Sanjay Ghodawat University, Kolhapur 2019-20

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| **Year and Program: 2019-20 and T.Y.B.Tech** | **School of Technology** | **Department of Aeronautical Engineering** |
| **Course Code: AET303** | **Course Title: Aircraft Structure-I** | **Semester – V** |
| **Day and Date** Thursday 21/11/19 | **End Semester Examination (ESE)** | **Time: 3 hours** 10.30am to 1.30 pm. **Max Marks: 100** |

**Instructions:**
1) All questions are compulsory.
2) Assume suitable data wherever necessary.
3) Figures to the right indicate full marks.

| Q.1 | **Attempt the Following** | Marks | Bloom's Level | CO |
|---|---|---|---|---|
| a) | Calculate direct stress distribution at x = 10mm and y = 15mm and position of neutral axis for a beam subjected to $M_x$ = 10kNm that has $I_{xx}$ = $10x10^6$ mm$^4$, $I_{yy}$ = $30x10^6$ mm$^4$ and $I_{xy}$ = $-35x10^6$ mm$^4$. | 07 | $L_3$ | CO1 |
| | OR | | | |
| a) | Derive load intensity, shear force and bending moment relationships for beam. | 07 | $L_2$ | CO1 |
| b) | The vertical and horizontal thickness are $t_f$ and $t_w$ respectively as shown in figure 1. Determine second moment of area $I_{xx}$ of I-section. | 08 | $L_3$ | CO2 |

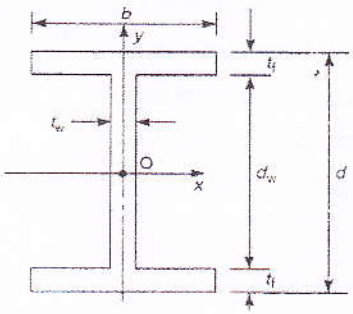



Fig. 1

OR

| | | | | |
|---|---|---|---|---|
| b) | Derive moment of area $I_{xx}$ for beam of circular diameter. | 08 | $L_2$ | CO2 |



ESE

Q.2

**Attempt the following**

a) Consider $I_{xx} = h^3t/3$ mm$^4$, $I_{yy} = h^3t/12$ mm$^4$ and $I_{xy} = h^3t/8$ for the beam as shown in the figure 2. Determine the shear flow distribution $q_2$ in thin-walled Z-section beam due to a shear load $S_y$ applied through shear center of the section. Thickness of all beam is t. 07 $L_3$ CO2

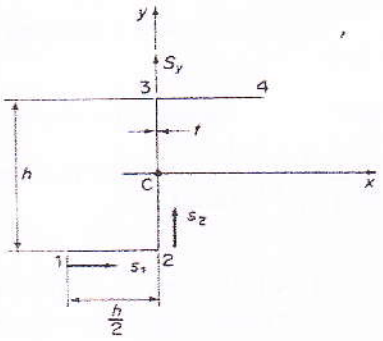



Fig. 2

OR

a) Explain in detail the concept of shear flow for symmetrical and/or unsymmetrical beam. 07 $L_3$ CO2

b) For beam in figure 3, assume all thickness $t_0$ is constant. Length of flange 23 is 2a. In flange 37, $s_1$ goes from 3 to 7. Consider unit rate of twist and $P_{R,37}$ = a. 1. Determine warping distribution $w_3$ and $w_7$ for beam in figure, 2. Calculate J for beam if $t_0$ = 2mm throughout. 08 $L_3$ CO2

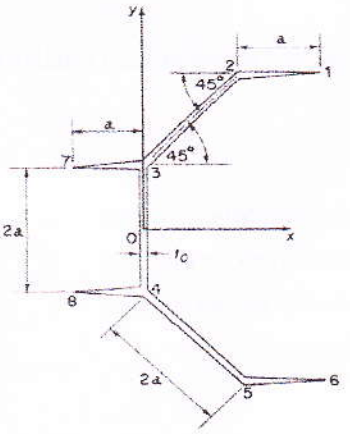



Fig. 3

OR



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b) Determine warping distribution $w_{01}$ in the rectangular closed section beam when subjected to torque T as shown in figure 4. Assume G is constant and $w_0 = 0$. The length of beam is a and width of the beam is b. 08 $L_3$ CO2

