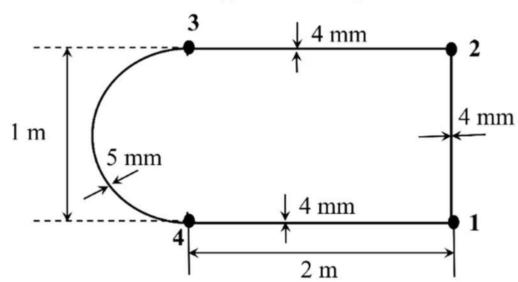
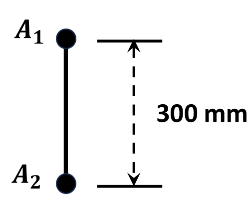
Name: Enrolment No:	

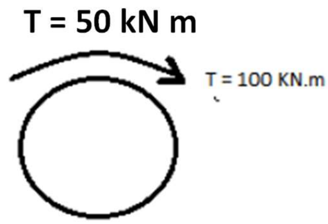
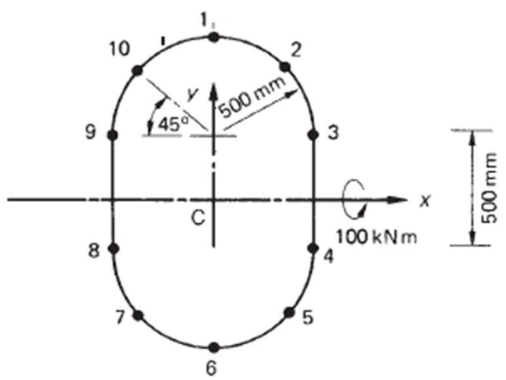
UPES
End Semester Examination, May 2025

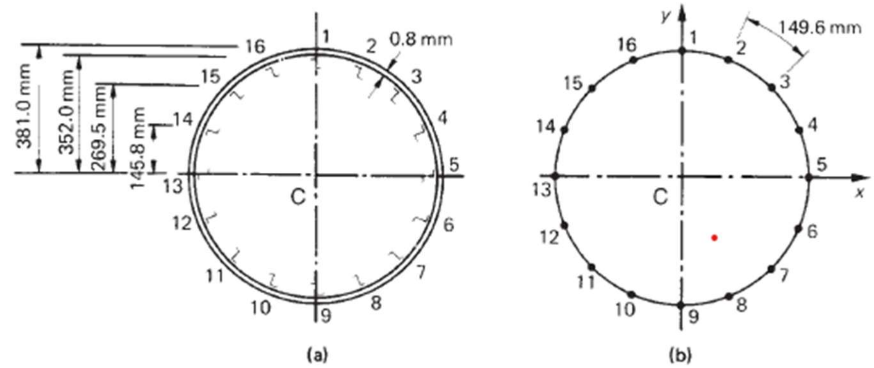
Course: Aircraft Structure II — **Semester: VI**
Program: Aerospace Engineering — **Time: 03 hrs.**
Course Code: ASEG 3021 — **Max. Marks: 100**

Instructions: Attempts all questions. Take the appropriate coordinate system whenever required.

SECTION A
(5Qx4M=20Marks)

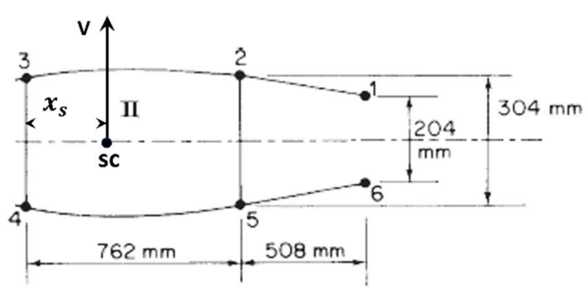
S. No.		Marks	CO
Q 1	Explain the boom analogy for idealization of aircraft structures.	4	CO1
Q 2	Derive the moment formula for curved web with constant shear flow.	4	CO1
Q 3	Determine the twist rate of shown closed thin cross-section in figure which is subjected to twisting moment of 10 kN-m. Take $G = 60$ GPa and boom area $B_1 = B_2 = B_3 = B_4 = 200\ \text{mm}^2$. Assume there is constant shear flow over the complete skin panel.  	4	CO2
Q 4	Determine the maximum bending stress carried by the idealized section subjected to positive bending moment of 80 kN.m about the centroid of section. Take A1 = A2 = 50 mm^2.  	4	CO1
Q 5	A thin circular beam cross-section of radius = 10 cm and thickness = 1 mm is subjected to torque T = 50 kN m, the value of maximum shear stress is?	4	CO2

