Program Name : **Diploma in Plastic Engineering**

Program Code : **PS**

Semester : **Fifth**

Course Title : **Advanced Plastics Processing Techniques (Elective-I)**

Course Code : **22552**

1. RATIONALE

Stretch blow molding and multi-layer blow molding are the latest technologies used for making bottles and containers for packaging. Plastic engineering technocrats should be aware of recent developments in injection blow molding, extrusion blow molding, PTFE processing and radiation processing as new products are coming in the market every day. Plastics engineer is expected to operate latest processing technologies along with theory of technology and screw design for better quality products. The advanced processing technology enhances production rate as well as quality to fulfill the requirements of emerged new market. This course will help plastic engineering technocrats to get placement in production department of plastic industries.

2. COMPETENCY

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

- **Produce plastic products using advanced plastic processing techniques.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented*** COs associated with the above mentioned competency:

a. Use specialized plastic injection moulding process equipment.
b. Use advanced plastic blow moulding process equipment.
c. Use advanced plastic extrusion process equipment.
d. Use compression moulding machine to manufacture PTFE products.
e. Use the plastic related radiation processing equipment.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical				
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

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

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

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

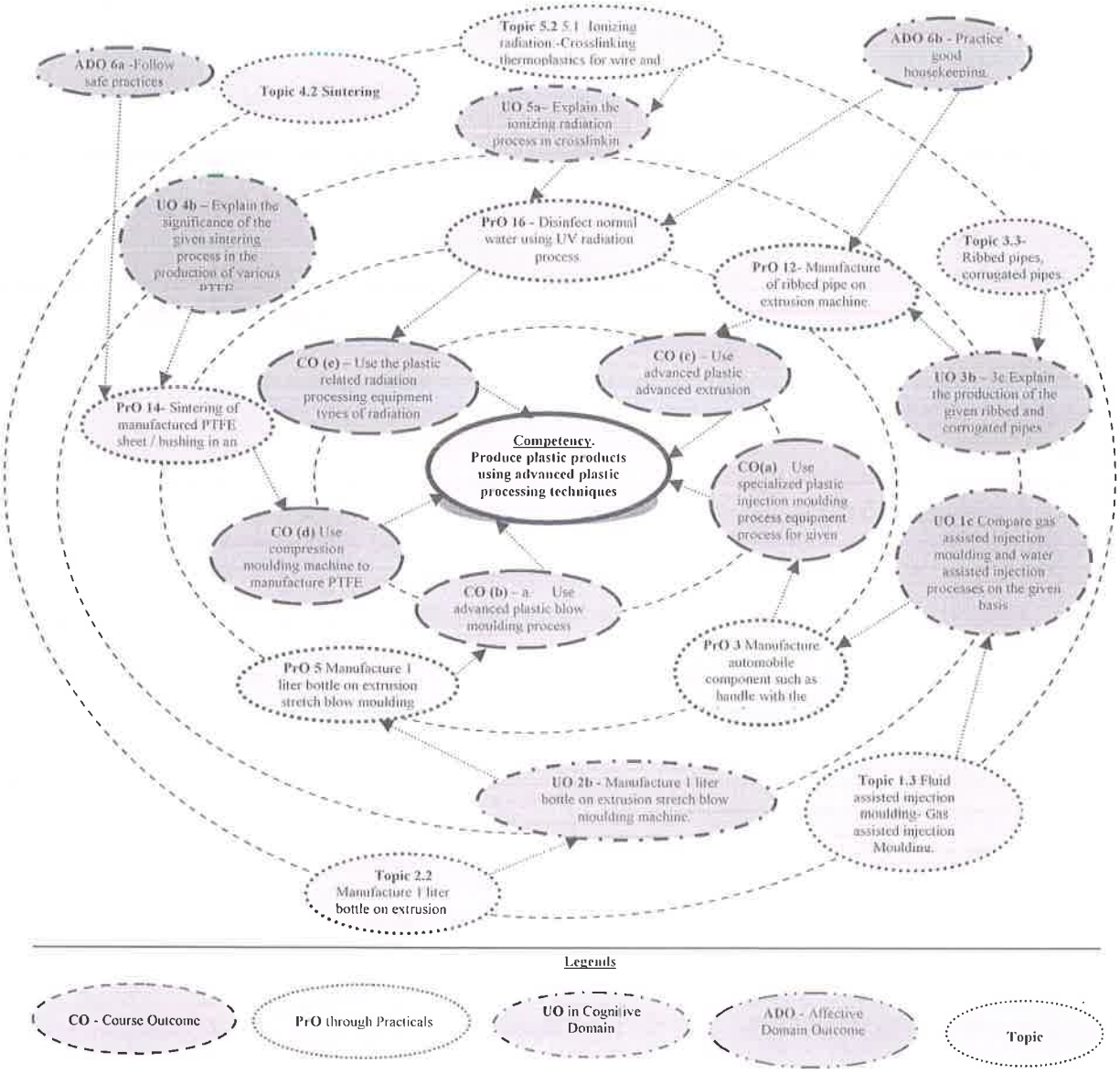

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1.	Manufacture clockwork part (for e.g. gear) on microinjection moulding machine.	I	02*
2.	Manufacture multilayer barrier cap using two colour co-injection moulding machine.	I	02*
3.	Manufacture automobile component such as handle with the help of gas assisted injection moulding technique.	I	02*
4.	Manufacture insulation rail for domestic iron by using thermoset injection moulding machine.		02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
5.	Manufacture 1 liter bottle on extrusion stretch blow moulding machine.	II	04*
6.	Manufacture 1 liter bottle on injection stretch blow moulding machine.	II	04*
7.	Manufacture 1 liter drum on accumulator blow moulding machine.	II	04*
8.	Manufacture 1 liter multilayer fuel tank for lawn and garden on multilayer blow moulding machine.	II	04*
9.	Control parison thickness on multilayer blow moulding machine.	II	02*
10.	Manufacture bilayer film on multilayer extrusion process.	III	02*
11.	Manufacture corrugated pipe on extrusion machine.	III	04*
12.	Manufacture ribbed pipe on extrusion machine.	III	04*
13.	Manufacture PTFE bushing on compression moulding machine.	IV	04*
