

Program Name : Diploma in Plastic Engineering
Program Code : PS
Semester : Fourth
Course Title : Finishing and Joining of Plastics
Course Code : 22452

1. RATIONALE

Many plastic products require some degree of machining and finishing after they have been processed and before they are put in the marketplace. Industrial plastics products many times need to be assembled with other similar or dissimilar products for functional purposes. Parts made of plastics also needed to be decorated e.g. printing, metallization etc. for better aesthetic appearance. The plastics diploma engineer (also called technologist) will be able to apply basic machining, finishing, joining and decorating techniques used with plastics in the industries which will help them to start an enterprise.

2. COMPETENCY

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

- Use relevant decorating and finishing process for plastic surface improvement.

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:

- Use finishing and machining techniques for plastics.
- Use appropriate adhesives for joining plastics.
- Join thermoplastic parts safely by using appropriate welding technique.
- Use suitable decorating technique safely for plastics.
- Apply relevant powder coating to improve surface characteristics.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
Max	Min	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 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 cognitive domain 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.

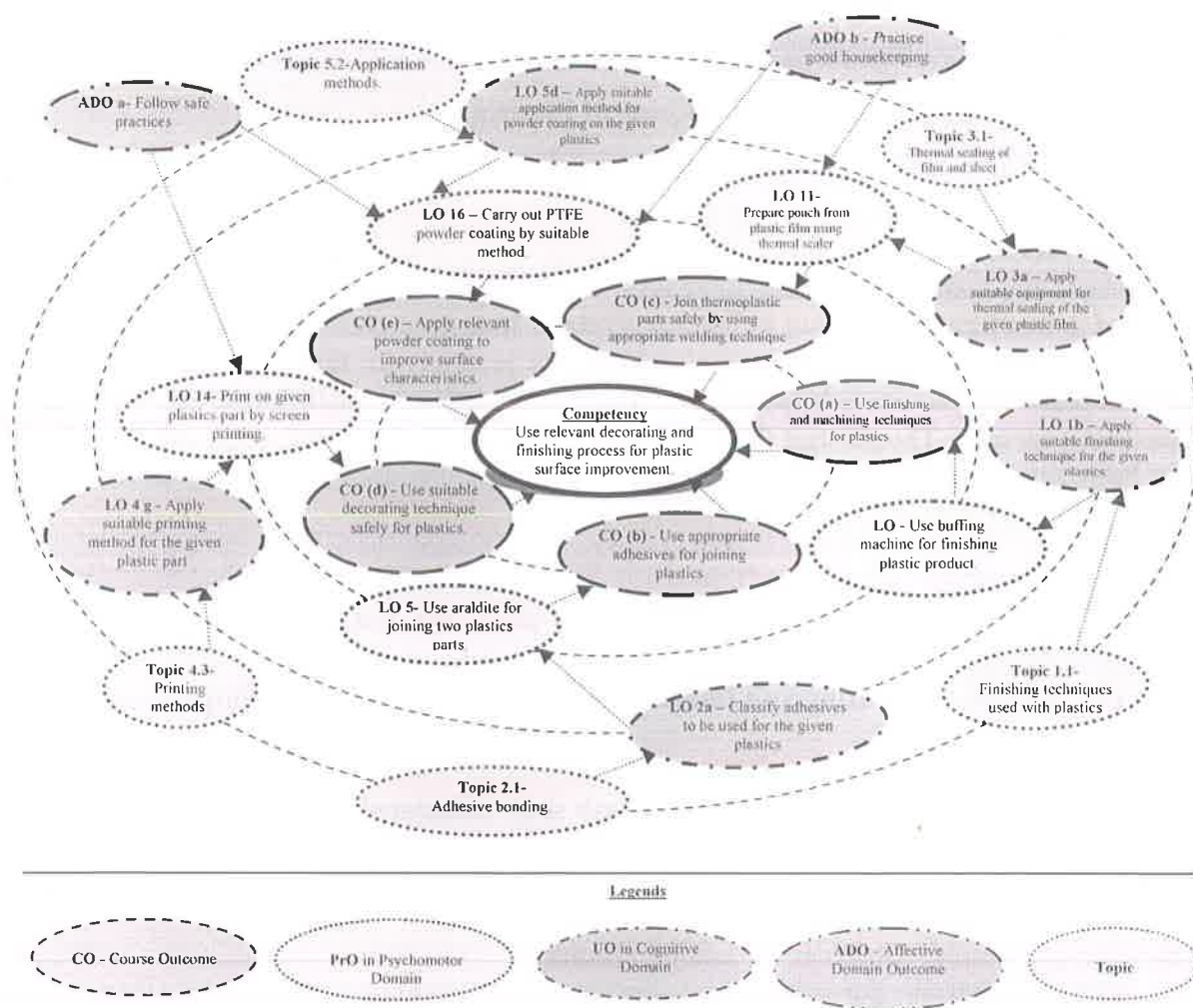


Figure 1 - Course Map

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	Use buffing machine for finishing plastic product.	I	02
2	Use tumbler machine for flash removal of thermosetting plastics.	I	02
3	Use drilling machine to make a hole in the plastic part and assemble plastic parts using nut and bolt.	I	02
4	Use pressure sensitive adhesive to join two polymer parts.	II	02
5	Use araldite for joining two plastic parts.	II	02
6	Repair leakage using epoxy adhesive.	II	02
7	Assemble PS parts using solvent cementing.	II	02
8	Prepare socket to PVC conduits.	II	02
9	Prepare PVC pipe line using socketed pipe and pipe joints such as bend, elbow, T etc. by solvent cementing.	II	02
10	Join plastic pipes using hot plate welding technique.	III	02



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
11	Prepare pouch from plastic film using thermal sealer.	III	02
12	Carry out the welding of PVC sheets by ultrasonic welding machine.	III	02
13	Prepare lamination of plastic to paper using lamination machine.	III	02
14	Print on given plastic part by screen printing.	IV	02
15	Decorate the given plastic part by hot stamping.	IV	02
16	Carry out PTFE powder coating by suitable method.	V	02
17	Carry out flexographic printing on plastic films.	V	02
	Total		34

Note

