MASSACHUSETTS INSTITUTE OF TECHNOLOGY Department of Aeronautics and Astronautics

16.00 Introduction to Aerospace and Design Problem Set #1

Issued: February 7, 2002

Due: February 21, 2002

1. Compute the maximum payload mass (in kg) for the Hindenburg zeppelin. Empty weight + fuel weight + payload weight = total gross weight (not counting the Hydrogen).

Specifications:

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Hindenburg gas volume (Hydrogen):	$1.94 \text{x} 10^5 \text{ m}^3$
Hindenburg empty weight:	$1.28 \times 10^{6} \text{ N}$
Fuel weight:	6.39x10 ⁵ N
Density of air:	1.2 kg/m^3
Density of H ₂ :	0.09 kg/m^3

2. A rock is initially inside a boat, which floats in water in a tub. The rock is then thrown overboard as shown below. Does the water level in the tub rise, fall, or stay the same? Justify your answer either using logic or mathematically.



3. Consider the wind tunnel shown below (approximate size: $20m \ge 6m$) with air entering from the left at 1 m/s at a static pressure of $1.013 \ge 10^5$ Pa. Make plots of air velocity vs. x, static pressure vs. x, dynamic pressure vs. x, and total pressure vs. x. The wind tunnel has a rectangular cross section, and is 1m deep (into the page).



4. Aerodynamically, would it be easier to make a model glider fly on Earth or on Mars?

Planet	gravitational acceleration	atmospheric density
Earth	9.8 m/s^2	1.2 kg/m^3
Mars	3.7 m/s^2	0.015 kg/m^3

5. The plot below shows C_L vs. angle of attack for a wing with the trailing edge flaps up and with the flaps set to 25° down. An 1800 kg aircraft is using this wing with a span of 10m and a chord of 2m (rectangular planform) while flying at 50 m/s at sea level ($\rho = 1.2 \text{ kg/m}^3$). The aircraft has a parasite drag coefficient $C_{D0} = 0.03$ when the flaps are up, and $C_{D0} = 0.05$ when the flaps are at 25°. Regardless of flap position, the wing efficiency is e = 0.8.

What angle of attack must the aircraft use to maintain steady, level flight with the flaps up? With the flaps at 25° ?

What is the drag force on the aircraft with the flaps up? With the flaps at 25°?



6. In the plot above, with the flaps at 25° the airfoil still produces positive lift at some negative angles of attack. Explain how this is possible.