INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	ANALYSIS OF AIRCRAFT STRUCTURES
Course Code	:	AAE006
Regulation	:	IARE - R16
Year	:	2018 – 2019
Class	:	B. Tech IV Semester
Branch	:	Aeronautical Engineering
Course coordinator	:	Dr. Y B Sudhir Sastry, Professor

COURSE OBJECTIVES (COs)
The course should enable the students to:

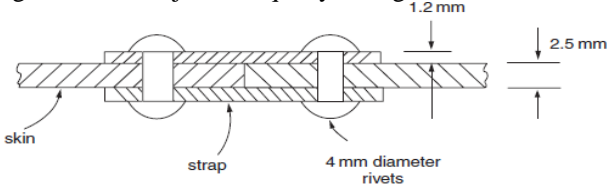| S. No	Description
I	Understand the aircraft structural components and its behavior under different loading conditions
II	Obtain knowledge in plate buckling and structural instability of stiffened panels for airframe structural analysis.
III	Explain the thin walled section and structural idealization 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.

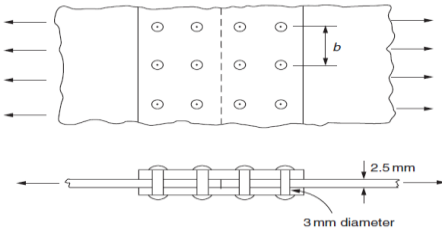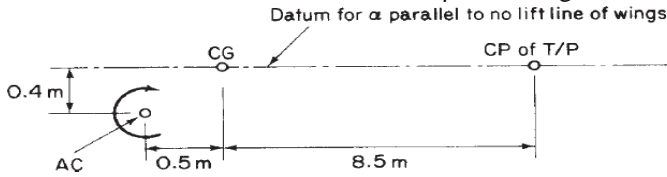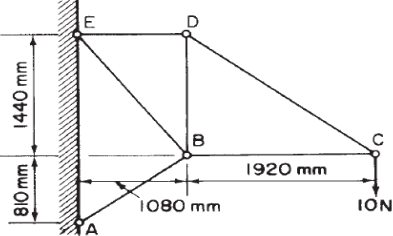## COURSE LEARNING OUTCOMES (CLOs)
Students, who complete the course, will be able to demonstrate the ability to do the following:
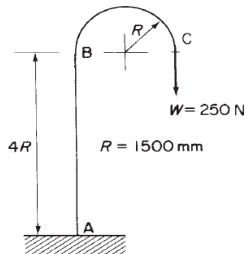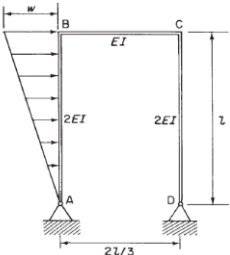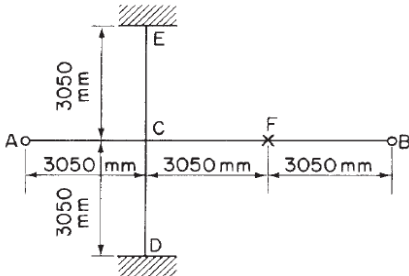
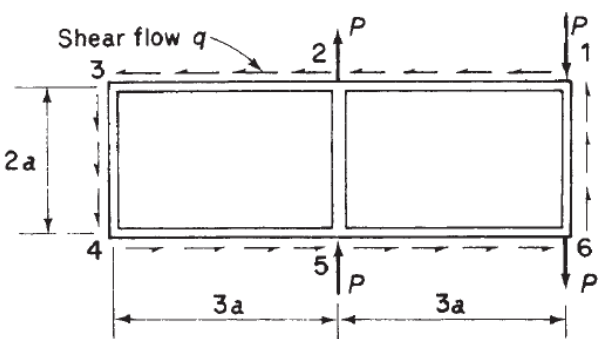|	
CAAE006.01	Discuss the Aircraft Structural components, various functions of the components and airframe loads acting on it.
CAAE006.02	Discuss different types of structural joints and the effect of Aircraft inertia loads, Symmetric maneuver loads, gust loads on the joints.
CAAE006.03	Differentiate Monocoque and semi monocoque structures and analyze stresses in thin and thick shells.
CAAE006.04	Explain energy principles and its application in the analysis of structural components of Aircraft.
CAAE006.05	Explain the Theory of thin plates and Analyze thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading.
CAAE006.06	Describe Buckling phenomena of thin plates and derive Elastic, inelastic, experimental determination of critical load for a flat plate.
CAAE006.07	Calculate the local instability, instability of stiffened panels, failure stresses in plates and stiffened panels.
CAAE006.08	Discuss critical buckling load for flat plate with various loading and end conditions
CAAE006.09	Solve for bending and shear stresses of symmetric and un-symmetric beams under loading conditions
CAAE006.10	Solve for deflections of beams under loading with various approaches
CAAE006.11	Calculate the shear stresses and shear flow distribution of thin walled sections subjected to shear loads.