- A suggestive list of **PrOs** is given in the above table. More such **PrOs** can be added to attain the **COs** and competency. A judicious mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- The 'Process' and 'Product' related skills associated with each **PrO** is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	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:

- Follow safe practices
- Practice good housekeeping
- Practice energy conservation
- Demonstrate working as a leader/a team member
- Maintain tools and equipment
- 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
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED



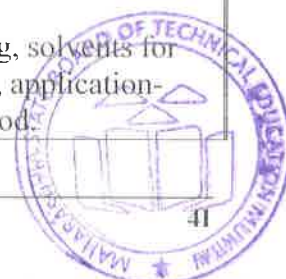
The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	Exp. No.
1	Buffing Machine	1
2	Tumbler- dia 500 mm	2
3	Hand Drilling machine	3
4	Socketing die and machine- 1-3 inch size	8
5	Pipe fixtures	9
6	Hot plate welding machine- Laboratory model	10
7	Heat sealing and cutting machine- Length 150 mm x Width 20 mm	11
8	Impulse sealer- Laboratory model	11
9	High frequency welding machine- Laboratory model	12
10	Lamination machine- A3 size	13
11	Screen printing setup- print area-15"x20", Power-1kw,	14
12	Hot stamping press and die- Laboratory model	15
13	Hot air oven- Temperature range- 0 to 200 °C	16

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics are to be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Finishing and Machining Plastics	1a. Justify finishing and machining technique for the given plastics. 1b. Apply suitable finishing technique for the given plastics. 1c. Describe procedure for filing, tumbling and polishing for the given plastics. 1d. Apply suitable machining technique for the given plastics. 1e. Describe procedure for drilling for the given plastics .	1.1 Finishing techniques used with plastics: Filing, Tumbling, Grinding, Sanding, Buffing, Ashing, Polishing. 1.2 Principal consideration and user guidelines for machining tool geometry. 1.3 Machining techniques: Drilling, Reamimng, Tapping, Threading, Turning, Milling, Sawing, Piercing, Trimming, Routing, Laser Machining.
Unit-II Joining Plastics	2a. Classify adhesives to be used for the given plastics. 2b. Describe procedure for preparing the given sustainable adhesive joint. 2c. Use suitable adhesive application tool for the given joint. 2d. Describe adhesive application method for the given joint. 2e. Select suitable solvent for the given cementing plastics. 2f. Apply suitable solvent application method for the given joint. 2g. Describe solvent cementing	2.1 Adhesive bonding: resins used, types of adhesives- liquid, mastics, hot melt, film, pressure sensitive. 2.2 Adhesive joints- butt, V, lap, tongue-and-groove, scarfed. 2.3 Adhesive application methods: Tube, knife, spatula, brush, roller, squeeze bottle, hot press bonding, meter-mix-disperse, roll coaters, curtain and screen coating, hot melt application. 2.4 Solvent Cementing, solvents for cementing plastics, application- dip, capillary method.



