INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	**AEROSPACE STRUCTURES**
Course Code	:	**AAEB07**
Regulation	:	IARE - R18
Year	:	2019 – 2020
Class	:	B. Tech IV Semester
Branch	:	Aeronautical Engineering
Course coordinator	:	Dr Y B.Sudhir Sastry, Professor
Course Faculty	:	Dr Y B.Sudhir Sastry, Professor Mr. GSD Madhav, Asst. Professor

COURSE OBJECTIVES

S. No	Description
I	Understand the aircraft structural components and its behavior under different loading conditions
II	Obtain Remember in plate buckling and structural instability of stiffened panels for airframe structural analysis
III	Explain the thin walled section and structural idealization of panels and differentiate from the type of loads carried.
IV	Solve for stresses and deflection in aircraft structures like fuselage, wing and landing gear.

COURSE OUTCOMES (COs)

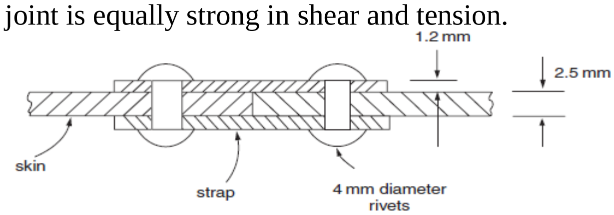
CO 1	Describe the concept of Structural components, structural joints, Monocoque and semi monocoque structures and also energy methods and principles.
CO 2	Describe the concept of thin plates subject to different types of loads and also buckling phenomena of thin plates, local instability and instability of stiffened panels.
CO 3	Understand the concept of symmetric and un-symmetric bending of beams shear stresses and shear flow distribution of thin walled sections and Torsion phenomenon.
CO 4	Explore the concept of Structural idealization and stress distribution of idealized thin walled sections.
CO 5	Discuss the concept of idealized thin walled sections, fuselage, Wing spar and box beams.

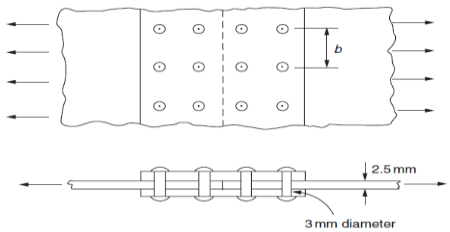
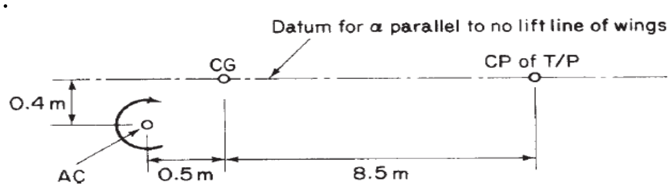
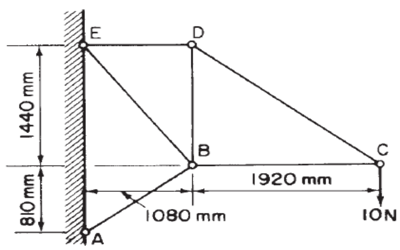
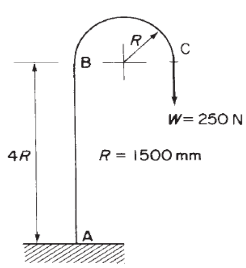
COURSE LEARNING OUTCOMES (CLOs)

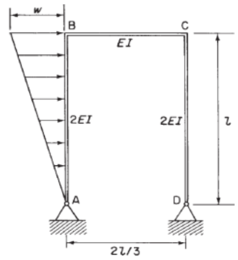
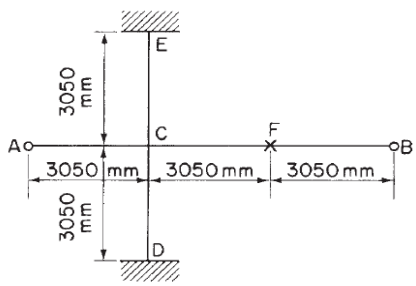
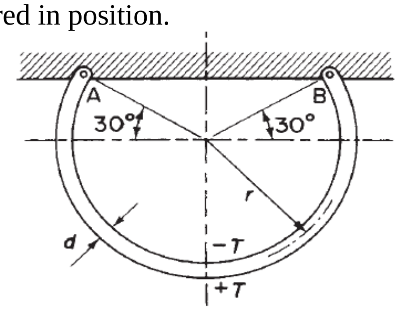
AAEB07.01	Discuss the Aircraft Structural components, various functions of the components and airframe loads acting on it.
AAEB07.02	Discuss different types of structural joints and the effect of Aircraft inertia loads, Symmetric maneuver loads, gust loads on the joints.
AAEB07.03	Differentiate Monocoque and semi monocoque structures and analyze stresses in thin and thick shells.

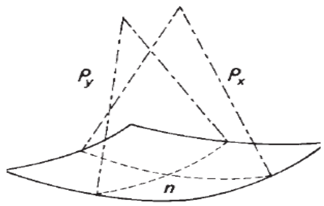
AAEB07.04	Explain energy principles and its application in the analysis of structural components of Aircraft.
AAEB07.05	Explain the Theory of thin plates and Analyze thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading.
AAEB07.06	Describe Buckling phenomena of thin plates and derive Elastic, inelastic, experimental determination of critical load for a flat plate.
AAEB07.07	Calculate the local instability, instability of stiffened panels, failure stresses in plates and stiffened panels.
AAEB07.08	Discuss critical buckling load for flat plate with various loading and end conditions
AAEB07.09	Solve for bending and shear stresses of symmetric and un-symmetric beams under loading conditions
AAEB07.10	Solve for deflections of beams under loading with various approaches
AAEB07.11	Calculate the shear stresses and shear flow distribution of thin walled sections subjected to shear loads.
AAEB07.12	Explain Torsion phenomenon, Displacements and Warping associated with Bredt-Batho shear flow theory of beams.
AAEB07.13	Explain the theory of Structural idealization
AAEB07.14	Principal assumptions in the analysis of thin walled beams under bending, shear, torsion.
AAEB07.15	Solve for stress distribution of idealized thin walled sections subjected to bending.
AAEB07.16	Solve for stress distribution of idealized thin walled sections subjected to, shear and torsion.
AAEB07.17	Calculate and analysis of idealized thin walled sections subjected to bending
AAEB07.18	Calculate and analysis of idealized thin walled sections subjected to shear and torsion.
AAEB07.19	Analyze fuselage of variable stringer areas subjected to transverse and shear loads.
AAEB07.20	Analyze Wing spar and box beams of variable stringer areas subjected to transverse and shear loads.

