CBCS SCHEME

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17ME61

Sixth Semester B.E. Degree Examination, June/July 2023
Finite Element Analysis

Time: 3 hrs. Max. Marks: 100

Note : 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Assume the suitable value for the missing data.***

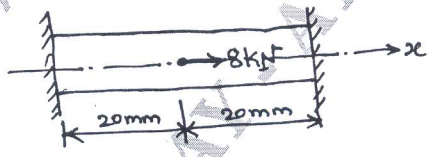
Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. What is FEA? Explain the basic steps involved in FEA for stress analysis of an Elastic body. **(10 Marks)**

b. Use Rayleigh – Ritz method to find stress and displacement at the midpoint of a bar shown in Fig. Q1(b). Take E = 70GPa ; A = 100mm^2. Assume the displacement model to be 2nd order polynomial. **(10 Marks)**

Fig.Q1(b)



OR

2 a. What are Interpolation function? Explain Interpolation model for Simplex Element , Complex and Multiplex Elements in detail. **(10 Marks)**

b. Use the Galerkin's method, to obtain the approximate solution of the differential equation.

$$\frac{d^2y}{dx^2} - 10x^2 = 5 \qquad 0 \le x \le 1$$

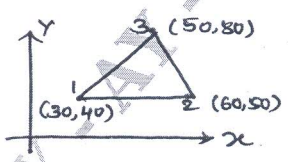
With boundary condition y(0) = y(1) = 0. Take the trial function as $N_1(x) = x(x-1)$ and $N_2(x) = x^2(x-1)$. **(10 Marks)**

Module-2

3 a. Derive the shape function for the one dimensional bar element, in natural coordinate system. **(10 Marks)**

b. For the triangular element, shown in Fig. Q3(b), obtain the strain displacement matrix 'B' and determine strain ϵ_x , ϵ_y and γ_{xy}. Nodal displacement {q} = {2 1 1-4 -3 7} × 10^{-2}mm. **(10 Marks)**

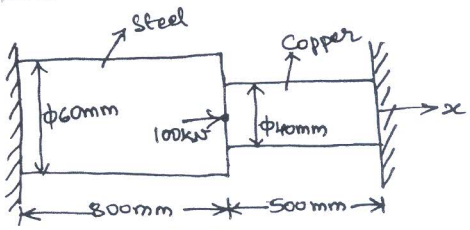
Fig.Q3(b)



OR

4 a. Using Penalty method of Handling boundary condition, determine the nodal displacement , stress in each element in bar shown if Fig. Q4(a) due to applied force P = 100kN. Take E_{steel} = 200GPa ; E_{cu} = 100GPa. **(10 Marks)**

Fig.Q4(a)



b. For the two bar truss shown in Fig. Q4(b) , determine the nodal displacement , stresses in each element. Take $E = 2 \times 10^5$ N/mm^2 , $A = 200$mm^2. **(10 Marks)**

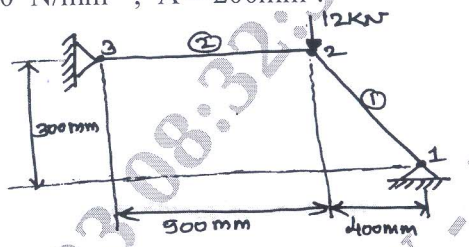


Fig.Q4(b)

Module-3

5 a. Derive Element Stiffness matrix for the Beam Element in Global Coordinate System. **(10 Marks)**

b. Solve for vertical deflection and slopes , at point 2 and 3, using beam elements for the structure shown in Fig. Q5(b). Also determine the deflection at the counter of the portion of the beam carrying UDL. $E = 2 \times 10^8$kN/m^2 , $I = 4 \times 10^6$mm^4. **(10 Marks)**

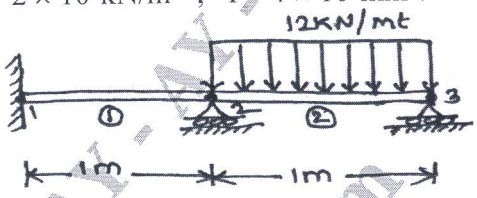


Fig.Q5(b)

