Q. Code: 869561

Reg. No. | | | | | | | | | | | | | | |

B.E / B.TECH. DEGREE EXAMINATIONS, MAY 2024

Seventh Semester

ME18701 – FINITE ELEMENT ANALYSIS

(Mechanical Engineering)

(Regulation 2018 / Regulation 2018A)

TIME: 3 HOURS **MAX. MARKS: 100**

CO 1 The students will apply the principles involved in the finite element approach on mechanical systems.

CO 2 The students will solve structural problems using 1D elements involving engineering applications.

CO 3 The students will apply the concept of 2D plane elasticity and analyze the stresses in structural members.

CO 4 The students will solve thermal and vibration problems using 1D elements.

CO 5 The students will differentiate the shape functions and stiffness matrix for Isoparametric elements.

PART- A (10 x 2 = 20 Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	State the three phases of finite element method.	**1**	**1**
2.	What is the difference between weak form and strong form of FEA?	**1**	**2**
3.	Write the nodal forces acting on a beam element, simply supported at its ends and carries a point load W at its centre.	**2**	**2**
4.	What is a bar in structure? When will beam element replace the bar element? Why?	**2**	**2**
5.	What are the disadvantages of CST element?	**3**	**2**
6.	What is a real-life example of plane stress?	**3**	**2**
7.	What is the difference between lumped and distributed mass?	**4**	**2**
8.	Why non-linear analysis is needed? Give some suitable situation where nonlinear analysis only provides proper solution.	**4**	**2**
9.	Name a few commercially available FEA packages.	**5**	**2**
10.	What is the difference between first order and second order FEA?	**5**	**2**

PART- B (5 x 14 = 70 Marks)

		Marks	CO	RBT LEVEL
11. (a)	Consider a 1 mm diameter, 50 mm long aluminum pin fin as shown in figure 11a. used to enhance the heat transfer from a surface wall maintained at 300°C. The governing differential equation and the boundary conditions	**(14)**	**1**	**3**

$$k\frac{d^2T}{dx^2} = \frac{Ph}{A_c}(T - T_\infty)$$

$$T(0) = T_w = 300°C$$

$$\frac{dT}{dx}(L) = 0 \qquad \text{(insulated tip)}$$

are given by

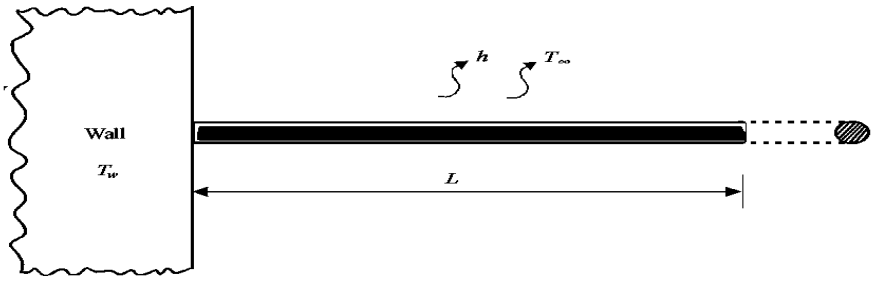


Figure 11(a).

Let k = 200 W/m/ °C, h = 20 W/m^2 °C , T∞ = 30 °C. Estimate the temperature distribution in the fin by Galerkin weighted residual method.

(OR)

(b)	Write the general steps of finite element analysis and explain with an example shown in the figure 11(b) below.	**(14)**	**1**	**3**

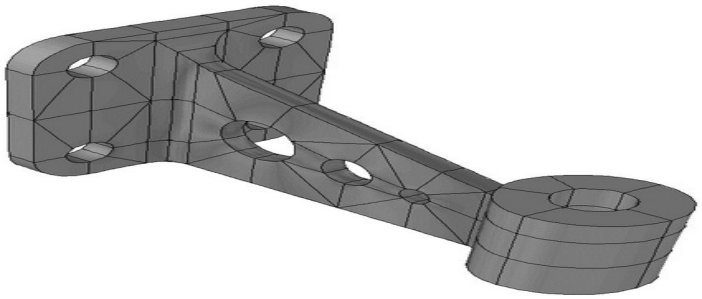


Figure 11(b)

12. (a)	Consider a bar shown in figure 12 a. An axial load of 200kN is applied at a point P. Take A_1 = 2400 mm^2, E_1 = 70 x 10^9 N/m^2, A_2 = 600 mm^2, E_1 = 200 x 10^9 N/m^2. Calculate the nodal displacement, stresses and reactions in the given bar.	**(14)**	**2**	**3**

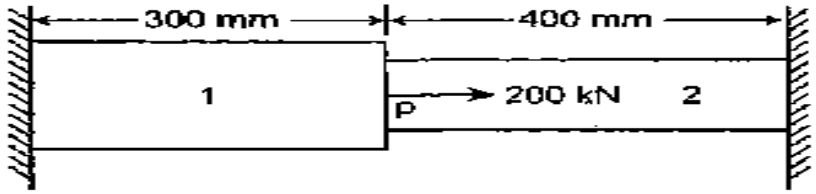


Figure 12.(a)

