 Methods of analysis
- 6.3 Conclusions of results

7. ELECTRON MICROSCOPY(SEM & TEM) :

- 7.1 Introduction
- 7.2 Methods of analysis
- 7.3 Conclusions of results

8.X-RAY ANALYSIS :

- 8.1 Introduction
- 8.2 Methods of analysis
- 8.3 Conclusions of results

REFERENCEBOOKS:

- | | |
|--|--------------------------|
| 1. Principle of High Polymers, Theory & Practice | Schmidt & Marlies |
| 2. Properties & Structure of Polymers | Tobolsky |
| 3. Polymer Science & Engg. | Wilkinson |
| 4. Polymer Melt Rheology | F.N. Gogabell |
| 5. Mechanical Testing of Plastics | S. Turner |
| 6. Testing Polymers | J. V. Schemitz & Browen |
| 7. Properties & Testing of Plastic Materials | A.E. Leves & J. A. Rhys. |
| 8. Hand Book of Plastic Test Methods | Ives, Mead & Reley |
| 9. Hand Books of Plastics Testing Technology | Vishu Shah |

SEMESTER SCHEME 2020-21

ADVANCED RUBBER TECHNOLOGY

Course Code	PL 60022
Course Title	ADVANCED RUBBER TECHNOLOGY
Number of Credits	3(L: 3, T:0, P: 0)
Prerequisites	NIL
Course Category	PE

COURSE OBJECTIVES:

Knowledge of this subject covers Manufacturing process of various natural and synthetic elastomers which is important part of polymers. This subject also covers properties, uses of rubbers along with processing techniques of rubber articles.

COURSE OUTCOME:

Students will learn about types of rubbers, modifications and their applications .

COURSE CONTENTS**1. MODIFIED NATURAL RUBBERS**

- 1.1. Anti crystallizing rubber
- 1.2. Grafted Rubber
- 1.3. Superior Processing Rubber

2. ELEMENTARY KNOWLEDGE OF VARIOUS SYNTHETIC RUBBERS:

- 2.1. Polyurethane
- 2.2. Fluoro-Rubbers

3. MACHINERIES USED FOR RUBBER PROCESSING**4. VULCANIZATION OF RUBBERS**

- 4.1. Sulphur
- 4.2. Non Sulphur

5. PREPARATION, CHEMISTRY AND PROPERTIES OF RUBBERS

- 5.1. Polysulfide
- 5.2. Silicon

6. PLASTICITY ANALYSIS OF RUBBER

- 6.1. Extrusion and mixing Test
- 6.2. Rotating disc viscometer

7. PHYSICAL TESTING OF RUBBERS**REFERENCE BOOKS:**

1. Natural Rubbers Science&Technology
2. Chemistry &Technology of Rubber
3. Polymer Chemistry of Synthetic Elastomers VolI &II
4. Rubber Technology&Manufacture
5. Synthetic Rubber
6. Rubber Materials & Their Compounds

Roberts
Morton
Kennedy
C.M.Blow
G.B.Bhitby,C.D.Davis
J. A.Brydson
