NEP-2020 Aligned Curriculum for

Three Year (Six Semesters) Diploma Programme in

CHEMICAL TECHNOLOGY (Rubber & Plastic)

(3rd to 4th Semester)

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Semester System

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(Effective From Session 2025 - 26)

Prepared By:

INSTITUTE OF RESEARCH, DEVELOPMENT & TRAINING, U.P., KANPUR

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PREFACE

An important issue generally debated amongst the planners and educators world over is how technical education can contribute to sustainable development of the societies struggling hard to come in the same bracket as that of the developed nations. The rapid industrialization and globalization has created an environment for free flow of information and technology through fast and efficient means. This has led to shrinking of the world, bringing people from different culture and environment together and giving rise to the concept of world turning into a global village. In India, a shift has taken place from the forgettable years of closed economy to knowledge based and opens economy in the last few decades. In order to cope with the challenges of handling new technologies, materials and methods, we have to develophuman resources having appropriate professional knowledge, skills and attitude. Technical education system is one of the significant components of the human resource development and has grown phenomenally during all these years. Now it is time to consolidate and infuse quality aspect through developing human resources, in the delivery system. Polytechnics play an important role in meeting the requirements of trained technical manpower for industries and field organizations. The initiatives being taken by the State Board of Technical Education, UP to revise the existing curricula of 42 diploma programmes as per the needs of the industry and making them NEP-2020/AICTE compliant, are laudable.

In order to meet the requirements of future technical manpower, we will have to revamp our existing technical education system and one of the most important requirements is to develop outcome-based curricula of diploma programmes. The curricula for diploma programmes have been revised by adopting time-tested and nationally acclaimed scientific method, laying emphasis on the identification of learning outcomes of diploma programme.

The real success of the diploma programme depends upon its effective implementation. However best the curriculum document is designed, if that is not implemented properly, the output will not be as expected. In addition to acquisition of appropriate physical resources, the availability of motivated, competent and qualified faculty is essential for effective implementation of the curricula.

It is expected of the polytechnics to carry out job market research on a continuous basis to identify the new skill requirements, reduce or remove outdated and redundant courses, develop innovative methods of course offering and thereby infuse the much needed dynamism in the system.

Director
Institute of Research Development & Training

ACKNOWLEDGEMENTS

We gratefully acknowledge the guidance and contribution received from the following Persons

1. Sh. Narendra Bhooshan, IAS, Additional Chief Secretary, Department of Technical Education, Govt. of UP, for his exemplary vision & approach.

2. Sh. Avinash Krishna Singh, IAS, Secretary, Directorate General, Department of Technical Education, Govt. of U.P.

3. Sh. F.R. Khan, Director, I.R.D.T. Kanpur for continually motivating, guiding and taking keen interest in the review of curriculum..

4. All the participants from industries, Polytechnics and other technical institutions for their professional inputs during curriculum workshops.

5. CDC Officer and other concerning staff of IRDT for their support and assistance in conducting curriculum workshops.

6. In the last but not least would like to thanks management of the industries who spare not only their precious time but also allowed the visit of their industries to the team making the curriculum

Shyam Lal
Textbook Officer/Course Coordinator
IRDT Kanpur

1 SALIENT FEATURES

1)	Name of the Programme	:	Diploma in Chemical Technology (Rubber & Plastic)
2)	Duration of the Programme	:	Three years (Six Semesters)
3)	Entry Qualification	:	Matriculation or equivalent NSQF Level as Prescribed by State Board of Technical Education, UP
4)	Pattern of the Programme	:	Semester Pattern
5)	NSQF Level	:	Level - 5
6)	Ratio between theory and Practical	:	40: 60 (Approx.)

7) **Industrial Training**

Four and six weeks of industrial training is made mandatory after the II and IV semesters during summer vacation.Total marks allotted to industrial training will be respectively 50 & 100.

In the last (6^{th} Semester) we have made the one semester Industrial training/Internship as optional along with usual classroom training.

8) **Ecology and Environment**

As per Govt. of India directives a subject on Environmental Science has been incorporated in the curriculum.

9) **Entrepreneurship and Start-ups**

A full subject Entrepreneurship & Start-ups has been incorporated in the curriculum.

10) **Student Centred Activities**

A provision of 4-8 hrs per week has been made for organizing Student Centered Activities for overall personality development of students. Such activities will comprise of co–curricular activities such as expert lectures, self-study, games, hobby classes like photography, painting, singing etc. seminars, declamation contests, educational field visits, NCC, NSS, library and other cultural activities.

11) **Project work**

A project work has been included in the curriculum to enable the student get familiarize with the practices and procedures being followed in the industries and provide an opportunity to work on some live projects in the industry.

2- PROGRAM OUTCOMES (POs)

PO1: Basics and Discipline specific Knowledge
Assimilate knowledge of basic mathematics, science, engineering fundamentals.

PO2: Problem's Analysis and solution
Identify, analyse and solve problems using standard methods and established techniques.

PO3: Design and Development
Design solutions for technical problems.
Assist in designing components, systems, or processes to meet specific requirements.

PO4: Engineering Tools, Experimentation, and Testing
Use modern engineering tools and appropriate techniques to conduct experiments as per BIS standard.

PO5: Socio/ Economic /Environmental impact assessment/remedy.

Apply relevant technologies while considering societal needs, environmental impact keeping in view sustainable and ethical responsibilities.

PO6: Project Management and Communication
Apply engineering management principles, work effectively as an individual or in a team, and communicate clearly on activities.

PO7: Lifelong Learning

Recognize the importance of continuous learning and actively pursue self-improvement to keep pace with technological developments

3- **Employment Opportunities -**

i) Chemical and Allied Industries like

- Fertilizer industry
- Petroleum refinery and petrochemical industry
- Oil and natural gas corporation
- Cement plant
- Cosmetic industry
- Sugar industry
- Mineral industry
- Pulp and Paper industry
- Polymer industry
- Food industry
- Agro industry
- Pharmaceutical industry
- Distilleries
- Paint and dye industry
- Rubber industry
- Soap & detergent industry
- Textile industry etc.
- Pesticide industry
- General processing industries
- Glass industry
- Ceramics industry
- Automobile industry (paint shop and electroplating shop)
- Test Equipment: Manufacturing and repairing

In various functional areas like erection and commissioning of plant, plant operation, energy conservation, plant utilities, production, water treatment, maintenance and safety, quality control, inspection and testing, marketing and sales, consultancy services and areas concerning environmental protection.

(ii) Research Organizations like CSIR laboratories, Defence laboratories, Atomic energy establishments etc.

(iii) Boards and Corporations.

(iv) Entrepreneurs to small/tiny units especially food, agro and chemical industries such as paints, soap, detergents, equipment repairing etc.

v) Academic Institutions (as technicians/instructors at all levels)

4. LEARNING OUTCOMES

Sr.	Learning Outcomes
After undergoing this programme, students will be able to:	
1	Prepare and interpret drawings of engineering components and plants
2	Read and interpret drawings related to plant layout, process equipment and components, process flow sheets and product manufacturing.
3	Apply concepts of mechanics to solve chemical engineering problems
4	Apply basic principles of mathematics, science and engineering to solve chemical engineering problems
5	Select various materials used in chemical processes, their properties and specifications
6	Understand various unit operations, unit processes and process instrumentation in process industry
7	Calculate the quantity of raw materials, energy inputs, manpower requirement and output from the process
8	Control the process and quality of the products commensurating with laid specifications
9	Recognise the need for and have the ability to engage in life long learning
10	Conduct experiments, analyse, interpret data and synthesise valid conclusions
11	Operate conventional machine for machining of components as per specifications as an aid to function effectively in the process industry.
12	Use electrical and electronic instruments to measure various engineering parameters
13	Use various measuring and gauging instruments
14	Select material as per desired application
15	Understand the general design of process equipments and testing
16	Operate different utility plants
17	Understand different renewable sources of energy and their applications.
18	Understand different plants utilities and their generation and maintenance
19	Use various software tools for automation and process development.
20	Interpret factory acts, laws and taxes
21	Develop communication and interpersonal skills for effective functioning in the world of work.
22	Communicate effectively in English and local language in oral and written form with others
23	Manage resources effectively at work place
24	Plan and execute given task/project as a team member or leader
25	Prepare detailed project proposal and report.
26	Use computer and IT tools for creating documents, making spread sheet and making presentation
27	Solve real life problems by application of acquired knowledge and skills
28	Use energy conservation methods to manage energy efficiency
29	Use appropriate practices for conservation and prevention of environment pollution and safety in process industries.

5- ABSTRACT OF CURRICULUM AREAS

HUMANITIES & SOCIAL SCIENCES COURSES [HS]	
	• Communication Skills in English
	• Sports and Yoga
	• Entrepreneurship and Start-ups
BASIC SCIENCES COURSE [BS]	
	• Mathematics
	• Applied Physics
	• Applied Chemistry
ENGINEERING SCIENCE COURSES [ES]	
	• Engineering Graphics
	• Engineering Workshop Practice
	• Introduction to IT Systems
	• Fundamentals of Electrical & Electronics Engineering
	• Engineering Mechanics
PROGRAM CORE COURSES [PC]	
	• Fundamentals Of Polymers & Elastomers
	• Chemical Process Calculation
	• Plastics Processing Technology
	• Heat And Mass Transfer
	• Fuild Mechanics And Solid Handling
	• Plastics Processing Technology Lab
	• Plastics Materials
	• Testing Of Plastics & Rubbers
	• Rubber Manufacturing Technology
	• Additives And Compounding

PROGRAM ELECTIVE COURSES [PE]	
	Program Elective -1 • Rubber Materials • Materials Science and Engineering **Program Elective-2** • Bio Degradable Polymers • Speciality Rubber and Thermoplastic Elastomer
OPEN ELECTIVE COURSES [OE]	
	Open Elective -1 ● Renewable Energy Technologies ● Internet Of Things

PROJECT WORK, SEMINAR AND INTERNSHIP IN INDUSTRY OR ELSEWHERE

- Summer Internship – I (3-4 weeks) after IInd Sem
- Summer Internship – II (4-6 weeks) after IVth Sem
- Major Project(In-House) / Internship / Industrial Training

AUDIT COURSES [AU]

- Environmental Science
- Essence of Indian Knowledge and Tradition
- Indian Constitution

6- STUDY AND EVALUATION SCHEME FOR CHEMICAL TECHNOLOGY (Rubber & Plastic)

NOTE: I & II Sem. is common to all Engineering & Technology branches and implemented from the session 2024-2025