CAAE006.12	Explain Torsion phenomenon, Displacements and Warping associated with Bredt-Batho shear flow theory of beams.
CAAE006.13	Explain the theory of Structural idealization
CAAE006.14	Principal assumptions in the analysis of thin walled beams under bending, shear, torsion.
CAAE006.15	Solve for stress distribution of idealized thin walled sections subjected to bending.
CAAE006.16	Solve for stress distribution of idealized thin walled sections subjected to, shear and torsion.
CAAE006.17	Calculate and analysis of idealized thin walled sections subjected to bending
CAAE006.18	Calculate and analysis of idealized thin walled sections subjected to shear and torsion.
CAAE006.19	Analyze fuselage of variable stringer areas subjected to transverse and shear loads.
CAAE006.20	Analyze Wing spar and box beams of variable stringer areas subjected to transverse and shear loads.

TUTORIAL QUESTION BANK

UNIT - I
AIRCRAFT STRUCTURAL COMPONENTS

PART - A (SHORT ANSWER QUESTIONS)

S No	QUESTIONS	Blooms Taxonomy Level	Course Learning Outcomes
1	What is Structural load?	Understand	CAAE006:01
2	What is basic function of structural components?	Understand	CAAE006:01
3	What are the types of structural joints?	Understand	CAAE006:02
4	What is Aircraft inertia loads?	Understand	CAAE006:02
5	What is Monocoque structure?	Understand	CAAE006:03
6	What is semi monocoque structures?	Understand	CAAE006:03
7	Define castiglianos theorem-I	Understand	CAAE006:04
8	Define castiglianos theorem-II	Remember	CAAE006:04
9	Define Maxiwells reciprocal theorem	Remember	CAAE006:04
10	Write the equation to find out Hoop stress in thin shells subjected to internal pressure	Remember	CAAE006:04

PART - B (LONG ANSWER QUESTIONS)

1	Explain what are different loads acting on aircraft structural components with figures	Remember	CAAE006:01
2	Explain the functions of aircraft structural components and draw the neat sketches of each component.	Remember	CAAE006:01
3	Design a simple lap joint by considering Rivet shear, Bearing pressure, Plate failure in tension and Shear failure in a plate	Remember	CAAE006:02
4	Derive castiglianos theorem-I Prove the theorem with the help of neat sketches and assumptions.	Understand	CAAE006:04
5	Derive castiglianos theorem-II, List out the applications, advantages and dis-advantages	Understand	CAAE006:04
6	Derive the basic equation δ = Σudl in Unit load method with the help of neat sketches and assumptions.	Remember	CAAE006:04
7	Derive the equation to find out deflection and slope of cantilever beam with udl by using castiglianos theorem	Remember	CAAE006:04
8	What is Rayleigh Ritz method, Explain in detail with the help of examples and also list out the applications?	Remember	CAAE006:04
9	Find out the vertical displacement of simply supported beam with point load at mid-point by using total potential energy method.	Remember	CAAE006:04

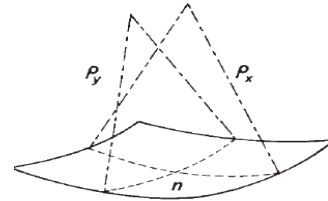| 10	What is maxiwells reciprocal theorem, Prove it and explain with the help of neat sketches.	Remember	CAAE006:04
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)			
1	Ajoint in a fuselage skin is constructed by riveting the abutting skins between two straps as shown in Fig. below. The fuselage 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 skinmust 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 inshear and tension.	Understand	CAAE006:02
2	The double riveted butt joint shown in Fig. below connects two plates whichare each 2.5mm thick, the rivets have a diameter of 3 mm. If the failure strength of therivets 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 toshear in the rivets and failure due to tension in the plate occur simultaneously. Calculatealso the joint efficiency.	Understand	CAAE006:02
3	An aircraft of all up weight 145 000N has wings of area 50m^{2}and meanchord 2.5 m. For the whole aircraftC_D=0.021+0.041C^2L, for the wings dC_L/dα=4.8, for the tailplane of area 9.0m2, dC_L,T/dα=2.2 allowing for the effects of downwash and the pitching moment coefficient about the aerodynamic centre (of complete aircraft less tailplane) 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 aircraftmeets a downgust of equivalent 'sharp-edged' speed 6 m/s. Calculate the tail load, thegust load factor and the forward inertia force, ρ_0=1.223 kg/m^3.	Understand	CAAE006:02
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.	Apply	CAAE006:03
5	A rigid triangular plate is suspended from a horizontal plane by three verticalwires attached to its corners. The wires are each 1mm diameter, 1440mm long, witha modulus of elasticity of 196 000 N/mm^2. The ratio of	Understand	CAAE006:03