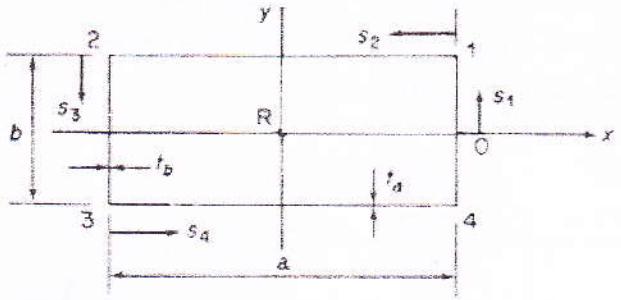



Fig. 4

Q.3 **Solve any Two**

a) Explain the following terms: 08 $L_2$ CO1

1) Sagging of beam 2) Hogging of beam

3) Neutral plane 4) Neutral axis

b) Write the derivation for the product second moment of area. 08 $L_2$ CO2

c) Answer the following: 08 $L_2$ CO2

1) What is CSRD?

2) Why do we assume CSRD for aircraft structure?

3) What is shear flow?

4) What is shear center?

d) 1. What is torsion? 2. What is torque? 08 $L_2$ CO2

3. What is pure torsion? 4. State Bredt-Batho formula.



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Q.4 **Solve any Two**

a) Determine the shear flow distribution $q_{12}$ and $q_{23}$ in the beam section shown in figure 5 when it is subjected to a shear load of 100kN in its vertical plane of symmetry. The thickness of the walls of the section is 2mm throughout. Consider $I_{xx} = 14.5 \times 10^6$ mm$^4$. 09 L3 CO2

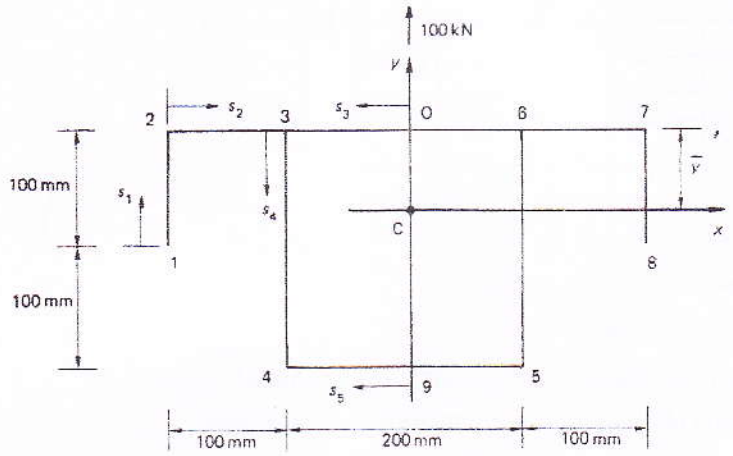



Fig. 5

b) Calculate the angle of twist per unit length and maximum shear stress in the wing whose cross-section is shown in figure 6 when subjected to torque of 55kNm. Consider G = 25000 N/mm$^2$, wall outer (12) = 900 mm and nose cell area = 20000 mm$^2$. 09 L3 CO2

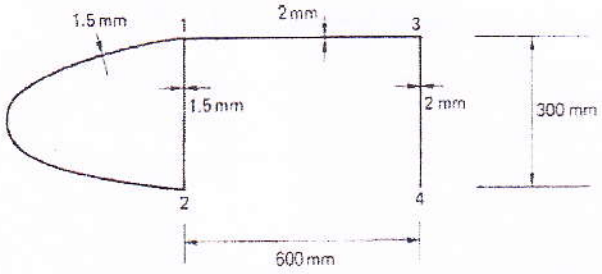



Fig. 6



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c) The wing box shown in figure 7 is subjected to torque of 100kN. Calculate rate of twist of section and maximum shear stress. Assume t = 2mm and G = 25000 N/mm$^2$. Length of flanges 12 = 78 = 34 = 56 = 500mm. 09 $L_3$ CO2