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	procedure for specific plastics for the given joint.	2.5 Cementing of specific plastics: Acrylics, Cellulosic Plastics, Nylon, PC, PS, PE, PPO, PVC.
Unit– III Welding of Thermoplastics	3a. Apply suitable equipment for thermal sealing of the given plastic film. 3b. Select suitable welding technique for the given plastics parts. 3c. Describe procedure for various welding techniques for the given parts. 3d. Apply suitable mechanical fastener for temporary joining of the given plastics parts. 3e. Select suitable fitting for the given closers of containers.	3.1 Thermal sealing of film and sheet: Jaw type bar sealer, Rotary sealer, Band rotary, Impulse type sealer, Hot knife and multi-point sealing . 3.2 High frequency or Dielectric heat sealing. 3.3 Hot gas welding. 3.4 Hot plate welding. 3.5 Induction welding. 3.6 Spin or Friction welding. 3.7 Ultrasonic Assembly. 3.8 Mechanical Joints: Mechanical fasteners, Inserts, Standard machine screws, Self-tapping screws, Bolts and nuts, Rivets, Spring clips and nuts, Hinges. 3.9 Press of shrink fitting, snap fitting, integral hinge.
Unit– IV Decorating Plastics	4a. Justify the need of surface treatment before decoration for the given plastics. 4b. Describe procedure of treatment techniques for the given plastics. 4c. Apply suitable pretreatment method for the given plastics part. 4d. Describe procedure for various painting techniques for the given plastics. 4e. Apply suitable coating method for the given plastics.. 4f. Describe procedure for various printing techniques for the given plastics. 4g. Apply suitable printing method for the given plastics part. 4h. Describe procedure for various metallization techniques for the given plastics. 4i. Apply suitable metallization method for the given plastics. 4j. Describe procedure for various textile finishing technique for the given plastics. 4k. Apply suitable textile finishing method for the given plastics.	4.1 Surface pretreatment Techniques: Washing, Mechanical Abrasion, Chemical Etching, Priming, Flame Treatment, Corona Discharge, Plasma Treatment. 4.2 Paints and Coating: Techniques- Spraying, Dip Coating, Flow Coating, Curtain Coating, Roll Coating. 4.3 Printing Methods: Screen Printing, Flexographic Printing, Rotogravure Printing, Pad Printing. 4.4 Hot Transfer Process. 4.5 Laser Marking and Dying. 4.6 Metallization: Electroless and Electrolytic Plating, vacuum evaporation, Sputtering. 4.7 Labels and Decals. 4.8 In-mould Decorating. 4.9 Flocking, Embossing and Surface Texturing. 4.10 Grinding and Polishing.



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit –V Coating Plastics	5a. Justify the need of powder coating on the given plastics. 5b. Describe manufacturing method for coating on the given plastics. 5c. Describe procedure for coating application method on the given plastics. 5d. Apply suitable application method for powder coating on the given plastics. 5e. Describe various types of powder coatings for the given plastics.	5.1 Powder Coating Manufacturing methods: Dry Blends, Melt Mix, Solution. 5.2 Application Methods: Fluidised Bed, Electrostatic Spraying, Friction Static Spraying. 5.3 Powder Coating Types: Thermoplastic: PVC, PE, CAB, Nylon, Thermoplastic Polyester, Thermosetting Types: Epoxy, Polyester/Polyurethane, Acrylics.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above 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	Finishing and Machining Plastics	08	02	04	04	10
II	Joining Plastics	10	04	04	08	16
III	Welding of Thermoplastics	10	04	04	08	16
IV	Decorating Plastics	12	04	06	08	18
V	Coating Plastics	08	02	04	04	10
Total		48	16	22	32	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 ULOs. 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

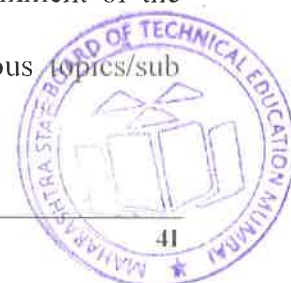
Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course:

- Prepare list of adhesives and paint manufacturing industries, their trade names and applications.
- Prepare chart for adhesives used for rubber and foam products.
- Prepare power point presentation of composition of adhesives and paints.
- Library /Internet survey of plastic welding processes.
- Prepare the list of printing machine manufacturers.

11. 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:

- 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. Use Flash/Animations to explain various topics.
- f. Guide student(s) in undertaking micro-projects.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. 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.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should 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. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty. Students should conduct following activities in group and prepare reports of about 4 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews.

- a. **Adhesive Bonding:** Prepare various types of adhesive joints using rubber/plastic parts and adhesive.
- b. **Flow Sheet Preparation:** Prepare flow sheet for adhesive manufacturing.
- c. **Chart Preparation:** Prepare chart for components of adhesive and their roles.
- d. **Assembly:** Prepare screen frame for screen printing.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	SPI Plastics Engineering Handbook	Berins, M.L.	Springer, US, 1991 ISBN: 978-1-4615-7606-8
2	Decorating Plastics	Margolis, J.M.	Hanser, New York, 1987 ISBN-13: 9783446146983
3	The Plastic Technology Handbook Volume -I	Rosato, D.; Rosato, M.G.; Schott, N.R.	Momentum Press, USA, 2010 ISBN-13: 978-1606500798

14. SOFTWARE/LEARNING WEBSITES

- a. www.ptonline.com/zones/decorating
- b. www.esterline.com/Portals/13/.../WP_InMoldDecorating_6Page.pdf
- c. www.speplasticsindustryresource.com/.../Decorating_and_Finishing/3335
- d. www.ndl.iitkgp.ac.in