	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.		
6	The tubular steel post shown in Fig. below supports a load of 250N at the free end 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. 	Remember	CAAE006:04
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, varyinglinearly in intensity from zero at A to '*w*'per unit length at B. Determine the distribution of bending moment in the frame, illustrating your resultswith a sketchshowing the principal values. 	Apply	CAAE006:04
8	Figure below shows a plan view of two beams, AB 9150mm long andDE 6100mm long. The simply supported beam AB carries a vertical load of 100000Napplied 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. 	Remember	CAAE006:04
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 deflectionat the mid-point of AB due to loads of 3000N applied at each of the extreme ends ofthe beam.	Remember	CAAE006:04
10	The rectangular frame shown in Fig. consists of two horizontal members123 and 456 rigidly joined to three vertical members 16, 25 and 34. All fivemembers have the same bending stiffness *El*. The frame is loaded in its own plane by a system of point loads *P* which are balancedby a constant shear flow *q* around the outside. Determine the	Understand	CAAE006:04

	distribution of the bendingmoment in the frame and sketch the bending moment diagram. In the analysis takebending deformations only into account.		
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<table>
<tr><td colspan="4" align="center">UNIT – II</td></tr>
<tr><td colspan="4" align="center">THIN PLATE THEORY</td></tr>
<tr><td colspan="4">PART - A (SHORT ANSWER QUESTIONS)</td></tr>
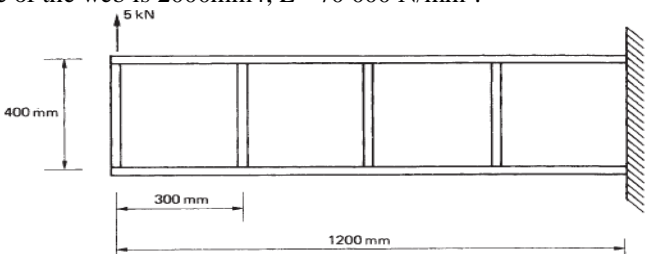<tr><td>1</td><td>Differentiate between thin plate and thick plate.</td><td>Remember</td><td>CAAE006:05</td></tr>
<tr><td>2</td><td>What is ρ_x and ρ_y from below diagram?
</td><td>Understand</td><td>CAAE006:05</td></tr>
<tr><td>3</td><td>Write the formula to find out Flexural rigidity of thin plate.</td><td>Understand</td><td>CAAE006:05</td></tr>
<tr><td>4</td><td>Give the formula for deflection of plate in the terms of infinite series.</td><td>Understand</td><td>CAAE006:06</td></tr>
<tr><td>5</td><td>Write the differential equation for strain energy.</td><td>Remember</td><td>CAAE006:06</td></tr>
<tr><td>6</td><td>Differentiate between Synclastic and Anticlastic.</td><td>Remember</td><td>CAAE006:06</td></tr>
<tr><td>7</td><td>Write the Built-in edge condition for a plate.</td><td>Remember</td><td>CAAE006:06</td></tr>
<tr><td>8</td><td>What is "N_x" in this equation $\frac{\partial^4 w}{\partial x^4} + \frac{\partial^4 w}{\partial x^2 \partial y^2} + \frac{\partial^4 w}{\partial y^4} = \frac{1}{D}\left(q + N_x \frac{\partial^2 w}{\partial x^2} + Ny\partial 2w\partial y2 + Nxy\partial 2w\partial x\partial y\right)$</td><td>Remember</td><td>CAAE006:07</td></tr>
<tr><td>9</td><td>The application of transverse and in-plane loads will cause the plate to deflect a further amount w1 so that the total deflection is.</td><td>Remember</td><td>CAAE006:07</td></tr>
<tr><td>10</td><td>What is the meaning of critical load in plates?</td><td>Remember</td><td>CAAE006:08</td></tr>
<tr><td colspan="4">PART - B (LONG ANSWER QUESTIONS)</td></tr>
<tr><td>1</td><td>Explain the basic theory of thin plates? Writ the assumptions and boundary conditions of the plate.</td><td>Remember</td><td>CAAE006:05</td></tr>
<tr><td>2</td><td>Derive the expression for direct/bending stress of a pure bending of thin plates? With the help of neat sketches.</td><td>Remember</td><td>CAAE006:05</td></tr>
<tr><td>3</td><td>What is the term flexural rigidity called in bending of thin plates and explain? Write the equation.</td><td>Remember</td><td>CAAE006:06</td></tr>
<tr><td>4</td><td>Clearly explain the difference between synclastic and anticlastic surface of thin plates?</td><td>Remember</td><td>CAAE006:05</td></tr>
<tr><td>5</td><td>Clearly draw the figure for plate element subjected to bending, twisting and transverse loads?</td><td>Remember</td><td>CAAE006:06</td></tr>
<tr><td>6</td><td>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?</td><td>Remember</td><td>CAAE006:05</td></tr>
<tr><td>7</td><td>Write the conditions for a plate which clamped at all edges? And write the</td><td>Remember</td><td>CAAE006:07</td></tr>
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	assumed deflected form of the plate which satisfies the boundary conditions for this plate?		
8	Write the conditions for a plate which simply supported all two edges and the other two edges are free?	Remember	CAAE006:07
9	Write the assumed deflected form of the plate which satisfies the boundary conditions for this plate?	Remember	CAAE006:08
10	Explain the behavior of the thin plates subjected to bending and twisting.	Understand	CAAE006:08

