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Question Paper Code : 40056

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

Fifth Semester

Aeronautical Engineering

AE 8502 — AIRCRAFT STRUCTURES — II

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the primary assumption made in the determination of director normal stress distribution produced by pure bending of beams.
2. Is beam curvature due to bending directly proportional/inversely proportional to the applied bending moment and directly proportional/inversely proportional to the product *EI* known as the *flexural rigidity* of the beam?

3. Relate bending moment and shear flow.
4. For a thin-walled angle section, where will the shear center lie?
5. Explain structural idealization with a neat sketch.
6. Calculate the twist of a thin-walled circular tube of mean radius 12 cm and wall thickness 2 mm subject to a pure torque of 640 Nm. Use G = 35 GPa.
7. What does the buckling mode of a thin plate depend upon?
8. A thin plate in compression is indicated in Figure 1 below. Express the deflected form of the plate using double trigonometric series where the displacement in the z-direction is *w*.

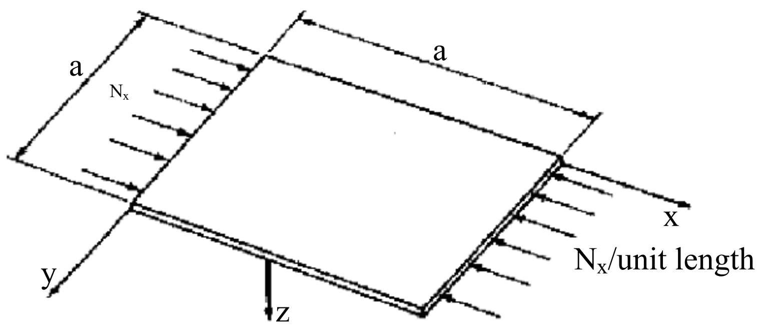

Figure – 1

9. Define proof load and ultimate load in aircraft design.

10. List a few materials used in the construction of modern aircraft.

PART B — (5 × 13 = 65 marks)

11. (a) (i) The cross-section of a beam has the dimensions shown in Figure 2. If the beam is subject to a negative bending moment of 100 kNm applied in a vertical plane, determine the distribution of direct stress through the depth of the section. (5)

(ii) Now determine the distribution of direct stress in the beam cross-section if the same bending moment 100 kNm is applied in a horizontal plane. (5)

(iii) Define unsymmetrical bending. If the bending moments in part (i) and (ii) are applied simultaneously, will the resulting bending be symmetric or unsymmetric - explain your answer. (3)

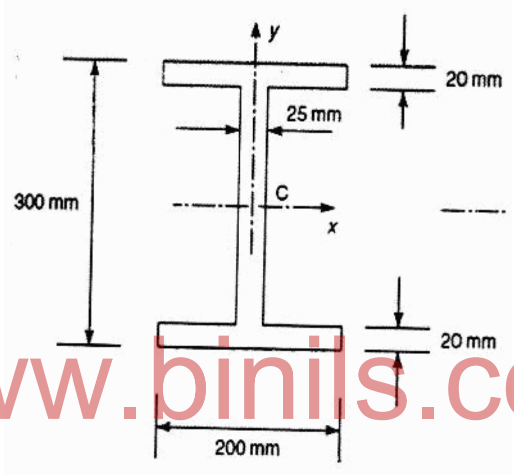

Figure – 2

Or

(b) The webs of the cross-section given in Figure 3 are ineffective in bending. Boom areas are as follows : A = 3 cm², B = C = 2.5 cm², and C = 2 cm², Bending moments are $M_x = 10\,kNm$ and $M_y = 4\,kNm$. Obtain an expression for the bending stress in the form $\sigma = Ay - Bx$. Find the neutral axis orientation with respect to the x-axis. Determine the normal stress in booms A and C in MPa, and state if the stress is tensile or compressive.

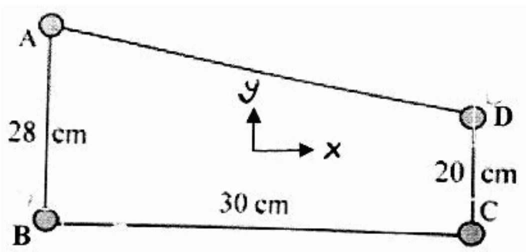

Figure – 3

12. (a) (i) Calculate the shear flow distribution in the channel section shown in Figure 4 produced by a vertical shear load of 4.8 kN acting through its shear centre. Assume that the walls of the section are effective in resisting shear stresses only while the booms, each of area 300 mm^2, carry all the direct stresses. Plot the shear flow diagram. (7)

(ii) Find the shear flow distribution in the channel section shown in Figure 4 using the delta $P(\Delta P)$ method. The same loads, cross-section dimensions, and assumptions, apply. (6)

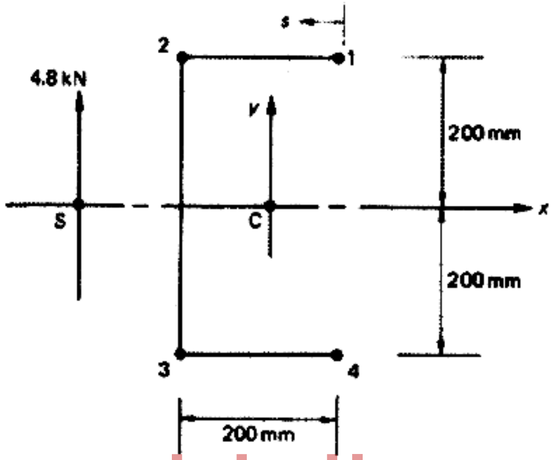

Figure – 4

Or

(b) The centroid location of the thin-walled angle section given in Figure 5 is (11.274mm, 5.2 mm) from corner 2. The section is subject to vertical shear of 300 N. Determine expressions for the resulting shear flow. Plot the shear flow pattern. Wall thickness is uniform and equal to 1.25 mm.

