CBCS SCHEME

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17ME61

Sixth Semester B.E. Degree Examination, July/August 2022
Finite Element Analysis

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 procedure involved in Finite Element Method (FEM) with a flowchart. **(10 Marks)**

b. Write short notes on following :
i) Potential Energy Approach ii) Galerkin's Method. **(10 Marks)**

OR

2 a. What are simplex, complex and multiplex elements? Explain. **(10 Marks)**

b. Write short notes on following :
i) Pascal's Triangle ii) Global and Natural Co-ordinate systems. **(10 Marks)**

Module-2

3 a. Derive the shape functions for ID linear and quadratic elements. **(10 Marks)**

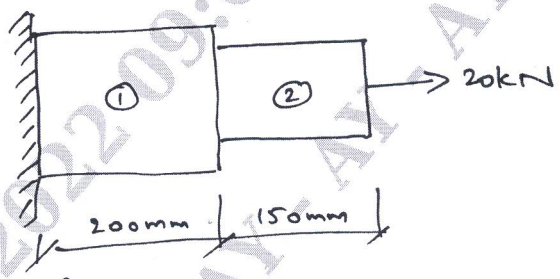
b. Using Gaussian quadrature, evaluate the following function using two and three sampling points, compare the answer with exact solution. **(10 Marks)**

$$I = \int_{-1}^{+1} (x^3 + 2x^2 + x + 5)\,dx$$

OR

4 a. Derive the element stiffness matrix for truss element. **(10 Marks)**

b. The structural member shown in Fig Q4(b) consists of two bars. Determine the following:
i) Element stiffness matrices ii) Global stiffness matrix iii) Global load vector
iv) Nodal displacements.



[$A_1 = 400mm^2$; $A_2 = 300mm^2$, Take $E_1 = E_2 = 200GPa$]

Fig Q4(b) **(10 Marks)**

Module-3

5 a. Derive the hermite shape functions of a beam element. **(10 Marks)**

b. Determine the maximum deflection in the uniform C/S of the cantilever beam as shown in Fig Q5(b). Consider the beam is treated as single finite element. Take $E = 70 \times 10^9 N/m^2$, $I = 4 \times 10^{-4} m^4$.

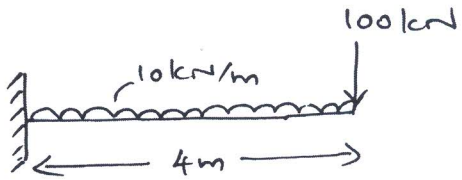


Fig Q5(b) **(10 Marks)**

OR

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

b. A solid stepped bar of circular cross section shown in Fig Q6(b) is subjected to a torque of 1kN-m at its free end and a torque of 3kN-m at its change in C/S. Determine the angle of twist and shear stresses in the bar. Take $E = 2 \times 10^5 N/mm^2$ and $G = 7 \times 10^4 N/mm^2$.

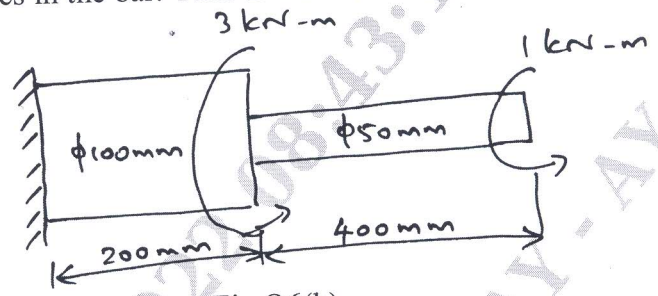


Fig Q6(b) **(10 Marks)**

Module-4

7 a. Derive the differential equation for ID heat conduction. **(10 Marks)**

b. Determine the temperature distribution through the composite wall shown in Fig Q7(b) when convection heat loss occurs on the left surface. Assume unit area. Take wall thickness $t_1 = 4cm$ and $t_2 = 2cm$. Assume $K_1 = 0.5W/Cm°C$ and $K_2 = 0.05W/Cm°C$, $h = 0.1W/cm^{2o}C$ and $T_\alpha = -5°C$.

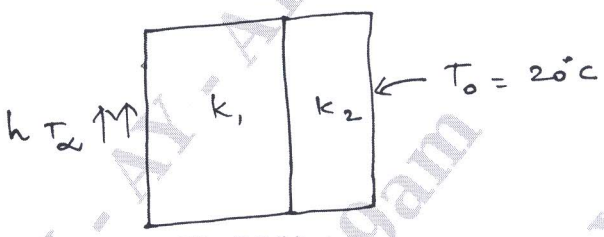


Fig Q7(b) **(10 Marks)**

OR

8 a. Explain the ID formulation of heat transfer through a fin. **(10 Marks)**

b. A metallic fin with thermal conductivity of 70W/Cm°C, 1cm diameter and 5cm long extends from a plane wall whose temperature is 140°C. Determine the temperature distribution along the fin if heat is transferred to ambient air at 20 °C with heat transfer co-efficient of $5W/cm^2$ °C. Take two elements. **(10 Marks)**

Module-5

9 a. What is axi-symmetric element? Mention its characteristics. **(10 Marks)**

b. Derive the element stiffness matrix [K] of an axi-symmetric element using potential energy approach. **(10 Marks)**

OR

10 a. Differentiate consistent mass matrix and Lumped mass matrix. Also unite their expressions for bar, truss and beam elements. **(10 Marks)**

b. Evaluate eigen values and eigen vector for the stepped bar shown in Fig Q10(b). Take E = 200GPa and specific height $7820Kg/m^3$. Take $A_1 = 400mm^2$ and $A_2 = 200mm^2$.

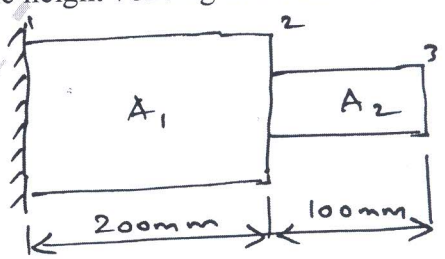


Fig Q10(b) **(10 Marks)**