Total No. of Questions – [06] Total No. of Printed Pages: 2

G.R. No.	

DECEMBER 2021 - ENDSEM EXAM
B.TECH. (MECHANICAL ENGINEERING) (SEMESTER - I)
COURSE NAME: FINITE ELEMENT ANALYSIS
COURSE CODE: MEUA40181A
(PATTERN 2018)

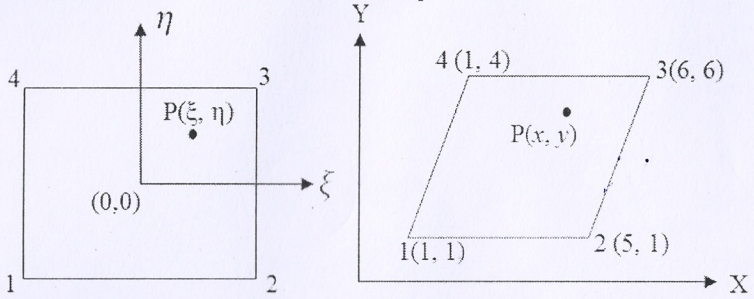
Time: [1 Hour] [Max. Marks: 30]

(*) Instructions to candidates:

1) **Answer Q.1 OR Q.2, Q.3 OR Q.4, Q.5 OR Q.6.**
2) **Figures to the right indicate full marks.**
3) **Use of scientific calculator is allowed**
4) **Use suitable data where ever required**

Q.1) a) Obtain shape function of 9 node rectangular element using Lagranges interpolation formula. For only corner nodes. **[4 marks]**

b) For four node quadrilateral element, find the x and y coordinates of point P whose location in parent element are given by $\xi = 0.6$ and $\eta = 0.6$. Also find u, v displacements of point P in X and Y directions respectively if displacement vector is $\{q\} = [0 \quad 0 \quad 0.15 \quad 0 \quad 0.25 \quad 0.15 \quad 0 \quad 0.08]^T$. **[6 marks]**



OR

Q.2) a) Obtain shape function of 8 node rectangular element. For middle nodes only. **[4 marks]**

b) Evaluate using one-point and two-point Gauss quadrature

$$I = \int_{-1}^{1} [3e^x + x^2 + \frac{1}{(x+2)}]$$ **[6 marks]**

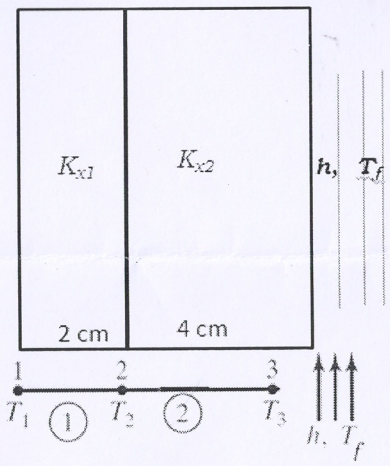
Q.3) a) Apply elimination approach for treatment of boundary condition with suitable example **[4 marks]**

b) Heat is generated (at center of plate) in a large plate (k = 0.8 W/m °C) at the rate of 4000 W/m^3 . The plate is 40 cm thick. Assume area as unity. The outside surfaces of the plate are exposed to ambient air at 30°C with a convective heat-transfer coefficient of 20 W/m^2 °C. For two element discretization, determine global stiffness matrix and global load vector. **[6 marks]**

OR

Q.4) a) Comment on applying Galerkin weighted residual method for finite element formulation. **[4 marks]**

b) For the composite wall as shown in Fig., the wall is maintained at 100 ^{0}C at the left face and convection mode of heat transfer occurs between right face and existing fluid (with h= 0.1 w/cm^2 ^0C, T_f = 30 ^0C). Consider Area A = 1 m^2 perpendicular to the direction of heat flow. K_{x1} =0.08 w/cm ^0C ; K_{x2} =0.2 w/cm ^0C . Determine Global conductance matrix and global load vector **[6 marks]**



Q.5) a) Derive consistent mass matrix for 1D linear bar element **[4 marks]**

b) 1D bar with length of 2.0 m is fixed at one end and is free at other end. Modulus of Elasticity (E) is 200GPa and Density is 7800kg/m^3. Find out characteristics polynomial equation, after applying boundary conditions? (Consider two elements for finite element discretization. Use lumped mass matrix) **[6 marks]**

OR

Q.6) a) Differentiate between lumped and consistent mass matrix? How it affects the FEA simulations? **[4 marks]**

b) For axial vibrations of stepped bar with area of cross-sections as A_1 = 400 mm^2, L_1 = 200 mm and A_2 = 300 mm^2, L_2 = 300mm, determine Global Stiffness Matrix and Global Mass Matrix. Use consistent mass matrix. Modulus of elasticity E = 210 GPa and Density ρ = 7900 kg/m^3. Model the bar by using two elements. **[6 marks]**