GUJARAT TECHNOLOGICAL UNIVERSITY

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

Diploma Engineering Syllabus (Semester VII)

Subject Code : 4372302

Subject Name : Design for Extrusion Dies

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

1. RATIONALE

Extrusion is the highest plastic consuming process mainly used for continuous manufacturing of rods, profiles, tubes, pipes, films, sheets, wire and cable etc. Amongst the different items of equipment employed for the operation of extrusion process, the extruder and die are perhaps the most important. Extrusion die design is a complex process that requires careful consideration of various factors to ensure optimal performance, product quality, and cost efficiency. Collaboration between engineers, material scientists, and manufacturing experts is often necessary to achieve the best results. A Plastic Diploma engineer has to supervise the designing and manufacturing process of dies and monitor extrudate production using these dies. This competency requires the knowledge of various designing aspects of extrusion dies. 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:

- **Design extrusion dies as per requirements of consumer.**

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) Identify various flows with respect to melt rheology.
b) Examine extrusion die design factors.
c) Illustrate assembly of die adaptor with screen pack and breaker plate.
d) Design extrusion die for various applications.

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 assembly drawing of blown film die.	IV	12
2	Draw detail drawings of blown film die drawn above.	IV	08
3	Draw assembly drawing of pipe die.	IV	08
	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.*

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Select proper die construction materials.	10
2	Analyze various die design factors.	20
3	Select proper die adaptor and breaker plate-screen pack assembly.	20
4	Analyze constructional features of dies for various extruded products.	20
5	Design dies for various extruded products.	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	Single screw extruder	1,3
2	Blown film die	1,2
3	Pipe die	3
4	Interactive board with LCD overhead projector	1,2,3
5	Drawing board, drafter and other drawing instruments	1,2,3

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 wastages

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 Polymer Melt Rheology	1a. Understand the terms related with rheology 1b. Identify various types of flow 1c. Compare various types of flow	1.1 Basic Definitions: shear, shear stress, shear rate & viscosity 1.2 Viscosity under simple shear: Effect of shear stress and shear rate on viscosity of melt 1.3 Velocity profiles of Newtonian and Non-Newtonian fluids 1.4 Types of flow 1.5 Elasticity under simple shear: Visco-elasticity, viscous flow and elastic flow
Unit- II Basics of Die Design	2a. Identify materials for extrusion die 2b. Understand die geometry 2c. Identify Factors affecting die design. 2d. Analyse die design factors	2.1 Factors affecting die design 2.2 General die design rules 2.3 Materials for extrusion dies 2.4 Equation for output of Newtonian fluid through tubular cross section 2.5 Land length and its importance in die design 2.6 Die geometry 2.7 Die restriction methods and its effect on melt flow 2.8 Die streamlining methods 2.9 Melt fracture phenomenon

		2.10 Die-swell and its effect on extrudate
Unit – III **Die Adaptor, Breaker Plate & Screen Pack**	3a. Understand die adaptor design 3b. Select proper adaptor design 3c. Understand functions of breaker plate and screen packs 3d. Analyse various breaker plate designs 3e. Select proper breaker plate design	**Die Adaptor** 3.1 Significance of die adaptor 3.2 Position of die adaptor and its fitting methods 3.3 Factors to be considered for adaptor design **Screen Pack & Breaker Plate** 3.4 Position and functions of screen pack and breaker plate 3.5 Various breaker plate designs 3.6 Factors for correct breaker plate assembly
Unit – IV **Types of Extrusion Dies**	4a. Understand constructional features of various dies 4b. Analyse various dies according to shape of extrudate 4c. Compare various types of die 4d. Select proper die	4.1 Types of various extrusion dies with respect to melt flow direction 4.2 Straight through, crosshead, offset dies and its applications **Flat and Tubular Film Dies** 4.3 Tubular (blown) film dies – side fed & center fed dies 4.4 Constructional features of tubular dies 4.5 Comparison of side fed & center fed tubular dies 4.6 Constructional features of flat film die 4.7 Multilayer film die and its features 4.8 Compare feed block and multi-manifold multilayer dies **Wire Coating Die** 4.9 Pressure and tubing die 4.10 Constructional features of wire coating die and functions of various components **Pipe & Tube Die** 4.11 Constructional features of tube die

