DHANALAKSHMI SRINIVASAN
COLLEGE OF ENGINEERING AND TECHNOLOGY
MAMALLAPURAM, CHENNAI

DEPARTMENT OF AERONAUTICAL ENGINEERING

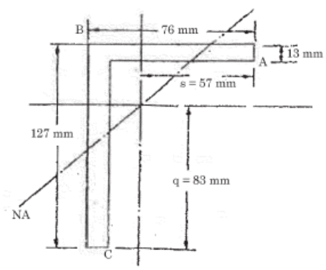
COURSE FILE

COURSE CODE	**:**	**C302**
SUBJECT CODE	**:**	**AE8502 (R-2017)**
SUBJECT NAME	**:**	**AIRCRAFT STRUCTURE - II**
YEAR / SEMESTER	**:**	**III / V**

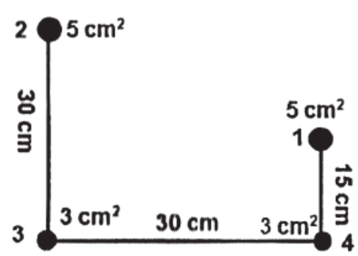
ASSIGNMENTS

ASSIGNMENT – 1

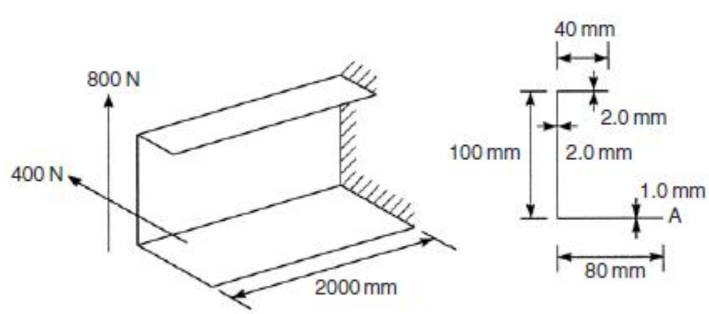
1. The cross-section of a 2 m long cantilever beam is indicated in Figure 11(b). The given beam is subject to its own self-weight of 27.5 kg/m where 1 kg = 9.81 N.
    a. Determine the bending moment Mx at the beam section adjacent to the fixed end and obtain an expression for the bending stress in the form σ = Ay– Bx. (4)
    b. Evaluate the bending stress at point B using the expression σ = Ay – Bx, and (4)
    c. Sketch the neutral axis on the cross-section and indicate its angle ith the x-axis. The centroid of the section is the intersection point of the indicated horizontal and vertical axes. Ixy = 1.186 × 10–6 m4. Ixx = 4 × 10–6 m4, Iyy = 1.08 × 10–6 m4 (5)



2. Determine the bending stresses developed in the idealized section shown in Figure 16(a). The section is subjected to bending moments with respect to centroidal axes Xand Y and they are MX= 5 kN-m and MY= 1 kN-m.

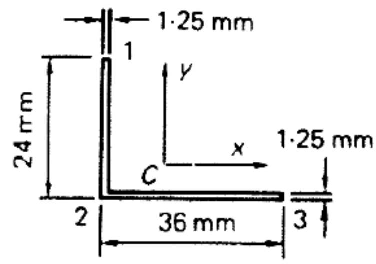


3. A thin-walled, cantilever beam of unsymmetrical cross-section supports shear loads at its free end as shown in Fig. P.16.2. Calculate the value of direct stress at the extremity of the lower flange (point A) at a section half-way along the beam if the position of the shear loads is such that no twisting of the beam occurs.

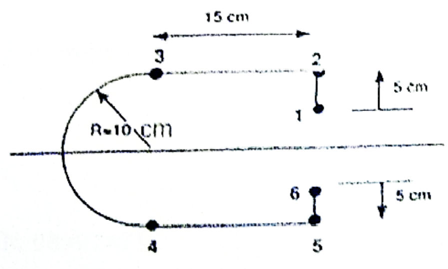


ASSIGNMENT – 2

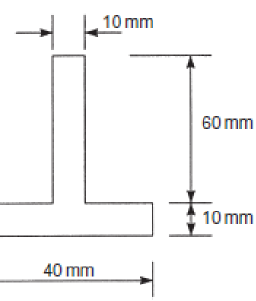
1. The centroid location of the thin-walled angle section given in Figure 5 is (11.274mm, 5.2 mm) from corner 2. The section is subject to vertical shear of 300 N. Determine expressions for the resulting shear flow. Plot the shear flow pattern. Wall thickness is uniform and equal to 1.25 mm.



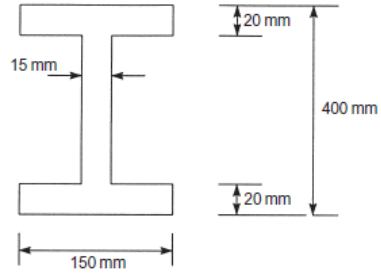
2. Find the shear flow distribution and locate the shear center location for the section shown in figure. For a vertical shear load of Sy = 50kN acting through shear center. Area of all stringers is same which is equal to $2cm^2$



3. A cantilever has the inverted T-section shown in Fig. It carries a vertical shear load of 4 kN in a downward direction. Determine the distribution of vertical shear stress in its cross-section.

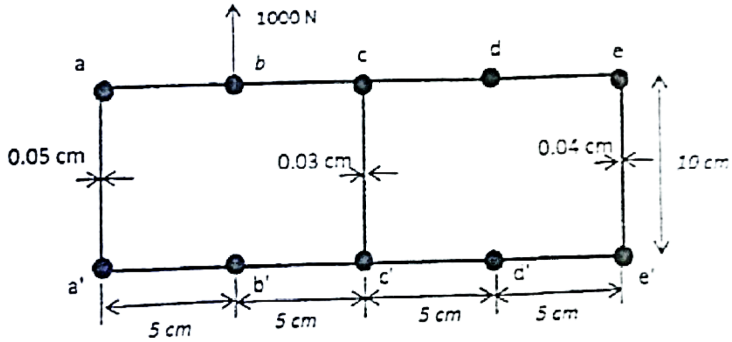


4. An I-section beam having the cross-sectional dimensions shown in Fig. carries a vertical shear load of 80 kN. Calculate and sketch the distribution of vertical shear stress across the beam section and determine the percentage of the total shear load carried by the web.

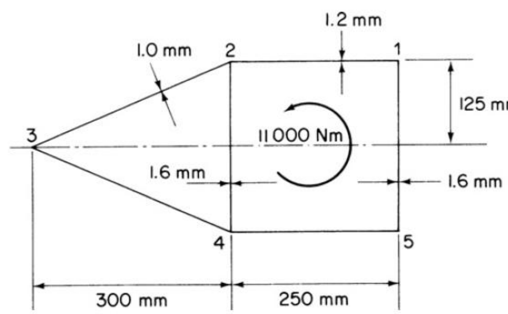


ASSIGNMENT – 3

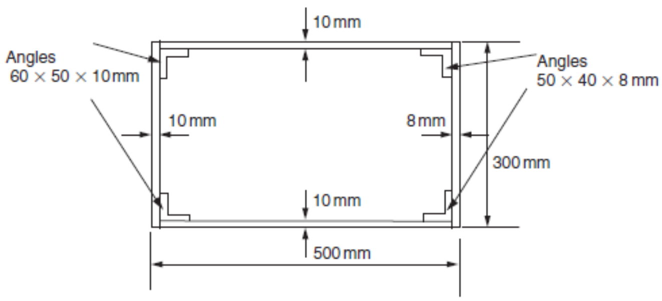
1. Find the shear flow distribution for the cross section shown in Figure. Given area of stringers a = a' = 2 cm²; b = b' = d = d' = 0.5 cm^2; c = c' = e = e' = 1 cm² and the thickness of ab=be=cd=de=a'b'=b'c'=c'd'=d'e' = 3 mm.



1. A thin-walled two-cell beam with the singly symmetrical cross-section shown in Fig. P.26.2 is built-in at one end where the torque is 11 000 Nm. Assuming the cross-section remains undistorted by the loading, determine the distribution of shear flow and the position of the centre of twist at the built-in end. The shear modulus *G* is the same for all walls.

