SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY :: PUTTUR
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QUESTION BANK

Subject with Code : Finite Element Analysis in Thermal Engineering(16ME8805) **Course & Specialization**: M.Tech – Th. Engg

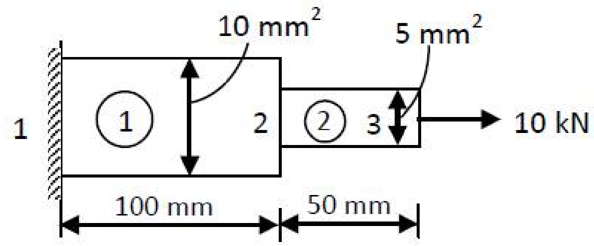
Year & Sem: I & I-Sem **Regulation:** R16

UNIT-I

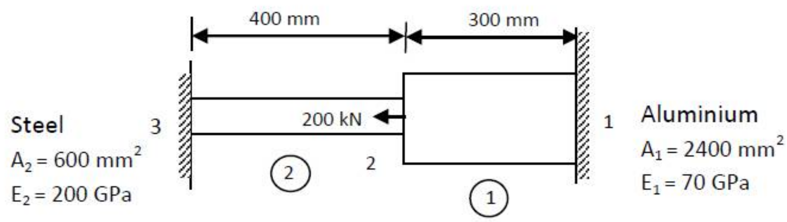
1.	(a)	List the advantages and disadvantages of FEM over other traditional variational methods.	[5M]
	(b)	Derive the finite element equation using the potential energy approach.	[5M]
2.		How can a three dimensional problem be reduced to a two dimensional problem? What are the stress strain relations with such simplification? Give examples.	[10M]
3.		Explain the Galerkin’s residual method and its use to derive the one-dimensional bar element equations.	[10M]
4.		Explain the Raleigh – Ritz method of functional approximation with the help of an example in detail.	[10M]
5.		How are boundary conditions treated in handling finite element equation? What are the approaches referred?	[10M]
6.	(a)	Explain basic steps involved in finite element analysis.	[5M]
	(b)	State principles of minimum potential energy and explain potential energy functional for 3-dimensional elastic body.	[5M]
7.		Explain the following:	
	(a)	Variational method.	[7M]
	(b)	Importance of boundary conditions.	[3M]
8.	(a)	Explain the procedure for finite element analysis starting from a given differential equation.	[5M]
	(b)	Derive the strain displacement relationship for 2D situation.	[5M]
9.	(a)	Define finite element method. Explain the various application fields of finite element method.	[5M]
	(b)	Write equilibrium equations in elasticity subjected to body and traction forces.	[3M]
	(c)	Write the stress-strain relationships for both plane stress and plane strain problems.	[2M]
10.	(a)	Compare finite element method with finite difference method.	[4M]
	(b)	How are boundary conditions treated in handling finite element equation? What are the approaches referred?	[6M]

UNIT-II

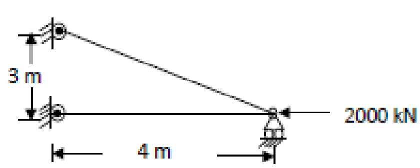
1. (a) Derive the stiffness matrix for plane stress element. [7M]
   (b) Write a note on quadratic shape functions. [3M]
2. (a) Derive shape functions for 1D two noded bar element. Hence explain the conditions that the shape function has to satisfy. [7M]
   (b) Write a note on the polynomials involved in linear, quadratic & cubic 1D element. [3M]
3. Derive stiffness equations for a bar element from the one dimensional second order equation by variational approach. [10M]
4. (a) Derive element stiffness matrix for one dimensional element. [4M]
   (b) A two element two noded bar is shown in figure below. Determine the nodal displacements and nodal forces. Take E = 200 GPa. [6M]



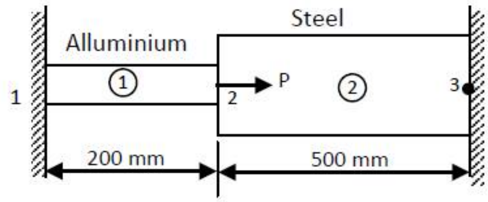
5. Explain the steps involved in analysis of beams with the help of a simple example and how boundary conditions are applied [10M]
6. A stepped bar is shown in the figure given below. Determine:
   (a) The nodal displacements and nodal forces. [4M]
   (b) The stresses in each element. [3M]
   (c) The principal and shear stress in each element. [3M]



7. 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. [10M]



