

# CBCS SCHEME

17ME61

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## 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.

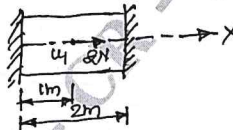


Fig.Q2(a)

(10 Marks)

- b. A cantilever beam is subjected to uniformly distributed load for the entire span of intensity 'P<sub>0</sub>' derive the equation for maximum deflection using polynomial functions by Rayleigh - Ritz method [Refer Fig.Q2(b)].

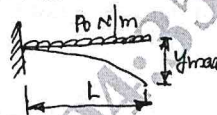


Fig.Q2(b)

(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  $E = 2 \times 10^5 \text{ N/mm}^2$ .

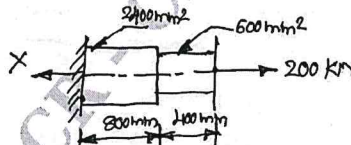


Fig.Q4(a)

(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  $E = 2 \times 10^5 \text{ N/mm}^2$  and  $A = 200 \text{ mm}^2$ .

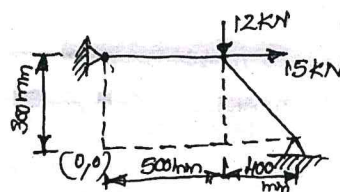


Fig.Q4(b)

(10 Marks)

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-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  $E = 200 \text{ GPa}$ ,  $I = 4 \times 10^6 \text{ mm}^4$  and  $l_e = 0.8\text{m}$

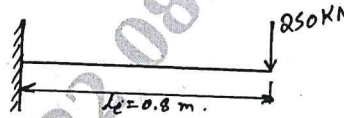


Fig.Q5(b)

(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  $E = 70 \text{ GPa}$  and  $I = 4 \times 10^{-6} \text{ m}^4$ .

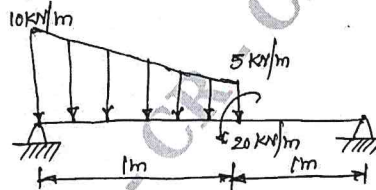


Fig.Q6(a)

(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  $E = 2 \times 10^5 \text{ N/mm}^2$  and  $G = 7 \times 10^4 \text{ N/mm}^2$ .

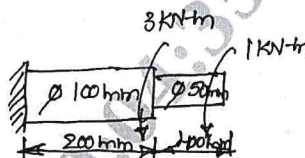


Fig.Q6(b)

(10 Marks)

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**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  $k_1 = 25 \text{ W/m}^\circ\text{C}$ ,  $k_2 = 35 \text{ W/m}^\circ\text{C}$ ,  $k_3 = 55 \text{ W/m}^\circ\text{C}$ ,  $h = 30 \text{ W/m}^2\text{C}$ ,  $T_\infty = 900^\circ\text{C}$ ,  $A = \text{Unit area}$ . (10 Marks)

OR

- 8 a. A metallic fin, with thermal conductivity of  $70 \text{ W/cm}^\circ\text{C}$ , 1 cm radius and 5 cm long extends from a plate wall whose temperature is  $140^\circ\text{C}$ . Determine the temperature distribution along the fin if it is transferred to ambient air at  $20^\circ\text{C}$  with heat transfer coefficient of  $5 \text{ W/cm}^2\text{C}$  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  $400 \text{ W/m}^2$ .

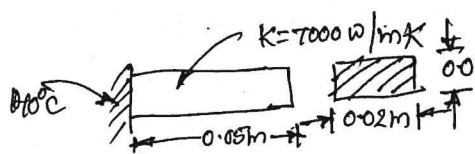


Fig.Q8(b)

(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  $\omega = 1000$  rev/min as shown in Fig.Q10(a). Determine the body force vector. Include the weight of the material, where the specific density is  $7850 \text{ kg/m}^3$ .

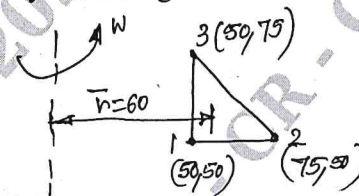


Fig.Q10(a)

(10 Marks)

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

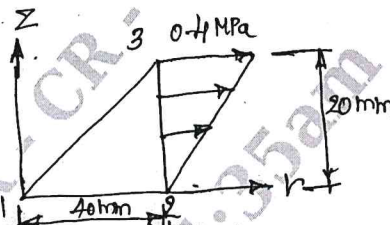


Fig.Q10(b)

(10 Marks)

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