


FINITE ELEMENT METHOD: VARIATIONAL METHODS TO COMPUTER PROGRAMMING

PROF. ATANU BANERJEE
PROF. ARUP NANDY
Department of Mechanical ENgineering
IIT Guwahati

TYPE OF COURSE : New | Both | UG/PG
COURSE DURATION : 12 weeks (20 Jul' 20 - 9 Oct' 20)
EXAM DATE : 17 Oct 2020

PRE-REQUISITES : Solid Mechanics, Engineering Mathematics: Linear Algebra, Vector Calculus

INTENDED AUDIENCE : Final year Under Graduate Students, First year Post Graduate Students
INDUSTRIES APPLICABLE TO : DRDO, ISRO, BARC, GE, Automobile and Aviation industries

COURSE OUTLINE :

Finite Element Method (FEM) is one of the most popular numerical method to boundary and initial value problems. One distinct feature of FEM is that it can be generalized to the domains of any arbitrary geometry. Theory of FEM is developed on Variational methods.

ABOUT INSTRUCTOR :

Prof. Atanu Banerjee, after obtaining PhD from Department of Mechanical Engineering, IIT Kanpur, joined Department of Mechanical Engineering, IIT Guwahati in 2010. He has taught Solid Mechanics, Finite Element Methods in Engineering, Modelling and Applications of Smart Materials in the same department. His research interest encompasses design and analysis of smart materials (namely, piezoelectric and shape memory alloy) based engineering applications, in which coupled electro-thermo-mechanical models are solved using FE tool.

Prof. Arup Nandy joined IIT Guwahati in July, 2017. He obtained his PhD from Mechanical Engineering department, IISc, Bangalore in 2016. His research interest is FEM formulation in different multiphysics domains like acoustics, structures, electromagnetics, electromagnetic forming. He has taught courses like Advanced Solid mechanics, Continuum mechanics, Finite element method in IIT Guwahati.

COURSE PLAN :

Week 1: : Variational Methods:Functional and Minimization of Functional; Derivation of Euler Lagrange equation

Week 2: One dimensional Finite Element Analysis:Gauss Quadrature integration rules with Computer Programming; Steps involved in Finite Element Analysis; Discrete system with linear springs;Continuous systems.

Week 3: Structural Elements in One dimensional FEM:Bar Element with Computer Programming, Truss Element with Computer Programming

Week 4: Beam Formulation, Boundary Hermite shape functions

Week 5: Frame Element with Computer Programming: Orthogonal matrix, Finite element equation; Element matrices, Assembly, Solution, Post- processing; Numerical example

Week 6: Generalized 1D Finite Element code in Computer Programming,Generalization of Assembly using connectivity data,Generalization of loading and imposition of boundary condition; Generalization of Post-processing using connectivity data.

Week 7: Brief background of Tensor calculus, epsilon-delta identity, Gauss-divergence theorem: different forms

Week 8: Two dimensional Scalar field problems, Computer implementation

Week 9: Two dimensional Vector field problems (Contd)

Week 10: Eigen value problemsAxial vibration of rod (1D), formulation and implementation Transverse vibration of beams (2D), formulation and implementation

Week 11: Transient problem in 1D & 2D Scalar Valued ProblemsTransient heat transfer problems, discretization in time : method of lines and Rothe method, Formulation and Computer implementations

Week 12: Choice of solvers: Direct and iterative solvers