COURSE CONTENTS

(actual coverage and sequence may differ depending on the participants background)

BACKGROUND: INTRODUCTION TO NUMERICAL METHODS
- Overview – basic ingredients of the FEM
- Comparison with alternative numerical methods

BASIC CONCEPTS OF FEM – ONE-DIMENSIONAL PROBLEMS
- Axial deformations of a bar or one-dimensional heat transfer
- Strong and weak forms (variational and virtual work statements)
- Primary and secondary variables of the formulation
- Essential vs. natural boundary conditions
- Methods of approximations (weak-form Galerkin method)
- Finite element approximation functions (linear, quadratic, and cubic elements)
- Assembly of element equations
- Illustrative examples and discussion of results in light of physical response

EXTENSION TO OF FEM TO TWO-DIMENSIONAL PROBLEMS
- Membrane and heat transfer-like problems in 2D
- Elements types (triangular and quadrilateral elements)
- Axisymmetric problems
- Discussions of representative field problems to understanding modeling issues

EIGENVALUE AND TIME-DEPENEDENT PROBLEMS
- Free vibration of elastic systems (natural frequencies, modal response, etc)
- Transient Analysis
- Time integration procedures
- Explicit dynamic integration

NUMERICAL/COMPUTATIONAL ISSUES
- Subparametric, isoparametric, and superparametric formulations
- Numerical integration
- General modeling considerations

PLANE ELASTICITY
- Governing equations of plane elasticity problems
- Elements types (triangular and quadrilateral elements)
- Incompatible modes
- Discussion of example problems to bring out modeling issues

THREE-DIMENSIONAL PROBLEMS
- Heat transfer-type problems
- Elasticity problems
- Types of 3-D Finite elements (interpolation functions)

INTRODUCTION TO NON-LINEAR PROBLEMS
- Geometric and material non-linearity
- Nonlinear formulation of a 2-D Model problem
- Solution algorithms for the solution of non-linear algebraic equations
- Derivation of tangent stiffness coefficients
- Convergence criteria

NONLINEAR BENDING OF BEAMS
- Euler-Bernoulli beam theory
- Nonlinear finite element formulation of Euler-Bernoulli beam theory
- Tangent stiffness calculations
- Membrane locking
- Timsohenko beam theory and its finite element model
- Shear locking
- Numerical examples

NONLINEAR BENDING OF PLATES
- Nonlinear finite element formulation of the first-order shear deformation (Mindlin) plate theory
- Tangent matrix coefficients
- Shear and membrane locking
- Numerical examples

CONTINUUM FORMULATIONS
- Continuum equations
- Measures of stress and strain
- Total and Updated Lagrangian descriptions
- Degenerated thick shell element
- Applications

COMPOSITE MATERIALS AND STRUCTURES
- An Introduction to Fiber-Reinforced Composite Materials
- Equations of Anisotropic Elasticity
- Linear Finite Element Analysis of Composite Plates and Shells
- Nonlinear Analysis of Composite Plates and Shells