KUMARAGURU
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B.E DEGREE EXAMINATIONS: APRIL / MAY 2023
(Regulation 2018)

Sixth Semester

MECHANICAL ENGINEERING

U18MEI6203: Finite Element Analysis

COURSE OUTCOMES

CO1: Solve problems by applying standard finite element techniques

CO2: Analyze 1-D finite elements and to build the stiffness matrix

CO3: Examine 2-D finite element continuum for structural applications

CO4: Solve 1-D and 2-D heat transfer problems using finite element approach.

CO5: Apply axisymmetric formulation for specific applications.

CO6: Make use of finite element principles in iso-parametric applications

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

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

1.	Why polynomial type of interpolation functions are preferred over trigonometric functions?	CO_1	[K_3]
2.	What is constitutive law?and give consitutive law for Plane stress problems?	CO_1	[K_2]
3.	Distinguish between 1D bar element and 1D beam element.	CO_2	[K_3]
4.	Write the stiffness matrix for a one dimensional two noded linear bar element?	CO_2	[K_2]
5.	Illustrate the shape function of a CST element?	CO_3	[K_3]
6.	Show that in what way the global stiffness matrix differs from element stiffness matrix?	CO_3	[K_2]
7.	Write down the governing differential equation for a two dimensional steady state heat transfer problems?	CO_4	[K_2]
8.	Write the conduction, free end convection and thermal load matrices for 1D heat transfer through a fin	CO_4	[K_2]
9.	Give four examples of practical applications of axisymmetric applications	CO_5	[K_1]
10.	Illustrate the purpose of Isoparametric elements ?	CO_6	[K_4]

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

11. a) The following differential equation is available for a physical phenomenon   8   CO1   [K$_2$]

$$\frac{d}{dx}\left(x\frac{du}{dx}\right) - \frac{2}{x^2} = 0, \quad 1 \leq x \leq 2$$

Boundary conditions are, $x = 1$ $u = 2$

$$x = 2 \quad x\frac{du}{dx} = -\frac{1}{2}$$

find the value of the parameter "a" by using following methods
- (i) Point Collocation method
- (ii) Sub domain Collocation Method

b) What are the different types of elements? Explain the significance of each?   8   CO1   [K$_2$]

12. Consider a bar shown in Fig. An axial load of P=200 kN is applied at point 2.   16   CO2   [K$_3$]
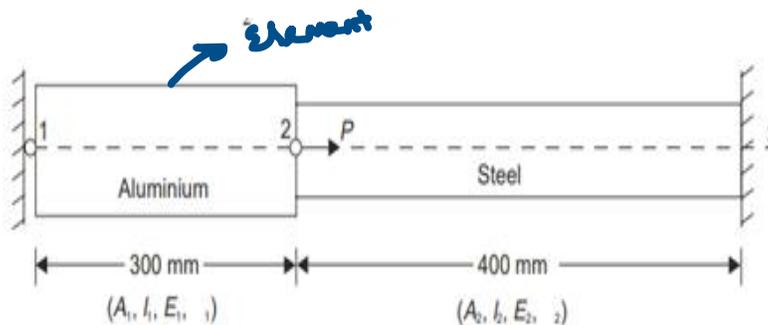Consider the following data.

$A_1 = 2400$ mm^2 $A_2 = 600$ mm^2
$E_1 = 70 \times 10^9$ N/m^2 $E_2 = 200 \times 10^9$ N/m^2

Determine the following:
- (a) Nodal displacements at node 2,
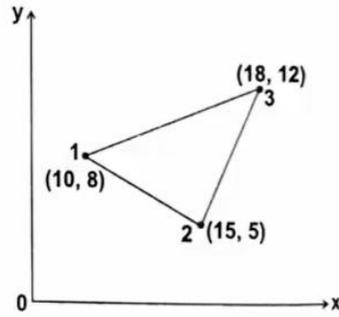- (b) Stresses in each material

13. a) Determine the elemental stresses and principal stresses for the CST element   10   CO3   [K$_3$]
shown in Fig. The nodal displacements are

u_1=0.002mm, v_1=0.001mm,

u_2=0.0005mm, v_2=0.0015 mm,

u_3=0.0012 mm ,v_3=0.0028mm.

Assume plane stress condition and unit thickness. All dimensions are in mm

b) For a thick cylinder subjected to internal and external pressure, indicate the steps of finding the radial stress.   6   CO5   [K$_3$]

14. a) A wall of 0.6m thickness having thermal conductivity of 1.2 W/mk. The wall is to be insulated with a material of thickness 0.06 m having an average thermal conductivity of 0.3 W/mk. The inner surface temperature in 1000°C and outside of the insulation is exposed to atmospheric air at 30°C with heat transfer co-efficient of 35 W/m^2 k. Calculate the nodal temperature.   10   CO4   [K$_3$]
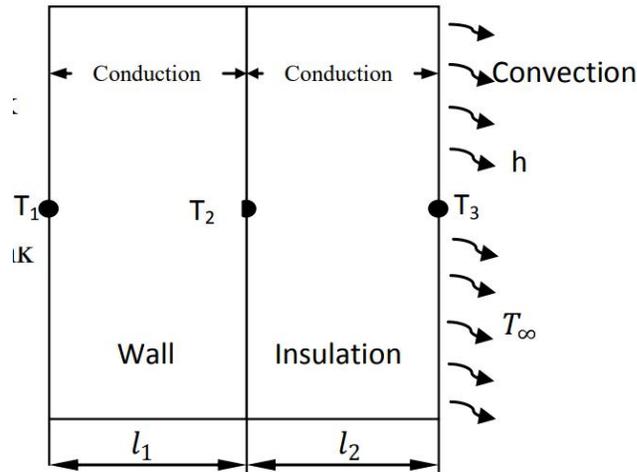

b) Derive the temperature function (T) and shape function (N) for one dimensional heat conduction.   6   CO4   [K$_2$]

15. a) The nodal coordinates for an axisymmetric triangular element shown in fig are given below.   10   CO5 [K₃]
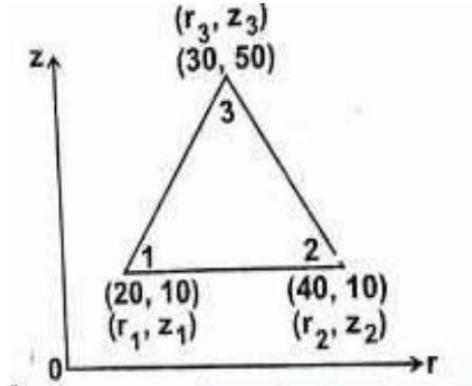
Evaluate the strain-displacement matrix for that element.

b) Distinguish with suitable examples plane stress and plane strain analysis   6   CO3 [K₂]

16. a) Evaluate the Jacobian matrix at the local coordinates $\varepsilon = \eta = 0.5$ for the linear quadrilateral element with its global coordinates as shown in figure.   10   CO6 [K₅]
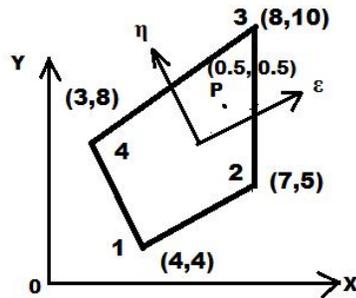
b) Using Gaussian quadrature formula, Evaluate   6   CO6 [K₃]

$$I = \int_{-1}^{+1} \left(1 + r + 2r^2 + 3r^3\right) dr$$

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