Course Name:
Finite Elements II

Course Number:
20147

Credit:
3

Course Content (outline):

- Principle of virtual work, principle of minimum potential energy, Galerkin-weighted residual and variational approaches
- Rayleigh-Ritz method for solid mechanics problems, Shape functions.
- Isoparametric elements, Numerical integration
- Displacement based FE formulation for large deformation
- Total and updated Lagrangian formulation, Strain-displacement relationships in large deformations
- FE discretization in large deformation, Nonlinear iterative strategy for solution of nonlinear equilibrium equations
- Newton-Raphson, Modified-Newton, Quasi-Newton (Davidon and BFGS) approaches
- Classical Plasticity theory, Elasto-plastic constitutive matrix
- Generalized plasticity theory, Single and double surface plasticity models
- Numerical computation of material property matrix, Elastic predictor-plastic corrector algorithm, Integration of constitutive relation
- Physical aspects of friction, Plasticity theory of friction, Modeling of friction
- Stress-strain relationships, Continuum model for friction, Penalty and Lagrange techniques
- Interface element formulation, Shape functions and stiffness matrix of 2D and 3D interface elements
- Dynamic equilibrium equations, Time domain discretization, Explicit time integration, Implicit time integration
- Single-step method, Generalized Newmark approach
- Error Estimation; ‘a-priori’ and ‘a-posteriori’ estimates; L2 projection and SPR techniques, Error norms (L2 and energy norms)
- Adaptive mesh refinement, h, p and h-p refinements, Adaptive mesh generator
- Mapping of variables; Error estimates and adaptive time stepping
- Causes of localization in solid mechanics, Governing equations of incompressible plasticity
- Theory of Cosserat continuum, Adaptive strategy for discontinuous displacements, Error indicator
- Adaptive mesh refinement, Element elongation

References:

- EA de Souza Neto, D Peric, D.J Owen, Computational Methods for Plasticity: Theory and Applications, Wily, UK, 2008.

- A.R. Khoei, Computational Plasticity in Powder Forming Process, Elsevier, UK, 2005.
- OC Zienkiewicz, RL Taylor, The Finite Element Method, McGraw-Hill, London, Vol 2, 2000.
- DRJ Owen, E. Hinton, Finite Elements in Plasticity: Theory and Practice, Pineridge Press, 1980.