GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Plastic Materials - I
(Course Code: 4332305)

Diploma programme in which this course is offered	Semester in which offered
Plastics Engineering (Sandwich Pattern)	Third

1. RATIONALE

The course deals with structures, properties & applications of plastic materials prepared by various polymerization techniques. The course will help students to understand uses of plastic materials for various applications in different industries as well as replacement of other engineering materials. It will also help to understand compounding of plastic, advance plastic materials and plastic product design in future.

2. COMPETENCY

Thepurpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Select the relevant plastic materials to produce specified plastic product.
- Set processing parameters for production of plastic parts.

3. COURSE OUTCOMES (COs)

The practicalexercises, the underpinning knowledgeand the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Co-relate structure with properties of various plastic materials.
b) Understand different properties of plastic materials.
c) Differentiate/Compare various plastic materials.
d) Use plastic materials in various fields.
e) Select the proper plastic materials to meet end use requirement for a given plastic product.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	2	3	30*	70	25	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

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

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are thesub-components of the COs.*Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Demonstrate Maxwell's model	1	04
2	Perform identification tests of high density polyethylene(HDPE)	2	02
3	Perform identification tests of Polystyrene(PS)	2	02
4	Perform identification tests of Polypropylene (PP)	2	02
5	Perform identification tests of PVC	2	02
6	Perform identification tests of PMMA	2	02
7	Perform identification tests of Polyester	2	02
8	Perform identification tests of Epoxy	3	02
9	Perform identification tests of Urea formaldehyde(UF)	3	02
10	Perform identification tests of Polycarbonate(PC)	4	02
11	Perform identification tests of Nylon	4	02
12	Perform identification tests of PTFE	4	02
	Total		**28**

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some **sample** 'Process' and 'Product' related skills(more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises**of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Preparaton of experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safe practices measures	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specificationsfor the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Dashpot	1
2	Weight	1
3	Burner (Bunsen Burner)	2 to 12
4	Test tube (10 ML)	2 to 12
5	Beaker (250 ML)	2 to 12
6	Titration sets (Burette 50ML; Pipette 10ML.)	2 to 12
7	Stand	2 to 12
8	Gauze mat	2 to 12
9	Tripod	2 to 12
10	Test tube rack	2 to 12
11	Funnel	2 to 12
12	Density tester	2 to 12

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample***Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfil the development of this competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Observe safety measures.
d) Practice environmental friendly methods and processes to avoid plastic waste.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year

8. UNDERPINNING THEORY

Only the major Underpinning Theory isformulated ashigher level UOs of *Revised Bloom's taxonomy*in order development of the COs and competency is not missed out by the students and teachers.If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	**Unit Outcomes (UOs)** (4 to 6 UOs at Application and above level)	**Topics and Sub-topics**
Unit – I Flow Characteristics	1a. Distinguish different types of plastic flow 1b. Understand rheology of material by model demonstration	1.1 Basics of plastic flow 1.2 Types of flow • Newtonian • Non-Newtonian Pseudo-plastic Dilatants Bingham. 1.3 Rheological properties • Temperature viscosity relation • Maxwell's Model
Unit– II Thermo Plastics materials	2a. Classify thermoplastic materials 2b. Co-relate structure and properties of thermoplastic material 2c. Compare/Distinguish between various thermoplastic material 2d.Identify given thermoplastic material 2e.Select suitable thermoplastic material for specific application	2.1 Structure, its related properties and applications of the following Thermoplastic material a. Olefins: Polyethylene(LDPE,HDPE), Polypropylene (PP) b. Vinyls : Polyvinyl chloride (PVC), Polyvinyl acetate(PVAc),Polyvinyl Alcohol(PVA) c. Styrenics: Polystyrene (PS),Styrene acrylonitrile(SAN), Acrylonitrile butadiene styrene(ABS) d. Acrylics :Polymethyl methacrylate (PMMA), Polyacrylo nitrile(PAN) e. Cellulosics: Cellulose acetate (CA), Cellulose nitrate(CN)
Unit– III Thermo Sets materials	3a. Classify thermo set materials 3b. Co-relate structure and properties of thermo set material 3c. Compare/Distinguish between various thermo set material 3d.Identify given thermo set material 3e.Select suitable thermo set material for specific application	3.1 Structure, its related properties and applications of fallowing Thermo set material a. Phenol formaldehyde(PF) b. Melamine formaldehyde(MF) c. Urea formaldehyde(UF) d. Epoxy e. Silicones f. Polyesters g. Furan h. Polyurethane resin(PUR) i. Diallyl phthalate(DAP)
Unit – IV Engineering Plastics	4a. Classify engineering plastic materials 4b. Co-relate structure and	4.1 Structure, its related properties and applications of fallowing engineering plastic materials:

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
	properties of engineering plastic 4c. Compare/Distinguish between various engineering plastic 4d.Identify given engineering plastic 4e.Select engineering plastic for specific application	a. Polyamides(nylon-6, nylon 6-6, nylon 6-12) b. Polytetrafluoroethylene(PTFE) c. Polyesters(PET,PBT) d. Acetal(POM) e. Polycarbonate(PC)

***Note**:The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

8. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Flow Characteristics	04	04	04	02	10
II	Thermo Plastics materials	10	12	07	06	25
III	Thermo Sets materials	08	10	05	05	20
IV	Engineering Plastics	06	08	04	03	15
Total		**28**	**34**	**20**	**16**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of theUOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may varyslightly from above table.*

9. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

1. Students will collect different plastic raw materials as well as molded products and would comment on their quality.
2. Students will collect information related to the experiment through internet.

3. Students will visit nearby industry.
4. Students will visit nearby plastic raw material suppliers shop/traders.
5. Prepare list of Plastic material suppliers along with brands, specifications, prices, terms and conditions etc.

10. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessedusing different assessment methods.
e) With respect to ***section No.11***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability.
g) Guide students for using plastic material data sheet.
h) Visit to nearby industries/ suppliers shop/traders.
i) Demonstration of samples of different type of materials in the class.
j) Mini projects to students about comparison of different type of materials.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare a chart for types of plastic materials
b) Collect products made by commodity plastics

c) Prepare model for Maxwell's model
d) Prepare chart for crystalline, semi-crystalline and amorphous plastic materials
e) Collect products made by thermoset materials
f) Collect products made by engineering plastics

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Plastics Material	J A Brydson	Publisher: Elsevier Science, London Year: 1999 ISBN: 978-0-7506-4132-6
2	Plastics Material and Processes	S. S. Schwartz	Publisher: Van Nostrand Reinhold, New York Year: 1982 ISBN: 978-0442227777
3	Engineering Plastics Handbook	James Margolis	Publisher: Mcgraw-hill, Michigan Year:2006 ISBN:9780071457675
4	Polymer Science	Govariker V.R	Publisher: New Age International Pub, Delhi Year: 2019 ISBN: 9788122438130
5	Thermoplastic Materials: Properties, Manufacturing Methods, and Applications	Christopher C. Ibeh	Publisher: CRC Press, Delhi Year: 2011 ISBN: 1420093835
6	Plastics Materials Properties and Applications	A. W. Birley, R. J. Heath	Publisher: Springer US, New York Year: 2012 ISBN: 9781461536642

14. SOFTWARE/LEARNING WEBSITES

1. https://www.slideshare.net/AsadRiaz31/newtonian-and-non-newtonian-fluids-76588937
2. http://www.curbellplastics.com/technical-resources/pdf/plastic-material-selection.pdf
3. https://www.sciencedirect.com/
4. https://omnexus.specialchem.com/selection-guides
5. https://www.bpf.co.uk/plastipedia/Default.aspx
6. https://www.engineeringenotes.com/engineering/thermoplastic-materials/list-of-thermoplastic-materials-engineering/42255
7. https://www.polyplastics.com/en/pavilion/beginners/04-03-3.html
8. https://www.youtube.com/watch?v=NPH2xMO86mc
9. https://www.youtube.com/watch?v=Cd4m5qmNZP0

15. PO-COMPETENCY-CO MAPPING

Semester III	Plastic Materials - I (Course Code: 4330305)									
	POs and PSOs									
Competency & Course Outcomes	**PO 1** Basic & Discipline specific knowledge	**PO 2** Problem Analysis	**PO 3** Design/ development of solutions	**PO 4** Engineering Tools, Experimentation &Testing	**PO 5** Engineering practices for society, sustainability & environment	**PO 6** Project Management	**PO 7** Life-long learning	**PSO 1** An ability to apply principles of material selection, product & mold/die design and development in plastic engineering.	**PSO 2** An ability to conduct safe and environment friendly manufacturing and recycling of plastic products.	**PSO 3** (If needed)
Competency **Select the relevant plastic materials to produce specified plastic product**	3	2	2	3	2	2	2	3	2	-
Set processing parameters for production of plastic parts.	3	2	-	-	2	1	2	2	2	
Course Outcomes 1 Co-relate structure with properties of various plastic materials.	2	2	-	3	1	1	2	2	1	-
2 Understand different properties of plastic materials.	3	-	1	1	2	1	2	2	2	-
3 Differentiate/ compare various plastic materials.	3	1	2	2	2	2	2	2	2	-
4 Use plastic materials in various fields.	3	2	3	1	3	2	1	2	3	-
5 Select the proper plastic materials to meet end use requirement for a given plastic product.	2	2	3	2	3	2	2	2	3	-

Legend: '**3'** for high, '**2**' for medium, **'1'** for low or **'-'** for the relevant correlation of each competency, CO, with PO/ PSO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

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