KUMARAGURU
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B.E/B.TECH DEGREE EXAMINATIONS: NOV/DEC 2023

(Regulation 2018)

Fifth Semester

AUTOMOBILE ENGINNERING

U18AUI5204 & Finite Element Analysis

COURSE OUTCOMES

CO1: Recognize the concepts of finite element method.

CO2: Formulate finite element techniques for design problems.

CO3: Devise equations in finite element analysis for 1D, 2D and 3D problems.

CO4: Analyze and solve problems in heat transfer and structural problems.

CO5: Familiarise a CAE software, to simulate engineering problems in heat transfer and structural mechanics.

CO6: Apply finite element techniques for Non-Linear Analysis.

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

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

1. Bring out the summary and the differences in Rayleigh-Ritz method and finite element method.   CO1   [K$_1$]

2. State and explain the principle of minimum potential energy.   CO1   [K$_2$]

3. Evaluate, $\frac{du}{d\xi}$ for the one-dimensional element shown in Fig.1, if q$_1$= 0.0762 mm and q$_2$=0.127 mm.   CO2   [K$_2$]

   Fig.1

4. Find the stress corresponding to element 1 for the given loading condition for the truss shown in Fig.2 (q$_3$ = -0.032 cm and q$_4$ = - 0.507 cm)   CO2   [K$_2$]
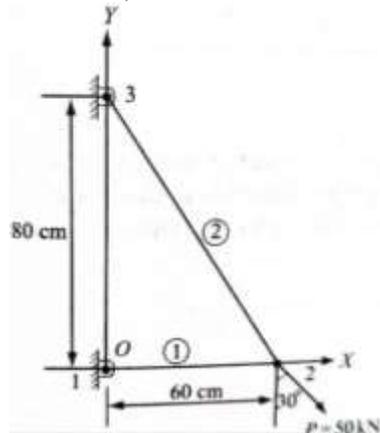
Fig.2

5.	State the necessary conditions to be satisfied in order to use axisymmetric elements		CO3	[K$_1$]
6.	Compare the characteristics of CST and LST element.		CO3	[K$_2$]
7.	Describe the boundary conditions that will be considered in steady-state one dimensional heat transfer analysis		CO4	[K$_2$]
8.	What is meant by an isoparametric element? Give an example		CO4	[K$_1$]
9.	Enumerate the difference between consistent and lumped mass matrix.		CO5	[K$_1$]
10.	What are the methods used to treat material non linear problems in FEA?		CO6	[K$_1$]

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

11.	a)	The differential equation of a physical phenomenon is given by,	8	CO1	[K$_3$]

$$\frac{d^2y}{dx^2} + 500x^2 = 0 \quad 0 \leq x \leq 1$$

Trail function, y = a$_1$ (x – x^4)

Boundary conditions are, y(0) = 0 , y(1) = 0

Calculate the value of the parameter a$_1$ by using

(i).Point collocation method

(ii).Subdomain collocation method.

	b)	Briefly explain various steps in solving a finite element problem involving structural applications.	8	CO1	[K$_2$]

| 12.	a)	The assembly shown in Fig.3 is made of solid A-36 steel cylinders whose Young's modulus is 200 GPa. If the gap between C and the rigid wall at D is initially 0.15 mm, determine the deflections at the nodal points and the element stresses when the force P = 200 kN is applied at B.	16	CO2	[K$_4$]
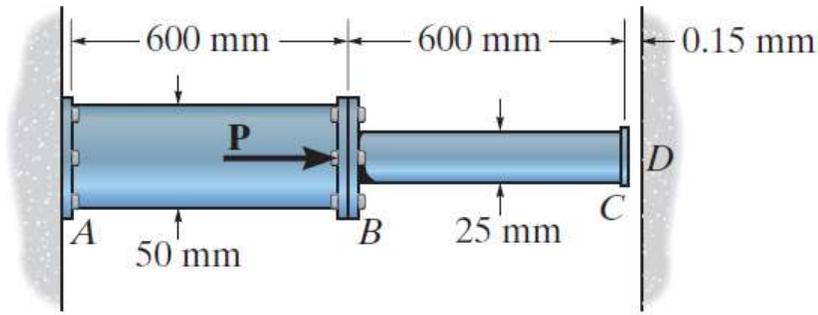
Fig.3

13. a) For the two-dimensional loaded plate shown in Fig.4, determine the nodal displacements using plane stress conditions. Body force may be neglected. Take thickness as 7 mm and Young's modulus as 200 GPa   16   CO3   [K4]
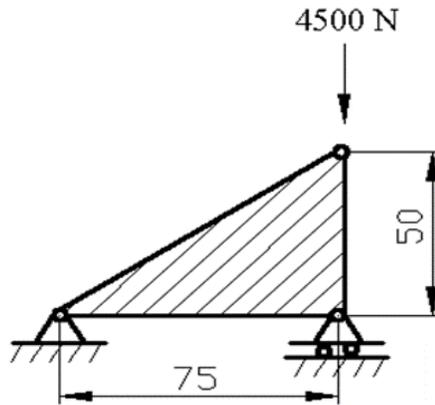
Fig.4

14. a) The fin shown in Fig.5 is insulated on the perimeter. The left end has a constant temperature of 100°C. A positive heat flux of $q = 5000$ W/m^2 acts on the right end. Let Kxx = 6 W/ (m-°C) and cross-sectional area $A = 0.1$m^2 Determine the temperatures at L/4, L/2, 3L/4, and L, where L = 0.4 m.   16   CO4   [K4]
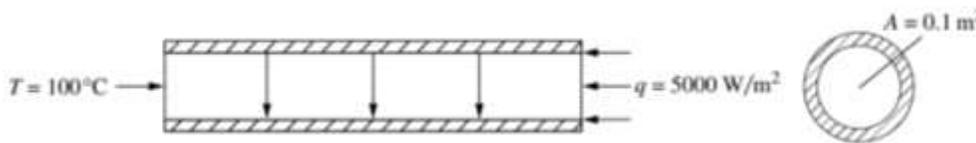
Fig.5

15. a) Derive the shape function for a noded quadrilateral element   8   CO5   [K3]

b) Using one and two Gauss-point numerical integration formulae, evaluate the following integral:

$$I=\int_3^5 \frac{1}{x}\,dx$$

Compare the results with the exact integration and trapezoidal rule.

8 CO5 [K₄]

16. a) Explain the different types of nonlinearities encountered in structural analysis.

16 CO6 [K₂]

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