CBCS SCHEME

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18ME61

Sixth Semester B.E. Degree Examination, Jan./Feb. 2023
Finite Element Methods

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Explain the steps involved in finite element method to solve engineering problems. **(08 Marks)**

b. A simply supported beam subjected to uniformly distributed load over the entire span. Derive the expression for maximum deflection using Rayleigh-Ritz method. Assume $y = C_1 \sin\left(\frac{\pi x}{L}\right) + C_2 \sin\left(\frac{3\pi x}{L}\right)$ as an admissible displacement function. **(08 Marks)**

c. What are confirming and non-confirming elements? **(04 Marks)**

OR

2 a. Explain the importance of node numbering scheme with suitable example. **(06 Marks)**

b. Explain Simplex, Complex and multiplex elements with examples. **(06 Marks)**

c. Derive strain-displacement relations for a two – dimensional elastic body. **(08 Marks)**

Module-2

3 a. Derive a shape function for one-dimensional quadratic element in natural co-ordinate system. **(06 Marks)**

b. Derive strain-displacement matrix [B] for a 3-noded triangular element. **(06 Marks)**

c. For the truss configuration shown in Fig Q3(c), determine the stiffness values K_{11}, K_{12}, K_{22} and K_{66} of the global stiffness matrix. Assume E = 210GPa, A = 6 × 10^{-4}m^2 for both the truss member.

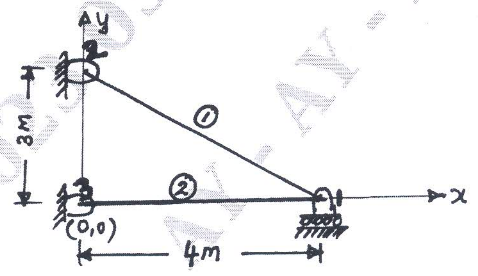

Fig Q3(c) **(08 Marks)**

OR

4 a. Evaluate the integral by 3-point gauss quadrate formula

$$I = \int_{-1}^{+1} (x^3 - 2x^2 + 5x - 7)dx$$ **(04 Marks)**

b. Derive stiffness matrix for a plane truss element. **(08 Marks)**

c. An axial bar subjected to force as shown in Fig Q4(c). Determine nodal displacement, stress in each material and reaction forces.

Assume : E_{steel} = 200GPa $E_{Aluminum}$ = 70GPa

A_{steel} = 2400mm^2 $A_{Aluminum}$ = 1200mm^2

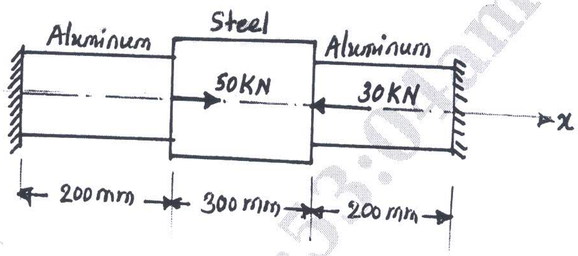

Fig Q4(c) **(08 Marks)**

Module-3

5 a. Derive the Hermite shape function for beam element and plot them. **(10 Marks)**

b. For the beam and loading as shown in Fig Q5(b) find the deflection at the centre of the beam. Assume $E = 200GPa$, $I = 4 \times 10^6 mm^4$

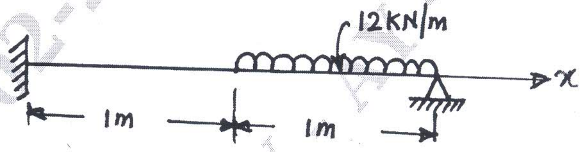

Fig Q5(b) **(10 Marks)**

OR

6 a. Derive stiffness matrix for a circular shaft subjected to pure torsion. **(10 Marks)**

b. A circular shaft subjected to torque at section "B" and "C" as shown in Fig Q6(b). Determine the maximum angle of twist and shear stress by taking modulus of rigidity for the shaft material as 70GPa.

