CBCS SCHEME

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15ME61

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

Time: 3 hrs. Max. Marks: 80

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

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-1

1 a. Explain the concept of Node Numbering scheme and convergence criteria. **(08 Marks)**

b. Define FEM and briefly explain the steps involved in FEM. **(08 Marks)**

OR

2 a. Determine the deflection at the center of a simply supported beam of span length 'l' subjected to uniformly distributed load throughout the length as shown in Fig.Q2(a) using Rayleigh Ritz method.

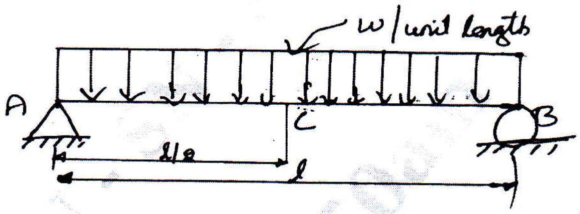

Fig.Q2(a) **(08 Marks)**

b. With neat sketches explain Plane stress and Plane strain. **(08 Marks)**

Module-2

3 a. Derive shape function for a 1-D bar element. **(06 Marks)**

b. A truss shown in Fig.Q3(b) made up of 2 bars. Determine nodal displacements, stress in each element and reaction at the support. A = 200mm^2 and E = 2×10^5 MPa.

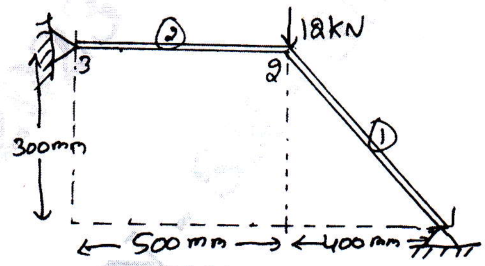

Fig.Q3(b) **(10 Marks)**

OR

4 a. The below Fig.Q4(a) shows a bar subjected to uniformly distributed load P_0. Take E = 70 GPa. A = 10^4 mm^2. Determine (i) Nodal displacement (ii) Stress in the element.

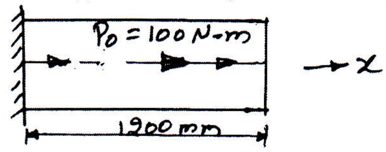

Fig.Q4(a) **(08 Marks)**

b. Explain CST and LST elements. Also find differentiate between CST and LST elements. **(08 Marks)**

Module-3

5 a. Derive Element Stiffness matrix for Torsion element. **(06 Marks)**

b. A solid stepped bar of circular cross section shown in the below Fig.Q5(b) is subjected to a torque of 1 kN-m at its free end and a torque of 3 kN-m at its C/S. Determine the angle of twist in the bar. Take $E = 2\times10^5$ N/mm^2 and $G = 7\times10^4$ N/mm^2.

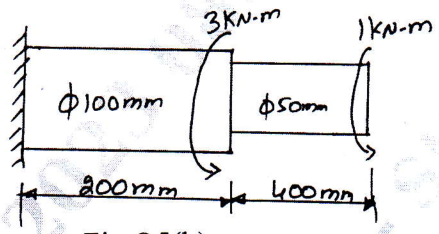

Fig.Q5(b) **(10 Marks)**

OR

6 a. Derive Hermit shape functions for a Beam element. **(08 Marks)**

b. For a beam shown in Fig.Q6(b) below, calculate the deflection under load. All the elements have E = 200 GPa and $I = 4\times10^{-6}$ m^4.

