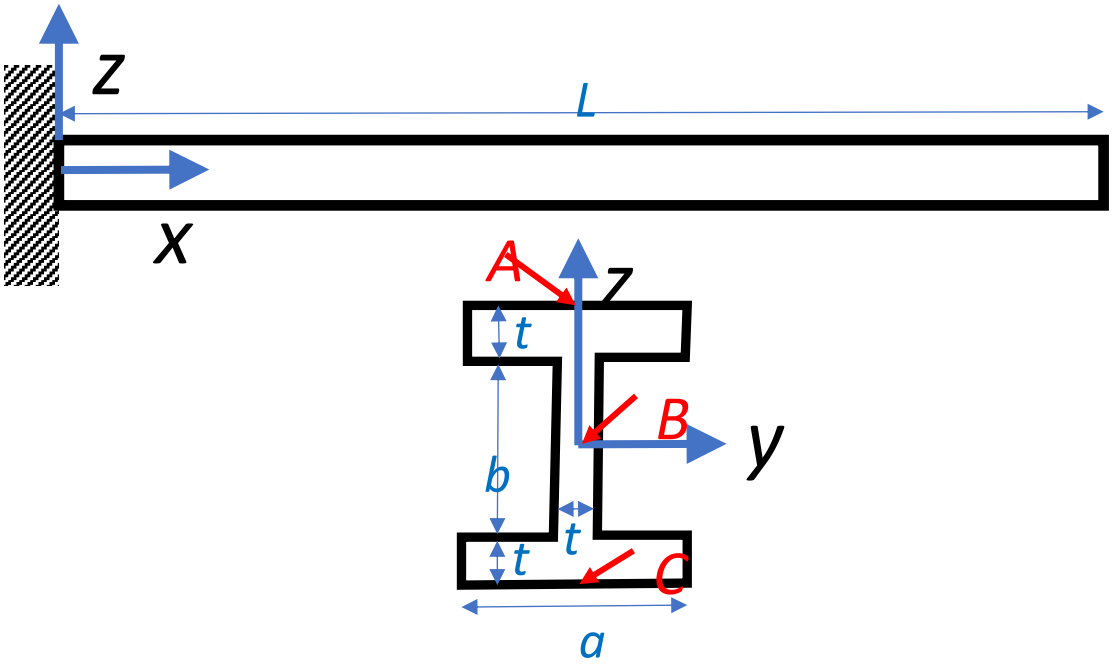
AE 323 – Spring 2019 – Homework #3
Wednesday Feb. 6, 2019
Due on Friday Feb. 15, 2019

Problem 1

Consider the cantilever I-beam shown in the figure below.



The cantilever beam is of length L and is made of a linearly elastic material with Young's modulus E, density ρ, and yield stress σ_y. It only supports its own weight (use g for the acceleration of gravity acting in the negative z direction).

1) What is the distributed transverse load f_z (in N/m) for this problem?
2) Compute the internal shear force $V_z(x)$ (in N) and internal bending moment $M_y(x)$ (in Nm).
3) Knowing that, by symmetry, the neutral axis of the beam goes through the center of the cross-section, compute the moments of inertia I_{yy}, I_{zz}, and I_{yz} of the cross-section (use the simplified relations assuming that $t << a$ and b).
4) Compute the axial stress σ_{xx} in the middle of the beam (i.e., $x = L/2$) at the top (point A in the figure), middle (point B) and bottom (point C) of the cross-section.
5) At what length L of the beam does the beam start to yield under its own weight, for $b=2a=12t$, and for ρ=7800 kg/m^3, g=10 m/s^2, t = 5 mm, and σ_y=200 MPa. Check the units of your solution.

Problem 2

Consider a simply supported beam of length L subjected to a uniform pressure p (in Pa) applied along its top surface in the negative z-direction. The cross-section has a T-shape (see figure below), with $t << a$ and b. The material has a stiffness E.

1) Find the location of the neutral axis (with respect to the (y_o,z_o) axis system shown in the figure) for a= 12 t and b = 10 t.
2) Compute the moment of inertia I_{yy} and I_{yz} with respect to the (y,z) axes passing through the center of gravity of the cross-section (use the exact expressions).
3) What is the distributed transverse load f_z (in N/m) for this problem?
4) Compute the resultant bending moment $M_y(x)$ in the beam
5) Compute the maximum tensile and compressive axial stresses in the beam. Indicate where it is located.