Register Number:……..

KUMARAGURU
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B.E/B.TECH DEGREE EXAMINATIONS: NOV /DEC 2024

(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: Analyze heat transfer and torsional problems.

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

Answer all the Questions:-

PART A (10 x 2 = 20 Marks)

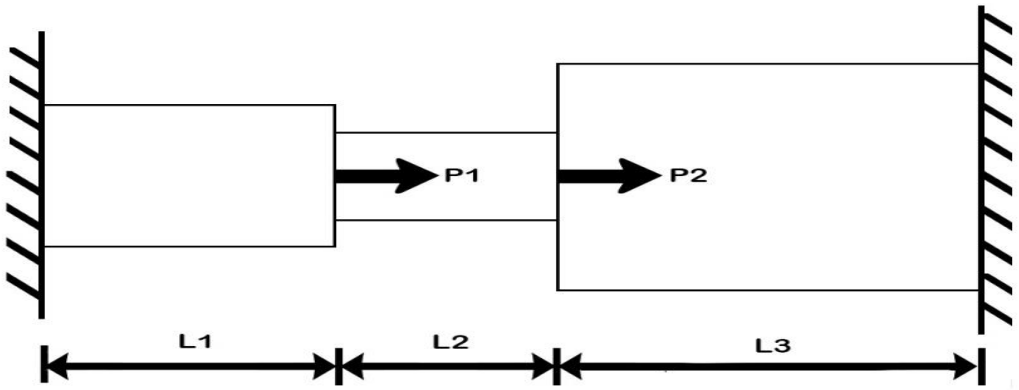
(Answer not more than 40 words)

1.	How Rayleigh Ritz method is providing better results than Galerkin approach for structural problems?	CO1	[K_2]
2.	State Hooke's Law and how it is used in the formulation of Finite Element Method (FEM) based calculations?	CO1	[K_2]
3.	Is it possible to determine the non-nodal points based unknown displacements in direct equilibrium method? Please briefly explain your answer with relevant expressions.	CO2	[K_2]
4.	In FEM approach, why we are neglecting the zero displacements based rows and columns in global elemental equations?	CO2	[K_2]
5.	List out all the number and name of the stresses developed in plane stress/plane strain and axisymmetric natured triangular elements that undergoes structural analysis.	CO3	[K_2]
6.	Enumerate any four practical examples that can use the concept of plane stress/plane strain and axisymmetric elemental FEA approaches.	CO3	[K_2]
7.	In what way isoparametric element formulations are differs from conventional quadratic element formulations?	CO4	[K_2]
8.	State the importance of Jacobian matrix in Isoparametric element.	CO4	[K_2]
9.	List the steps involved in the finite element formulations/procedures of conventional 1-D heat transfer problems.	CO5	[K_2]

10. Janani has decided to do research on drones under thermal loading. She concentrated her efforts on achieving certain targets, such as measuring heat flux and assessing thermal stress. What are the major material data-based initial conditions that she has to impose in the solver? CO5 [K3]

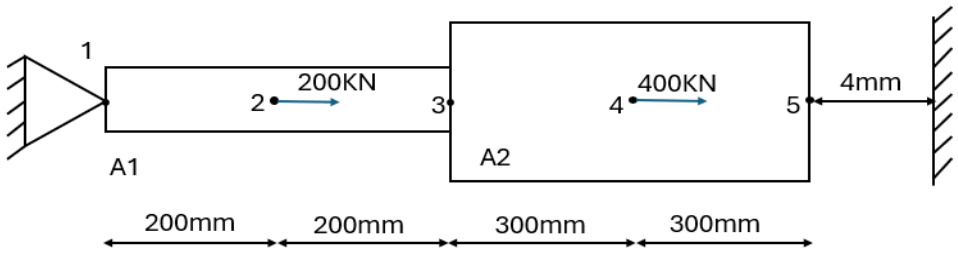
Answer any FIVE Questions:-
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11. The stepped composite bar shown in below figure. Determine the Horizontal displacements of second and third nodes using Rayleigh Ritz method. Take the trail function as $u = a_0 + a_1 x + a_2 x^2$. Assume E_1=210GPa; E_2=70GPa; E_3=205GPa; A_1=2400 mm^2; A_2=1200 mm^2; A_3=3600 mm^2; L_1=1000mm; L_2=500mm; L_3=750mm. P_1=100kN; P_2=150kN and μ_1=0.27, μ_2=0.34, μ_3=0.3 respectively.



16 CO1 [K4]

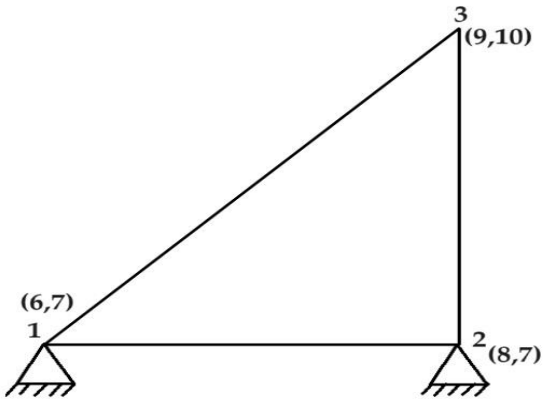
12. Consider the below shown bar, in which calculate the nodal displacement, elemental stress, Reaction forces on support under the imposed load and supports. Take A_1=300mm^2,A_2=500mm^2, E=200GPa and γ=0.30.



