GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Metallurgy Engineering

Course / Subject Code : DI02021011

Course / Subject Name: Metallurgical Drawing

w. e. f. Academic Year:	2024-2025
Semester:	2nd
Category of the Course:	ESC

Prerequisite:	N.A.
Rationale:	Drawing serves as a fundamental medium for communication and representation in the field of design and engineering. It plays a crucial role in bridging the gap between conceptual ideas and practical implementation, especially for technicians who closely collaborate with design engineers. Mastery of technical drawing skills equips students with the ability to visualize objects in three-dimensional space and interpret complex working drawings, thereby translating engineering concepts into precise lines, shapes, and dimensions. This course in the diploma program is designed to enhance students' proficiency in technical drawing while fostering a comprehensive understanding of critical aspects of metallurgy engineering design.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Illustrate the seven crystal systems (cubic, tetragonal, orthorhombic, hexagonal, monoclinic, triclinic, and trigonal) used to describe metallic structure	R,U
02	Interpret and draw binary phase diagrams, Iron-Carbon equilibrium diagrams, Time-Temperature-Transformation (TTT), and Continuous Cooling Transformation (CCT) diagrams to analyze phase changes in metals and understand their thermal and mechanical properties.	R/U
03	Create technical drawings of furnaces, including refractory materials, auxiliary components, and fuel systems, showcasing design principles and internal structures.	R/U
04	Illustrate various types of weld joints, weld grooves, and welding positions used in industrial applications, adhering to standard welding symbols and specifications.	R/U
05	Draw various casting patterns, including split, match plate, and gated patterns, and represent gating systems, risers, and runners in casting processes.	R/U

06	Draw metal forming operations such as rolling, forging, extrusion, and drawing with detailed illustrations of equipment.	R/U

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
0	0	6	3	0	0	50	50	100

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Crystal Structure Representation** • Introduction to crystallography and metallic structures. • Visualization and drawing of the seven crystal systems	12	15
2.	**Phase and Transformation Diagrams** • Construction and interpretation of binary alloy diagrams • Draw the iron carbon diagram. • Drawing TTT diagrams for eutectoid steel. • Drawing CCT diagrams and analyzing practical cooling processes.	18	20
3.	**Furnace Design and Components** Draw drawings of following furnaces; • Blast furnaces • LD furnace • Electric arc furnaces. • Induction furnaces.	18	20

4.	**Welding and Joint Design** Draw the following: • Types of weld joints: butt, lap, corner, edge, and T-joints. • Weld groove types: square, bevel, V, U, and J grooves. • Welding positions: flat, horizontal, vertical, and overhead. • Drawing and interpretation of standard welding symbols.	15	15
5	**Pattern and Gating System Design** Draw the below followings: • Types of casting patterns:	15	15
	• Solid, split, gated, match-plate, and skeleton patterns. • Gating system components: sprue, runners, risers, and gates.		
6	**Metal Forming Operations** • Draw the Rolling, Forging and Extrusion operation.	12	15
	Total	**90**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
50	50	0	0	0	0

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

Sr. No.	**Title of Book**	**Author**	**Publication with place, year and ISBN**
1	Introduction to Foundry Technology	Winter, A.K.	McGraw-Hill, New York, 1958
	Foundry Technology	Peter R. Beeley	Halsted Press Division, Wiley, New York, 1972, ISBN: 0470153067

2	Engineering Metallurgy Vol. I & II	Higgings, R.A.	Tata McGraw-Hill
3	Mechanical metallurgy	Dieter	McGraw-Hill, New York, 1986 (3rd Edition) ISBN: 0070168938.
4	Elements of metallurgy	Swaroop, D	Rastogi Publications

(b) Open-source software and website:

1. https://www.youtube.com/watch?v=Qs_Ykrjdsus
2. https://www.youtube.com/watch?v=-GZ9ZqK_Ac0
3. https://www.youtube.com/watch?v=QCcgvIgYHpw
4. https://www.youtube.com/watch?v=bKri_B1ruVg
5. https://www.youtube.com/watch?v=iB6jArEloYE
6. https://www.youtube.com/watch?v=YuQFhbRaWD0
7. https://www.youtube.com/watch?v=nrYv4Io0SQs

Suggested Course Practical List:

No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Draw the seven crystal systems: cubic, tetragonal, orthorhombic, hexagonal, monoclinic, triclinic, and trigonal.	I	06
2	Construct and interpret binary phase diagrams for alloys (e.g., Cu-Ni or Al-Si systems).	II	06
3	Draw the iron-carbon equilibrium diagram with all critical phase regions (ferrite, austenite, cementite, and pearlite).	II	12
4	Create a Time-Temperature-Transformation diagram and Continuous Cooling Transformation diagram for eutectoid steel.	III	12
5	Drawing Industrial Furnaces like blast furnace, LD furnace, electric arc furnace, and induction furnace.	IV	12
6	Draw different weld joints: butt, lap, corner, edge, and T-joints, weld grooves: square, bevel, V, U, and J and welding positions.	V	12

7	Draw solid, split, gated, match-plate, and skeleton patterns used in casting processes and Illustrate gating components such as sprues, runners, risers, and gates, indicating flow paths for molten metal.	V	12
8	Draw the process of rolling, showing rolls, input material, and deformation zones. Illustrate open-die and closed-die forging processes, labeling dies, hammers, and workpieces. Draw the direct and indirect extrusion process with cross-sections of the extrusion die and material flow.	V	12
Total		**84**	

List of Laboratory/Learning Resources Required:

Sr. No.	Equipment Name with Broad Specifications
	NIL

Suggested Project List:

- Modeling and Visualizing the Seven Crystal Systems in Metals
- Constructing and Analyzing Binary Alloy and Iron-Carbon Diagrams
- Design and Sectional Drawing of an Industrial Furnace
- Designing and Drawing Welding Joints and Grooves
- Designing a Complete Gating System for a Casting
- Drawing and Analyzing Metal Forming Processes: Rolling, Forging, and Extrusion
- Investigation of the Effects of Cooling Rates on Steel Microstructures
- Simulation of the Iron making Process in a Blast Furnace

Suggested Activities for Students:

1. Provide students with models of different materials (metals and alloys). Have them identify and categorize the crystal systems in these material

2. Provide students with TTT and CCT diagrams for eutectoid steel and ask them to predict phase transformations under different cooling conditions.
3. Ask students to design key furnace components such as tuyères, hearth, and charging mechanisms for a blast furnace.
4. Create a quiz where students match welding symbols with the correct joint type, groove type, and position.

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