AOE 3104 - Problem Sheet 2

Due: February 3, 2003

Read: Marchman: Chapter 1 (again), Chapter 2 (Just read it for the big picture, don't worry about the derivations)

6. The atmosphere of Jupiter is essentially made up of hydrogen, H_2. For Hydrogen, the specific gas constant is 4157 Joules/(kg)(K). The acceleration of gravity of Jupiter is 24.9 m/s^2. Assuming an isothermal (constant temperature) atmosphere with a temperature of 150 K, and assuming that Jupiter has a definable surface, calculate the altitude above that surface where the pressure is one-half the surface pressure.

7. Consider an airplane flying with a velocity of 60 m/s at a standard altitude of 3km. At a point on the wing, the airflow velocity is 70 m/s. Calculate the pressure at this point. Assume incompressible flow.

8. In early low-speed airplanes, the venturi tube was used to measure airspeed. This simple device is a convergent-divergent duct. (The front section's cross-sectional area decreases in the flow direction, and the back section's cross-sectional area increases in the flow direction. Somewhere in between the inlet and exit of the duct, there is a minimum area, called the throat). Let A_1 and A_2 denote the inlet and throat areas, respectively. Let p_1 and p_2 be the pressures at the inlet and throat, respectively. The venturi tube is mounted at a specific point on the plane where the inlet velocity V_1 is essentially the same as the free stream velocity, i.e. the velocity of the airplane through the air. With a knowledge of the area ratio, A_1/A_2 (a fixed design feature) and a measurement of the pressure difference $p_1 - p_2$, the airplane's velocity can be determined. Find an expression for the velocity in terms of the pressure difference, the area ratio, and the constant density. If the airplane is flying at standard sea level conditions, $A_1/A_2 = 4$, and $p_1 - p_2 = 80$ lb/ft^2, evaluate your expression and determine the speed of the airplane.

9. A supersonic transport is flying at a velocity of 1500 mi/hr at a standard altitude of 50,000 ft. Calculate the Mach number of the transport.

10. The altimeter of a low-speed Piper Aztec reads 8000ft. A Pitot tube mounted on the wingtip measures a pressure of 1650 lb/ft^2. If the outside air temperature is 500 deg R, What is the true velocity of the airplane?, What is the equivalent airspeed?

11. The altimeter on a low-speed airplane reads 2 km. The airspeed indicator reads 50 m/s. If the outside air temperature is 280 k, what is the true velocity of the airplane?

12. A high-speed subsonic Boeing 707 airliner is flying at a pressure altitude of 12 km. A Pitot tube on the vertical tail measures a pressure of 2.96×10^4 N/m^2. At what Mach number is the airplane flying?

13. A high-speed aircraft is flying at Mach 0.95 in a standard atmosphere at 30,000ft.
Determine: a) True airspeed
b) indicated airspeed on a incompressibly calibrated airspeed indicator
c) indicated airspeed on a compressibly calibrated airspeed indicator
d) equivalent airspeed