			
SECTION B **(4Qx10M= 40 Marks)**			
Q 6	The doubly symmetrical fuselage section shown in the figure below has been idealized into an arrangement of direct stress carrying booms and shear stress carrying skin panels; the boom areas are all 150 mm^2. Determine the direct stresses in the booms when the section is subjected to a bending moment of 100 kN m. 	**10**	**CO4**
Q 7	The fuselage of a light passenger carrying aircraft has the circular cross-section shown in figure (a). The cross-sectional area of each stringer is 100 mm^2 and the vertical distances given in figure (a) are to the mid-line of the section wall at the corresponding stringer position. The idealised section of fuselage is shown in figure (b) with equally spaced booms over the surface of fuselage. If the fuselage is subjected to a vertical shear load of 100 kN applied at a distance of 150 mm in right side from the vertical axis of symmetry for the idealised section, determine the distribution of shear flow in the fuselage section. *Note: Draw the shear distribution over fuselage section.*	**10**	**CO4**

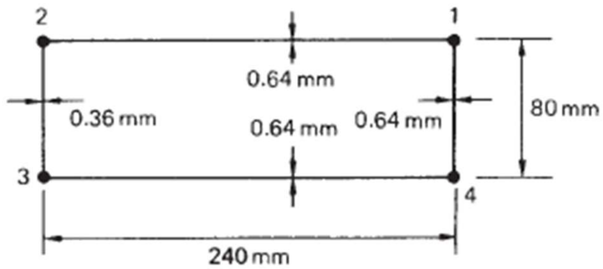


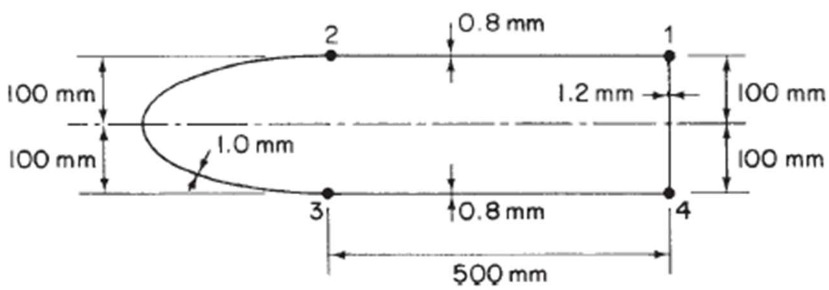
Q 8 — The wing section shown in the figure below has been idealized such that the booms carry all the direct stress and walls are effective only in shear. Determine the location of the shear center $\boldsymbol{x_s}$ from web 34. *(Hint: Take the vertical shear load* V *passing through the shear center* sc.*)* — **10** — **CO3**

Wall	Length (mm)	Thickness (mm)	Boom Area (mm^2)	G (N/mm^2)	Cell Area (mm^2)
12, 56	510	0.56	$B_1 = B_6 = 645$	27600	$A_{II} = 258000$
23, 45	765	0.92	$B_2 = B_5 = 1290$	27600	
34	304	2.03	$B_3 = B_4 = 1935$	27600	
25	304	1.63		27600	



Q 9 — Determine the position of the shear centre of the rectangular four boom beam section shown in figure. The booms carry only direct stresses, but — **10** — **CO3**

<table>
<tr><td></td><td>the skin is fully effective in carrying both shear and direct stress. The area of each boom is 100 mm^2.


Or,
Figure shows the cross-section of a single cell, thin-walled beam with a horizontal axis of symmetry. The direct stresses are carried by the booms B_1 to B_4, while the walls are effective only in carrying shear stresses. Assuming that the basic theory of bending is applicable, determine the position of the shear centre SC. The shear modulus G is the same for all walls. Take $B_1 = B_4 = 450$ mm^2, $B_2 = B_3 = 550$ mm^2, Cell area = 135000 mm^2.

