



Birla Institute of Technology & Science, Pilani
Hyderabad Campus

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
ACADEMIC-GRADUATE STUDIES AND RESEARCH DIVISION
FIRST SEMESTER 2023-2024
COURSE HANDOUT (PART-II)

Date: 03-08-2023

In addition to Part-I (General Handout for all courses appended to the timetable), this portion gives further specific details regarding the course.

Course Code: ME G613

Name of the Course: Advanced Finite Element Modelling and Analysis

Instructors: AMOL VUPPULURI, PAVAN KUMAR PENUMAKALA

Practical Instructors: AMOL VUPPULURI, PAVAN KUMAR PENUMAKALA

I. Course Description:

Linear bending, modal and stability analysis of structures; incremental iterative solution methods for nonlinear static and dynamic problems; nonlinear analysis considering geometric nonlinearity; elastoplastic analysis; alternative numerical approaches; industrial case studies on thermal analysis, coupled field analysis; fluid flow analysis; fatigue, creep and fracture, crash analysis, composite structures, shape optimization.

II. Scope and Objective of the Course:

Linear bending of plates, modal and stability analysis of structures; incremental-iterative solution methods for nonlinear static and dynamic problems; nonlinear analysis considering geometric nonlinearity; elastoplastic analysis; alternative numerical approaches; industrial case studies on thermal analysis, coupled field analysis; fluid flow analysis; fatigue, creep and fracture, crash analysis, composite structures, shape optimization.

II. Textbooks

R. D. Cook, D. S. Malkus, M. E. Plesha, Rober J. Witt. Concept and Applications of Finite Element Analysis, Fourth Edition (Wiley Student Edition), Wiley, New York, 2007.

III. References

1. J. N. Reddy, An Introduction to Nonlinear Finite Element Analysis: with applications to heat transfer, fluid mechanics, and solid mechanics, Second Edition, Oxford University Press, 2014.
2. K. J. Bathe, Finite Element Procedures, Eastern Economy Edition, PHI, 2012.
3. O. C. Zienkiwicz, R. L. Taylor and J. Z. Zhu, The Finite Element Method for Solid and Structural Mechanics, Seventh Edition, Elsevier, 2014.





4. O.C. Zienkiewicz, R. L. Taylor and P. Nithiarasu, The Finite Element Method for Fluid Dynamics, Seventh Edition, Elsevier, 2014.
5. J. N. Reddy and D. Gartling, The Finite Element Method in Heat Transfer and Fluid Dynamics, Third Edition, CRC Press, 2010.
6. J. Donea and A. Huerta, Finite Element Methods for Flow Problems, First Edition, Wiley, 2003.

IV. Course Contents

Module	Learning Objectives	Topic	Number of Lectures	Source
1.	Review of fundamentals of Finite Element Modelling	Variational methods, weak form, interpolation functions, element types, numerical integration.	3	TB- Ch1, Ch4, Ch5
2.	Bending	Plate behaviour, Kirchoff theory, Mindlin theory, first-order shear deformation theory, shear locking, higher-order elements.	6	TB- Ch15
3.	Static Structural analysis including geometrical nonlinearity	Total Lagrangian formulation, Updated Lagrangian formulation, Type of nonlinearities, Solution Techniques for Nonlinear Algebraic Equations, Geometrically nonlinear bending analysis of beam	6	TB-Ch17
4.	Static Structural Analysis including material nonlinearity	Constitutive modelling of hyperelastic materials, elasto-plastic and viscoplastic materials, Elasto-plastic analysis of a bar using FEM	6	TB-Ch17
5.	Thermal Analysis	Two-dimensional Steady-State Heat Conduction, Heat Transfer in Thin Fins, Thermomechanical analysis	6	TB-Ch12
6	Modal and Dynamic Analysis of Structures	Eigen-Value Problems in two dimensions. Modal analysis of bar, beam, and 2-D plane-stress structures. Transient analysis, temporal integration techniques	5	TB-Ch11
7	Fluid Flow Analysis	1-D and 2-D Potential Flows, Flow of Viscous Incompressible Fluids	5	TB-Ch12
8	Advances in Finite Element Methods	XFEM for fracture mechanics problems, Mesh-free Methods	5	Class notes
Total			42	



IV(a): Practical Exercises:

S.No.	Title of the Practical Exercise	Tools to be used
1	Linear Buckling Analysis of a rectangular plate subjected to uniform compressive loading along its top edge	Ansys/COMSOL
2	Thermomechanical analysis of an electronic device	Ansys/COMSOL
3	Dynamic analysis: Modal analysis of a bracket	Ansys/COMSOL
4	Dynamic analysis: Vibration of an automobile suspension	Ansys/COMSOL
5	Dynamic analysis: Harmonic analysis of a bracket	Ansys/COMSOL
6	Dynamic analysis: Harmonic analysis of a guitar string	Ansys/COMSOL
7	Dynamic analysis: Transient analysis of a bracket for time-dependent general loading	Ansys/COMSOL
8	Dynamic analysis: Impact loading on a beam	Ansys/COMSOL
9	Transient Thermomechanical Analysis of a Welded Joint	Ansys/COMSOL
10	Geometric nonlinearity: Large deformation analysis of a plate with geometric nonlinearity	Ansys/COMSOL
11	Geometric nonlinearity: Post-buckling geometrically nonlinear analysis of a plate with a hole	Ansys/COMSOL
12	Material nonlinearity: plastic deformation of an Aluminium sphere with isotropic hardening	Ansys/COMSOL
13	Material nonlinearity: plastic deformation of an Aluminium hollow cylinder with isotropic hardening	Ansys/COMSOL
14	Material nonlinearity: Stress analysis of a reinforced viscoelastic cylinder	Ansys/COMSOL
15	Material nonlinearity: Viscoplastic Analysis of a Eutectic Solder Cylinder	Ansys/COMSOL
16	Material nonlinearity: Combined Plasticity and Creep Analysis of a Eutectic Solder Cylinder	Ansys/COMSOL
17	Contact problem nonlinearity: Contact Analysis of a Block Dropping on a Beam	Ansys/COMSOL
18	Contact problem nonlinearity: Simulation of a Nano-indentation Test	Ansys/COMSOL
19	Submodeling analysis of a thin plate with a hole	Ansys/COMSOL
20	Static Condensation and Substructuring analysis of an electronic package	Ansys/COMSOL



V. Evaluation Scheme and Schedule

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Mid semester test	90 min	25%	12/10 4.00 - 5.30PM	Close book
Literature Survey / Presentation/Project	-	20%		Open book
Lab		20%		Open book
Comprehensive Examination	3 hrs	35%	16/12 FN	Close book

VI. Chamber Consultation Hour: It will be announced in the class.

VII. Notices concerning the course: All notices concerning the course are displayed in CMS only.

VIII. Make-up Policy: Make-up for any component of the evaluation will be permitted only in genuinely serious cases only after the production of necessary medical certificates and with prior permission.

IX Academic Honesty and Integrity Policy:

Academic honesty and integrity are to be maintained by all the students throughout the semester, and no type of academic dishonesty is acceptable.

Instructor-In-Charge
ME G613