THIRD SEMESTER

SR. NO.	SUBJECTS	COURSE TYPE AND CATEGORY	STUDY SCHEME PERIODS/WEEK			CREDITS	MARKS IN EVALUATION SCHEME								TOTAL MARKS OF INTERNAL & EXTERNAL
							INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
			L	T	P		TH	PR	TOT	TH	HRS	PR	HRS	TOT	
3.1	Fundamentals Of Polymers & Elastomers	Program Core (Theory)	3	-	-	3+0=3	40		**40**	60	3	-	-	**60**	**100**
3.2	Chemical Process Calculation	Program Core (Theory)	2	-	-	2+0=2	40		**40**	60	3		-	**60**	**100**
3.3	Plastics Materials	Program Core (Theory)	3	-	-	3+0=3	40		**40**	60	3	-	-	**60**	**100**
3.4	Plastics Processing Technology	Program Core (Theory)	3	-	-	3+0=3	40		**40**	60	3	-	-	**60**	**100**
3.5	Fuild Mechanics And Solid Handling	Program Core (Practicum)	2	-	4	2+2=4		60	**60**		-	40	3	**60**	**100**
3.6	Plastics Processing Technology Lab	Program Core (Practical)	-	-	6	0+3=3	-	60	**60**	--	-	40	3	**40**	**100**
3.7	Summer Internship **(4 Weeks)		-	-	4	0+2=2	-	50	**50**	-	-	-	-	**-**	**50**
#Student Centered Activities			-	-	9	-	-	50	**50**	-	-	-	-	**-**	**50**
TOTAL			**13**	**-**	**23**	**20**			**380**					**320**	**700**

****** Students will present a seminar on their summer internship along with certificate, project and report.

Student Centered Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. Photography etc., Seminars, Declamation Contests, voluntary contribution in physical activities, Educational Field Visits, NCC, NSS, Cultural Activities and Self-Study etc.

Note- 1) Each period will be 60 minutes duration.
2) Each session will be of 16 weeks.
3) Effective teaching will be at least 14 weeks.

STUDY AND EVALUATION SCHEME FOR CHEMICAL TECHNOLOGY (Rubber & Plastic)

FOURTH SEMESTER

SR. NO.	SUBJECTS	COURSE TYPE AND CATEGORY	STUDY SCHEME PERIODS/WEEK			CREDITS	MARKS IN EVALUATION SCHEME								TOTAL MARKS OF INTERNAL & EXTERNAL
							INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
			L	T	P		TH	PR	TOT	TH	HRS	PR	HRS	TOT	
4.1	Testing Of Plastics & Rubbers	Program Core (Theory)	2	-	-	2+0=2	40	-	40	60	3	-	-	60	100
4.2	Heat And Mass Transfer	Program Core (Practicum)	2	-	2	2+1=3	40	-	40	60	3	-	-	60	100
4.2	Rubber Manufacturing Technology	Program Core (Practicum)	2	-	4	2+2=4	-	60	60	-	-	40	3	40	100
4.3	Additives And Compounding	Program Core (Practicum	2	-	2	2+1=3	-	60	60		-	40	-	40	100
4.5	Testing Of Plastics & Rubbers Lab	Program core Practical	-	-	4	0+4=2	-	60	60	-	-	40	3	40	100
4.6	Program Elective – 1	Program Core (Theory)	2	-	-	2+0=2	40	-	40	60	3	-	-	60	100
4.7	Program Elective – 2	Program Core (Theory)	2	-	-	2+0=2	40	-	40	60	3	-	-	60	100
4.8	Open Elective -1	Open Elective	2	-	-	2	50*	-	-	-	-	-	-	-	-
	Advanced Skill Certification	Open Elective-1*	-	-	-		-	-	-	-	-	-	-	-	-
4.9	Essence Of Indian Knowledge And Tradition	Audit Course	2	-	-	-	50*	-	-	-	-	-	-	-	-
# Student Centered Activities			-	-	9	-	-	50	50	-	-	-	-	-	50
TOTAL			15	-	21	20			390	-		-	-	360	750

*Students will submit the certificate.

(Q) This Course is Qualifying only, Exam marks will not be added in total.

Advance Skill Development:

To fulfill the requirements for Advanced Skill Development, a minimum of 20 hours of skill certification is necessary. This certification must be obtained from a recognized national or international agency or institute. The assessment and certification process will be conducted by the respective agency or institute. Students must present their certificate to earn 02 credits for this subject.

Student Centered Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. Photography etc., Seminars, Declamation Contests, voluntary contribution in physical activities, Educational Field Visits, NCC, NSS, Cultural Activities and Self-Study etc.

-Industrial Training (Summer Internship-II) of 4-6 Weeks after 4th Semester, Evaluation will be in 5th Semester

PROGRAM ELECTIVE-1

SR. NO.	SUBJECT NAME
1	Rubber Materials
2	Materials Science and Engineering

PROGRAM ELECTIVE-2

SR. NO.	SUBJECT NAME
1	Bio Degradable Polymers
2	Specialty Rubber and Thermoplastic Elastomer

OPEN ELECTIVE-1

SR. NO.	SUBJECT NAME
1	RENEWABLE ENERGY TECHNOLOGIES
2	INTERNET OF THINGS
3	ANY COURSE OF MINIMUM 02 CREDIT FROM NPTEL MOOCS THROUGH SWAYAM AICTE-ELIS AND CENTRALLY FUNDED TECHNICAL INSTITUTES C-DAC CERTIFICATES CONDUCTED BY THE INSTITUTE OF NATIONAL IMPORTANCE (IIT, NIT, IIT ETC.) ISRO E-LEARNING OTHER RELEVANT GOVERNMENT, INTERNATIONAL/NATIONAL PLATFORMS OF REPUTE, NEILIT

DETAILED CONTENTS OF VARIOUS SUBJETS

THEORY	3.1 FUNDAMENTALS OF POLYMERS & ELASTOMERS	L	T	P
		3	-	-

COURSE OBJECTIVES

This course is designed to teach students the fundamentals of polymer. After taking it, students will be confident about the different polymerization techniques, which will be useful for them during their professional careers.

Course Outcomes

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

CO1 - Understanding of the Basics of Polymer Science, Monomers, Polymer, Elastomer & their requirements
CO2 -Knowledge of different polymerisation techniques
CO3 - Determine molecular weight and its distribution
CO-4 Understanding of the basics of Polymer Rheology
CO5 - Relate the effect of crystallinity and Tg on polymer properties
CO6 - Understand the fundamentals of polymer reaction

COURSE CONTENT

Unit -1 (Periods- 12)

Source of Petroleum Product, C1-C6 Fraction Definition of Monomer - Functionality of monomers - Polymer, Polymerisation and Degree of polymerisation – Newtonian vs Non Newtonian fluid - Classification of polymers - Chemistry of polymerisation - Chain polymerisation - Free Radical polymerisation - Initiation - Chain transfer agents – Propagation - Inhibitors – termination - Ionic polymerisation - Cationic polymerisation - Anionic polymerization, Ziegler-Natta catalysts, Poly condensation polymerization.

Unit 2 (Periods- 08)

Bulk polymerisation- Solution polymerisation - Suspension polymerisation- Emulsion polymerisation–Melt Polycondensation – Solution Polycondensation – Interfacial Polycondensation.

Unit 3 (Periods- 12)

Average molecular weight concept - Number average molecular weight - Weight average Molecular weight – Molecular weight and degree of polymerization - Molecular weight determination, Amorphous Vs Crystalline Polymers - Glass transition temperature - factors influencing the glass transition temperature.

Unit 4 (Periods- 10)

Polymer reactions (Definition and example only) - Hydrolysis - Acidolysis - Hydrogenation - Cross-linking reactions of rubber and thermoset plastic, Viscoelastic Behaviour, Introduction to Thermoplastic,

Thermoset and Elastomers.

Instructional Strategy

1. To help students learn and appreciate new concepts and principals, teachers should provide examples from daily life, realistic situations and real-world engineering and technological applications.
2. The demonstration can make the subject exciting and foster the student's scientific mindset.
3. ICT tools must be used to deliver the content more attractively so that the attention of the learners is drawn and will create a curiosity in them to understand the content in a better way.
4. Industrial visit can be arranged to make the students realise the application of theoretical knowledge gained in the classroom.

Text Books:

1. V.R.Gowarikar, N.V.Viswanathan & Jayadev Sridhar - Polymer Science - New age international publishers - 1986.
2. Fred W.Billmeyer - Text Book of Polymer Science - Wiley Interscience - 1971.
3. P.Ghosh – Polymer science and Technology – Tata McGraw Hill, New Delhi,

References:

1. Anilkumar & S.K.Gupta -Fundamentals of Polymer Science - Tata McGraw Hill Pub. Co. 1978.
2. Odian.G - Principles of Polymerisation – McGraw-Hill, New York – 1970
3. Plastics Material, J A Brydson (Author)7th Edition, Butterworth-Heinemann, 26 October 1999

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	12	30
2	08	20
3	12	30
4	10	20
Total	42	100

THEORY	3.2 CHEMICAL PROCESS CALCULATION	L	T	P
		2	-	-

COURSE OBJECTIVE

This subject explains the basic chemical engineering calculations. It is one of the core subjects. In this subject, students learn the fundamental concepts on which chemical engineering design is based. This subject helps the student prepare the material and energy balance of a process and calculate the quantity of material and energy input and output of a process plant.

COURSE OUTCOME

CO1 Define and explain the significance of material and energy balances in process systems.

CO2 Solve problems using gas laws and evaluate properties of gas mixtures.

CO3 Apply material balance concepts to various unit operations without chemical analysis

CO4 Perform material balances involving chemical reactions with recycle and purge streams.

CO5 Calculate energy requirements and perform energy balance involving heat and combustion.

CO6 Analyse combustion processes and determine air/fuel requirements using fuel analysis.

COURSE CONTENTS

UNIT-1: INTRODUCTION (03 Periods)

Introduction to material and energy balance in chemical industries Unit conversion, S.I. system, M.K.S. system, C.G.S. system.

UNIT-2: GASES AND GAS MIXTURE (06 Periods)

Boyle's law, Charle's law, Ideal Gas law, value of universal gas constant, Amagat's Law Average molecular weight, density and composition (by weight and by mole) of gas mixture. Various units of concentration: PPM (parts per million), PPB (parts per billion) molarity, molality, normality.

UNIT-3: MATERIAL BALANCE WITHOUT CHEMICAL REACTION (06 Periods)

Steps for solving simple material balance problems. Solving simple problems on various unit operations like drying, evaporation, crystallization, distillation, mixing and absorption. Concept of: By-pass streams.

UNIT-4: MATERIAL BALANCE WITH CHEMICAL REACTION (04 Periods)

Limiting component, excess component, percent excess, yield, conversion, and selectivity recycle, and purge related simple problems.