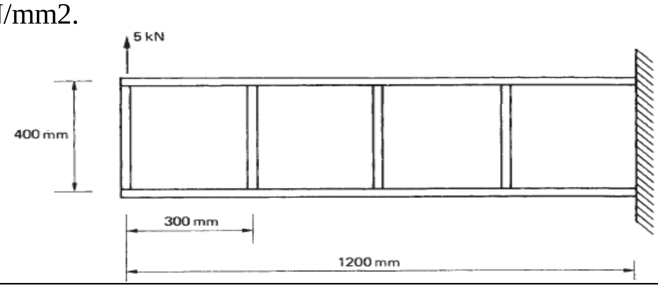
UNIT - I				
AIRCRAFT STRUCTURAL COMPONENTS				
PART - A (SHORT ANSWER QUESTIONS)				
S No	**QUESTIONS**	CO	**Blooms taxonomy level**	**Course Learning Outcomes**
1	What is Structural load?	CO 1	Remember	AAEB07:02
2	What is basic function of structural components?	CO 1	Remember	AAEB07:02
3	What are the types of structural joints?	CO 1	Remember	AAEB07:02
4	What is Aircraft inertia loads?	CO 1	Understand	AAEB07:02
5	What is Monocoque structure?	CO 1	Understand	AAEB07:02
6	What is semi monocoque structures?	CO 1	Remember	AAEB07:02

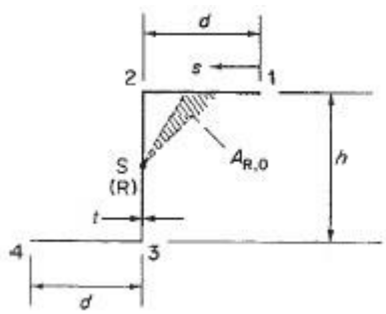
7	Define castiglianos theorem-I	CO 1	Understand	AAEB07:04
8	Define castiglianos theorem-II	CO 1	Remember	AAEB07:04
9	Define maxiwells reciprocal theorem	CO 1	Remember	AAEB07:04
10	Write the equation to find out Hoop stress in thin shells	CO 1	Remember	AAEB07:04
	PART - B (LONG ANSWER QUESTIONS)			
1	Explain what are different loads acting on aircraft structural components with figures	CO 1	Remember	AAEB07:02
2	Explain the functions of aircraft structural components	CO 1	Remember	AAEB07:02
3	Design a simple lap joint by considering Rivet shear, Bearing pressure, Plate failure in tension and Shear failure in a plate	CO 1	Remember	AAEB07:01
4	Derive castiglianos theorem-I with proof.	CO 1	Understand	AAEB07:01
5	Derive castiglianos theorem-II	CO 1	Understand	AAEB07:02
6	Derive the basic equation $\delta = \Sigma udl$ in Unit load method	CO 1	Remember	AAEB07:02
7	Derive the equation to find out deflection and slope of cantilever beam with udl by using castiglianos theorem	CO 1	Remember	AAEB07:04
8	What is Rayleigh Ritz method, Explain in detail	CO 1	Remember	AAEB07:04
9	Find out the vertical displacement of simply supported beam with point load at mid-point by using total potential energy method	CO 1	Remember	AAEB07:04
10	With figure, give a proof of maxiwells reciprocal theorem.	CO 1	Remember	AAEB07:04
	PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)			
1	A joint in a fuselage skin is constructed by riveting the abutting skins between two straps as shown in Fig. below. The fuselage skins are 2.5mm thick and the straps are each1.2mmthick; the rivets have a diameter of 4 mm. If the tensile stress in the fuselage skin must not exceed 125 N/mm^2 and the shear stress in the rivets is limited to 120 N/mm^{2}determine the maximum allowable rivet spacing such that the joint is equally strong in shear and tension. 	CO 1	Understand	AAEB07:01
2	The double riveted butt joint shown in Fig. below connects two plates which are each 2.5mm thick, the rivets have a diameter of 3 mm. If the failure strength of the rivets in shear is 370 N/mm^{2}and the ultimate tensile strength of the plate is 465 N/mm^{2}determine the necessary rivet pitch if the joint is to be designed so that failure due to shear in the rivets and failure due to tension in the plate occur simultaneously. Calculate also the joint efficiency.	CO 1	Understand	AAEB07:01

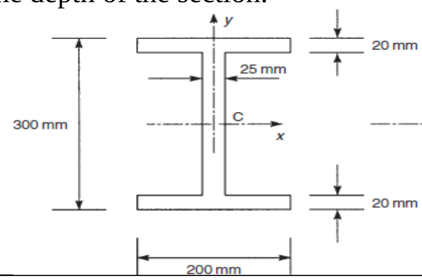
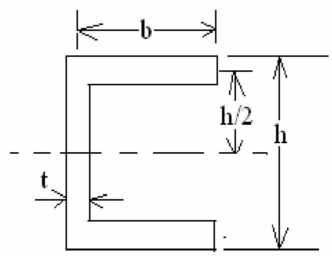
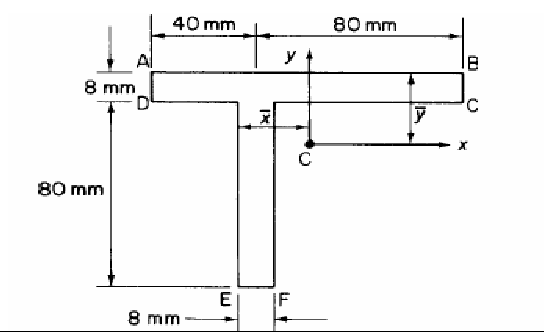
	 			
3	An aircraft of all up weight 145 000N has wings of area $50m^2$ and mean chord 2.5 m. For the whole aircraft $C_D=0.021+0.041C_L^2$, for the wings $dC_L/d\alpha=4.8$, for the tail plane of area 9.0m2, $dC_{L,T}/d\alpha=2.2$ allowing for the effects of downwash and the pitching moment coefficient about the aerodynamic centre (of complete aircraft less tail plane) based on wing area is $C_{M,0}=-0.032$. Geometric data are given in below Fig. During a steady glide with zero thrust at 250 m/s EAS in which $C_L=0.08$, the aircraft meets a down gust of equivalent ‘sharp-edged’ speed 6 m/s. Calculate the tail load, the gust load factor and the forward inertia force, $\rho_0=1.223$ kg/m^3.  	CO 1	Understand	AAEB07:01
4	Find the magnitude and the direction of the movement of the joint C of theplane pin-jointed frame loaded as shown in Fig. below. The value of L/AE for eachmember is 1/20 mm/N.  	CO 1	Remember	AAEB07:01
5	A rigid triangular plate is suspended from a horizontal plane by three vertical wires attached to its corners. The wires are each 1mm diameter, 1440mm long, with a modulus of elasticity of 196 000 N/mm^2. The ratio of the lengths of the sides of the plate is 3:4:5. Calculate the deflection at the point of application due to a 100 N load placed at a point equidistant from the three sides of the plate.	CO 1	Understand	AAEB07:03
6	The tubular steel post shown in Fig. below supports a load of 250N at the freeend C. The outside diameter of the tube is 100mm and the wall thickness is 3 mm. Neglecting the weight of the tube find the horizontal deflection at C. The modulus of elasticity is 206 000 N/mm^2.  	CO 1	Remember	AAEB07:02