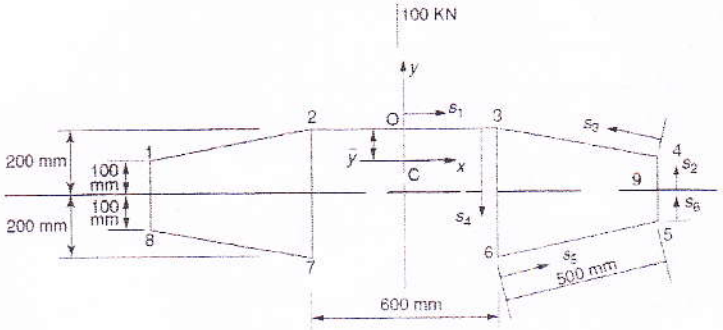



Fig. 7

Q.5 **Solve any Two**

a) Calculate the deflection of the free end of a cantilever 2000 mm long having a channel section as shown in figure 8 which is supporting a vertical, upward load of 48kN acting through the shear centre of the section. The effective direct stress carrying thickness of the skin is zero while its actual thickness is 1 mm. Young's modulus E and shear modulus G are 86000 and 43000 N/mm respectively. Consider $q_{12} = q_{34}$ = -6 N/mm, $q_{23}$ = -12 N/mm and $I_{xx} = 48x10mm^4$. 09 $L_3$ CO3

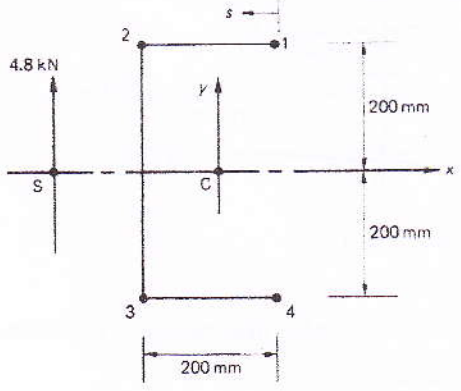



Fig. 8



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b) The fuselage shown in figure 9 is subjected to bending moment of 100kNm applied in vertical plane of symmetry. If section has been completely idealized into combination of direct panels, calculate direct stress in booms 3 and 4. 09 $L_3$ CO3

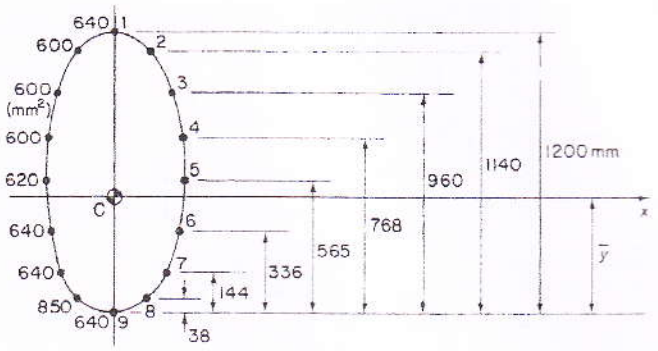



Fig. 9

c) Idealize the section shown in figure 10 into an arrangement of direct stress carrying booms and shear stress only carrying panels suitable for resisting bending moments in a vertical plane. Part of a wing section is in the form of the two-cell box in which the vertical spars are connected to the wing skin through angle sections have a cross-sectional area of 300mm$^2$. Position the booms at the spar/skin junctions. Length of flange 25 is 300mm. 09 $L_3$ CO3

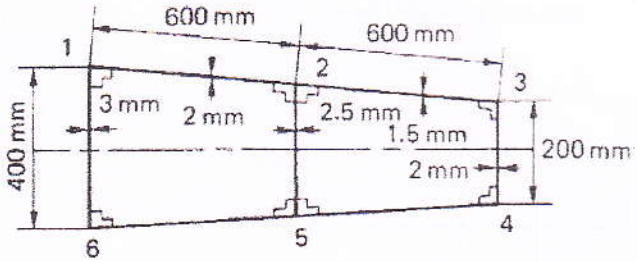



Fig. 10

Q.6 **Solve any Three**

a) Explain about combined beam and write the steps needed to find shear flow distribution in combined beams. 06 $L_2$ CO2



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| | | | | |
|---|---|---|---|---|
| ) | Analyze the examination of combined beams for bending and torsion when compared to analyzing individual open and closed beams. | 06 | $L_4$ | CO2 |
| ) | For bending and torsion of open and closed beams, describe the effect of idealization of structure. | 06 | $L_2$ | CO2 |
| ) | Describe idealization of aircraft structure with sketches. | 06 | $L_2$ | CO3 |

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