AOE 3104 Problem Sheet 1

Due 27 January, 2003

Read: Marchman: Chapter 1

1. Write a computer code (in any language) that will compute the properties of the standard atmosphere (pressure, absolute temperature, and density) in both US Customary and SI units for a specific geopotential altitude (h), given in either feet or meters. The code should handle altitudes that include both the troposphere and the stratosphere. All input data should be converted to SI units and the internal atmospheric calculations done in those units. The output should be in the same units as the input (or in both units if you wish). Submit a printout of the computer code, and a table of output of altitude, pressure, density, and temperature for every 1000 meters from sea-level to 25,000 meters (SI units) and for every 3000 ft from sea-level to 75,000 ft for US Customary units.

Note: The following problems should be completed using the standard atmospheric tables provided in Marchman's notes. Also all altitudes given are geopotential altitudes.

2. Fact: Above a specified altitude (18,000) ft, an aircraft altimeter is set to convert measured atmospheric (static) pressure to the altitude associated with that pressure in a standard atmosphere. The altitude read is called flight level (as opposed to altitude). During fight testing, however, the altimeter is always (for all altitudes) set in this manner and the altitude read is called pressure altitude.

Question: At some altitude, the density is $4{,}100 \times 10^{-4}$ slugs/ft^3 and the temperature is -60.0 deg F. What is the pressure altitude of this aircraft? What is the density altitude of this aircraft (ft)?

3. Assume that the pressure conditions at sea-level are standard, and that the lapse rate is standard, but the sea-level temperature is elevated to 120 degrees (say the in the desert). If we are at a geopotential altitude of 5000 ft, what will be the pressure, density, and (loosely speaking), the temperature altitudes of this aircraft (ft)? (Note, when considering takeoff requirements, density altitude is important. What are the implications of the calculations that you just completed?)

4. Determine at what geometric altitude that the error between the geometric altitude and the geopotential altitude is greater than 5% of the geometric altitude. The radius of the Earth is 6378.135 km

5. What would be the depth of the atmosphere if air were incompressible with a density equal to that of standard sea-level air? (In ft, miles, km)

6. The small wind tunnel at Virginia Tech has a 3 ft diameter test section. It is open to the atmosphere so the temperature and pressure of the air in the test section is the same as that of the surrounding atmosphere. If we assume a standard atmosphere, (Blacksburg is at 2100 ft above sea-level), what is the mass rate of air flow (slugs/sec) through the tunnel if it is running at a speed of 60 miles/hr. (88 ft/sec)?