Reg. No. : ☐☐☐☐☐☐☐☐☐☐☐☐

Question Paper Code : 20865

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2022.

Sixth/Seventh Semester

Automobile Engineering

ME 8692 — FINITE ELEMENT ANALYSIS

(Common to : Manufacturing Engineering / Mechanical Engineering/Mechanical Engineering (Sandwich)/Mechanical and Automation Engineering/Production Engineering)

(Regulations 2017)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the advantages and limitations of FEM?

2. Differentiate between the Ritz Technique and Galerkin Method.

3. Using Lagrangian polynomials derive the shape functions for a 1D quadratic element. Plot the variation of shape function of a quadratic element.

4. What are the properties of the Stiffness matrix?

5. With suitable examples and the governing equations distinguish between vector and scalar variable problems.

6. What are the characteristics of a shape function?

7. Derive the constitutive matrix for plain strain element.

8. Give the B (Strain displacement) matrix for a linear quadrilateral element.

9. What are the three modules of any finite element analysis package?

10. Derive the shape functions for linear isoparametric triangular element and plot the variation of the same.

11. (a) The surface temperatures of a steel wall (k = 53.6 W/m K) 0.3 m thick are maintained at 100°C and 40°C. Water at the temperature of $T_\infty = 20°C$ flows through the surface at 40°C. The convection heat transfer coefficient associated with water flow is 40 W/m²K. Calculate the intermediate temperature using Ritz method.

Or

(b) For a tapered bar as shown in figure below subjected to its own self weight, determine the deflection at the free end using any weighted residual technique. Assume E = 200 GPa and y = 77 kN/m².

1000 mm

1000 mm

100 x 100 Sq

25 x 25 Sq
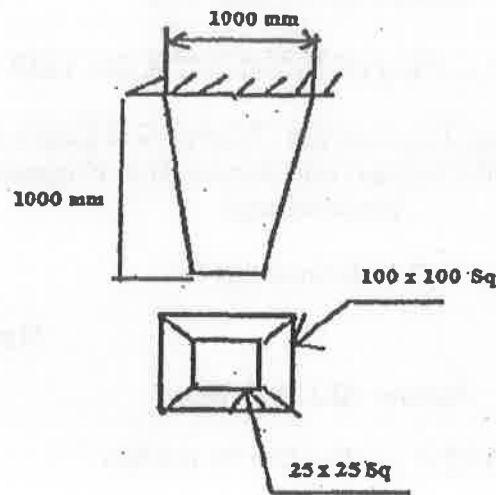
12. (a) Determine the nodal displacements, element stresses and support reactions for the stepped bar loaded as shown in Figure, below. $P_1 = 100$ kN and $P_2 = 75$ k N. The details of each section of the bar are tabulated below:

Portion	Material	E (GPa)	Area (mm²)
A	Steel	200	1200
B	Aluminium	70	800

A

B

P_2

P_1

750mm ── 650mm
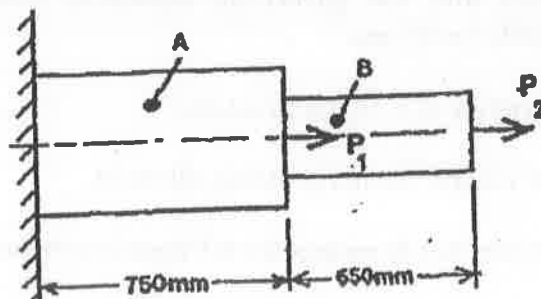
Or

(b) Determine the deflection and slope in beam, loaded as shown in figure below, at the mid-span and at the tip. Determine also the reactions at the fixed end. $E_1 = 200$ GPa. $E_2 = 85$ GPa, $I = 20 \times 10^{-6} m^4$.
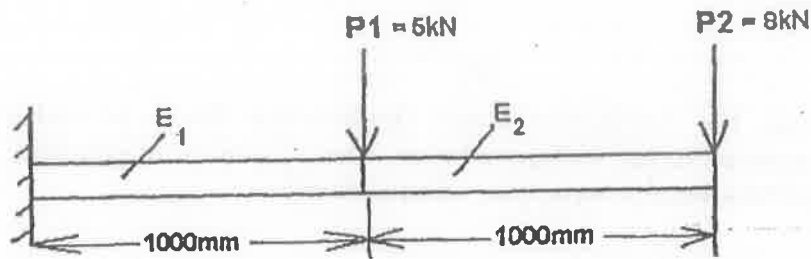
13. (a) Determine using any numerical technique, the temperature distribution along a circular fin of length 8 cm and radius 1 cm. The fin is attached to a boiler whose wall temperature is 120 °C and the free end is insulated. Assume convection coefficient h=10 W/cm² °C, Conduction coefficient K= 70 W/cm°C and $T_\infty = 40$°C. Calculate the temperatures at every 1cm from the left end.

Or

(b) Heat is transferred through a stainless steel plate 40 mm thick, one of the faces is maintained at 350°C and the other at 50°C. The thermal conductivity of the stainless steel is 19.1 W/m K at 200°C. Calculate temperature distribution along the plate. Solve using two dimensional element.

14. (a) Derive the governing equations for plane strain and plane stress. Also derive the Strain Displacement matrix for a bilinear rectangular element.

Or

(b) Derive the constitutive matrix for Plane Stress and Plane strain elements. Give atleast two practical examples for Plane Stress and Plane strain analysis.

15. (a) Explain preprocessing, processing and post processing in detail. Describe different convergence requirements in FEA.

Or

(b) Write short notes (i) Serendipity (ii) Nonlinear solution Techniques (iii) Isoparametric elements (iv) C_0, C_1 continuity elements.

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16. (a) Determine the shape function for 9 nodded quadratic rectangular elements.

Or

(b) Determine the displacement and the reaction forces at nodes in the spring system shown in figure below. Use minimum of potential energy principal to assemble equations of equilibrium.