SARVAJANIK UNIVERSITY

Sarvajanik College of Engineering and Technology

Bachelor of Technology

Mechanical Engineering Department
B. Tech. Semester V

Course Name : Finite Element Method **Course Code: BTME19522**
Type of course : Honors – CAD-CAM
Prerequisite : Computer Aided Design and Numerical Methods for Mechanical Engineers
Rationale of course : This subject will provide the basic principles of finite element analysis procedure also theory and characteristics of finite elements that represent engineering structures.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
3	0	2	4	60	25	15	30	20	

CA1: Continuous Assessment (assignments/projects/open book tests/closed, book tests.) **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self, learning attitude/solving advanced problems**. TEE:** Term End Examination**. TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course)**. CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in the course.

Content:

Sr. No.	Content	Total Hrs	Module Weightage
1	**Introduction:** Historical Background, mathematical modeling of field problems in engineering, scope of finite element methods, application of FEM, Ritz method, Weighted residual methods: Galerkin's method, Principal of a minimum potential energy, principle of virtual work, Boundary value problem.	07	15
2	**Formulation of Stiffness Matrix:** Procedure of Finite Element Method, Discretization process; types of elements 1D, 2D and 3D elements, size of the elements, location of nodes, node numbering scheme, Stiffness matrix of bar element by direct method, Global stiffness matrix for bar elements, Properties of global stiffness matrix.	07	15

3	**One Dimensional Elements:** Elimination and penalty approach, computation of stresses and strains for bar, Stiffness Matrix for Bar Element, formulation of truss element, plane truss: stiffness and force matrix, Beam theory, Beam stiffness matrix, Global beam stiffness matrix, equivalence load for various distributed loads, potential energy and Galerkin's method for beam elemental equation.	**10**	**25**
4	**Two Dimensional Elements:** Constant Strain Triangle, Linear Strain Triangle, Quadrilateral Elements (Q4, Q8): shape function, jacobian matrix, Numerical Evaluation of Element Stiffness, Computation of Stresses, Geometric Nonlinearity and Static Condensation, Axisymmetric Element, Finite Element Formulation of Axisymmetric Element and its application.	**14**	**30**
5	**Thermal and Fluid Problems:** Steady state heat transfer: element formulations, treatment to boundary conditions with application to 1-D heat conduction, computation of thermal stresses and strains for bar, heat transfer through thin fins, potential flow problems.	**07**	**15**

Percentage Distribution of Marks as per Revised Bloom's Taxonomy (Theory/Practical):

Percentage Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**25**	**25**	**20**	**10**	**05**

Legends: R: Remembrance, **U:** Understanding, **A:** Application**, N:** Analyze, **E:** Evaluate**, C:** Create and above Levels

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:

Sr. no.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	CAD / CAM and Automation	Farazdak Haidery	Nirali Prakashan	2015	9th
2	A first course in Finite Element Method	D.L. Logan	Thomson Asia Pvt. Ltd	2016	6th
3	Introduction to Finite Elements Engineering	T. R. Chandrupatla and A. D. Belegundu	Pearson Education	2015	4th
4	Finite Element Analysis	S. S. Bhavikati	New Age International Publishers	2015	3rd
5	Introduction to Finite Element Method	J.N. Reddy	McGraw Hill	2020	4th

Course Outcomes (CO's):

CO No.	CO Statement After learning this subject, students will be able to	Marks % Weightage
CO-1	Explain the fundamentals of finite element method.	10
CO-2	Formulate the equations of different elements in finite element methods.	20
CO-3	Evaluate the bar and truss problem by finite element method.	25
CO-4	Solve 2-D finite element problems involving triangular, quadrilateral elements.	30
CO-5	Apply the knowledge of FEM for heat transfer analysis and flow analysis.	15

Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO-1	2	1	0	0	1	0	0	0	0	0	0	0	0	2	0
CO-2	3	3	2	1	1	0	0	0	1	1	0	1	1	3	1
CO-3	3	3	2	2	3	1	1	1	1	0	0	1	1	3	2
CO-4	3	3	1	1	3	0	0	0	1	1	0	1	2	3	1
CO-5	3	3	3	2	3	1	0	0	1	0	1	1	2	3	2
Rationale*	**14**	**13**	**8**	**6**	**11**	**2**	**1**	**1**	**4**	**2**	**1**	**4**	**6**	**14**	**6**

Rationale - Mapping of CO's with PO's and CO's with PSO's:

It will help to give basic understanding of finite element method apply to solve various material characteristics of engineering components, develop the problem analysis skill in students as they are able to correlate with real life problems. Students will able to design and analyze mechanical systems using modern computing and analysis software and their application solve technical problems.

This course highly maps with Program outcomes 1, 2,3,4,5 and Program Specific Outcomes 2. It states that the course will develop engineering knowledge, problem analysis, design / development of solutions, conduct investigations of complex problems, modern tool usage and finally it will lead to with the use of modern computing tools.

List of Practical:

1) Solve numerically and compare 1D – Structural problems using FEA software.
2) Solve numerically and compare Cantilever Beam problems using FEA software.
3) Solve numerically and compare Stepped Section problems using FEA software.
4) Solve numerically and compare torsional deflection and moment for a shaft subject to torque using FEA software.
5) Solve numerically and compare circumferential and longitudinal stress of pressurized cylindrical pressure vessel using FEA software.
6) Solve Structural Two Dimensional Plate problems using FEA software.
7) Solve Heat transfer problems in 2-D Plate using FEA software.
8) Solve axisymmetric problems using FEA software.

Major Equipment:

1) Computational Facility

List of Open learning website:

1) https://nptel.ac.in/courses/112104193
2) https://nptel.ac.in/courses/112104116

List of Open Source Software:

1. Open source FEA software