Course Handout for
ME G512 Finite Element Methods

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Course Content

Introduction

Lec. 1 Introduction to FEA, problem classification, modeling and discretisation.

Lec. 2-3 Interpolation, elements, nodes, dof, history & applications of FEA, solving a problem using FEA.

1-D Elements

Lec.4 Bar element, beam element, with arbitrary orientation.

Lec.5-6 Assembly of elements, properties of stifness matrices and boundary conditions.

Lec.7 Mechanical and thermal loads, stresses.

Lec.8 Solved Examples

Basic Elements

Lec.9 Interpolation and shape functions.

Lec.10 Formulae for element matrices.

Lec.11 Linear triangle and bilinear rectangle.

Lec.12-14 Choice of interpolation functions, improved triangles and quadrilaterals, nodal loads.

Variational Methods

Lec.15 Introduction to functional, strong and weak forms, principle of stationary potential energy.

Lec.16 Potential energy of an elastic body.

Lec.17 Rayleigh-Ritz method.

Lec.18 Strong and weak forms.

Lec.19-20 Finite element form of the Rayleigh-Ritz method.

Weighted Residual Methods

Lec.21 Galerkin method.

Lec.22 Other methods of weighted residuals.

Lec.23-24 Galerkin FEM in 1-D: Beam dynamics and heat ?ow in a bar.

Lec.25 Galerkin FEM in 2-D.

Lec.26 Mixed formulation.

Isoparametric Elements

Lec.27 Introduction, bilinear quadrilateral.

Lec.28 Quadrature.

Lec.29 Quadratic quadrilaterals.

Lec.30 Hexahedral isoparametric elements.

Lec.31 Incompatible modes, nodeless dof.

Lec.32 Load considerations.

Lec.33 Stress calculations.

FEA in Structural Dynamics and Vibrations

Lec.34 Equations, mass and damping matrices.

Lec.35 Mass matrices: Consistent, diagonal and others.

Lec.36 Natural frequencies and modes, damping

Lec.37 Reduction of number of dofs.

Lec.38 Modal methods.

Lec.39 Ritz vectors.

Lec.40 Component mode synthesis.

Evaluation Scheme

- Project + Assignments - 35%

- Mid-term Exam - 25%

- Comprehensive Exam - 40%

Examination Schedule

Mid-term Exam: 7/10 8:00 - 9:30 AM

Comprehensive Exam: Afternoon 10/12 AN

Textbooks

1. Cook, Robert D., 'Concepts and applications of finite element analysis', *Wiley India Pvt. Ltd.*

Reference books

1. Reddy, J. N., 'Introduction to finite element method', *Tata McGraw Hill*.

2. Shames, Irving H., Dymn, Clyve L., 'Energy and finite element methods in structural analysis', *Taylor & Francis*.