UNIT-5: ENERGY BALANCE & COMBUSTION (09 Periods)

Definitions of Specific heat (Cp & Cv)/sensible heat, latent heat. Hess's law and associated basic problems. Concept of Heat of reaction, heat of combustion & heat of formation. Adiabatic reaction and adiabatic flame temperature Calorific Value: Net and gross and its basic numerical problems. Combustion: proximate and ultimate analysis, air fuel ratio in Boiler/Furnaces, Theoretical oxygen/air required. Problems of fuel analysis. Oxidation of sulphur and its compounds.

Instructional Strategy

1. To help students learn and appreciate new concepts and principals, teachers should provide examples from daily life, realistic situations and real-world engineering and technological applications.
2. The demonstration can make the subject exciting and foster the student's scientific mindset.
3. ICT tools must be used to deliver the content more attractively so that the attention of the learners is drawn and will create a curiosity in them to understand the content in a better way.
4. Industrial visit can be arranged to make the students realise the application of theoretical knowledge gained in the classroom.

MEANS OF ASSESSMENT

Assignments and quiz/class tests

Mid-term and end-term written tests

RECOMMENDED BOOKS

Stoichiometry by B. I. Bhatt &S. M. Vora; McGraw Hill Publication

Chemical Process Principles Part-1 by O.A. Hougen and K.M. Watson.

Chemical Process Principles Part-1 by R.A. Rastogi

Solved Examples in Chemical Engineering by G.K. Ray

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	03	10
2.	06	22
3.	06	23
4.	04	15
5.	09	30
Total	28	100

THEORY	3.3 PLASTICS MATERIALS	L	T	P
		3	-	-

COURSE OBJECTIVE

This course aims to equip students with a thorough understanding of the fundamental methods used in the synthesis and fabrication of various plastic materials. It will cover the essential physical and chemical properties, processing techniques, and practical applications of plastics in different industries. Additionally, the course will emphasize the correlation between the molecular structure of plastics and their resultant properties, enabling students to predict and evaluate material performance based on structural characteristics. And to acquire basic knowledge on thermoplastic and thermoset plastics properties and their applications.

COURSE OUTCOMES

1. To understand different types of plastics and their widely used abbreviations.
2. Explain the relationship between the structure and properties of different plastic materials, and the synthesis and manufacturing of common engineering plastics and their properties for a variety of applications
3. Identify and classify plastics into thermoplastics and thermosets with reference to their characteristics and applications.
4. Select appropriate plastic materials for specific engineering or product design applications.
5. Understand the concept and characteristics of speciality plastics and their applications
6. Evaluate the suitability of various plastics based on their performance under different environmental and operational conditions.

COURSE CONTENTS

UNIT I COMMODITY PLASTICS (Periods- 12)

Plastics – Definition and Classifications – Abbreviations. Polyolefins: Polyethylene – Types: LDPE, HDPE, LLDPE – Structure – Manufacture of High-Density Polyethylene by Zeigler process - Properties and applications of PE, HDPE,LLDPE LDPE – Polypropylene – Types: Isotactic, Syndiotacic and Atactic – Structure – Properties and applications of PP. Polystyrene: Structure, Properties and applications of PS, SAN, ABS ,HIPS and EPS Polyvinyl chloride: Manufacture of PVC - Structure – Property – Difference between rigid and flexible PVC - Applications.

UNIT II ENGINEERING PLASTICS (Periods- 14)

Polyamides (Nylon 6 & Nylon 6,6 (only)): Structure, Preparation, Properties and applications Polyesters – PET: Structure, Preparation, Properties and applications, ABS Structure, Preparation, Properties and applications PMMA: Structure, Preparation, Properties and applications Polyacetals: Structure, Preparation, Properties and applications PC: Structure, Preparation, Properties and applications Fluorine containing Plastics:

UNIT II HIGH PERFORMANCE PLASTICS (Periods- 08)

Structure, Properties and applications (only) of PPO, PPS, Polysulphones, PEEK, Structure, Preparation, properties & applications of PTFE.

UNIT IV THERMOSETTING PLASTICS (Periods- 08)

Kevlar.Structure, Properties and Applications (only) of PF, UF, Epoxy and Unsaturated Polyester resin.

Text Books:

4. V.R.Gowarikar, N.V.Viswanathan & Jayadev Sridhar - Polymer Science - New age international publishers - 1986.
5. Fred W.Billmeyer - Text Book of Polymer Science - Wiley Interscience - 1971.
6. P.Ghosh – Polymer science and Technology – Tata McGraw Hill, New Delhi,
7. Irvin.I. Rubin, “Hand Book of Plastic Materials and Technology”, Wiley Interscience, NY,1990.

References:

4. Anilkumar & S.K.Gupta -Fundamentals of Polymer Science - Tata McGraw Hill Pub. Co. 1978.
5. Odian.G - Principles of Polymerisation – McGraw-Hill, New York – 1970
6. Plastics Material, J A Brydson (Author)7th Edition, Butterworth-Heinemann, 26 October 1999
7. OlagokeOlabisi, “Hand Book of Thermoplastics”, Marcel Decker, inc., 1997

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	12	30
2.	14	30
3.	08	25
4.	08	15
Total	42	100

THEORY	3.4 PLASTICS PROCESSING TECHNOLOGY	L	T	P
		3	-	-

COURSE OBJECTIVE

To enable students to gain a clear understanding of the various processing techniques used in the manufacturing of plastic materials. The course focuses on the fundamental principles and basic operations involved in the processing of thermoplastics, particularly through methods such as injection moulding, extrusion, and blow moulding. Additionally, students will be introduced to automation technologies and the integration of robotics in modern moulding processes.

COURSE OUTCOME

CO1: Explain the principles and operational steps involved in compression and transfer moulding processes, including equipment types and troubleshooting methods.

CO2: Identify and describe the components, cycle operations, and types of injection moulding processes used for both thermoplastics and thermosets.

CO3: Analyse different blow moulding techniques such as extrusion, injection, and stretch blow moulding, and assess their suitability for various applications.

CO4: Demonstrate understanding of extrusion and thermoforming processes, including machine parts, heating techniques, and forming methods used in plastic fabrication.

CO5: Describe the working principles of rotational moulding and calendering, and evaluate different joining techniques such as ultrasonic welding, adhesive bonding, and thermal sealing.

COURSE CONTENTS

Unit I COMPRESSION AND TRANSFER MOULDING (Periods- 08)

Compression moulding process - moulding cycle - types of compression press - Bulk factor - Troubleshooting. Transfer moulding process - moulding cycle - pot vs plunger type - comparison of compression moulding process and transfer moulding process. List of experiments:

Unit II INJECTION MOULDING (Periods- 10)

Injection moulding types – Parts of injection moulding and their function – Thermoplastic injection moulding process and cycle time – Types of clamping system – Thermoset injection moulding process - Troubleshooting

Unit III BLOW MOULDING (Periods- 08)

Parison programming for convergent and divergent die - extrusion blow moulding process – Injection blow moulding process - Injection stretch blow moulding process – B low up ratio - Troubleshooting.

Unit IVEXTRUSION AND THERMOFORMING (Periods- 08)

Extruder parts and functions – Extrusion process – Thermoforming - Heating sources - radiant - contact heating – hot air heating - Draft angle -Draw ratio of sheet – Thermoforming techniques-vacuum forming techniques: Straight vacuum forming – Plug assist forming - Bubble or blister forming.

Unit V ROTATIONAL MOULDING, CALENDERING AND JOINING (Periods- 08)

Rotational moulding process: Types of rotational moulding - Batch type machine process - Straight line (Shuttle) machine process - Carousel type machine process - Calendaring process- Types of calendars – Joining: Adhesive bonding - Ultrasonic welding – Vibration welding – Thermal sealing

Instructional Strategy

1. To help students learn and appreciate new concepts and principals, teachers should provide examples from daily life, realistic situations and real-world engineering and technological applications.
2. The demonstration can make the subject exciting and foster the student's scientific mindset.
3. ICT tools must be used to deliver the content more attractively so that the attention of the learners is drawn and will create a curiosity in them to understand the content in a better way.
4. Industrial visit can be arranged to make the students realise the application of theoretical knowledge gained in the classroom.

TEXTBOOK

1. Crawford, R.J. – Plastics Engineering, Butterworth-Heinemann, 3rd Edition, 2011.(Covers fundamental and advanced plastic processing techniques including injection, blow, rotational moulding, extrusion, and thermoforming.)

REFERENCE BOOKS:

1. Strong, A. Brent – Plastics: Materials and Processing, Pearson Education, 3rd Edition, 2006. (Provides a comprehensive overview of plastic materials, processing methods, and industrial applications.)
2. Rosato, D.V. and Rosato, D.V. – Injection Molding Handbook, Springer, 3rd Edition, 2000. (A detailed guide on injection moulding machines, process parameters, and troubleshooting.)
3. Ghosh, P. – Polymer Science and Technology of Plastics and Rubber, Tata McGraw-Hill, 2nd Edition, 1998. (Offers foundational knowledge of polymers with emphasis on processing and structure-property relationships.)
4. Brydson, J.A. – Plastics Materials, Butterworth-Heinemann, 8th Edition, 2007 (A classic reference text on plastic material types, processing behaviors, and selection guidelines.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	08	15
2.	10	25
3.	08	20
4.	08	20
5.	08	20
Total	42	100

PRACTICUM	3.5 FLUID MECHANICS & SOLID HANDLING	L	T	P
		2	-	2

COURSE OBJECTIVE

The subject gives knowledge of the measurement of fluid flow and various fluid transportation machinery. The knowledge gained from this subject is directly used in different subjects studied in Chemical Engineering. The knowledge of this subject helps in the installation of different fluid flow and transportation machinery. Solid handling is the fundamental of different machine and equipment's used in the chemical industries such as grinding, crushing, ball mills etc. chain belts and screw conveyor, filtration & mixing equipment's. Theoretical and experimental work will inculcate their interest in learning and teaching among the students and teachers.

COURSE OUTCOME

1. After studying this subject, the students will be able to:
2. Understand Fluid properties and their flow behavior.
3. Understand Fluid Transportation Techniques and flow measurement.
4. Understand Size Reduction principle and related machinery.
5. Understand Working of Mixing Equipment's and conveyors

COURSE CONTENTS

Unit-1: INTRODUCTION TO FLUIDS (05 Periods)

Properties of fluids- Density and viscosity, Vapor pressure and surface tension, cohesion and adhesion, Hydrostatic Pressure. Types of Fluids- Ideal and Real fluids, Compressible and Incompressible Fluids (liquid), Newtonian and Non-Newtonian fluids (rheology of fluids) and Newton's Law of Viscosity.

