SCHEME OF COURSE WORK

Course Details:

Course Title	**FINITE ELEMENT ANALYSIS**	**L T P C**	**3 0 0 3**
Course Code	**19ME2102**		
Program	**M. Tech**		
Specialization	**CAD/CAM**		
Semester	**I**		
Prerequisites	**Mechanics of Solids at UG level**		
Courses to which it is a prerequisite	**------**		

Course Outcomes (COs):

At the end of the course a student will be able to

CO	Course Outcomes	Cognitive Level
CO1	Apply Rayleigh-Ritz, Galerkin methods to solve engineering problems and analyze linear 1D problems like bars and trusses.	Remember , Understand , Apply
CO2	Analyze 2D structural problems using CST element and axi-symmetric problems with triangular elements.	Understand , Apply, Analyze
CO3	Explain shape functions for 4 and 8 noded quadrilaterals, 6 noded triangle elements and apply numerical integration to solve; 1D and 2D; stiffness integration.	Remember , Understand , Apply
CO4	Solve linear 2D structural beams and frames problems; 1D heat conduction and convection heat transfer problems	Remember , Understand , Apply
CO5	Calculate the Eigenvalues and Eigenvectors for stepped bar and beam, explain geometric and material nonlinearity	Remember , Understand , Apply

Program Outcomes (POs):

At the end of the program, the students in CAD/CAM will be able to

1. acquire fundamentals in the areas of computer aided design and manufacturing
2. apply innovative skills and analyze computer aided design and manufacturing problems critically
3. identify, formulate and solve design and manufacturing problems
4. carry out research related to design and manufacturing
5. use existing and recent CAD/CAM software
6. collaborate with educational institutions, industry and R&D organizations in multidisciplinary teams
7. apply project and finance management principles in engineering projects
8. prepare technical reports and communicate effectively
9. engage in independent and life-long learning and pursue professional practice in

their specialized areas of CAD/CAM

10. exhibit accountability to society while adhering to ethical practices
11. act independently and take corrective measures where necessary

Course Outcome Versus **Program Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S			M	M			M		
CO2	S	S			M	M			M		
CO3	S	S			M	M			M		
CO4	S	S			M	M			M		
CO5	S	S			M	M			M		

S - Strongly correlated, *M - Moderately* correlated, *Blank - No correlation*

Assessment Methods:	Assignment / Quiz / Seminar / Case Study / Mid-Test / End Exam

Teaching-Learning and Evaluation

Week	TOPIC / CONTENTS	Course Outcomes	Sample questions	TEACHING LEARNING STRATEGY	Assessment Method &Schedule
Fundamentals of machining					
1	Introduction, comparison of FEM with other methods, Galerkin Method and Rayleigh-Ritz method	CO1	Explain Galerkin method with a suitable example	Lecture Discussion Problem solving	Assignment-I (Week 8) Mid-I (Week 9)
2	shape functions and characteristics, properties of stiffness matrix, treatment of boundary conditions	CO1	Explain penalty approach of handling boundary conditions	Lecture Discussion	Assignment-I (Week 8) Mid-I (Week 9)
3	Convergence: requirements for convergence, h refinement and p-refinement, basic equations of elasticity, strain displacement relations	CO1	Discuss h-refinement and p-refinement to enhance convergence	Lecture Discussion	Assignment-I (Week 8) Mid-I (Week 9)

4	1-D structural problems axial bar element stiffness matrix and load vector, .	CO1	Problems on 1-D stepped bars to compute displacements, stresses and reactions	Lecture Discussion Problem solving	Assignment-I (Week 8) Mid-I (Week 9)
5	Plane trusses, element stiffness matrix, assembly of global stiffness matrix and load vector, stress calculations	C01	Problems in plane trusses to solve for displacements, stresses and reactions	Lecture Discussion Problem solving	Assignment-I (Week 8) Mid-I (Week 9)
6	Two-dimensional problems using CST: FE modelling, isoparametric representation, PE approach, element stiffness, force terms, stress calculations	CO2	Derive the strain-displacement matrix of a CST element	Lecture Discussion Problem solving	Assignment-I (Week 8) Mid-I (Week 9)
7	Axisymmetric formulation, FE Modelling using triangular elements, body force terms, surface traction, stress calculations, cylinder subjected to internal pressure, infinite cylinder.	CO2	Derive the stiffness matrix of an axi-symmetric triangle	Lecture Discussion Problem solving	Assignment-I (Week 8) Mid-I (Week 9)
8	Isoparametric formulation: 4-noded quadrilateral and its shape functions, element stiffness matrix, element force vectors	CO3	Derive the strain-displacement matrix of a 4-noded quadrilateral element	Lecture Discussion Problem solving	Assignment-I (Week 8) Mid-I (Week 9)
9	**MID-I**				
10	nine - noded quadrilateral, eight-noded quadrilateral, six-node triangle, sub parametric, super parametric elements, serendipity elements	CO3	Derive the shape functions of 9-noded quadrilateral	Lecture Discussion	Assignment-II (Week 17) Mid-I (Week 18)

11	Numerical Integration- 1D and 2D integrations, stiffness integration, stress calculations	CO3	Problems on evaluation of 1-D and 2-D integrals by Gaussian	Lecture Discussion Problem solving	Assignment-II (Week 17) Mid-II (Week 18)

			numerical integration		
12	Beams and frames: finite element formulation, load vector, boundary conditions, shear force and bending moment, and plane frames	CO4	Problems on 2-D beams and plane frames to compute displacements	Lecture Discussion Problem solving	Assignment-II (Week 17) Mid-II (Week 18)
13	Scalar field problems: steady state heat transfer-one-dimensional heat conduction problems, onedimensional heat transfer in thin fins.	CO4	Solution to on 1-D heat transfer problems by FEM	Lecture Discussion Problem solving	Assignment-II (Week 17) Mid-II (Week 18)
14	formulation-solid body with distributed mass, element mass matrices	CO5	Derivation of element mass matrices for 1-D bar and beam elements	Lecture Discussion	Assignment-II (Week 17) Mid-II (Week 18)
15	evaluation of Eigenvalues and Eigenvectors for a stepped bar and a beam	CO5	Problems of 1-D stepped bars and beams to compute natural frequencies and vibration modes	Lecture Discussion Problem solving	Assignment-II (Week 17) Mid-II (Week 18)
16	Introduction to nonlinear problems, geometric nonlinearity, material nonlinearity	CO5	Discuss how nonlinearities are handled with FEM	Lecture Discussion	Assignment-II (Week 17) Mid-II (Week 18)

17	nonlinear dynamic problems, analytical problems.	CO5	Discuss the FE formulation of nonlinear dynamic problems	Lecture Discussion	Assignment-II (Week 17) Mid-II (Week 18)
18	**Mid-II**				
19	**End Semester**				