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B. E. (Eighth Semester) Examination, Nov.-Dec. 2021

(New Scheme)

(Mech. Engg. Branch)

FINITE ELEMENT METHODS

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all question. Asnwer any* ***one*** *part from part (b) & (c). Assuming mission data suitably. Part (a) of each question is compulsory.*

Unit-I

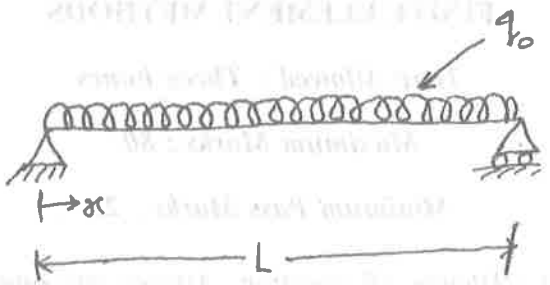
1. (a) Define FEM and write its applications. 2

(b) Consider a simply supported beam under uniformly distributed load as shown in figure. The governing differential equation and the boundary conditions are given by

$$EI\ \frac{d^4v}{dn^4} - q_0 = 0; \quad V(0) = 0;$$

$$\frac{d^2v}{dn^2}(0) = 0; \quad V(L) = 0; \quad \frac{d^2v}{dn^2}(L) = 0$$

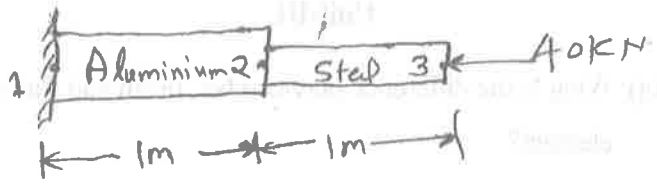
14



(c) Figure below shows an assemble of two bar elements made of steel and aluminium. Find the nodal displacement, element stresses and the reaction force. Take : 14

E (for steel) = 210 GPa, Area, A (for steel) = 2 cm^2

E (for Al) = 70 GPa, Area, A (for Al) = 4 cm^2



Unit-II

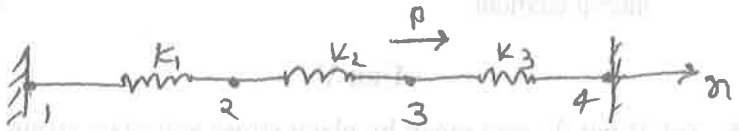
2. (a) What do you mean by shape function? 2

(b) Derive the element stiffness matix for quadratic bar element. 14

(c) For the spring system shown in figure following information is given :

$K_1 = 100$ N/mm, $K_2 = 200$ N/mm,

$K_3 = 100$ N/mm, $P = 500$ N & $u_1 = u_4 = 0$



Find :

(i) The global stiffness matrix

(ii) Displacement of nodes 2 and 3

(iii) The reaction forces at nodes 1 and 4

(iv) The forces in the spring 14

Unit-III

3. (a) What is the difference between bar, beam and frame element? 2

   (b) Derive the stiffness matrix for the beam element. 14

   (c) Derive the stiffness matrix for the frame element. 14

Unit-IV

4. (a) Why the Three-node triangular element is also known as Constant Strain Triangular (CST) element. 2

   (b) Derive the element stiffness matrix for three noded triangular element. 14

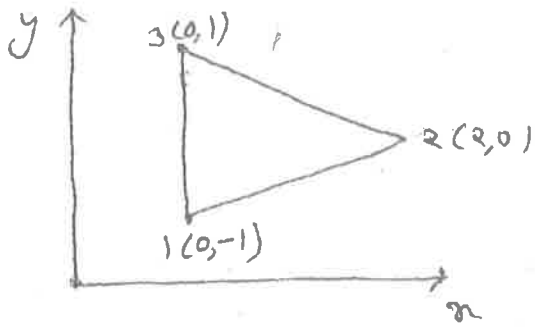
   (c) Derive the shape functions of four noded quadri-lateral element. 14

Unit-V

5. (a) What do you mean by plane stress and plain strain. 2

   (b) Derive the strain-displacement relationship matrix for three-noded triangular element in plane stress. 14

   (c) Evaluate strain displacement matrix, strain and stress matrix for the following plane stress condition problem shown in fig.



Take

$$u_1 = 0, v_1 = 0 \cdot 25,\ u_2 = 0,\ v_2 = 0 \cdot 35,,$$

$$u_3 = 0,\ v_3 = 0 \cdot 25$$

The thickness of element $= 10$ m

Young's modulus $= 200$ GPa

and Poisson's ratio, $\upsilon = 0 \cdot 25$ 14