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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)

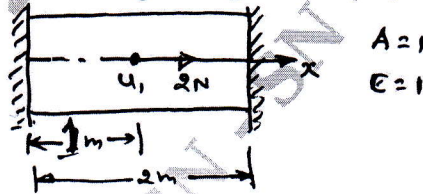


Fig.Q.1(b)

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 $E = 2 \times 10^5 \text{ N/mm}^2$.

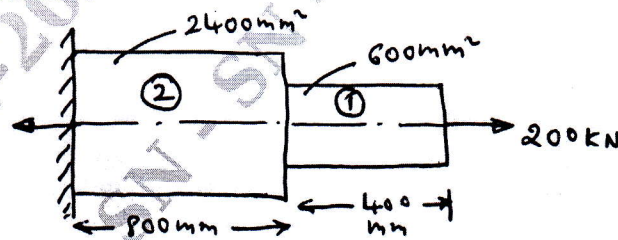


Fig.Q.3(b)

(10 Marks)

OR

- 4 a. Derive shape functions for C.S.T element in natural coordinates. (10 Marks)
 b. Using Gaussian quadrature evaluate,

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

(10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
 2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

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. $E = 200\text{GPa}$, $I = 4 \times 10^6\text{mm}^4$. (10 Marks)

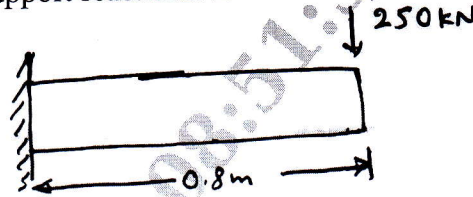


Fig.Q.5(b)

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 $E = 2 \times 10^5\text{N/mm}^2$ $G = 7 \times 10^4\text{N/mm}^2$. (10 Marks)

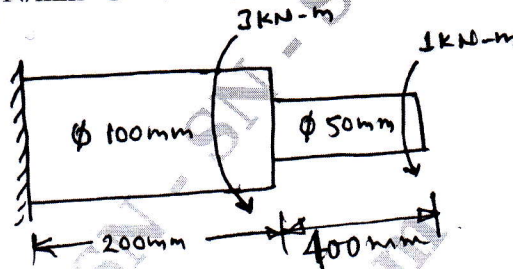


Fig.Q.6(b)

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 400W/m^3 . (10 Marks)

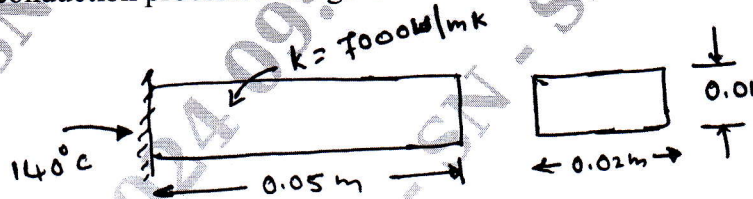


Fig.Q.7(b)

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 $P_1 = 10\text{m}^2/\text{sec}$ and that at right end $P_4 = 1\text{m}^2/\text{sec}$ for the fluid flow through smooth pipe $K_x = 1$. (20 Marks)

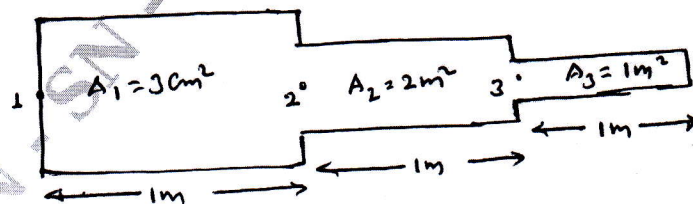


Fig.Q.8

Module-5

- 9 a. For the element of axisymmetric body rotating with constant angular velocity $\omega = 1000 \text{ rev/min}$ shown in Fig.Q.9(a). Determine the body force vector include weight of material, where specific density is 7850 kg/m^3 . (10 Marks)

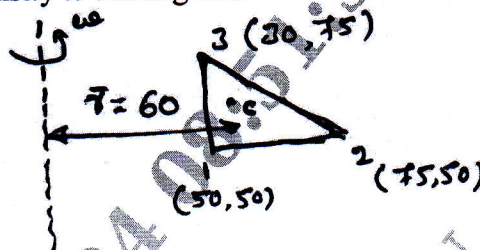


Fig.Q.9(a)

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

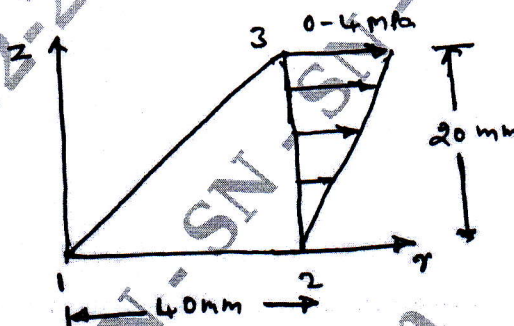


Fig.Q.9(b)

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)