PART – C (PROBLEM SOLVING AND CRITICAL THINKING)

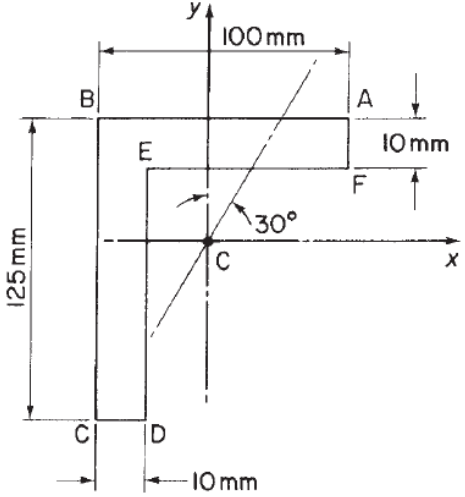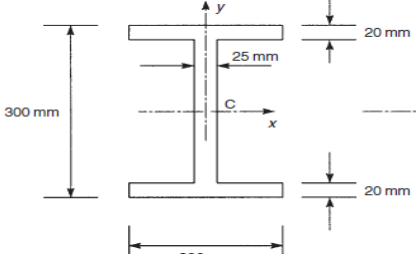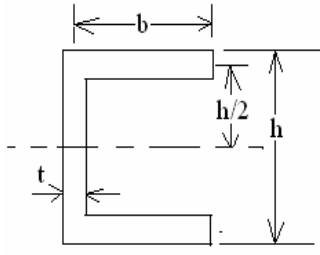|			
1	Derive the equation $(1/\rho) = M / [D (1+ \upsilon)]$ of thin plate subjected to pure bending.	Remember	CAAE006:06
2	Derive the equation $M_{xy} = D (1-\upsilon)\, \partial^2 w/\partial x \partial y$ for a thin plate subjected to bending and twisting	Understand	CAAE006:06
3	A plate 10mmthick 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.	Understand	CAAE006:06
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.	Understand	CAAE006:06
5	A rectangular plate $a \times b$, 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 $A11$ and hence find the maximum value of deflection.	Remember	CAAE006:06
6	A thin rectangular plate $a \times b$is simply supported along its edges and carries a uniformly distributed load of intensity $q0$ and supports an in-plane tensile force Nxper unit length.Determine the deflected form of the plate.	Understand	CAAE006:07
7	A rectangular plate $a \times b$, simply supported along each edge, possesses a small initial curvature Determine, using the energy method, its final deflected shape when it is subjected to acompressive load Nxper unit length along the edges $x =0$, $x =a$.	Remember	CAAE006:07
8	Explain Instability of Stiffened panels, with the help of neat sketches.	Understand	CAAE006:07
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 critical load. 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/mm^2.	Understand	CAAE006:08
10	Derive the equation for critical stress $(\sigma_{CR}) = [\ k\pi^2 E\ /12(1 - \upsilon2)]\ (t/b)2$ for plate subjected to the compressive load.	Remember	CAAE006:08

