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An Introduction to Finite Elements

Instructor

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Department: Civil Engineering

Course Time: Mon., Wed., Fri., 11:00 - 12:00 hours

Lecture venue: L7, Central Lecture Hall

Detailed Course Page:

Announcements

Brief description of the course

Core course for all ME students entering Civil Engineering; also taken by ME students from other departments and PhD scholars from Civil Engineering Department and elsewhere. The course covers the essentials of semi-discretization strategy via weak formulation as entailed in the finite element method, emphasizing applications to solid mechanics.

Prerequisites

None. However, the students are expected to have learnt their undergraduate maths properly.

Syllabus

Elements of variational formulations; normed function spaces and inner product spaces; Riesz representation theorem and weighted-residual/Galerkin/Rayleigh-Ritz methods; finite elements (FE) - weak formulations with continuous and piecewise smooth shape functions; isoparametric FE formulations; smooth, polynomial reproducing shape functions and moving least squares (MLS); virtual work/weak formulations with MLS methods; local error estimates; numerical integration â€“ Gauss quadrature; applications to plane stress, plane strain and the general 3D linear elastostatic cases; enforcing essential and natural boundary conditions;

dimensional descent and applications to beams; MATLAB-based simulation exercises.

Course outcomes

The essence of weak formulations and its advantages over direct solutions of strong forms in numerical implementation; how does the notion of piecewise implementation useful in solving solid mechanics problems with complex geometry; how to interpret convergence of numerical solutions

Grading policy

20% each for 2 class tests; 10% for the assignments and 50% for the final exam.

Assignments

The students were asked for solve 8 assigments, most of which related to numerical implementation of the methods taught.

Resources

Mainly, but not entirely, based on the instructor's personal notes. In addition, the following texts were used:

1. Zienkiewicz, O.C. and Taylor, R. L., 2000, â€œThe Finite Element Method: Vol. 1 (The Basis)â€•, Butterworth-Heinemann.

2. Brenner, C. S. and Scott, L. R., 1994, â€œMathematical Theory of Finite Element Methodsâ€•, Springer-Verlag.