Register Number:……..

KUMARAGURU
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B.E DEGREE EXAMINATIONS: APRIL / MAY 2023

(Regulation 2018)

Sixth Semester

AERONAUTICAL ENGINEERING

U18AET6002**:** Finite Element Method

COURSE OUTCOMES

CO1: Identify the mathematical model for simple and complex engineering problems using FEM approach.

CO2: Calculate stress, strain, and displacement value of simple 1-D problems.

CO3: Solve complex axisymmetric problems under various boundary conditions.

CO4: Apply finite element concept to Isoperimetric Element.

CO5: Analyse heat transfer and torsional problems.

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-
PART A (10 x 2 = 20 Marks)
(Answer not more than 40 words)

1.	Define superparametric and subparametric elements.	CO1	[K_1]
2.	Compare Rayleigh ritz and Galerkin approach in context of precision.	CO1	[K_1]
3.	Explain the significance of transformation matrix in truss elements.	CO2	[K_2]
4.	Justify the use of polynomials in shape function	CO2	[K_2]
5.	Give the displacement equation for CST element.	CO3	[K_2]
6.	Define traction force.	CO3	[K_1]
7.	Write down the stiffness matrix for a 2D iso-parametric quadrilateral element	CO4	[K_2]
8.	State any four merits of isoparametric elements.	CO4	[K_1]
9.	What are the three types of boundary conditions in 1D heat transfer?	CO5	[K_1]
10.	Write down the finite element formulation of stress function for torsion.	CO5	[K_2]

Answer any FIVE Questions: -
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11.	a)	A bar of uniform cross section is clamped at one end and left free at the other end and it is subjected to uniform axial load P as shown in figure 11(a). Calculate the displacement in a bar by using two terms polynomial and three terms polynomial with the help of Rayleigh Ritz methods. Compare with exact solutions.	8	CO1	[K4]

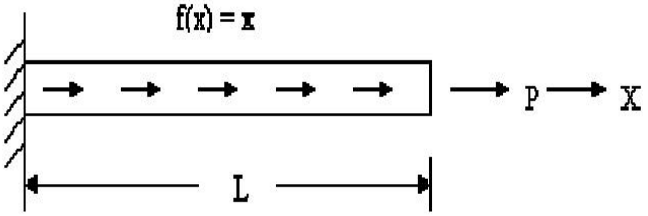

Figure 11(a) Two noded bar element subjected to point load

	b)	The circular rod depicted in Figure 11 (b) has an outside diameter of 60 mm, length of 1 m, and is perfectly insulated on its circumference. The left half of the cylinder is aluminum, for which K_x = 200 W/m-°C and the right half is copper having k_x = 389 W/m-°C. The extreme right end of the cylinder is maintained at a temperature of 80°C, while the left end is subjected to a heat input rate 4000 W/m^2. Using four equal-length elements, determine the steady-state temperature distribution in the cylinder Galerkine weighted residual approach.	8	CO1	[K4]

Figure 11 (b)

12.		For a tapered plate of uniform thickness t= 10 mm as shown in the below figure 12, find the displacements at the nodes by forming two element model. The bar has mass density ρ=7300 kg/m^3, Young's Modulus E=2x10^5 N/mm^2.In addition to self-weight, the plate is subjected to a point load P=10kN at its center. Also determine the reaction force at the support.	16	CO2	[K4]

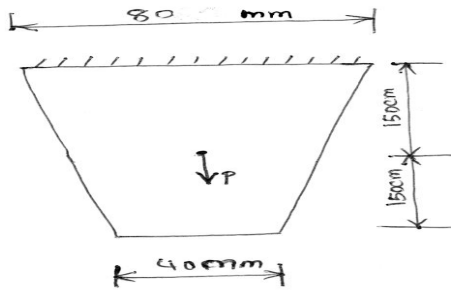

Figure 12

13.	a)	The plane strain triangular element have the coordinates of 1 (1, 1), 2 (8, 4) and 3 (2, 7) also the nodal displacements are $u_1 = 0.001$; $u_2 = 0.003$; $u_3 = -0.002$; $v_1 = -0.004$; $v_2 = 0.002$; $v_3 = 0.005$; Obtain strain-displacement relationship matrix, stress-strain relationship matrix and determine the strains of ε_x, ε_y and γ_{xy}. Let E = 70 GPa and Poissons ratio is 0.3 also unit thickness. All co-ordinates are in millimeters.	12	CO3	[K4]
	b)	State the conditions for a body to satisfy Axisymmetric stress	4	CO3	[K2]
14		Evaluate the shape function for N_1, N_2, N_3 at the interior point P and Jacobian J of the transformation for the triangular element shown in figure 14 below.	16	CO4	[K4]

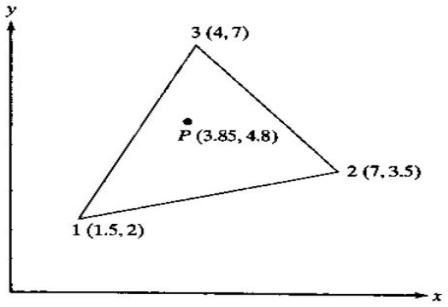

Figure 14

15.	a)	A furnace wall is made up of three layers, wherein the inside layer with thermal conductivity of 8.5 W/mK, the middle layer with thermal conductivity of 0.25 W/mK, and the outer layer with thermal conductivity of 0.08 W/mK. The thicknesses of the inner, middle, and outer layers are 25 cm, 5 cm, and 3 cm respectively. The inside temperature of the wall is 873 K and outside of the wall is exposed to atmospheric air at 303 K with heat transfer coefficient of 45 W/m^2K. Determine the nodal temperatures.	14	CO5	[K4]
	b)	List out the numerical methods that can effectively solve thermal problems and justify the answer.	2	CO5	[K2]
16		A four noded rectangular element shown in figure 16 below, determine Jacobian matrix, Strain displacement matrix and Element stresses. Take E= 2 x 10^5 N /mm^2, $\mu = 0.25$, u = [0, 0, 0, 0.003, 0.004, 0.006, 0.004, 0, 0]T, ε= 0.0 and η= 0.0. Assume plane stress condition.	16	CO4	[K4]

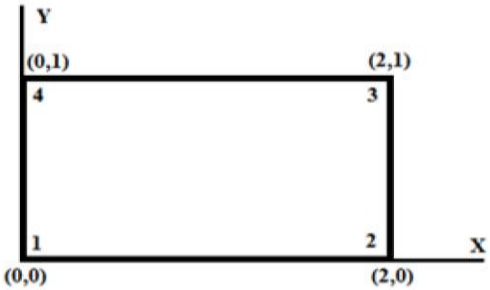

Figure 16

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