FINITE ELEMENT METHOD

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PRE-REQUISITES : Solid Mechanics/Numerical methods in Engineering

INTENDED AUDIENCE : BE/B.Tech (Elective), M.Tech, PhD

INDUSTRIES APPLICABLE TO : Civil/Mechanical/Aerospace/Ocean and naval Architecture

COURSE OUTLINE :
This is an introductory level course on Finite Element Method. After attending the course, the students will be able to comprehend FEM as a numerical technique to solve partial differential equations representing various physical phenomena in structural engineering. The proposed course also provides a hands-on training on translating FEM formulation into computational code in MATLAB.

ABOUT INSTRUCTOR :
Prof. Biswanath Banerjee is presently an Assistant Professor in the Department of Civil Engineering, IIT Kharagpur. He obtained his Bachelors degree in Construction Engineering from Jadavpur University in 2000, MTech in Structures from IIT Kharagpur in 2004 and PhD in Computational Mechanics from IISc Bangalore in 2009. Prior to joining IIT Kharagpur, Professor Banerjee spent two years as Post-doctoral Research Fellow in Cornell University, USA. He has also spent for some time in industries like Gammon India Limited, TRF Limited (A Tata enterprise) and Research labs in SERC Chennai (A CSIR Unit) as a Scientist.Professor Banerjees research area is in the field of Computational Mechanics and Reverse Engineering Problems.

Prof. Amit Shaw is presently an Associate Professor in the Department of Civil Engineering, IIT Kharagpur. He obtained his Bachelors degree in Civil Engineering from IIEST Shibur (formerly Bengal Engineering College Shibpur) in 2000, MTech in Structures from IIT Roorkee in 2003 and PhD in Computational Mechanics from IISc Bangalore in 2007. Prior to joining IIT Kharagpur, Professor Shaw spent two years as Research Fellow in University of Aberdeen, UK. He also worked for some time in industries like Gammon India Limited and L&T ECC.

COURSE PLAN :

Week 1: Introduction, Boundary value problems and solution methods, Direct approach – example, advantage and limitations.

Week 2: Elements of calculus of variation, Strong form and weak form, equivalence between strong and weak forms, Rayleigh-Ritz method.
quadrature in three dimension, examples.

Week 3: Method of weighted residuals – Galerkin and Petrov-Galerkin approach; Axially loaded bar, governing equations, discretization, derivation of element equation, assembly, imposition of boundary condition and solution, examples.

Week 4: Finite element formulation for Euler-Bernoulli beams.

Week 5: Finite element formulation for Timoshenko beams.

Week 6: Finite element formulation for plane trusses and frames computer implementation.

Week 7: Finite element formulation for two-dimensional problems - completeness and continuity, different elements (triangular, rectangular, quadrilateral etc.), shape functions, Gauss quadrature technique for numerical integration.

Week 8: Finite element formulation for two-dimensional scalar field problems; Iso-parametric formulation Application to Heat conduction and torsion problems.

Week 9: Finite element formulation for two-dimensional problems in linear elasticity; Formulation.

Week 10: Finite element formulation for two-dimensional problems in linear elasticity; Examples and computer implementation.

Week 11: Implementation issues, locking, reduced integration, B-Bar method.

Week 12: Finite element formulation for three-dimensional problems; Different elements, shape functions, Gauss quadrature in three dimension, examples.