CE6101E THEORY OF ELASTICITY AND PLASTICITY

CLASS SCHEDULE

Total Lecture Sessions: 39

1. Introduction to the Mathematical Theory of Elasticity
2. Elasticity, Stress, Strain, Hooke’s law
3. Two-dimensional idealisations, plane stress and plane strain problems
4. Equations of equilibrium
5. Strain-displacement relations
6. Constitutive relations
7. Compatibility conditions, displacement and traction boundary conditions

8-10. Two-dimensional problems in rectangular coordinates, stress function, solution by polynomials, Saint Vénant’s principle, bending of a cantilever

11. Determination of displacements
12. Two-dimensional problems in polar coordinates
13. General equations, problems of axisymmetric stress distribution
14. Pure bending of curved bars
15. Effect of circular hole on stress distribution in plates
16. Concentrated force at a point on a straight boundary
17. Introduction to Cartesian Tensors, transformation laws of cartesian tensors
18. Special tensors and tensor operations, the Kronecker’s delta, the permutation tensor, the e-δ identity
19. Symmetry and skew- symmetry, contraction, derivatives and the comma notation
20. Gauss’ theorem, base vectors and special vector operations, eigenvalue problem of a symmetric second order tensor

21, 22. Equations of elasticity using index notation

23. Stress-strain problems in three dimensions
24. Principal stresses, principal strains, three-dimensional problems
25. Energy theorems and variational principles of elasticity
26. Strain energy and complementary energy, Clapeyron’s theorem
27. Virtual work and potential energy principles
28. Principle of complementary potential energy, Betti’s reciprocal theorem
29. Principle of linear superposition, uniqueness of elasticity solution

30, 31. Torsion of straight bars: Elliptic and equilateral triangular cross-section

32. Membrane analogy, narrow rectangular cross-section
33. Torsion of rectangular bars, torsion of rolled profile sections, hollow shafts and thin tubes
34. Introduction to Plasticity, one-dimensional elastic-plastic relations

35, 36. Isotropic and kinematic hardening, yield function

37, 38. Flow rule, hardening rule

39. Incremental stress-strain relationship, governing equations of elastoplasticity.

References:

1. Timoshenko, S.P. and Goodier, J.N., Theory of Elasticity, Mc Graw Hill, Singapore, 1982.
2. Srinath, L.S., Advanced Mechanics of Solids, Second Edition, Tata McGraw Hill, India, 2003.
3. Ameen, M., Computational Elasticity–Theory of Elasticity, Finite and Boundary Element Methods, Narosa Publishing House, 2008.
4. Leipholz, H., Theory of Elasticity, Noordhoff International Publishing, Layden, 1974.
5. Sokolnikoff, I.S., Mathematical Theory of Elasticity, Tata Mc Graw Hill, India, 1974.
6. Xu, Z., Applied Elasticity, Wiley Eastern Ltd, India, 1992.
7. Chakrabarty, J, Theory of Plasticity, Elsevier, London, 2006.
8. Hill, R., Mathematical Theory of Plasticity, Oxford University Press, 1998.
9. Chen, W.F., and Han, D.J., Plasticity for Structural Engineers, Springer Verlag, 1998.

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