8. (a) Derive shape functions for one dimensional two noded beam element. Hence explain the conditions that the shape function has to satisfy. [4M]
   (b) Derive strain-displacement matrix for one-dimensional beam element. [6M]
9. An axial load P = 300 kN is applied to a stepped bar at 200C as shown in diagram. The temperature is then raised to 800C. Determine nodal displacements and stresses. [10M]

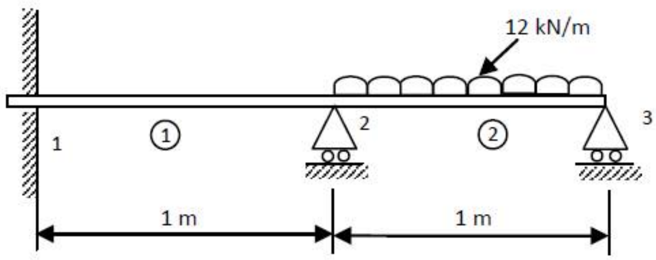


$E_1 = 70 \times 10^9\ N/mm^2$, $E_2 = 2 \times 10^{11}\ N/mm^2$

$A_1 = 900\ mm^2$, $A_2 = 1200\ mm^2$

$\alpha_1 = 23 \times 10^{-6} / {}^\circ C$, $\alpha_2 = 23 \times 10^{-6} / {}^\circ C$

10. For a beam shown in diagram determine slopes at nodes 2 and 3 vertical deflection at midpoint of distributed load. [10M]



E = 200 GPa
$I = 4 \times 10^6\ mm^4$

UNIT-III

1. Derive the shape functions for a 4 node (corner) rectangular element using Lagrange method. [10M]

2. (a) Discuss the importance of isoparametric concept used in FEM. [3M]
   (b) Derive the element stiffness matrix of a CST element for plane stress condition. [7M]

3. (a) What is shape function? Derive the shape function for 3-noded CST element. [5M]
   (b) Explain in detail the applications of isoparametric elements in two and three dimensional stress analysis. [5M]

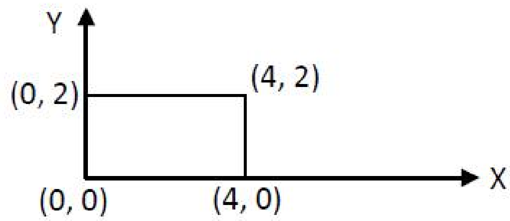
4. (a) Derive Jacobian transpose matrix for three noded constant strain triangle element. [6M]
   (b) Define isoparametric element. What are the advantages? [4M]

5. Explain in detail how the element stiffness matrix and the load vector are evaluated in iso-parametric formulations. [10M]

6. (a) Write the basic equations for 2D problem in stress analysis. [3M]
   (b) Derive inverse of the Jacobian transformation matrix for 3D tetrahedral elements. [7M]

7. 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, [10M]

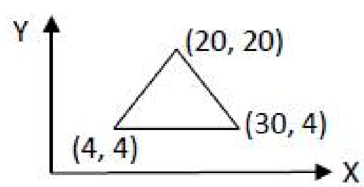
0.0, 0.02, 0.03, 0.06, 0.015, 0.10, 0.0] cm. Take E = 20 x 10^6 N/cm^2 & ν = 0.25. Assume plane stress conditions.



8. (a) Using natural coordinates derive the shape function for a linear quadrilateral element. [5M]

(b) Write short notes on: [5M]
(i) Uniqueness of mapping of iso-parametric elements.
(ii) Gaussian quadrature integration technique.

9. 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. [10M]



10. (a) Write a note on the procedure for performing numerical integration using Gaussian quadrature. [3M]

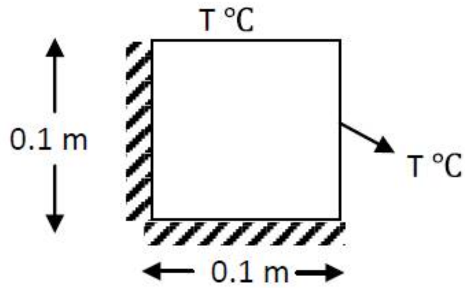
(b) Evaluate the expression $I = \int_{-1}^{1}\left[3e^{x} + x^{2} + \frac{1}{x+2}\right]dx$, using one point and two point Gaussian quadrature you may use the following standard values. [7M]

