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Question Paper Code : 40053

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

Fourth Semester

Aeronautical Engineering

AE 8403 – AIRCRAFT STRUCTURES – I

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Give examples of practical continuous beams.

2. Write down an expression for the axial rigidity and stiffness of a planar truss member.

3. Basis for the dummy and unit load methods are (the principle of superposition Castigliano's theorems / the principle of virtual work and Maxwell's reciprocal theorem).

4. Energy methods may be used in the analysis of (determinate structures / indeterminate structures / both determinate and indeterminate structures).

5. Sketch the axial load — transverse deflection curve of a practical column for different amounts of eccentricity.

6. About which axis would a column buckle when subject to axial compression?

7. Usually ductile materials are limited by their (shear / tensile) strength while brittle materials (ductility <5%) are limited by their (shear / tensile) strength.

8. What are the characteristics of brittle fracture?

9. Which parts of an aircraft are subject to thermal loads?

10. What types of loads is an aircraft landing gear subject to?

PART B — (5 × 13 = 65 marks)

11. (a) A continuous beam ABCD is carrying a uniformly distributed load of 1 kN/m over span ABC in addition to concentrated loads as shown in Figure 1. Calculate support reactions. Also, draw the bending moment and shear force diagrams. Assume EI to be constant for all members. (13)

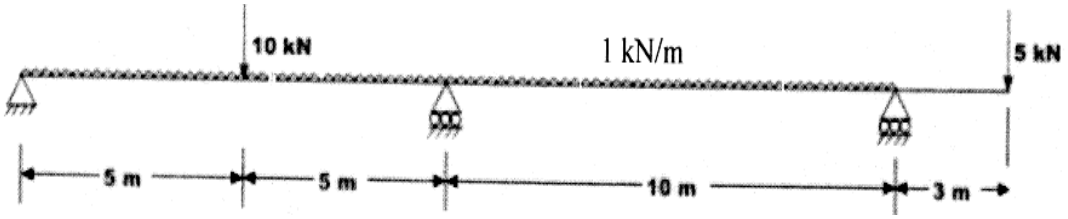


Figure 1

Or

(b) (i) Differentiate between externally indeterminate and internally indeterminate truss. (5)

(ii) What are the basic assumptions in planar truss analysis? (4)

(iii) Why do we sometimes provide redundant members in a truss? (4)

12. (a) State Castigliano's first theorem. Consider a cantilever beam AB carrying a concentrated load P and a couple of moment M_0 acting at the free end as indicated in Figure 2. We wish determine the vertical deflection and angle of rotation at the free end of the beam. Obtain required quantities using Castigliano 's theorems. (13)

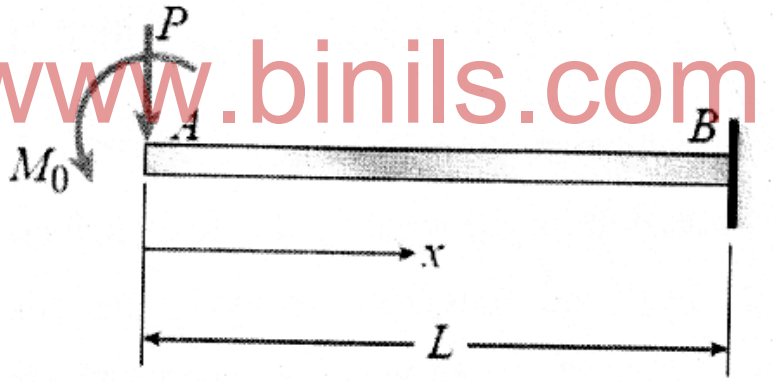


Figure 2

Or

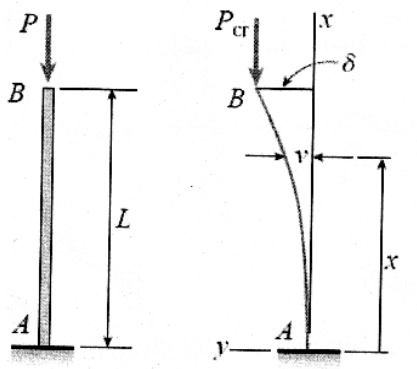
(b) A cantilever beam AR is subjected to three different loading conditions (i) concentrated load P at its free end, (ii) a couple M_0 at its free end, and (iii) both loads acting simultaneously Evaluate the strain energy in each case. Check if the principle of superposition is valid for strain energy. Comment on your answer. (13)