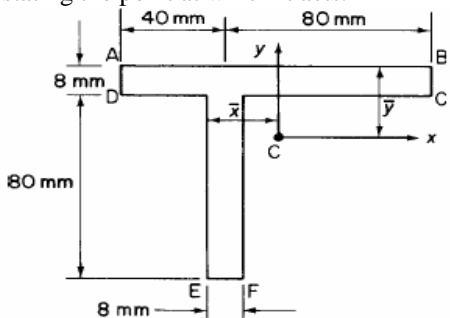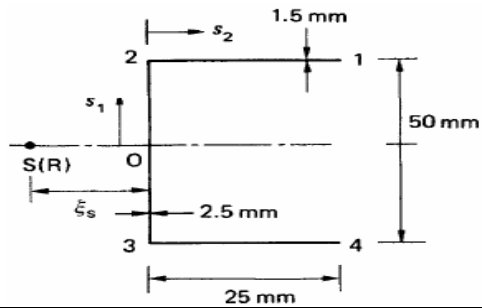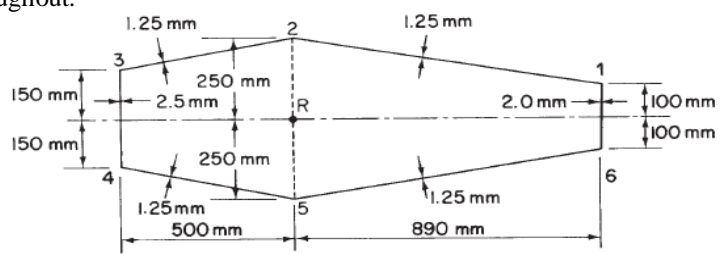|	
UNIT-III	
BENDING SHEAR AND TORSION OF THIN WALLED BEAMS	

PART - A (SHORT ANSWER QUESTIONS)

1	What is flexural rigidity?	Remember	CAAE006:09
2	What is neutral plane?	Remember	CAAE006:09

3	The term $\int y^2 dA$ is known as the	Understand	CAAE006:09
4	Write the expression for σ_z in terms of M_x , M_y, &I_{xx}, I_{yy} , I_{XY} is	Remember	CAAE006:09
5	Write the relation between shear force and intensity of load	Remember	CAAE006:09
6	What is the other name of the Singularity function?	Remember	CAAE006:10
7	What is the name of strain produced by a temperature change ΔT?	Apply	CAAE006:10
8	What is shear flow distribution?	Understand	CAAE006:11
9	What is Warping distribution?	Remember	CAAE006:11
10	Write the value of I_{XY} for unsymmetrical section.	Remember	CAAE006:11
11	Give the definition for Warping.	Remember	CAAE006:11

PART – B (LONG ANSWER QUESTIONS)

1	Write short notes on the following:
	  i. Symmetrical bending
	  ii. Unsymmetrical bending
		Understand	CAAE006:08

2	Explain the following terms.
	  i. Shear center
	  ii. Shear flow
	  iii. Centre of twist
		Understand	CAAE006:08

3	Derive the equations to find out the primary and secondary warping of an open cross section subjected to torsion.	Understand	CAAE006:09
4	Derive the Bredt-Batho formula for thin walled closed section beams with the help of neat sketch.	Understand	CAAE006:09
5	Explain the condition for Zero warping at a section, and derive the warping of cross section.	Understand	CAAE006:10
6	What do mean by shear centre? Explain with the help of figure for open sections.	Understand	CAAE006:10
7	In order to understand open sections, one has to be clear about centroid, neutral point and shear centre. Explain them with mathematical expression.	Understand	CAAE006:10
8	Derive the expression for the ripple factor of π-Section filter when used with a Full-wave-rectifier. Make necessary approximations?	Remember	CAAE006:11
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. 	Remember	CAAE006:12
10	Derive the total torque equation for arbitrary section beam subjected to torsion	Understand	CAAE006:12

Part – C (Problem Solving and Critical Thinking)

1	Derive $(\sigma_z) = [(M_y I_{xx} - M_x I_{xy}) / (I_{xx} I_{yy} - I_{xy}^2)] x + [(M_x I_{yy} - M_y I_{xy}) / (I_{xx} I_{yy} - I_{xy}^2)] y$	Understand	CAAE006:9

2	Figure below shows the section of an angle purlin. A bending moment of 3000Nm is applied to the purlin in a plane at an angle of 30° to the vertical y axis. If the sense of the bending moment is such that its components M_x and M_y both produce tension in the positive xy quadrant, calculate the maximum direct stress in the purlin stating clearly the point at which it acts.	Understand	CAAE006:09
3	Define and explain the terms i) shear flow, ii) shear centre, iii) centre of twist.	Remember	CAAE006:09
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.	Understand	CAAE006:09
5	Derive the equation to find out the shear center of figure shown.	Remember	CAAE006:10
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.	Remember	CAAE006:10
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	Remember	CAAE006:11