`(OR)

(b) Determine the displacement at Node 1 for the given truss in the figure 12b. **(14) 2 3**

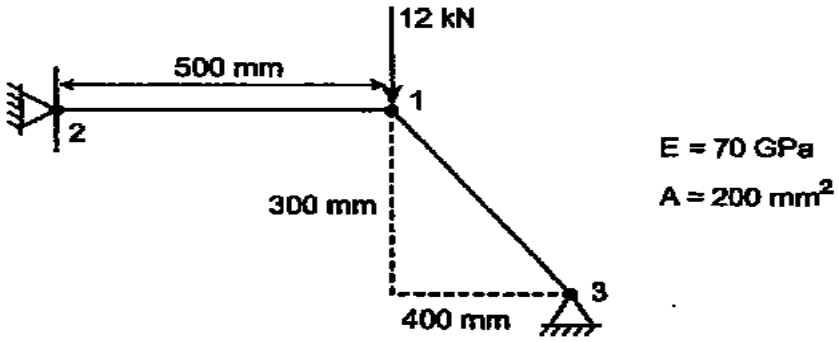


Figure 12 b.

13. (a) Determine the shape functions at the interior point P for the given CST element in figure 13a. **(14) 3 3**

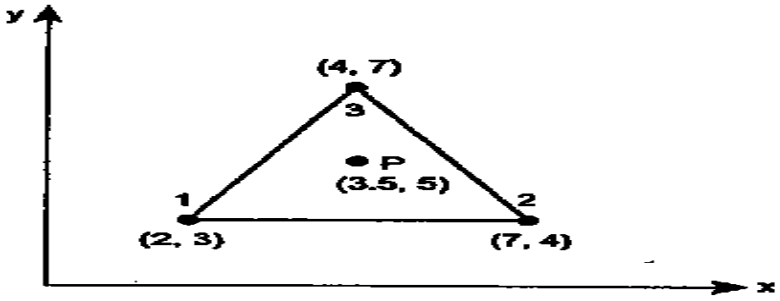


Figure 13 (a)

(OR)

(b) Calculate the element stresses for the CST element shown in Figure 13b. **(14) 3 3**

The nodal displacements are: $\{u_1, v_1, u_2, v_2, u_3, v_3\} = \{3, 2, 1.5, 0.2, 4.2, 2\}$ mm. Take E = 210 GPa and $\mu = 0.25$. Assume plane stress condition.

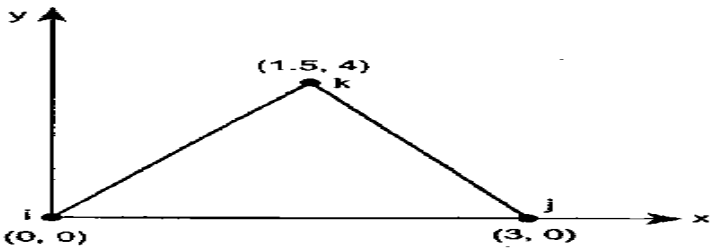
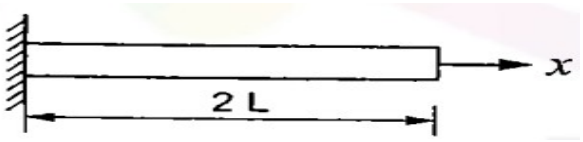


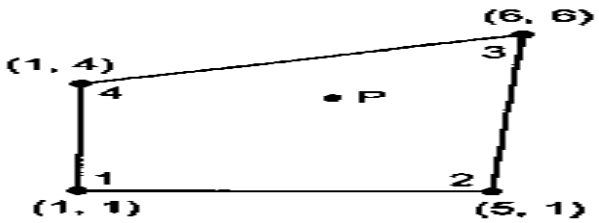
Figure 13(b)

14. (a)	Determine the natural frequencies of the beam shown in figure 14 (a). using two element discretization.	**(14)**	**4**	**4**



(OR)

(b)	Determine the expression of shape function for heat transfer in 2D element.	**(14)**	**4**	**4**
15. (a)	For the Isoparametric element shown in figure 15a., determine the cartesian coordinates of point P, for, $\varepsilon = \eta = 0.5$.	**(14)**	**5**	**3**



(OR)

(b)	Evaluate the function using the two-point Gaussian quadrature method as stated below.	**(14)**	**5**	**3**

$$I = \int_{-1}^{1} \int_{-1}^{1} (2x^2 + 3xy + 4y^2)\, dx\, dy$$

$x_1 = 0.57735, \qquad y_1 = 0.57735$

$x_2 = -0.57735, \qquad y_2 = -0.57735$

PART- C (1 x 10 = 10 Marks)

(Q.No.16 is compulsory)

		Marks	CO	RBT LEVEL
16.	An aluminum alloy of fin of 7 mm thick and 50 mm long protrudes from a wall, which is maintained at 120^0 C. The ambient air temperature is 22^0 C. The heat transfer coefficient and thermal conductivity of the fin material are 140 W/m^{2}k and 55 W/mk. Determine the temperature distribution of the fin shown in figure 16.	**(10)**	**4**	**5**

Figure 16