GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM
RECYCLING OF PLASTIC
(Code: 3372305)

Diploma Programme in which this course is offered	Semester in which offered
Plastics Engineering	7th Semester

1. RATIONALE

Plastics are being used in practically all areas of consumer products, including construction, transportation, packaging, automobile and agriculture. In recent world more concern is on the possible damaging impact of plastics on the environment. A Plastic Diploma engineer has to identify all possible sources of plastic waste generation and do recycling of it with or without energy recovery within government norms. This competency requires the knowledge of various plastic recycling techniques. Hence the course has been designed to develop this competency and its associated cognitive, practical and affective domain learning outcomes.

2. COMPETENCIES

The course should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- Identify sources of plastic waste.
- Select suitable plastic recycling method.

3. COURSE OBJECTIVES:

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

1. Select waste disposal method.
2. Select proper separation method.
3. Identify primary and secondary recycling methods.
4. Analyze various tertiary and quaternary recycling methods.
5. Understand recycling methods of various plastics.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit **ESE** - End Semester Examination; **PA** - Progressive Assessment.

5. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
UNIT – I SOURCES OF PLASTIC WASTE AND ITS MANAGEMENT	1.a Identify sources of plastic waste 1.b Select waste disposal method	1.1 Introduction to Plastics Waste 1.2 Definitions of related terms – Waste Plastic, Industrial Plastic Waste, Postconsumer Plastic Waste, Nuisance Plastic, Scrap Plastic, Primary Recycling, Secondary Recycling, Tertiary Recycling And Quaternary Recycling 1.3 Economic and environmental impact of Plastic Waste 1.4 Sources of waste – postconsumer, municipal and industrial waste 1.5 Management of plastic waste - 4 R (reduction, reuse, recycling and recovery) 1.6 Plastic cycle - flow of plastic products and plastic waste 1.7 Waste disposal a. Landfill of municipal solid waste– open dumping and sanitary landfill b. Plastics in landfill c. Future trends
UNIT- II SEPARATION METHODS	2. a Identify various separation methods. 2. b Select proper separation method.	2.1 Size reduction by mechanical methods 2.2 Separation of plastics using physical properties 2.3 Separation using recycling codes 2.4 Separation processes specific to plastics a. Separation of paper/plastic mixtures-Application of Heat, Wet Separation Process, Electro Dynamic Separation b. Separation of plastic from plastic-coated fabric c. Separation of mixtures of plastics-Float Sink Method, Using Selective Wetting Characteristics, Solvent Separation
UNIT – III PRIMARY & SECONDARY RECYCLING METHODS	3.a Identify primary and secondary recycling methods 3.b Analyze various methods 3.c Select suitable method	**Primary Recycling** 3.1 Introduction 3.2 Primary recycling methods a. Granulators b. Cryogenic grinding c. Plunger and screw type stuffer d. In-line recycling

Unit	Major Learning Outcomes	Topics and Sub-topics
		Secondary Recycling 3.3 Introduction to secondary recycling 3.4 Various technical approaches for secondary recycling 3.5 Secondary recycling by mechanical reworking of plastic waste 3.6 Recycling by chemical modification of plastic waste 3.7 Secondary recycling by co-extrusion and co-injection molding 3.8 Use of plastic as a filler
UNIT – IV TERTIARY AND QUATERNARY RECYCLING	4.a Identify tertiary and quaternary recycling methods. 4.b Select proper method	**Tertiary Recycling** 4.1 Pyrolysis a. Introduction to pyrolysis and its advantages b. Introduction to pyrolysis reactors of plastics waste – Union Carbide System, Reactor by Japan Steel Works 4.2 Chemical decomposition of plastic waste a. Hydrolysis b. Glycolysis **Quaternary Recycling** 4.3 Introduction to quaternary recycling 4.4 Constructional features of incinerators 4.5 Incineration of plastic waste and its problems
UNIT – V RECYCLING METHODS OF SPECIFIC PLASTICS	5.a Understand recycling methods of various plastics.	5.1 Describe recycling methods of following plastics : a. PVC b. PET c. PMMA d. HDPE e. LDPE f. PS

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	**Sources of Plastic Waste and its Management**	9	4	8	2	14
II	**Separation Methods**	8	4	8	2	14
III	**Primary & Secondary Recycling Methods**	9	3	11	0	14
IV	**Tertiary And Quaternary Recycling**	8	4	10	0	14
V	**Recycling Methods of Specific Plastics**	8	4	10	0	14
TOTAL		**42**	**19**	**47**	**4**	**70**

7. SUGGESTED LIST OF EXERCISES/PRACTICALS

S. No.	Unit Number	Description of Laboratory Experiment	Hours
1	I	To study various sources of plastic waste.	2
2		To study waste disposal methods.	2
3	II	To perform plastic waste size reduction by mechanical method.	2
4		To carry out separation of plastics using float-sink method.	2
5		To study various separation methods of paper/plastic mixtures.	2
6	III	To perform primary recycling of plastic using granulators.	2
7		To study recycling by chemical modification of plastic waste.	2
8		To study secondary recycling by co-extrusion and co-injection molding.	2
9	IV	To study various pyrolysis reactors.	2
10		To study quaternary recycling methods.	2

11	V	To carry out depolymerisation of PMMA for recovery of monomer.	2
12		To study recycling methods of PET	2
13		To study recycling methods of PVC.	2
14		To study recycling methods of HDPE.	2
		TOTAL	**28**

8. SUGGESTED LEARNING RESOURCES

(A) List of Books:

SR. NO.	TITLE OF BOOK	AUTHORS	PUBLICATION
1	Plastic Waste	Jacob Leidner	Marcel Dekker
2	Feedstock Recycling of Plastic Waste	Jose Aguado & David Serrano	Royal Society of Chemistry
3	Mixed Plastic Recycling Technology	Bruce Hegberg, Gary Brenniman W.H.Hallenback	Noyes Data Corporation
4	Plastics Technology Handbook	Donald Hudgin	Taylor & Francis
5	Recycling of Plastic Materials	La Mantia	Chemtec Publishing
6	Modern Plastics Handbook	Harper	McGraw-Hill

(B) List of Software/Learning Websites:

1. http://nzic.org.nz/ChemProcesses/environment/14E.pdf
2. http://www.g.eng.cam.ac.uk/impee/topics/RecyclePlastics/files/Recycling%20Plastic%20v3%20PDF.pdf
3. http://plasticisrubbish.com/2013/03/20/recycling-plastic-2
4. https://web.anl.gov/PCS/acsfuel/preprint%20archive/Files/Volumes/Vol42-4.pdf

9. SUGGESTED LIST OF STUDENT ACTIVITIES

1. Students will collect different plastic products with recycling codes.
2. Students will prepare identification chart with recycling codes.
3. Students will prepare flow chart of plastic cycle.
4. Students will visit nearby industries and collect information about recycling process.

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics:

1. **Prof. A.S.Amin, LPE, Government Polytechnic, Ahmedabad.**
2. **Prof. J.R.Desai, LPE, Government Polytechnic, Valsad.**
3. **Smt. S.R.Shah, LPE, Government Polytechnic, Valsad.**
4. **Prof. B.I.Oza, LPE, Government Polytechnic, Ahmedabad.**
5. **Prof. N.C.Suvagya, LPE, Government Polytechnic, Chhotaudepur.**

Coordinator and Faculty Members from NITTTR Bhopal

1.
2.