Hall Ticket No | | | | | | | | | | | Question Paper Code: AAEC23

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal-500043, Hyderabad

B.Tech VI SEMESTER END EXAMINATIONS (REGULAR) - JULY 2023
Regulation: UG-20
FINITE ELEMENT ANALYSIS

Time: 3 Hours **(AERONAUTICAL 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

1. (a) 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]

   (b) 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
   i) The nodal displacement at point P
   ii) Stress in each material
   iii) Reaction forces [BL: Apply| CO: 1|Marks: 7]

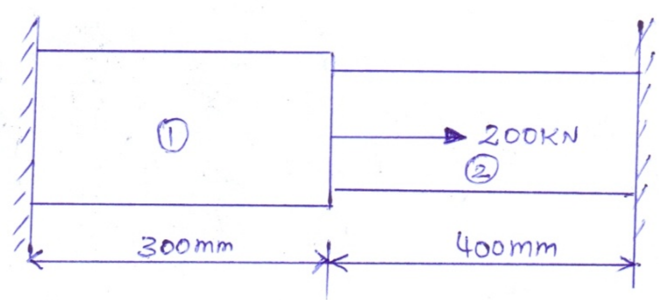

Figure 1

MODULE – II

2. (a) 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]

   (b) 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]

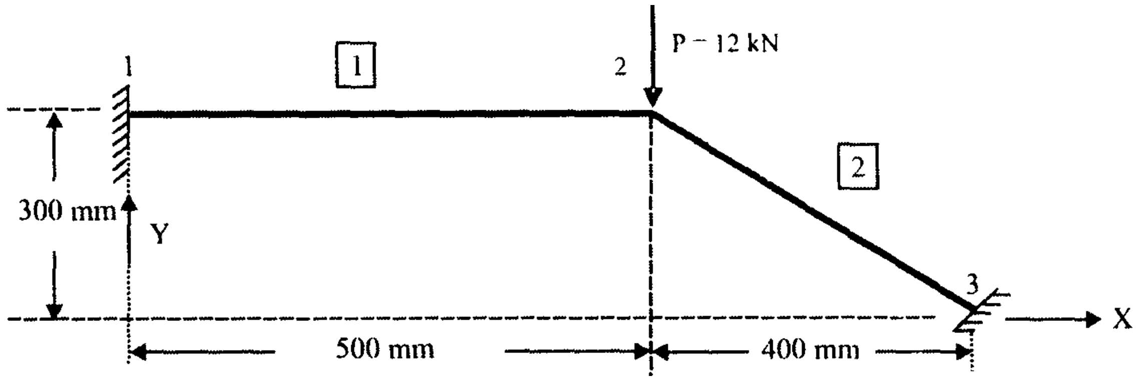

Figure 2

MODULE – III

3. (a) Summarize about CST element. State its properties and applications. Distinguish between CST and LST elements. [BL: Understand| CO: 3|Marks: 7]

   (b) For a constant strain triangular element shown in Figure 3, assemble strain-displacement matrix. Take t= 20mm and $E = 200 \times 10^5 N/mm^2$.All dimensions are in mm

   [BL: Apply| CO: 3|Marks: 7]

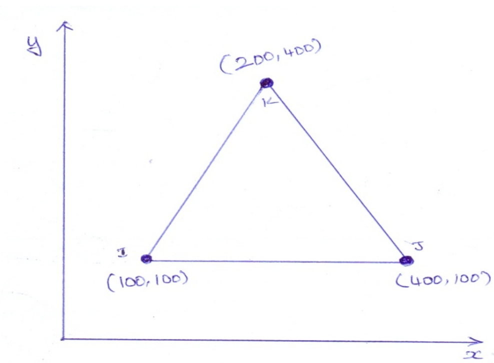

Figure 3

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]

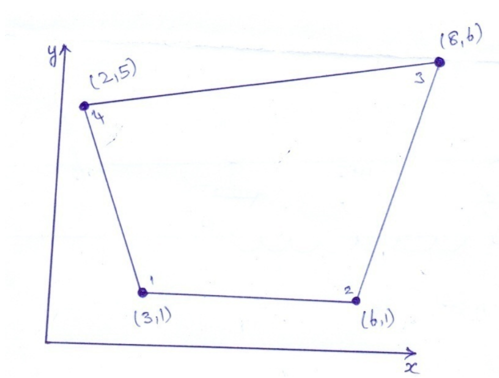

Figure 4

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 $35W/m^2K$. 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 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 $40W/m^2K$. 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 lumped mass matrix for the following elements

   i) Beam element

   ii) Plane truss element

   iii) CST 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]

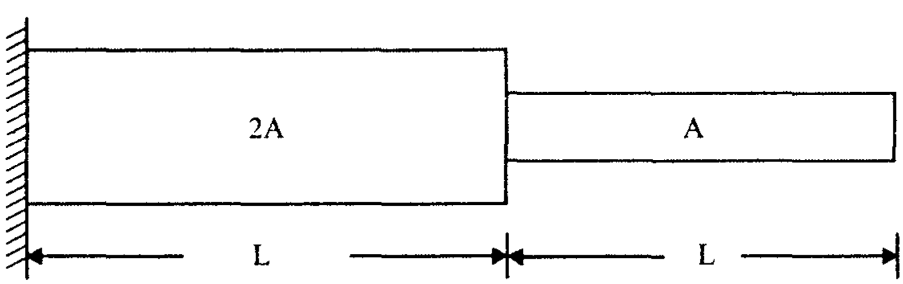

Figure 5

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