14.	Sintering manufactured PTFE sheet / bushing in an oven.	IV	02*
15.	Finish manufactured PTFE bushing on lathe machine.	IV	02
16.	Disinfect normal water using UV radiation process.	V	02
	Total		**46**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. All the above listed practical need to be performed compulsorily, so that the student reaches the 'Applying Level' of Blooms's 'Cognitive Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO are to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
a.	Setting of experimental set up	20
b.	Operate equipment skillfully	30
c.	Follow safety measures	10
d.	Work in team	10
e.	Record observation	10
f.	Interpret results to conclude	10
g.	Answer to sample questions	05
h.	Submit report in time	05
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Work as a leader/a team member.
d. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs

according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year and
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	Pro. S. No.
1.1	Microinjection moulding machine with auxiliary equipment and single cavity gear die with shot volume – 4 cm^3 and clamping capacity 62kN	1
1.2	Co-injection moulding machine with auxiliary equipment and single cavity bottle cap die with shot capacity 110g and clamping force 65 ton.	2
1.3	Gas assisted injection moulding machine with auxiliary equipment with single cavity handle die with clamping force 6000KN and shot weight 1830 g.	3
1.4	Thermoset injection moulding machine with auxiliary equipment with single cavity insulation rail die having clamping force – 125 Ton and shot weight 214g.	4
1.5	Extrusion stretch blow moulding machine with auxiliary equipment with single cavity 1 liter bottle die.	5
1.6	Injection stretch blow moulding machine with auxiliary equipment with 1 liter bottle die.	6
1.7	Accumulator blow moulding machine with auxiliary equipment with 1 liter drum die.	7
1.8	Multilayer blow moulding machine with auxialry equipment with 1 liter fuel tank die	8
1.9	Multilayer baby film extrusion machine to manufacture two layer film.	10
1.10	Extrusion machine with auxiliary equipment with ribbed or corrugated pipe die having die diameter 10 mm.	11
1.11	Compression moulding press having dimensions 3500 x 2200 x 2300mm with auxiliary equipment with single cavity bushing die having dimensions of die such as 20Od x 16Id.	12
1.12	Oven having 232in. L x 54in. W x 63in. H.	13
1.13	Laboratory grade lathe machine	14
1.14	Laboratory grade UV irradiation equipment	

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs in cognitive domain for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Specialized Injection Moulding Processes	1a. Describe with sketches microinjection moulding machine on the given basis along with merits and demerits. 1b. Describe with sketches co-injection moulding process on the given basis. 1c. Describe with sketches with sketches the	1.1 Microinjection moulding machines- Merits & Demerits 1.2 Co-Injection Moulding Two Colour Injection Moulding