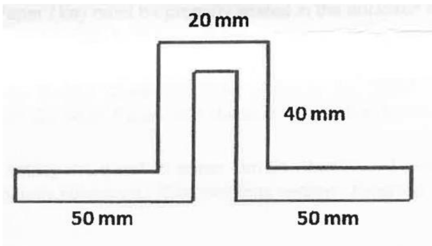


2. Idealize the box section shown in Fig. P.20.1 into an arrangement of direct stress carrying booms positioned at the four corners and panels which are assumed to carry only shear stresses. Hence determine the distance of the shear centre from the left-hand web.



ASSIGNMENT – 4

1. Explain how Needham's method is used to determine the crippling stress for a thin-walled channel section. Using the same determine the crippling stress for the section shown in Figure. Compressive yield stress is 250 MPa and modulus of elasticity is 70 GPa. Thickness is 3 mm throughout

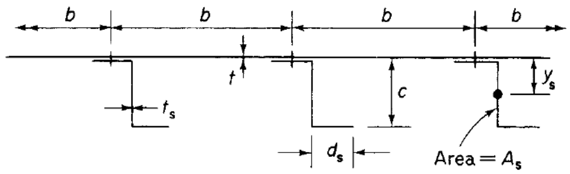


2. Explain the pure tension field and semi tension field beam analysis and bring out their differences.

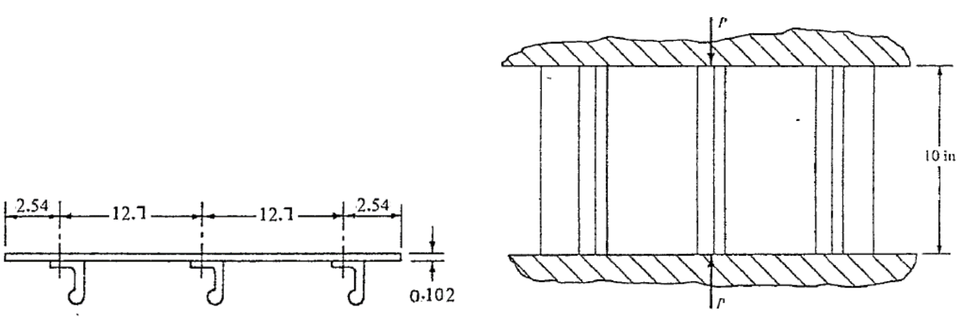
3. A panel, comprising flat sheet and uniformly spaced Z-section stringers, a part of whose cross section is shown in Fig. P.9.3, is to be investigated for strength under uniform compressive loads in a structure in which it is to be stabilized by frames a distance *l* apart, *l* being appreciably greater than the spacing *b*.

   (a) State modes of failure you would consider and how you would determine appropriate limiting stresses.

   (b) Describe a suitable test to verify your calculations, giving particulars of the specimen, the manner of support, and the measurements you would take. The latter should enable you to verify the assumptions made, as well as to obtain the load supported.



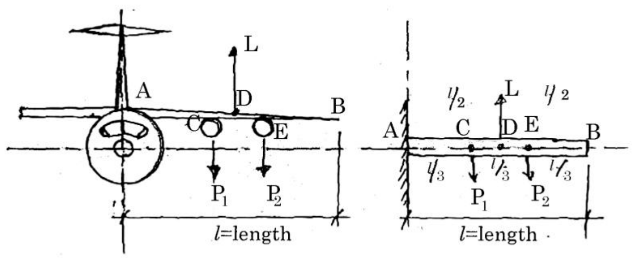
4. The sheet stringer panel shown in Fig. 11.28 is loaded in compression by means of rigid members. The sheet is assumed to be simply supported at the loaded ends and at the rivet lines and to be free at the sides. Each stringer has an area of 6.4516 cm^2 Assume E = 71016000118 N/m^2 for the sheet and stringers. Find the total compressive load P:
   (a) When the sheet first buckles
   (b) When the stringer stress σ_c is 6.8948×10^7 N/m^2
   (c) When the stringer stress σ_c is 2.06843×10^7 N/m^2



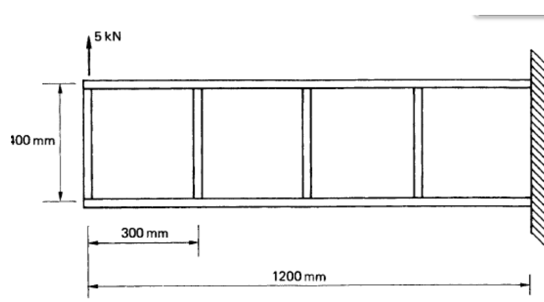
ASSIGNMENT – 5

1. (i) What are the types of loads that an aircraft is subject to – classify and explain 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)

2. List out the different structural elements contained in an aircraft semi- monocoque wing. What are their functions? Draw the wing diagram neatly. (7)
   ii) Discuss the cantilever type of aircraft wing for a transport aircraft shown in Figure 15. (a) (ii) to find moment distribution. (Model the wing). (6)



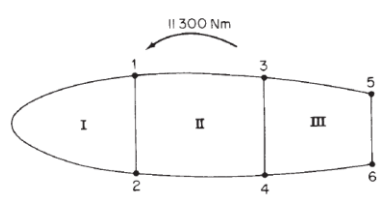
3. The beam shown in Fig. 9.12 is assumed to have a complete tension field web. If the cross-sectional areas of the flanges and stiffeners are, respectively, 350mm^2 and 300mm^2 and the elastic section modulus of each flange is 750mm^3, determine the maximum stress in a flange and also whether or not the stiffeners will buckle. The thickness of the web is 2mm, and the second moment of area of a stiffener about an axis in the plane of the web is 2000mm^4; E = 70 000N/mm^2.



4. Calculate the shear stress distribution in the walls of the three-cell wing section shown in Fig when it is subjected to an anticlockwise torque of 11.3 kN m.

Wall	Length (mm)	Thickness (mm)	G (N/mm^2)	Cell area (mm^2)
12^o	1650	1.22	24 200	$A_I = 258\,000$
12^i	508	2.03	27 600	$A_{II} = 355\,000$
13, 24	775	1.22	24 200	$A_{III} = 161\,000$
34	380	1.63	27 600	
35, 46	508	0.92	20 700	
56	254	0.92	20 700	

Note: The superscript symbols o and i are used to distinguish between outer and inner walls connecting the same two booms.

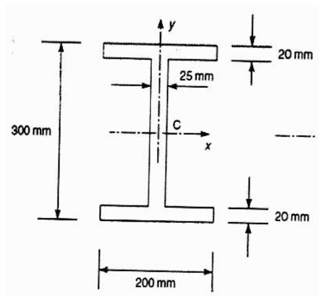
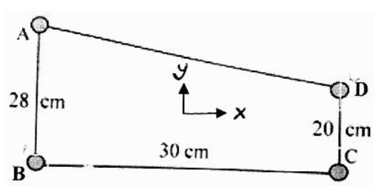
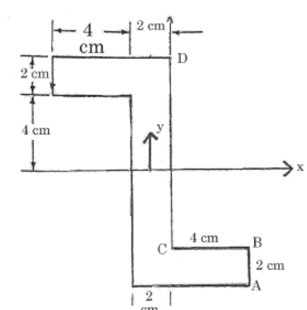


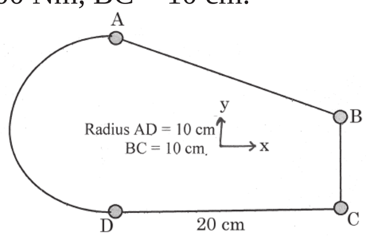
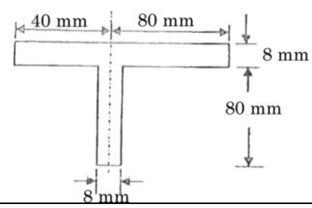
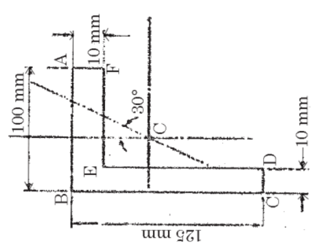
QUESTION BANK

