



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Metallurgy Engineering

Course / Subject Code : DI03021041

Course / Subject Name : Metal Forming

w. e. f. Academic Year:	2024-25
Semester:	3 rd
Category of the Course:	PCC

Prerequisite:	Students are expected to possess a foundational understanding of engineering materials, mechanics of materials, workshop practices, and engineering drawing.
Rationale:	This course examines the critical role of metallic engineering products across diverse industries, including construction, fabrication, and transportation. Recognizing metal forming processes such as rolling, forging, extrusion, and drawing as primary manufacturing methods for these products, the curriculum is designed to introduce students to the fundamental principles underpinning these techniques, with a strong emphasis on the associated metallurgical considerations. Given that metal forming constitutes a foundational manufacturing practice, a thorough understanding of metal deformation behavior, the consequent alterations in mechanical and physical properties, and the essential equipment employed in component production is imperative. This course aims to equip students with a comprehensive knowledge of metalworking operations that optimize both the metallurgical integrity and the economic efficiency of component manufacturing.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Classify and differentiate metal forming processes	R
02	Select rolling process for manufacturing of specific products	U
03	Discuss various forging processes	U
04	Explain extrusion and drawing as metal forming processes	U
05	Choose miscellaneous metal forming process for specific products	A

**Revised Bloom's Taxonomy (RBT)*



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Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	Introduction to metal forming processes: 1.1 Mechanical properties of metals and alloys 1.2 Stress-strain diagram for elastic and plastic materials 1.3 Metallurgical factors in metal forming processes 1.3.1 Types of deformation 1.3.2 Recovery 1.3.3 Recrystallization 1.3.4 Grain growth 1.3.5 Strain hardening 1.4 Classification of metal forming processes 1.5 Importance and applications of metal forming 1.6 Advantages and limitations of various metal forming processes. 1.7 Hot and cold metal working processes	08	18%
2.	Rolling Process: 2.1 Introduction of the rolling process 2.2 Theory and principles of rolling 2.3 Types of rolling mills and equipment 2.4 Manufacturing of rolled products like sheet, angle and channel 2.5 Defects in rolled products and remedies	08	18%
3.	Forging Process: 3.1 Introduction to forging processes 3.2 Types and applications of forging operations 3.3 Equipment used in forging 3.4 Advantages and limitations of forging. 3.5 Defects in forged products and remedies	08	18%



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4.	Drawing and extrusion processes: 4.1 Principles of drawing and extrusion processes 4.2 Classification and types of drawing and extrusion 4.3 Machines and equipment used in drawing and extrusion 4.4 Application, advantages and limitations of drawing and extrusion 4.5 Common defects and remedies in drawing and extrusion	08	18%
5.	Sheet Metal Forming Processes: 5.1 Introduction to sheet metal forming 5.2 Bending and deep drawing processes 5.3 Stretch forming and blanking 5.4 Piercing, slug production, and coining	08	18%
6.	Sustainability in Metal Forming Industries: 6.1 Introduction to sustainable metal forming 6.2 Energy consumption and waste management 6.3 Material efficiency and recycling in metal forming 6.4 Environmental impact and regulations 6.5 Future trends in sustainable metal forming	05	10%
Total		45	100%

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
18	26	26	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:

1. Mechanical Metallurgy by George E. Dieter (Tata McGraw-Hill, New Delhi, India, 2012, ISBN: 0-07-100406-8)
2. Handbook of Metal Forming by Kurt Lange (Society of Manufacturing Engineers, Michigan, USA, 1985, ISBN: 0-87263-457-4)
3. Technology of Metal Forming Processes by Surender Kumar (PHI Learning, New Delhi, India, 2008, ISBN: 978-81-203-3425-0)
4. Manufacturing Technology, Volume 1 (Foundry, Forming and Welding) by P. N. Rao (McGraw-Hill, New Delhi, India, 2013, ISBN: 978-1-25-906257-5)



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5. Engineering Metallurgy: Part II by R. A. Higgins (Hodder and Stoughton, London, England, 1976, ISBN: 9780340185063)
6. Metal Process Engineering by P. Polukin, B. Gringerg, S. Kantenik, V. Zhadan, and D. Vasilye (MIR Publishers, Moscow, Russia, 1977)

(b) Open source software and website:

1. <http://msvs-dei.vlabs.ac.in/msvs-dei/>
2. <https://nptel.ac.in/courses/112107250>
3. <https://youtu.be/aQf6Q8t1FQE>
4. https://youtu.be/Um_g8sQ_p3Y
5. <https://www.altair.com/newsroom/partner-perspectives/sustainability-in-metalforming/>

Suggested Course Practical List:

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approximately Hours required
1.	Analyze mechanical properties of metals and alloy with the help of stress-strain diagram.	1	2
2.	Compare microstructural changes before and after metal forming.	1	4
3.	Demonstrate the construction, working, and types of rolling mills based on roll arrangements	2	4
4.	Demonstrate cold and hot rolling operations to produce flat products such as strips and plates, and observe their effects on surface finish.	2	4
5.	Identify defects of rolling products and suggest remedies.	2	2
6.	Demonstrate the use of forging equipment for open-die and closed-die forging operations	3	4
7.	Identify defects of forging products and suggest remedies.	3	2
8.	Demonstrate wire drawing and rod extrusion processes.	4	4
9.	Identify various products manufactured by sheet metal operations.	5	4
		Total	30 hrs.



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List of Laboratory/Learning Resources Required:

Sr. No.	Equipment Name with Broad Specifications
1.	Universal Testing Machine (UTM) <ul style="list-style-type: none">- Capacity: 20 Ton to 40 Ton (suitable for mild steel and aluminum samples)- Type: Computerized / Digital or Analog- Load Cell Accuracy: $\pm 1\%$ of indicated load- Grips: Wedge-type for flat and round specimens- Accessories: Extensometer, bending fixtures
2.	Metallurgical Microscope <ul style="list-style-type: none">- Magnification: 100\times, 400\times, 600\times, 1000\times- Eyepiece: 10\times, 15\times- Objective lenses: 10\times, 40\times, 100\times (oil immersion)- Light Source: LED or Halogen with intensity control- Stage: Mechanical XY movement with fine and coarse focus
3.	Specimen Preparation Set <ul style="list-style-type: none">- Abrasive Cutter: 4"–10" cutting wheel, coolant system, vice clamp- Belt Grinder: 1 HP motor, 100 mm wide belt, adjustable table- Polishing Machine: Double disc, 8" or 10" dia., variable speed (500–1000 rpm)- Consumables: Emery papers (80 to 1000 grit), alumina powder, velvet cloth, etchants
4.	Manual Rolling Mill <ul style="list-style-type: none">- Roller Diameter: 100–150 mm- Roll Face Width: 200–300 mm- Drive: Manual hand-crank or motorized (optional)- Roll Material: Hardened steel- Gap Adjustment: Screw or lever-type
5.	Forging Furnace (Lab Scale) <ul style="list-style-type: none">- Type: Muffle Furnace / LPG-Fired Forge Furnace- Max Temperature: 1100–1200$^{\circ}$C- Chamber Size: 150 mm x 150 mm x 300 mm (varies by model)- Temperature Control: Digital PID controller with thermocouple
6.	Anvil and Forging Tool Kit <ul style="list-style-type: none">- Anvil: Weight: 40–100 kg, hardened cast iron or steel- Tools: Hand hammer (1-3 kg), sledge hammer, flatters, tongs, swages, chisels
7.	Model Sets, Charts, and Posters <ul style="list-style-type: none">- Posters/Charts: Rolling mill types, forging processes, extrusion steps, drawing setups- Cut-section Models: Die setups, roll arrangements, product profiles- Size: Standard A2/A1 laminated prints



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Additional suggested project list:

1. Investigate how cold working affects tensile strength, hardness, and ductility using standard test methods.
2. Perform rolling on small metal pieces and evaluate surface quality and thickness reduction.
3. Prepare and observe specimens under a microscope to compare grain structure changes.
4. Document common defects in metal forming with sketches or real samples and suggest remedies.
5. Perform both hot and cold working on similar materials and evaluate dimensional precision.
6. Create a model or poster presentation showing different roll arrangements used in industry.
7. Survey nearby fabrication or manufacturing units and document the sheet metal processes they use.
8. Illustrate the drawing and extrusion operations, including equipment and process steps.
9. Analysis of grain structure change during recrystallization after deformation
10. Use metallography to study the microstructural changes near forged zones.
11. Design a comprehensive display showing types of forming processes and their applications.

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