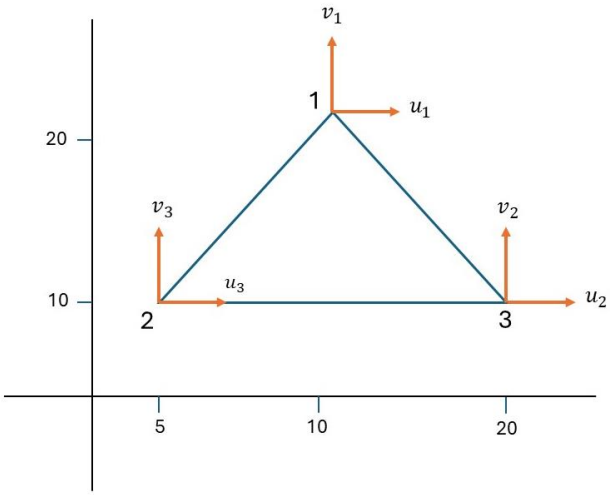
16 CO2 [K5]

13. Calculate the element stiffens matrix, thermal force vector and nodal displacements for the axisymmetric triangular element shown in below figure. 16 CO3 [K5]

The element experience 50°C increases in temperature. The dimensions are in mm. Take $\alpha=10\times10^{-6}$/°C E=200 GPa μ=0.25.



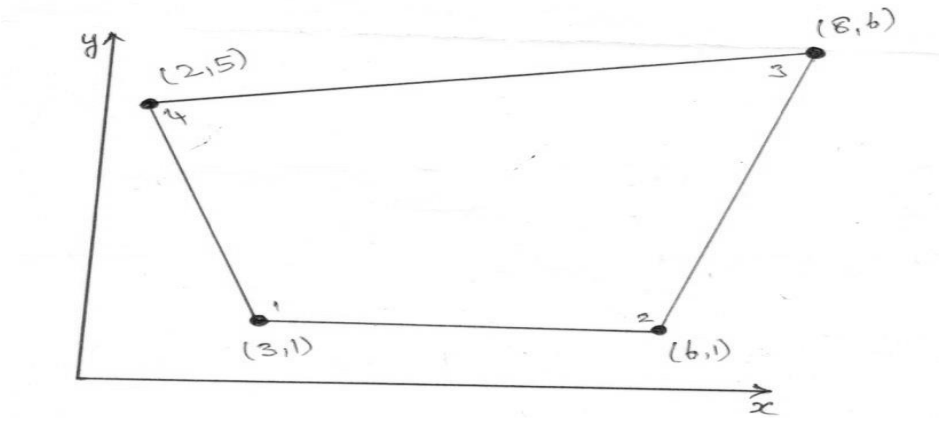
14. The coordinates of the CST element are (10, 20), (5, 10), (20, 10) and the nodal displacement are $u_1 = 0.025$ mm, $u_2 = 0.05$ mm, $u_3 = 0.05$ mm, $v_1 = 0.025$ mm, $v_2 = 0.025$ mm, $v_3 = 0.020$ mm. Calculate the elemental strain, elemental stress, principle stress and principle angle. Assume plane strain condition μ=0.37, $E = 70 \times 10^3$ N/mm^2.



16 CO3 [K4]

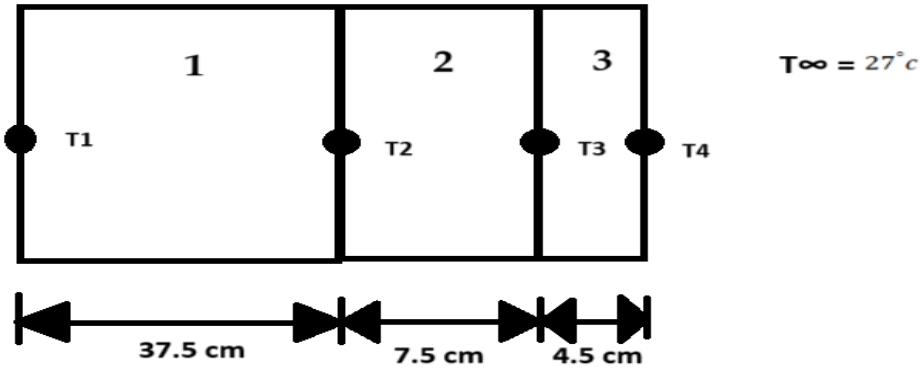
15. a) Evaluate the integral $I = \int_{-1}^{1} \left[3e^x + x^2 + \frac{1}{(x+2)}\right] dx$ using one point and two point Gaussian quadrature. Also compare this with exact solution. 8 CO4 [K4]

b) For an iso-parametric element, determine the local coordinates at 'P' which has a Cartesian coordinates of (7,4) where x_1, x_2, x_3, x_4 are 3,6,8,2 and y_1, y_2, y_3, y_4 are 1,1,6,5. 8 CO4 [K4]



16. The furnace wall is made up of three layers, inside layer thermal conductivity of 8.5 $\frac{W}{mK}$, the middle layer thermal conductivity of 0.25 $\frac{W}{mK}$ and the outer layer thermal conductivity of 0.08 $\frac{W}{mK}$. the respective thickness of inner, middle, and outer layer is 37.5 cm,7.5cm and 4.5 cm. the inside temperature of the wall is 900°c and the outside of the wall exposed to the atmospheric air with 27°cwith heat transfer coefficient of 40 $\frac{W}{m^2K}$. Determine the nodal temperature of the wall.

16 CO5 [K_5]



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