	SIDDHARTH GROUP OF INSTITUTIONS :: PUTTUR Siddhartha Nagar, Narayanavanam Road – 517583 **QUESTION BANK** **Subject Code :** FEM (18ME3004) **Course & Branch :** M.Tech – CAD/CAM **Year & Sem :** I & Il –Sem **Regulation :** R18

UNIT – I

1.	**a.**	Derive the strain displacement relationship for 2D situation.	[6M]
	b.	Explain the stress – strain relation of an orthotropic material.	[6M]
2.		Discuss the basic steps involved in FEM and explain in detail with example.	[12M]
3.		Explain the Galerkin's residual method and its use to derive the one-dimensional bar element equations.	[12M]
4.	**a.**	In a plane strain condition σ_x = 150 MPa, σ_y = -100 MPa, E = 2 X 10^5 MPa, μ = 0.25. find the stresses in z-direction and strain in x & y direction	[12M]
	b.	State and explain the principle of minimum potential energy.	[6M]
5.		Explain the Raleigh – Ritz method of functional approximation with the help of an example in detail.	[12M]
6.		How are boundary conditions treated in handling finite element equation? What are the approaches referred?	[12M]
7.		How can a three dimensional problem be reduced to a two dimensional problem? What are the stress strain relations with such simplification? Give examples.	[12M]
8.		The following differential equation is available for a physical phenomenon. $\frac{d^2y}{dx^2} + 50 = 0, 0 \le x \le 10$ trail function is, $y = a_1 x(10 - x)$Boundary conditions are, y(0)=0, y(10)=0 Find the value of parameter a_1 by all Weighted Residuals methods.	[12M]
9.	**a.**	Explain the principle of virtual work.	[6M]
	b.	Write the advantages, disadvantages and limitations of finite element method.	[6M]
10.	**a.**	State the methods of engineering analysis	[2M]
	b.	What are structural and non-structural problems?	[2M]
	c.	State various applications of FEM in different fields of engineering.	[2M]
	d.	Name WRM methods.	[2M]

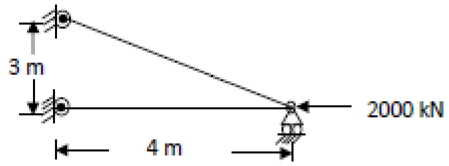
e. State the methods of engineering analysis [2M]

UNIT – II

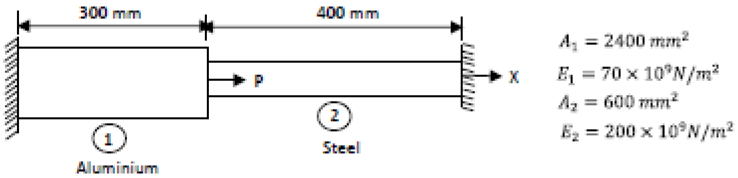
1. a. Explain in detail the finite element modelling of one – dimensional problem. [6M]

b. Derive the element stiffness matrix and nodal load vectors for 2- noded 1-D element. [6M]

2. Determine the nodal displacement, element stresses and support reactions for the two-bar truss shown in figure. Take E = 210 GPa and A = 600 mm^2 for each element. [12M]

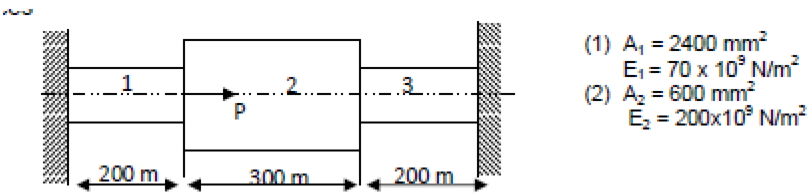


3. a. Determine the nodal displacements stress in each material and the reaction forces. For the bar shown in figure. An axial load P = 150×10^3 N is applied as shown. [12M]

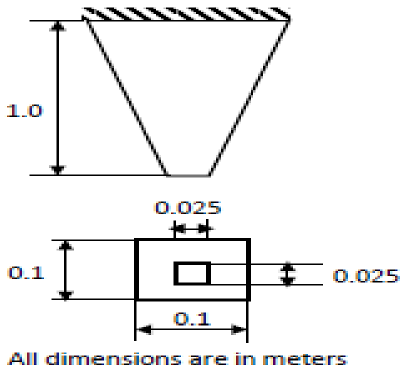


b. Explain the shape functions used in 1-D Bar problems. [2M]

4. An axial load P = 200×10^3 N is applied on a bar shown. Using the penalty approach for handling boundary conditions, determine nodal displacements, stress in each material and reaction forces [12M]