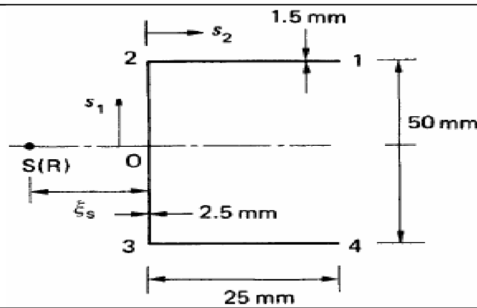
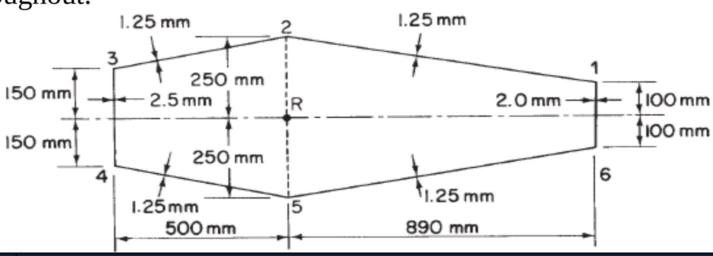
7	The plane frame ABCD of Fig. consists of three straight members with rigid joints at B and C, freely hinged to rigid supports at A and D. The flexural rigidity of AB and CD is twice that of BC.A distributed load is applied to AB, varying linearly in intensity from zero at A to '*w'* per unit length at B. Determine the distribution of bending moment in the frame, illustrating your results with a sketch showing the principal values. 	CO 1	Remember	AAEB07:04
8	Figure below shows a plan view of two beams, AB 9150mm long and DE 6100mm long. The simply supported beam AB carries a vertical load of 100 000Napplied at F, a distance one-third of the span from B. This beam is supported at C on the encastré beam DE. The beams are of uniform cross-section and have the same second moment of area 83.5×106 mm^4. E =200 000 N/mm^2. Calculate the deflection of C. 	CO 1	Remember	AAEB07:04
9	Abeam 2400mmlong is supported at two points A and B which are 1440mmapart; point A is 360 mm from the left-hand end of the beam and point B is 600mmfrom the right-hand end; the value of EI for the beam is 240×108Nmm^2. Find the slope at the supports due to a load of 2000N applied at the mid-point of AB. Use the reciprocal theorem in conjunction with the above result, to find the deflection at the mid-point of AB due to loads of 3000N applied at each of the extreme ends of the beam.	CO 1	Remember	AAEB07:04
10	Figure below shows a frame pinned to its support at A and B. The frame Centre-line is a circular arc and the section is uniform, of bending stiffness EI and depth d. Find an expression for the maximum stress produced by a uniform temperature gradient through the depth, the temperatures on the outer and inner surfaces being respectively raised and lowered by amount T. The points A and B are unaltered in position. 	CO 1	Understand	AAEB07:04

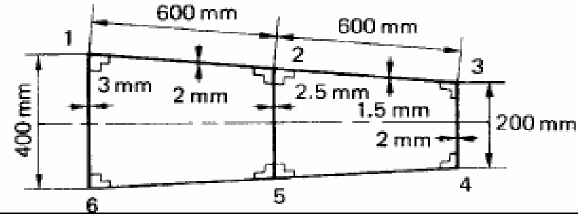
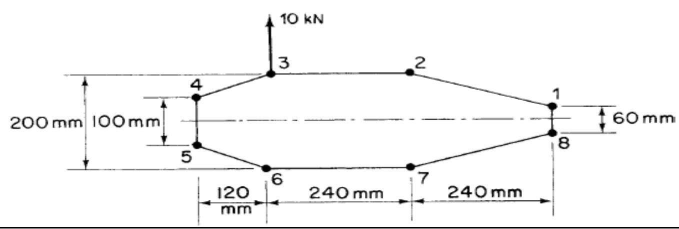
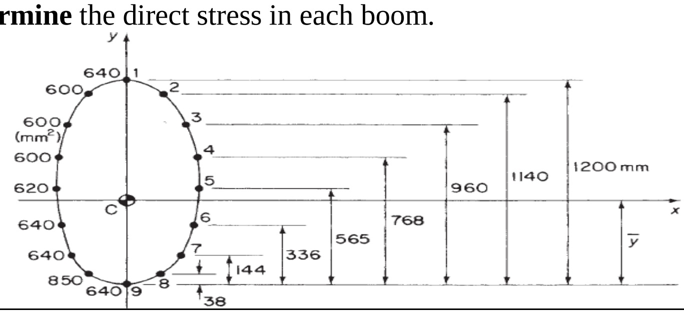
UNIT – II				
THIN PLATE THEORY				
PART - A (SHORT ANSWER QUESTIONS)				
1	Differentiate between thin plate and thick plate.	CO 2	Remember	AAEB07:04
2	What is $\rho_x and \rho_y$ from below diagram? 	CO 2	Understand	AAEB07:04
3	Write the formula Flexural rigidity of thin plate.	CO 2	Understand	AAEB07:04
4	Give the formula for deflection of plate in the terms of infinite series.	CO 2	Understand	AAEB07:04
5	Write the differential equation for strain energy.	CO 2	Remember	AAEB07:04
6	Differentiate between Synclastic and Anticlastic.	CO 2	Remember	AAEB07:04
7	Write the Built-in edge condition for a plate.	CO 2	Remember	AAEB07:04
8	What is "N_x" in this equation $\frac{\partial^4 w}{\partial x^4}+\frac{\partial^4 w}{\partial x^2 \partial y^2}+\frac{\partial^4 w}{\partial y^4}=\frac{1}{D}\left(q+N_x\frac{\partial^2 w}{\partial x^2}+N_y\frac{\partial^2 w}{\partial y^2}+N_{xy}\frac{\partial^2 w}{\partial x \partial y}\right)$	CO 2	Remember	AAEB07:04
9	The application of transverse and in-plane loads will cause the plate to deflect a further amount w1 so that the total deflection is.	CO 2	Remember	AAEB07:04
10	Critical load is also called as	CO 2	Remember	AAEB07:04
PART - B (LONG ANSWER QUESTIONS)				
1	**Explain** the basic theory of thin plates?	CO 2	Remember	AAEB07:06
2	**Derive** the expression for direct/bending stress of a pure bending of thin plates?	CO 2	Remember	AAEB07:05
3	**What** is the term flexural rigidity called in bending of thin plates and explain?	CO 2	Remember	AAEB07:05
4	Clearly e**xplain** the difference between synclastic and anticlastic surface of thin plates?	CO 2	Remember	AAEB07:05
5	**Clearly** draw the figure for plate element subjected to bending, twisting and transverse loads?	CO 2	Remember	AAEB07:06
6	**Write** the conditions for a plate which simply supported all edges? And write the assumed deflected form of the plate which satisfies the boundary conditions for this plate?	CO 2	Remember	AAEB07:06
7	**Write** the conditions for a plate which clamped at all edges? And write the assumed deflected form of the plate which satisfies the boundary conditions for this plate?	CO 2	Remember	AAEB07:05
8	**Write** the conditions for a plate which simply supported all two edges and the other two edges are free? And write the assumed deflected form of the plate which satisfies the boundary conditions for this plate?	CO 2	Remember	AAEB07:05
9	**Write** the conditions for free	CO 2	Remember	AAEB07:05
10	**Explain** the basic theory of thin plates?	CO 2	Understand	AAEB07:05
PART – C (PROBLEM SOLVING AND CRITICAL THINKING)				
1	**Derive** the equation (1/ρ) =M / [D (1+ υ)] of thin plate subjected to pure bending.	CO 2	Remember	AAEB07:06

