

AAE 558

Finite Element Methods in Aerospace Structures

Description:

Introduction to the advanced matrix methods in treating aerospace structures. Static analysis of wing, fuselage, and rocket structures. Stability and large displacement of ribs, stringers, and skins. Vibration of wing-fuselage combinations. Structural damping. Vibration of stretched or compressed wing panels.

Format: 3 hrs lecture per week

Credit hours: 3

Status: Elective, Structures

Offered: Fall

Pre-requisite: AAE 453 or consent of instructor

Co-requisite: None

Course Instructor: Profs. Farris and Kim

Text: Cook, R.D., Malkus, D.S., and Plesha, M.E., *Concepts and Applications of Finite Element Analysis*, Wiley, 3rd, 1989

Assessment Method: Weekly Homework (1/3), Mid-term Exam 1 (1/4), Mid-term Exam 2 (1/4), Special project (1/6). Grading policy is an instructor option and may vary.

Course Objective:

Goal:

The goal of AAE 558 is to introduce the theory behind finite element calculations of stress, strain, and deformation in structures and materials and describe the role of a commercial finite element package in structural analysis and design.

Objectives include developing abilities to:

Understand the relationship between shape functions and constitutive behavior and element stiffness matrices

Develop the weak form of the equations of mechanics

Relate mesh and loading to the assembled stiffness matrix

Provide criteria for engineering judgment required to assess the appropriateness of the choice of a finite element model for a particular structure

Necessary Background:

1. Mechanics of materials and structural analysis
2. Linear Algebra

Topics (number of 50 minute Lectures):

1. Introduction: stiffness matrix for rod elements; assemblage; equations of elasticity (3 lectures)
2. The stiffness method for the plane truss and application of boundary conditions (6 lectures)
3. The weak form of the mechanics equations: stationary principles, the Rayleigh-Ritz method (6 lectures)
4. Displacement based-elements for structural mechanics: interpolation and shape functions; straight-sided triangles and tetrahedra; consistent nodal loads; introduction to ABAQUS for analyzing 2 and 3D structural continua (12 lectures)
5. The isoparametric formulation; higher order elements; convergence characteristics (6 lectures)
6. Axisymmetric elements and solids of revolution (3 lectures)
7. Special topics: structural dynamics; plasticity; contact elements (6 lectures)

Relationship of course to program objectives:

This elective course supports AAE objective (1) by providing students with advanced concepts, theories and approaches used to analyze and design aerospace structures. Several homework assignments require students to use computers to address open-ended problems (2a). The final project generally has a research component that requires students to develop life-long learning skills (3) and requires both written reports (2c). The students are required to examine capabilities of ABAQUS that are not developed in class. Examples of the role of finite element analysis in reconstruction of structural failures are given through guest lectures of practicing engineers (4).

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