CBCS SCHEME

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18ME61

Sixth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Define Finite Element Methods. Explain general steps in Finite Element Methods. **(10 Marks)**

b. Fig.Q.1(b) shows a bar fixed at both ends subjected to an axial load as shown. Determine displacement at loading point and corresponding stress using R-R method. **(10 Marks)**

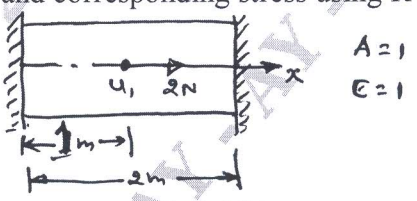

Fig.Q.1(b)

OR

2 a. Explain convergence criteria and different types of elements in Finite Element Methods. **(10 Marks)**

b. A cantilever beam subjected to U.D.L. Derive an equation for maximum deflection using Galerkin's method use polynomial function. **(10 Marks)**

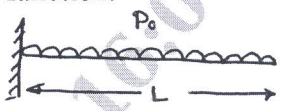

Fig.Q.2(b)

Module-2

3 a. Derive shape functions for TET-4 element. **(10 Marks)**

b. A stepped bar shown in Fig.Q.3(b). Determine the nodal displacement and stresses at each node. Take $E = 2 \times 10^5 N/mm^2$.

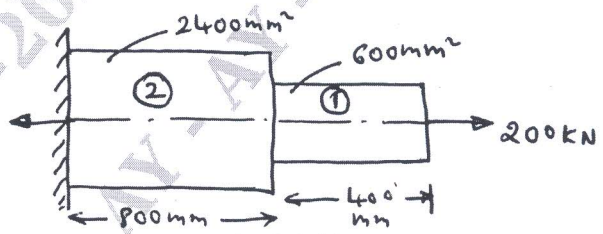

Fig.Q.3(b)

(10 Marks)

OR

4 a. Derive shape functions for C.S.T element in natural coordinates. **(10 Marks)**

b. Using Gaussian quadrature evaluate,

$$I = \int_{-1}^{+1} \left[3e^3 + 3^2 + \frac{1}{3+2} \right] d_3$$ by one point and two point formula. **(10 Marks)**

Module-3

5 a. Derive Hermite shape functions for beam element. **(10 Marks)**

b. A cantilever beam subjected to point load of 250kN as shown in Fig.Q.5(b). Determine deflection at free end and support reactions. E = 200GPa, I = $4 \times 10^6 mm^4$. **(10 Marks)**

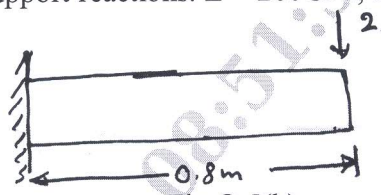

Fig.Q.5(b)

OR

6 a. Derive stiffness matrix for torsion of shaft. **(10 Marks)**

b. A solid stepped bar of circular cross section as shown in Fig.Q.6(b). Subjected to torque of 1kN-m at free end and torque 3kN-m at change in C/S. Determine angle of twist and shear stresses in bar E = $2 \times 10^5 N/mm^2$ G = $7 \times 10^4 N/mm^2$. **(10 Marks)**

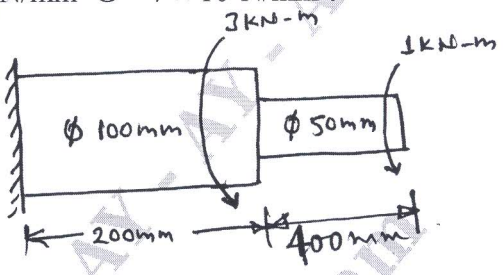

Fig.Q.6(b)

Module-4

7 a. Derive differential equation for 1D heat conduction. **(10 Marks)**

b. Determine the temperature distribution in a rectangular fin shown in Fig.Q.7(b). Assume steady and only conduction process. Heat generated inside the fin as $400 W/m^3$. **(10 Marks)**

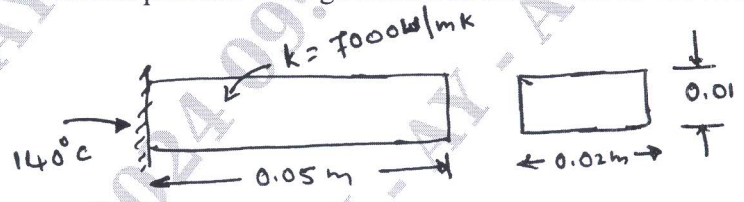

Fig.Q.7(b)

OR

8 For the smooth pipe of variable C/S shown in Fig.Q.8. Determine the potential at junctions, the velocities in each section pipe and volumetric flow rate. The potential at left end $P_1 = 10 m^2/sec$ and that at right end $P_4 = 1 m^2/sec$ for the fluid flow through smooth pipe $K_x = 1$. **(20 Marks)**

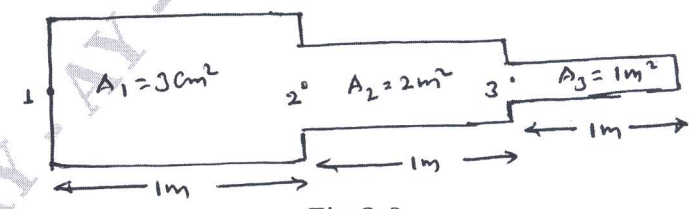

Fig.Q.8

Module-5

9 a. For the element of axisymmetric body rotating with constant angular velocity W = 1000 lev/min shown in Fig.Q.9(a). Determine the body force vector include weight of material, where specific density is 7850kg/m^3. **(10 Marks)**

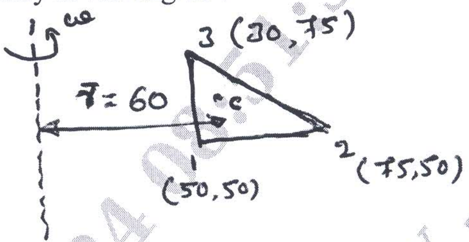

Fig.Q.9(a)

b. Evaluate nodal forces used to replace the linearly varying surface traction shown in Fig.Q.9(b). **(10 Marks)**

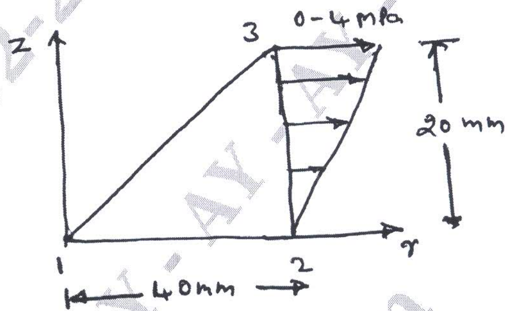

Fig.Q.9(b)

OR

10 a. Derive an equation for consistent mass matrix of 1D bar element. **(10 Marks)**

b. Derive an equation for truss element in consistent mass matrix. **(10 Marks)**

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