CBCS SCHEME

USN 17ME61

Sixth Semester B.E. Degree Examination, Feb./Mar. 2022
Finite Element Analysis

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define FEM. Explain basic steps involved in FEM. **(10 Marks)**

b. Explain principle of minimum potential energy and principle of virtual work. **(10 Marks)**

OR

2 a. Fig.Q2(a) shows a bar fixed at both ends subjected to an axial load as indicated determine the displacement at loading point and the corresponding stress, using Rayleigh-Ritz method.

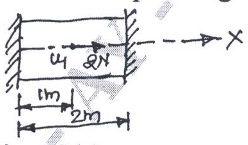

Fig.Q2(a) **(10 Marks)**

b. A cantilever beam is subjected to uniformly distributed load for the entire span of intensity 'P_0' derive the equation for maximum deflection using polynomial functions by Rayleigh – Ritz method [Refer Fig.Q2(b)].

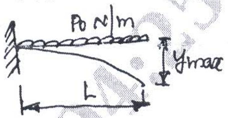

Fig.Q2(b) **(10 Marks)**

Module-2

3 a. Derive the shape function of the bar element in local coordinate system. **(10 Marks)**

b. Derive the interpolation function of quadratic bar element in natural coordinate system. **(10 Marks)**

OR

4 a. A stepped bar shown in Fig.Q4(a), determine the nodal displacement and stresses at each node. Take $E = 2\times10^5$ N/mm².

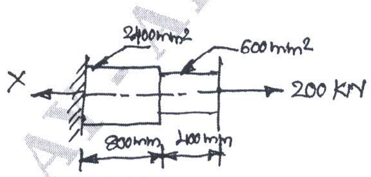

Fig.Q4(a) **(10 Marks)**

b. For a bar shown in Fig.Q4(b), determine the following :
(i) Nodal displacement (ii) Stress in each element (iii) Reaction at the support
Take $E = 2\times10^5$ N/mm² and $A = 200$ mm².

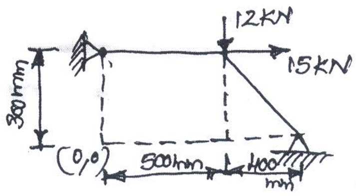

Fig.Q4(b) **(10 Marks)**

Module-3

5 a. Derive the stiffness matrix for a beam element. **(10 Marks)**

b. A cantilever beam subjected to point load of 250 kN as shown in Fig.Q5(b). Determine the deflection at the free end and the support reactions. Take E = 200 GPa, I = 4×10^6 mm^4 and l_e = 0.8m

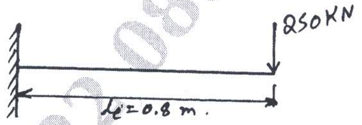

Fig.Q5(b) **(10 Marks)**

OR

6 a. For the beam loaded as shown in Fig.Q6(a), determine deflection and shape. Also find the shear force and BM. Take E = 70 GPa and I = 4×10^{-6} m^4.

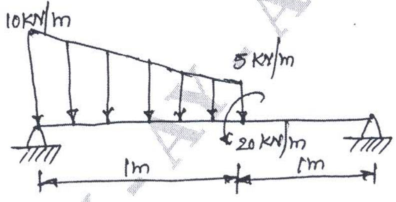

Fig.Q6(a) **(10 Marks)**

b. A solid stepped bar of circular cross section shown in Fig.Q6(b) is subjected to a torque of 1 kN-m at its free end and a torque of 3 kN-m at its change in C/S. Determine the angle of twist and shear stresses in the bar. Take E = 2×10^5 N/mm^2 and G = 7×10^4 N/mm^2.

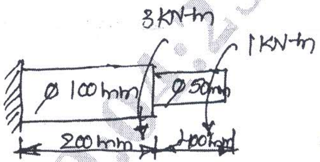

Fig.Q6(b) **(10 Marks)**

Module-4

7 a. Derive an expression for 1D heat conduction. **(10 Marks)**

b. Determine the temperature distribution in the composite wall using 1D heat element, use penalty approach of handling boundary conditions.
Assume k_1 = 25 W/m°C, k_2 = 35 W/m°C, k_3 = 55 W/m°C, h = 30 W/m^{2}C , T_∞ = 900°C , A = Unit area. **(10 Marks)**

OR

8 a. A metallic fin, with thermal conductivity of 70 W/cm °C, 1 cm radius and 5 cm long extends from a plate wall whose temperature is 140°C. Determine the temperature distribution along the fin if it is transferred to ambient air at 20°C with heat transfer coefficient of 5 W/cm^2 °C take two elements along the fin. **(12 Marks)**

b. Determine the temperature distribution in rectangular fin as shown in Fig.Q8(b). Assume steady state and only conduction process. Take heat generated inside the fin as 400 W/m^2.

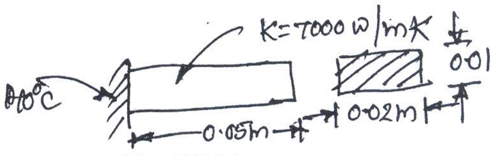

Fig.Q8(b) **(08 Marks)**

Module-5

9 Derive an expression for stiffness matrix of axisymmetric body with triangular element.

(20 Marks)

OR

10 a. For the element of an axisymmetric body rotating with constant angular velocity W = 1000 rev/min as shown in Fig.Q10(a). Determine the body force vector. Include the weight of the material, where the specific density is 7850 kg/m^3.

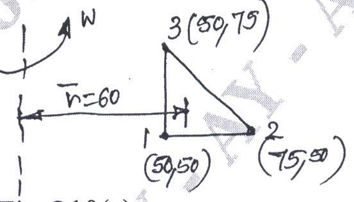

Fig.Q10(a)

(10 Marks)

b. Evaluate the nodal forces to replace the linearly varying surface traction shown in Fig.Q10(b).

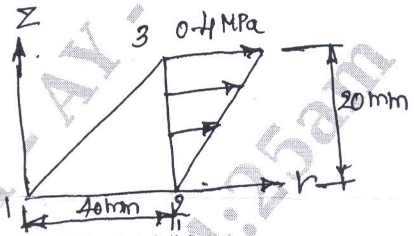

Fig.Q10(b)

(10 Marks)

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