Birla Institute of Technology & Science, Pilani
Hyderabad Campus

ACADEMIC – GRADUATE STUDIES AND RESEARCH DIVISION

FIRST SEMESTER 2022-2023
Course Handout Part II

Date: 23/08/2022

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

Course No. : CE G619
Course Title : Finite Element Analysis
Instructor-in-Charge : Dr. Raghu Piska

Course Description : Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.

Scope and Objective of the Course:

Finite element method is the most powerful numerical technique mankind has ever found to solve partial differential equations. The method not only has wide applications in Civil, Mechanical, Aerospace, Electrical Engineering but also in Biomechanics etc. making it a more versatile and efficient numerical technique. Every physical phenomenon is governed by partial differential equations which are difficult to solve for complicated domain and complicated boundary conditions. Whereas Finite elements can easily deal with these difficulties and gives a solution closer to the exact solution in most of the cases. Hence the method offers great scope to analyze the problems in structural engineering. The objective of this course is to impart the knowledge on how to formulate and implement the finite element method to analyze any structure with a specified domain, material, loading and boundary conditions.

Course Outcomes: At the end of this course, the students will be able to:

CO1. Develop the finite element formulation of a given problem
CO2. Analyze rods, trusses, beams, frames, plates and shells using finite element method
CO3. Understand how to develop a new FE formulation
CO4. Develop MATLAB codes for the finite element analysis of various structural elements.

Student Learning Outcomes (SLOs) assessed in this course – **(a), (b), (c), (d), (e), (f), (h), (j),** and **(k).**

Student Learning Outcomes (SLOs):

SLOs are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

(a) an ability to apply knowledge of mathematics for solving differential equations
(b) an ability to understand the mechanics behind the behavior of structures
(c) an ability to develop finite element formulation for a given differential equation
(d) an ability to analyze structural elements using appropriate finite elements
(e) an ability to identify, formulate, and solve engineering problems
(f) an ability to develop codes for analyzing a problem using finite elements

Textbook:

1. *JN Reddy, (2009) "An Introduction to the Finite Element Method". 3rd Edition, McGrawHill*

Reference books:

1. Robert D Cook, David S Malkus, Michael Plesha and Rober J Witt (2001). "*Concepts and Applications of Finite element analysis*", Wiley.
2. C S Krishnamoorthy (1994). "*Finite Element Analysis: Theory and Programming"*, McGrawHill
3. Tirupati R Chandrupatla, Ashok D. Belegundu (2011). "*Introduction to Finite Elements in Engineering"*, Pearson

Course Plan:

Lecture No.	Learning objectives	Topics to be covered	Chapter in the Text Book	SLO
1-3	Introduction	Introduction to Basic Structural Mechanics, Mathematical preliminaries	Ch-1 and Ch-2	a
4-5	Finite element formulation – 1D bar problem	Derivation of governing equation of 1D bar problem and the finite element formulation	Ch-3	a, c
6-7	Numerical problems	Solving examples involving 1D bar elements	Ch-3	b
8-10	Truss elements	Truss element formulation and Numerical problems	Ch-4	b, d
11-13	Beam elements	Finite element formulation of Euler Bernoulli and Timoshenko beam theories	Ch-5	a, b
14-16	Numerical	Numerical problems on beams	Ch-5	b

	problems			, d
17-19	Frame elements	Formulation and Numerical examples	Ch-5	b , d
20	Isoperimetric formulation	Isoparametric finite element formulation	Ch-8	c
21-23	Introduction 2D finite elements	2D finite element formulation, plane stress and plane strain formulation, Numerical integration and modeling techniques	Ch - 11	c
24	Axisymmetric problems	Finite element formulation of axi-symmetric problems		c , d
25-26	2D numerical examples	Problem solving of 2D finite elements	Ch-9,11	a
27-29	Finite element formulation of plate bending	Finite element formulation of Kirchhoff and Mindlin plate theories	Ch-12	b , c
30-31	Shell finite elements	Shell finite element formulation	Material will be supplied during class	a , b , c
32-33	Mixed Finite elements	Finite element formulation using mixed finite elements	Material will be supplied during class	e
34-35	Material and Geometric nonlinearity	Finite element formulation considering material and geometric nonlinearity	Material will be supplied during class	e
36-38	Dynamic analysis using FEM	Free vibration and transient dynamic problems	Ch-6	e
39-42	Programming FEM	Developing Finite element codes for bar and beam elements both for static and dynamic problems	Ch-7	f

Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Mid Semester Test	90 min	25	04/11 9.00 - 10.30AM	Closed book

Comprehensive Exam	180 min	35	27/12 FN	OPEN BOOK
Assignments (Theory+Programming)		20	-	OPEN BOOK
Teaching presentation		05		OPEN BOOK
Mini Project		15		OPEN BOOK

Chamber Consultation Hour: To be announced in the class

Notices: Concerning this course will be displayed on CMS

Make-up Policy: Make-up would be granted only for genuine cases with prior permission.

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

CE G619