13. (a) (i) Sketch the first three buckled mode shapes of a pinned-pinned column and write the respective buckling load expressions. How could we practically make a axial compression which exceeds the first mode buckling load? Discuss methods which increase the buckling load of columns. (9)

(ii) How is the critical stress of a column determined? Sketch the curve of critical buckling stress versus column slenderness ratio — what is the curve called? (4)

Or

(b) Derive and obtain the governing differential equation for the deflection curve of a fixed-free column shown in Figure 3. Apply boundary conditions obtain the equation of the deflection curve for the first mode of the fixed-free buckled column. Find the buckling load and plot the Corresponding mode shape. (13)



$$P_{cr} = \frac{\pi^2 EI}{4L^2}$$

Figure 3

14. (a) (i) Explain the distortion energy failure theory (this is also called the von Mises yield criterion). (7)

(ii) Define the factor of safety in aircraft design. Why is the safety factor required? (6)

Or

(b) (i) Explain the determination of yield stress for a ductile material. Differentiate between fracture and yielding. (6)

(ii) Write notes on the maximum shear stress failure criterion. Show Mohr's circle construction for yielding in uniaxial tension. Why are failure theories required? (7)

15. (a) (i) Differentiate between static loads and dynamics loads and give examples. (4)

(ii) Briefly discuss temperature effect on material behavior. When the entire structure shown in Figure 4 is subject to thermal heating, will there be induced stress — explain your answer. (9)

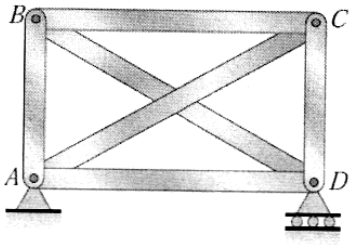


Figure 4

Or

(b) (i) A prismatic bar AB of length L is held between immovable supports. If the temperature of the bar is raised uniformly by an amount delta T, obtain an expression for thermal stress is developed in the bar. (Assume that the bar is made of linearly elastic material) (6)

(ii) Write notes on the fatigue failure of materials. What is a S-N curve? (7)

PART C — (1 × 15 = 15 marks)

16. (a) Determine the support reactions of the fixed beam with one end fixed and other supported on a spring as shown in Figure 5. The stiffness of spring is EI/L^3. Find the spring deflection and neatly draw the bending moment diagram. (15)

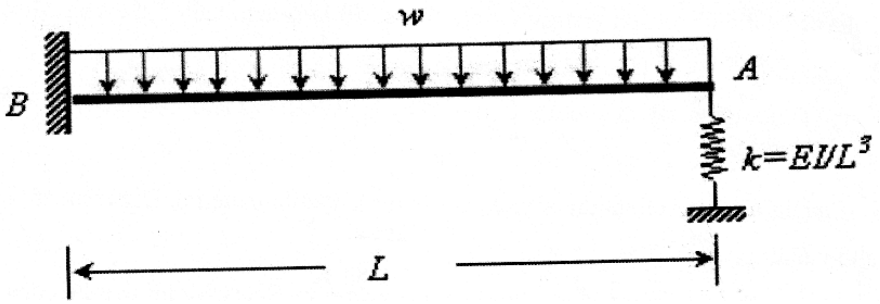


Figure. 5

Or

(b) A round, prismatic steel bar (E = 210 GPa) of length L = 2.0 m and diameter d = 15mm hangs vertically from a support at its upper end as shown in Figure 6. A sliding collar of mass M = 20 kg drops from a height h= 150 mm onto the flange at the lower end of the bar without rebounding. (i) Calculate the maximum elongation of the bar due to the impact and determine the corresponding impact factor. (ii) Calculate the maximum tensile stress in the bar and determine the corresponding impact factor. (15)

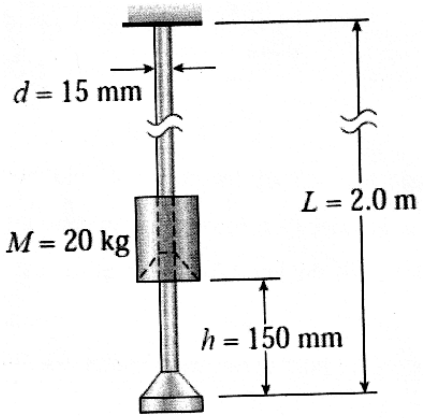


Figure. 6