7E7011

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# 7E7011

## B. Tech. VII Sem. (Main / Back) Exam., Nov. – Dec. - 2018

## Mechanical Engineering

## 7ME1A Finite Element Methods

## Common With ME, PI

**Time: 3 Hours**

**Maximum Marks: 80**
**Min. Passing Marks: 26**

*Instructions to Candidates:*

*Attempt any **five questions,** selecting **one question** from **each unit.** All questions carry **equal** marks. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly.*

*Units of quantities used/calculated must be stated clearly.*

*Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL 2. NIL

## UNIT- I

Q.1 (a) Explain the following –

(i) Uniqueness of a solution [2]

(ii) Banded Symmetric Matrix [2]

(iii) Meshing [2]

(iv) Band width and semi band width [2]

(b) Explain Gauss elimination method with the help of an example. [8]

**OR**

Q.1 (a) Describe general procedure to solve Finite Element Method Problem. [8]

(b) Derive global stiffness matrix for a three spring system using local stiffness matrix for each element. [8]

## UNIT- II

Q.2 (a) Explain principal of minimum potential energy. Also write an example to explain it. [8]

(b) The figure 1 below shows a system of three linear spring elements connected as shown. Node 1 is fixed and node 3 is given a specified displacement $\delta$. Determine the nodal displacement and forces required at node 3 for the specified conditions. [8]

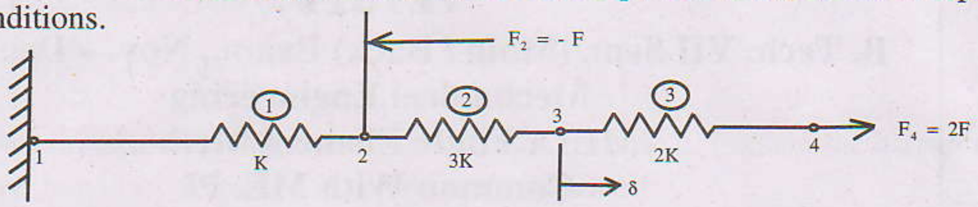


Figure - 1

**OR**

Q.2 (a) Explain in detail stress and strain tensor. Support your answer with neat diagrams. [8]

(b) Consider a stepped bar as shown in figure2, for which E = 200GPa, $A_1$ = 200 $mm^2$ and $A_2$ = 10$mm^2$. Determine nodal displacements, reaction forces and stresses in each element. [8]

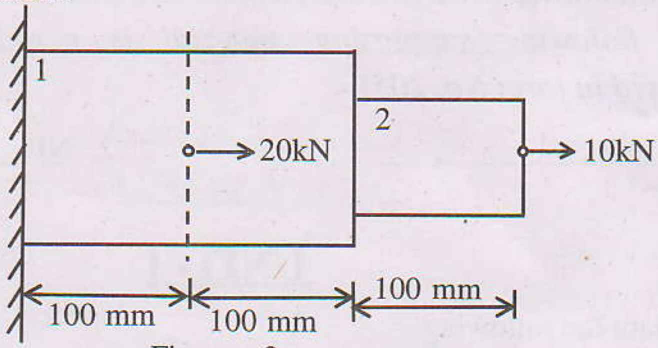


Figure - 2

## UNIT- III

Q.3 (a) Explain constant strain triangle (CST). Also formulate its shape functions. [8]

(b) For a three bar truss system shown in figure 3, determine the nodal displacements and stresses in each member. Find the support reactions also. Take E = 200GPa. [8]

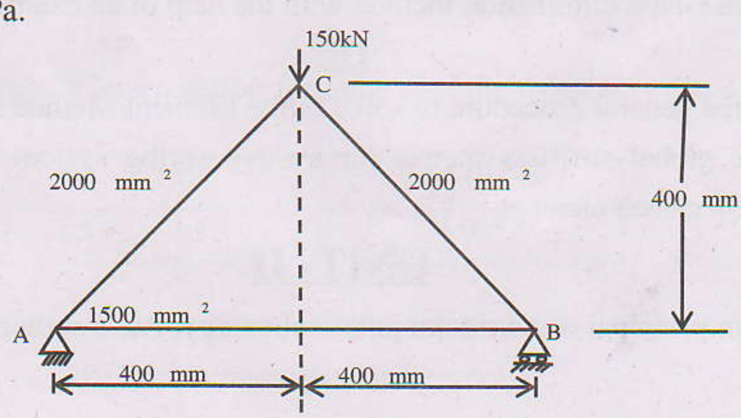


Figure 3

**OR**

Q.3 (a) Describe the formulation for plane stress and plane strain problems. [4]

