CE3037 COMPUATIONAL ELASTICITY

Prerequisite: CE2001 Mechanics of Solids or equivalent

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3	0	0	3

Total: 42 hours

Module 1 (12 hours)

Introduction Theory of Elasticity: Analysis and design of structural systems, problems of elastostatics, types of loads, the displacement, strain and stress fields.

Analysis of stresses: State of stress at a point, notation and sign convention, stress components on an arbitrary plane, stress transformation, differential equations of equilibrium, principal stresses, traction boundary conditions.

Analysis of strains: State of strain at a point, principal strains, compatibility conditions.

Constitute Relations: Generalised Hooke's Law, isotropic elasticity.

Module 2 (9 hours)

Two-dimensional problems of elasticity: Two-dimensional idealisations, plane stress and plane strain problems, axisymmetric problems, Saint Vénant's principle.

Energy theorems and variational principles: Strain energy and complementary energy, virtual work, principle of stationary potential energy.

Module 3 (12 hours)

Introduction to finite element method: Brief history, direct stiffness method.

Interpolation: Shape functions for C^0 and C^1 elements, Lagrangian and Hermitian interpolation functions for one dimensional elements, Lagrangian interpolation functions for two-dimensional elements.

Variational formulation: Potential energy of an elastic body, Rayleigh-Ritz method, piecewise polynomial field, finite element form of Rayleigh-Ritz method, finite element formulations derived from a functional.

Structure stiffness equations: Properties of [K], solution of unknowns, element stiffness equations, assembly of elements, displacement boundary conditions, Gauss elimination solution of equations, stress computation, support reactions, summary of finite element procedure.

Displacement-based elements for structural mechanics: formulas for element stiffness matrix and load vector, overview of element stiffness matrices, consistent element nodal load vector, equilibrium and compatibility in the solution, convergence requirements, patch test, optimal stress points.

Module 4 (9 hours)

The isoparametric formulation: Plane bilinear element, Gauss quadrature, quadratic plane elements, transition elements, consistent element nodal loads, appropriate order of quadrature, stress computation.

Coordinate transformation: transformation of vectors, transformation of stress, strain, material properties, and stiffness.

Topics in structural mechanics: condensation, substructuring, symmetry.

References

1. Timoshenko, S.P. and Goodier, J.N., Theory of Elasticity, McGraw Hill, Singapore, 1982.
2. Cook, R.D., Malkus, D.S., Plesha, M.E., and Witt, R.J., Concepts and Applications of Finite Element Analysis, John Wiley, India, 2001.
3. Ameen, M., Computational Elasticity—Theory of Elasticity, Finite and Boundary Element Methods, Narosa Publishing House, India, 2008.
4. Krishnamoorthy, C.S., Finite Element Analysis, Theory and Programming, Tata Mc Graw Hill, India, 1996.
5. Zienkiewicz, O.C., Taylor, R.L., and Zhu, J.Z., The Finite Element Method—Its Basis & Fundamentals, 6th Edition, Elsevier, India, 2007.
6. Desai, C.S., Elementary Finite Element Method, Prentice Hall of India, 1998.
7. Chandrupatla, T.R., and Belegundu, A.D., Introduction to Finite Elements in Engineering, Prentice Hall of India, 1998.
8. Rajasekaran, S., Finite Element Analysis in Engineering Design, Wheeler Pub, India, 1998.
9. Shames, I.H., and Dym, C.L., Energy and Finite Element Methods in Structural Mechanics, Wiley Eastern, India, 1995.

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