COMPUTATIONAL CONTINUUM MECHANICS

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PRE-REQUISITES : Introduction to Solid Mechanics I and II, A undergraduate course in Engineering Mathematics. Exposure to undergraduate course on numerical methods will be an added advantage.

INTENDED AUDIENCE : Masters student and research scholars

INDUSTRIES APPLICABLE TO : VSSC, ISRO, Siemens India Limited, Ansys India or any firm involved in R&D involving finite element analysis

COURSE OUTLINE :

Continuum mechanics as a full-fledged course is a very interesting but a challenging subject. Usually,its application within the nonlinear finite element codes is not clear to the student. Computational continuum mechanics tries to bridge this gap. Hence, it can be treated as an applied version of continuum mechanics course. It assumes no prior exposure to continuum mechanics. The course starts with sufficient introduction to tensors, kinematics, and kinetics. Then, the course applies these concepts to set up the constitutive relations for nonlinear finite element analysis of a simple hyperelastic material. This is followed by the linearization of the weak form of the equilibrium equations followed by discretization to obtain the finite element equations, in particular, the tangent matrices and residual vectors is discussed. Finally, the Newton-Raphson solution procedure is discussed along with line search and arc length methods to enhance the solution procedure.

ABOUT INSTRUCTOR :

Prof. Sachin Singh Gautam is currently an Assistant professor in the Department of Mechanical Engineering, IIT Guwahati. He obtained his M.Tech. and Ph.D. from and worked as a postdoctoral fellow in AICES, RWTH Aachen University. His area of research is in nonlinear finite element methods and computational contact-impact problems. He has carried out projects from SERB, DST and VSSC, ISRO. He currently working on the incorporation of a contact module in the ISROs structural analysis software tool FEASTSMT (Indias first commercial FE package which is under Make-In-India). He has guided students on research problems jointly with Siemens R&D and Cummins R&D. He has guided three research scholars and is currently guiding five full-time PhD students, one part-time student. He has guided 17 M.Tech students and currently guiding 7 more. His research group has received various awards and fellowships like the DAAD fellowship and best paper award. He has 15 book chapters, 24 journal papers, and over 60 conference publications.

COURSE PLAN :

Week 1: Introduction - origins of nonlinearity

Week 2: Mathematical Preliminaries -1: Tensors and tensor algebra

Week 3: Mathematical Preliminaries -2: Linearization and directional derivative, Tensor analysis

Week 4: Kinematics - 1: Deformation gradient, Polar decomposition,Area and volume change

Week 5: Kinematics - 2: Linearized kinematics, Material time derivative,Rate of deformation and spin tensor

Week 6: Kinetics - 1 : Cauchy stress tensor, Equilibrium equations,Principle of virtual work

Week 7: Kinetics - 2 : Work conjugacy, Different stress tensors, Stress rates

Week 8: Hyperelasticity - 1: Lagrangian and Eulerian elasticity tensor

Week 9: Hyperelasticity - 2: Isotropic hyperelasticity, Compressible Neo-Hookean material

Week 10: Linearization : Lineation of internal virtual work, Linearization of external virtual work

Week 11: Discretization: Discretization of Linearized equilibrium equations - material and geometric tangent matrices

Week 12: Solution Procedure: Newton-Raphson procedure, Line search and Arc length method