GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Compression Transfer and Injection Moulding Of Thermosets
(Course Code: 4332303)

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

1. RATIONALE

A plastic diploma engineer has to supervise operations of compression, transfer and injection moulding process of various thermoset materials. This competency requires the knowledge of compression transfer and injection molding process and the working principle of different kinds of plastic moulding machines and tools involved in the process. Hence the course has been designed to develop this competency and its associated cognitive, practical and affective domain learning outcomes.

2. COMPETENCY

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

- Operate Compression, Transfer molding and Injection machine.
- Change mold on Compression, Transfer and Injection machine.
- Set process parameters of Compression, Transfer and Injection machine.
- Troubleshoot defects found in Compression, Transfer and Injection molded products.
- Utilize auxiliary equipments for better output and quality of products.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Set process parameters for compression m/c, transfer m/c and injection m/c of thermoset.
b) Select appropriate compression mould and material for various products.
c) Select pot type/plunger type transfer moulding process.
d) Troubleshoot problems in processing of thermoset materials.
e) Recommend compression moulding process/transfer moulding process/ injection moulding process to produce a thermoset 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	
3	0	2	4	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 the sub-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	Identify the different parts of compression moulding machine	1	02
2	Adjust the settings of a compression moulding machine for producing a particular product	1	02
3	Calculate compression moulding pressure for Urea formaldehyde(UF)	1	02
4	Operate an automatic compression mould for a given product safely	2	02
5	Identify the different parts of transfer moulding machine	3	02
6	Calculate transfer moulding cycle time for a given product	3	02
7	Operate a transfer moulding machine for a given product safely	3	02
8	Calculate transfer moulding temperature for Phenol formaldehyde(PF)	3	02
9	Design to produce integral pot transfer mould for a given product	4	02
10	Design plunger transfer mould for a given product	4	02
11	Identify the parts of an injection mouding machine for thermoset	5	02
12	Operate an injection moulding machine for thermoset safely	5	02
	Total		**24**

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	Prepare 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 specifications for 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	Compression molding machine	1,2
2	Transfer molding machine	1,2
3	Injection molding machine for thermoset	1,2
4	POT transfer mold	3,4
5	Plunger Transfer mold	3,4
6	Weighing scale	3,4
7	Hopper loader	3,4
8	Testing equipments	4,5

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 fulfill the development of this competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Practice environmental friendly methods and processes to avoid metal 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 is formulated as higher 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 Compression moulding process	1a. Describe compression moulding machine parts 1b. Select appropriate material for product 1c. State the steps to operate compression moulding machine 1d. Apply compression moulding techniques on different systems.	1.1 Basic principle of compression moulding, Compression moulding press, Type, Manual, Semi automatic, Fully automatic, Constructional details, Heating system, Steam heating, Electric heating, Oil heating. 1.2 Material selection criteria, Fillers and additives, Preheating, Bulk factor and performs 1.3 Moulding process, Complete moulding cycle, Moulding cycle v/s time diagram, Process variables, Post curing, cooling fixtures and finishing, Advantages and disadvantages, Trouble shooting, Start-up and shut down procedure. 1.4 Applications of compression moulding
Unit– II Compression mould	2a. Distinguish different types of compression mould 2b. Design compression mould as per requirements 2c. Calculate powder well 2d. Distinguish between stripper plate mould and side-ram moulds	2.1 Hand compression mould, Mould parts, Function, Types, Open flash mould, Positive mould, Landed positive mould, Semi-positive mould. 2.2 Assembly and detail drawing, Automatic compression mould, Land length, Pressure pad, Powder well, Core pins and loose parts, significance, Methods of ejection. 2.3 Volume calculation, Height calculation, Press tonnage requirement for mould 2.4 Stripper plate mould, side-ram moulds
Unit– III Transfer moulding process	3a. Describe the concepts of transfer moulding. 3b. Describe the Machine	3.1 Basic principle of transfer moulding process 3.2 Transfer moulding machine, Constructional details, Types, Pot