Types of Fluid flow: Streamline flow, steady and unsteady state flow, uniform and non- uniform flow, Reynold Number, Elementry knowledge of laminar and turbulent flow.

Experiment:

Ex 1. Determination of Density using Density Bottle and Hydrometer.

Ex 2. To measure the viscosity of different liquids (Ford cup)

Unit-2: PRESSURE MEASUREMENTS AND FLOWMETERS (05 Periods)

Pressure: Types of Pressure, Atmospheric, Gauge & Absolute Pressure, Barometric Leg List of Pressure measuring devices: U-Tube Manometer –computation of Pressure difference using U-Tube manometer - Inclined Manometer –Simple Problems in U-Tube manometer. Basic law of Bernoulli theorem and its application: Orifice meter, venturimeter, pitot tube, rotameter. Definition:-Cofficient of contraction, Coefficient of velocity, coefficient of discharge.

Experiment:

Ex3. Study Sketch and Demonstration of U-Tube Manometer.

Ex4. To determine the co-efficient of discharge of orifice-meter.

Ex5. To determine the co-efficient of discharge of venturimeter

UNIT-3: PIPE, FITTING AND VALVES & TRANSPORTATION OF FLUIDS (08 Periods)

Type of Pipes, Standard sizes of pipes on the basis of Wall thickness, Difference between Tube and Pipe Joints and fittings, Gate valve, Globe valve, Ball valve, Needle valve, Non return value, Butterfly valve, Diaphragm valve, Control Valves, Solenoid Operating Valves. Pumps- Classification of Pumps, Centrifugal Pump: Parts of centrifugal pump, working of Centrifugal pump, riming, Cavitation, Net Positive Suction Head (NPSH). (derivation excluded). Positive displacement Pump: Reciprocating pumps based on Fluid Handling and based on action of piston/plunger, Construction & working of Gear pump, Rotary Pump, Diaphragm pump, Screw pump.

Experiment:

Ex 6. Study Sketch and Demonstration of centrifugal pump.

Ex 7.Study-Sketch or Demonstration of Reciprocating Pumps/gear pump

Unit-4: CHARACTERISATION OF SOLID PARTICLES: (04 Periods)

Concept and role of unit operation in Industries, Characterization of solid particles, screening equipment, standard screens.

Experiment:

Ex 8 To analyze the given sample on a set of screens and report the analysis

Unit-5: MECHANICAL SEPARATIONS AND MIXING EQUIPMENTS: (06 Periods)

Types of filtration equipment, their application and operation, sand filters, filter-press, leaf-filters, rotary filters, filter aids. Centrifugal filtration, Classifiers ,Cyclones and cyclone separators Mixing equipment's used for liquid-liquid, liquid-solid and liquid-gas system.

Experiments:

Ex.9 To find the rate of filtration with the help of filter press.

Ex.10 To perform an experiment on rotary vacuum filter and find rate of filtration

Ex.11 To perform an experiment on cyclone separator

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INSTRUCTIONAL STRATEGY

The teacher should give small assignments to the student. Give industrial-based practical problems for fluid mechanics and solid handling.

MEANS OF ASSESSMENT

Assignments and quiz/class tests

Mid-term and end-term written tests

RECOMMENDED BOOKS

Unit Operations of Chemical Engineering by McCabe, Smith; McGraw Hill

Introduction to Chemical Engineering by Badger & Banchero; McGraw Hill

Chemical Engineering Volume-1 by Richardson & Coulson; Pergamon Press

Mechanical Operations by Swain Palra, G.K. Roy, Tata McGraw Hill Publication

Mechanical Operations by Kiran D. Patil, Nirali Publication

Chemical Engineering, Vol. I and II by Coulson and Richardson, Pergamon Press Publication

Unit Operation of Chemical Engineering by McCabe and Smith; McGraw Hill Publication

Introduction to Chemical Technology by Badger and Banchero, McGraw Hill Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	05	20
2	05	20
3	08	30
4	04	10
5	06	20
Total	**28**	**100**

PRACTICAL	3.6 PLASTICS PROCESSING TECHNOLOGY LAB	L	T	P
		-	-	6

COURSE OBJECTIVE

The practical component of this course is designed to provide students with hands-on experience in operating various plastic processing machines and equipment. It enables them to apply theoretical knowledge in real-world settings and develop technical competencies in key moulding processes. Practical exposure enhances understanding of process parameters, material behavior, equipment operation, and defect analysis. This experience prepares students for professional roles in polymer processing and related industries by fostering both skill and confidence in manufacturing environments.

COURSE OUTCOME

CO1: Operate and demonstrate the compression moulding machines and understand the moulding cycle parameters.

CO2: Identify and assemble major components of an injection moulding machine and perform moulding of thermoplastics and thermosets.

CO3: Conduct blow moulding experiments and interpret the effects of parison design and process variables on the final product quality.

CO4: Perform extrusion and thermoforming operations and assess the impact of heating techniques and material draw ratios.

CO5: Analyze defects in moulded parts, identify root causes, and suggest suitable troubleshooting methods.

LIST OF EXPERIMENTS

1. **Study and Operation of Compression Moulding Machine**
   - Understand machine components
   - Perform a basic compression moulding cycle using thermoset materials
2. **Injection Moulding of Thermoplastics**
   - Identify machine parts and functions
   - Produce a plastic part and study the effect of cycle parameters
3. **Extrusion Process for Thermoplastics**
   - Operate single-screw extruder
   - Extrude simple profiles and assess output consistency
4. **Blow Moulding Process**
   - Perform extrusion blow moulding
   - Study the influence of blow-up ratio and parison design

5. **Thermoforming Techniques**
    - Carry out vacuum forming using plug assist and straight vacuum techniques
    - Analyze effect of heating method and draft angle
6. **Rotational Moulding**
    - Demonstrate the batch-type rotational moulding process
7. **Plastic Joining Techniques**
    - Study of ultrasonic welding and vibration welding
    - Evaluate joint strength and surface finish
8. **Troubleshooting in Plastic Processing**
    - Identify and analyze common moulding defects
    - Suggest corrective measures based on process observation

Textbook

1. Crawford, R.J. – Plastics Engineering, Butterworth-Heinemann, 3rd Edition, 2011.(Covers fundamental and advanced plastic processing techniques including injection, blow, rotational moulding, extrusion, and thermoforming.)
2. Processing of Plastics by SK Nayak,RT Nagrelli

Reference Books:

1. Strong, A. Brent – Plastics: Materials and Processing, Pearson Education, 3rd Edition, 2006. (Provides a comprehensive overview of plastic materials, processing methods, and industrial applications.)
2. Rosato, D.V. and Rosato, D.V. – Injection Molding Handbook, Springer, 3rd Edition, 2000. (A detailed guide on injection moulding machines, process parameters, and troubleshooting.)
3. Ghosh, P. – Polymer Science and Technology of Plastics and Rubber, Tata McGraw-Hill, 2nd Edition, 1998. (Offers foundational knowledge of polymers with emphasis on processing and structure-property relationships.)
4. Brydson, J.A. – Plastics Materials, Butterworth-Heinemann, 8th Edition, 2007 (A classic reference text on plastic material types, processing behaviors, and selection guidelines.)

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	12	15
2	12	15
3	12	15
4	12	15
5	12	10
6	12	10
7	12	10
8	12	10
Total	96	100

THEORY	4.1 TESTING OF PLASTICS & RUBBERS	L	T	P
		2	-	-

COURSE OBJECTIVE

This course provides essential knowledge and practical skills for evaluating the mechanical, thermal, rheological, electrical, optical, and chemical properties of polymers. Accurate testing is vital for material selection, quality control, and product development. By understanding standard test methods and equipment, students are prepared to meet industry demands in polymer processing and application.

COURSE OUTCOME

CO1: To gain knowledge on how the plastics materials are tested for its mechanical, thermal, and permanence properties.

CO2 Able to identify the plastic materials for some specified applications based on their properties.

CO3 Understanding the Thermal properties and their testing

CO4: Analyse polymers' flow and deformation behaviour through rheological methods such as Melt Flow Index, Mooney Viscometer, and Oscillating Disc Rheometer.

CO5: Evaluation of electrical and optical properties of polymers, including dielectric strength, arc resistance, light transmittance, haze, and gloss using appropriate testing instruments and procedures.

CO6: Assess the chemical resistance and stability of polymers through solvent stress cracking, ESCR tests, and determination of volatile and ash content

COURSE CONTENT

UNIT I : MECHANICAL PROPERTIES OF POLYMER (Periods – 8)

Tensile strength - Stress curve - Equipment and procedure - Tear Resistance and procedure - Impact strength - Izod – Charpy – Falling dart equipment and procedure – Abrasion resistance (DIN method) - Equipment and procedure – Rebound resilience - Equipment and procedure, Hardness Testing By Shore A and D

Unit II : THERMAL PROPERTIES OF POLYMER (Periods – 5)

Thermal properties: Heat distortion Temperature (HDT), Vicat Softening Point (VSP), Thermal Expansion Flammability tests: - Limiting oxygen index – Horizontal burning method

Unit III: **RHEOLOGICAL PROPERTIES OF POLYMER** (Periods – 5)

Rheological Properties: Melt Flow Index – equipment and procedure – Mooney Viscometer - Oscillating Disc Rheometer - equipment and procedure.

Unit IV: ELECTRICAL AND OPTICAL PROPERTIES OF POLYMER (Periods – 6)

Electrical properties: Requirements of an insulator – Dielectric strength (Step by step method) – equipment and procedure – Factors affecting Dielectric strength. – Arc resistance – equipment and procedure. Optical properties: Light Transmittance and Haze – equipment and procedure – Gloss – equipment and procedure.

UNIT –V : CHEMICAL PROPERTIES (Periods – 8)

Chemical properties: Solvent stress cracking resistance – equipment and procedure – Environmental Stress **Cracking** Resistance (ESCR) – equipment and procedure, Volatile Content, Ash Content,

Instructional Strategy

1. To help students learn and appreciate new concepts and principals, teachers should provide examples from daily life, realistic situations and real-world engineering and technological applications.
2. The demonstration can make the subject exciting and foster the student's scientific mindset.
3. ICT tools must be used to deliver the content more attractively so that the attention of the learners is drawn and will create a curiosity in them to understand the content in a better way.
4. Industrial visit can be arranged to make the students realise the application of theoretical knowledge gained in the classroom.

