

**B.Tech. VII Semester(Main&Back) Examination, November - 2019**  
**Mechanical Engg.**  
**7ME1A Finite Element Methods**

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.*

**Unit - I**

1. a) Solve following equations by using Gauss Elimination method (12)

$$X_1 + 2X_2 + 3X_3 = 1$$

$$2X_1 + 3X_2 + 2X_3 = 2$$

$$3X_1 + 3X_2 + 4X_3 = 1$$

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- b) Write five properties of stiffness matrices. (4)

**(OR)**

1. a) For the given spring system with arbitrary numbered nodes, obtain : (12)



$$k_1 = 1000 \text{ lb/in}, k_2 = 2000 \text{ lb/in}, k_3 = 3000 \text{ lb/in}$$

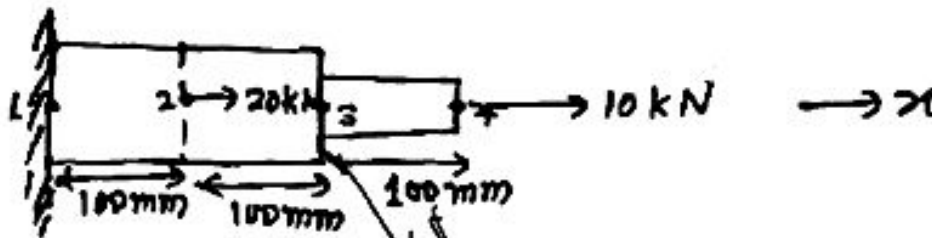
The force at node 4 = 5000 lb.

- The Global stiffness matrix
- The displacement of nodes 3 and 4.
- The reaction forces at nodes 1 and 2.

- b) Define Bandwidth and write any matrix of bandwidth of 2. (4)

### Unit - II

2. a) Using MPE approach for the given system. Calculate : (12)
- Displacements at node 2, 3 and 4.
  - Reaction force at node 1.



$$A_1 = 20 \text{ mm}^2 \quad E_1 = 50 \text{ GPa}$$

$$A_2 = 10 \text{ mm}^2 \quad E_2 = 100 \text{ GPa}$$

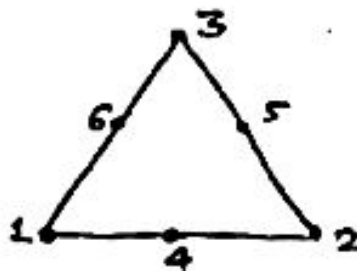
- b) Sketch and name the different types of 1D, 2D and 3D elements used in FEA. (4)

(OR)

2. a) Derive the shape functions for the three noded line element and plot the variation of interpolation functions of it. (12)
- b) Discuss FE model concept/discretization. (4)

### Unit - III

3. a) Derive the shape functions for the all the 6 nodes for following triangular element. (8)



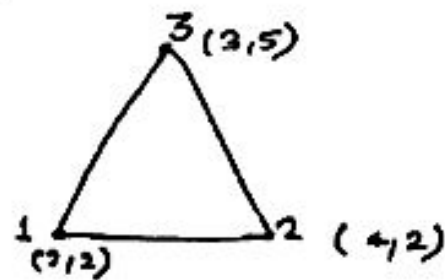
Node 4, 5 and 6 are mid point nodes.

- b) Evaluate the following integral I, by using 2 point Gauss quadrature, also compare the result with exact solution.

$$I = \int_{-1}^1 \left( 3e^x + x^2 + \frac{1}{(x+2)} \right) dx \quad (8)$$

(OR)

3. a) Calculate the shape functions matrix  $[N]$  at node 1,2,3 and also at the centroid of the triangle. (8)



- b) Explain plane stress and plane strain problems with suitable examples. (8)

#### Unit - IV

4. Obtain a two term Galerkin solution for the problem

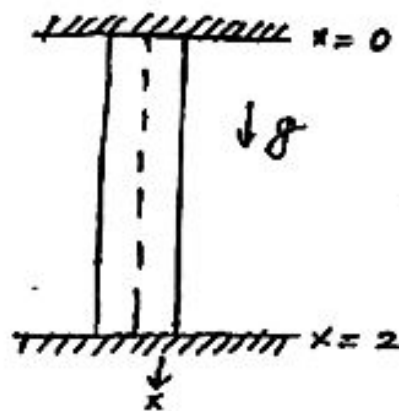
$$\frac{d^2 y}{dx^2} - 10x^2 = 5, \quad 0 \leq x \leq 1$$

With boundary conditions  $y(0) = y(1) = 0$ .

- And using the trial functions  $N_1(x) = x(x-1)$  and  $N_2(x) = x^2(x-1)$ . (16)

(OR)

4. Using Rayleigh - Ritz method, find the displacement of the mid - point of the rod as shown in figure. (16)



Body force per unit volume,  $P_g = 1$   $E = A = 1$ .

#### Unit - V

5. Discuss

- a) Convergence and Aspect ratio.  
b) Concept of element mass matrix in dynamic analysis. (8+8)

(OR)

5. Write notes on

- a) Static condensation and Polynomial interpolation. (8)  
b) Methods of mesh refinement. (8)