2	**Derive** the equation $M_{xy} = D\,(1-\upsilon)\,\partial^2 w/\partial x\partial y$ for a thin plate subjected to bending and twisting	CO 2	Understand	AAEB07:06
3	A plate 10mmthick is subjected to bending moments Mx equal to 10 Nm/mm and My equal to 5 Nm/mm. **find** the maximum twisting moment per unit length in the plate and the direction of the planes on which this occurs.	CO 2	Understand	AAEB07:06
4	A thin rectangular plate a×b is simply supported along its edges and carries a uniformly distributed load of intensity q0. **Determine** the deflected form of the plate and the distribution of bending moment.	CO 2	Understand	AAEB07:05
5	A rectangular plate *a*×*b*, is simply supported along each edge and carries a uniformly distributed load of intensity q0.**Determine** using the energy method, the value of the coefficient *A*11 and hence find the maximum value of deflection.	CO 2	Remember	AAEB07:05
6	A thin rectangular plate *a*×*b*is simply supported along its edges and carries a uniformly distributed load of intensity *q*0 and supports an in-plane tensile force *Nx* per unit length. **Determine** the deflected form of the plate.	CO 2	Understand	AAEB07:05
7	A rectangular plate *a*×*b*, simply supported along each edge, possesses a small initial curvature **Determine**, using the energy method, its final deflected shape when it is subjected to a compressive load *Nx* per unit length along the edges *x* =0, *x* =*a*.	CO 2	Remember	AAEB07:05
8	**Explain** Instability of Stiffened panels.	CO 2	Understand	AAEB07:06
9	The beam shown in is assumed to have a complete tension field web. If the cross-sectional areas of the flanges and stiffeners are, respectively, 350mm2 and 300mm2 and the elastic section modulus of each flange is 750mm3, **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 2000mm4; *E* =70 000 N/mm2. 	CO 2	Understand	AAEB07:05
10	**Derive** the equation for critical stress (σCR) = [kπ2E /12(1 – υ2)] (t/b)2 for plate subjected to the compressive load.	CO 2	Remember	AAEB07:05
	UNIT-III			
	BENDING SHEAR AND TORSION OF THIN WALLED BEAMS			
	PART - A (SHORT ANSWER QUESTIONS)			
1	What is flexural rigidity?	CO 3	Remember	AAEB07:09
2	What is neutral plane?	CO 3	Remember	AAEB07:09
3	The term $\int y^2 dA$ is known as the	CO 3	Understand	AAEB07:09
4	Write the expression for $\sigma_z$interms of M_x , M_y, &I_{xx}, I_{yy} , I_{XY} is	CO 3	Remember	AAEB07:09
5	Write the relation between shear force and intensity of load	CO 3	Remember	AAEB07:09
6	Singularity function is also known as	CO 3	Remember	AAEB07:09
7	The strain produced by a temperature change ΔT is given by	CO 3	Remember	AAEB07:09

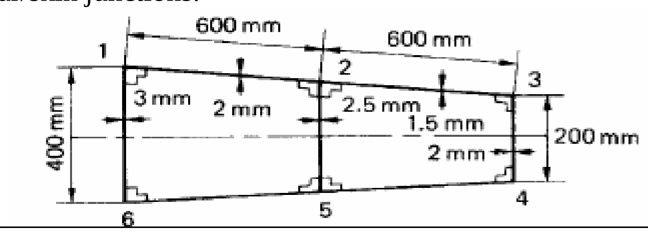
8	What is shear flow distribution?	CO 3	Understand	AAEB07:11
9	What is Warping distribution?	CO 3	Remember	AAEB07:11
10	Write the value of I_{XY} for unsymmetrical section.	CO 3	Remember	AAEB07:11
11	Give the definition for Warping	CO 3	Remember	AAEB07:11
	PART – B (LONG ANSWER QUESTIONS)			
1	**Write** short notes on the following: Symmetrical bending Unsymmetrical bending	CO 3	Understand	AAEB07:09
2	**Explain** the following terms. Shear center Shear flow Centre of twist	CO 3	Understand	AAEB07:09
3	**Derive** the equations to find out the primary and secondary warping of an open cross section subjected to torsion.	CO 3	Understand	AAEB07:09
4	**Derive** the Bredt-Batho formula for thin walled closed section beams with the help of neat sketch.	CO 3	Understand	AAEB07:09
5	**Explain** the condition for Zero warping at a section, and derive the warping of cross section.	CO 3	Understand	AAEB07:09
6	**What** do mean by shear centre? Explain with the help of figure.	CO 3	Understand	AAEB07:09
7	In order to understand open sections, one has to be clear about centroid, neutral point and shear centre. **Explain** them with mathematical expression.	CO 3	Understand	AAEB07:10
8	**Derive** the expression for the ripple factor of π-Section filter when used with a Full-wave-rectifier. Make necessary approximations?	CO 3	Remember	AAEB07:09
9	a) Explain about torsion bending phenomena. b) An open section beam of length *L* has the section shown in Fig. The beam is firmly built-in at one end and carries a pure torque *T*. Derive expressions for the direct stress and shear flow distributions produced by the axial constraint (the *σ*_ and *q* _ systems) and the rate of twist of the beam. 	CO 3	Remember	AAEB07:11
10	Derive the total torque equation for arbitrary section beam subjected to torsion	CO 3	Understand	AAEB07:11
	Part – C (Problem Solving and Critical Thinking)			
1	**Derive** $(\sigma_z) = [(M_y I_{xx} - M_x I_{xy}) / (I_{xx} I_{yy} - I_{xy}^2)]\, x + [(M_x I_{yy} - M_y I_{xy}) / (I_{xx} I_{yy} - I_{xy}^2)]\, y$	CO 3	Understand	AAEB07:10
2	Figure in pg 495 problem P.16.1of Megson shows the section of an angle purlin. A bending moment of 3000 Nm is applied to the purlin in a plane at an angle of 30^0 to the vertical *y* axis. If the sense of the bending moment is such that its components *Mx* and *My* both	CO 3	Understand	AAEB07:09