Number of Points	Locations	Weights
1	0.0	2.0
2	$\pm 1/\sqrt{3}$	1

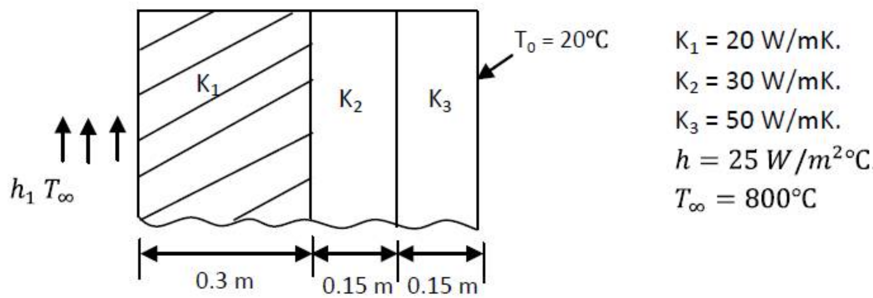
UNIT-IV

1. Find the temperature distribution in the square plate as shown in figure [10M]

below. Assume
$= 20\ W/mK,\ T = 500°C,\ q = 100\ W/m^3.$



2. A composite wall consists of 3 materials shown in figure below. The outer temperature is T0 = 20. Convection heat transfer takes place on the inner surface of the wall with T_∞=800^{O}C and h = 25 W/m^{2}K. Determine the temperature distribution in the wall. [10M]



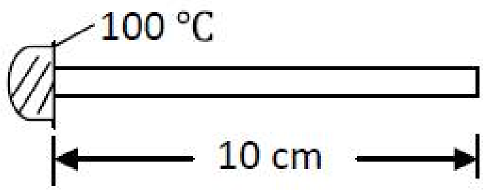
3. (a) Write the governing equation for one dimensional heat conduction. [3M]
   (b) Explain with examples of boundary conditions in one dimensional heat conduction. [7M]

4. Quote the examples of scalar field problems in engineering along with their governing equations. Field variables, parameters and possible boundary conditions may be recognized. [10M]

5. (a) Explain in detail the one dimensional formulation of fin [5M]
   (b) Derive the basic differential equation in heat transfer analysis. [5M]

6. 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 [10M]

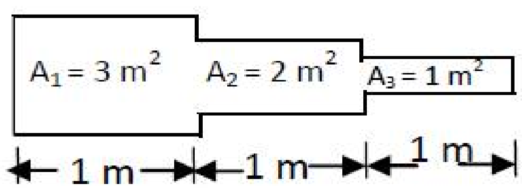
T_∞ = 2000 ^{o}C



7. Derive 1D steady state heat conduction equation. [10M]

8. A composite slab consists of three materials of thermal conductivities 12 W/mK, 20 W/mK, 40 W/mK and lengths 0.15 m, 0.3 m, and 0.2 m respectively. The composite slab has a uniform cross section of 0.05 m^2. The left end of the slab is at 500 ^oC and the right end is exposed to the convective heat transfer coefficient of 12 W/m^2K at 25 ^oC. Determine the temperature distribution within the wall. [10M]

9. Determine the potentials at the junctions, the velocities in each pipe and the volumetric flow rate for the smooth pipe of variable cross-section shown in figure. The potential at the left end is 10 m and that at the right end is 3 m. The permeability coefficient in 1 m/sec. [10M]



10. Derive the Finite element equation for torsional bar element [10M]

UNIT-V

1. Write a note on:
   - (a) Block corner nodes, sides and subdivisions in mesh generation. [5M]
   - (b) Generation of coordinates and connectivity. [5M]
2. Write a note on:
   - (a) Region and block representation in mesh generation. [5M]
   - (b) Generation of node numbers in mesh generations. [5M]
3. Write a short notes on:
   - (a) Preprocessing. [3M]
   - (b) Elements connecting. [4M]
   - (c) FEA application packages [3M]
4. Write a short notes on:
   - (a) Mesh generation. [5M]
   - (b) Transient heat conduction analysis. [5M]
5. (a) Derive an expression for least square fit for a four noded quadrilateral. [5M]

	(b)	Write a note on contour plotting.	[5M]
6.		Explain briefly the problem modeling and boundary conditions in:	
	(a)	Cylinder subjected in internal pressure.	[3M]
	(b)	Press fit on an elastic shaft.	[3M]
	(c)	Thermal stress problem.	[2M]
	(d)	Belleville spring.	[2M]
7.		How is FEM suitable for computer implementation? Write the general outline of a finite element program	[10M]
8.	(a)	"FEM is best suited for computer implementation". Justify the statement.	[5M]
	(b)	What are the salient features of any finite element package?	[5M]
9.		Explain in detail about the process of a 1-D pipe thermal analysis by using computer implementation	10M
10.	(a)	Briefly Explain about the overview and computer application packages of the FEA.	[5M]
	(b)	Write the advantages and disadvantages of computer Implementation. And also mention the applications.	[5M]

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