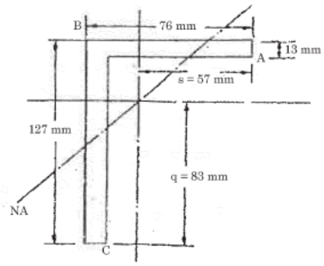
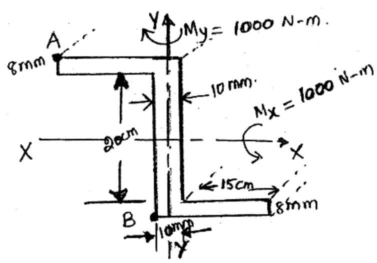
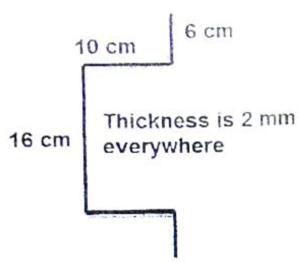
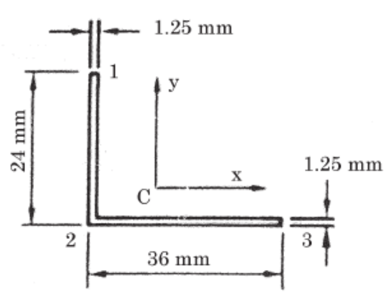
Subject Code & Name: AE8502 – AIRCRAFT STRUCTURES - II

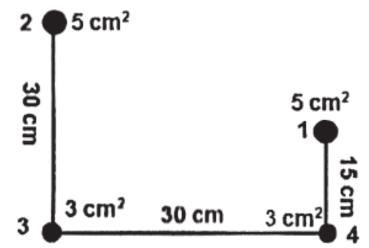
Year / Sem : III / V

UNIT I – UNSYMMETRICAL BENDING			
Q. No	**Question**	**BT Level**	**Competence**
PART – A			
1.	Under what circumstances will the neutral axis pass through the centroid of a beam section when the section is subjected to bending?	L2	Understanding
2.	A rectangular cross section is subjected to a skew load. Mark the neutral axis and sketch the bending stress distribution.	L2	Understanding
3.	What is unsymmetrical bending? Give an example	L1	Remembering
4.	Define: Principal Axis and Neutral Axis	L1	Remembering
5.	State the assumptions made in elementary beam theory?	L1	Remembering
6.	Define pure bending of beam?	L1	Remembering
7.	What is the difference between symmetric and unsymmetric bending?	L1	Remembering
8.	Name the three different method of Bending stress calculation in an unsymmetrical section.	L1	Remembering
9.	Define Anticlastic bending?	L2	Understanding
10.	Define Skew loads?	L2	Understanding
11.	Bending of section subjected to skew load will be symmetrical or unsymmetrical and justify your answer?	L2	Understanding
12.	During steady level flight, is an aircraft fuselage subject to symmetrical or unsymmetrical bending? Justify your answer	L2	Understanding
13.	A beam under unsymmetrical bending will deflect in a direction which is (always perpendicular to the neutral axis/usually inclined to the neutral axis/parallel to either one of the principal axis of inertia direction).	L2	Understanding
14.	When does a beam with an unsymmetrical cross-section experience symmetrical bending?	L2	Understanding
15.	The bending moment about centroidal axes X and Y are Mx = 1500Nm and My= 600 Nm. Determine the moment about principal axes Xp and Yp if Xp is oriented at an angle 36º in anticlockwise direction from X-axis.	L3	Apply
16.	Considering bending moment about centroidal axes of Q1 determine the bending moment about neutral axis oriented at an angle 15º in anticlockwise direction from X axis.	L3	Apply
17.	Write down the expression for orientation of principal axis of beam with unsymmetrical cross section in z-x plane and subjected to bending moments Mx and Mz?	L2	Understanding
18.	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?	L2	Understanding
PART – B			

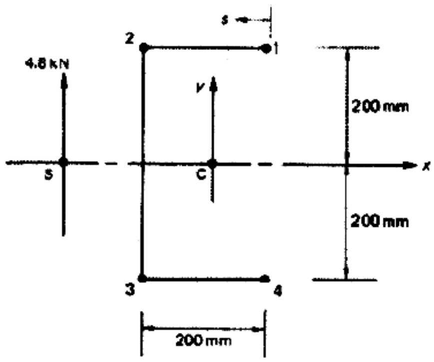
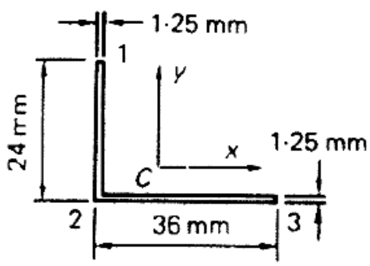
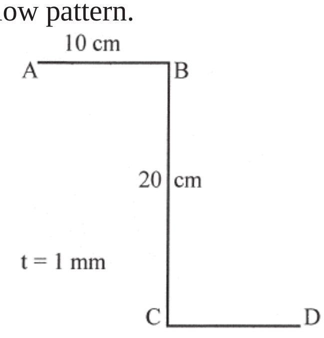
1.	(i) The cross-section of a beam has the dimensions shown in Figure 2. If the beam is subject to a negative bending moment of 100 kNm applied in a vertical plane, determine the distribution of direct stress through the depth of the section. (5) (ii) Now determine the distribution of direct stress in 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) 	L3	Apply
2.	The webs of the cross-section given in Figure 3 are ineffective in bending. Boom areas are as follows: A = 3 cm^2, B = C = 2.5 cm^2, and C = 2 cm^2. Bending moments are Mx =10 kNm and My =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. 	L3	Apply
3.	The section indicated in Figure 1 is subject to bending moments MX= 5000 N cm and M_Y = –4000 N cm. Determine the bending stress at corner points A, B and C and determine the neutral axis inclination angle. 		

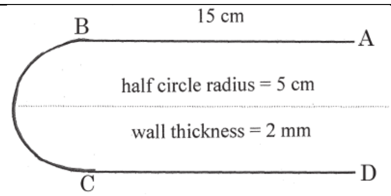
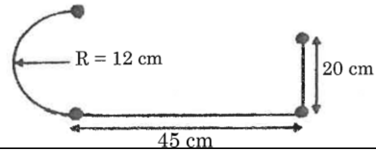
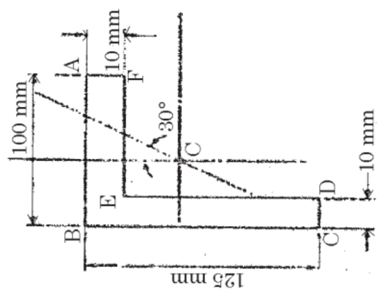
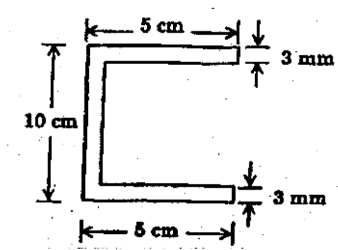
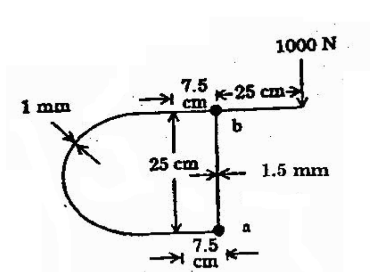
4.	The webs of the section indicated in Figure 2 are ineffective in bending A, B, C, D = 2 cm2. Determine the bending stresses in the flanges A, B, C and D when the section is subject to bending moment MX= 1500 Nm, BC = 10 cm.  	L3	Apply
5.	Derive an expression for bending stress in an unsymmetrical section subjected to Mx and My and modify this expression with respect to principal axis and Neutral axis.	L3	Apply
6.	Obtain the bending stress values at all the corner points for the section shown in Fig. Q. 11 (b).  	L3	Apply
7.	An Angle section in fig. Q. 12 (b) is subjected to Mx = 20 KNm and My =15 KNm. Find maximum bending stress.  	L3	Apply
8.	Find the bending stress distribution in a thin-walled Z section whose thickness is t, height h, flange width h/2 and subjected to a positive bending moment Mx.	L3	Apply
9.	(i) Define neutral axis and write the bending stress expression along this axis (σ_N) . (5) (ii) Derive an expression for the bending stress in an unsymmetrical section using ‘Generalised method’. (8)	L3	Apply
10.	The cross-section of a 2 m long cantilever beam is indicated in Figure 11(b). The given beam is subject to its own self-weight of 27.5 kg/m where 1 kg = 9.81 N. (i). Determine the bending moment Mx at the beam section adjacent to the fixed end and obtain an expression for the bending stress in the form σ = Ay– Bx. (4)	L3	Apply