	produce tension in the positive *xy* quadrant, **calculate** the maximum direct stress in the purlin, stating clearly the point at which it acts.			
3	**Explain** the i) shear flow, ii) shear centre, iii) centre of twist.	CO 3	Remember	AAEB07:09
4	The cross-section of a beam has the dimensions shown in figure. 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. 	CO 3	Understand	AAEB07:09
5	**Derive** the equation to find out the shear center of figure shown. 	CO 3	Remember	AAEB07:10
6	The beam section of problem 1 above, is subjected to a bending moment of 100 kNm applied in a plane parallel to the longitudinal axis of the beam but inclined at 30◦ to the left of vertical. The sense of the bending moment is clockwise when viewed from the left-hand edge of the beam section. **Determine** the distribution of direct stress.	CO 3	Remember	AAEB07:10
7	A beam having the cross section shown in Figure is subjected to a bending moment of 1500 Nm in a vertical plane. **Calculate** the maximum direct stress due to bending stating the point at which it acts. 	CO 3	Remember	AAEB07:10
8	**Determine** the maximum shear stress and the warping distribution in the channel section shown in Figure when it is subjected to an anticlockwise torque of 10 Nm. G=25000 N/mm^2.	CO 3	Understand	AAEB07:10
9	Calculte the shear centre for C-channel section as shown.		Remember	CAAE002:10

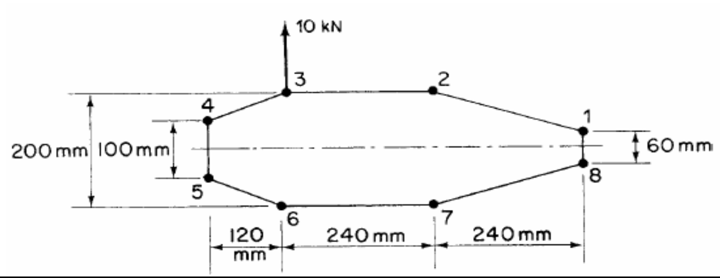
				
10	**Determine** the warping distribution in the doubly symmetrical rectangular, closed section beam, shown in Fig, when subjected to an anticlockwise torque *T*.	CO 3	Remember	AAEB07:10
11	A single cell, thin-walled beam with the double trapezoidal cross-section shown in Fig is subjected to a constant torque *T* =90,500Nm and is constrained to twist about an axis through the point R. Assuming that the shear stresses are distributed according to the Bredt–Batho theory of torsion, **calculate** the distribution of warping around the cross-section. Illustrate your answer clearly by means of a sketch and insert the principal values of the warping displacements. The shear modulus *G*=27 500N/mm2 and is constant throughout. 	CO 3	Remember	AAEB07:10
UNIT-IV				
STRUCTURAL IDEALIZATION				
PART – A (SHORT ANSWER QUESTIONS)				
1	**Define** structural idealization.	CO 4	Remember	AAEB07:13
2	**Derive** the equation to find out boom areas with neat sketches.	CO 4	Understand	AAEB07:13
3	**Explain** how to idealization the pannel	CO 4	Understand	AAEB07:13
4	**Derive** the equation for shear flow.	CO 4	Understand	AAEB07:13
5	**Explain** what are structural Idealization and its principle.	CO 4	Understand	AAEB07:13
6	**What** is the boom area?	CO 4	Understand	AAEB07:14
7	**Write** short notes on the following: (a) Booms in structures. (b) Structural idealization.	CO 4	Remember	AAEB07:14
8	**Explain** about air loads.	CO 4	Remember	AAEB07:13
9	**Draw** the Actual and Idealized panels.	CO 4	Understand	AAEB07:13
10	**Write** the equation to find out the bending stress of idealized panel.	CO 4	Understand	AAEB07:13
PART – B (LONG ANSWER QUESTIONS)				
1	Part of a wing section is in the form of the two-cell box shown in Figure in which the vertical spars are connected to the wing skin through angle sections, all having a cross-sectional area of 300 mm^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.	CO 4	Understand	AAEB07:15

				
2	The thin-walled single cell beam shown in Figure 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: B_1=B_8=200 mm^2, B_2=B_7=250 mm^2 B_3=B_6=400 mm^2, B_4=B_5=100 mm^2. 	CO 4	Remember	AAEB07:16
3	The fuselage section shown in Fig. is subjected to a bending moment of 100 kNm applied in the vertical plane of symmetry. If the section has been completely idealized into a combination of direct stress carrying booms and shear stress only carrying panels, **determine** the direct stress in each boom. 	CO 4	Understand	AAEB07:16
4	**Calculate** the shear flow distribution in the c-channel section. produced by a vertical shear load of 4.8 kN acting through its shear centre. Assume that the walls of the section are only effective in resisting shear stresses while the booms, each of area 300mm2, carry all the direct stresses. Web length is 200m and flange length is 100mm.	CO 4	Understand	AAEB07:14
5	**Derive** the equation to find out the bending stress of idealized panel.	CO 4	Remember	AAEB07:15
6	**Derive** the equation to find out the bending stress of idealized panel, if M_x equal to zero.	CO 4	Remember	AAEB07:15
7	**Derive** the equation to find out the bending stress of idealized panelif M_y equal to zero with neat sketch.	CO 4	Remember	AAEB07:15
8	**Calculate** the bending stress developed in the boom of fuselage subjected to a bending moment of 100 kNm applied in the vertical plane of symmetry, the distance between boom and axis is 660mm and moment of Inertia 278 x 10^6	CO 4	Remember	AAEB07:16
9	**Draw** the neat sketches of idealized simple wing section. Derive bending stress and shear flow distribution.	CO 4	Remember	AAEB07:16
10	**Draw** the neat sketches of idealized simple fuselage section. Derive bending stress and shear flow distribution.	CO 4	Remember	AAEB07:16