(b) Find the nodal displacements and element stresses in propped beam shown in figure 4. Idealize the beam into two CST elements as shown. Assume plane stress conditions. Take $\mu = 0.25$, $E = 2\times10^5$ N/mm$^2$ and thickness (t) = 15mm. [12]

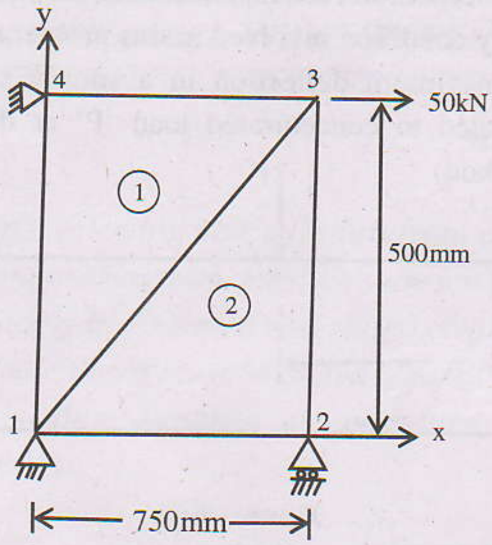


Figure - 4

# UNIT- IV

Q.4 (a) Explain 1 Dimensional heat transfer for a bar element in detail. [4]

(b) Using Rayleigh – Ritz method, determine the expression for displacement and stress in a fixed bar subjected to axial force P as shown in figure 5, Also, draw displacement and stress variation diagram. Take three terms in displacement function. [12]

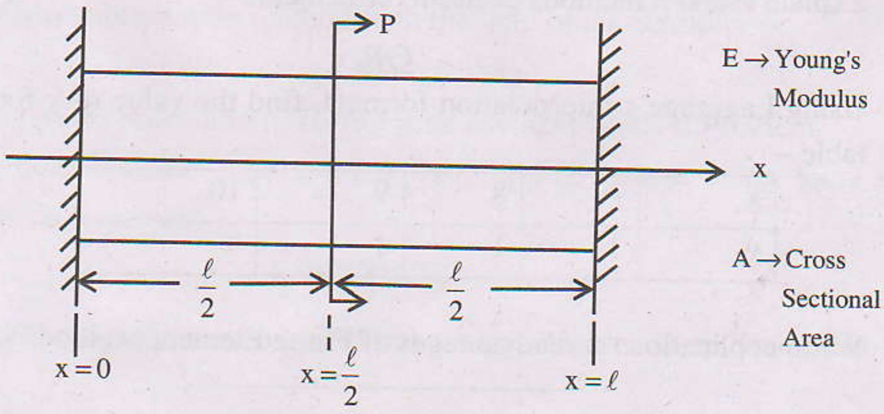


Figure - 5

**OR**

Q.4 (a) Using Galerkin's approach, find element stiffness matrix and force vector for 1 dimension equilibrium equation.

$$\frac{d}{dx}\left(EA\frac{du}{dx}\right)+e\,Ag=0$$

Use quadratic interpolation for displacement variable u. Explain the essential and natural boundary condition involved in this problem. [8]

(b) Calculate the maximum deflection in a simply supported beam as shown in figure 6, subjected to concentrated load 'P' at the center of the beam. (Use collocation method) [8]

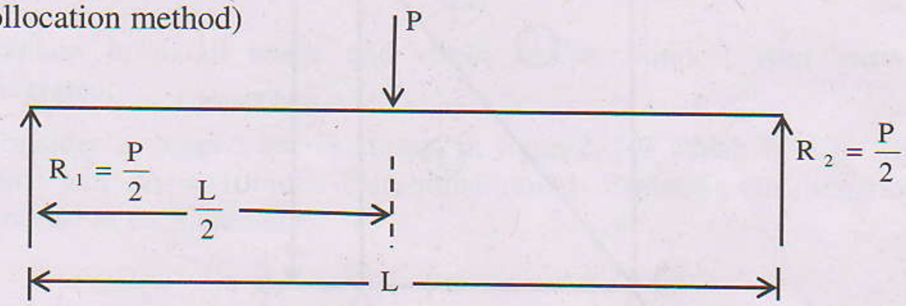


Figure - 6

## UNIT- V

Q.5 (a) Explain the following -

(i) Convergence of solution [2]

(ii) Compatibility [2]

(iii) Element Continuity [2]

(iv) Static Condensation [2]

(b) Explain P and h methods of mesh refinement. [8]

**OR**

Q.5 (a) Using Lagrange's interpolation formula, find the value of y for x = 9.5 from the table – [8]

| | | | | |
|---|---|---|---|---|
| x | 7 | 8 | 9 | 10 |
| y | 3 | 1 | 1 | 9 |

(b) Write applications and advantages of Finite Element Method. [8]

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