GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering Level: Under Graduate

Branch: Plastics Engineering

Subject Code: BE05053051

Subject Name: Circularity of Plastics

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective Course 1

Prerequisite :	□ Understanding of different types of plastics such as thermoplastics and thermosets and their basic properties. □ Basic knowledge of plastic processing techniques such as extrusion, injection moulding, blow moulding, etc. □ Awareness of plastic waste generation, segregation, and the importance of recycling and sustainability.
Rationale:	At the end of the course, the student will understand the sources of plastic waste & recycling techniques for plastic waste. The student will also have knowledge of various methods of recycling individual plastics and plastic products. They can apply this knowledge in effective waste management of plastics.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Identify the sources of plastic waste, define the terminologies and understand the life cycle of plastic waste and 4 R concept.
02	Understand and explain the separation process specific to municipal refuse and plastic waste.
03	Apply the knowledge Primary, Secondary, Tertiary & Quaternary recycling techniques for recycling of plastics.
04	Understand the Landfill techniques for disposal of plastics
05	Explain the recycling techniques specific to particular plastic and plastic products and apply this knowledge in practical field

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	00	30	15	90	03	70	30	10	10	30	150

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE

= End- Semester Examination, PA = Progressive Assessment

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Plastic Waste and Circular Economy** • Introduction to plastic waste • Definitions related to plastic waste • Sources of plastic waste • Plastics cycle: Flow of plastic products and plastic waste • Generation of industrial plastic waste • Concept of 4R (Reduce, Reuse, Recycle, Recover) • Importance of circular economy in plastics	2	6
2.	**Collection, Segregation and Separation of Plastic Waste** • Waste segregation and separation concepts • Separation of components of municipal solid refuse • Size reduction methods for waste processing **Separation Methods** • Density separation • Air classification • Magnetic separation • Electrostatic separation **Separation Processes Specific to Plastics** • Separation of paper–plastic mixtures • Separation of plastics from plastic-coated fabrics • Separation of mixed plastics • Identification and separation using recycling codes	7	20
3.	**Primary Recycling (Mechanical Recycling of Clean Waste)** • Definition and concept of primary recycling • Degradation of thermoplastics due to repetitive processing • Mechanisms of polymer degradation during recycling **Equipment Used** • Granulators and shredders • Processing of difficult materials • Cryogenic grinding technique **Reprocessing Systems** • Reprocessing of low bulk-density plastic waste • Plunger and screw type stuffers	6	15

	• In-line automatic recycling systems		
4.	**Secondary Recycling (Mechanical Recycling of Mixed Waste)** • Concept and approaches to secondary recycling • Equipment requirements for secondary recycling **Equipment for Mixed Plastic Waste Processing** • Mitsubishi Reverzer system • Klobbe machine • FN machine **Advanced Processing Methods** • Secondary recycling using co-extrusion • Secondary recycling using co-injection molding • Use of plastic waste as fillers in products	7	15
5.	**Tertiary Recycling (Chemical Recycling)** • Introduction to chemical recycling • Pyrolysis of plastics waste **Pyrolysis Systems** • Pyrolysis of municipal solid refuse • Pyrolysis reactions in plastics decomposition **Pyrolysis Reactors** • Union Carbide apparatus • Japan Steel Works Ltd. system **Chemical Decomposition Processes** • Depolymerization • Feedstock recycling • Recovery of fuels and chemicals	7	18
6.	**Quaternary Recycling (Energy Recovery)** • Concept of energy recovery from plastics • Incineration of municipal solid refuse **Incineration of Plastic Waste** • Problems associated with incineration of pure plastics • Environmental concerns **Incinerator Types** • Fluidized bed incinerators • Rotary kiln incinerators • Systems suitable for plastic waste	7	10
7.	**Recycling of Specific Plastics and Plastic Products** • Recycling of HDPE containers • Recycling of PP/HDPE woven sacks to pellets • Recycling of PE films and plastic bags • PET recycling processes • Recycling of PVC • Recycling of PS (Polystyrene)	5	8

	• Recycling of PU (Polyurethane) • Recycling of medical plastic waste		
8.	**Environmental Implications and Polymer Degradation** • Environmental impact of plastic waste • Effects of recycling on polymer properties • Polymer degradation during recycling • Sustainable waste management strategies • Role of circular economy in plastics sustainability	4	8
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	20	10	10	5	5

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Plastics Waste by Jacob Leidner
2. Plastics Fabrication and Recycling by Manas Chanda & Salil Roy
3. Introduction to Plastics recycling by Vannessa Goodship
4. Plastic Waste management Processing and Disposal by Muralisrinivasan Natamai Subramanian

(b) Open source software and website:

- https://www.pantechco.jp/english/recycling/pe/
- https://en.wikipedia.org/wiki/Plastic_recycling
- https://earth911.com/inspire/what-do-those-plastic-recycling-codes-mean/

Suggested Course Practical List:

Practical based on above topics.

List of suggested activities for Term-Work / Self-Learning:

S. No.	Activity	No. of Hours	Total Hours Claimed	Evaluation Criteria
1	Industry / Research laboratory visit	Visit = 5 h, Report preparation = 5 h	10	Based on report submitted
2	Poster / chart / power point preparation on technical topics	Duration = 10 h	10	Based on Poster / Chart / PPT preparation and presentation skills

3	Assignment writing	5 assignments of 2 h each	10	Based on the assignment submitted
4	Technical Video based learning related to the subject	Duration of video = 5 h Report preparation = 5 h	10	Report / presentation based on the video learning outcomes
5	Group Discussion on emerging / trending technical topics based on subject	Duration = 1 h each	-	Based on performance in group discussion, technical depth, knowledge, etc.
6	Attending Expert Lecture / Webinar / Seminar	Duration = 1 h each	-	Based on Short report
7	Self-learning on-line course	Minimum duration of the course should be 10 h	10	Examination based assessment at the end of course. Based on the certificate produced
8	Exhibition / Conference / Trade Fair / Industrial exposure for 2-3 days	Visit = 15 h, Report preparation = 5 h	20	Based on learning, observations and short report
9	Working model on technical topics	Working = 15 h	15	Based on design, understanding & presentation of the model
10	Non-working model on technical topics	Non-working = 5 h	5	Based on design, understanding & presentation of the model
11	Videos on Industrial safety aspects based on subject	Duration of video = 5 h Report preparation = 5 h	10	Based on report submitted

- Above activities are suggestive, faculty can choose any of these activities and cover up the rest of the 15 Self Learning Hours.
- The number of hours is suggestive.
- Faculty can sub-divide the number of hours based on the activity. However, the total number of hours is fixed.

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