GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Basic Mould Design
(Course Code: 4332302)

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

1. RATIONALE

Mould design is the heart of plastic engineering. The quality of any plastic component lies in the accurate design of plastic mould. Every plastic diploma engineer has to invariably handle different types of moulds and the materials required for product manufacturing in small scale or large scale plastic industries. Engineer will have to identify, analyze and choose the most relevant mould for different applications. Moreover engineer will also have to use different types of hand or machine operated plastic moulding equipment. Hence, this course has been designed to develop such competency and skills.

2. COMPETENCY

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

- **Select different type of plastic moulds for various injection molding applications.**

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) Draw suitable parting line for injection molded product.
b) Select integer/insert-bolster method for mould construction.
c) Select appropriate type of feed system.
d) Select appropriate ejection system for injection moulding products.
e) Design efficient cooling system for core and cavity plates.

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 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	Draw plan and sectional elevation of different injection moulded parts with actual dimensions.	I	2
2	Sketch various types of parting surfaces.		2
3	Draw plan and sectional elevation of various components of an injection mould.	II	4
4	Draw assembly drawing of hand injection mould for given plastic products.		8
5	Draw detail drawing of hand injection mould for given plastic products.		4
6	Draw various types of runner.	III	2
7	Sketch various types of gate.		2
8	Sketch ejector plate assembly, ejector elements, ejector systems and various types of sprue puller.	IV	4
9	Draw cooling system for integer type core & cavity	V	2
10	Draw cooling system for insert type core & cavity		2
	TOTAL		**32**

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	Product drawing planning.	20
2	Mold drawing layout planning.	30
3	Selection of scale as per drawing sheet dimensions.	10

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
4	Use of proper instruments.	20
5	Give proper dimensioning and annotations.	20
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	Interactive board with LCD overhead projector	1,2,3,4,5
2	Drawing board, drafter and other drawing instruments	1,2,3,4,5
3	Hand Injection Mold	1,2,3
4	Machine Injection Mold	1,2,3,4,5
5	Standard Mold Components- Register Ring, Guide Pin, Sprue Bush etc	2
6	Measuring Instruments – Vernier Caliper, Micrometer	1,2,3,4,5
7	Tools	2

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) 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 Injection Molded Part And Parting Surface	1a. Identify injection molded parts 1b. Compare flat parting surface and non-flat parting surface. 1c. Distinguish Stepped, Profiled and Angled parting surfaces 1d. For a given situation select the relevant parting surface	1.1 Introduction to injection molded products 1.2 Part drawing : Part sectional elevation and plan 1.3 Concepts of core, cavity and product 1.4 Parting line : Importance of parting line selection 1.5 Introduction to Parting surfaces 1.6 Flat parting surface 1.7 Non-flat parting surfaces: Stepped, Profiled, Angled parting surface & Complex edge forms
Unit – II Injection Mould Construction	2a. Describe functions of various mould components. 2b. Compare integer and insert-bolster methods 2c. Identify proper guide pin 2d. Select proper register ring 2e. Describe types of sprue pullers 2f. Distinguish the features between hand mould and machine mould	2.1 Basic Mold Terminology : Impression, Core and cavity plates, Fixed half and moving half, Sprue bush, Feed system : Runner-gate and sprue, Register ring, Ejection, Back plate, Socket headed screw, Dowel and Guide pin, Guide bush, Venting, Cooling channel, Ejector assembly 2.2 Mold Cavities and cores • Methods of incorporation core and cavity : Integer cavity and core plates, Insert-bolster • Inserts : Core and Cavity and its fitting methods • Types of bolster plates : Solid type, Strip type, Frame type, Chase type and Bolster Plate • Comparison of Integer and Insert-Bolster methods 2.3 Guide Pillar and Guide bush • Function of guide pillar and bush • Guide pillar and guide bush types : Leader pins, Standard, Spigotted, Surface fitting and Pull-back • Guide pillar size range

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
		• Material of construction • Positioning of Guide pillar 2.4 Sprue Bush : Spherical seating and flat fitting 2.5 Register Ring/ Locating ring • Function and importance • Types : Reduced diameter, Constant diameter, Increased diameter and Increased depth 2.6 Sprue puller and its types : Reversed tapered, Grooved, Z-type and Mushroom headed 2.7 Assembly and detail drawing of hand injection mold
Unit – III **Feed System**	2a. Compare feed system design for single and multi-impression mold 2b. Select proper runner cross section 2c. Distinguish runner balancing and gate balancing 2d. Select appropriate gate type	3.1 Introduction of feed system and its importance in mould design 3.2 Feed system structure for single impression and multi-impression 3.3 Runner Design : • Runner requirements • Runner cross section shape • Runner size • Runner layout for multi-impression molds • Runner balancing 3.4 Gate Design : • Gate requirements • Positioning of gate and its effect on product • Gate balancing • Types of gate : Sprue gate, Rectangular edge gate, Overlap gate, Fan gate, Tab gate, Diaphragm gate, Ring gate, Film gate, Pin gate, Round edge gate, Subsurface (submarine) gate and Winkle gate
Unit – IV		4.1 Introduction of ejection system