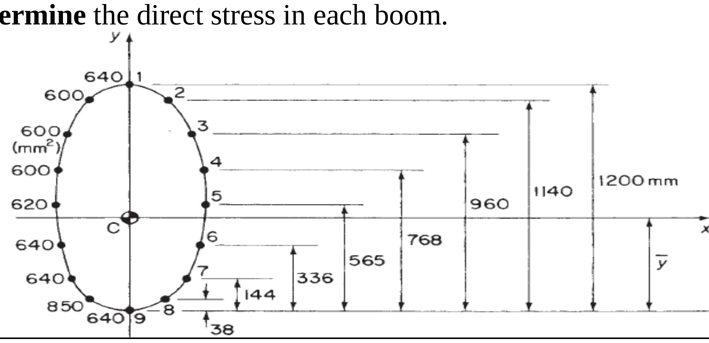
<table>
<tr><th colspan="5">PART – C (PROBLEM SOLVING AND CRITICAL THINKING)</th></tr>
<tr><td>1</td><td>Calculate the bending stress developed in the boom of fuselage subjected to a bending moment of 50 kNm applied in the horizontal plane of symmetry, the distance between boom and axis is 204mm and moment of Inertia 27 x 10^6 mm^4.</td><td>CO 4</td><td>Remember</td><td>AAEB07:14</td></tr>
<tr><td>2</td><td>Part of a wing section is in the form of the two-cell box shown in Figure in which the vertical spars are connected to the wing skin through angle sections, all having a cross-sectional area of 300 mm^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.



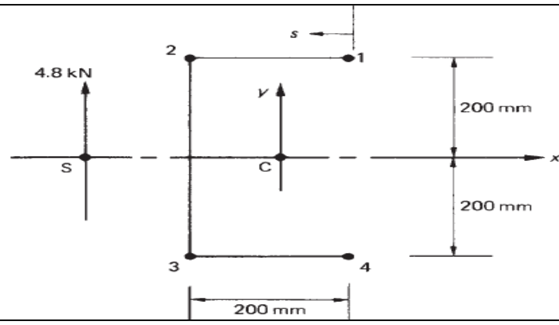
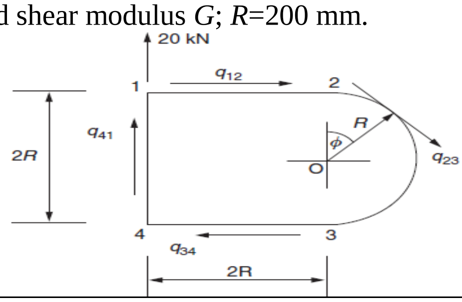
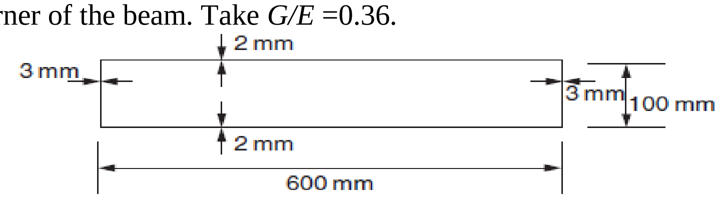
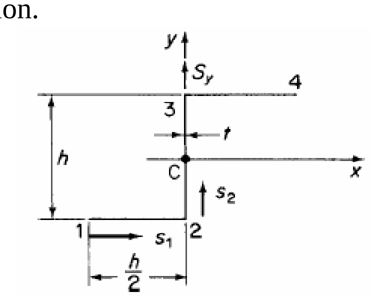
</td><td>CO 4</td><td>Understand</td><td>AAEB07:14</td></tr>
<tr><td>3</td><td>The thin-walled single cell beam shown in Figure has been idealized into a combination of direct stress-carrying booms and shear-stress-only-carrying walls. If the section supports a vertical shear load of 25 kN acting in a vertical plane through booms 3 and 6, calculate the distribution of shear flow around the section. Boom areas: B_1=B_8=300 mm^2, B_2=B_7=450 mm^2 B_3=B_6=400 mm^2, B_4=B_5=100 mm^2.

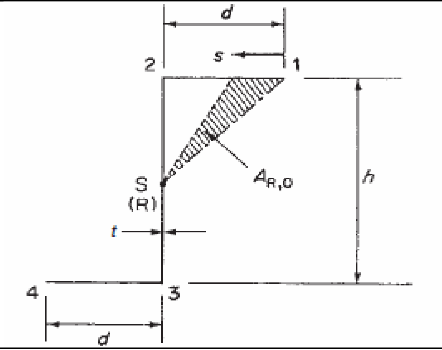


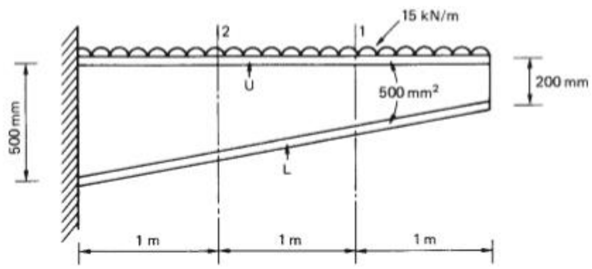
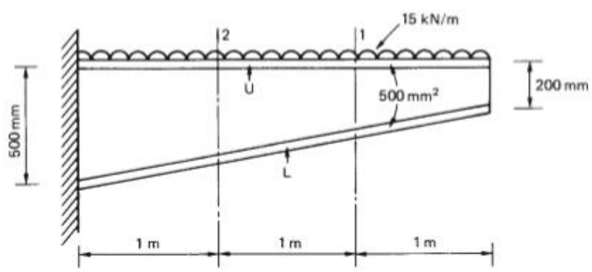
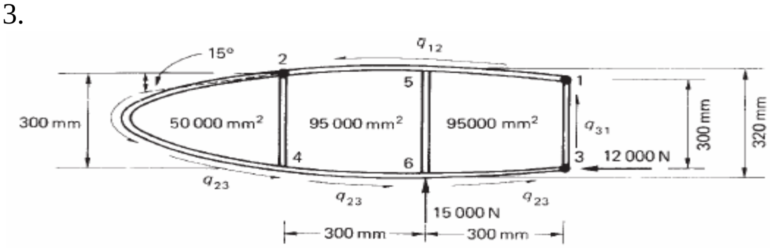
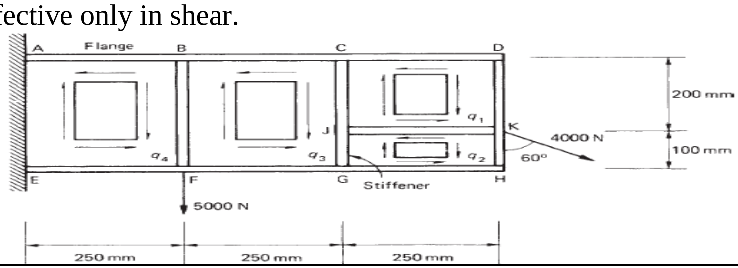
</td><td>CO 4</td><td>Understand</td><td>AAEB07:15</td></tr>
<tr><td>4</td><td>The fuselage section shown in Fig. 20.5 is subjected to a bending moment of 100 kNm applied in the vertical plane of symmetry. If the section has been completely idealized into a combination of direct stress carrying booms and shear stress only carrying panels, determine the direct stress in each boom.

