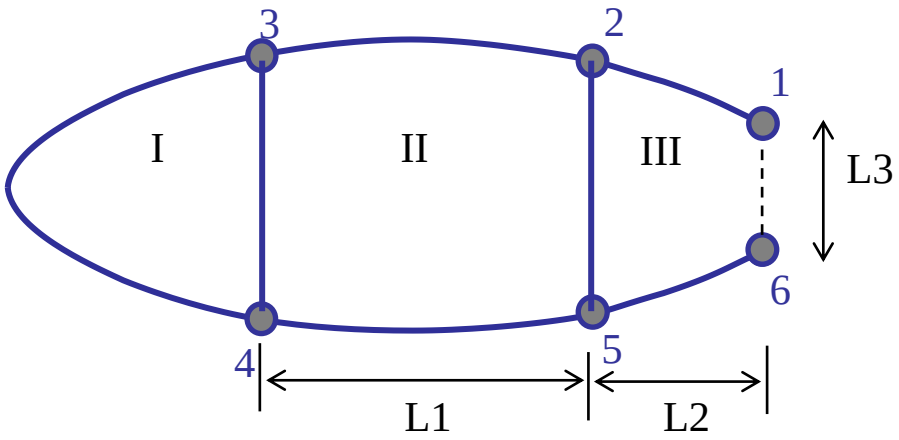
Aeronautical Structures (MECA0028-1)

June 2023

Question n° 1



The wing depicted here above has the idealized cross-section properties reported in the four Tables here below. The cell number III is not closed (there is no wall between booms 1 and 6). The **booms distribution is not symmetrical**.

Wall	Length (mm)	Thickness (mm)	Shear modulus (GPa)
12, 56	610	1.	22
23, 45	920	1.	22
34(	1220	1.	22
34|	365	1.	71
25	365	1.	71

Boom	Section (mm^2)
1	1 000
2	1 300
3	1 300
4	1 000
5	1 000
6	1 000

Cell	Area (mm^2)
I	134 000
II	372 000
III	202 000

Distance	Length (mm)
L1	914
L2	610
L3	245

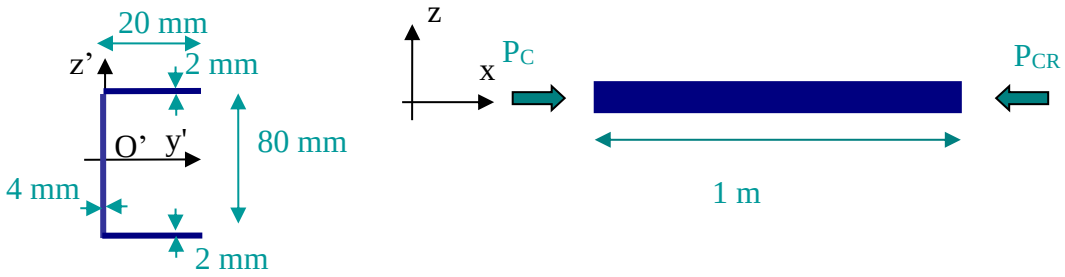
We consider the following assumptions

- The booms carry the direct stress (due to bending) only;
- The skin panels sustain the shear stress only;
- The taper effect can be neglected;
- Twist and shear centres are assumed to coincide.

You are requested to compute

A) The bending inertia centre of the wing section.
B) The location of the shear centre of the wing section.
C) The twist rate for a load T_y= 3kN, T_z = 8kN passing through this shear centre.

Question n° 2



	Aluminum Alloy	Titanium Alloy
Young's modulus E [GPa]	71	120
Poisson's ratio ν [-]	0.33	0.33
Yield stress σ_0 [MPa]	200	800

We consider two U-section beams of identical geometry as illustrated here above. The considered materials are as follows:

1. The first beam is made entirely of aluminium alloy;
2. The second beam has its web made of aluminium alloy and the two flanges made of titanium alloy.

Considering that the walls thickness can be assumed small compared to the other dimensions, you are requested to answer to the following questions, for each of the two beams:

1. In the referential $O'y'z'$, where is the location of the inertia centre C governing the bending behaviour? Be careful that different materials are involved in the beam.
2. What are the values of the modified second moments of area EI_{yy}, EI_{zz}, and EI_{yz}, governing the bending behaviour?
3. Assuming that the beam is 1-meter long, clamped at both extremities, and that torsion is not allowed, what is the Euler critical buckling load?
4. Assuming that the beam is 1-meter long, clamped at one extremity only, and that torsion is not allowed, what is the Euler critical buckling load?
5. How efficient is the design of the beam considering the the yield stress of the involved materials.