MEANS OF ASSESSMENT

Assignments and quiz/class tests
Mid-term and end-term written test

Reference

Text Book

1. Textbook on Fundamentals of Plastics Testing - Prof. (Dr.) S.K..Nayak
2. Handbook of Plastics Testing Technology (Society of Plastics Engineers Monographs),Vishu Shah (Author) 2nd Revised edition, Wiley–Blackwell 18 November 1998

Reference

1. Simple Methods for Identification of Plastics, Dietrich Braun (Author)4th Revised ed., Carl Hanser Verlag GmbH & Co 4 April 2013

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	08	25
2.	05	15
3.	05	15
4.	06	20
5.	08	25
Total	**28**	**100**

PRACTICUM	4.2 HEAT AND MASS TRANSFER	L	T	P
		2	-	2

COURSE OBJECTIVES

Most of the Chemical Engineering operations will involve heat and mass addition or heat and mass removal in one way or the other. It is, therefore, extremely necessary to have good understanding about the heat and mass transfer mechanisms. This subject enables the students to apply this knowledge for understanding the performances of various heat transfer and mass equipment such as heat exchangers, condensers, evaporators, distillation, boiling point diagrams, extraction operation, humidification and drying processes etc. used in almost all chemical and related industries. The subject has experiments as well, to be aware of the facts involved in actual process.

COURSE OUTCOMES

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

CO 1:To understand different mode of heat transfer, conduction, convection and radiation

CO 2: Analyze heat exchanger performance using LMTD and use it for parallel or counter flow Recognizer various type of heat exchanger working principle, and basic geometries of heat exchanger.

CO 3; Understand the concept of boiling, condensation and evoparation

CO 4: To know the concept of rate of mass transfer diffusion and distillation

CO 5: To know the concept of Humidification, extraction and drying

COURSE CONTENTS

UNIT 1- MODE OF HEAT TRANSFER: (6 PERIODS)

Conduction, Convection and Radiation, Fourier's Law, Thermal conductivity, one dimensional steady state heat conduction through a plane wall and composite wall, Insulation and insulating materials, critical thickness of insulation, physical properties of insulating materials Natural and Forced convection, Individual heat transfer coefficients and overall heat transfer coefficients. dimensional analysis and significance of various dimensional groups such as Reynolds number, Prandtl number, Nusselt number, Grasshof number.

Reflection, absorption and transmission of radiation, Emmisive power, Wein’s displacement law, Stefan Boltzmann Law, Planck’s law, Kirchhoff’s law, Concept of black body, Grey body.

Experiment:

1. To determine the thermal conductivity of metal rod.
2. To determine thermal conductivity (insulating powder) by measuring apparatus.
3. To determine heat transfer coefficient, laboratory scale set up- Natural and forced convection apparatus

UNIT 2- HEAT EXCHANGERS : (3 PERIODS)

Introduction, classification, individual and overall heat transfer coefficient, fouling factor, LMTD for parallel and counter current heat exchangers, construction and description of:- Concentric double pipe, Shell and tube (1-1 heat exchanger and 1-2 heat exchanger), Plate type heat exchanger, Basic of extended surface equipment (fins) and its application.

Experiment:

Laboratory- scale shell and tube heat exchangers apparatus setup.

Laboratory- scale double pipe heat exchanger for heat transfers coefficient apparatus setup.

UNIT 3- **BOILING & CONDENSATION, EVAPORATORS:** (4 PERIODS)

Interface, bubble and film boiling, boiling regime (boiling curve), Concept of condensation, types of condensation i.e. drop wise and film wise condensation Evaporation Capacity, Evaporation Economy (steam economy), construction and description of open pan, long type vertical evaporator, and agitated thin film evaporator, multiple effect evaporator, feeding arrangements- forward, backward, mixed and parallel feed.

Experiment:

To study and the construction of an open pan evaporator.

Laboratory scale single effect evaporator setup

UNIT 4- DIFFUSION AND DISTILLATION: (8 PERIODS)

Definition of diffusion, Rate of diffusion in Mass Transfer, Fick's law, diffusion in the gas phase-Equimolecular counter diffusion, diffusion through a stationary gas (Stefan's Law), Mass. Transfer Coefficient. DISTILLATION: Various distillation methods:- Equilibrium or flash distillation, Differential distillation, Batch distillation, Vacuum and Steam distillation, Azeotropic and Extractive distillation. Bubble cap plate column Vapor liquid equilibrium diagram, Raoult's law; Relative volatility, constant boiling mixtures, equilibirium diagram and construction of equilibrium diagram, Fractionating column calculation- Heat & material balance, Reflux ratio, equilibrium plate, Location of feed plate. Sub cooled reflux; effect of reflux ratio, Total reflux, Minimum reflux ratio Entrainment; Mc-Cable Thiele diagram-section above and below feed plate; Intersection of operating line. Location of q-line, optimum reflux ratio, calculation of no. of equilibrium plate by Mc-Cable Thiele diagram.

Experiment:

8: Solid and liquid diffusion apparatus

9: Distillation packed column apparatus setup

UNIT 5- HUMIDIFICATION, EXTRACTION AND DRYING (7 PERIODS)

Determination of (1) Humidity (2) Percentage humidity (3)Relative humidity (4) Humid volume (5) Humid heat (6) bulb and wet bulb temperature (7) Adiabatic saturation temperature (8) Use of Humidity chart (9) Dew point temperature. Construction and description of cooling towers. (Natural and induced draft}

EXTRACTION : Applications of extraction, Choice of solvent, Steps of extraction operation, Solid Liquid extraction, construction and description of Moving Bed type oil seed extractor. Liquid extractor; description and construction of Mixer settler extraction system. Drying : General drying behavior- Critical moisture content, equilibrium moisture content: Description and construction of dryer: Tray & Rotary dryer.

Experiment:

10.To measure humidity and temperature using wet bulb thermometer.

11. Liquid liquid extrtactor laboratory -scale setup.

12. Laboratory scale tray dryer setup

13. Laboratory scale cooling tower setup.

INSTRUCTIONAL STRATEGY

Instructional Strategy

1. To help students learn and appreciate new concepts and principals, teachers should provide examples from daily life, realistic situations and real-world engineering and technological applications.
2. The demonstration can make the subject exciting and foster the student's scientific mindset.
3. ICT tools must be used to deliver the content more attractively so that the attention of the learners is drawn and will create a curiosity in them to understand the content in a better way.
4. Industrial visit can be arranged to make the students realise the application of theoretical knowledge gained in the classroom.

MEANS OF ASSESSMENT

Assignments and quiz/class tests

Mid-term and end-term written tests

RECOMMENDED BOOKS

Mass Transfer Operations by Treybal, Kogakusha Publication

Introduction to Chemical Engineering by Badger and Banchero, McGraw Hill Publication

Unit Operation of Chemical Engineering by McCabe and Smith; McGraw Hill Publication

Chemical Engineers Handbook by Perry and Chilton, McGraw Hill Publication

Mass Transfer Operations by Kiran D. Patil, Nirali Publication

Heat Transfer by Chapman, MacMillan Publication.

Process Heat Transfer by Kern, McGraw Hill Publication.

Heat Transfer by McAdams, McGraw Hill Publication.

Heat Transfer by KA Gavahane, NiraliPublications.

Process Heat Transfer by Kern DQ, McGraw Hill Book, New York

Heat Transfer Principles and Applications by K Dutta; Prentice Hall, India.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	06	23
2	03	13
3	04	15
4	08	27
5	07	22
Total	**28**	**100**

PRACTICUM	4.3 RUBBER MANUFACTURING TECHNOLOGY	L	T	P
		2	-	4

COURSE OBJECTIVES

This course is to provide students with a comprehensive understanding of the types, properties, processing, and applications of natural and synthetic rubber. The course aims to impart knowledge on rubber compounding, vulcanization, processing technologies, and product manufacturing methods used in the rubber industry. It also focuses on practical laboratory skills related to the identification, processing, and testing of rubber materials.

COURSE OUTCOME

CO1: Describe the sources, extraction, and processing methods of natural rubber and explain the production and properties of various synthetic elastomers.

CO2: Identify and differentiate between natural and synthetic rubbers using standard laboratory tests.

CO3: Understand the principles of rubber compounding and evaluate the role of various compounding ingredients in determining rubber properties.

CO4: Analyze the process of sulphur and non-sulphur vulcanisation and assess different vulcanisation systems (CV, semi-EV, EV) for industrial applications.

CO5: Demonstrate knowledge of rubber processing techniques including mastication, mixing, extrusion, moulding, calendaring, and curing.

CO6: Apply processing methods to manufacture rubber products such as tyres, hoses, seals, footwear, and coated fabrics.

CO7: Conduct practical experiments involving rubber mastication, compounding, vulcanisation, and sheet production to gain hands-on experience.

COURSE CONTENT

UNIT I : NATURAL RUBBER &SYNTHETIC ELASTOMERS (Periods – 07)

Tapping latex, Processing of Latex - Dry rubber production (Smoked sheet, air dried sheet, Crepe etc.) Grading of rubbers - Modified natural rubber, Reclaimed rubber - process of reclamation – applications. Manufacturing, structure, properties, compounding, curing and applications - Polyisoprene, Polybutadiene, SBR, EPDM, Butyl rubber, Neoprene, Nitrile rubber, Silicone rubber, Fluoroelastomer, Polysulphide rubber, polyurethane rubber, Acrylic rubber.

List of experiments:

1. Identification of NR
2. Identification of BR, SBR

UNIT II RUBBER COMPOUNDING AND VULCANISATION (Period- 07)

Compounding Design and Vulcanisation Sulphur vulcanisation and non-sulphur vulcanisation, vulcanisation systems Conventional, semi-efficient, Efficient - Role of compounding ingredients: fillers, plasticisers, accelerators, activators, promoters, antioxidants, antiozonants, processing aids, fillers and effect of fillers, Blowing agents, etc.

List of experiments:

1. Vulcanisation of Rubber
2. Different Vulcanisation processes: Conventional, semi-efficient, Efficient.

UNIT III RUBBER PROCESSING TECHNOLOGY (Periods – 07)

Mastication – Softening rubber by mechanical shearing. Mixing and compounding techniques using internal mixers (like Banbury) or open mills. moulding methods: compression, transfer. For making profiles, tubes, and sheets. Injection, Extrusion, and calendaring processes to produce thin sheets or rubber-coated fabrics. Curing presses and autoclaves

List of experiments:

1. Mastication of natural rubber
2. Mixing of rubber compound with carbon black, sulfur, and accelerators
3. Produce thin rubber sheets or fabric coating.

UNIT IV RUBBER PRODUCT MANUFACTURING (Periods – 07)

Design and manufacturing of rubber products, Manufacturing of Belting, Hoses, Footwear, Rubber metal bonded items, sports goods, cellular rubber, tyres etc.