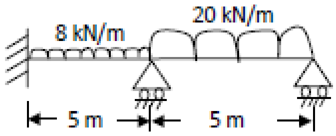


5. Find the deflection at the free end for the member shown in figure under its own weight. Take Young's modulus as 200 GPa and density as 7700 kg/m^3. [12M]



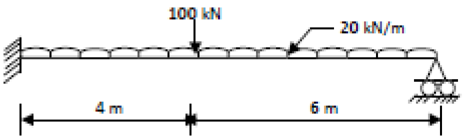
6. Derive the strain displacement matrix, stiffness matrix and nodal load vectors for a 2-noded beam element. [12M]

7. Analyse the beam shown in figure by finite element method and determine the end reactions. Also determine the deflections at mid spans given E = 2 x 10^5 N/mm^2 and I = 5 x $10^5$$mm^4$. [12M]



8. Drive an expression for shape function and assembly the stiffness matrix for bending in beam elements. [12M]

9. Determine the consistent nodal vector due to loads acting on the beam shown in figure: [12M]



10. **a.** Define shape function. What are the characteristics of shape function? [2M]

b. Give element stiffness matrix for 1D 2 noded bar element. State the properties of a stiffness matrix. [2M]

c. Differentiate between BAR and TRUSS elements in FEM. [2M]

d. Explain the classical beam theory and also write the assumptions in classical beam theory [2M]

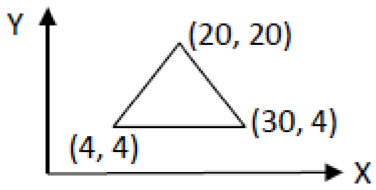
e. Derive strain displacement matrix for 2 noded 1D bar element. [2M]

UNIT - III

1.		Derive Linear interpolation polynomials in terms of global coordinates for triangular (2D simplex) elements?	[12M]
2.		Derive Linear interpolation polynomials in terms of local coordinates for triangular (2D simplex) elements.	[12M]
3.		What are the different types of elements in interpolation models?	[12M]
4.		Explain briefly about selection of the order of the interpolation polynomial?	[12M]
5.		What are the convergence requirements? Explain.	[12M]
6.		Discuss about the shape functions of 2D quadratic rectangular element in natural coordinates?	[12M]
7.		Write about shape functions of 2D quadratic triangular element in natural coordinates?	[12M]
8.		Derive the element stiffness matrix and strain displacement matrix for a 4-noded iso-parametric quadrilateral element.	[12M]
9.	**a**	Using natural coordinates derive the shape function for a linear quadrilateral element.	[6M]
	b	Write short notes on: (i) Uniqueness of mapping of iso-parametric elements. (ii) Gaussian quadrature integration technique.	[6M]
10.	**a.**	Write the Polynomial form of interpolation functions for (i) Linear (ii) Quadratic and (iii) Cubic elements.	[2M]
	b.	What is 2D Pascal Triangle?	[2M]
	c.	Write the properties of shape functions.	[2M]
	d.	Write the Lagrangian interpolation function.	[2M]
	e.	Write the shape function for Biquadric rectangular element.	[2M]

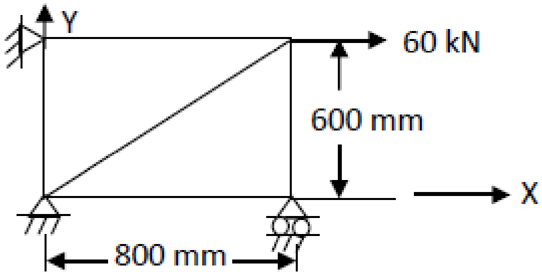
UNIT – IV

1. Determine the element stresses for the triangular element shown in figure. The nodal displacements are given as u_1 = 0.005 mm, u_2 = 0.002 mm, u_3 = 0.0 mm, u_4 = 0.0 mm, u_5 = 0.004 mm, and u_6 = 0.0 mm Take E = 200 GPa & v = 0.3. Use unit thickness for plane strain. [12M]



2. Derive the shape functions, strain-displacement matrix, stiffness matrix and nodal load vectors for a constant strain triangular element. [12M]

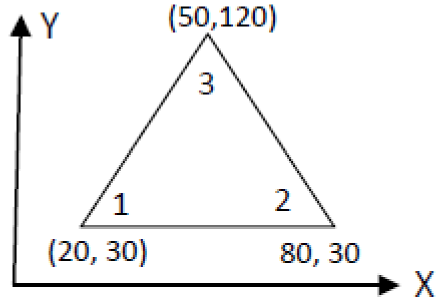
3. Find the nodal displacements and element stresses in the propped beam shown in figure. Idealize the beam into two CST elements as shown in the figure. Assume plane stress condition. μ = 0.25, Take E = 2 x 10^5 N/mm^2, thickness = 18 mm. [12M]



