17MD013THEORY OF PLASTICITY

COURSE CODE	COURSE TITLE	L	P	T	C
17MD013	THEORY OF PLASTICITY				

Course Objectives:

1. To understand the concepts of stresses, strains and stress-strain relationships, as well as Yield and failure criteria.
2. To provide the knowledge of various theoretical elements of plasticity and establish plasticity models for metallic structures.
3. To apply the principles of the theory of plasticity for large deformations in nonlinear analysis of structures.

Learning Outcomes:

After the completion of this course, students will be able to:

1. Describe the elastic and plastic behaviour from stress-strain curves for materials;
2. Recognize typical plastic yield criteria established in constitutive modeling;
3. Understand the physical interpretation of material constants in mathematical formulation of constitutive relationship;
4. Solve analytically the simple boundary value problems with elasto-plastic properties;
5. Develop constitutive models based on experimental results on material behavior.

Lab Components:

1. Equal Channel Angular Press (ECAP) test of an aluminium billet through an 90 degree channel;
2. Strain hardening test of a metal (aluminium) after large plastic deformation.

Skills Acquired:

1. Derive the equations in the theory of plasticity for large deformations and apply established plasticity models in the analysis of metallic structures.
2. Identify material parameters from laboratory experiments, and implement plasticity models in the nonlinear analysis of mechanical structures.

UNIT-I

Introduction :Uniaxialbehaviorinplasticity,Indexnotation,Cartesiantensors, Yieldand failurecriteria,stressdeviatortensors, invariants principal stresses, mean stresses,Elastic strain energy,Mohr'srepresentation ofstressin2&3dimensions,Haigh-westergaardstressspace, Yieldcriteria:Tresca&vonMisesrules,Drucker-prager criterion, anisotropic yieldcriteria.

UNIT-II

Strainat point:Cauchy'sformulaforstrains,principalstrains,principalshearstrains,derivativestrain tensor, Strain-displacementrelationships, Linearelasticstressstrainrelations, generalizedHooke's law,nonlinear elasticstressstrainrelations, principle ofvirtual workanditsrateforms.

UNIT-III

Criteriaforloadingandunloading:
Elasticandplasticstrainincrementtensors,plasticpotentialand flowruleassociated withdifferentYieldcriteria,Convexity, normalityanduniquenessconsiderations forelastic-plasticmaterials, Expansionofthickwalledcylinder.

UNIT-IV

Incremental stressstrainrelation: Prandtl-Reuss materialmodel, Flow plasticity theory, J_2deformationtheory,Drucker-pragermaterial,Generalisotropicmaterials.

UNIT-V

Deformation theoryinplasticity:
Loadingsurface,Hardeningrules,FlowrulesandDruckersstability postulate, effectivestressandeffectivestrain,mixedhardeningmaterial.

TEXTBOOKS:

1. L. M. Kachanov, "Fundamentals of the theory of plasticity", 4th edition, Dover Publications, 2004.

2.Dr.SadhuSingh,"Theoryofplasticity",2nd Edition,KhannaPublications,1990.

REFERENCEBOOK:

1.J.Chakrabarty,"TheoryofPlasticity",3rd Edition,ElsevierPublications,2006.

2.Dr.SadhuSingh,"Theoryofplasticity& Metal forming process",3rd Edition,KhannaPublications,1999.