List of experiments:

1. To create profiles (e.g., tubes, rods, seals).
2. To Mould rubber into shaped products under heat and pressure
3. To produce thin rubber sheets or fabric coating.

Instructional Strategy

1. To help students learn and appreciate new concepts and principals, teachers should provide examples from daily life, realistic situations and real-world engineering and technological applications.
2. The demonstration can make the subject exciting and foster the student's scientific mindset.
3. ICT tools must be used to deliver the content more attractively so that the attention of the learners is drawn and will create a curiosity in them to understand the content in a better way.
4. Industrial visit can be arranged to make the students realise the application of theoretical knowledge gained in the classroom.

Text Books:

1. Kothandaraman B, Rubber Materials, Ane Books, 2008.
2. Rubber Products Manufacturing Technology, Anil K. Bhowmick, Malcolm M. Hall, Henry Benary Publisher: Taylor & Francis
3. Brydson J, Rubber Chemistry, Butterworths, 1978

References:

1. Morton, M.; Rubber Technology, Chapman Hall, 1995.
2. C.M. Blow - Rubber Technology and Manufacture - Butterworths Publication- 1971.
3. G. Alliger - Vulcanisation of Elastomers - Reinhold Publishing co. 1965.
4. Franta, I; Elastomers and Rubber Compounding Materials, Elsevier, 1989.
5. Dick. J.S., Rubber Technology Compounding and Testing for Performance, Hanser Publisher, 2001
6. Analysis of rubbers – Lab manual

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	07	25
2.	07	25
3.	07	30
4.	07	20
Total	**28**	**100**

THEORY	4.4 ADDITIVES AND COMPOUNDING	L	T	P
		2	-	2

INTRODUCTION

Polymer Additives and Compounding is a critical subject in the field of polymer science, directly linking the chemical structure of materials with their performance, manufacturability, and real-world functionality. This topic serves as a bridge between polymer synthesis and application, enabling students to understand how raw polymers are transformed into functional, commercially viable products.

COURSE OUTCOME

CO1: Understand and differentiate the various types of polymer degradation, such as thermal, mechanical, photo, oxidative, and hydrolytic, with relevant industrial examples.

CO2: Explain the importance, classification, and functionality of various polymer additives, including antioxidants, UV stabilisers, heat stabilisers, and processing aids.

CO3: Classify and compare different types of fillers and reinforcing materials, including natural and synthetic fibres, and evaluate their impact on polymer properties.

CO4: Understand Selection of Polymers and Compounding ingredients, General objectives, possibilities, and limitations of mixing and Compounding Equipment

CO5: Understand the principles and operational mechanisms of various compounding and mixing machineries such as two-roll mills, internal mixers, and extruders.

CO6: Apply **theoretical** knowledge in selecting appropriate additives and fillers to meet desired polymer performance characteristics in real-world applications.

COURSE CONTENT

UNIT I POLYMER DEGRADATION (07 PERIODS)

Polymer degradation - Types of degradation: Thermal degradation - Thermal degradation of PVC - Mechanical degradation – Mastication of NR, Photo degradation - Photo degradation of PMMA, Oxidative degradation – Oxidative degradation of PP - Hydrolytic degradation Importance of compounding additives – Requirement of additives – Classification of additives (Functional, Process, Modifier and Miscellaneous) – Antioxidants – Antiozonants – UV absorber – UV stabiliser – Heat stabiliser and its classification.

Experiment –

1. Understanding the Thermal degradation of PVC products
2. Processing of Plastics Using Plasticisers

UNIT II FILLERS AND REINFORCEMENTS (07 PERIODS)

Types of fillers: Based on source – Based on reinforcement – Based on colour – Types of carbon black - Fibres – Types of fibres: Based on source – Natural fibre- Sisal fibre, Synthetic fibre Glass fibre and its types – Carbon fibre and its types – Aramid fibre and its types – Nano filler vs conventional filler

Experiment –

1. Processing of Plastics using glass fibre
2. Processing of plastics using Natural Fibre

UNIT III PROCESSING AND CURING AADDITIVES (08 PERIODS)

Plasticiser and its role – Types of PLASTICISERS - Miscellaneous additives (Definition and example only): Flame retardant – Blowing agents – Impact modifier – Antistatic agent – Colourants. Curing system: Definition of Crosslinking – Vulcanising agents for rubbers – Accelerators and their types – Activator for rubbers.

Experiment –

1. Processing of Plastics using Blowing agent
2. Vulcanisation of Rubber

UNIT IV COMPOUNDING MACHINERIES (06 PERIODS)

Mixing vs Compounding – Two Roll Mill – Internal MIXER: Twin screw extruder – Banbury – Kneader – Ribbon Blender – Ball Milling

Experiment –

1. Operation of Two Roll Mill
2. Operation of Internal Mixer
3. Operation of Ball Mill

Instructional Strategy

1. To help students learn and appreciate new concepts and principals, teachers should provide examples from daily life, realistic situations and real-world engineering and technological applications.
2. The demonstration can make the subject exciting and foster the student's scientific mindset.
3. ICT tools must be used to deliver the content more attractively so that the attention of the learners is drawn and will create a curiosity in them to understand the content in a better way.
4. Industrial visit can be arranged to make the students realise the application of theoretical knowledge gained in the classroom.

Text Books:

Holloway - Composite materials – Elsevier, Amsterdam, 1966.

References:

1. Brian Parkyn – Glass Reinforced Plastics , 1970.
2. Gibbs & Cox – Marine Design Manual for FRP- McGraw Hill Book Co. – 1960.
3. P.Ghosh – Fiber science and technology – Tata McGraw-Hill, New Delhi, 2004
4. Geoffery Pritchard – Reinforced Plastics Durability – Wood head Publishing – 2000
5. R.H.Sonneborn - Fiberglass Reinforced Plastics – Reinhold, New York, 19

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted(%)
1	14	25
2	14	20
3	16	35
4	12	20
Total	56	100

PRACTICAL	4.5 TESTING OF PLASTICS & RUBBERS (LAB)	L	T	P
		-	-	6

COURSE OBJECTIVE

The performance and application of polymer materials greatly depend on their physical, mechanical, thermal, electrical, and chemical properties. This laboratory course is designed to provide hands-on experience in standard testing methods used to evaluate these properties. Through practical exposure to instruments like UTM, MFI tester, durometers, and impact testers, students will develop the technical skills required for quality control, product validation, and material selection in the polymer industry. This practical training bridges theoretical knowledge with real-world industrial practices, preparing students for careers in polymer manufacturing, testing, and research

COURSE OUTCOME

CO1: Use standard equipment to conduct tests to determine mechanical properties such as tensile strength, impact resistance, and hardness .
CO2: Evaluate thermal properties and flammability behaviour of polymers using appropriate methods.
CO3: Perform rheological testing such as Melt Flow Index (MFI) to assess processability.
CO4: Measure electrical and optical properties of polymers and interpret their industrial relevance.
CO5: Analyse chemical properties including ESCR, carbon black content, and ash content for quality assurance.
CO6: Apply BIS standards for product testing and relate experimental results to real world applications.

LIST OF EXPERIMENTS

1. Determination of Melting Point of polymers
2. Measurement of Tensile Strength using a Universal Testing Machine
3. Impact Strength Testing of plastics (Izod and Charpy methods)
4. Determination of Falling Dart Impact Strength
5. Measurement of Melt Flow Index (MFI)
6. Evaluation of Electrical Properties (e.g., Dielectric Strength, Arc Resistance)
7. Hardness Testing using Shore A and Shore D durometers
8. Study on the Effect of Temperature on the compression set of rubber
9. Measurement of Rebound Resilience of polymers
10. Determination of Environmental Stress Cracking Resistance (ESCR)
11. Determination of Ash Content in polymer samples

MEANS OF ASSESSMENT
Practical Experiments

Reference

Text Book

I. .Textbook on Fundamentals of Plastics Testing - Prof. (Dr.) S.K..Nayak
II. Handbook of Plastics Testing Technology (Society of Plastics Engineers Monographs),Vishu Shah (Author) 2nd Revised edition, Wiley–Blackwell 18 November 1998

Reference

III. Simple Methods for Identification of Plastics, Dietrich Braun (Author)4th Revised ed., Carl Hanser Verlag GmbH & Co 4 April 2013

PROGRAM ELECTIVE -1

THEORY	4.6 (a) RUBBER MATERIALS	L	T	P
		2	-	-

Course Objectives

To study the manufacturing technology, properties and applications of various elastomers. The concepts of flexible polymer chains and their influence on the properties of rubber. Appreciate the influence of chemical structure on various properties of elastomer. Acquire basic knowledge on Natural Rubber, properties and its applications. Familiar with the preparation, properties and application of various synthetic rubbers.

COURSE OUTCOMES

CO1 After successful completion of this course, the students should be able to understand different rubbers

CO2 Select a rubber for a given application based on its properties

CO3 Differentiate the various categories of rubber

CO4 Understand the applications of various rubbers

CO5 Identify different rubbers by chemical method

Unit I : GENERAL PURPOSE RUBBER (Period – 12)

Natural Rubber: NR Latex – Composition – Conversion of NR Latex into Ribbed Smoked Sheet, Pale crepe and Brown crepe – Vulcanisation - Properties of dry rubber an Applications – Strain induced crystallisation - NR vs IR. BR: Structure – Types Manufacture of BR - Properties and Applications SBR: Structure - Types – Manufacture of emulsion SBR and solution SBR - Properties and Applications. EPDM: Structure – Dienes – Manufacture of EPDM - Properties and Applications.

Unit II : **SPECIALITY RUBBERS (Period – 10)**

Selection criteria for the special-purpose rubbers for various applications. Butyl rubber – Structure – Manufacture of IIR - Properties and Applications. Chloroprene rubber – Structure – Manufacture of CR - Properties and Applications. Nitrile Rubber – Structure – types – Manufacture of NBR - Vulcanization - Properties and Applications Silicone - Structure – Liquid silicone rubbers – Properties - silicones in medical applications

Unit III: HIGH PERFORMANCE RUBBER (Period – 06)

Structure, Properties and Applications (only) of Fluoro rubbers - Ethylene–Vinyl Acetate (EVA) copolymers – Elastomers based on modified polyethylene – Acrylate rubbers – Polysulphide rubbers and Polyurethanes. Introduction to Thermoplastic elastomers based on Plastics–Rubber Blends.

Instructional Strategy

1. To help students learn and appreciate new concepts and principals, teachers should provide examples from daily life, realistic situations and real-world engineering and technological applications.
2. The demonstration can make the subject exciting and foster the student's scientific mindset.
3. ICT tools must be used to deliver the content more attractively so that the attention of the learners is drawn and will create a curiosity in them to understand the content in a better way.
4. Industrial visit can be arranged to make the students realise the application of theoretical knowledge gained in the classroom.