4. Calculate the temperature distribution in a 1-D fin, the fin is rectangular in shape and is 120 mm long, 40 mm wide and 10 mm thick. One end of the fin is fixed and other end is free. Assume that convection heat loss occurs from the end of the fin. Use 2 elements. The temperature at fixed end is120 ^oC, h = 10^{-3} W/mm ^oC, K = 0.3 W/mm ^oC, $T_{(am(B)}$ = 20 ^oC [12M]

5. Derive the shape functions, strain-displacement matrix, stiffness matrix and nodal load vectors for a linear strain triangular element. [12M]

6. Evaluate the stiffness matrix for the elements shown in figure below. The coordinates are given in units of millimetres. Assume plane stress conditions. Let E = 210 GPa, passion ratio 0.25, and thickness 10 mm: [12M]

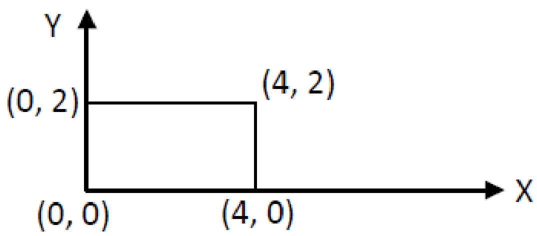


7. **a.** Explain the isoparametric concept in finite element analysis. [6M]

b. Explain the terms isoparametric, subparametric and superparametric elements. [6M]

8. Derive the stiffness matrix and nodal load vectors for an axisymmetric pressure vessel. [12M]

9. Determine J, B and σ at r = 0 and s = 0 for the four node quadrilateral element shown in figure. The nodal displacements are given by. d = [0.0, 0.0, 0.02, 0.03, 0.06, 0.015, 0.10, 0.0] cm. Take E = 20 x 10^6 N/cm^2 & ν = 0.25. Assume plane stress conditions. [12M]



10. **a.** What are CST and LST elements? [2M]

b. What is QST element? Define Plane stress and plane strain analysis. [2M]

c. Write down the expression for the shape functions for a CST element. [2M]

d. Write down the shape functions for an axisymmetric element. [2M]

e. What is axisymmetric element? What are the conditions for a problem to be axisymmetric? [2M]

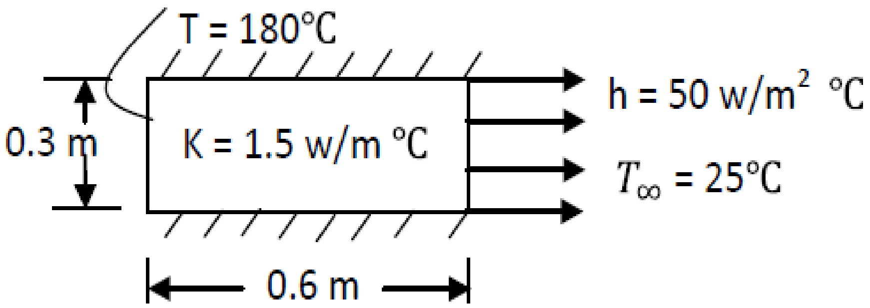
UNIT – V

1. Derive 1D steady state heat conduction equation. [12M]

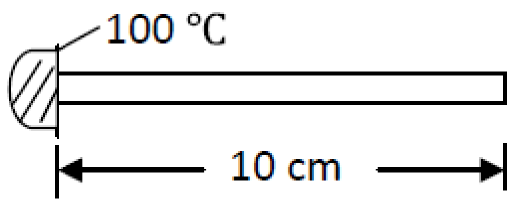
2. **a.** Explain in detail the one dimensional formulation of fin [6M]

b. Derive the basic differential equation in heat transfer analysis. [4M]

3. For the 2-D body shown in figure, determine the temperature distribution. The edges on the top and bottom of the body are insulated. Assume. $K_x = K_y$ Use three element models. [12M]



4. Determine the temperature distribution in 1-D rectangular cross-section as shown in figure. The fin has rectangular cross-section and is 10 cm long, 4 cm wide and 1 cm thick. Assume that convection heat ion occurs from the end of the fin. Take K = 4 W/cm ^{o}C, h = 0.1 W/cm^{2} ^{o}C and T_{∞} = 2000 ^{o}C [12M]



5. Explain Hamilton principle with example. [6M]

6. Explain 2-D finite element formulation in fluid flow and thermal stress analysis [12M]

7. Explain the 1-D finite element formulation in fluid flow and thermal stress analysis [12M]

8. Explain, how to conduct the convergence test or mesh refinement study in finite element analysis? [6M]

9. What is the reason behind a H-method and a P-method in FEA? Explain in detail. [6M]

10. Write short note on FEM convergence requirements. [6M]