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
	parts of transfer moulding. 3c. State the steps to operate transfer moulding machine for different applications 3d. Compare the compression moulding and transfer moulding.	transfer, Plunger transfer, Screw transfer 3.3 Moulding process, Process steps, Process variables, Advantages and disadvantages, Trouble shooting, Start-up and shut down procedure, Applications of transfer moulding 3.4 Compression moulding process vs Transfer molding process.
Unit – IV Transfer moulds	4a. Distinguish different types of transfer mould 4b. Design transfer mould as per requirements 4c. Design the various components for transfer mould 4d. Explain cull removing techniques	4.1 Introduction, Integral pot transfer mould, Mould parts, Function, Factors to be considered for determining pot dimensions, Plunger transfer mould, Types, Top plunger, Bottom plunger 4.2 Mould parts, Function, Transfer chamber calculation, Chamber depth, Transfer pressure, Compare Integral Pot transfer mould and Plunger transfer mould 4.3 Venting, gate and runner designs for transfer mould 4.4 Cull and its removal
Unit – V Injection moulding of thermoset	5a. Describe injection moulding machine parts 5b. Stated the steps to operate injection moulding machine 5c. Discriminate compression, transfer and injection moulding process	5.1 Basic principle of injection moulding, Constructional details of injection moulding machine 5.2 Moulding process, Process steps, Process variables, Advantages and disadvantages, Trouble shooting, Start-up and shut down procedure, Applications of injection moulding process 5.3 Comparison with injection moulding of thermoplastics, Comparison with compression and transfer moulding process.

***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 QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Compression moulding process	14	6	9	10	25
II	Compression mould	08	5	5	5	10
III	Transfer moulding process	07	3	3	4	15
IV	Transfer moulds	08	3	3	4	10
V	Injection moulding of thermoset	05	3	3	4	10
Total		**42**	**20**	**23**	**27**	**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 the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly 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 samples of various injection molded products.
2. Students will visit nearby injection molding process industry.
3. Students will showcase different types of defective products.

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 assessed using 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) Visit to nearby industries.
h) Video/animation films on working of an injection molding machine.

i) Video/animation films on remedies to overcome defects found in an injection molded products.

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) Compression, Transfer and Injection molding machine construction: Neat sketch along with names of all parts.
b) Auxiliary equipments: Show utilities of all these auxiliary equipments.
c) Compression, Transfer and Injection molding: Draw a cycle diagram and explain in detail.
d) Activities during Mold change: Detailed statement indicating activities during changing of molds.
e) Chart preparation on troubleshooting in a Compression, Transfer and Injection molding.
f) Collect products made by Compression, Transfer and Injection molding process.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1.	Injection Molding Advanced Troubleshooting Guide: The 4m Approach	Randy Kerkstra Steven Brammer	Publication:Hanser ISBN :978-1-56990-834-1 Year:2021
2.	Injection molding machine	A.Whelan	Publication: Elsevier applied science publishers ISBN: 0-85334-245-8 Year: 1984

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
3.	Injection molding theory and practice	Irvin I. Rubin	Publication: Wiley ISBN: 978-81-265-4576-6 Year:2014
4.	Injection Molding: Technology and Fundamentals	MusaR.Kamal , AvramI.Isayev	Publication: Hanser ISBN: 978-3446416857 Year:2009
5.	Injection molding handbook	Dominick V. Rosato, Donald V. Rosato, Marlene G. Rosato	Publication: Springer Science+Business Media, LLC ISBN 978-1-4613-7077-2 Year:2000
6.	Plastics Materials and Processes	SeymourS.Schwartz, SidneyH.Goodman	Publication: Van ISBN:9780442227777 Year:1982
7.	Injection and Compression Molding Fundamentals	Avraam I. Isayev	Publication: Taylor & Francis Inc CRC Press ISBN: 978-0824776701 Year:1987
8.	Compression Molding	Bruce Allen Davis	Publication: Carl Hanser Verlag GmbH & Co ISBN: 3446221662, 9783446221666 Year: 2003

14. SOFTWARE/LEARNING WEBSITES

1. Moldex3D 2022
2. Autodesk Moldflow
3. CADMOULD
4. Moldflow Insight
5. SolidWorks Plastics
6. Cadpress
7. Sigmasoft
8. Free3d molding
9. Siemens Automations
10. www.yotube.com

15. PO-COMPETENCY-CO MAPPING

Semester III	Technology for Injection Molding (Course Code: 4332303)
	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 materials 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	2	3	2	3	1	1	2	2	2	-
Course Outcomes 1 Set process parameters for compression m/c, transfer m/c and injection m/c of thermoset.	2	1	1	1	1	1	1	1	1	-
2 Select appropriate compression mould and material for various products	1	1	1	3	1	1	1	2	1	-
3 Select pot type/plunger type transfer moulding process	1	3	1	1	1	1	2	1	1	-
4 Troubleshoot problems in processing of thermoset materials	1	1	2	1	1	1	1	1	1	-
5. Recommend compression moulding process/transfer moulding process/ injection moulding process to produce a thermoset product.	1	1	1	1	1	1	3	1	2	-

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

GTU Resource Persons

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