RECOMMENDED BOOKS

1. Morton, M.; Rubber Technology, Chapman Hall, 1995.
2. C.M.Blow - Rubber Technology and Manufacture - Butterworths Publication-1971.
3. G.Alliger - Vulcanization of Elastomers - Reinhold Publishing co. 1965.
4. Franta, I; Elastomers and Rubber Compounding materials, Elsevier, 1989.
5. Dick. J.S., Rubber Technology Compounding and testing for Performance, Hanser Publisher, 2001
6. Analysis of rubbers – Lab manual
7. Kothandaraman B, Rubber Materials, Ane Books, 2008.
8. Brydson J, Rubber Chemistry, Butterworths, 1978

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	12	40
2	10	35
3	06	25
Total	28	100

PROGRAM ELECTIVE -1

THEORY	**4.6 (b) MATERIAL SCIENCE AND ENGINEERING**	L	T	P
		2	-	-

INTRODUCTION

This course provides an in-depth understanding of the structure, properties, and applications of various engineering materials with a special focus on rubbers and polymers. Students will learn how to relate material properties to their structure and processing behaviour, with practical applications in rubber product manufacturing and design.

COURSE OBJECTIVE

1. Understand the structure-property relationships of metals, polymers, ceramics, and composites.
2. Gain knowledge of crystalline and amorphous structures in materials.
3. Learn about mechanical, thermal, and electrical behaviours of rubber and polymer materials.
4. Identify the causes of material degradation and how to select appropriate materials for applications.
5. Apply testing methods to evaluate and compare the performance of materials.

DETAILED CONTENT

UNIT-I: INTRODUCTION & STRUCTURE OF METALS (Periods-08)

Scope of Material Science, Overview of different engineering materials and applications, Classification of materials, Thermal, Chemical, Electrical, Mechanical properties of various materials Crystallography Fundamentals: Crystal, Unit Cell, Space Lattice, Arrangement of atoms in Simple Cubic Crystals, BCC, FCC and HCP Crystals, Number of atoms per unit Cell, Atomic Packing Factor. Deformation: Overview of deformation behaviour and its mechanism, behaviour of material under load control and strain control. Failure Mechanisms: Overview of failure modes, fracture, fatigue and creep.

UNIT-II NON-METALS & ADVANCED MATERIALS (Periods-8)

Inorganic materials: Ceramics, Glass and refractories - organic materials: wood, plastics, and rubber. Advanced materials: Biomaterials, nano-materials and Metal Matrix composites. Ceramics-Classification, properties, applications- Adhesives: Classification, properties and applications, Smart materials - properties and applications.

UNIT-III HEAT TREATMENT: (Periods-06)

Purpose of heat treatment, Solid solutions and their types, Formation and decomposition of Austenite, Martensite Transformation – Simplified Transformation Cooling Curves. Various heat treatment processes-hardening, tempering, annealing, normalising, case hardening, and surface hardening. Hardenability of steels, Selection of case carburising and induction hardening steels. Types of heat treatment furnaces (only basic idea)

Unit IV: **MATERIALS SELECTION AND APPLICATIONS** (Periods-06)

Selection Criteria: Design considerations, environmental and economic factors. Applications: Materials used in aerospace, automotive, electronics, and biomedical fields. Smart Materials

Instructional Strategy

1. To help students learn and appreciate new concepts and principals, teachers should provide examples from daily life, realistic situations and real-world engineering and technological applications.
2. The demonstration can make the subject exciting and foster the student's scientific mindset.
3. ICT tools must be used to deliver the content more attractively so that the attention of the learners is drawn and will create a curiosity in them to understand the content in a better way.
4. Industrial visit can be arranged to make the students realise the application of theoretical knowledge gained in the classroom.

Textbooks and References

Textbooks:

1. Materials Science and Engineering – V. Raghavan
2. Callister's Materials Science and Engineering – William D. Callister
3. Polymer Science – V.R. Gowariker
4. Introduction to Rubber Technology – Maurice Morton

References:

1. Rubber Technologist's Handbook – S. Blow
2. Essentials of Materials Science and Engineering – Donald R. Askeland
3. Engineering Materials – Kenneth G. Budinski & Michael K. Budinski

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	08	30
2	08	25
3	06	25
4	06	20
Total	28	100

PROGRAME ELECTIVE -2

THEORY ELECTIVE -1	4.7 (a) BIODEGRADABLE POLYMERS	L	T	P
		2	-	-

COURSE OBJECTIVE

This course enables students to gain knowledge about different types of biopolymers, their unique properties, and diverse applications. Biopolymers are increasingly utilized in fields such as agriculture, pharmaceuticals, medicine, and packaging due to their eco-friendly characteristics. By supporting environmentally sustainable practices, biopolymers contribute to reducing the environmental impact of traditional polymer use. Upon completing the course, students will have a solid understanding of the latest developments in polymer science and will be motivated to pursue advanced studies or research in this evolving area.

COURSE OUTCOMES

CO1 To understand the need for biopolymers

CO2 To know the various sources for biopolymers

CO3 To select and process biopolymers based on customer requirements.

CO4 To explore the applications of biopolymers in packaging

CO5 To discover the applications of biopolymers in agriculture.

COURSE CONTENT

Unit I INTRODUCTION (Periods – 09)

Sources for Polymers – Sustainability of Petroleum resources - Need for Alternate – Polymer Recycling and Environmental Issues – Bio derived Polymers - Biodegradation and its Evaluation techniques - Introduction to Life Cycle Assessment

Unit -II BIOPOLYMER RESOURCES (Periods – 09)

Polysaccharide based polymers – Gelatinization – Starch based blends - Biodegradation of Starch based Polymers - Production of Lactic acid and Polylactide - Properties and applications of Polylactide – Chitin & Chitosan and its derivatives as biopolymers. Plant and animal based Proteins – Solution casting of proteins – Processing of proteins as plastics – Preparation and properties of hemicellulose – Cellulose based Composites – Surface and Chemical modifications of Cellulose fibers

Unit -III APPLICATION OF BIOPOLYMER (Periods – 10)

Food Packaging – Functional Properties – Safety and Environmental aspects – Shelf life – Films and coatings in Food Applications – Materials for edible films and coatings – Biopolymer coatings for paper and paperboard –

Bio- nanocomposite films and coatings Biopolymer Films – Biodegradable mulching – Advantages and Disadvantages – Chemical sensors – Biosensors - Functionalized Biopolymer Coatings and Films – Applications of biopolymers in horticulture

Text Books:

1. David Plackett, "Biopolymers – New Materials for Sustainable films and Coatings", John Wiley & Sons Ltd, 2011

References:

1. David Kaplan, "Biopolymers from Renewable resources", Springer, 1998
2. Carmen Scholz, Richard A Gross, "Polymers from Renewable Resources: Biopolymers and Biocatalysis", American Chemical Society, 2001

Instructional Strategy

1. To help students learn and appreciate new concepts and principals, teachers should provide examples from daily life, realistic situations and real-world engineering and technological applications.
2. The demonstration can make the subject exciting and foster the student's scientific mindset.
3. ICT tools must be used to deliver the content more attractively so that the attention of the learners is drawn and will create a curiosity in them to understand the content in a better way.
4. Industrial visit can be arranged to make the students realise the application of theoretical knowledge gained in the classroom.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	9	30
2	9	30
3	10	40
Total	28	100

PROGRAME ELECTIVE -2

THEORY ELECTIVE -2	4.7 (b) SPECIALITY RUBBER AND THERMOPLASTIC ELASTOMER	L	T	P
		2	-	-

COURSE OBJECTIVE

This course explores the characteristics, processing methods, and applications of specialty rubbers and thermoplastic elastomers (TPEs). These materials are valued for their unique ability to perform in demanding conditions and for combining the flexibility of rubber with the ease of thermoplastic processing. Widely used in industries such as automotive, healthcare, electronics, and consumer products, specialty rubbers and TPEs offer both performance and versatility. The course equips students with a strong understanding of material composition, compounding, and processing techniques, while also introducing them to current innovations and industrial applications. It prepares learners for roles in polymer engineering, product design, and advanced material development.

COURSE OUTCOMES

The objective of this course is to enable the students to

CO1: Identify and classify speciality rubbers and TPEs based on their structure and applications.

CO2: Understand compounding ingredients and processing techniques.

CO3: Analyse the functional properties and performance of elastomeric materials.

CO4: Apply knowledge to suggest suitable materials for specific industrial applications.

CO5: Recognise sustainability and recycling aspects of modern elastomers.

Unit I INTRODUCTION TO SPECIALTY RUBBERS (Periods – 09)

Definition and classification, Comparison with general-purpose rubbers , Properties and applications of: Butyl rubber (IIR), Nitrile rubber (NBR), Epichlorohydrin rubber (ECO), Fluoroelastomers (FKM), Silicone rubber (VMQ), Polyurethane rubber (PU) Ethylene Vinyl Acetate Rubbers (EAM/EVA): Thermoplastic 1,2-Polybutadiene, Trans-1-4-Polyisopren Manufacturing, Properties, Processing, Compounding, Applications Vulcanizable & Thermoplastic EVA Rubber

Unit -II THERMOPLASTIC ELASTOMERS (TPES) (Periods – 09)

Definition and characteristics of TPEs, Advantages over conventional rubber, Classification of TPEs:, Styrenic block copolymers (SBC), Thermoplastic polyurethanes (TPU), Thermoplastic vulcanizates (TPV), Thermoplastic polyesters (COPE), Thermoplastic polyamides (PEBA) Introduction, Basic Structure,

Compounding & Mixing of Polyethylene, Processing, Physical Properties of Crosslinked Polyethylene, Applications of Crosslinked Polyethylene.