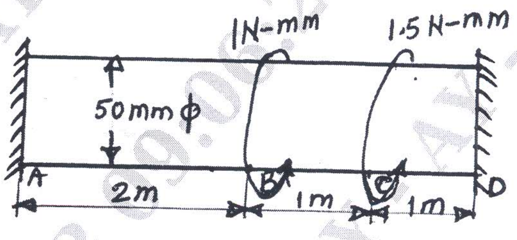

Fig Q6(b) **(10 Marks)**

Module-4

7 a. Explain different types of boundary conditions used in heat transfer problems. **(08 Marks)**

b. Heat is generated in a large plat at the rate of $4000 W/m^3$. The plate is 25mm thick. The outside surfaces of the plate are exposed to ambient air at 30°C with a convective heat transfer co-efficient of $20 W/m^{2o}C$. Determine the temperature distribution in the wall. Assume the thermal conductivity for the plate material as 0.8W/m°C. Model the plate with 2 bar elements. **(12 Marks)**

OR

8 a. Derive differential equation in one – dimensional for fluid flow through porous medium. **(10 Marks)**

b. For the Smooth pipe with stepped cross-section as shown in Fig Q8(b), determine the potentials at the junctions. The potentials at the left end is 10m and that at the right end is 2m. Assume the permeability coefficient is 1m/sec.

$A_1 = 3m^2$, $A_2 = 2m^2$, $A_3 = 1m^2$

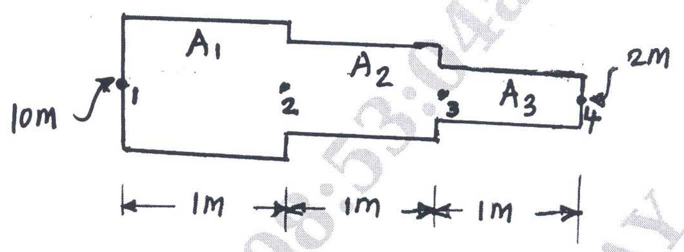

Fig Q8(b) **(10 Marks)**

Module-5

9 a. Derive the strain displacement matrix for axisymmetric constant strain triangle element. **(12 Marks)**

b. For the axisymmetric element shown in Fig Q9(b), determine the strain displacement matrix [B]. Take E = 200GPa, and $\upsilon = 0.3$

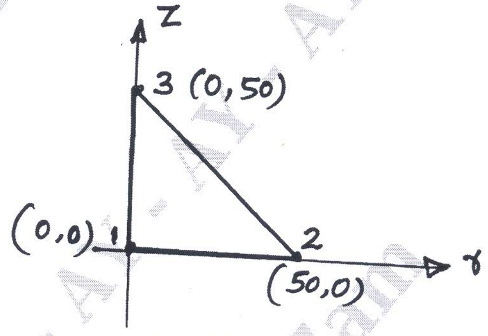

Fig Q9(b) **(08 Marks)**

OR

10 a. Derive the consistent mass matrix for two-noded bar element. **(06 Marks)**

b. Determine the eigenvalues and eigenvectors for the stepped bar as shown in Fig Q10(b). Take E = 200GPa, $\rho = 7830$ Kg/m^3

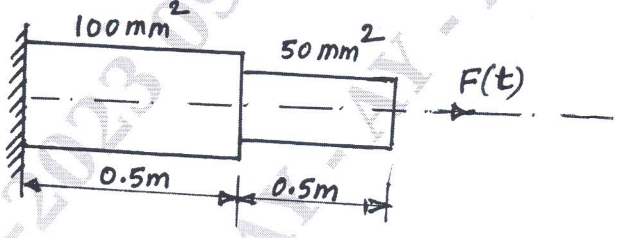

Fig Q10(b) **(14 Marks)**

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