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	constructional features of the liquid injection moulding process on the given basis. 1d. Explain with sketches the working of injection moulding machine for thermosets on the given basis. 1e. Describe with sketches the tie bar less injection moulding process on the given basis. 1f. Justify the operational setting and mechanisms of relevant specialized injection moulding process for given application.	1.3 Fluid assisted injection moulding- Gas Assisted injection Moulding 1.4 Water Assisted injection Moulding Reaction Injection Moulding 1.5 Liquid Injection Moulding 1.6 Lost Core Moulding 1.7 Structural Foam Moulding Low Pressure foam high pressure foam 1.8 Injection moulding machines for thermosets. 1.9 Tie bar less Injection Moulding
Unit– II Advanced Blow Moulding Process	2a. Compare extrusion blow moulding and injection stretch blow moulding processes on the given basis. 2b. Manufacture 1 liter bottle on extrusion stretch blow moulding machine. 2c. Explain with sketches the working of accumulator blow moulding on the given basis. 2d. Describe with sketches the multi-layer blow moulding process on the given basis. 2e. Justify the operational setting and mechanisms of relevant advanced blow moulding process for manufacturing of the given plastics product.	2.1 Classification of Advanced Blow Moulding Processes 2.2 Injection Stretch Blow Moulding Principles and Operation of forced Extrusion 2.3 Accumulator Blow Moulding 2.4 Multi-layer Blow Moulding.
Unit III- Advanced Extrusion Process	3a. Explain with sketches the given downstream equipments and their applications. 3b. Describe with sketches the production of the given multilayer films. 3c. Explain with sketches the production of the given ribbed and corrugated pipes. 3d. Justify the operational setting and mechanisms of relevant advanced extrusion process for manufacturing of the given hollow products.	3.1 Downstream equipment Dies and applications. 3.2 Multi-layer films- co-extruded sheets, 3.3 Ribbed pipes, corrugated pipes.
Unit-IV PTFE processing	4a. Describe with sketches the working of the given compression moulding process for the production of various raw PTFE products. 4b. Explain with sketches the significance of the given sintering process in the production of various PTFE products.	4.1 Compression moulding of PTFE powder 4.2 Sintering 4.3 Finishing of PTFE product

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	4c. Explain with sketches the finishing process applied for the given PTFE product. 4d. Justify the operational setting and mechanisms of carrying out processing of the given PTFE products.	
Unit –V Radiation processing	5a. Explain with sketches the ionizing radiation process in crosslinking of the given polymers. 5b. Explain with sketches the selection of non-ionizing radiation process for the given application. 5c. Justify the operational setting of relevant manufacturing process for various types of given radiation products. 5d. Justify mechanisms of relevant manufacturing process for various types of given radiation products.	5.1 Ionizing radiation :- Crosslinking thermoplastics for wire and cable Crosslinking thermoplastics for packaging films Cross-linked foamed resins Irradiated concrete-plastics composites 5.2 Non-ionizing radiation :-Ultraviolet radiation Infrared radiation Dielectric energy

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Specialized injection moulding process	4	02	02	04	08
II	Advanced blow moulding process	12	02	04	12	18
III	Advanced extrusion process	12	02	04	10	16
IV	PTFE processing	12	02	04	10	16
V	Radiation processing	08	04	04	04	12
Total		**48**	**12**	**18**	**40**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. 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:

a. Prepare journals based on practical performed in laboratory.
b. Give seminar on relevant topic.

c. Undertake micro-projects.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.
i. Demonstrate students thoroughly before they start doing the practice.
j. Encourage students to refer different websites to have deeper understanding of the subject.

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. Similar micro-projects could be added by the concerned faculty:

a. Manufacture different parts by using thermoset injection moulding machine.
b. Manufacture different automobile components with the help of gas assisted injection moulding technique.
c. Manufacture half liter bottle of different shapes on extrusion stretch blow moulding machine.
d. Manufacture multicolored corrugated pipe on extrusion machine.
e. Any other micro-projects suggested by subject faculty on similar line.

13. SUGGESTED LEARNING RESOURCES :

S. No.	Title of Book	Author	Publication
1	Specialized Injection Moulding Techniques	Hans-Peter Heim	Elsevier Publishers, Gurgaon, 2017. ISBN: 9780323341004

S. No.	Title of Book	Author	Publication
2	Blow moulding handbook	Rosato, D.	Hanser Publishers, Cincinnati, 1987 ISBN : 9783446150713
3	Specialized Moulding Techniques	Hans-Peter Heim and Potente, H.	Elsevier Publishers, Gurgaon, 2002. ISBN: 9781884207914

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=b1U9W4iNDiQ
b. https://www.youtube.com/watch?v=E5-hR5Mcqbo
c. https://www.youtube.com/watch?v=K1CNap8UnQI
d. https://www.youtube.com/watch?v=JZ7Y4Ub4QE0