 QP-97378

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(Time: 3 Hours) (Total marks: 80)

N.B.: 1) Question No. 1 is compulsory.

2) Attempt any three questions out of the remaining five questions.

3) Assume suitable data if required.

Q1 Attempt any four from the following.

a) Explain the sources of errors in FEM. (5)

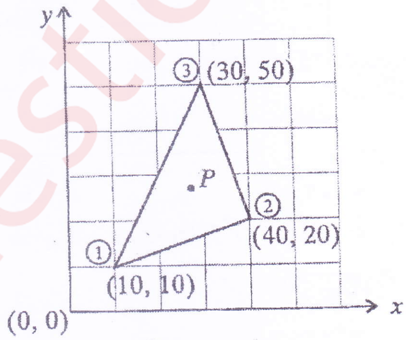
b) Distinguish between plane stress and plane strain conditions along with the stress-strain relation matrices. (5)

c) What do you mean by pre-processing, processing and post-processing with reference to FEM software package? (5)

d) Explain p-method and h-method of mesh efinement with diagrams. (5)

e) Explain different types of boundary conditions with suitable examples. (5)

Q2 a) A triangular element has nodal coordinates (10, 10), (40, 20) and (30, 50) for nodes 1, 2 and 3 respectively. For the point P located inside the triangle, determine x and y coordinates if the shape functions, ϕ_1=0.15 and ϕ_2=0.25. (10)



b) Solve the following differential equation by Galerkin method and find u(0.5).

$$\frac{d^2u}{dx^2} + u - x^2 = 0; \quad 0 \le x \le 1$$ (10)

$$\text{BCS; } u(0) = 0, \quad u'(1) = 1$$

(10)

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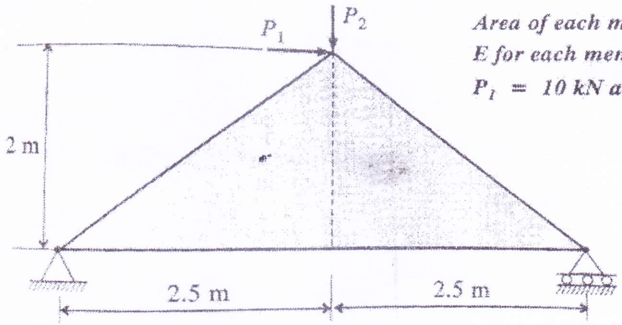
Q3 a) Find nodal displacements, support reactions and element stresses for the following truss.

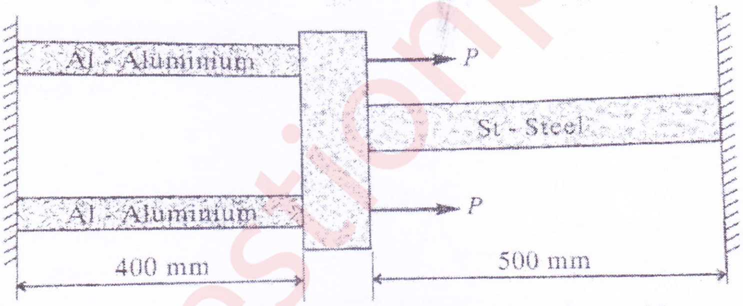


Area of each member = 1000 mm²
E for each member = 210 GPa
P_1 = 10 kN and P_2 = 20 kN

b) Using the concept of serendipity, derive the shape functions for eight node rectangular element in natural co-ordinate system (ξ and η). **(10)**

Q4 a) Find the natural frequency of axial vibrations of a bar of uniform cross section of 60 mm² and length of 1 meter using consistent mass matrix. Take E=200 GPa and density = 8000 kg/m³. Take two linear elements. **(10)**

b) Determine the unknown reactions and displacement for the arrangement of bars shown in figure. **(10)**



$d_{St} = 40\ mm$ $\quad d_{Al} = 25\ mm$

$E_{St} = 2.1 \times 10^5\ N/mm^2$ $\quad E_{Al} = 0.7 \times 10^5\ N/mm^2$

$P = 5\ kN$

Q5 a) The governing differential equation for the steady state one dimensional conduction heat transfer with convection heat loss from lateral surfaces is given by: **(15)**

$$k\frac{d^2T}{dx^2} + q = \left(\frac{P}{A}\right)h(T - T_\infty)$$

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Where, k: coefficient of thermal conductivity of material, T: Temperature, q: Internal heat source per unit volume, P: Perimeter, A: Coss sectional area, T_∞: Ambient temperature.

Develop the finite element formulation for linear element. Use Rayleigh-Ritz method mapped over general element. Derive the relevant element matrix equation.

b) Explain the procedure of Rayleigh-Ritz method based on PSTP. **(5)**

Q6 a) A CST element has nodal coordinates (10, 10), (70, 35) and (75, 25) for nodes 1, 2, and 3 respectively. The element is 2 mm thick and is of material with properties E=70 GPa. Poisson's ratio is 0.3. Upon loading of model the nodal deflection were found to be u_1= 0.01 mm, v_1= -0.04 mm, u_2= 0.03 mm, v_2= 0.02 mm, u_3= -0.02 mm, v_3= -0.04 mm. **(10)**

Determine:

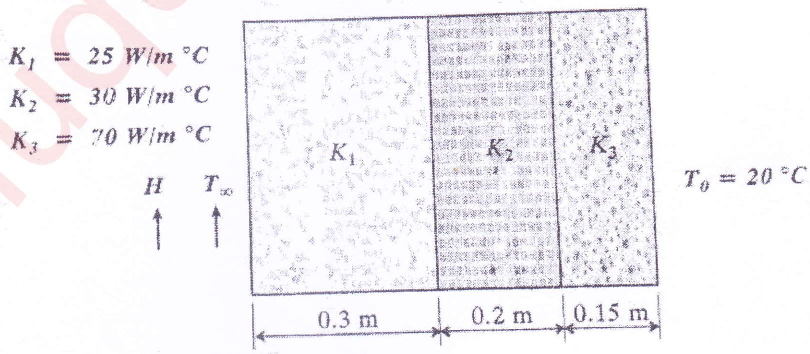
The Jacobian for (x-y) – (ξ-η) transformation

The Strain displacement relation matrix

The strains ξ_x, ξ_y and γ_{xy}

The element stresses

b) A composite wall consists of three materials, as shown in figure below. The outer temperature T_0= 20 ^{0}C. Convection heat transfer takes place on the inner surface of the wall with T_∞= 800 ^{0}C and H= 30 W/m^2 ^{0}C. Determine temperature distribution in the wall. **(10)**



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