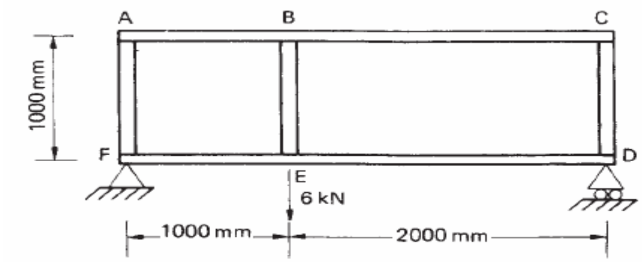
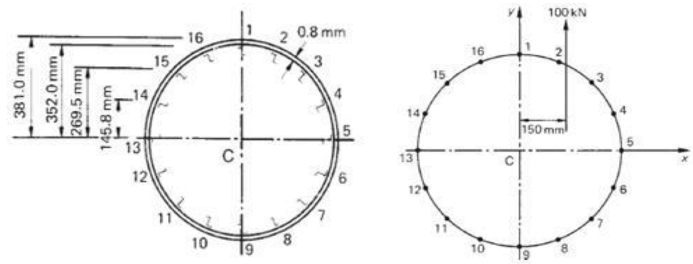
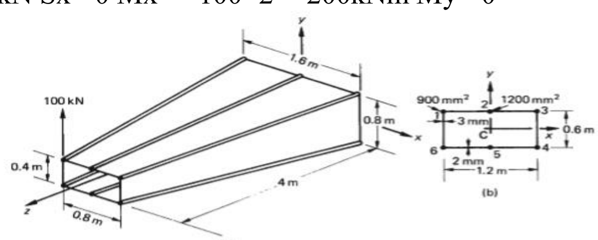
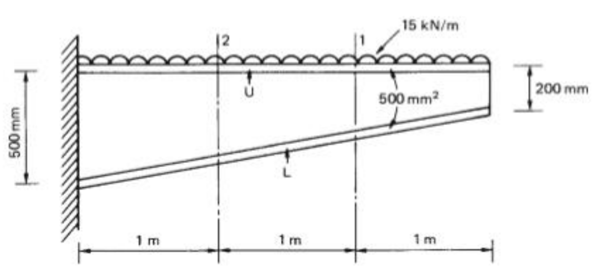


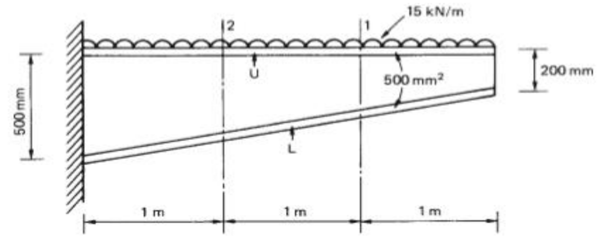
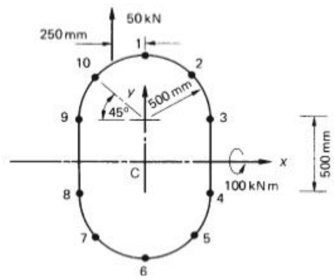
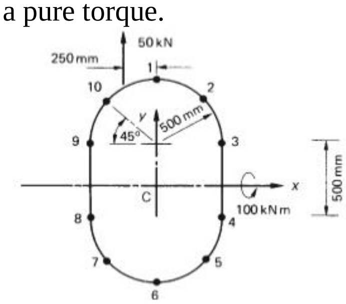
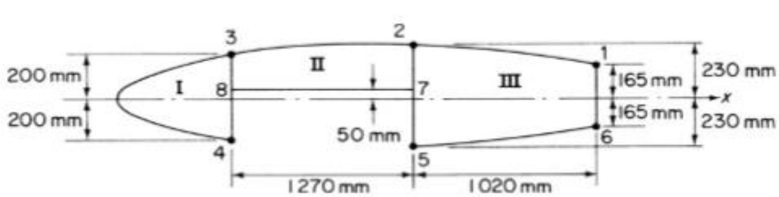
</td><td>CO 4</td><td>Understand</td><td>AAEB07:15</td></tr>
<tr><td>5</td><td>Calculate the shear flow distribution in the channel section shown in Fig. produced by a vertical shear load of 4.8 kN acting through its shear centre. Assume that the walls of the section are only effective in resisting shear stresses while the booms, each of area 300mm2, carry all the direct stresses.</td><td>CO 4</td><td>Understand</td><td>AAEB07:16</td></tr>
</table>

				
6	**Determine** the shear flow distribution at the built-in end of a beam whose cross-section is shown in Fig. below. All walls have the same thickness *t* and shear modulus *G*; *R*=200 mm. 	CO 4	Understand	AAEB07:16
7	A shallow box section beam whose cross-section is shown in Fig. is simply supported over a span of 2m and carries a vertically downward load of 20 kN at mid span. Idealize the section into one suitable for shear lag analysis, comprising eight booms, and hence **determine** the distribution of direct stress along the top right-hand corner of the beam. Take *G/E* =0.36. 	CO 4	Understand	AAEB07:15
8	**Determine** the shear flow distribution in the thin-walled Z-section shown in Figure due to a shear load *Sy* applied through the shear center of the section. 	CO 4	Understand	AAEB07:15
9	An open section beam of length L has the section shown in Figure. The beam is firmly built-in at one end and carries a pure torque T. Derive expressions for the direct stress and shear flow distributions produced by the axial constraint (the σ_Γ and q_Γ systems) and the rate of twist of the beam.	CO 4	Understand	AAEB07:15

