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Question Paper Code : 52534

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Sixth Semester

Aeronautical Engineering

AE 6601 – FINITE ELEMENT METHODS

(Regulation 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the basic requirement of finite element methods?
2. What are the h and p-versions of finite element method?
3. List out the characteristics of shape functions.
4. Write down the stiffness matrix for a beam element.
5. What is the difference between CST and LST element?
6. Write down the shape function expressing in terms of area coordinates for LST element.
7. What is the purpose of Isoparametric elements?
8. Write down shape function expressions for quadrilateral element with four nodes.
9. List down methods used for solving simultaneous algebraic equations.
10. List down finite element analysis software packages.

PART B — (5 × 13 = 65 marks)

11. (a) Using Rayleigh-Ritz method, determine the expressions for displacement and stress in a fixed bar subject to axial force P as shows in Fig.11 (a) Draw the displacement and stress variation diagram. Take 3 terms in displacement function. (13)

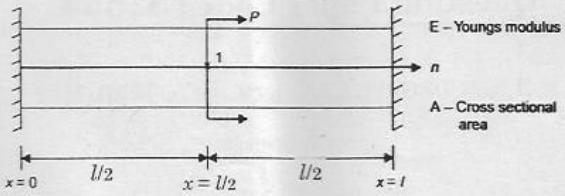


Fig. 11 (a)

Or

(b) The differential equation of a physical phenomenon is given by $\frac{d^2y}{dx^2} - 10x^2 = 5$. Obtain two terms Galerkin solution by using the trial functions : $N_1(x) = x(x-1)$; $N_2(x) = x^2(x-1)$; $0 \le x \le 1$ boundary Conditions are : $y(0) = 0$ $y(1) = 0$. (13)

12. (a) The thin plate of uniform thickness 20 mm, is as shown in Fig. 12 (a). In addition to the self weight, the plate is subjected to a point load of 400 N at mid-depth. The Young's modulus E = 2 × 10^5 N/mm² and unit weight p = 0.8 x 10^{-4} N/mm². Analyse the plate after modeling it with two elements and compute the stresses in each element. Determine the support reactions also. (13)

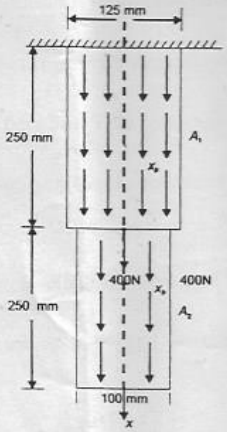


Fig. 12 (a)

Or

(b) A stepped bar ABC is subjected to an axial load of 300 kN as shown in Fig. 12 (b). It is also subjected to an increase in temperature of 40° C. The cross section area of AB, made of steel, is 900 mm² and that of BC, made of aluminum is 1200 mm². Modulus of elasticity of aluminum and steel are respectively 70 GPa and 200 GPa. Coefficients of normal expansion of aluminum and steel are respectively 23 × 10^{-6} /°C and 11.7 × 10^{-6}/° C. Determine the stresses developed in AB and BC by considering the bar ABC divided into two elements.

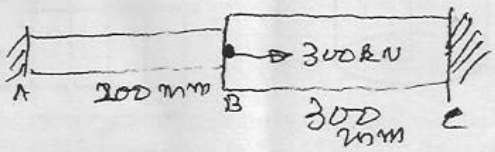
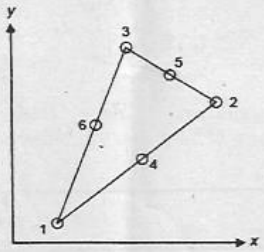


Fig. 12 (b)

13. (a) Determine the shape function for Linear Strain Triangular (LST) element and sketch the variation of N_1 and N_4. Use natural coordinate system. Fig. 13 (a) shows the typical LST element. (13)



(a) Typical LST element

Fig. 13 (a)

Or

(b) Solve the axisymmetric field problem shown in Fig. 13 (b) for the mesh shown there. Note that the problem has symmetry about any z = constant line. Determine assembled conductivity matrix and source vector. (13)

