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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

B.Tech IV Semester End Examinations (Regular) - May, 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) What are Aircraft inertia loads and explain the basic function of structural components? **[7M]**
   (b) Calculate the vertical displacements at one fourth and mid-span of the simply supported beam of length L, having udl throughout the beam and flexural rigidity EI by using Energy Method. **[7M]**
2. (a) Explain the different loads acting on aircraft structural components with neat sketches. **[7M]**
   (b) The aircraft for which the stalling speed V_s in level flight is 46.5 m/s has a maximum allowable maneuver load factor n1of 4.0. In assessing gyroscopic effects on the engine mounting the following two cases are to be considered:
      i. Pull-out at maximum permissible rate from a dive in symmetric flight, the angle of the flight path to the horizontal being limited to 600 for this aircraft.
      ii. Steady, correctly banked turn at the maximum permissible rate in horizontal flight. Find the corresponding maximum angular velocities in yaw and pitch. **[7M]**

UNIT – II

3. (a) Explain pure bending of thin plates with derivations **[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]**
4. (a) Derive the equation for plates subjected to bending and twisting. **[7M]**
   (b) Derive the equation to find out the critical stresses due to buckling of thin plates. **[7M]**

UNIT – III

5. (a) Determine the deflection curve and the deflection of the free end of the cantilever shown in Figure 1, the flexural rigidity of the cantilever is EI and its section is doubly symmetrical. **[7M]**

Figure 1

   (b) Explain displacements associated with the Bredt-batho shear flow. **[7M]**

6. (a) Derive the direct stress distribution of beam having arbitrary cross section due to bending. **[7M]**

   (b) Explain and drive the equation for torsion of open section beams. **[7M]**

UNIT – IV

7. (a) Part of a wing section is in the form of the two-cell box shown in Figure 2 a 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]**

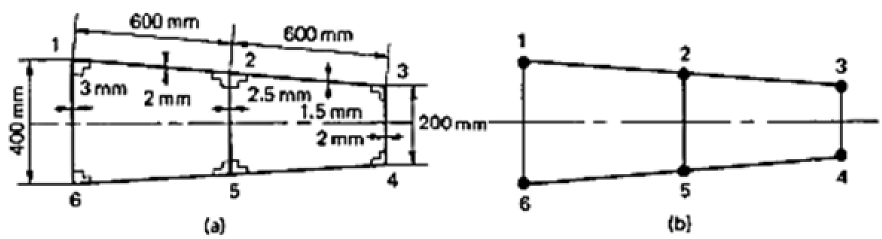

Figure 2

   (b) Calculate the deflection of the free end of a cantilever 2000mm long having a channel section identical and supporting a vertical, upward load of4.8 kN acting through the shear center 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 3. 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 $B_1 = B_8 = 200mm^2, B_2 = B_7 = 250mm^2, B_3 = B_6 = 400mm^2, B_4 = B_5 = 100mm^2$ **[7M]**

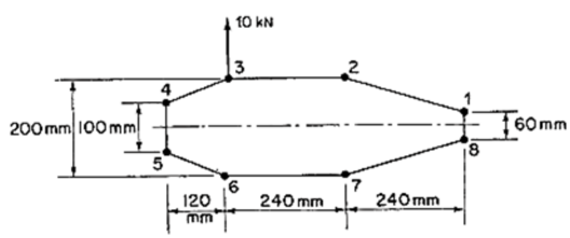

Figure 3

   (b) 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 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]**

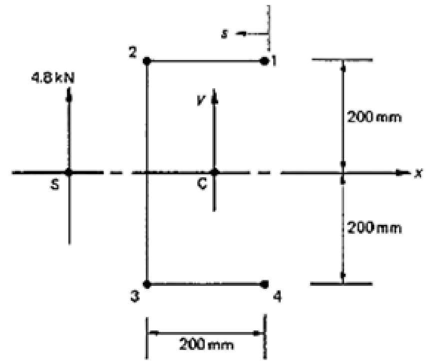

Figure 4

UNIT – V

9. (a) The doubly symmetrical fuselage section shown in Figure 5 has been idealized into an arrangement of direct stress carrying booms and shear stress carrying skin panels; the boom areas are all $150mm^2$. Calculate the direct stresses in the booms and the shear flows in the panels when the section is subjected to a shear load of 50 KN and a bending moment of 100 kN m **[7M]**

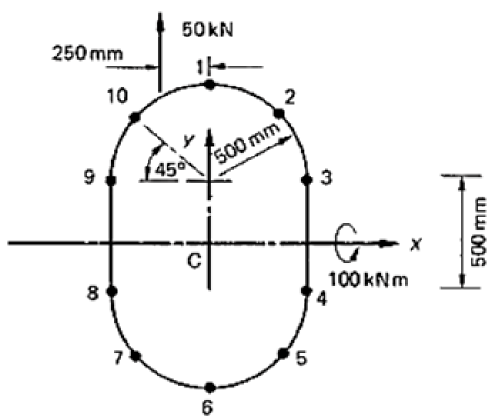

Figure 5

(b) The wing section shown in Figure 6 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. $B_1 = B_6 = 2580mm^2, B_2 = B_5 = 3880mm^2, B_3 = B_4 = 3230mm^2$. **[7M]**

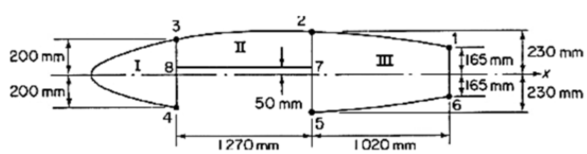

Figure 6

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 shown in Figure 7. The beam supports loads which produce a shear force S_y =10 kN and a bending moment M_x =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 through out, the vertical webs are all 1.0mm thick while the remaining walls are all 0.8mm thick **[7M]**

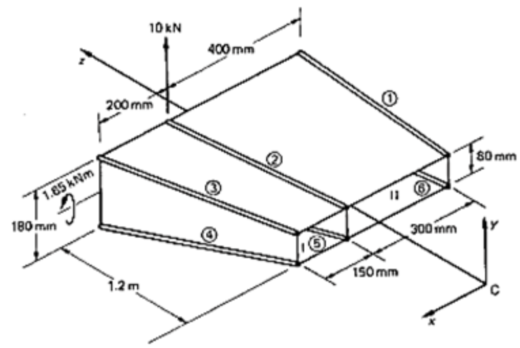

Figure 7

(b) Calculate the deflection at the free end of the two-cell beam showing Figure 8 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. **[7M]**

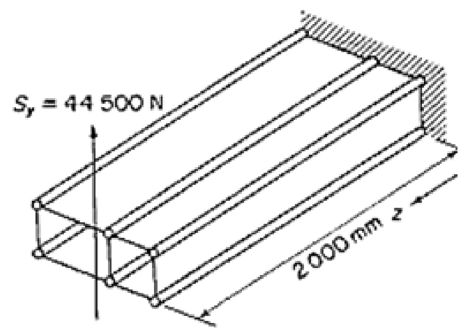

Figure 8

— ○ ○ ◯ ○ ○ —