Department of Aerospace Engineering, IIT, Madras

AS202 Structures

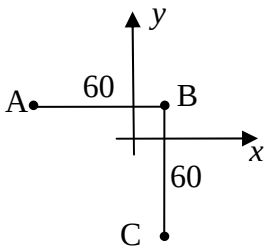
Final Exam

Date: April 27, 2009 Duration: 3 hours min

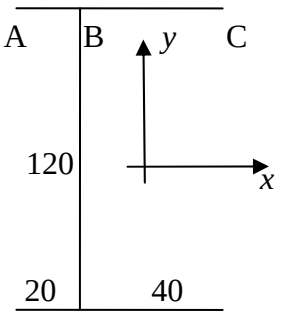
Max Marks: 60

Open Book / Open Notes

1. A thin-walled (1 mm thickness) equal-angle section ABC has flanges of width 60mm as shown in figure below. It is subjected to loads of M_x=20kN-m and M_y=10kN-m.
   (a) Determine the bending stress σ_{zz} at the points A, B and C. (12)
   (b) Determine the location (position / orientation) of the Neutral Axis and show it on a sketch of the cross section. (4)
   (c) Determine the principal axes of the section and show these on a sketch of the cross section, clearly indicating the I_{max} and I_{min} axes. (4)



2. Consider the constant thickness (1 mm) 120mm x 60 mm offset-I section shown in figure below, with an applied vertical shear force S_y=20kN through the shear centre. Determine the shear flow in the horizontal flange ABC and hence determine the location of the shear centre of the section. Note: work your way in from the ends (A and C) of the flange towards the web intersection B. (10)

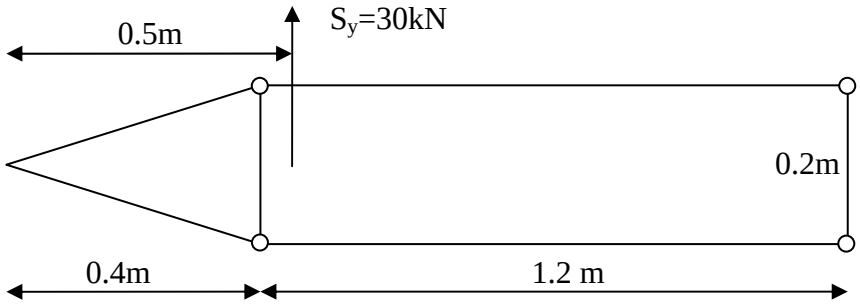


3. A light airplane wing section is structurally idealized as a triangle (0.4m height x 0.2m base) + rectangular box (1.2 m x 0.2 m) as shown in the figure below; the boom areas (which includes the area contribution from the skin) can be taken as 2500mm^2 each (front) and 2000 mm^2 each (rear). The lift load can be taken as 30kN acting 0.5m from the leading edge.

a) Determine all the shear flows in the section and show these on a sketch. (12)

b) If the skin thickness is 1.5 mm throughout, what is the maximum shear stress? (2)

c) What is the twist / unit length of the wing section? (G = 25 GPa) (4)



4. A compressively loaded aircraft structural member has the 60mm x 30 mm x 1mm wall thickness channel cross section as shown in the figure below. The effective column length of the member is 0.5 m and the crippling constant $K = \frac{k\pi^2}{1-\nu^2}$ can be taken as 3.6 for the web BC and 0.39 for the flanges AB and CD. (E=70GPa)

a) What is the (Euler) buckling load for this column? (4)

b) Determine the crippling stress for the flanges and the web and hence the total crippling load for the section as a whole. (6)

c) Based on (a) and (b) predict the failure load / mode for the column (2)