USN | | | | | | | | | |

15ME61

Finite Element Method

Time: 3 hrs.

Max. Marks: 80

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

Module-1

1 a. List the type of elements with neat sketch. **(06 Marks)**

  b. A simply supported beam subjected to point load at the centre. Derive an equation for maximum deflection using trigonometrically function by RR method. **(10 Marks)**

OR

2 a. List the advantages and disadvantages of FEM. **(03 Marks)**

  b. Explain Elasticity matrix [D] for stress and plain strain. **(04 Marks)**

  c. Explain simplex, complex and multiplex elements. **(09 Marks)**

Module-2

3 a. Derive the shape function, in natural coordinate system for:

   (i) Constant strain triangle.

   (ii) 1D bar element. **(08 Marks)**

  b. Using two point Gaussian quadrature formula evaluate and compare with exact solution:

   (i) $I = \int\limits_{-1}^{+1}\left(1 + \xi + 2\xi^2 + 3\xi^3\right)d\xi$

   (ii) $I = \int\limits_{-2}^{+2}\left(4 - y\right)^2 dy$ **(08 Marks)**

OR

4 a. For the stepped bar shown in Fig. Q4 (a), determine the nodal displacement, element stresses and reaction at supports.

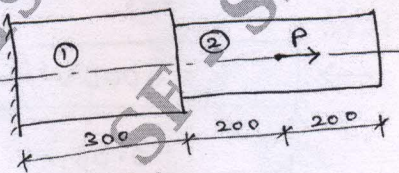 $E_1 = 70$ GPa; $E_2 = 200$ GPa; $P = 200$ KN; $A_1 = 2400$ mm^2; $A_2 = 600$ mm^2 **(08 Marks)**

Fig. Q4 (a)

  b. A plane truss shown in Fig. Q4 (b), determine nodal displacements, stresses in each element and reaction at supports.

  $E = 200$ GPa ; $A_1 = 1200$ mm^2; $A_2 = 1000$ mm^2; $P = 50$ KN **(08 Marks)**
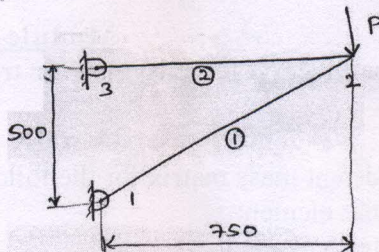
Fig. Q4 (b)

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Module-3

5 a. Derive the Hermite function of a beam element. **(08 Marks)**

   b. For the beam element shown in figure Q5 (b), determine the displacement and slope at the free end. Take $E = 70$ GPa, $I = 4 \times 10^{-4}$ m^4 **(08 Marks)**
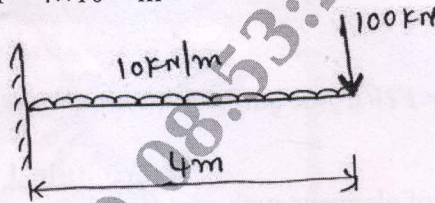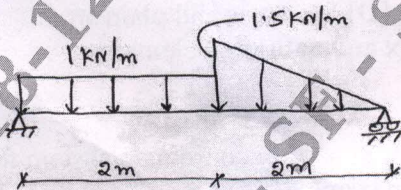

Fig. Q5 (b)

OR

6 a. Derive the stiffness matrix for a torsion element. **(06 Marks)**

   b. Find the deflection and slopes at the nodes for the aluminium beam shown in Fig. Q6 (b). **(10 Marks)**

$E = 70$ GPa
$I = 2 \times 10^{-6}$ m^4

Fig. Q6 (b)

Module-4

7 a. With brief explanation obtain the rate equation that describes the rate of energy flow for the following conditions:
   (i) Conduction   (ii) Convection   (iii) Radiation **(06 Marks)**

   b. Derive the shape function of a 1 D bar element with temperature T_1 and T_2 at the nodes. **(10 Marks)**

OR

8 a. Determine the temperature distribution in the rectangular fin shown in Fig. Q8 (a). Neglect convection heat transfer and assume heat generated inside the fin as 500 W/m^3 **(08 Marks)**
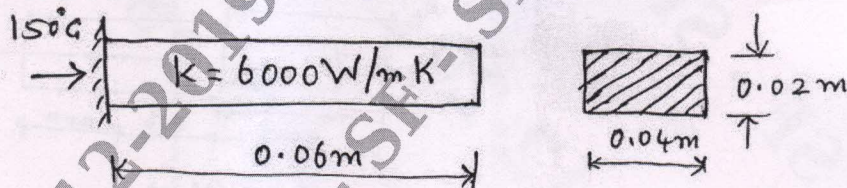

Fig. Q8 (a)

   b. Derive the stiffness matrix for fluid flow in 1 D bar element. **(08 Marks)**

Module-5

9 Derive the shape function for axisymmetric triangular element. **(16 Marks)**

OR

10 Derive the consistent mass matrix for the following:
    (i) 1 D bar element.
    (ii) 1 D truss element. **(16 Marks)**

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