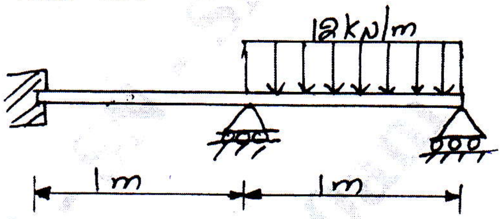

Fig.Q6(b) **(08 Marks)**

Module-4

7 a. A metallic fin, with thermal conductivity of 70 W/cm °C , 1 cm diameter and 5 cm long extends from a plane wall whose temperature is 140°C. Determine the temperature distribution along fin if heat transferred to ambient temperature at 20°C with heat transfer coefficient of 5 W/cm °C. Take two elements along fin. [Refer Fig.Q7(a)]

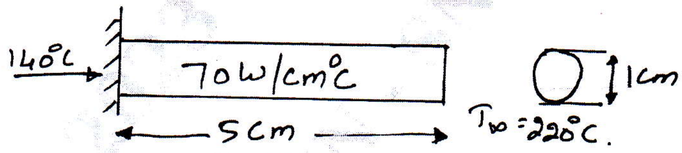

Fig.Q7(a) **(08 Marks)**

b. For the smooth pipe shown in Fig.Q7(a) with uniform cross-section of 1 m^2, determine the flow velocities at the center and right end, knowing the velocity at the left $V_x = 2$ m/s.

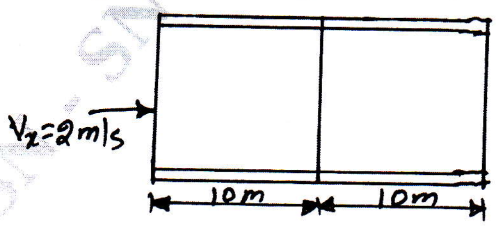

Fig.Q7(a) **(08 Marks)**

OR

8 a. Derive governing differential equation for 1-D Heat transfer (conduction). **(06 Marks)**

b. Determine the temperature distribution through the composite wall shown in Fig.Q8(b) below, when convection heat loss occurs on the left surface. Assume unit area, Assume wall thickness $t_1 = 4$ cm and $t_2 = 2$ cm. $K_1 = 0.5$ W/cm °C, $K_2 = 0.05$ W/cm °C, $h = 0.1$ W/cm^2 °C and $T_\infty = -5$°C.

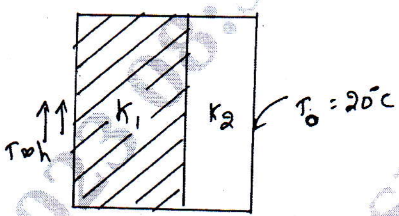

Fig.Q8(b) **(10 Marks)**

Module-5

9 a. Evaluate the eigen values and eigen vectors of longitudinal vibration of the constrained uniform circular as shown in Fig.Q9(a). (Take two elements).

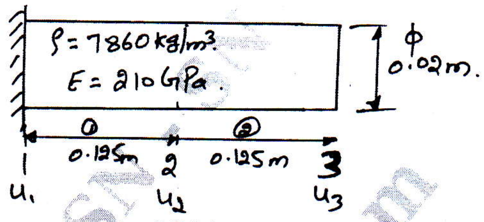

Fig.Q9(a) **(08 Marks)**

b. Derive consistent mass matrix and lumped mass matrix for a bar element. **(08 Marks)**

OR

10 a. For the element of an axisymmetric body rotating with a constant angular velocity W = 1000 rev/min as shown in Fig.Q10(a) below. Determine the body force vector. Include the weight of the material, where the specific density is 7850 kg/m^3.

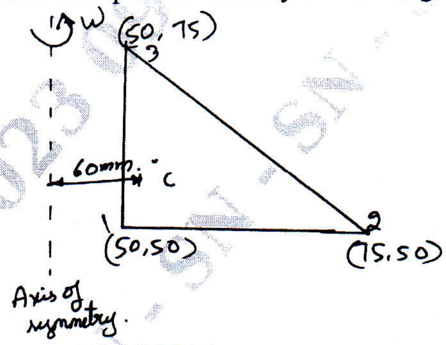

Fig.Q10(a) **(06 Marks)**

b. Derive the stiffness matrix of axisymmetric bodies with triangular elements. **(10 Marks)**

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