CBCS SCHEME

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21ME53

Fifth Semester B.E. Degree Examination, June/July 2024
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. Define FEA. Explain the basic steps involved in problem solving in FEA. **(10 Marks)**

b. A rectangular bar is subjected to an axial load 'P' as shown in Fig. Q1 (b). Determine the expression for potential energy functional and also find the extreme value of P.E. for the following data :
E = 200 GPa, P = 3 kN, L = 100 mm, b = 20 mm, t = 10 mm.

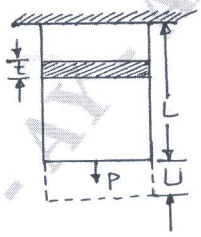

Fig. Q1 (b) **(10 Marks)**

OR

2 a. Explain plane stress and plane strain problems with suitable examples. **(10 Marks)**

b. Explain Simplex, Complex and Multiplex elements. **(10 Marks)**

Module-2

3 a. With usual notations, obtain the expression for shape functions of a 1-D Quadratic bar element in Natural co-ordinate system. **(10 Marks)**

b. Write the set of commands employed in ANSYS software to perform structural analysis for a uniform bar structure as shown in Fig. Q3 (b).

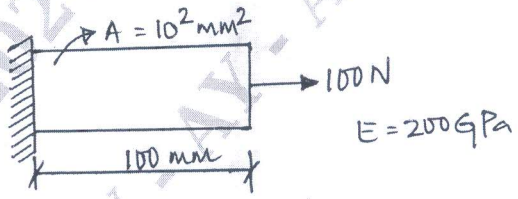

Fig. Q3 (b) **(10 Marks)**

OR

4 a. Determine the nodal displacement and elemental stresses for a bar subjected to uniform distributed load 'P_0' as shown in Fig. Q4 (a). Given E = 70 GPa and A = 10^4 mm^2.

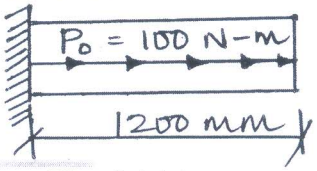

Fig. Q4 (a) **(10 Marks)**

b. Determine the nodal displacement and elemental stresses for a truss as shown in Fig. Q4 (b). Given $A = 200\ mm^2$ and $E = 2\times10^5\ N/mm^2$.

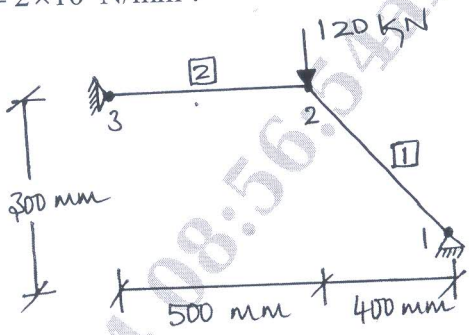

Fig. Q4 (b) **(10 Marks)**

Module-3

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

b. A Cantilever beam subjected to a point load of 250 kN as shown in Fig. Q5 (b). Determine the deflection at the free end and support reactions. Take $E = 200\ GPa$ and $I = 4\times10^6\ mm^4$.

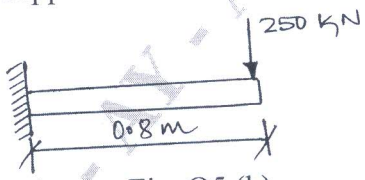

Fig. Q5 (b) **(10 Marks)**

OR

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

b. A solid stepped bar of circular cross section is subjected to a torque of 1 KN-m at its free end and to a torque of 3 KN-m at its change in cross section as shown in Fig. Q6 (b). Determine the angle of twist and shear stresses in the bar. Take $E = 2\times10^5\ N/mm^2$ and $G = 7\times10^4\ N/mm^2$.

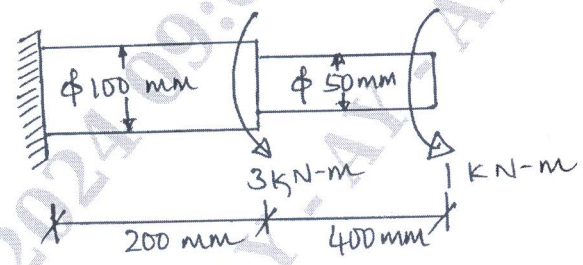

Fig. Q6 (b) **(10 Marks)**

Module-4

7 a. With usual notations, derive the differential equation for 1-D heat conduction body. **(10 Marks)**

b. Determine the temperature distribution in the rectangular fin as shown in Fig.Q7 (b). Assume steady state and only conduction process. Take heat generated inside the fin as $400\ W/m^3$.

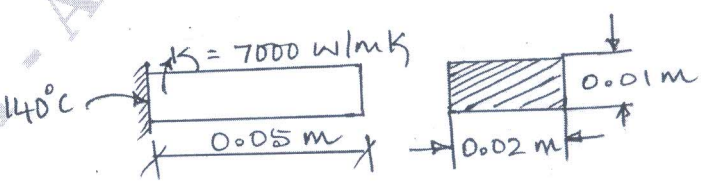

Fig. Q7 (b) **(10 Marks)**

OR

8 a. With usual notations, derive the differential equations for a fluid flow through a porous medium. **(10 Marks)**

b. For a smooth pipe with uniform cross section of 1 m^2; determine the flow velocities at the centre and at the right end of the Fig. Q8 (b). Given velocity at the left is 2 m/sec.

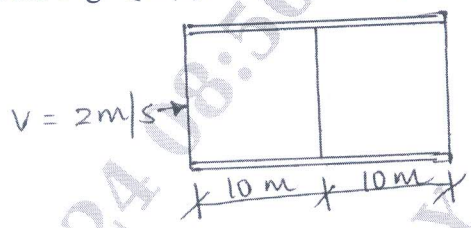

Fig. Q8 (b) **(10 Marks)**

Module-5

9 a. Derive an expression for the body force vector of an axisymmetric solid element. **(10 Marks)**

b. For the element of an axisymmetric body rotating with a constant angular velocity $\omega = 1000$ rpm as shown in Fig. Q9 (b). Determine the body force vector by considering the specific density as 7850 kg/m^3.

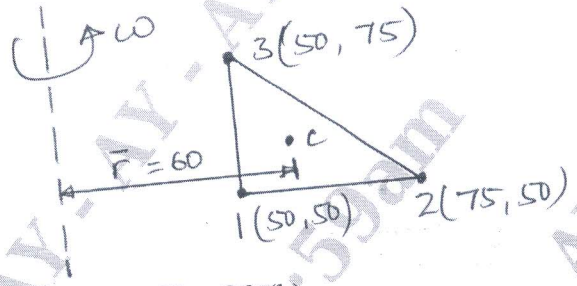

Fig. Q9 (b) **(10 Marks)**

OR

10 a. With usual notations, derive the consistent element mass matrices equation for a 1-D bar element. **(10 Marks)**

b. Determine the natural frequency of vibration of the Cantilever beam as shown in Fig. Q10 (b). Take E = 200 GPa, $\rho = 7840$ kg/m^3; $I = 2000$ mm^4 and $A = 240$ mm^2.

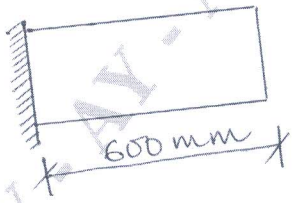

Fig. Q10 (b) **(10 Marks)**

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