				
10	Write the equation to find out the bending stress of idealized panel, if M_x equal to zero.	CO 4	Remember	AAEB07:16
UNIT-V				
STRESS ANALYSIS OF AIRCRAFT COMPONENTS- WING, FUSELAGE				
PART - A (SHORT ANSWER QUESTIONS)				
1	The fuselage shell section has been idealized such that the fuselage skin is effective only in	CO 5	Remember	AAEB07:17
2	Wings and fuselages are usually tapered along their lengths for greater	CO 5	Remember	AAEB07:17
3	Wing ribs perform functions similar to those performed by	CO 5	Remember	AAEB07:17
4	A thin rectangular strip suffers warping across its thickness when subjected to	CO 5	Remember	AAEB07:17
5	The theory of the torsion of closed section beams is known as	CO 5	Remember	AAEB07:17
6	A section does not remain rectangular but distorts; the effect is known as	CO 5	Understand	AAEB07:17
7	If the shear force is 400 N over the length of the 200 mm stiffener, the shear flow is	CO 5	Remember	AAEB07:18
8	A bending moment M applied in any longitudinal plane parallel to the z-axis may be resolved into components	CO 5	Remember	AAEB07:18
9	For a symmetric section about both axes, the shear centre lies at	CO 5	Understand	AAEB07:19
10	In many aircrafts, structural beams, such as wings, have stringers whose cross-sectional areas vary in the direction.	CO 5	Remember	AAEB07:20
PART - B (LONG ANSWER QUESTIONS)				
1	Explain direct stress distribution on wing section with neat sketch.	CO 5	Remember	AAEB07:16
2	Derive shear flow distribution on wing section with neat sketch.	CO 5	Understand	AAEB07:16
3	Derive shear flow distribution on fuselage section.	CO 5	Remember	AAEB07:16
4	Explain the functions of fuselage frames and wing ribs.	CO 5	Remember	AAEB07:17
5	Explain torsion on three boom shell with neat sketch.	CO 5	Understand	AAEB07:17
6	**Write** a detailed note on the following Fuselage frames Wing ribs	CO 5	Understand	AAEB07:18
7	The beam shown in Figure is simply supported at each end and carries a load of 6000N. if all direct stresses are resisted by the flanges and stiffeners and the web panels are effective only in shear, **calculate** the distribution of axial load in the flanges ABC and the stiffeners BE and the Shear flows in the panels.	CO 5	Understand	AAEB07:18
8	**Derive** the equation to find out shear flow in a tapered wing.	CO 5	Remember	AAEB07:18
9	A wing spar has the dimensions shown in Fig. and carries a uniformly distributed load of 15 kN/m along its complete length. Each flange has a cross-sectional area of 500mm^2 with the top	CO 5	Remember	AAEB07:20

	flange being horizontal. If the flanges are assumed to resist all direct loads while the spar web is effective only in shear, **determine** the flange loads and the shear flows in the web at sections 1 and 2m from the free end. 			
10	**Calculate** the shear flows in the web panels and direct load in the flanges and stiffeners of the beam shown in Figure if the web panels resist shear stresses only. 	CO 5	Remember	AAEB07:20
PART – C (PROBLEM SOLVING AND CRITICAL THINKING)				
1	**Calculate** the shear flows in the web panels and the axial loads in the flanges of the wing rib shown in Figure. Assume that the web of the rib is effective only in shear while the resistance of the wing to bending moments is provided entirely by the three flanges 1, 2 and 3. 	CO 5	Understand	AAEB07:16
2	A cantilever beam shown in Figure carries concentrated loads as shown. **Calculate** the distribution of stiffener loads and the shear flow distribution in the web panels assuming that the latter are effective only in shear. 	CO 5	Understand	AAEB07:16
3	The beam shown in Figure is simply supported at each end and carries a load of 6000 N. If all direct stresses are resisted by the flanges and stiffeners and the web panels are effective only in shear, **calculate** the distribution of axial load in the flange ABC and the stiffener BE and the shear flows in the panels.	CO 5	Understand	AAEB07:17

				
4	The fuselage shown in Fig. a) below is subjected to a vertical shear load of 100 kN applied at a distance of 150mm from the vertical axis of symmetry as shown, for the idealized section, in Fig. b). **Calculate** the distribution of shear flow in the section. 	CO 5	Understand	AAEB07:17
5	The cantilever beam shown in Fig. is uniformly tapered along its length in both x and y directions and carries a load of 100kN at its free end. Calculate the forces in the booms and the shear flow distribution in the walls at a section 2m from the built-in end if the booms resist all the direct stresses while the walls are effective only in shear. Each corner boom has a cross-sectional area of $900mm^2$ while both central booms have cross-sectional areas of $1200mm^2$. The internal force system at a section 2m from the built-in end of the beam is Sy =100kN Sx =0 Mx =−100×2=−200kNm My =0 	CO 5	Remember	AAEB07:18
6	Awing spar has the dimensions shown in Fig and carries a uniformly distributed load of 15kN/m along its complete length. Each flange has a cross-sectional area of $500mm^2$ with the top flange being horizontal. If the flanges are assumed to resist all direct loads while the spar web is effective only in shear, determine the flange loads and the shear flows in the web at sections 1 and 2m from the free end. 	CO 5	Understand	AAEB07:18
7	If the web in the wing spar of fig. has a thickness of 2mm and is	CO 5	Understand	AAEB07:19

	fully effective in resisting direct stresses, calculate the maximum value of shear flow in the web at a section 1m from the free end of the beam. 			
8	The doubly symmetrical fuselage section shown in Fig. has been idealized into an arrangement of direct stress carrying booms and shear stress carrying skin panels; the boom 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 50kN and a bending moment of 100kNm. 	CO 5	Understand	AAEB07:20
9	Determine the shear flow distribution in the fuselage section of fig. by replacing the applied load by a shear load through the shear centre together with a pure torque. 	CO 5	Understand	AAEB07:20
10	The wing section shown in Fig. has been idealized such that the booms carry all the direct stresses. If the wing section is subjected to a bending moment of 300kNm applied in a vertical plane, calculate the direct stresses in the booms. Boom areas: B_1 $=B_6$ $=2580mm^2$ B_2 $=B_5$ $=3880mm^2$ B_3 $=B_4$ $=3230mm^2$ 	CO 5	Remember	AAEB07:20

Prepared By: Dr. Y B Sudhir Sastry, Professor **HOD, AE**