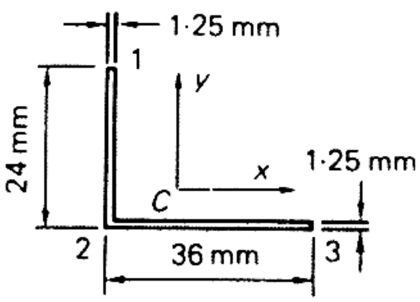

Figure – 5

13. (a) (i) Explain the procedure using which the shear center position of an unsymmetrical multi-flange box beam section can be determined. Assume that the webs are ineffective in bending. (6)

(ii) The closed section indicated in Figure 6 is subject to a 900 N vertical shearing load through the shear centre. Plot the resulting shear flow and determine the shear center position. Assume that the webs of the given section are ineffective in bending $A = B = 2\,cm^2$. (7)

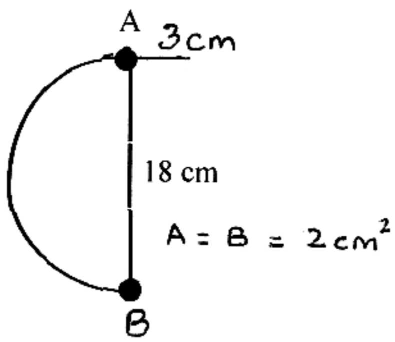

Figure – 6

Or

(b) Refer Figure 7. The section is subject to vertical shear S_y applied through the shear centre. Make the initial cut in the curved web. Find and plot the open section shear flow in terms of S_y. Next close the cut and find the constant shear flow to be added, q_0 Neatly plot the final shear flow in terms of S_y. Find the shear centre distance e. Flange areas 2,3 = 550 mm² while flange areas 1,4 = 450 mm². The webs of the given section are assumed to be *ineffective* in bending.

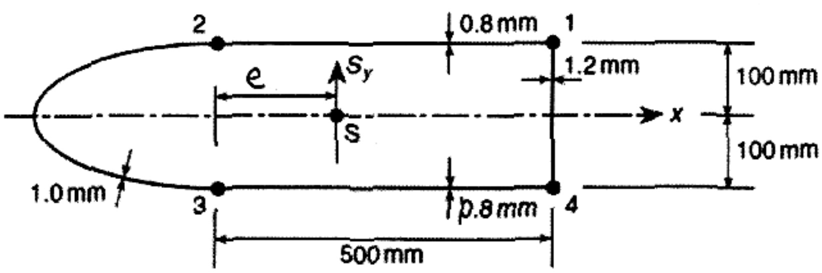

Figure – 7

14. (a) (i) Briefly differentiate between primary buckling and local buckling. (3)

(ii) Where are thin-walled columns encountered in aircraft structures? Write short notes on the local failure of such thin-walled columns. (5)

(iii) Write down the formula of thin plate buckling and explain it. Discuss methods of increasing the compressive load carrying ability of thin plates. (5)

Or

(b) (i) Consider a plate subject to compression along the x-direction. Write down the expression for the critical buckling load and state the principle that was used for its determination. (4)

(ii) Explain how the plate buckling coefficient is defined and obtained. Sketch curves of the plate buckling coefficient versus plate aspect ratio. (9)

15. (a) Explain the construction and significance of the aircraft flight envelope or V-n diagram. State typical load factor limits for different aircraft types.

Or

(b) (i) What are the types of loads that an aircraft is subject to - classify and explain the these loads. Sketch and indicate how these loads act on an aircraft. (7)

(ii) Sketch a typical spanwise lift distribution for a wing-fuselage combination. How are shear force and bending moment diagrams constructed for an aircraft wing? (6)

PART C — (1 × 15 = 15 marks)

16. (a) The webs of the section given in Figure 8 are ineffective in bending. A, B, C and D = 1.6 cm^2. The given section is subject to $V_x = 1\,kN$. Plot the shear flow due to $V_x = 1\,kN$. Find the line of action of V_x such that the section does not twist. (15)

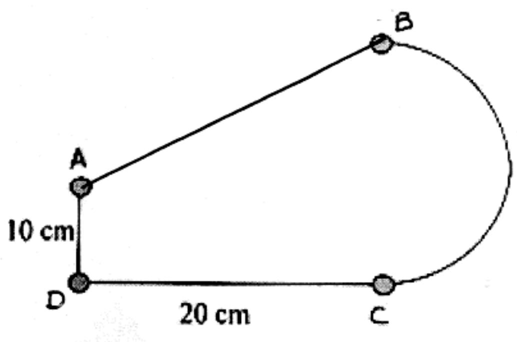

Figure – 8

Or

(b) A beam cross-section as indicated in Figure 9 is subject to a positive bending moment of 1800 Nm. Calculate the bending stress in corner point A and B. (15)

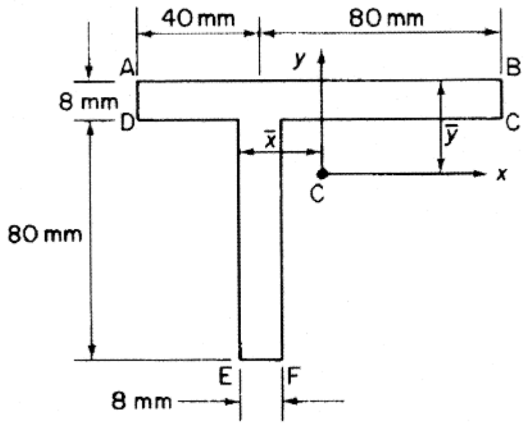

Figure – 9