Aerospace Structures Pre-Laboratory
Lab 8 Thin-Walled Section and Shear Center
Section 4 Group 2
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Question 1

(30 points) For specimens I and II (Table 1 below), derive an expression for the area moment of inertia, I, about its neutral axis in terms of h, b and t.

Table 1: Dimensions for the two types of cross sections of specimens.

Specimen ID	Cross section type	Height, h (inch)	Width, b (inch)	Thickness, t (inch)	Outer diameter, OD (inch)	Opening angle, $2\theta_0$ (deg)
I	Plastic C-channel	2.43	1.456	0.08	N/A	N/A
II	Metal C-channel	0.84	0.56	0.055	N/A	N/A
III	PVC circular open	N/A	N/A	0.071	1.66	3.1
IV	PVC circular open	N/A	N/A	0.071	1.66	36.3
V	PVC circular open	N/A	N/A	0.071	1.66	103.7

Question 2

(25 points) Calculate the theoretical shear center of each of the five specimens using the following expressions as derived on pages 9 and 11 in lecture notes:

$$\text{C-channel: } e = \frac{h^2 b^2 t}{4I} \tag{1}$$

$$\text{Circular open-channel: } e = \frac{2r[\cos\theta_0(2\pi - 2\theta_0) + 2\sin\theta_0]}{2\pi - 2\theta_0 + \sin(2\theta_0)} \tag{2}$$

See Figure 1 for all the corresponding parameters h, b, t, r, and θ_0. Note that the total opening angle is $2\theta_0$.

Hint: To derive the expression for I for specimens I and II, you can do one of two ways: (1) calculate I for the horizontal flanges and vertical web individually and then sum up or (2) use "subtraction" method by calculating I for a larger "outer" rectangular area and then subtracting it from I of the smaller "inner" area. You will also need parallel axis theorem. Also, as indicated in Figure 1, the shear center offset e for the C-channel beams is measured from the center of the vertical web, while e for the circular open-channel pipes is measured from the center of circular cross section. Likewise, height h is measured between mid-planes of top and bottom flanges, and r is mean radius, i.e., $r = \frac{OD - t}{2}$.

P

b

h

t

e

Height **h** is measured between mid-planes of
top and bottom flanges as in lecture notes

OD

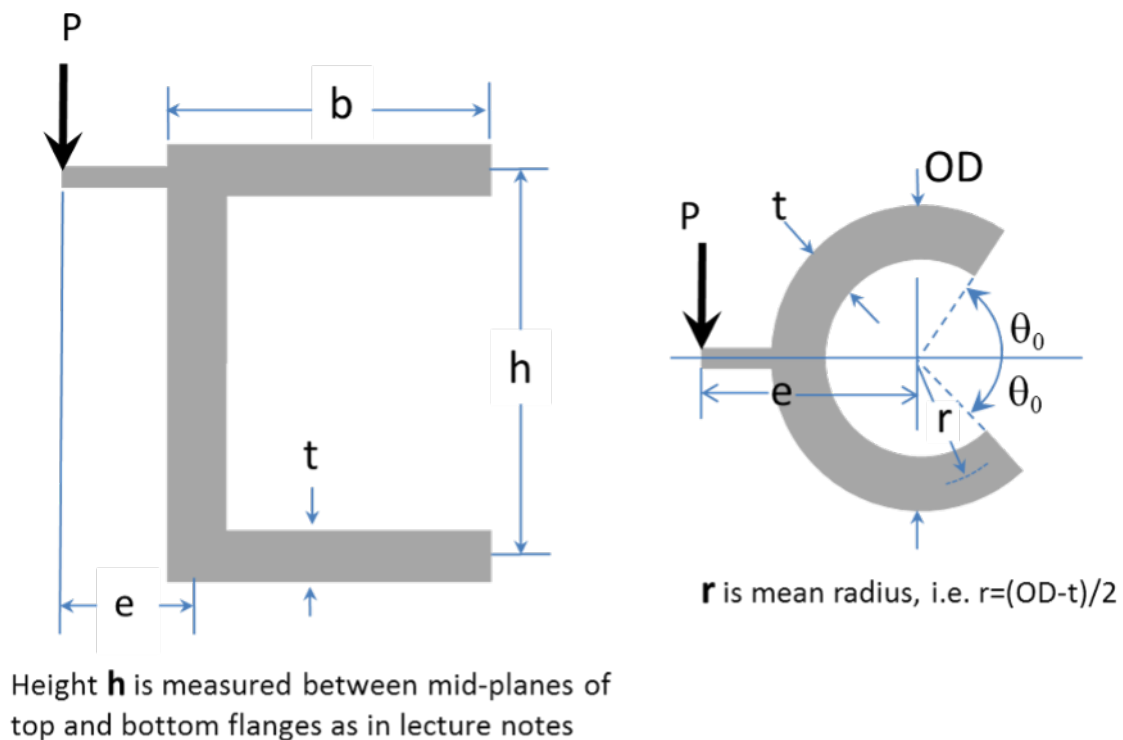P

t

θ_0

θ_0

e

r

r is mean radius, i.e. r=(OD-t)/2

Figure 1: Schematic diagrams of the thin-walled cross section of specimen: (left) C-channel
and (right) circular open channel.

Question 3

(5 points) Tabulate the results.