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B. E. (Eighth Semester) Examination, April-May, 2021

(New Scheme)

(Mech. Engg. Branch)

FINITE ELEMENT METHODS

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Part (a) is compulsory of* ***two*** *marks. Attempt any* ***two*** *from (b), (c) and (d) for Q. 1, Q. 4. Attempt any* ***one*** *from (b), (c) for Q. 2, Q. 3, Q. 5. Assume suitable data if required.*

1. (a) State advantages and applications of FEM. 2

(b) For the differential equation $\frac{d^2y}{dx^2} + 20x^2 = 0$ for

$0 < X < 1$ and with boundary conditions $y(0) = 0$ and $y(1) = 0$, find the solution of this problem using Galerkin weighted residual method. 7

(c) Using principle of minimum potential energy find displacement of nodes 3 and 4 for Fig. 1 shown below. 7

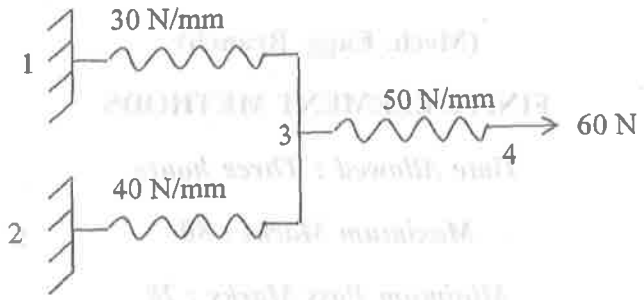

Fig. 1

(d) Obtain nodal displacement for stepped bar as shown in Fig. 2. take $E = 200$ GPa, $A_1 = 400$ mm^2, $L_1 = 200$ mm, $A_2 = 300$ mm^2, $L_2 = 150$ mm. 7

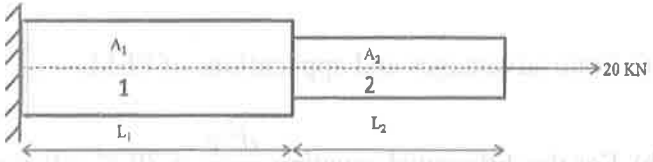

Fig. 2

2. (a) Write properties of shape functions. 2

(b) Derive shape function and stiffness matrix for quadratic bar element. 14

(c) For composite wall shown in Fig. 3 determine interface temperature t_2, t_3 considering three elements. 14

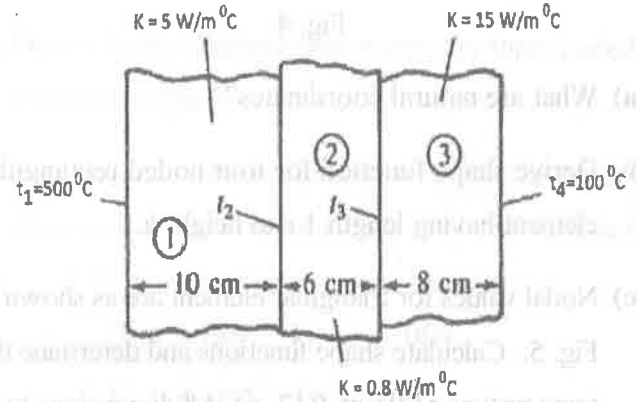

Fig. 3

3. (a) Write difference between beam and frame element. 2

(b) Derive shape function and stiffness matrix for beam element. 14

(c) A concentrated load $P = 60$ kN is applied at the center of a fixed beam of length 3 m, depth 200 mm and width 120 mm. Calculate the deflection and

slope at the midpoint. Also find reactions at the supports. Assume $E = 2{\cdot}1 \times 10^5$ N/mm^2 as shown in Fig. 4. 14

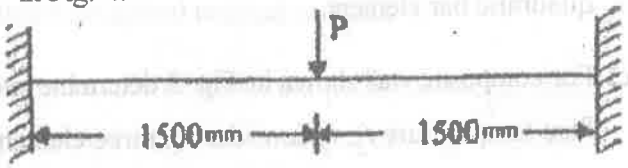

Fig. 4

4. (a) What are natural coordinates? 2

(b) Derive shape function for four noded rectangular element having length 1 and height h. 7

(c) Nodal values for triangular element are as shown in Fig. 5. Calculate shape functions and determine the temperature of Point P (7, 6). All dimensions in cm. 7

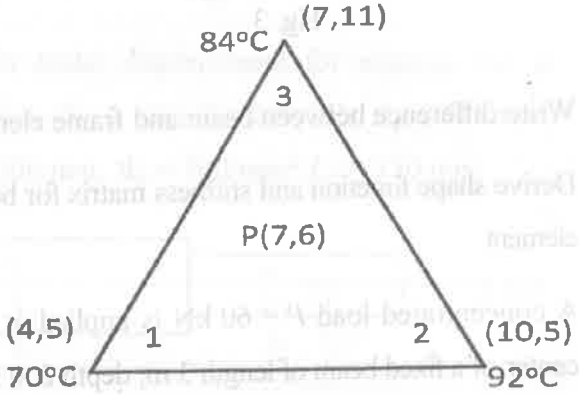

Fig. 5

(d) Obtain the value of following integral using two point and three point gauss quadrature technique and compare the result with exact values

$$\int_{-1}^{1} \left(2 + 5x + 8x^3\right) dx$$ 7

5. (a) Define Plane Stress and Plain Strain. 2

(b) Derive Strain-Displacement matrix for three noded triangular element. 14

(c) For triangular element shown in Fig. 6. Determine stress and strain in element. Take $E = 200$ GPa and $\mu = 0{\cdot}3$. Assume plane stress conditions.

$U_1 = 0{\cdot}001, \quad V_1 = -0{\cdot}004$

$U_2 = 0{\cdot}003, \quad V_2 = 0{\cdot}002$

$U_3 = -0{\cdot}002, \quad V_3 = 0{\cdot}006$ 14

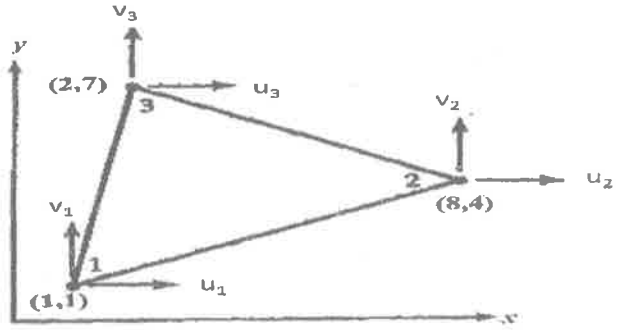

Fig. 6 (all values in mm)