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
Ejection System	4a. State the need for the ejector grid 4b. Compare types of ejector grid 4c. Describe function of ejector plate assembly parts 4d. Understand functioning of ejector plate assembly return system 4e. Select suitable ejection technique	and its importance in mould design 4.2 Ejector grid and its types: • In-line ejector grid • Frame type ejector grid • Circular support ejector grid 4.3 Parts of ejector plate assembly and its function : ejector plate, retaining plate, ejector assembly guide system, ejector rod and rod bush, stop pins 4.4 Ejector plate assembly actuation methods 4.5 Ejector plate assembly return system 4.6 Ejection techniques : • Pin ejection • Stepped pin ejection • D-shaped pin ejection • Sleeve ejection • Blade ejection • Valve ejection • Air ejection • Stripper bar ejection • Stripper plate ejection
Unit – V Cooling System	5a. Justify the need for a cooling system. 5b. Select integer cavity plate cooling method 5c. Distinguish integer core plate cooling 5d. Select proper cavity insert cooling method 5e. Compare core insert cooling methods	5.1 Importance of cooling in mould design 5.2 Integer type cavity plate cooling methods: U-circuit, Rectangular circuit , Z-circuit 5.3 Integer type core plate cooling methods: Angle hole system, Baffled hole system, Stepped circuit 5.4 Cavity insert cooling: U-circuit, copper pipe system, Interconnecting groove design 5.5 Core insert cooling :Circular and rectangular milled groove design, Helical core cooling, Deep chamber design, Baffle hole system

***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	Injection Molded Part And Parting Surface	04	02	03	02	07
II	Injection Mould Construction	14	06	07	08	21
III	Feed System	08	06	04	04	14
IV	Ejection System	08	06	04	04	14
V	Cooling System	08	06	04	04	14
Total		**42**	**26**	**22**	**22**	**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 injection moulded articles and observe parting line on articles.
2. Students will collect feed system for single impression and multi-impression molds.
3. Students will visit nearby mould making industry.

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:

f) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
g) Guide student(s) in undertaking micro-projects.
h) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.

i) 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.
j) With respect to ***section No.11***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
k) Guide students on how to address issues on environment and sustainability.
l) Visit to nearby mold making industries.
m) Video/animation on working of different type of injection molds.

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:

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1.	Injection Mold Design	Pye R.G.W	Affilited East-West Press Pvt. Ltd, New Delhi, 2018, 5551234102501
2.	The Complete Part Design Handbook	Campo, E.	Hanser Publications, Ohio, 2006, 9783446412927
3.	How to Make Injection Molds	Menges, G., Michaeli, W., Mohren, P.	Hanser Publications, Ohio, 2001, 9781569902820
4.	Injection Mold Design Handbook	Caoen B., Rees H.	Hanser Publications, Ohio, 2022, 9781569908150
5.	Injection Mold Design Engineering 2e	Kazmer, D.	Hanser Publications, Ohio, 2016, 9781569905708
6.	Plastics Mold Engineering Handbook	Dubois J.H., Pribble W.I	Springer US, 2013, 9781468465808

14. SOFTWARE/LEARNING WEBSITES

1. https://www.waste.nl/wp-content/uploads/2021/01/29-Vertical-injection-mould-machine_FINAL_eng.pdf
2. Components of an Injection Mold (ewmfg.com)
3. The-Basics-of-Mold-Design-4-Part-1-A-Look-at-Parting-Surface-and-Its-Types : Skill-Lync
4. Injection molding gate types and their application-moldchina.com
5. https://www.natechplastics.com/select-the-right-ejection-system
6. fy17-mold-engineer-11-factors-mold-cooling-ebook-en.pdf (autodesk.net)
7. Injection Mold Cooling Design guideline for Core & Core Pin - Upmold

15. PO-COMPETENCY-CO MAPPING

Semester I	**Basic Mould Design (Course Code: 4332302)**									
	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 different types of plastic moulds for various injection molding applications.**	2	1	3	1	1	1	1	3	-	-
Course Outcomes										
1 Draw suitable parting line for injection molded product.	2	-	3	1	-	-	1	3	-	-
2 Select integer/insert-bolster method for mould construction.	3	1	3	1	1	1	1	3	-	-
3 Select appropriate type of feed system.	2	1	3	1	-	1	1	3	-	-

4 Select appropriate ejection system for injection moulding products.	2	1	3	1	1	1	1	3	-	-
5. Design efficient cooling system for core and cavity plates.	2	1	3	1	1	-	1	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

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
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