OR

6 a. Derive an Potential energy functional for beam element. **(08 Marks)**

b. A solid stepped bar of circular cross – section as shown in Fig. Q6(b), subjected to a torque of 2kN/m at its free end and a torque of 5kN/m at its change in cross – section. Determine the angle of twist and shear stress in the bar.
Take $E = 2 \times 10^5$N/mm^2 and $G = 7 \times 10^4$ N/mm^2. **(12 Marks)**

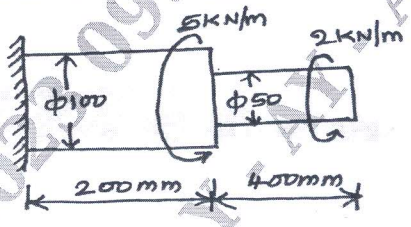


Fig.Q6(b)

Module-4

7 a. Find the temperature distribution in 1 – D fin as shown in Fig. Q7(a). **(10 Marks)**

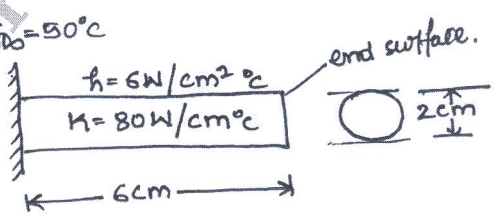


Fig.Q7(a)

b. Derive Fluid flow stiffness matrix for a 1 – D base element. **(10 Marks)**

OR

8 a. For the brick wall shown in Fig. Q8(a), the inner surface temperature is 28°C and outer surface is exposed to cold air at -15°C. Determine the temperature distribution in steady state within the wall by considering 2 one dimensional heat flow elements. **(08 Marks)**

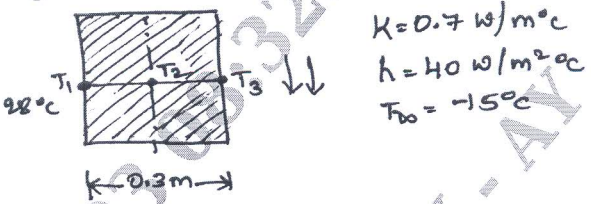


Fig.Q8(a)

b. Solve for temperature distribution in the composite wall as shown in Fig. Q8(b). Using 1 – D heat elements, use Penalty approach of handling boundary condition. **(12 Marks)**

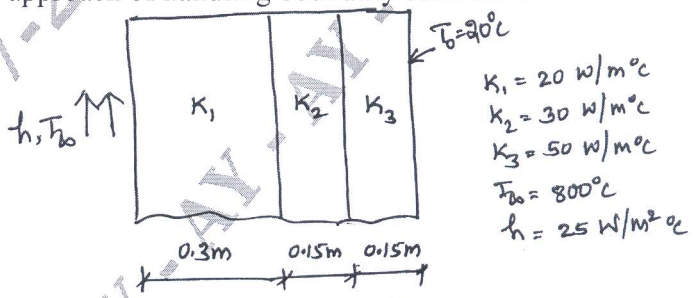


Fig.Q8(b)

Module-5

9 a. Derive an Strain displacement matrix [B] for an Axisymmetric Triangular Element. **(10 Marks)**

b. For the element of an axisymmetric body rotating with a constant angular velocity w = 100 rev/min as shown in Fig. Q9(b), evaluate the approximate body force matrix. Include the weight of the material, where weight density $\rho_w = 0.283$ lb/in^3. **(10 Marks)**

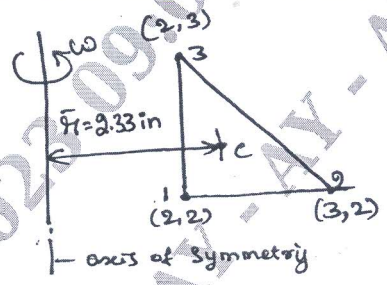


Fig.Q9(b)

OR

10 a. Derive an Consistent mass matrix for the bar element by Variational method. **(10 Marks)**

b. Derive an Consistent mass matrix for truss element in Global co-ordination system. **(10 Marks)**

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