



# GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3171921

Semester – VII

Subject Name: METAL FORMING ANALYSIS

Type of course: Professional Elective

Prerequisite: Nil

### Rationale:

In present era it is highly essential to be able to prepare final product with minimum wastage and good surface quality. This is desirable to ensure that all the expected requirement of product are addressed and if required, its performance is also assessed. Metal forming offers a convenient option for manufacturing of product.

### Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
3	0	2	4	70	30	30	20	150

### Content:

Sr. No.	Content	Total Hrs
1	Introduction to hot forming, cold forming, warm forming its advantages and disadvantages Typical stress strain diagram for ductile materials Forming properties of metals and alloys (yield strength/flow stress, ductility, strain hardening, strain rate sensitivity, effect of temperature and hydrostatic pressure on yield strength) Classification of forming processes and advantages of metal forming.	02
2	Stress of stress at a point, stresses on an inclined plane, Principal stress, Two dimensional Mohr's circle for stress analysis, Deformation and strain, Stress of strain at a point. Yield conditions, Von Mises' hypothesis of yielding, Tresca's hypothesis of yielding, graphical representation of yield criteria, Elastic stress strain relations for isotropic elastic materials, Idealized stress strain relations in plastic deformations, Isotropic and kinematic work hardening	08
3	Introduction to; (i). Theory of slip lines, (ii). upper bound theorem and (iii). lower bound theorem	03
4	FORGING processes: Introduction, classification of forging, forging machines, metal flow in forging, Analysis of plane strain compression, analysis of compression of circular disc	06



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	with slab method	
5	EXTRUSION Processes: Introduction, calculation of extrusion load using slab method, slip line method & upper bound method. Defects in extrusion. Direct & indirect extrusion. WIRE DRAWING Processes: Introduction, defects, maximum possible reduction. Wire drawing load calculation using slab method.	06
6	ROLLING Processes: Classification, types of mill, Analysis of longitudinal strip or sheet rolling process (calculation of roll separating force, torque & power, angle of bite, maximum reduction in rolling), rolling defects, roll flattening, roll camber	06
7	SHEET METAL FORMING Processes: various sheet metal operations, Blanking and punching operations, compound and progressive dies, nesting, clearance, forces in blanking, Bending of plates, bendability, spring back, bending force, bending moment for real material, stress and strain in bending, stress in deep drawing, drawability. drawing load, Anisotropy in sheetmetal	10
8	Introduction to forming limit diagram, Friction and lubrication in forming processes	04
	Total Hours	45

### Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	10	10	10	10	10

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

### Reference Books:

1. Ghosh A. and Mallik A. K., "Manufacturing Science", East -West Press, New Delhi, 1998.
2. Juneja B. L., "Fundamentals of Metal Forming Processes", New Age International Publishers, 2010.
3. Hosford William F. and Caddell R. M., "Metal Forming Mechanics and Metallurgy", Prentice Hall, 1993.



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4. Mielnik Edward M., "Metal Working Science and Engineering", McGraw Hill, 1991.
5. Dieter G. E., "Mechanical Metallurgy", McGraw Hill, 1988.
6. Rao P.N., "Manufacturing Technology", Tata McGraw Hill, 1990.
7. Wangoner Robert H. and Jean-Loup Chenot, "Fundamentals of Metal Forming", John Wiley & Sons, 1997.
8. Beddoes J. and Bibby M. J., "Principles of Metal Manufacturing Processes", Viva Books, 2000.
9. Sharma P. C., "Production Engineering", S. Chand & Co., New Delhi, 2003

### Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Classify various forming process	10
CO-2	Analyse theory of stress strain	15
CO-3	Identify and analyse various methods bulk metal forming processes	40
CO-4	Analyse sheet metal forming processes	25
CO-5	Evaluate forming limit diagram	10

### List of Experiments:

#### Experiments based on above contents and should include below mentioned topics.

1. To construct a slip-line net for upsetting a work piece.
2. Experimental determination of stress strain behavior for ductile material and to evaluate the various elastic and plastic constants.
3. To analyze flow stress of the given material and to plot a graph of forging ratio vs. flow stress.
4. Plot the bulge profile of the forged pieces, to find the radius of curvature of bulging of the forged pieces and to plot a graph of forging ratio vs.  $H_f / R_c$ .
5. To analyze the bending force vs. bending angle for 'V' bending of strip and to plot the strain distribution.
6. SHEET METAL FORMING Processes: various sheet metal operations, Blanking and punching operations, compound and progressive dies, nesting, clearance, forces in blanking, Bending of plates, bendability, spring back, bending force, bending moment for real material, stress and strain in bending, stress in deep drawing, drawability. drawing load, Anisotropy in sheetmetal



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7. Introduction to forming limit diagram, Friction and lubrication in forming processes
8. To measure the force required in extrusion of model material by using a die having different diameter and to draw the graphs between extrusion force vs. extrusion ratio.
9. To study the rolling process and plot the graph for percentage reduction in area vs. power in rolling.
10. Industrial visits for exposure to various metal forming processes and report preparation based on observations and learning.

### **Design based Problems (DP)/Open Ended Problem:**

1. Review of various methods for experimental measurements of friction in metal forming processes.
2. To plot the forming limit diagram and to study the effect of various strain paths on formability
3. To review research paper on experimental strain measurement in sheet metal forming processes

### **List of Open Source Software/learning website:**

1. Code\_Aster
2. AutoForm
3. CalculiX
4. [www.nptel.ac.in](http://www.nptel.ac.in)