AMITY UNIVERSITY
UTTAR PRADESH

Course Title: INTRODUCTION TO FINITE ELEMENT METHOD **Credit Units: 05**

L	T	P/S	SW/ FW	TOTAL CREDIT UNITS
3	1	2	-	5

Course Code: to be decided

Course Level: UG

Course Objectives

This course will introduce the numerical analysis techniques to solve the various problems related to structural loading like bending, deflection and buckling etc. It will teach the students how to model the loading problems in structures like trusses and beam which can't be easily solved by analytical approaches.

Pre-requisites: Mechanics of Solids, Aircraft Structures - I & II

Course Contents/Syllabus:

	Weightage (%)
Module I : Introduction to Finite Element Method	**16**
Descriptors / Topics*:* Engineering Analysis, History, Advantages, Classification, Basic steps, Convergence criteria, Role of finite element analysis in computer-aided design., Mathematical Preliminaries, Differential equations formulations, Variational formulations, weighted residual methods.	
Module II : One-Dimensional Elements	**20**
Descriptors/Topics : Analysis of Bars and Trusses, Basic Equations and Potential Energy Functional, 1-D Bar Element, Admissible displacement function, Strain matrix, Stress recovery, Element equations, Stiffness matrix, Consistent nodal force vector: Body force, Initial strain, Assembly Procedure, Boundary and Constraint Conditions, Single point constraint, Multipoint constraint, 2-D Bar Element, Shape functions for Higher Order Elements.	
Module III : Two-Dimensional Elements	**20**
Descriptors/Topics : Analysis of Plane Elasticity Problems: Three-Noded Triangular Element (TRIA 3), Four-Noded Quadrilateral Element (QUAD 4), Shape functions for Higher Order Elements (TRIA 6, QUAD 8), Analysis of Bodies of Revolution under axi-symmetric loading: Axisymmetric Triangular and Quadrilateral Ring Elements. Shape functions for Higher Order Elements.	

Module IV : Three-Dimensional Elements	**24**
Descriptors/Topics : Applications to Solid Mechanics Problems: Basic Equations and Potential Energy Functional, Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family. Shape functions for Higher Order Elements.	
Module V : Dynamic Considerations	**20**
Descriptors/Topics : Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, axisymmetric triangular element, quadrilatateral element, beam element. Lumped mass matrix, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.	

Student Learning Outcomes:

- Apply finite element method to analyze airplane structures under various load conditions.
- Analyze formation of stress and strain matrix in 2D and 3D cases.
- Analyze various shape functions in higher order elements in 2D and 3D cases.
- Develop various codes of FEM to analyze structural loads on different aircraft components .

Pedagogy for Course Delivery: Session Plan / course-material uploading, Class-room teaching associated with assignments**,** presentations**,** quiz, viva-voce and evaluation.

Lab/ Practicals details, if applicable:

List of Experiments:

- Introduction to FEM software and modelling a cantilever beam deflection due to selfweight.
- Analysis of cantilever beam deflection due to end loading
- Analysis of cantilever beam deflection due to uniformly distributed loading
- Analysis of 2-D Truss structure
- Analysis of stress on a flat plate with a hole at its centre
- Axisymmetric analysis of transverse stress on a 3D plate with a hole at one corner
- Analysis of loading and stress distribution in a stepped bar with different cross section area
- Heat transfer analysis using pure conduction and heat generation.

Assessment/ Examination Scheme:

Theory L/T (%)	Lab/Practical/Studio (%)	Total
80	20	100

Theory Assessment (L&T):

Continuous Assessment/Internal Assessment - 30					End Term Examination
Components (Drop down)	**A**	**CT**	**S/V/Q**	**HA**	**70**
Weightage (%)	5	10	8	7	70

Lab/ Practical/ Studio Assessment:

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

Text & References:

- Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2007.
- Lakshminarayana H. V., Finite Elements Analysis – Procedures in Engineering, Universities Press, 2004
- Rao S. S., Finite Elements Method in Engineering, 4th Edition, Elsevier, 2006.
- P.Seshu, Textbook of Finite Element Analysis -PHI, 2004.
- J.N.Reddy, Finite Element Method, McGraw -Hill International Edition.
- Bathe K. J. Finite Elements Procedures, PHI.
- Finite Element Analysis C.S. Krishnamoorthy TMH

Any other Study Material:

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