Aerodynamics
SYE 3801
Spring 2015

HW#3

Due: February 3rd, 2015, at the start of class

Hard copies only

Total Points: 100

Solve the following problems (Note: Several are from Chapter 2 of the textbook):

1) Using the entire algorithm of the derivative calculate f′(x) given:

   f(x) = x/(x + 1)

2.1 Consider the low-speed flight of the Space Shuttle as it is nearing a landing. If the air pressure and temperature at the nose of the shuttle are 1.2 atm and 300 K, respectively, what are the density and specific volume?

2.7 Assume that, at a point on the wing of the Concorde supersonic transport, the air temperature is $-10°C$ and the pressure is 1.7×10^4 N/m^2. Calculate the density at this point.

2.11 Consider an ordinary, helium-filled party balloon with a volume of 2.2 ft^3. The lifting force on the balloon due to the outside air is the net resultant of the pressure distribution exerted on the exterior surface of the balloon. Using this fact, we can derive Archimedes' principle, namely that the upward force on the balloon is equal to the weight of the air displaced by the balloon. Assuming that the balloon is at sea level, where the air density is 0.002377 slug/ft^3, calculate the maximum weight that can be lifted by the balloon. *Note:* The molecular weight of air is 28.8 and that of helium is 4.

2.14 In a gas turbine jet engine, the pressure of the incoming air is increased by flowing through a compressor; the air then enters a combustor that looks vaguely like a long can (sometimes called the *combustion can*). Fuel is injected in to the combustor and burns with the air, and then the burned fuel–air mixture exits the combustor at a higher temperature than the air coming into the combustor. (Gas turbine jet engines are discussed in Ch. 9.) The pressure of the flow through the combustor remains relatively constant; that is, the combustion process is at *constant pressure*. Consider the case where the gas pressure and temperature entering the combustor are 4×10^6 N/m^2 and 900 K, respectively, and the gas temperature exiting the combustor is 1500 K. Calculate the gas density at (*a*) the inlet to the combustor and (*b*) the exit of the combustor. Assume that the specific gas constant for the fuel–air mixture is the same as that for pure air.

2.17 Consider a stationary, thin, flat plate with area of 2 m^2 for each face oriented perpendicular to a flow. The pressure exerted on the front face of the plate (facing into the flow) is 1.0715×10^5 N/m^2, and is constant over the face. The pressure exerted on the back face of the plate (facing away from the flow) is 1.01×10^5 N/m^2, and is constant over the face. Calculate the aerodynamic force in pounds on the plate. *Note:* The effect of shear stress is negligible for this case.