SCHEME OF COURSE WORK

Course Details:

Course Title	: Finite Element Analysis		
Course Code	: 13ME2202	**L T P C**	**:4 0 0 3**
Program:	**: M.Tech.**		
Specialization:	**: CAAD**		
Semester	**: Ist**		
Prerequisites	**:--**		
Courses to which it is a prerequisite	**:--**		

Course Outcomes (COs):

The student will be able to

CO1	Apply direct stiffness, Rayleigh-Ritz, Galerkin method to solve engineering problems and outline the requirements for convergence
CO2	Analyze linear 1D problems like bars and trusses; 2D structural problems using CST element and analyse the axi-symmetric problems with triangular elements
CO3	Write shape functions for 4 and 8 node quadrilateral, 6 node triangle elements and apply numerical integration to solve; 1D and 2D; stiffness integrations
CO4	Solve linear 2D structural beams and frames problems; 1D heat conduction and convection heat transfer problems
CO5	Evaluate the Eigenvalues and Eigenvectors for stepped bar and beam, explain nonlinear geometric and material non linearity

Program Outcomes (POs):

At the end of the program, the students in CAAD will be able to

PO 1	acquire knowledge in latest computer-aided design and analysis tools
PO 2	create 3D models of real-time components using latest CAD software
PO 3	acquire technical skills to formulate and solve engineering and industrial problems
PO 4	carry out analysis for the design of new products
PO 5	have proficiency to solve problems using modern engineering design tools
PO 6	have capability to work in multidisciplinary streams
PO 7	apply project and finance management skills to organise engineering projects
PO 8	prepare technical reports and present them effectively
PO 9	engage in lifelong learning
PO 10	realize professional and ethical responsibilities
PO 11	conduct surveys, analyse data, plan, design and implement new ideas into action

Course Outcome Versus **Program Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO-1	S			M							
CO-2		S		S	S						
CO-3			S	M							
CO-4			S	M	S						
CO-5					S	M					

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

Assessment Methods

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

1. **Teaching-Learning and Evaluation**

Week	Topic / Contents	Course Outcomes	Sample questions	Teaching -Learning Strategy	Assessment Method & Schedule
1	comparison of FEM with other methods, Variational approach, Galerkin Methods	CO-1	1.Define principle of minimum potential energy 2. Variational approach based on displacement method 3.Write short notes on shape functions of bar element 4.Differentiate plain stress case and strain case	Lecture Demonstration Problem solving	Assignment - I (Week 2 - 4)
2	principle of minimum potential energy Rayleigh- Ritz method, shape functions and characteristics	CO-1			
3	properties of stiffness matrix, treatment of boundary conditions, Convergence: requirements for convergence	CO-1			
4	h refinement and p-refinement, basic equations of elasticity, strain displacement relations	CO-1			
5	1-D structural problems – axial bar element – stiffness matrix, load vector	CO-2	1..Determne the nodal displacements of given stepped bar 2. Determine the nodal displacements of given plane truss 3. Derive strain displacement matrix for CST element	Lecture Problem solving	Seminar - I (Week 6 - 8)
6	Trusses: Plane trusses, element stiffness matrix, assembly of global stiffness matrix, load vector, stress calculations	CO-2			
7	Two-dimensional problems using CST: FE modelling, isoparametric representation, PE approach, element stiffness, force terms, stress calculations, axisymmetric formulation	CO-2			
8	FE Modelling using CST- PE approach, body force terms, surface traction, stress calculations, cylinder	CO-2			

	subjected to internal pressure, infinite cylinder				
9	Mid-Test 1	CO-1, CO-2			Mid-Test 1 (Week 9)
10	4-noded quadrilateral and its shape functions, element stiffness matrix, element force vectors	CO-3	1. Solve the following integral function using Gaussian quadrature one-point, two point formulae and compare with the exact solution. 2. Derive the shape functions for four nodded quadrilateral is parametric element.	Lecture Discussion Problem solving	Assignment - II (Wee12 - 14)
11	Numerical Integration-1D and 2D integrations, stiffness integration, stress calculations, nine -node quadrilateral,	CO-3			
12	eight-node quadrilateral, six-node triangle, sub parametric, super parametric elements, serendipity elements	CO-3			
13	finite element formulation, load vector, boundary considerations, shear force and bending moment of beams and frames	CO-4	1. Determine the nodal displacements of given frame and beam 2. Determine the temperature distribution on 2D plate 3. Consider a brick wall thickness 0.3m with the thermal conductivity of 0.7 W/mK.The inner surface is at 280C and the outer surface is exposed to cold air withthe heat transfer coefficient of 40 W/m2 K at -150C. Determine the steady state temperature distribution and also the heat flux through the wall. Use two elements and obtain the solution 4. A beam of length 2 m is fixed at both ends. Estimate the deflection at the centerof the beam where load is acting vertically downward of 10 kN. Divide the beam into two elements. Compare the solution with theoretical calculations. Take E = 2 × 1011 N/m2, A = 250 mm2	Lecture Discussion Problem solving	Seminar - II (Week 16 - 18)
14	steady state heat transfer-one-dimensional heat conduction, one-dimensional heat transfer in thin films	CO-4			

15	formulation-solid body with distributed mass, element mass matrices,	CO-5	1. Explain the following with examples. (a) Lumped parameter model. (b) Consistant mass matrix model. 2. Find the natural frequencies and the corresponding mode shapes for the longitudinal vibrations for the stepped bar. Assume A1 = 2A and A2 = A ;I1 = I2 = I & ; E1 = E2 = E. 3. Write brief notes geometric nonlinearity and material non linearity	Lecture Problem solving	
16	evaluation of Eigen values and Eigen vectors for a stepped bar and a beam,	CO-5			
17	introduction to non-linear problems, geometric nonlinearity, material non linearity non-linear dynamic problems, analytical problems	CO-5			
18	Mid-Test 2	CO-3, CO-4, CO-5			Mid-Test 2 (Week 18)
19/ 20	END EXAM	All Cos			