Hall Ticket No | | | | | | | | | | | Question Paper Code: AAE006

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

B.Tech IV Semester End Examinations (Supplementary) - July, 2018

Regulation: IARE – R16

ANALYSIS OF AIRCRAFT STRUCTURES

Time: 3 Hours **(AE)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Explain what are different loads acting on aircraft structural components with figures. **[7M]**

   (b) A cylindrical pressure vessel has an internal diameter of 2m and is fabricated from plates 20mm thick. If the pressure inside the vessel is 1.5 N/mm^2 and, in addition, the vessel is subjected to an axial tensile load of 2500 kN, calculate the direct and shear stresses on a plane inclined at an angle of 60^0 to the axis of the vessel. Calculate also the maximum shear stress. **[7M]**

2. (a) Determine the deflection of the mid-span point of the linearly elastic, simply supported beam the flexural rigidity of the beam is EI shown in Figure 1 below, By using total potential energy method **[7M]**

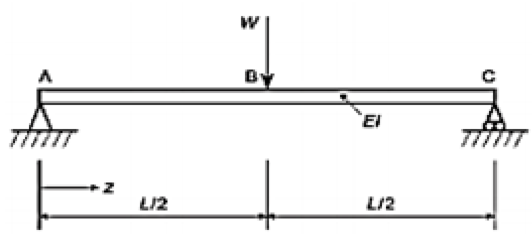

Figure 1

   (b) A cantilever beam of solid, circular cross-section supports a compressive load of 50 kN applied to its free end at a point 1.5mm below a horizontal diameter in the vertical plane of symmetry together with a torque of 1200Nm as shown in Figure 2. Calculate the direct and shear stresses on a plane inclined at 60^0 to the axis of the cantilever at a point on the lower edge of the vertical plane of symmetry. **[7M]**

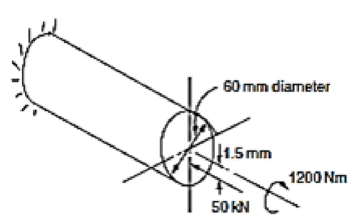

Figure 2

UNIT – II

3. (a) Explain pure bending of thin plates with derivations. **[7M]**

   (b) Direct stresses of 160 N/mm^2 (tension) and 120N/mm^2 (compression) are applied at a particular point in an elastic material on two mutually perpendicular planes. The principal stress in the material is limited to 200N/mm^2 (tension). Calculate the allowable value of shear stress at the point on the given planes. Determine also the value of the other principal stress and the maximum value of shear stress at the point. Verify your answer using Mohr's circle. **[7M]**

4. (a) A bar of solid circular cross-section has a diameter of 50mm and carries a torque T, together with an axial tensile load, P. A rectangular strain gauge rosette attached to the surface of the bar gave the following strain readings: $\varepsilon_a = 1000 \times 10^{-6}$, $\varepsilon_b = 200 \times 10^{-6}$ and $\varepsilon_c = 300 \times 10^{-6}$ where the gauges 'a' and 'c' are in line with, and perpendicular to, the axis of the bar, respectively. If Young's modulus, E, for the bar is 70000N/mm^2 and Poisson's ratio vd is 0.3, calculate the values of T and P **[7M]**

   (b) A thin rectangular plate a×b is simply supported along its edges and carries a uniformly distributed load of intensity q_0. Determine the deflected form of the plate and the distribution of bending moment. **[7M]**

UNIT – III

5. (a) Derive the direct stress distribution due to bending. **[7M]**

   (b) The cross-section of a beam has the dimensions shown in Figure 3. If the beam is subjected 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. **[7M]**

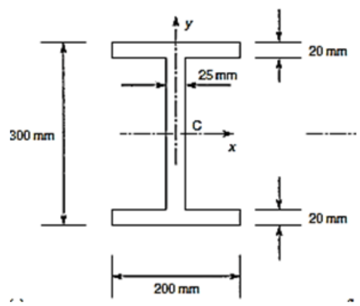

Figure 3

6. (a) Explain Parallel axis theorem. **[7M]**

   (b) A beam having the cross-section shown in Figure 4. is subjected to a bending moment of 1500Nm in a vertical plane. Calculate the maximum direct stress due to bending stating the point at which it acts. **[7M]**

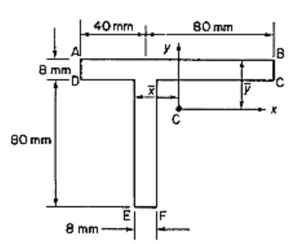

Figure 4

UNIT – IV

7. (a) Part of a wing section is in the form of the two-cell box shown in Figure 5 below in which the vertical spars are connected to the wing skin through angle sections all having a cross sectional area of $300mm^2$. Idealize the section into an arrangement of direct stress carrying booms and shear stress only carrying panels suitable for resisting bending moments in a vertical plane. Position the booms at the spar/skin junctions. **[7M]**

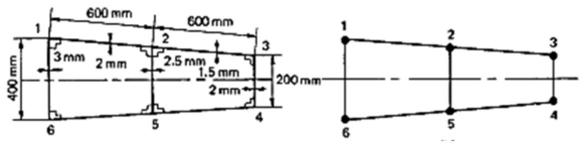

Figure 5

(b) Calculate the deflection of the free end of a cantilever 2000mm long having a channel section identical and supporting a vertical, upward load of 4.8 kN acting through the shear centre of the section. The effective direct stress carrying thickness of the skin is zero while its actual thickness is 1 mm. Young's modulus E and the shear modulus G are 70 000 and $30000N/mm^2$, respectively.

