

USN

--	--	--	--	--	--	--	--	--	--

15ME61

Sixth Semester B.E. Degree Examination, Jan./Feb. 2021 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 the Basic steps involved in FEM. (04 Marks)
- b. Write a note on Node Numbering and Node location. (04 Marks)
- c. For the spring system show in Fig Q1(c), using the principle of minimum potential energy. Determine the nodal Displacements.

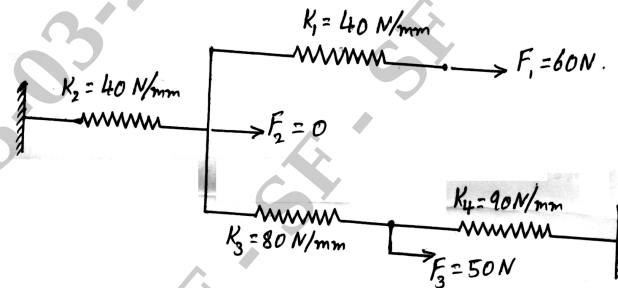


Fig Q1(c) (08 Marks)

OR

- 2 a. Write a note on simplex, complex and multiplex Elements. (06 Marks)
- b. Write the Interpolation polynomial functions in global co-ordinates for 1D, 2D and 3D simplex Elements. (06 Marks)
- c. Explain the Boundary conditions for structural, Heat transfer and fluid flow problems. (04 Marks)

Module-2

- 3 a. Derive the shape functions for the 8-noded Rectangular element in Lagrangian. (08 Marks)
- b. Evaluate $I = \int_{-1}^1 [a_0 + a_1\xi + a_2\xi^2 + a_3\xi^3] d\xi$, using 2-point Gaussian quadrature formula. (08 Marks)

OR

- 4 a. For the Bar shown in Fig Q4(a), determine the Nodal Displacement, Element stresses and support reactions, Take, $A_1 = 250\text{mm}^2$, $A_2 = 400\text{mm}^2$, $E_1 = E_2 = 200\text{GPa}$,

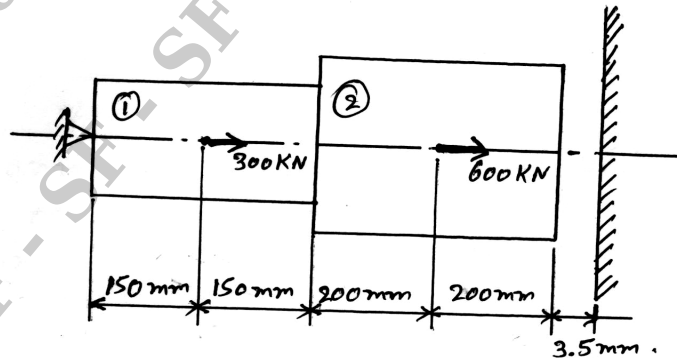
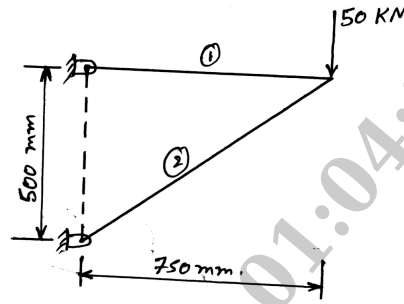


Fig Q4(a) (08 Marks)
1 of 3

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.



- b. A truss shown in Fig Q4(b) is made of 2 bars. Determine :
 i) Nodal Displacements ii) Stresses in each elements.



$A_1 = 1000\text{mm}^2$
 $A_2 = 1200\text{mm}^2$
 $E_1 = E_2 = 200\text{GPa}$

Fig Q4(b)

(08 Marks)

Module-3

- 5 a. Derive the Hermite shape function for a Beam element. (08 Marks)
 b. A cantilever beam subjected to point load of 250kN as shown in Fig Q5(b). Determine deflection at tip and support reactions, Take, $E = 200\text{GPa}$, $I = 4 \times 10^6\text{mm}^4$ and $l_e = 0.8\text{m}$.

