AOE 3104 Problem Sheet 3

Due 10 February, 2003

Read Chapter 3,Marchman

14. We wish to design a wind tunnel experiment to accurately measure the lift and drag coefficients that pertain to a Boeing 777 in actual flight at Mach 0.84 at an altitude of 35,000 ft. The wingspan of a 777 is 199.9 ft. However, in order to fit in a wind tunnel test section, the wingspan of the model is 6 ft. The pressure in the airstream of the wind tunnel is 1 atmosphere. Calculate the necessary values of the airstream velocity, temperature, and density in the test section. Assume that the viscosity varies as the square root of the temperature. Hint: for dynamic similarity we need to match Reynolds number and Mach number. Note: The answer to this problem leads to an ***absurdity***. Discuss the nature of this absurdity in relation to the real word of wind tunnel testing.

15. Consider an NACA 2412 airfoil (data in figure attached) with a chord of 1.5 m at an angle of attack of 4 deg. For a free-stream velocity of 30 m/s at standard sea-level conditions, calculate the lift and drag per unit span. Note the viscosity coefficient at standard sea-level conditions is $1.7894 \times 10^{-5}$ kg/(m-s).

16. For the NACA 2412 airfoil, (see figure attached), show that, an $\alpha$ = 6 deg, $C_l = 0.85$ and $C_{m1/4} = -0.037$. The aerodynamic center of this airfoil is located at $h_{ac} = 0.2553$. Calculate the value of the moment coefficient about the aerodynamic center.

17. A model is being tested in the wind tunnel at a speed of 100 miles/hour. The flow in the test section is at standard sea-level conditions.

a) What is the pressure at the model's stagnation point, (lbs/ft$^2$)

b) If the tunnel speed is measured by a pitot-static tube connected to a U tube manometer, what is the reading of the manometer in inches of water?

c) At one point on the model, the pressure is measured at 2058 lbs/ft$^2$. What is the local 0 airspeed at that point?

18. A jet engine has an inlet area of 4 ft$^2$, inlet velocity of 300 ft/sec, and an inlet density of standard sea-level air. At the exit, the conditions are $V_e$ = 1800 ft/sec, and the exit area is 2 ft$^2$. The inlet an exit pressures are local atmospheric pressures.

a) Determine the thrust for this engine.

b) How would the answer in part (a) change if we included the fact that we added 0.15 slugs of fuel per sec to the airflow through the engine?