FACULTY OF ENGINEERING & TECHNOLOGY

First Year Master of Engineering

Semester II

Course Code: **102320203**

Course Title: **Finite Element Analysis**

Type of Course: Core Course V

Course Objectives: The subject aims to understand the numerical methods for solving governing equations of basic Mechanical systems. This course also introduces the fundamentals of dynamic and non-linearity conditions.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Internal		External		Total
Lecture	Tutorial	Practical		Theory	J/V/P*	Theory	J/V/P*	
3	0	2	4	30/15	20/10	70/35	30/15	150/75

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction: Basic concepts, Historical back ground, Applications, Comparison of FEM with other methods, Variational approach, Glerkin's approach, Co-ordinate systems, Element shapes, Interpolation function, Virtual energy principle, Rayleigh-Ritz method, Properties of stiffness matrix, Treatment of boundary conditions, Solution of system of equations, Shape functions and characteristics, Basic equations of elasticity, Strain-Displacement relationship.	9
2	1-D Structural Problems: Axial bar element, Stiffness matrix, Load vector, Temperature effects, Quadratic shape functions and Problems. Analysis of Trusses, Plane Truss and Space Truss elements and problems. Analysis of Beams, Shape functions, Stiffness matrix, Load vector and Problems.	9
3	2-D Structural Problems: Formulation of triangular elements, CST and LST, Force terms, Stiffness matrix and Load vectors, Boundary conditions, Iso- Sub- Super parametric elements, Quadrilateral elements, Shape functions, Numerical Integration. Finite element modelling of Axi-symmetric solids subjected to Axi-symmetric loading. Introduction to Torsional problems.	9

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4	Scalar Field Problems: 1-D Heat conduction formulation of slabs and fins, Problems. 2-D heat conduction formulation and problems.	**4**
5	Dynamic Problems: Formulation, Consistent and lumped mass matrices, Solution of eigenvalue problems, Transformation methods, Jacobi method, Vector Iteration and Subspace Iteration Methods.	**6**
6	Non-Linearity: Introduction and types of non-linearity, Formulation of geometrical and material nonlinearity	**2**

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks						**R**: Remembering; **U**: Understanding; **A**: Application, **N**: Analyze; **E**: Evaluate; **C**: Create
R	**U**	**A**	**N**	**E**	**C**	
15	15	25	20	15	10	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1	A First Course in the Finite Element Method, D Logan, Thompson Learning.
2	Concepts and Applications of Finite Element Analysis, R D Cook, D S Malkus, M E Plesha, and R J Witt, Wiley.
3	Text book of Finite Element Analysis, Seshu P., PHI.
4	Finite Element Procedures, Bathe K. J., PHI.
5	Introduction to Finite Elements in Engineering, Chandrupatla T. R. and Belegunda A. D., PHI.
6	The Finite Element Method - A Practical Course, Liu G. R. and Quek S. S., Butterworth Heinemann.
7	Finite element Method in Engineering, S S Rao, Elsevier.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Understand the concept of FEM and develop algorithms for analysis of various mechanical systems.	**20**
CO-2	Apply the knowledge of FEA to perform 1D stress and heat transfer analysis.	**30**
CO-3	Formulate and solve problems related to trusses and beams.	**30**
CO-4	Develop 2D Finite Element formulation for triangular and quadrilateral elements.	**15**
CO-5	Analyse dynamic problems and non-linearity presents in geometry and material	**5**

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List of Practicals / Tutorials:

1	Introduction about FEA software package.
2	Understand the procedure and execute 1-D structural analysis using FEA software.
3	Exercise on plane and space Truss problems using FEA software
4	Exercise on Beam problems with different boundary and loading conditions using FEA software.
5	Analyse the effect of element formulation and number of elements in 2D structural problems using different element types in FEA software.
6	Understand the procedure and execute 1-D steady state heat transfer problems using FEA software.
7	Understand the procedure and execute 2D steady state heat transfer problems using FEA software.
8	Exercise on Torsional Problems using FEA software.
9	Modal Analysis of Cantilever beam for natural frequency determination.
10	Exercise on Dynamic problems using FEA software.

Supplementary learning Material:

Curriculum Revision:	
Version:	**1**
Drafted on (Month-Year):	Apr-20
Last Reviewed on (Month-Year):	Jul-20
Next Review on (Month-Year):	Apr-22

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