



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal-500043, Hyderabad

B.Tech VI SEMESTER END EXAMINATIONS (REGULAR) - JULY 2023

Regulation: UG-20

FINITE ELEMENT METHODS

Time: 3 Hours

(MECHANICAL ENGINEERING)

Max Marks: 70

Answer ALL questions in Module I and II

Answer ONE out of two questions in Modules III, IV and V

All Questions Carry Equal Marks

All parts of the question must be answered in one place only

MODULE – I

- A simply supported beam of length 'l' subjected to a UDL on the entire span and a point load P at the center of the span. Using Rayleigh Ritz method to determine the deflection at the mid span and slope. [BL: Apply| CO: 1|Marks: 7]
 - Consider a bar as shown in Figure 1. An axial load of 200kN is applied at point P. Take $A_1 = 2400mm^2$, $E_1 = 70GPa$, $A_2 = 600mm^2$ and $E_2 = 200GPa$. Calculate the following
 - The nodal displacement at point P
 - Stress in each material
 - Reaction forces[BL: Apply| CO: 1|Marks: 7]

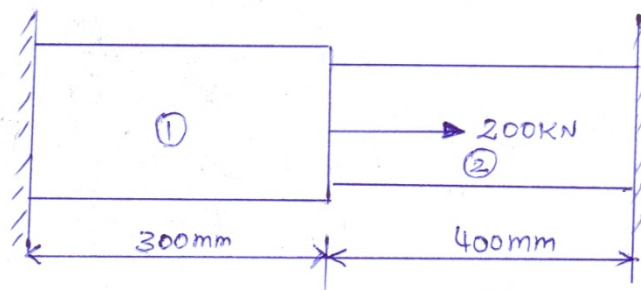


Figure 1

MODULE – II

- Explain the principle of minimum potential energy. Determine the shear forces and bending moments for the cantilever beam having length 'l'. [BL: Apply| CO: 2|Marks: 7]
 - Determine the nodal displacements, element stresses and support reactions in the truss structure shown in Figure 2, assuming points 1 and 3 are fixed. Use $E = 70 GPa$ and $A = 200mm^2$ [BL: Apply| CO: 2|Marks: 7]

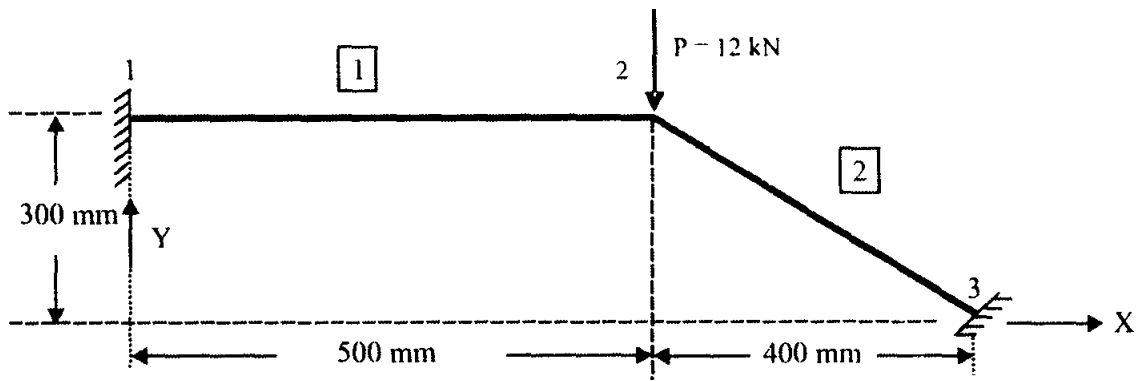


Figure 2

MODULE – III

3. (a) Summarize about CST element. State its properties and applications. How an LST element can be considered as CST element? [BL: Understand| CO: 3|Marks: 7]
- (b) For a constant strain triangular element shown in Figure 3, assemble strain-displacement matrix. Take $t = 20\text{mm}$ and $E = 200 \times 10^5 \text{N/mm}^2$. All dimensions are in mm [BL: Apply| CO: 3|Marks: 7]

