MIE 1804: FINITE ELEMENT METHOD IN MECHANICAL ENGINEERING:

THEORY AND APPLICATIONS

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Students undertaking this subject must possess a solid grasp of solid mechanics, mathematics, numerical analysis and programming.

The course content may be changed from year to year without prior notice.

This course is divided into two main components: fundamentals of the finite element method and applied finite element. Whilst some coverage of commercial codes is provided, this course does not teach students how to use ANSYS or ABAQUS. This is not our focus. The emphases in this course are on understanding the fundamentals of the finite element method, what it does and why, building your own finite element code, avoiding the pitfalls and applying it to real engineering problems.

Part I - Fundamentals of the Finite Element Method

Chapter 1: Introduction to the Finite Element Method

Chapter 2: Trial Functions

Chapter 3: Fundamental Concept of the Finite Element Method
Fundamental Concept of the FEM, Finite Element Solution Steps, Interpolation or Shape Function, Basic FE Algorithms, The Spring Model, Case Studies and Examples.

Chapter 4: Review of Pertinent Elasticity Formulae

Chapter 5: Derivation of Element Stiffness Matrix for a General Bar Element

Chapter 6: Truss and Frame Elements

Chapter 7: Beam Bending Elements
Assumptions and simplifications, Hermitian Shape Functions. Derivation of Beam Element Stiffness Matrix, Consistent Loading, Assembly of Beam Elements, Applications and Examples.
Chapter 8: Finite Element Programming

Chapter 9: Derivation of Element Stiffness Matrix for 2-D Plane Elements

Chapter 10: Three Dimensional Elasticity Problems
Types of Elements and D.O.F., Shape Functions, Element Stiffness Matrix in Three Dimensions, Applications and limitations.

Chapter 11: Dynamic Analysis of Structures

Part II - APPLIED Finite Element Modelling

Chapter Twelve: Accuracy of the Finite Element Model
Basic Input Data, Geometry Definition, Material Properties, Displacement Constraints, Applied Forces, Problem Definition, Problem Details, Free Body Diagram, Approximation to Geometry, Finite Element Model, Element Density, Element Distortion, Refined Mesh Modelling, Boundary Conditions, Sources of Uncertainties, Check of input data, Check of Constitutive Model, Benchmark Case(s), Check with Existing Analytical Model(s), Stress and Strain Contours, Continuity of Displacements, Equilibrium of Interface Stress and Reactions, Examples and applications

FINITE ELEMENT PROJECTS
In support of the above syllabus, students will be assigned finite element projects. Two types of projects are offered:

Either

- Develop own FE code,
  or
- Use a commercial code to solve a 3D problem