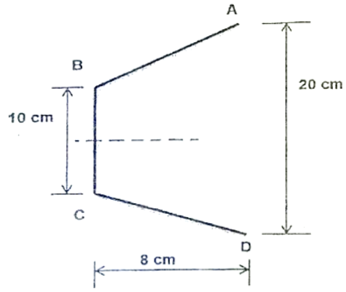
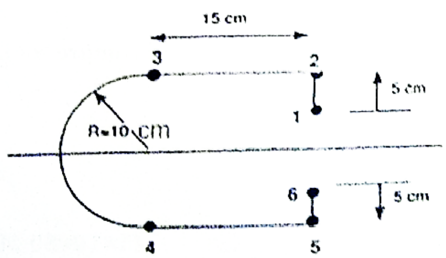
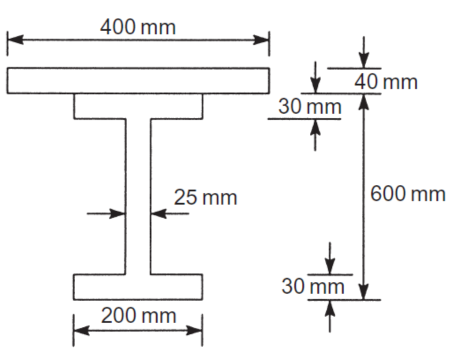
<table>
<tr><td></td><td>(ii). Evaluate the bending stress at point B using the expression σ = Ay – Bx, and (4)
(iii). Sketch the neutral axis on the cross-section and indicate its angle with the x-axis. The centroid of the section is the intersection point of the indicated horizontal and vertical axes. Ixy = 1.186 × 10–6 m4. Ixx = 4 × 10–6 m^4, Iyy = 1.08 × 10^{-6} m^4 (5)
</td><td></td><td></td></tr>
<tr><td>11.</td><td>Obtain the bending stress values at two points, A and B, mentioned in the following Figure. Find the location (only) of neutral axis with respect to vertical axis.
</td><td>L3</td><td>Apply</td></tr>
<tr><td>12.</td><td>The symmetrical Section shown in the Fig is subjected to bending moments of Mx = 1000Nm and My = 2500Nm. Obtain the magnitude and location of the maximum bending stress using k method. The section is in x-y Plane
</td><td>L3</td><td>Apply</td></tr>
<tr><td colspan="4" align="center">PART – C</td></tr>
<tr><td>1.</td><td>i) Determine the section properties of the angle section given in Figure. What are principal axes of inertia and how are they determined?
</td><td>L4</td><td>Analyze</td></tr>
</table>

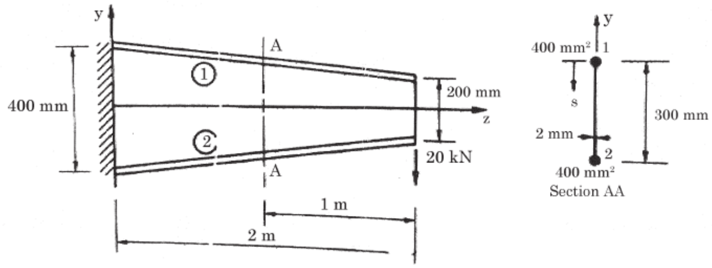
	ii) Consider a uniform cantilever beam with an angle cross-section. The beam is subject to a tip shearing load P which is inclined at α° to the x-axis. Explain how tip deflection magnitude and direction can be determined by resolving the given load along principal directions. (8)		
2.	Determine the bending stresses developed in the idealized section shown in Figure 16(a). The section is subjected to bending moments with respect to centroidal axes Xand Y and they are MX= 5 kN-m and MY = 1 kN-m.  	L4	Analyze

UNIT II – SHEAR FLOW IN OPEN SECTIONS			
Q. No	**Question**	**BT Level**	**Competence**
PART – A			
1.	Relate bending moment and shear flow.	L2	Understanding
2.	For a thin-walled angle section, where will the shear center lie?	L2	Understanding
3.	What is the locus of centroids of the different cross-sections of an elastic beam called?	L2	Understanding
4.	Sketch and mark the approximate shear center location of the thin-walled angle section	L2	Understanding
5.	What are the cross-section types for which shear center and section centroid coincide?	L2	Understanding
6.	Define shear flow and state its S.I. units.	L1	Remembering
7.	Define shear center and Elastic Axis.	L1	Remembering
8.	Indicate the position of shear center for a channel section and angle section.	L2	Understanding
9.	If the webs of the section shown below are in effective in bending, plot the shear flow for a vertical load through the shear center.	L2	Understanding
10.	A thin curved web carries a constants shear flow ‘q’. Calculate the resulting torque of the shear flow about an arbitrary point ‘O’.	L2	Understanding
11.	What do you know about shear centre and centre of twist?	L2	Understanding
12.	Draw and mark shear centre for equal angle section and Z-section.	L2	Understanding
13.	Sketch the shear stress and bending stress variations on I and T sections.	L2	Understanding
14.	What is meant by Structural idealization?	L2	Understanding
15.	What are the cross sectional type for which the shear centre and section centroid coincide?	L2	Understanding
16.	Sketch the shear flow distribution for a thin-walled Z section subjected to a vertical load through the shear centre.	L2	Understanding
17.	Write the properties of the shear flow, when it crosses the booms	L2	Understanding

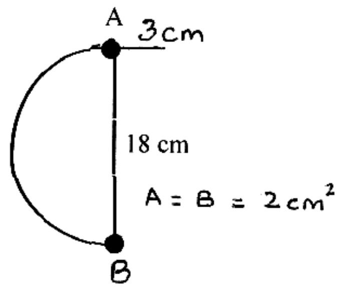
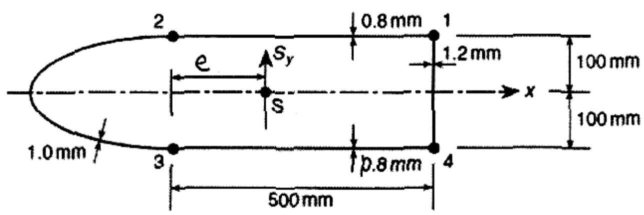
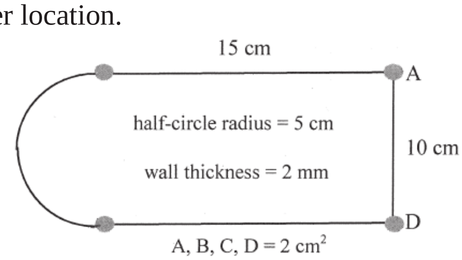
18.	Differentiate wall effective and walls ineffective.	L2	Understanding
PART – B			
1.	(i) Calculate the shear flow distribution in the channel section shown in Figure produced by a vertical shear load of 4.8 kN acting through its shear centre. Assume that the walls of the section are effective in resisting 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 using the delta $P(\Delta P)$ method. The same loads, cross section dimensions, and assumptions, apply. (6)  	L4	Analyze
2.	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.  	L4	Analyze
3.	A thin-walled Z-section with wall thickness 1 mm is indicated in Figure. Obtain expressions for the shear flow distribution in A-B and B-C when the given section is subject to shear force Vy = 1 kN. Plot the resulting shear flow pattern.  	L4	Analyze
4.	The section indicated in Figure 4 is subject to Vy = 18 kN. Derive and obtain expressions for shear flow in the horizontal and curved portions. Obtain and mark the shear centre position.	L4	Analyze