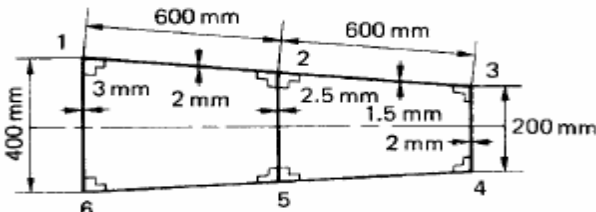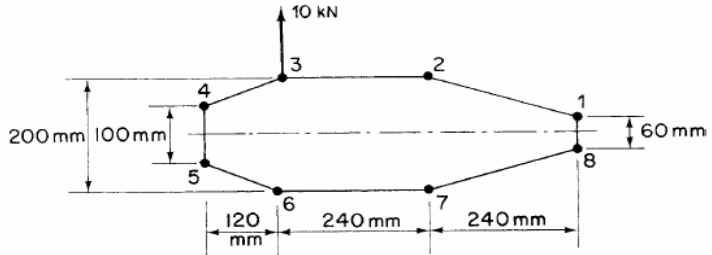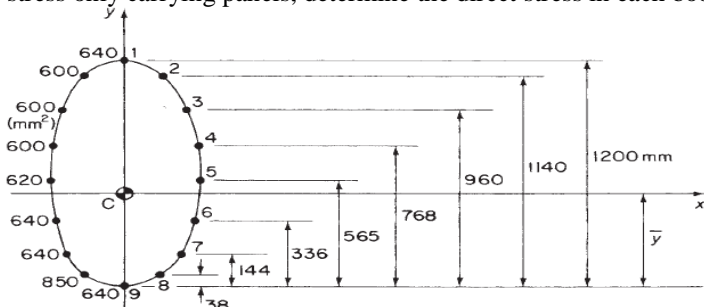|	due to bending stating the point at which it acts.		
8	Determine the maximum shear stress and the warping distribution in the channel section shown in Figure when it is subjected to an anticlockwise torque of 10 Nm. G=25000 N/mm^2.	Understand	CAAE006:12
9	Calculte the shear centre for C-channel section as shown.	Remember	CAAE002:12
10	Determine the warping distribution in the doubly symmetrical rectangular, closed section beam, shown in Fig, when subjected to an anticlockwise torque T.	Remember	CAAE006:12
11	A single cell, thin-walled beam with the double trapezoidal cross-section shown in Fig is subjected to a constant torque T =90,500Nmand 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.	Remember	CAAE006:12
	UNIT-IV		
	STRUCTURAL IDEALIZATION		
	PART – A (SHORT ANSWER QUESTIONS)		
1	Define structural idealization.	Remember	CAAE006:13
2	Derive the equation to find out boom areas with neat sketches.	Understand	CAAE006:13
3	Explain how to idealization the panel	Understand	CAAE006:13
4	Derive the equation for shear flow.	Understand	CAAE006:13
5	Explain what are structural Idealization and its principle.	Understand	CAAE006:13
6	What is the boom area?	Understand	CAAE006:14
7	Write short notes on the following: (a) Booms in structures. (b) Structural idealization.	Remember	CAAE006:14

8	Explain about air loads.	Remember	CAAE006:15
9	Draw the Actual and Idealized panels.	Understand	CAAE006:16
10	Write the equation to find out the bending stress of idealized panel.	Understand	CAAE006:16

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.	Understand	CAAE006:15
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.	Apply	CAAE006:16
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.	Understand	CAAE006:16
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.	Understand	CAAE006:15
5	Derive the equation to find out the bending stress of idealized panel.	Remember	CAAE006:15
6	Derive the equation to find out the bending stress of idealized panel, if M_x equal to zero.	Remember	CAAE006:15
7	Derive the equation to find out the bending stress of idealized panelif M_y equal to zero with neat sketch.	Remember	CAAE006:15
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 is660mm and moment of Inertia 278 x 10^6	Remember	CAAE006:16

9	Draw the neat sketches of idealized simple wing section. Derive bending stress and shear flow distribution.	Remember	CAAE006:16
10	Draw the neat sketches of idealized simple fuselage section. Derive bending stress and shear flow distribution.	Remember	CAAE006:16
	PART – C (PROBLEM SOLVING AND CRITICAL THINKING)		
1	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 10^6mm^4.	Apply	CAAE006:14
2	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.	Understand	CAAE006:14
3	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.	Understand	CAAE006:15
4	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.	Understand	CAAE006:15
5	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 300mm^2, carry all the direct stresses.	Understand	CAAE006:16