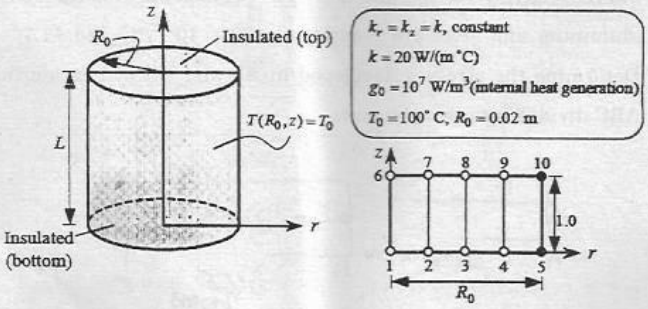


Fig. 13 (b)

14. (a) Determine Jacobian matrix and strain displacement matrix corresponding to the Gauss point (0.57735, 0.57735) for the element shown in Fig. 14 (a). (13)

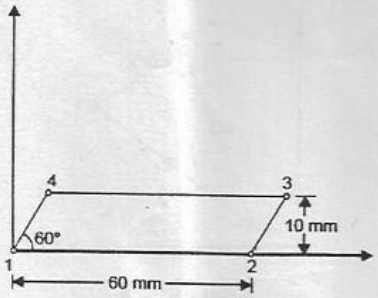


Fig. 14 (a)

Or

(b) The quadrilateral element shown in Fig. 14 (b) is 20 mm thick and is subjected to surface forces T_x and T_y. Determine expressions for its equivalent nodal forces. If $T_x = 10$ N/mm² and $T_y = 15$N/mm², determine the numerical values of the nodal forces. (13)

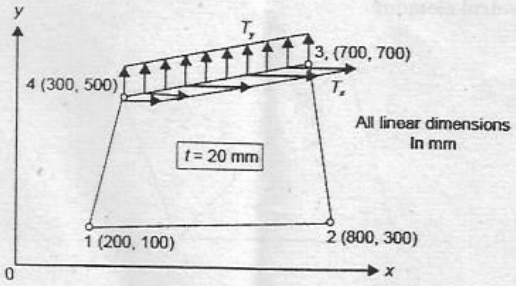


Fig. 14 (b)

15. (a) Calculate the temperature distribution in a one-dimensional fin with the physical properties given in Fig. 15 (a). The fin is rectangular in shape, and is 8 cm long, 4 cm wide, and 1 cm thick. Assume that convection heat loss occurs from the end of the fin. (13)

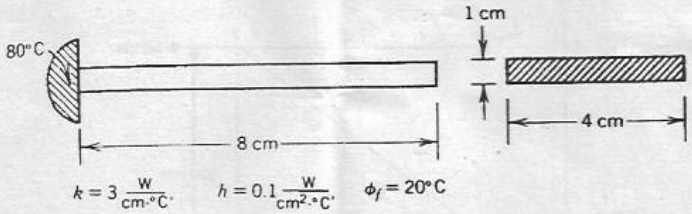


Fig. 15 (a)

Or

(b) Consider the shaft with a rectangular cross section shown in Fig. 15 (b). Determine, in terms of M and G, the angle of twist per unit length. (13)

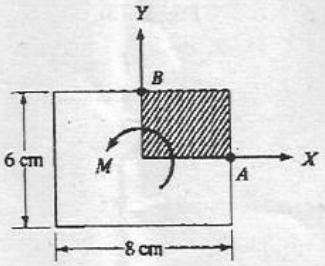


Fig. 15 (b)

PART C — (1 × 15 = 15 marks)

16. (a) Determine the shape functions for a tetrahedron element shown in Fig. 16 (a). Further, explain the method of finding shape function for a hexahedral element. (15)

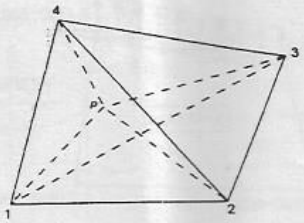


Fig. 16 (a)

Or

(b) Determine strain-displacement matrix [*B*] of two CST elements of the propped beam shown in Fig. 16 (b). Idealize the beam into two CST elements as shown in the figure. Assume plane stress condition. (15)

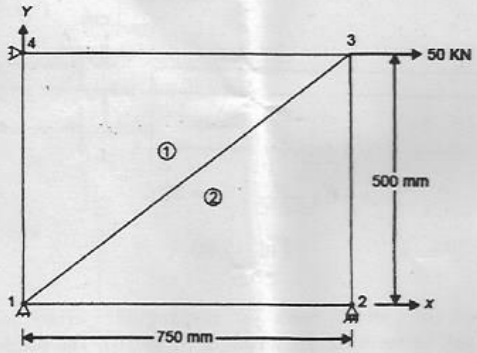


Fig. 16 (b)