AMITY UNIVERSITY
UTTAR PRADESH

Course Title: FINITE ELEMENT METHODS **Credit Units: 04**

Course Level: UG **Course Code: MAE404**

L	T	P/S	SW/FW	TOTAL CREDIT UNITS
3	0	2	-	4

Course Objectives: The objective of this course is to learn how to design and analyze structural components of machine system, especially using the finite element method. The course exposes students to analytical and numerical methods for computing stresses and strains in structures, use of finite element software for static structural analysis and the application of design and failure criteria to ensure that mechanical components can carry the design load without failure.

Pre-requisites: Concepts of stress-strain, Design of Machine Elements, Strength of materials.

Course Contents/Syllabus:

	Weightage (%)
Module I:	**18%**
Descriptors/Topics **1.** Introduction to Finite Element Method for solving problems, historical development, basic concepts. **2.** FEM applications - General field problems in engineering- Modeling – Discrete and continuous models – Characteristics - Difficulties involved in solution. **3.** The relevance and place of FEM, Boundary and initial value problems concepts, Stress-strain displacement relations, Potential Energy approach. 4. Variation and weighted residual methods-Galerkin FE formulation.	
Module II:	**17%**
Descriptors/Topics 1. Discretization of domain & discretization procedures, element shapes, numbering, mesh generation. 2. Interpolation functions, local and global coordinate convergence requirements	

3. Finite element modeling coordinates and shape functions. Quadratic shape functions.	
Module III:	**25%**
Descriptors/Topics 1. Element stiffness matrix, Assembly of Global stiffness matrix and load vector. 2. Equation generation and treatment of boundary conditions. Stress, strain and support reaction calculations. **3.** FE modeling direct approach: 1-D bar element stiffness – assembly of elements.	
Module IV:	**20%**
Descriptors/Topics 1. 2-D stress and deformation analysis, Finite element modelling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. 2. Analysis of Beams: Element stiffness matrix for two nodes, two degrees of freedom per node beam element. 3. Derivation of load vector for concentrated and UDL, simple problems on beams.	
Module V:	**20%**
1. Analysis of Trusses: Finite element modeling, coordinates and shape functions. 2. Assembly of global stiffness matrix and load vector, finite element equations. Dynamic Analysis. 3. Formulation of finite element model, element matrices. 4. evaluation of Eigen values and Eigen vectors for a stepped bar and a beam	

Student Learning Outcomes:

On completion of the course the student will be able to:

1. Understand the basic finite element formulation techniques.
2. Be able to derive equations in finite element methods for 1D, 2D and 3D
3. Problems
4. Be able to formulate and solve basic problems in heat transfer, solid mechanics
5. and fluid mechanics
6. Be able to write computer program based on finite element methods.
7. Be able to use FEM software, to solve basic engineering problems in heat transfer, solid mechanics and fluid mechanics.

Pedagogy for Course Delivery:

The course pedagogy will include lectures, numerical practice, case studies, seminars and presentations. It also includes discussion on real life problems related to design of mechanical components.

Lab/ Practicals details, if applicable:

List of Experiments:

1. Introduction: Introduction to finite element method , areas of application general steps in finite element.
2. A simple axial model and an intermediate complexity level in axial 1D problem
3. Direct stiffness method – spring element: derivation of the stiffness matrix, example of a spring assemblage
4. Truss Elements problems 2D and 3D
5. Frame Elements problems 2D and 3D
6. Prismatic bar under axial loading.
7. Bending of beams
8. Static Analysis Using Plate, Shell and Solid Elements
9. Natural Frequency and Dynamic Response Analysis
10. Steady and Unsteady State Heat Transfer

Assessment/ Examination Scheme:

Theory L/T (%)	Lab/Practical/Studio (%)	Total
75%	25%	100%

Theory Assessment (L&T):

	Continuous Assessment/Internal Assessment				End Term Examination
Components (Drop down	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

Lab/ Practical/ Studio Assessment:

	Continuous Assessment/Internal Assessment				End Term Examination	
Components (Drop down	A	PR	LR	V	PR	V
Weightage (%)	5	10	10	5	35	35

Text & References:

Text Books:

- Introduction to Finite Elements in Engineering / Chandraputla, Ashok and Belegundu / Prentice –Hall.
- The Finite Element Methods in Engineering / SS Rao / Pergamon.
- Finite Element Analysis and Programming An Introduction S. Shivaswamy / Narosa Pub.

Reference Books:

- J An introduction to Finite Element Method / JN Reddy / Me Graw Hill
- Finite Element Methods/ Alavala/TMH\
- The Finite Element Method for Engineers – Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and Ted G. Byrom / John Wiley & sons (ASIA) Pte Ltd.
- Finite Element Analysis/ C.S.Krishna Murthy
- Zienkiewicz, Taylor and Zhu, "The Finite Element Method: Its Basis and Fundamentals", Elsevier, 2005
- Bathe, "Finite Element Procedures", Prentice Hall, 1995.
- Hughes, "The Finite Element method: linear static and dynamic finite element analysis", Dover Publications,

Any other Study Material:

- Lab Manuals of various software.
- Programming in C.