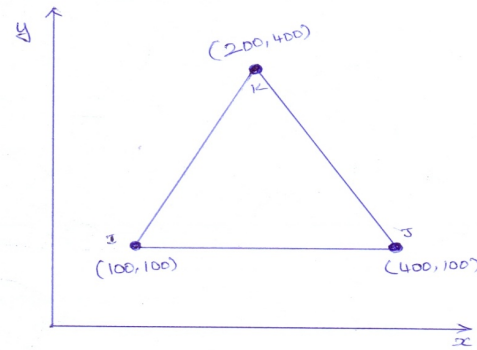


Figure 3

4. (a) List the conditions for a problem to be axi-symmetric. Obtain shape function for an eight noded quadrilateral element. [BL: Understand| CO: 4|Marks: 7]
- (b) For an isoparametric quadrilateral element shown in Figure 4, determine the local coordinates of the point P which has cartesian coordinates (7, 4). [BL: Apply| CO: 4|Marks: 7]

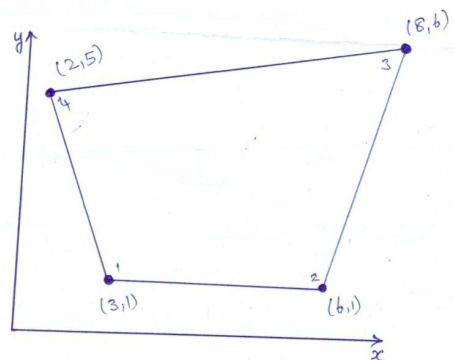


Figure 4

MODULE – IV

5. (a) Determine the one dimensional equation for one dimensional heat conduction element with free end convection. [BL: Apply| CO: 5|Marks: 7]
- (b) A wall of 0.9m thickness is having thermal conductivity of 1.2W/m K . The wall is to be insulated with a material of thickness 0.09m having an average thermal conductivity 0.3W/m K . The surface temperature is 1000°C and outside insulation exposed to atmospheric air at 40°C with heat transfer coefficient $35\text{W/m}^2\text{K}$. Use finite element method to calculate the nodal temperature. [BL: Apply| CO: 5|Marks: 7]
6. (a) Obtain the stiffness matrix for heat flow in a rectangular fin, where k , h and P denotes thermal conductivity, convective heat coefficient and perimeter of fin. [BL: Apply| CO: 5|Marks: 7]
- (b) Consider a brick wall of thickness 0.3 m, $k = 0.7 \text{ W/m K}$. The inner surface is at 28°C and the outer surface is exposed to cold air at -15°C . The heat transfer coefficient associated with the outside surface is $40\text{W/m}^2\text{K}$. Determine the steady state temperature distribution within the wall and also the heat flux through the wall. Use two elements and obtain the solution. [BL: Apply| CO: 5|Marks: 7]

MODULE – V

7. (a) Find the natural frequencies of vibrations of a simple cantilever beam. Mention the convergence requirements in the finite element method. [BL: Apply| CO: 6|Marks: 7]
- (b) Give the consistent and lumped mass matrix for the following elements
- i) Beam element
- ii) Bar element [BL: Apply| CO: 6|Marks: 7]
8. (a) Differentiate between boundary value problem and initial value problem. Explain the importance of element mass matrix in FEM with suitable example. [BL: Understand| CO: 6|Marks: 7]
- (b) Find the natural frequencies of longitudinal vibrations of the same stepped shaft of areas A and $2A$ and of equal lengths (L), when it is constrained at one end, as shown in Figure 5. [BL: Apply| CO: 6|Marks: 7]

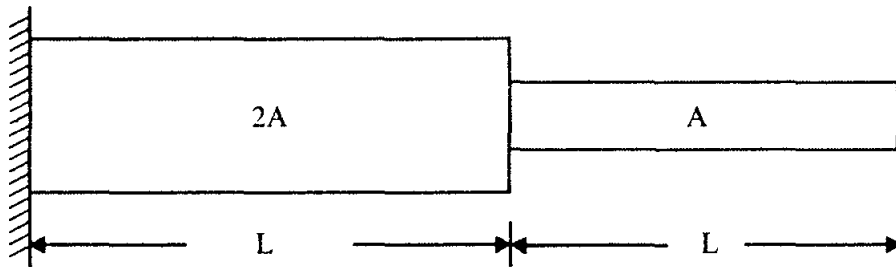


Figure 5

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