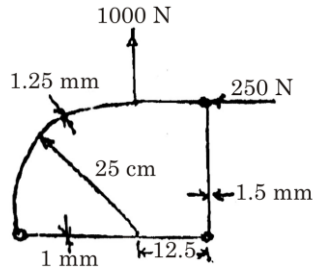
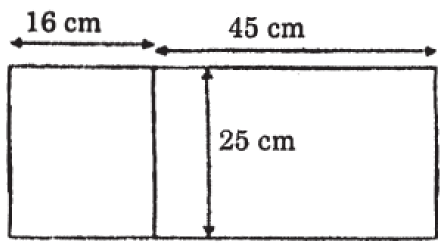
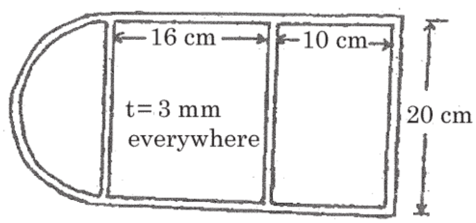
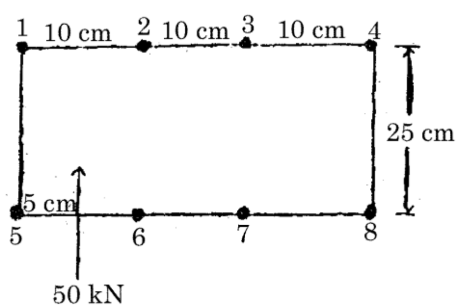
			
5.	Find the shear center location of the section shown in the Figure 12 (a). The webs are ineffective in bending and each concentrated area = 4 cm^2. A load of 10 kN as vertical direction is applied through the shear center. The skin thickness is constant and it is 2 mm throughout. 	L4	Analyze
6.	Derive an expression for shear flow of an open tube of any arbitrary cross section subjected to shear loads Sx and Sy without twist and modify this expression for closed tube	L4	Analyze
7.	An Angle section in fig. is subjected to Mx = 20 kNm and My =15 kNm. Find maximum bending stress. 	L4	Analyze
8.	Determine the shear flow and shear center for the section shown in Figure. Section is subjected to a vertical shear load of 5 KN. 	L4	Analyze
9.	Determine the shear flow and shear center for the section shown in Fig 	L4	Analyze

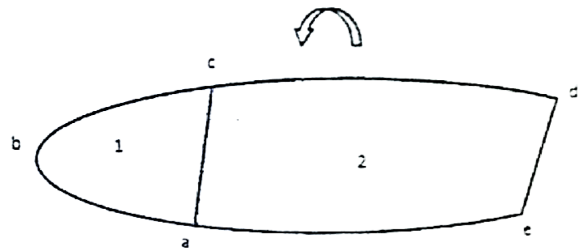
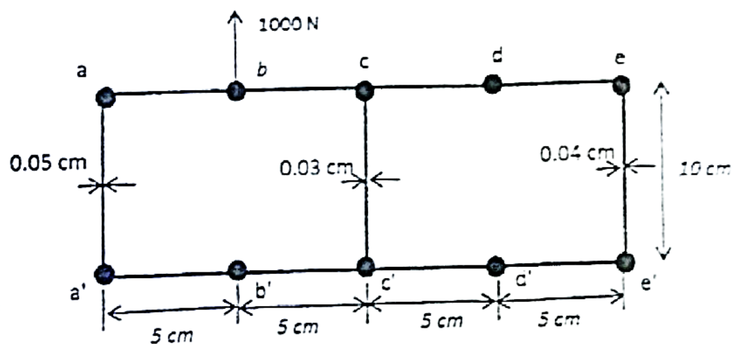
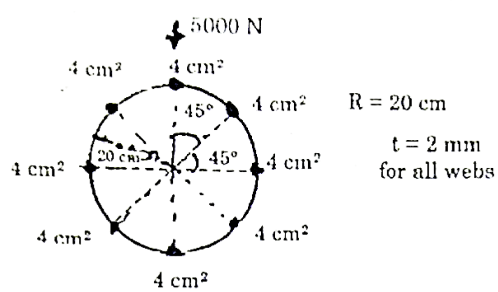
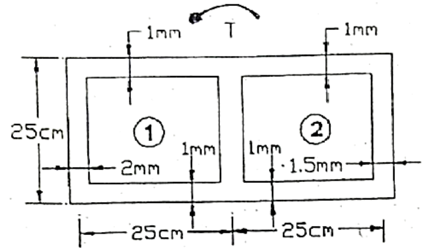
<table>
<tr><td>10.</td><td>In the Figure, the portions AB and CD are equally inclined with respect to the axis. Wall thickness is 2mm throughout. Determine the shear flow pattern for a vertical load of 1500N applied through the shear center.

</td><td>L4</td><td>Analyze</td></tr>
<tr><td>11.</td><td>Find the shear flow distribution and locate the shear center location for the section shown in figure. For a vertical shear load of Sy = 50kN acting through shear center. Area of all stringers is same which is equal to $2cm^2$.

</td><td>L4</td><td>Analyze</td></tr>
<tr><td>12.</td><td>Find the shear flow distribution and location of shear center for the thin-walled channel section subjected to a vertical load of 1500N whose thickness is 2mm, Flange width 30cm and web height 40cm.</td><td>L4</td><td>Analyze</td></tr>
<tr><td colspan="4">PART – C</td></tr>
<tr><td>1.</td><td>A doubly symmetrical I-section beam is reinforced by a flat plate attached to the upper flange as shown in Fig. If the resulting compound beam is subjected to a vertical shear load of 200 kN, determine the distribution of shear stress in the portion of the cross section that extends from the top of the plate to the neutral axis. Calculate also the shear force per unit length of beam resisted by the shear connection between the plate and the flange of the I-section beam.

</td><td>L4</td><td>Analyze</td></tr>
</table>

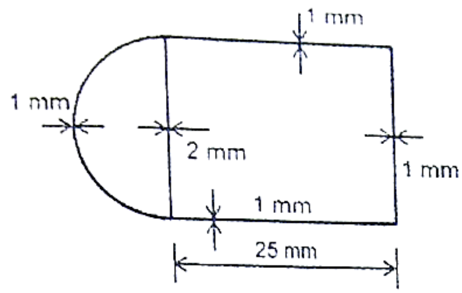
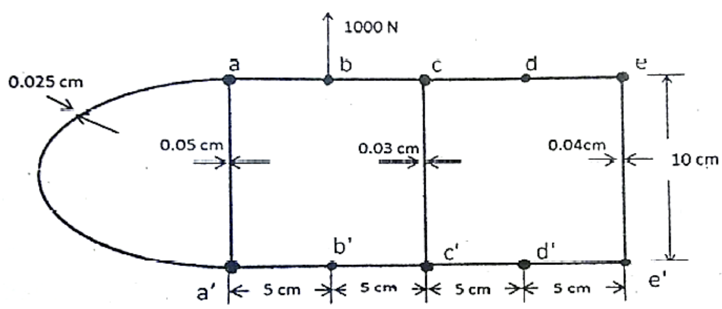
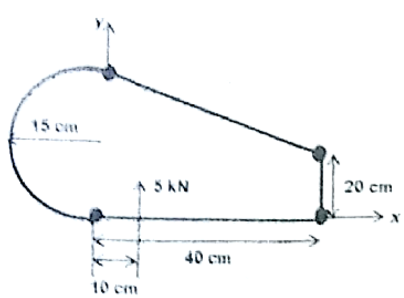
1.	A thin-webbed tapered beam is indicated in Figure 6. Obtain and plot the shear flow distribution in the web at a section located 1 m from the free-end. The web (t = 2 mm) is fully effective in resisting bending. 	L4	Analyze
2.			