Unit – III PROCESSING OF TPE (Periods – 07)

Differences in processing TPES vs thermoset rubber, Troubleshooting common processing defects, Formulation techniques for speciality rubbers and TPEs, Dry Heat Aging, Humid Ageing. Unvulcanised Rubber-Plastic Blends, Properties of Blends Prepared by Dynamic Vulcanisation

Unit IV : APPLICATIONS AND TRENDS (Periods – 03)

Industrial applications in automotive, medical, electrical, and consumer goods, Sustainability and recycling of TPEs, Advances in bio-based and high-performance elastomers, Future trends in specialty elastomer development

INSTRUCTIONAL STRATEGY

1. To help students learn and appreciate new concepts and principals, teachers should provide examples from daily life, realistic situations and real-world engineering and technological applications.
2. The demonstration can make the subject exciting and foster the student's scientific mindset.
3. ICT tools must be used to deliver the content more attractively so that the attention of the learners is drawn and will create a curiosity in them to understand the content in a better way.
4. Industrial visit can be arranged to make the students realise the application of theoretical knowledge gained in the classroom.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	9	30
2	9	30
3	7	25
4	3	15
Total	28	100

OPEN ELECTIVE -1

Open Elective	4.8 (a) Renewable Energy Technologies	L	T	P
		2	-	-

COURSE 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 CONTENT

UNIT-I: Introduction: (06 Periods)

World Energy Use; Reserves of Energy Resources; Environmental Aspects of Energy Utilisation; Renewable Energy Scenario in India and around the World; Potentials; Achievements / Applications; Economics of renewable energy systems.

Unit-II: Solar energy: (06 Periods)

Solar Radiation; Measurements of Solar Radiation; Flat Plate and Concentrating Collectors; Solar direct Thermal Applications; Solar thermal Power Generation Fundamentals of Solar Photo Voltaic Conversion; Solar Cells; Solar PV Power Generation; Solar PV Applications.

Unit-III: Wind Energy: (05 Periods)

Wind Data and Energy Estimation; Types of Wind Energy Systems; Performance; Site Selection; Details of Wind Turbine Generator; Safety and Environmental Aspects.

Unit-IV: Bio-Energy: (05 Periods)

Biomass direct combustion; Biomass gasifies; Biogas plants; Digesters; Ethanol production; Bio diesel; Cogeneration; Biomass Applications.

Unit-V: Other Renewable Energy Sources: (06 Periods)

Tidal energy; Wave Energy; Open and Closed OTEC Cycles; Small Hydro-Geothermal Energy; Hydrogen and Storage; Fuel Cell Systems; Hybrid Systems.

REFERENCE BOOKS:

1. O.P. Gupta, Energy Technology, Khanna Publishing House, Delhi (ed. 2018)
2. Renewable Energy Sources, Twidell, J.W. & Weir, A., EFN Spon Ltd., UK, 2006.
3. Solar Energy, Sukhatme. S.P., Tata McGraw Hill Publishing Company Ltd., 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, GN Tiwari and MK Ghoshal, Narosa, New Delhi, 2007.
6. Renewable Energy and Environment-A Policy Analysis for India, NH Ravindranath, UK Rao, B Natarajan, P Monga, Tata McGraw Hill.
7. Energy and The Environment, RA Ristinen and J J Kraushaar, Second Edition, John Willey & Sons, New York, 2006.
8. Renewable Energy Resources, JW Twidell and AD Weir, ELBS, 2006.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	06	20
2.	06	20
3.	05	20
4.	05	20
5.	06	20
Total	**28**	**100**

OPEN ELECTIVE -1

Open Elective	4.8 (b) Internet of Things	L	T	P
		2	-	-

COURSE CONTENT

Unit I - Introduction to Internet of Things

- Define the term "Internet of Things"
- State the technological trends which have led to IoT.
- Describe the impact of IoT on society.

Unit II - Design consideration of IoT

- Enumerate and describe the components of an embedded system.
- Describe the interactions of embedded systems with the physical world.
- Name the core hardware components most commonly used in IoT devices.

Unit III-Interfacing by IoT devices

- Describe the interaction between software and hardware in an IoT device.
- Explain the use of networking and basic networking hardware.
- Describe the structure of the Internet.

SUGGESTED SOFTWARE/LEARNING WEBSITES:

1. https://www.raspberrypi.org/blog/getting-started-with-iot/
2. https://www.arduino.cc/en/IoT/HomePage
3. https://www.microchip.com/design-centers/internet-of-things
4. https://learn.adafruit.com/category/internet-of-things-iot
5. http://esp32.net/

SUGGESTED LEARNING RESOURCES

1- Internet of Things by Raj Kamal, McGraw Hill Education; First edition (10March 2017)

2- internet of Things: AHands-On Approach by Arsheep Bahge andVijay Madisetti, Orient Blackswan Private Limited - New Del-hi; First edition (2015) ISBN : 978-8173719547

AUDIT COURSE	4.9 ESSENCE OF INDIAN KNOWLEDGE AND TRADITION	L	T	P
		2	-	-

COURSE OBJECTIVES:

Understand the fundamental aspects of the Indian Knowledge System, its integration with modern science, principles of Yoga and holistic healthcare, and practical applications in contemporary contexts.

COURSE OUTCOMES

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

1. Overview, importance, and relevance of the Indian Knowledge System, including Vedas, Upavedas, Vedangas, and Upangas.
2. Relevance of science and spirituality, and contributions of ancient Indian science and technology.
3. Basic principles of Yoga, benefits of holistic healthcare, and integration with modern healthcare.
4. Practical applications and case studies of the Indian Knowledge System's relevance today.

COURSE CONTENTS

Unit 1: Introduction to Indian Knowledge System **(16 Periods)**

Overview of Indian Knowledge System

Importance and relevance

1. Introduction to the Vedas
2. Upavedas
3. Vedangas
4. Upangas

Unit 2: Modern Science and Indian Knowledge System **(06 Periods)**

1. Relevance of Science and Spirituality,
2. Science and Technology in Ancient India,

Unit 3: Yoga and Holistic Healthcare **(04 Periods)**

1. Basic principles of Yoga
2. Benefits of holistic healthcare practices
3. Integration with modern healthcare

Unit 4: Case Studies / Assignment **(02 Periods)**

Practical Applications / Case studies demonstrating the relevance of Indian Knowledge System in modern times

MEANS OF ASSESSMENT

Viva -Voce Exam

8- GUIDELINES FOR ASSESSMENT OF STUDENT-CENTRED ACTIVITIES (SCA)

It was discussed and decided that the maximum marks for SCA should be 50 as it involves a lot of subjectivity in the evaluation. The marks may be distributed as follows-

15 Marks for general behaviour and discipline
(by HODs in consultation with all the teachers of the department)

10 Marks for attendance as per following:
(by HODs in consultation with all the teachers of the department)

a) 75 - 80% 06 Marks

b) 80 - 85% 08 Marks

c) Above 85% 10 Marks

25 Marks maximum for Sports/NCC/Cultural/Co-curricular/NSS activities as per following:
(by In-charge Sports/NCC/Cultural/Co-curricular/NSS)

a) 25 - State/National Level participation

b) 20 - Participation in two of above activities

c) 15 - Inter-Polytechnic level participation

9- LIST OF EQUIPMENT

Plastics Processing LAB

Sl No	Name	Approx Cost per Unit
01	Injection Moulding Machine	2000000
02	Compression Moulding Machine	700000
03	Lab Extruder (Single Screw)	800000
04	Thermoforming	20000
05	Extrusion Blow Moulding with compressor	600000

Plastic Testing Lab

Sl No	Name	Approx Cost per Unit
01	Universal Testing Machine with Computer, load cell 100 KN Tensile and Compression specimen holder	1000000
02	HDT VSP Apparatus	200000
03	Weighing Balance with density kit	70000
04	Shore A and Shore D Hardness Tester	20000
05	IZOD Charpy impact tester	500000
07	Muffle Furnace	30000
08	Hot air Oven	15000

Rubber Manufacturing Lab

Sl No	Name	Approx Cost per Unit
01	Internal Mixer lab type with safety guard	500000
02	Oscillating Disk Rheometer	800000
03	Two Roll Mill lab type with safety guard	300000
04	Vulcanisation Press – 15 Nos	1500 Each
05	Bath Tub Stainless steel with cover	5000

Fluid mechanics and solid handling

S. N.	Equipment Name	Approx Cost per Unit
1	Density Bottles (5 ml)	600
2	Density Bottles (10 ml)	800
3	Density Bottles (100 ml)	1000
4	Hydrometer	790
5	Ostwald Viscometer /Digital Viscometer	10000
6	Redwood Viscometer /Digital Viscometer	17584
7	U-Tube manometer (For Demonstration Purposes)	1580
8	Reynolds Experiment set-up	50000
9	Bernoulli's Theorem Experiment Set-up	30000
10	Venturi Meter & Orifice Meter Experiment Set-up	35000
11	Vacuum pump with experiment set-up	20000
12	Determination of Frictional losses through pipe	55000
13	Centrifugal pumps and reciprocating pump(For Demonstration Purposes)	30000
14	Rota-meter, Venturi meter, Orifice meter, pitot tube	80000
15	Globe valve, check valves, Butterfly valve, Needle valve, Gate Valve, Diaphragm Valve	18000
16	Experiments related raw materials	50000
17	Ball Mill	75000
18	Jaw Crusher	70000
19	Sieve shaker with sieves	30000
20	Roller mill/Roll crusher	50000
21	Cyclone Separator	40000
22	Plate and frame filter press	80000
23	Mixer: Liquid-Liquid Mixer	40000
24	Solid-Liquid Mixer	40000
25	Centrifuge experimental set-up	50000
26	Ribbon Mixer	35000
27	Laboratory slurry mixture	80000
28	Experiments related raw materials.	50000

10 - List of Participants / Experts

The following experts participated in various workshop for Developing the Curriculum's Structure and Contents of **Chemical Technology (Rubber & Plastic)** at I.R.D.T. Kanpur.

1. Mr. Rakesh Kumar, Head of Department (Chemical), Government Polytechnic, Kanpur
2. Mr. Abhinav Jain, Head of Department (Chemical), Government Polytechnic, Mankeda, Agra
3. Dr. Shivcharan Prajapati, Lecturer (Paint Technology), Government Polytechnic, Bindki, Fatehpur
4. Mr. Vinod Prasad Sharma, Lecturer (Paint Technology), Government Polytechnic, Kanpur
5. Dr. Shashi Bala Gautam, Lecturer (Chemical), Government Polytechnic, Kanpur
6. Mr. Mausam Kumar, Lecturer (P.M.T.), Government Polytechnic, Kanpur
7. Mr. Devesh Srivastava, Lecturer (Chemical), Government Polytechnic, Bindki, Fatehpur
8. Mrs. Kanchan Kushwaha, Lecturer (Petro-Chemical), Government Polytechnic, Kotwan, Mathura

11 . EVALUATION SCHEME

a. For Theory Courses:

(The weightage of Internal assessment is 40% and for End Semester Exam is 60%) The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

b. For Practical Courses:

(The weightage of Internal assessment is 60% and for End Semester Exam is 40%) The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

c. For Summer Internship / Projects / Seminar etc.

Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

Note: The internal assessment is based on the student's performance in mid semester tests (two best out of three), quizzes, assignments, class performance, attendance, viva-voce in practical, lab record etc.