		4.12 Construction features of straight through and offset pipe die 4.13 Significance of internal and external sizing calibrators **Sheet Dies** 4.14 Constructional features of coat hanger sheet die 4.15 Fish tail die constructional features and its applications **Dies for Solid Sections** 4.16 Dies for Rod, tape and profiles

***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.*

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	Polymer Melt Rheology	4	2	5	0	07
II	Basics of Die Design	12	4	12	5	21
III	Die Adaptor, Breaker Plate & Screen Pack	8	4	8	2	14
IV	Types of Extrusion Dies	18	4	14	10	28
Total		**42**	**42**	**14**	**39**	**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.*

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:

1. Students will collect information about recent trends in extrusion die design.
2. Students will prepare banners showing constructional features of various dies.
3. Students will visit nearby industries and collect information about die design.

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:

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) Collect information on machine shop available locally.
h) Visit to nearby industries related to die manufacturing industries.
i) Video/animation on design of different type of extrusion dies.

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.	Extrusion of Plastics	Fisher E.G	Plastics and Rubber Institute, 1989, 9780470150122
2.	Extrusion Dies for Plastics and Rubbers	Michaeli W., Chapman H.	Carl Hanser Verlag GmbH & Company KG, 2017, 9781569906811
3.	Dies for Plastics Extrusion	Joshi M.V.	Macmillan India Limited, 1992, 9780333904497
4.	Polymer Extrusion	Rauwendal C.	Carl Hanser Verlag GmbH & Company KG, 2014, 9781569905166
5.	Extruding Plastics	Rosato D.V.	Springer US, 2013, 9781461557937
6.	Die Design for Extrusion of Plastic Tubes and Pipes	Sushil Kainth	Hanser Publishers, 2018, 9781569906729

14. SOFTWARE/LEARNING WEBSITES

1. https://www.researchgate.net/publication/267231878_Basic_Concepts_in_Polymer_Melt_Rheology_and_Their_Importance_in_Processing
2. What Are Newtonian and Non-Newtonian Fluids? (craneengineering.net)
3. https://www.dynisco.com/userfiles/files/The_Die_and_Post_Extrusion_Equipment.pdf
4. https://www.gmatw.com/en/article/Here-are-10-key-points-to-understand-extrusion-dies.html
5. https://youtu.be/WaB-dsB1Kfk
6. https://www.youtube.com/watch?v=XfJ5f3FGAuI&pp=ygUdYnJlYWtlciBwbGF0ZSBhbmQgc2NyZWVuIHBhY2s%3D
7. https://www.youtube.com/watch?v=6OdSNuqeF4E&pp=ygUXdHlwZXMgb2YgYmxvd24gZmlsbSBkaWU%3D
8. https://www.youtube.com/watch?v=HXZyAz9mMKA&pp=ygUfc2l6aW5nIGNhbGlicmF0b3JzIGZvciBleHRydWRlcg%3D%3D
9. https://youtu.be/zcBv_JvFDBI

15. PO-COMPETENCY-CO MAPPING

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

Semester VI	Design for Extrusion Dies (Course Code: 4372302)									
	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 Design extrusion dies as per requirements of consumer.	1	3	3	2	2	2	2	3	1	-

Course Outcomes										
1. Identify various flows with respect to melt rheology.	1	2	1	1	1	1	2	3	1	-
2. Examine extrusion die design factors.	1	2	2	2	1	1	2	3	1	-
3. Illustrate assembly of die adaptor with screen pack and breaker plate.	1	2	2	2	1	1	2	2	1	-
4. Design extrusion die for various applications.	1	3	3	2	2	1	2	3	1	-

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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