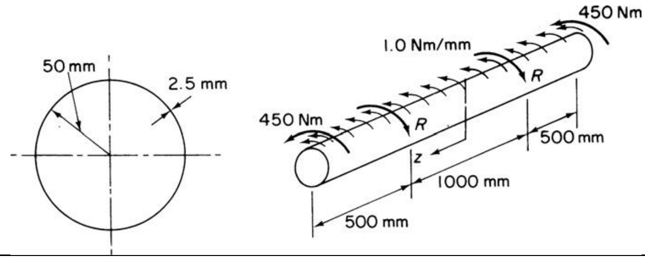
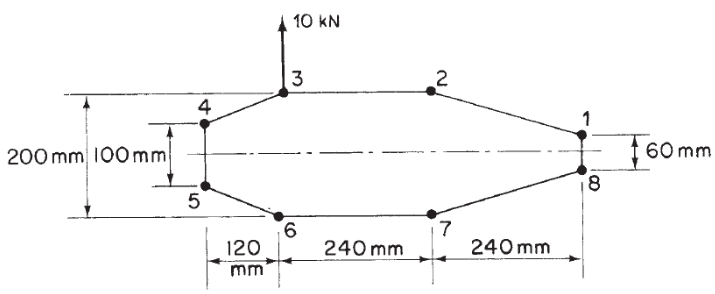
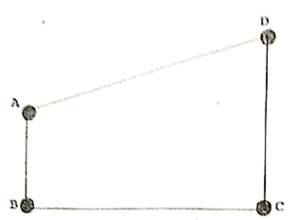
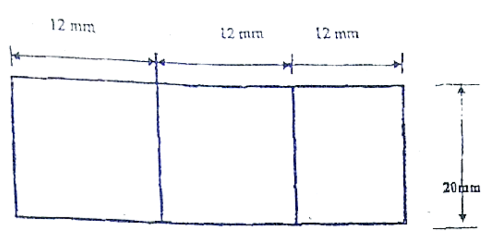
UNIT III – SHEAR FLOW IN CLOSED SECTIONS			
Q. No	**Question**	**BT Level**	**Competence**
	PART – A		
1.	Explain structural idealization with a neat sketch.	L2	Understanding
2.	Calculate the twist of a thin-walled circular tube of mean radius 12 cm and wall thickness 2 mm subject to a pure torque of 640 Nm. Use G = 35 GPa.	L3	Apply
3.	What does shear center position depend on?	L1	Remembering
4.	Give the S. I. units of shear flow and state the relationship between shear flow and shear stress.	L1	Remembering
5.	The shear center position for a thin-walled slit circular tube will: i) Coincide with the centroid position ii) Lie very close to the centroid of the section iii) Be located outside the slit tube.	L2	Understanding
6.	Show that torque due to shear flow in a constant shear flow thin web is given by the expression T = 2 Aq.	L2	Understanding
7.	Write the expression for shear flow in a single cell tube under torque.	L1	Remembering
8.	A curved web carries a constant shear flow ‘q’. Obtain the torque of the shear flow about an arbitrary point ‘O’.	L2	Understanding
9.	Give an example of a statically indeterminate thin-walled structure.	L2	Understanding
10.	A multi-cell thin-walled closed tube is said to be statically indeterminate – explain why?	L2	Understanding
11.	Find the shear flow in a circular tube subjected to a vertical shear through its center and sketch the variation.	L2	Understanding
12.	What are the assumptions made in Bredt-Batho analysis?	L1	Remembering
13.	Explain the procedure involved in analysis of two cells subjected to torque?	L1	Remembering
14.	Define Warping?	L2	Understanding
15.	Write the expression for angle of twist per unit length in a single cell structure.	L1	Remembering

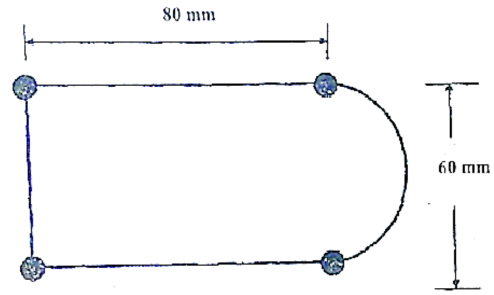
16.	To carry a load, monocoque is heavier than semi monocoque construction. (True/False)	L2	Understanding
17.	Explain how the torque is realized by an aircraft wing?	L2	Understanding
18.	Explain how a thin beam subjected to shear resists the load?	L2	Understanding
PART – B			
1.	(i) Explain the procedure 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 center. Plot the resulting shear flow and determine the shear center position. Assume that the webs of the given section are ineffective in bending $A = B = 2cm^2$. (7) 	L4	Analyze
2.	Refer Figure. The section is subject to vertical shear Sy applied through the shear centre. Make the initial cut in the curved web. Find and plot the open section shear flow in terms of Sy. Next close the cut and find the constant shear flow to be added, q_0 Neatly plot the final shear flow in terms of Sy. 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. 	L4	Analyze
3.	The section indicated in Figure 2 is subject to a vertical shear force 1.2 kN acting through the shear centre. Obtain and plot the resulting shear flow pattern. A, B, C, D = 2 cm². Find the horizontal distance between the shear center and point D.	L4	Analyze
4.	The webs of the section indicated in Figure 5 are ineffective in bending. The given section is subject to a vertical shear force 30 kN acting through the shear centre. Obtain the shear flow pattern and find the shear center location. 	L4	Analyze

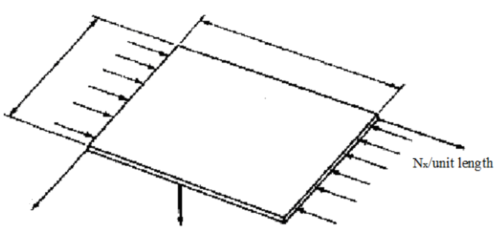
5.	Determine the shear flow pattern and the location of shear centre for a three flange box beam as shown in Figure.  	L4	Analyze
6.	A two-cell closed structure shown in Figure 13(b) is subjected to a clockwise torque of 5000 N-m. Wall thickness = 2.1 mm throughout. compute the shear flow and the associated twist in the cell structure.  	L4	Analyze
7.	A multi cell structure shown in Fig. 3 is subjected to a clockwise torque of 1000 N-m. Compute the shear flow in the cell structure and the associated twist.  	L4	Analyze
8.	Obtain the shear flow for the box beam shown in Fig. 4. A1 = A5 = 25 cm^2, A2 = A3 = A6 = A7 = 7 cm^2 and A4 = A8 = 12cm^2.  	L4	Analyze
9.	A multi-cell tube is subject to a pure torque. Derive from first principles, the expression for the cell twist. Name the theory used and state all the assumptions involved.	L4	Analyze
10.	Calculate the shear flow distribution in the wall of two cell tube section shown in Figure when subjected to a torque of 10,000 N-cm. Areas of cell 1 and cell 2 are given as 2580 cm^2 and 3500 cm^2 respectively. The length and thickness of each portion are given below.	L4	Analyze

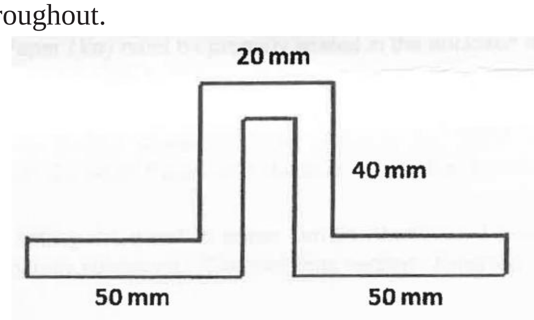
	Wall / Length in cm / Thickness in mm abc / 165 / 1.2 ac / 50 / 2.0 cd, ea / 75 / 1.2 de / 35 / 1.5 		
11.	Find the shear flow distribution for the cross section shown in Figure. Given area of stringers a = a' = 2 cm²; b = b' = d = d' = 0.5 cm^2; c = c' = e = e' = 1 cm² and the thickness of ab=be=cd=de=a'b'=b'c'=c'd'=d'e' = 3 mm. 	L4	Analyze
12.	Find the shear flow in all the webs of the closed single cell shown in under a vertical load of 5000 N. Area of each boom is 4 cm². 	L4	Analyze
13.	Find the shear flow and twist per unit length of the two cell tube made of aluminium as shown in figure and subjected to a torque 75000 Ncm. 	L4	Analyze

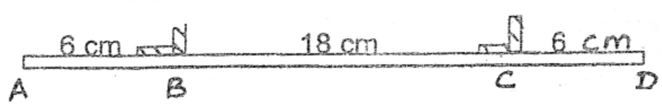
14.	A two-cell structure shown in the figure 13 (a) is made up of aluminum alloy is subjected to torque. Find the angle of twist of cell for a length of 50 cm. Given Young's modulus of the material as 70 GPa.  	L4	Analyze
15.	Find the shear flow distribution for the cross section shown in Figure. Given area of stringers a = a' = 2 cm^2; b = b' = d = d' = 0.5 cm^2; c = c' = e = e' = 1 cm^2 and the thickness of ab=be=cd=de=a'b'=b'c'=c'd'=d'e' = 0.03 cm.  	L4	Analyze
16.	i) Derive an expression for the twist in terms of shear flow in a closed section subjected to a torque T ii) A circular tube of radius 10 cm and thickness 2 mm is divided into 2 cells by a diametric web of 8 mm thick. Calculate the shear flow and the value of Twist/unit length when it is subjected to a torque of 100 N-m.	L4	Analyze
17.	Find the sheat flow distribution for the closed section shown in fig.  	L4	Analyze
PART – C			
1.	A uniform thin-walled beam is circular in cross-section and has a constant thickness of 2.5 mm. The beam is 2000 mm long, carrying end torques of 450Nm and, in the same sense, a distributed torque loading of 1.0Nm/mm. The loads are reacted by equal couples *R* at	L4	Analyze

<table>
<tr>
<td></td>
<td>sections 500mm distant from each end (Fig).
Calculate the maximum shear stress in the beam and sketch the distribution of twist along its length. Take G=30 000N/mm2 and neglect axial constraint effects.