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.	Understand	CAAE006:16
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.	Understand	CAAE006:15
8	Determine the shear flow distribution in the thin-walled Z-section shown in Figure due to a shear load S_y applied through the shear center of the section.	Understand	CAAE006:15
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.	Understand	CAAE006:15

10	Write the equation to find out the bending stress of idealized panel, if M_x equal to zero.	Apply	CAAE006:16

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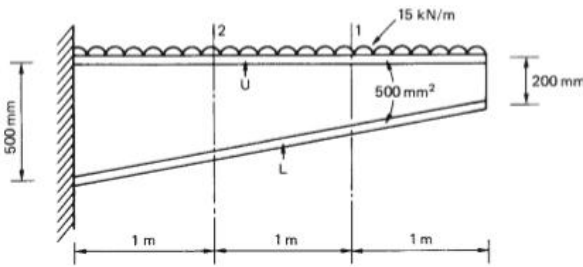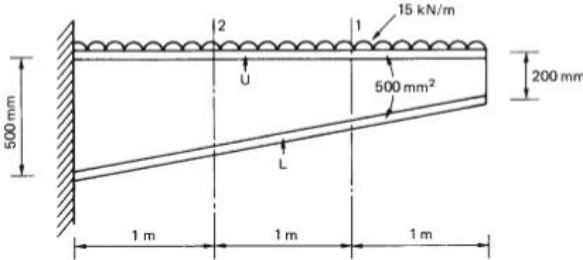<tr><td colspan="4" align="center">UNIT-V</td></tr>
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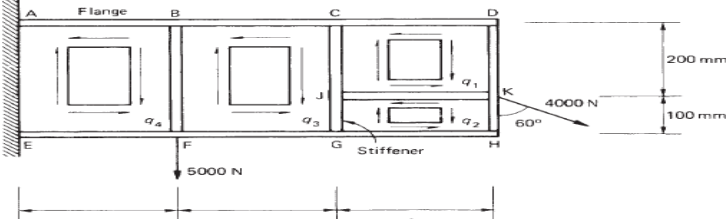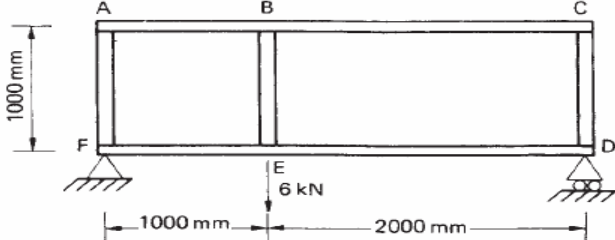|			
	STRESS ANALYSIS OF AIRCRAFT COMPONENTS- WING, FUSELAGE		
	PART - A (SHORT ANSWER QUESTIONS)		
1	The fuselage shell section has been idealized such that the fuselage skin is effective in which stress?	Evaluate	CAAE006:17
2	Why wings and fuselages are usually tapered along their lengths?	Remember	CAAE006:17
3	Wing ribs perform functions similar to those performed by which part of the wing?	Remember	CAAE006:17
4	A thin rectangular strip suffers warping across its thickness when subjected to what type of loads?	Remember	CAAE006:17
5	What is the name of the theory of the torsion of closed section beams?	Remember	CAAE006:17
6	A section does not remain rectangular but distorts; what that effect is called?	Understand	CAAE006:17
7	If the shear force is 400 N over the length of the 200 mm stiffener, What is the shear flow?	Remember	CAAE006:18
8	A bending moment M applied in any longitudinal plane parallel to the z-axis may be resolved into which components?	Remember	CAAE006:18
9	Explain about the shear centre for any symmetric section about both axes.	Understand	CAAE006:19
10	In many aircrafts, structural beams, such as wings, have stringers whose cross-sectional areas vary in which direction?	Remember	CAAE006:20
	PART - B (LONG ANSWER QUESTIONS)		
1	Explain the direct stress distribution on wing section with neat sketch.	Remember	CAAE006:16
2	Explain how the shear flow distribution on wing section with neat sketch.	Understand	CAAE006:16
3	Derive equations to find out the shear flow distribution on fuselage section.	Remember	CAAE006:16
4	Draw neat sketches and explain the functions of fuselage frames and wing ribs.	Remember	CAAE006:17
5	Explain how the torsion effect will be there on three boom shell with neat sketch.	Understand	CAAE006:17
6	Write a detailed note on the following i) Fuselage frames ii) Wing ribs	Understand	CAAE006:18
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.	Understand	CAAE006:18
8	Explain about tapered wing and derive the equation to find out shear flow.	Apply	CAAE006:19
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 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. 	Remember	CAAE006:20