[7M]

8. (a) The thin-walled single cell beam shown in Figure 6 has been idealized into a combination of direct stress carrying booms and shear stress only carrying walls. If the section supports a vertical shear load of 10 kN acting in a vertical plane through booms 3 and 6, calculate the distribution of shear flow around the section **[7M]**

Boom Area's
$B_1 = B_8 = 200mm^2$
$B_2 = B_7 = 250mm^2$
$B_3 = B_6 = 400mm^2$
$B_4 = B_5 = 100mm^2$

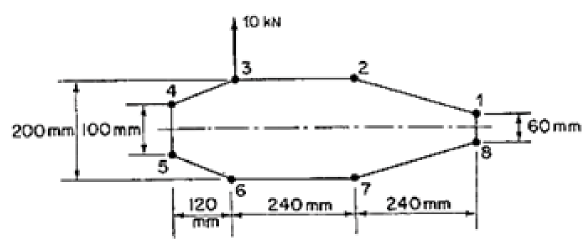

Figure 6

(b) Calculate the shear flow distribution in the channel section shown in Figure 7 produced by a vertical shear load of 4.8 kN acting through its shear center. Assume that the walls of the section are only effective in resisting shear stresses while the booms, each of area $300mm^2$, carry all the direct stresses. **[7M]**

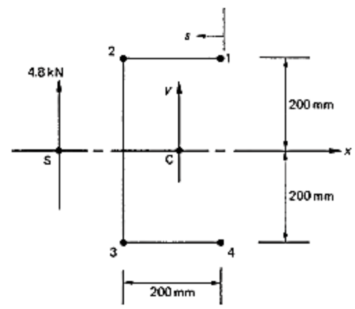

Figure 7

UNIT – V

9. (a) The fuselage of a light passenger carrying aircraft has the circular cross-section shown in Figure 8. The cross-sectional area of each stringer is $100mm^2$ and the vertical distances are to the mid-line of the section wall at the corresponding stringer position. The distance between two Boom's is 149.6mm. If the fuselage is subjected to a bending moment of 200 kNm applied in the vertical plane of symmetry, at this section, calculate the direct stress distribution. **[7M]**

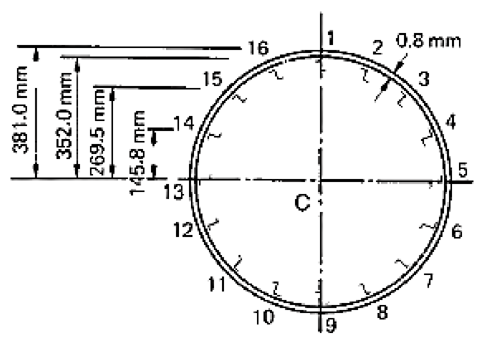

Figure 8

(b) The wing section shown in Figure 9 has been idealized such that the booms carry all the direct stresses. If the wing section is subjected to a bending moment of 300 kNm applied in a vertical plane, calculate the direct stresses in the booms. **[7M]**

Boom Area's

$B_1 = B_6 = 2580mm^2$

$B_2 = B_5 = 3880mm^2$

$B_3 = B_4 = 3230mm^2$

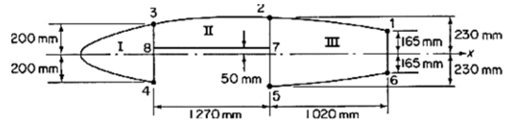

Figure 9

10. (a) A two-cell beam has singly symmetrical cross-sections 1.2m apart and tapers symmetrically in the y direction about a longitudinal axis as shown in Figure 10. The beam supports loads which produce a shear force S_y =10 kN and a bending moment Mx=1.65 kNm at the larger cross-section; the shear load is applied in the plane of the internal spar web. If booms 1 and 6 lie in a plane which is parallel to the yz plane calculate the forces in the booms and the shear flow distribution in the walls at the larger cross-section. The booms are assumed to resist all the direct stresses while the walls are effective only in shear. The shear modulus is constant throughout; the vertical webs are all 1.0mm thick while the remaining walls are all 0.8mm thick **[7M]**

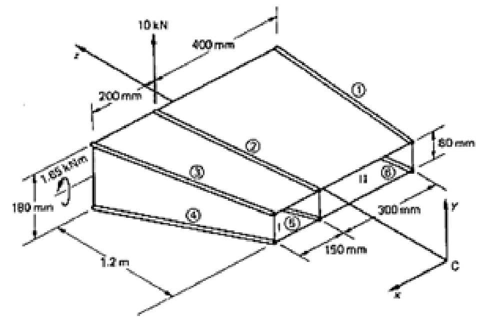

Figure 10

(b) Calculate the deflection at the free end of the two-cell beam shown in Figure 11 allowing for both bending and shear effects. The booms carry all the direct stresses while the skin panels, of constant thickness throughout, are effective only in shear. E= 69,000N/mm^2, G= 25,900N/mm^2. Boom's $B_1 = B_3 = B_4 = B_6 = 650mm^2$. $B_2 = B_5 = 1300mm^2$. **[7M]**

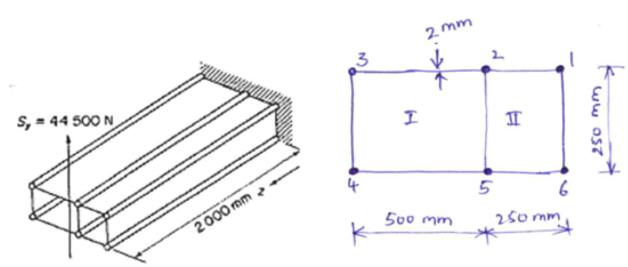

Figure 11

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