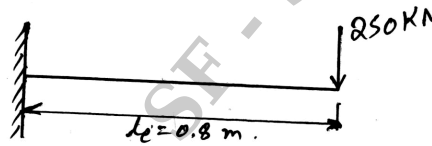


Fig Q5(b)

(08 Marks)

OR

- 6 a. Derive the stiffness matrix for the torsion of shaft. (08 Marks)
 b. A Bar of circular cross section having a diameter of 50mm is fixed at both ends and subjected to a torque at B and C as shown in Fig Q6(b). Determine maximum angle of twist and shear stresses. Take $G = 7 \times 10^4\text{ N/mm}^2$, $E = 2 \times 10^5\text{ N/mm}^2$.

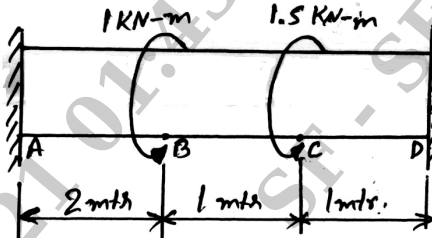


Fig Q6(b)

(08 Marks)

Module-4

- 7 a. Calculate the temperature distribution in a 1-D fin with the physical properties given in Fig Q7(a). There is a uniform generation of heat inside the wall of $Q = 400\text{W/m}^3$.

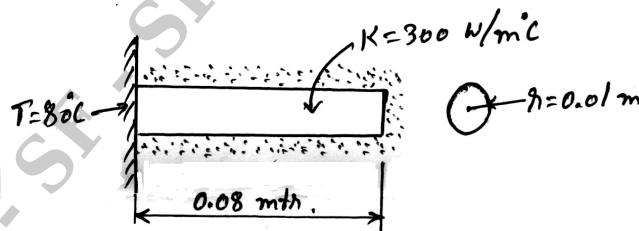


Fig Q7(a)

(08 Marks)

- b. Determine the temperature distribution through the composite wall as shown in Fig Q7(b). Convection heat loss occurs on the right surface. Assume a unit area.

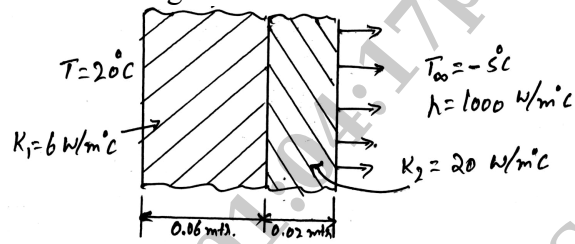


Fig Q7(b)

(08 Marks)

OR

- 8 a. Derive the stiffness matrix for 1-D fluid flow system. (08 Marks)
 b. For the smooth pipe shown in Fig Q8(b), with uniform cross section of 1 m^2 , determine the flow velocities at the centre and right end, Take velocity at left $V_x = 2\text{ m/sec}$.

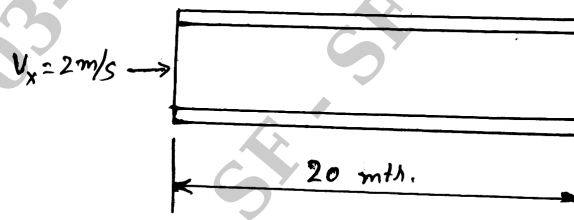


Fig Q8(b)

(08 Marks)

Module-5

- 9 a. Derive the Jacobian matrix of axisymmetric body with triangular element. (06 Marks)
 b. Evaluate the nodal forces used to replace the linearly varying surface traction shown in Fig Q9(b)

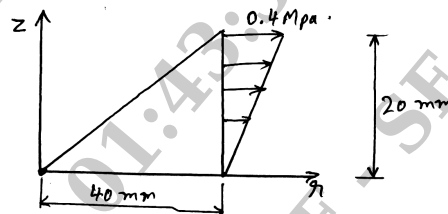


Fig Q9(b)

(10 Marks)

OR

- 10 a. Derive an expression of element mass matrix for a bar element. (06 Marks)
 b. Evaluate eigen value and eigen vector of longitudinal vibration of the constrained uniform circular bar shown in Fig Q10(b). Take minimum 2 elements. $E = 210\text{ GPa}$, $\rho = 7860\text{ kg/m}^3$.

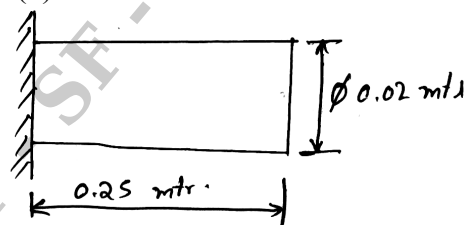


Fig Q10(b)

(10 Marks)
