CBCS SCHEME

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.***

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. 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.

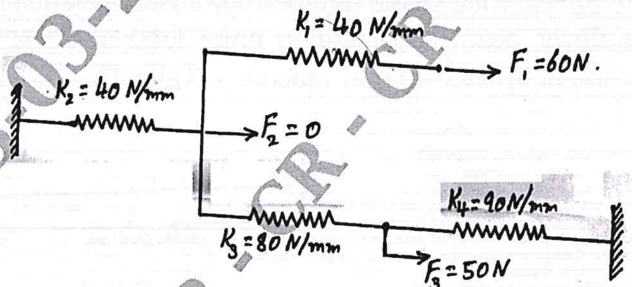


Fig Q1(c) **(08 Marks)**

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 $I = \int_{-1}^{1}\left[a_0 + a_1\xi + a_2\xi^2 + a_3\xi^3\right] d\xi$, 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, $A_1 = 250mm^2$, $A_2 = 400mm^2$, $E_1 = E_2 = 200GPa$,

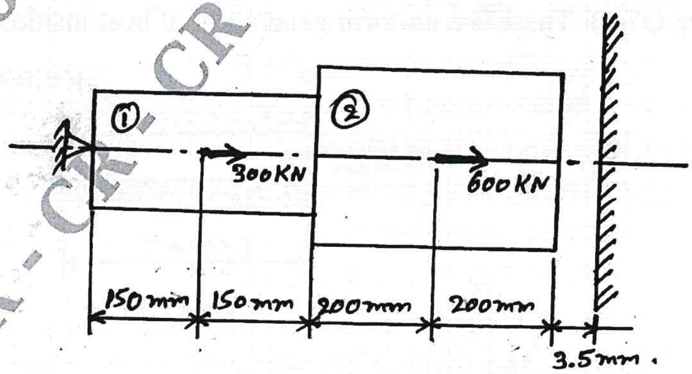
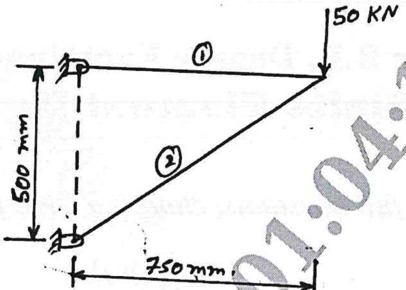


Fig Q4(a) **(08 Marks)**

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



$A_1 = 1000mm^2$
$A_2 = 1200mm^2$
$E_1 = E_2 = 200GPa$

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 = 200GPa, I = $4 \times 10^6 mm^4$ and $\ell_e = 0.8m$.

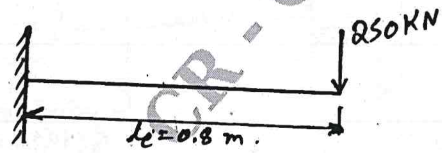


Fig Q5(b)

(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 = 7×10^4 N/mm^2, E = 2×10^5 N/mm^2.

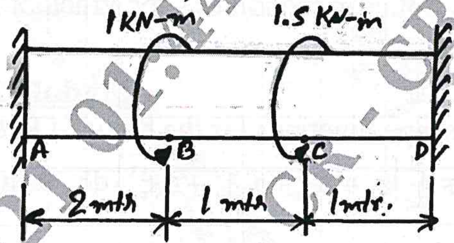


Fig Q6(b)

(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 = 400W/m^3.

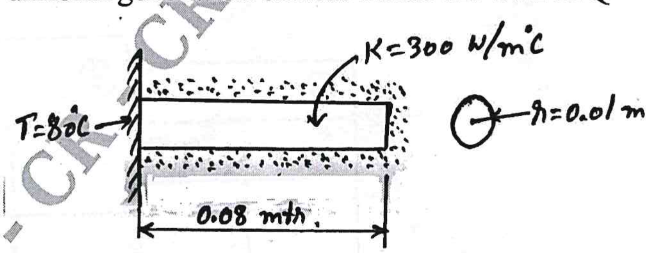


Fig Q7(a)

(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.

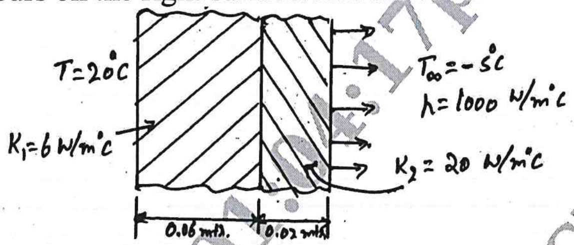


Fig Q7(b) **(08 Marks)**

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 $1m^2$, determine the flow velocities at the centre and right end, Take velocity at left $V_x = 2m/sec$.

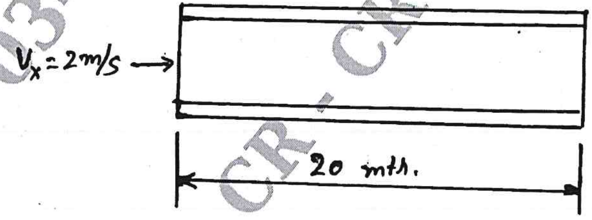


Fig Q8(b) **(08 Marks)**

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)

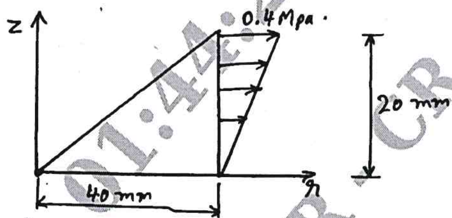


Fig Q9(b) **(10 Marks)**

OR

10 a. Derive an expression of element mass matrix for a bar element. **(06 Marks)**

b. Evaluate eigne value and eigen vector of longitudinal vibration of the constrained uniform circular bar shown in Fig Q10(b). Take minimum 2 elements. $E = 210GPa$, $\rho = 7860kg/m^3$.

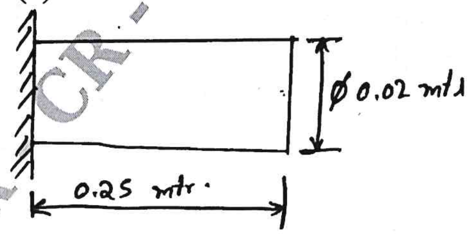


Fig Q10(b) **(10 Marks)**

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