</td><td></td><td></td></tr>
<tr><td colspan="4">SECTION-C
(2Qx20M=40 Marks)</td></tr>
<tr><td>Q 10</td><td>Determine the shear flow distribution and the forces in booms in a tapered cantilever beam carries a load of 40 kN at its free end as shown in figure below at a section 1.5 m from the built-in end. Assume that the skin and web panels are effective in resisting shear stress only, the beam tapers symmetrically in a vertical direction about its longitudinal axis.</td><td>20</td><td>CO3</td></tr>
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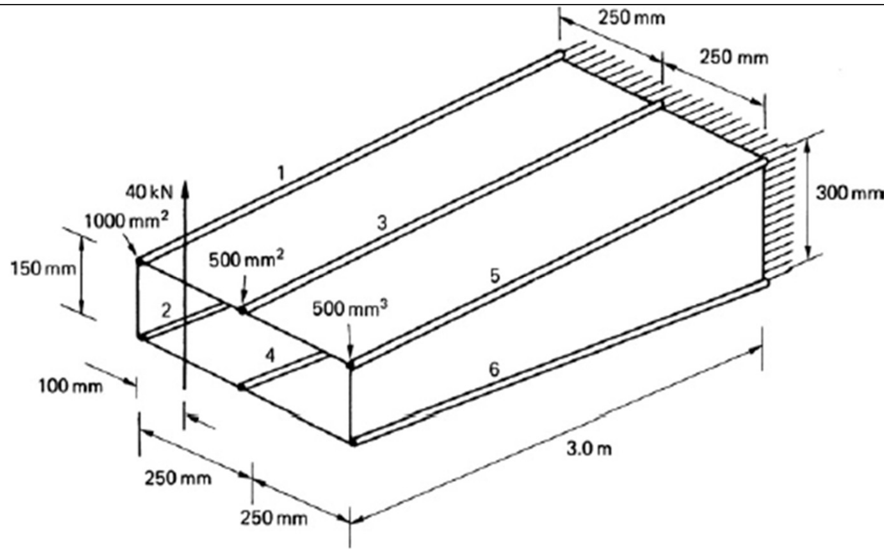
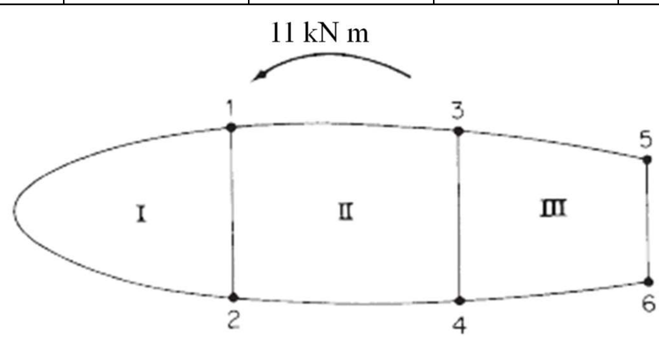


Q 11

Determine the shear flow distribution of idealized wing section as shown in Figure below, the wing is subjected to CCW twisting moment of 11 KN m.

Wall	**Length (mm)**	**Thickness (mm)**	**G (N/mm^2)**	**Cell Area (mm^2)**
12^{0}	1650	1.2	25 000	A_I = 258000
12^{i}	500	2.0	25 000	A_{II} = 355000
13, 24	775	1.2	25 000	A_{III} = 160000
34	400	1.6	25 000	
35, 46	500	0.9	28 000	
56	250	0.9	25 000	



Or,

20

CO4

The wing section shown in the figure below has been idealized such that the booms carry all the direct stress and walls are effective only in shear. The wing carries a vertically upward shear load of 90 kN in the plane of web 572. Calculate the shear stress distribution in the section.

Wall	**Length (mm)**	**Thickness (mm)**	**Boom Area (mm^2)**	**G (N/mm^2)**	**Cell Area (mm^2)**
12, 56	1023	1.22	$B_1 = B_6 =$ 2580	27600	A_I = 265000
23	1274	1.63	$B_2 = B_5 =$ 3880	27600	A_{II} = 213000
34	2200	2.03	$B_3 = B_4 =$ 3230	27600	A_{III} = 413000
483	400	2.64		27600	
572	460	2.64		27600	
61	330	1.63		27600	
78	1270	1.22		82800