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Question Paper Code : 40060

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

Sixth Semester

Aeronautical Engineering

AE 8601 – FINITE ELEMENT METHODS

(Common to Aerospace Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Express the governing differential equation along with boundary conditions for a bar under axial loading.

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2. State two differences between the finite element and the finite difference methods.

3. What would be the outcome if a bar element is used in place of a beam element while analyzing beam problems?

4. How is the size of element stiffness matrix determined for a 3D-truss element?

5. What type of 2D-analysis will be preferred to study a very long gas pipe buried under earth?

6. Draw a finite element that can be used to study axisymmetric problems, and specify its nodal degrees of freedom.

7. What are natural coordinates?

8. Give the shape functions for a quadrilateral finite element.

9. State the boundary condition in a torsion problem.

10. What are the different stages in the finite element method?

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PART B — (5 × 13 = 65 marks)

11. (a) (i) What is called 'functional' in Ritz approach? Explain how to get a required functional to solve elasticity problems. (5)

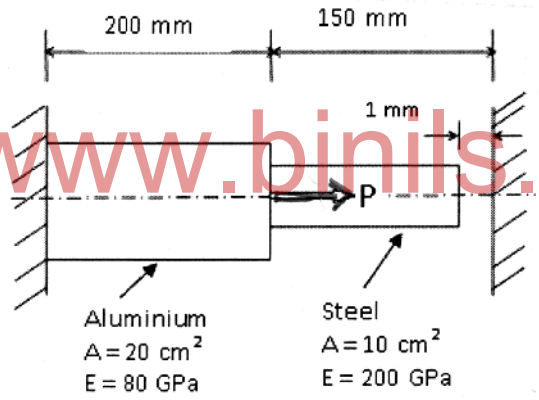
(ii) Discuss any one weighted residual method in detail to solve boundary value problems. (8)

Or

(b) (i) Briefly explain the importance of solution convergence in the finite element method. (4)

(ii) Discuss the finite difference method elaborately and its applications. (9)

12. (a) An axial load of 200 kN is applied on a bar as shown in Figure below. Using at least two linear finite elements, determine the nodal displacements and element stresses. The gap between the right end of the bar and the support is 1 mm before the application of the load. (13)



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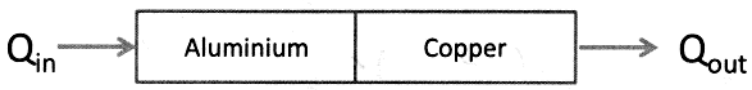
Or

(b) The circular rod shown below has an outer diameter of 60mm, length of 1m, and is perfectly insulated on its circumference. The left half of the cylinder is aluminum, for which the thermal conductivity is 200 W/m°C and the right half is copper having thermal conductivity 400 W/m°C. The extreme right end of the cylinder is maintained at a temperature of 80°C, while the left end is subjected to a heat input rate 4000 W/m². Determine the steady state temperature distribution in the cylinder. (13)



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13. (a) Derive the element stiffness matrix for a constant strain triangular finite element. (13)

Or

(b) Explain axisymmetry. How are axisymmetric problems solved using the finite element method? (13)

14. (a) (i) Brief the need of shape functions in the finite element method. (4)

(ii) Express all shape functions for a nine-node quadrilateral element, and graphically represent the shape functions for the corner four nodes. (9)

Or

(b) (i) Explain the construction of two-dimensional nodal load vectors for point loads and distributed loads. (6)

(ii) Discuss the most widely used numerical integration technique in finite element method and explain its requirements. (7)

15. (a) Discuss in detail the steps involved to solve a torsion problem using the finite element method. (13)

Or

(b) (i) Explain natural boundary conditions for a two-dimensional heat transfer problems. (5)

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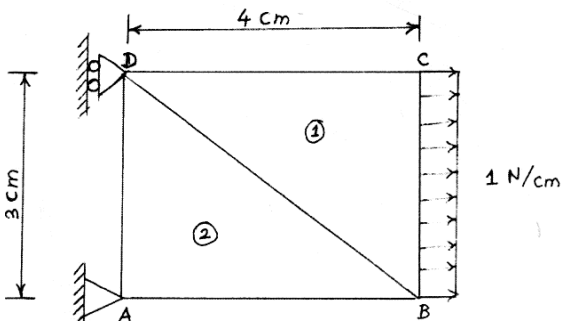
(ii) Discuss elaborately the various sources of error in the finite element method, and the ways to minimize them. (8)

PART C — (1 × 15 = 15 marks)

16. (a) Determine the deflection of a thin steel plate ABCD subjected to an external load as shown in figure below using two constant strain triangular elements.



Or

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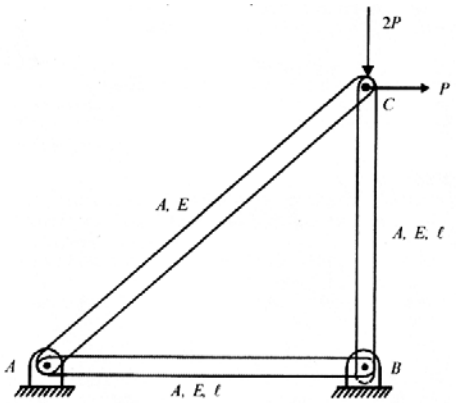
(b) The planar structure shown below is hinged at supports A and B. The elements of the truss have identical cross-sectional properties. Find out the displacement of the node C for the given loading. The notations *A, E* and l respectively represent the cross-sectional area, the elasticity modulus, and the length of the truss member. (15)



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