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Question Paper Code : 70835

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Sixth Semester

Mechanical Engineering

ME 6603 – FINITE ELEMENT ANALYSIS

(Common to: Mechanical Engineering (Sandwich), Automobile Engineering, Manufacturing Engineering, Mechanical and Automation Engineering)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. What do you mean by constitutive law?
2. Why polynomial type interpolation functions are mostly used in FEM?
3. Polynomials are generally used in shape function, why?
4. Differentiate between longitudinal vibration and transverse vibration.
5. State the assumptions in the theory of pure torsion.
6. What is an LST element?
7. Write down the stress-strain relationship matrix for an axisymmetric triangular element.
8. What are the types of shell element?
9. Sketch and write the advantages of Serendipity elements.
10. What is the significance of Jacobian of transformation?

PART B — ($5 \times 13 = 65$ marks)

11. (a) Explain the steps involved in finite element formulation.

Or

(b) For the differential equation $-\frac{d}{dx}\left[(1+x)\frac{dy}{dx}\right] = 0$ for $0 < x < 1$ with the boundary conditions $y(0) = 0$ and $y(1) = 1$, obtain an approximate solution using Rayleigh-Ritz method.

12. (a) For the bar element as shown in the Fig. 12(a). Calculate the nodal displacements and elemental stresses.

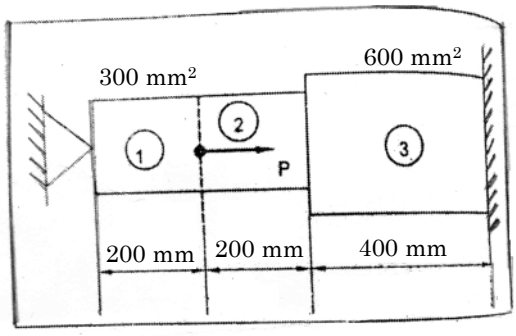

Fig. 12(a)

Or

(b) Determine the eigen values for the stepped bar shown in Fig. 12(b).

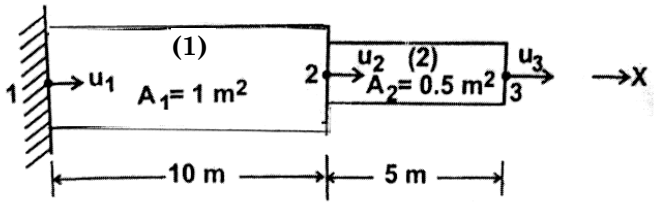

Fig. 12(b)

13. (a) Determine the stiffness matrix for the CST Element shown in Fig 13(a). The coordinates are given in mm. Assume plane strain conditions. $E = 210\ GPa, v = 0.25$ and $t = 10\ mm$. (13)

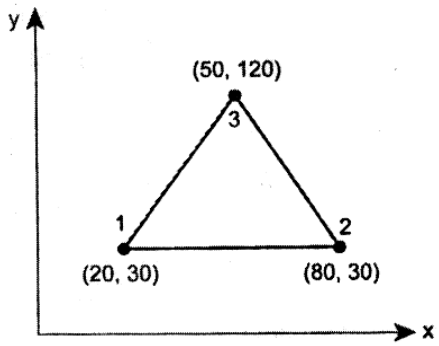

Fig 13(a)

Or

(b) Derive the expression of shape function for heat transfer in 2D element. (13)

14. (a) The nodal co-ordinates for an axisymmetric triangular element are given figure 14 (a). Evaluate strain_Displacement matrix for that element. (13)

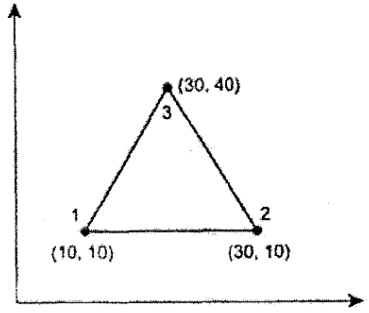

Fig 14(a)

Or

(b) Calculate the element stiffness matrix for the axisymmetric triangular element shown in Fig 14(b). The element experience a 15°C increase in temperature. The coordinates are in mm. Take $\alpha = 10 \times 10^{-6}/^{\circ}C, E = 2 \times 105\ N/mm^2, \gamma = 0.25$.

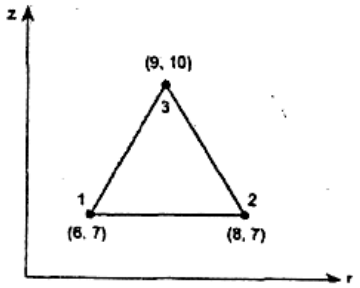

Fig 14(b)

15. (a) (i) Using Gauss Quadrature evaluate the following integral and compare with the exact value. (7)

$$I = \int_{-1}^{+1} (5\xi^3 - 4\xi^2 + 3\xi + 2) d\xi$$

(ii) Evaluate the shape functions for one corner node and one mid side node of a quadratic quadrilateral Serendipity element. (6)

Or

(b) (i) Why do we use natural coordinates? Differentiate between subparametric, isoparametric and superparametric elements. (5)

(ii) For the four noded element shown in Fig. 15(b) determine the Jacobian and evaluate its value at the point (1/3, 1/3). (8)

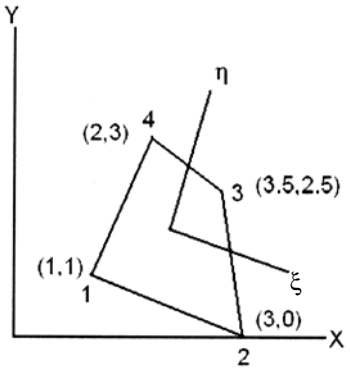

Fig. 15 (b)

PART C — (1 × 15 = 15 marks)

16. (a) For the two bar truss as shown in Fig.16(a) determine the displacement at node 2 and the stresses in both elements.

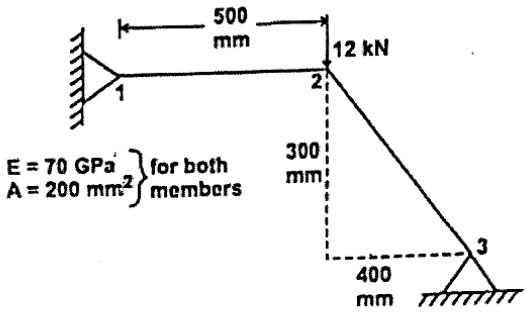

Fig. 16(a)

Or

(b) Solve the following simultaneous equation using Gaussian elimination method.

$2a + b + 2c - 3d = -2$

$2a - 2b + c - 4d = -15$

$1a + 2c - 3d = -5$

$4a + 4b - 4c + d = 4$