MFG-513 Advanced Topics in Finite Element Analysis

SPRING - 2021

Instructor:	**Date:**	**Time:**
Eralp Demir	Monday	13:40-15:30
	Tuesday	12:40-13:30
Email:	**Zoom link:**	**Zoom ID:**
eralpd@sabanciuniv.edu	https://zoom.us/j/4653244758	465 324 4758

Office Hours: After class, or by appointment, or post your questions in the website of the class.

Main References:

- Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J.Witt, *Concepts and Applications of Finite Element Analysis*, John Wiley & Sons Inc., 2002.
- Zienkiewicz, O.C., Taylor, R.L., Taylor, R.L. and Taylor, R.L., 2000. The finite element method: solid mechanics (Vol. 2). Butterworth-heinemann.
- M. Asghar Bhatti, *Advanced Topis in Finite Element Analysis of Structures*, John Wiley & Sons Inc., 2006.

Objectives:
Objective of this course is to teach fundamentals of finite element methodology with numerical implementations and applications.

Prerequisites: MFG-512 or equivalent solid mechanics background

Tentative Course Outline:

1. Introduction to Matlab: Matrix and tensor operations, basic coding, important built-in functions
2. Review of Finite Element Method: Discretization of equilibrium equation, shape functions, solution procedure for linear problems, 1D bar element example, truss elements (2D)
   (a) 1D bar elements
   (b) Truss elements
   (c) Beam elements
3. Analysis of Elastic Solids: General form of finite element equations, 2D & 3D isoparametric elements, interpolation of fields, evaluation of line - area and volume integration, numerical integration by Gauss-Quadrature, constitutive equations, computation of stresses
   (a) Triangular (3-noded, 6-noded)
   (b) Quadrilateral (4-noded, 8-noded, 9-noded)
   (c) Tetrahedron (4-noded, 10-noded)
   (d) Hexahedron (8-noded, 20-noded, 27-noded)

4. Plates and Shells: Basis for composite mechanics, Bogner-Fox-Schmidt rectangular and triangular plate elements, shell elements, implementation of orthotropic material properties, laminate mechanics
5. Heat transfer problems: Thermal problems, energy balance and its discretization, solution of steady-state and transient heat problems
6. Non-linear Finite Element Analysis
   (a) Small-Strain Plasticity - Material Non-linearity: Isotropic plasticity
   (b) Geometrical Non-linearity: Large Displacement Theory
   (c) Large-Strain Plasticity - Material & Geometric Non-linearity
   (d) Crystal Plasticity
7. Mesh-less methods

Computer Programmes: Matlab, MSC MARC

Grading Policy: Assignments (20%), Project (30%), Midterm (20%), Final (30%).

Class Policy:

- Regular attendance is essential and expected.