CBCS SCHEME

USN | | | | | | | | | | **15ME61**

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

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. **(05 Marks)**

b. Explain briefly Node location system and node numbering scheme in FEM. **(04 Marks)**

c. Derive an expression for total potential energy of elastic body subjected to body force, traction force and a point force. **(07 Marks)**

OR

2 a. Using Rayleigh-Ritz method, determine the displacement at mid-point and stress variation in one dimensional bar as shown in Fig.Q2(a).

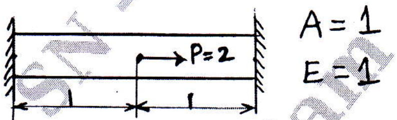


Fig.Q2(a) **(07 Marks)**

b. Write an equilibrium equation of a 3-D elastic body subjected to a body force. **(03 Marks)**

c. Write an Interpolation polynomial function for linear, quadratic and cubic elements (Line and Triangular). **(06 Marks)**

Module-2

3 a. Derive the shape function for 1-D Quadratic element in natural coordinates. **(06 Marks)**

b. Find the shape function for a 3-noded Constant Strain Triangular (CST) elements. **(06 Marks)**

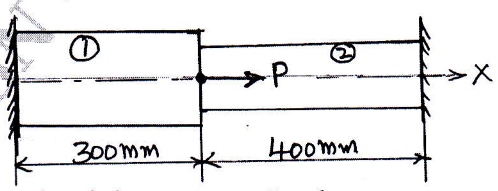
c. Evaluate the following integral using two point Gauss-Integration method.

$$I = \int_{-1}^{+1} \left[3e^{\xi} + \xi^2 + \frac{1}{(\xi + 2)}\right] d\xi$$ **(04 Marks)**

OR

4 a. Consider the bar shown in Fig.Q4(a). An axial load $P = 200\times10^3$ N is applied as shown. Using penalty approach for handling boundary conditions do the following :

(i) Determine the Nodal displacement.
(ii) Determine the Stress in each element.
(iii) Determine the reaction forces.



Aluminium	Steel
$A_1 = 2400\ mm^2$	$A_2 = 600\ mm^2$
$E_1 = 70$ GPa	$E_2 = 200$ GPa

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

b. Consider the truss shown in Fig.Q4(b), X-Y coordinates of the two nodes are indicated in the figure. If $q = [1.5, 1.0, 2.1, 4.3]^T \times 10^{-2}$ mm. Take E = 300 GPa, A = 100 mm^2. Determine the following :
(i) Local coordinates (q′) (ii) Stress in the element (iii) Stiffness matrix of the element.

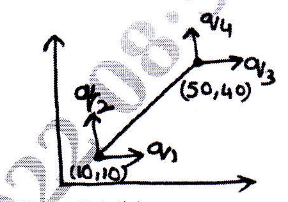


Fig.Q4(b) **(06 Marks)**

Module-3

5 a. Derive Hermit shape function for a beam element. **(06 Marks)**

b. For the beam and loading shown in Fig.Q5(b), determine the slopes at 2 and 3 and the vertical deflection at the midpoint of the distributed load. Take E = 200 GPa, I = 4×10^6 mm^4.

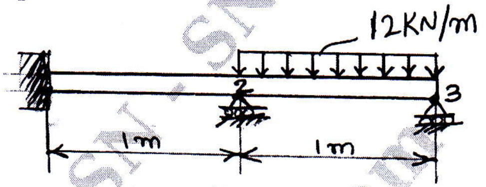


Fig.Q5(b) **(10 Marks)**

OR

6 a. Derive the stiffness matrix for a circular shaft subjected to pure torsion. **(06 Marks)**

b. A hallow circular shaft 2m long is firmly supported at each end and has an outside diameter 80mm and inside diameter 63.8mm. The shaft is subjected to a torque of 12 kN-m applied at a point 1.5m from one end. Calculate the maximum shear stress and angle of twist in the shaft. The shear modulus G = 8×10^4 N/mm^2. **(10 Marks)**

Module-4

7 a. Derive the element stiffness matrix for one dimensional heat conduction. **(06 Marks)**

b. A wall of 0.6m thickness having thermal conductivity of 12 W/mK. The wall is to be insulated with a material thickness of 0.06m having an average thermal conductivity of 0.3 W/mK. The inner surface temperature is 1000°C and the outside of the insulation is exposes to an atmospheric air at 30°C with heat transfer coefficient 35 W/m^2K. Calculate the nodal temperatures. **(10 Marks)**

OR

8 a. Briefly explain one dimensional heat transfer in thin films. **(04 Marks)**

b. Deduce the Governing differential equation for one dimensional fluid flow through a process medium. **(06 Marks)**

c. Derive the stiffness matrix for one dimensional fluid element. **(06 Marks)**

Module-5

9 a. Derive the stiffness matrix of axisymmetric bodies with triangular elements. **(08 Marks)**

b. Evaluate the Nodal forces used to replace the linearly varying surface traction shown in Fig.Q9(b).

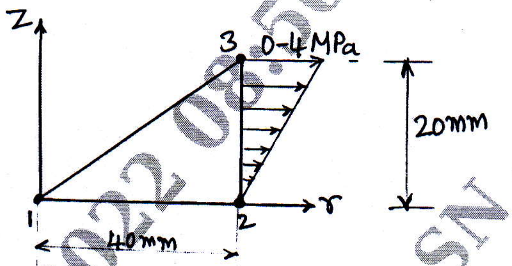


Fig.Q9(b) **(08 Marks)**

OR

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

b. For the stepped bar shown in Fig.Q10(b), determine the eigen values and eigen vector. Take $A_1 = 400\ mm^2$, $\rho = 7850\ kg/m^3$, $E = 200$ GPa, $A_2 = 200\ mm^2$. **(10 Marks)**

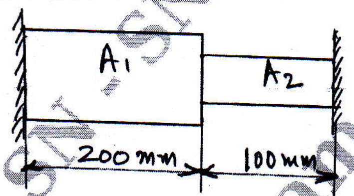


Fig.Q10(b)

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