ME406 Elastic and Plastic Behavior of Materials										
L	**T**	**P**	Credit	Area		**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
3	0/1	2/0	4	DEC/GEC		15/25	25	20/25	40/50	-

Objective: To familiarize the students with basics of state of stress and strain, in three dimensions, Yield criteria, forming processes, forging, rolling, wire drawing. To impart in-depth knowledge of real-life application Sheet metal forming operations, Sheet metal cutting operations like blanking, shearing and laser cutting and its force analysis, bending and spring back, die design for deep drawing and bending

Syllabus		**Contact Hours**
Unit-1	**Introduction:** Stress and strain tensor, three invariants, transformation rules, equilibrium equations, Study of stress-strain diagrams of various materials under states of tensile, compressive, shearing and bending stress.	**6**
Unit-2	**Basic theory of elasticity:** Constitutive law, Generalized Hooke's law, work of elastic deformation, plane stress and plane strain conditions, simple shear, elastic change in volume and shape, specific work of elastic deformation	6
Unit-3	**Fundamentals of plastic deformation:** General information about structure of metals, single crystal and its deformation, geometry and movement of dislocations, Burger's vectors, circuits and dislocation loops, deformation of metals: slip and twinning, effect of hot and cold working on properties of metals. Micro and macro hardness tests, Erichsen cupping test, Limit dome height test, forming limit diagram. **Elements of plasticity:** Flow curves, true stress-true strain, yielding criteria in metals, strain hardening and discontinuous yielding, combined stress states, yield locus, anisotropy in yielding, yield surface and normality, Octahedral shear stress and shear strain, plastic stress-strain relations.	8
Unit-4	**Fracture:** Study of ductile and Brittle fractures, Griffith theory of brittle fracture, ductile fracture, ductile - Brittle transition behaviour, notch effect and notch sensitivity, effect of hydrostatic pressure on fracture and methods of protection against fracture. Strain energy release rate, stress intensity factor, fracture toughness and design, plane strain toughness testing, plasticity corrections, Crack opening displacement, J-integral.	8
Unit-5	**Fatigue:** Stress cycles, the nature of fatigue: low cycle and high cycle fatigue, S-N curve, mechanism of fatigue, fatigue strength of metals and statistical nature of fatigue, effect of mean stress on fatigue, strain life equations, fatigue crack propagation, stress concentration, size and surface effects on fatigue, fatigue failure under combined stress, cumulative fatigue damage due to varying amplitude of stress, other factors affecting fatigue strength, local strain approach.	6
Unit-6	**Creep:** Time dependent mechanical behaviour, creep curve, design curves, Constant-temperature creep tests, mechanism of creep rupture: dislocation, diffusion and grain boundary sliding, deformation mechanism maps, activation energy for steady state creep, empirical relation for creep behavior, plastic flow rules for creep, metallurgical factors affecting creep behaviour, selection of creep resistant materials and applications.	**8**
	Total	**42**

Reference Book:	
1	Mechanical metallurgy, George E. Dieter, 1988, Mc Graw Hill, New York, ISBN-0071004068.
2	Metal forming- Mechanics and Metallurgy. Hosford, W.F., Cadell, R. M., 2007. Cambridge University Press, ISBN- 0521881218.

3	Dislocations and mechanical behaviour of materials, Shetty, M.N., 2013, PHI Learning, New Delhi, ISBN-9788120346383.

Course Outcomes

CO1	Describe the elastic and plastic behaviour from stress-strain curves for materials;
CO2	Recognize typical plastic yield criteria established in constitutive modeling;
CO3	Understand the physical interpretation of material constants in mathematical formulation of constitutive relationship;
CO4	Analyze theories of failure and design components for safe operation.
CO5	Develop constitutive models based on experimental results on material behavior.
CO6	Examine the properties of ideally plastic solid and apply the concepts of energy methods in solving structural problems.

CO-PO/PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	1	2	2	1	3
CO2	3	3	2	2	2	2	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	2	2	1	1	1	1	1	2	2	1	3
CO4	3	3	3	3	2	2	2	1	1	1	1	2	3	1	2
CO5	3	3	3	3	3	2	2	1	1	1	1	3	3	2	3
CO6	3	3	3	3	3	2	2	2	1	1	1	2	3	2	3