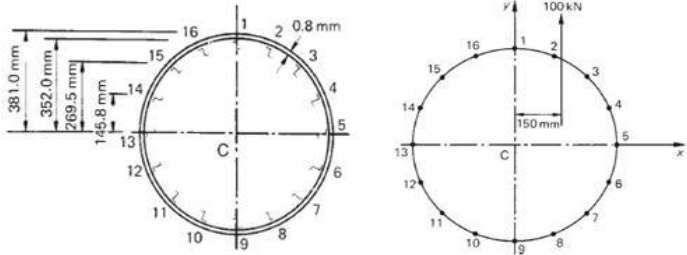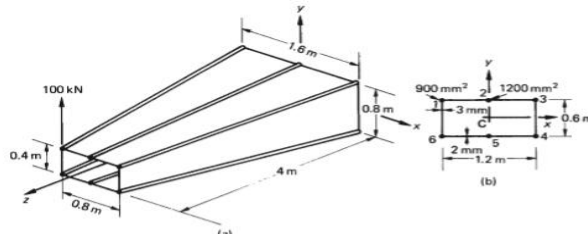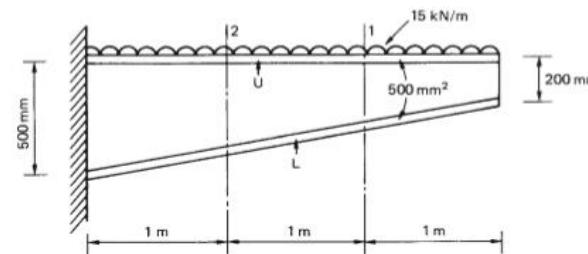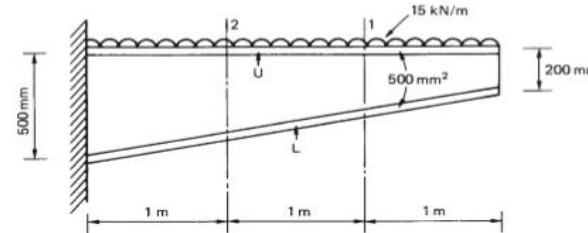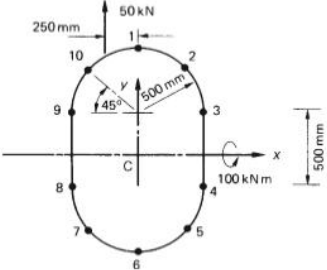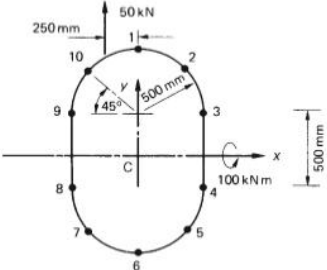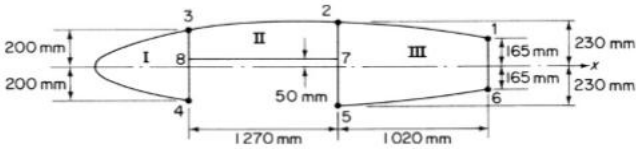| 10	Calculate the shear flows in the web panels and direct load in the flanges and stiffeners of the beam shown in Figure if the web panels resist shear stresses only.	Remember	CAAE006:20

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.	Understand	CAAE006:16
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.	Understand	CAAE006:16
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.	Understand	CAAE006:17
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.	Understand	CAAE006:17

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 900mm² while both central booms have cross-sectional areas of 1200mm². 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 	Apply	CAAE006:18
6	A wing spar has the dimensions shown in Fig and carries a uniformly distributedloadof15kN/malongitscompletelength.Eachflangehasacross-sectionalareaof500mm² 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. 	Understand	CAAE006:18
7	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 500mm² 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. If the web in the wing spar of fig. has a thickness of 2mm and is 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. 	Understand	CAAE006:19

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 all150mm^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.	Understand	CAAE006:20
9	Determine the shear flow distribution in the fuselage section of fig. by replacingtheappliedloadbyashearloadthroughtheshearcentretogetherwithapure torque.	Understand	CAAE006:20
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: $B_1 = B_6 = 2580mm^2$ $B_2 = B_5 = 3880mm^2$ $B_3 = B_4 = 3230mm^2$	Apply	CAAE006:20

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