CBCS SCHEME

USN

15ME61

Sixth Semester B.E. Degree Examination, Aug./Sept.2020
Finite Element Method

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Explain briefly about Node location system and numbering scheme. **(06 Marks)**

b. For the spring system shown in Fig.Q1(b), using principle of minimum potential energy, determine the nodal displacements. Take $F_1 = 75N$, $F_2 = 100N$.

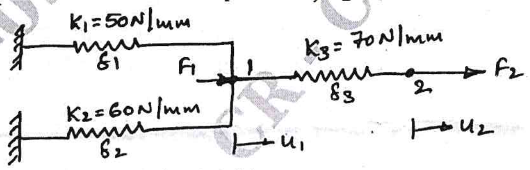

Fig.Q1(b) **(10 Marks)**

OR

2 a. State and explain convergence requirements. **(04 Marks)**

b. Write a short note on :

(i) Geometrical isotropy for 2D Pascal triangle.

(ii) Coordinate system. **(06 Marks)**

c. Explain simplex, complex and multiplex elements. **(06 Marks)**

Module-2

3 a. Derive the shape function for triangular (CST Element) in natural coordinate system. **(08 Marks)**

b. Derive the shape functions for a 4-node Quadrilateral element in natural co-ordinates. **(08 Marks)**

OR

4 a. Obtain an expression for stiffness matrix of a truss element. **(06 Marks)**

b. Find the nodal displacement, stress and reaction of truss element shown in Fig.Q4(b). Take E = 200 GPa.

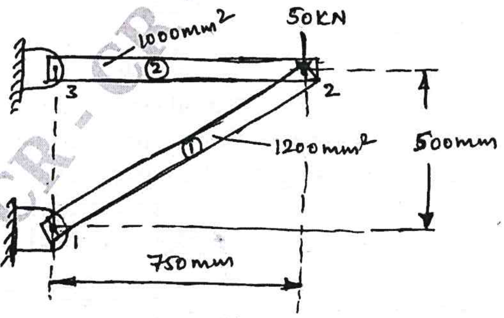

Fig.Q4(b) **(10 Marks)**

Module-3

5 a. Derive the Hermite function for a beam element. **(08 Marks)**

b. For the beam and loading shown in Fig.Q5(a), determine the slopes at 2 and 3 and the vertical deflection at the midpoints of the distributed load. Take E = 200 GPa, $I = 4 \times 10^6 \text{ mm}^4$.

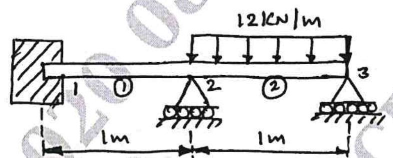

Fig.Q5(a) **(08 Marks)**

OR

6 a. Derive the stiffness matrix for a circular shaft subjected to pure torsion. **(08 Marks)**

b. A solid stepped bar of circular c/s shown in Fig.Q6(b) is subjected to a torque of 1 kN-m at its free end and torque of 3 kN-m at its change in c/s section. Determine the angle of twist and shear stress in the bar. Take $E = 2 \times 10^5 \text{ N/mm}^2$, $G = 7 \times 10^4 \text{ N/mm}^2$.

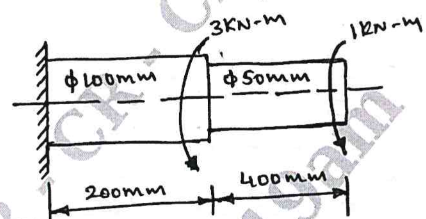

Fig.Q6(b) **(08 Marks)**

Module-4

7 a. Derive element conductivity matrix for 1-dimensional heat flow element. **(06 Marks)**

b. Determine the temperature distribution through the composite wall subjected to convection heat loss on the right side surface with convective heat transfer co-efficient as shown in Fig.Q7(b). The ambient temperature is – 5°C.

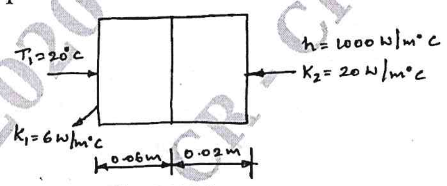

Fig.Q7(b) **(10 Marks)**

OR

8 a. Derive the stiffness matrix for 1D fluid element. **(08 Marks)**

b. For the smooth pipe shown in Fig.Q8(b), with uniform c/s of 1 m^2. Determine the flow velocities at the centre and right end, knowing the velocity at the left is $V_x = 2\text{m/s}$.

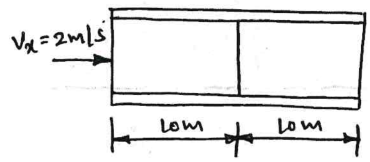

Fig.Q8(b) **(08 Marks)**

Module-5

9 a. Derive the shape function for an axisymmetric triangular element. **(08 Marks)**

b. For the element of an axisymmetric body rotating with a constant angular velocity ω = 1000 rev/min as shown in Fig.Q9(b), determine the body force vector. Include the weight of the material, where the specific density is 7850 kg/m^3.

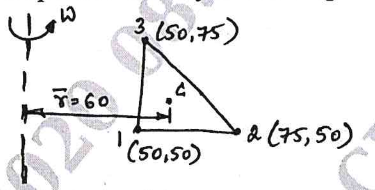

Fig.Q9(b) **(08 Marks)**

OR

10 a. Derive the consistent mass matrix for bar element. **(06 Marks)**

b. Determine the natural frequency of longitudinal vibration of the bar shown in Fig.Q10(b). Take, E = 200 GPa, ρ = 7840 kg/m^3, A = 240 mm^2.

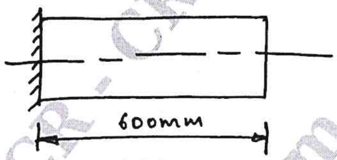

Fig.Q10(b) **(10 Marks)**

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