</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>The thin-walled single cell beam shown in Fig. 20.11 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.
Boom areas: $B1 = B8 = 200\text{mm}^2$, $B2 = B7 = 250\text{mm}^2$, $B3 = B6 = 400\text{mm}^2$, $B4 = B5 = 100\text{mm}^2$.

</td>
<td>L4</td>
<td>Analyze</td>
</tr>
<tr>
<td>3.</td>
<td>Determine the shear flow distribution in the walls of the section indicated in Fig. 1 when the given section is subject to a vertical shearing force = 60 kN acting through the shear center of the section. Areas A B C and D are 2 cm while AD 32 cm, AD = 12 cm, BC=24 cm. The webs of the section may be assumed to be ineffective in bending.

</td>
<td>L4</td>
<td>Analyze</td>
</tr>
<tr>
<td>4.</td>
<td>Derive and obtain an expression for the cell twist when the section given in Fig is subject to a pure torque T. The shear modulus of the material used is 'G' while the wall thickness 't' is the same throughout.

</td>
<td>L4</td>
<td>Analyze</td>
</tr>
</table>

5.	Find the shear flow distribution and locate the shear centre for the section shown in Fig. Each of the stringers has an area of $4cm^2$ and the section is subjected to vertical shear of 50kN. 	L4	Analyze

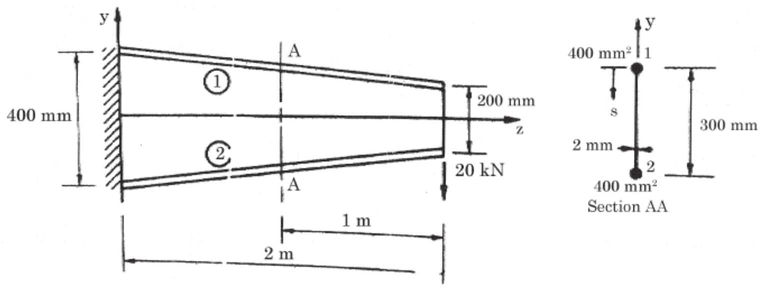
UNIT IV – BUCKLING OF PLATES			
Q. No	**Question**	**BT Level**	**Competence**
PART – A			
1.	What does the buckling mode of a thin plate depend upon?	L2	Understanding
2.	A thin plate in compression is indicated in Figure 1 below. Express the deflected form of the plate using double trigonometric series where the displacement in the z-direction is *w*. 	L2	Understanding
3.	In the elastic buckling of thin plates where the elastic plate buckling formula is applicable, on what parameters does the buckling constant K depend on?	L2	Understanding
4.	What is the delta P (ΔP) method is used for?	L2	Understanding
5.	Write few sentences about effective width of a rectangular plate under compression	L2	Understanding
6.	Mention about the methods used to describe crippling strength of rectangular panel under compression	L1	Remembering
7.	Brief the buckling of sheets in shear and bending and sketch the mode shapes.	L1	Remembering
8.	Find the buckling stress for the plate. The panel dimensions are 30 cm × 15 cm × 2 mm. All the edges are simply supported. The material used is 2024-T3. Given KC= 4.	L2	Understanding
9.	Buckling refers to the phenomenon of ——————.	L2	Understanding
10.	Give the stress expressions for the plate when it is subjected to compression, shear and bending.	L2	Understanding

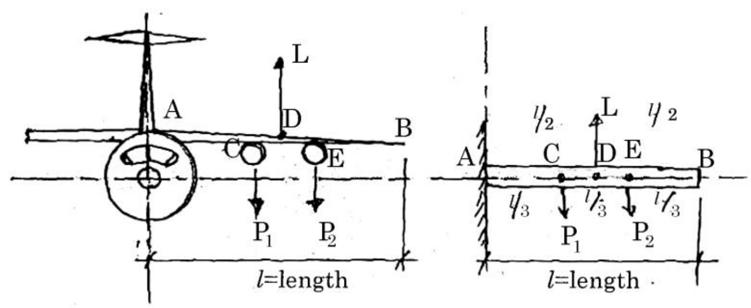
11.	Give the stability criteria for the plate when it is subjected to combined bending and compression, combined bending and shear	L2	Understanding
12.	Explain buckling in shear for a sheet and sketch the mode shape.	L2	Understanding
13.	Describe the buckling modes of a thing walled section.	L2	Understanding
14.	Define stress ratio and write margin of safety in terms of stress ratio.	L2	Understanding
15.	Explain about the buckling of plates due to combined bending and compression.	L2	Understanding
16.	What is meant by sheet stiffener panel?	L2	Understanding
17.	Write the expression for margin of safety of a flat plate under combined shear and longitudinal direct stress.	L2	Understanding
18.	Summarize the application of Needham method.	L2	Understanding
19.	What are the possible failure modes of thin-walled structural columns	L2	Understanding
PART – B			
1.	(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)	L2	Understanding
2.	(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)	L3	Apply
3.	Explain the behaviour of thin sheets under compression. How will the stress distribution take place? What is effective sheet width and how can this width be determined?	L2	Understanding
4.	Explain the Needham and Gerard methods for the determination of crippling stress	L2	Understanding
5.	Explain how Needham's method is used to determine the crippling stress for a thin-walled channel section. Using the same determine the crippling stress for the section shown in Figure. Compressive yield stress is 250 MPa and modulus of elasticity is 70 GPa. Thickness is 3 mm throughout.  	L4	Analyze
6.	Explain how Gerard's method is used to determine the crippling stress for a thin-walled channel section. Using the same determine the	L4	Analyze

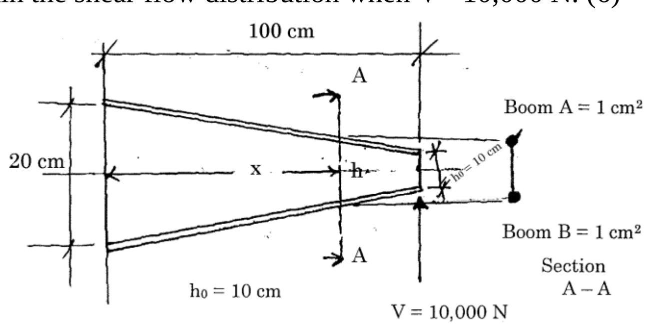
	crippling stress for the section shown in Figure above Compressive yield stress is 250 MPa and modulus of elasticity is 70 GPa. Thickness is 3 mm throughout.		
7.	i) Differentiate between buckling and crippling and explain any one method to determine crippling strength. (8) ii) Explain the pure tension field and semi tension field beam analysis and bring out their differences. (8)	L2	Understanding
8.	Write notes on the following topics: (i) Effective width of a thin stiffened sheet subject to compression (7) (ii) Strength of a thin-walled open section column. (6)	L2	Understanding
9.	Describe the phenomenon of buckling of thin plates. Explain the significance of the plate buckling coefficient ‘k’.	L2	Understanding
10.	Using the concept of effective sheet width, explain how the compressive failure strength of a thin stiffened panel can be estimated.	L2	Understanding
11.	Explain the pure tension field and semi tension field beam analysis and bring out their differences. (8)	L2	Understanding
	PART – C		
1.	The sheet-stringer panel shown in Fig is loaded in compression. The sheet is assumed to be simply-supported at the loaded ends and along the rivet lines, but free at the sides. Each-stringer has an area of 0.7 cm^2. E = 70 GPa for the sheet and stringer material. Panel-length is 1m. Find the total compressive load carried under the following conditions: (16) (i) when the sheet first buckles. (ii) when the stringer stress is 200 MPa. How can the ultimate load carrying capability of this sheet-stringer panel be estimated?  	L4	Analyze
2.	i) Differentiate between primary and secondary buckling. (3) (ii) Explain how the strength of a given thin-walled column can be increased without changing the column dimensions. (3) (iii) Estimate the column strength of a 3 m long column whose cross-section is the same as shown in Fig.2. On both of the end faces of the column the support condition is simply-supported along AB, BC, and CD. The edges containing point A and D may be taken as free. (10)	L4	Analyze
3.	Derive and obtain an expression for the buckling stress of a rectangular sheet subject to compression in the x-direction. State the assumptions used.	L3	Apply

