Course and Instructor Information

Course Title: CE 5166
Credits: 3
Prerequisites: Not open for credit to students who have passed ME 5521
Instructor: Jeongho Kim

Course Description

Formulation of finite elements methods for modal and transient analysis. Development of implicit and explicit transient algorithms. Stability and accuracy analysis. Formulation of finite element methods for material and geometric nonlinearities. Development of nonlinear solution algorithms. Applications using commercial finite element code.

Course Objectives

By the end of the semester, students should be able to:

1. Set up a finite element model and perform modal, harmonic, transient, and nonlinear analyses of solid mechanics problems using commercial software.
2. Interpret finite element analysis results such as displacements, strains and stresses.

Course Outline

Dynamic Analysis

- Dynamic governing equations, mass matrix, damping matrix, stiffness matrix
- Modal analysis: undamped and damped systems, natural frequencies, mode shapes, algorithms for eigenvalues/vectors, modal superposition method
- Harmonic analysis: resonance, frequency sweep
- Linear transient analysis: explicit method, 1d wave propagation example, implicit method, Newmark method, HHT method, accuracy and stability

Nonlinear Analysis

- Material nonlinear analysis: nonlinear static, nonlinear & dynamic explicit, nonlinear & dynamic implicit
- Plasticity theories: yield criteria, flow & hardening rules
- Geometrically nonlinear analysis: total Lagrangian formulation, updated Largrangian formulation, deformation gradient, stress and strain measures

Contact Analysis

- Contact constraints, contact formulations
- Lagrange multiplier (LM), Penalty method (PM), Augmented Lagrange (LM)
- contact kinematics, constitutive relations (normal, tangential),
  hard contact, softened contact, small vs finite sliding, node-to-surface contact, surface-to-surface contact

Other Advanced Topics

Course Materials: No Textbook Required