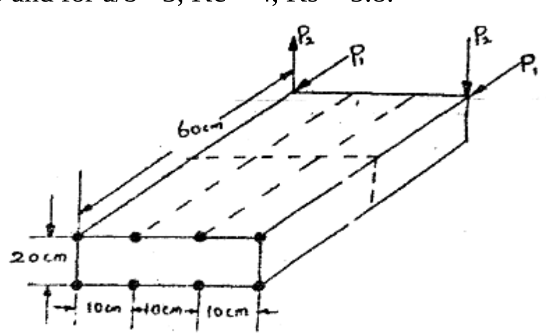
UNIT V – STRESS ANALYSIS OF WING AND FUSELAGE			
Q. No	**Question**	**BT Level**	**Competence**
	PART – A		
1.	Define proof load and ultimate load in aircraft design	L2	Understanding
2.	List a few materials used in the construction of modern aircraft.	L2	Understanding
3.	State the range of maximum positive allowable load factor ‘n’ for a passenger aircraft.	L2	Understanding
4.	A typical aircraft wing under steady level flight conditions will normally undergo (symmetrical bending without twisting/unsymmetrical bending and twisting/symmetrical bending and twisting).	L2	Understanding
5.	What is diagonal tension field beam?	L2	Understanding
6.	List two functions of aircraft spar. Which cross section you prefer for a stringer?	L1	Remembering
7.	Explain with neat sketches, shear flow around a multi cell structure.	L1	Remembering
8.	Describe the semi-cantilever type of aircraft wing.	L2	Understanding
9.	Define gust loads.	L2	Understanding
10.	Explain the difference between complete tension and semi tension field beam.	L2	Understanding
11.	What is meant by Wagner beam?	L2	Understanding
12.	Define Load Factor?	L2	Understanding
13.	Write short notes on Wagner’s beam theory?	L2	Understanding
14.	During steady level flight, an aircraft wing will be subject to (a) bending and shear (b) bending, torsion and shear (c) bending alone. Select the right option.	L2	Understanding
15.	List the structural parts of an aircraft fuselage and name their functions	L2	Understanding
16.	What is meant by V-n Diagram?	L2	Understanding
17.	What is Schrenk’s curve and where it is used	L2	Understanding
18.	What is meant by semi tension field beam theory	L2	Understanding
19.	List any major structural elements on an aircraft wing with their functions.	L2	Understanding
	PART – B		
1.	Explain the construction and significance of the aircraft flight envelope or V-n diagram. State typical load factor limits for different aircraft types.	L2	Understanding
2.	(i) What are the types of loads that an aircraft is subject to – classify and explain 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)	L2	Understanding
3.	i) Categorize the different loads acting on an aircraft and give examples. (7)	L2	Understanding

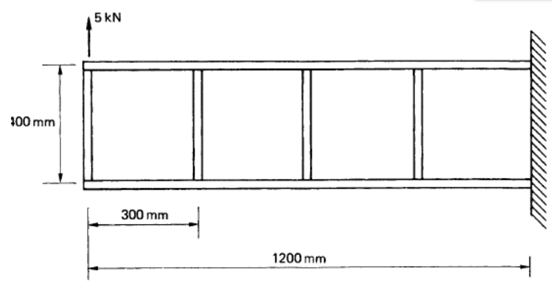
<table>
<tr><td></td><td>ii) Explain Schrenk’s method of estimating the lift distribution over an aircraft wing. (6)</td><td></td><td></td></tr>
<tr><td>4.</td><td>A thin-webbed tapered beam is indicated in Figure 6. Obtain and plot the shear flow distribution in the web at a section located 1 m from the free-end. The web (t = 2 mm) is fully effective in resisting bending.


</td><td>L4</td><td>Analyze</td></tr>
<tr><td>5.</td><td>i) List out the different structural elements contained in an aircraft semi- monocoque wing. What are their functions? Draw the wing diagram neatly. (7)
ii) Discuss the cantilever type of aircraft wing for a transport aircraft shown in Figure 15. (a) (ii) to find moment distribution. (Model the wing). (6)


</td><td>L4</td><td>Analyze</td></tr>
<tr><td>6.</td><td>The tapered beam shown in Figure 15. (b) (i) is subjected to a vertical load V
i) Derive an expression for shear flow at any point in the web of the beam. (7)
ii) Obtain the shear flow distribution when V= 10,000 N. (6)


</td><td>L4</td><td>Analyze</td></tr>
<tr><td>7.</td><td>List down various loads acting on aircraft during different flight maneuvers. Draw the flight envelope/V-n diagram and indicate salient points in the diagram.</td><td>L2</td><td>Understanding</td></tr>
</table>

8.	Describe how the shear force and bending moment diagrams for wing and fuselage are defined.	L2	Understanding
9.	(i) Explain Wagner beam. (8) (ii) Explain lift load distribution on a cantilever wing. (8)	L2	Understanding
10.	Draw the shear force and bending moment diagram on an aircraft wing if the lift load distribution is approximated by a trapezoidal variation. Also draw Schrenk's curve and give the expression for maximum shear force and bending moment.	L2	Understanding
11.	Discuss in brief about the following: i) V- n Diagram ii) Gust Load iii) Semi tension Field beam theory	L2	Understanding
12.	Differentiate, between shear resistance beams and tension field beams. (8) Discuss the analysis of a semi-cantilever type of aircraft wing. (8)	L2	Understanding
13.	What are the functions of various structural components of aircraft? Bring out the salient factors with regard to stress analysis in wing and fuselage.	L2	Understanding
	PART – C		
1.	A Wagner beam of length 1200 mm, fixed as a cantilever is subjected to a tip load of 5 kN. The depth of the beam is 400 mm and the stiffener spacing is 300 mm. The cross-section areas of the flanges and stiffeners are 350 mm^2 and 300 mm^2 respectively. The elastic section modulus of each flange is 750 mm^3, the thickness of the web is 2 mm and the second moment of area of a stiffener about an axis in the plane of the web is 200 mm4. Determine the maximum stress in a flange and also whether the stiffeners will buckle or not. B = 70000 N/mm^2.	L4	Analyze
2.	Explain in detail about Tension field web beams. (6) ii) Explain in detail the construction of shear force and bending moment diagrams for the aircraft wing. (10)	L2	Understanding
3.	What are the various loads that an aircraft fuselage and wings are subjected to? Discuss them in brief.	L2	Understanding
4.	Find the Margin of Safety for the box beam shown in Figure given: P1 = 12 kN and P2 = 10kN. Area of each stringer = 3 cm^2 and the sheet thickness is 2 mm throughout. Assume the sheets are effective in bending and made of 2024-T3 Aluminum alloy. For a/b = 2, Kc =5, Ks = 6.5 and for a/b =3, Kc = 4, Ks = 5.8. 	L4	Analyze

5.	The beam shown in Fig. 9.12 is assumed to have a complete tension field web. If the cross-sectional areas of the flanges and stiffeners are, respectively, $350mm^2$ and $300mm^2$ and the elastic section modulus of each flange is $750mm^3$, determine the maximum stress in a flange and also whether or not the stiffeners will buckle. The thickness of the web is 2mm, and the second moment of area of a stiffener about an axis in the plane of the web is $2000mm^4$; $E = 70\ 000N/mm^2$. 	L4	Analyze

END