Homework problems for AE-201A

1. At 12 km in the standard atmosphere, the pressure, density, and temperature are 1.9399 x 10^4 N/m^2, 3.1194 x 10^{-1} kg/ml, and 216.66 K, respectively. Using these values, calculate the standard atmospheric values of pressure, density, and temperature at an altitude of 18 km, and check with the standard altitude tables.

2. Consider an airplane flying at some real altitude. The outside pressure and temperature are 2.65 x 10^4 N/m^2 and 220 K, respectively. What are the pressure and density altitudes?

3. Consider an airplane flying at an altitude where the pressure and temperature are 530 lb/ft^2 and 216.6667 K, respectively. Calculate the pressure and density altitudes at which the airplane is flying.

4. During a flight test of a new airplane, the pilot radios to the ground that she is in level flight at a standard altitude of 35,000 ft. What is the ambient air pressure far ahead of the airplane?

5. Consider an airplane flying at a pressure altitude of 33,500 ft and a density altitude of 32,000 ft. Calculate the outside air temperature.

6. An airplane is flying at a velocity of 130 mi/h at a standard altitude of 5000 ft. At a point on the wing, the pressure is 1750.0 lb/ft^2. Calculate the velocity at that point, assuming incompressible flow.

7. Consider an airplane flying at a standard altitude of 5 km with a velocity of 270 m/s. At a point on the wing of the airplane, the velocity is 330 m/s. Calculate the pressure at this point.

8. Consider a low-speed airplane flying at a velocity of 55 m/s. If the velocity at a point on the fuselage is 62 m/s, what is the pressure coefficient at this point?

9. Consider an infinite wing with a NACA 1412 airfoil section and a chord length of 3 ft. The wing is at an angle of attack of 5° in an airflow velocity of 100 ftls at standard sea-level conditions. Calculate the lift, drag, and moment about the quarter-chord per unit span.

10. A reciprocating engine for light aircraft has the following characteristics: bore= 11.1 cm, stroke= 9.84 cm, number of pistons= 4, compression ratio= 6.75, mechanical efficiency= 0.83. It is connected to a propeller with an efficiency of 0.85. If the fuel-to-air ratio is 0.06 and the pressure and temperature in the intake manifold are 1 atm and 285 K, respectively, calculate the power available from the engine-propeller combination at 2800 rpm.

11. Consider a turbojet-powered airplane flying at a standard altitude of 40,000 ft at a velocity of 530 mi/h. The turbojet engine has inlet and exit areas of 13 and 10 ft^2, respectively. The velocity and pressure of the exhaust gas at the exit are 1500 ft/s and 450 lb/ft^2, respectively. Calculate the thrust of the turbojet.

12. The mass flow through a rocket engine is 25 kg/s. If the exit area, velocity, and pressure are 2 m^2, 4000 m/s, and 2×10^4 N/m^2, respectively, calculate the thrust at a standard altitude of 50 km.

13. Consider a rocket with kerosene--oxygen as the fuel-oxidizer combination. The ratio of initial weight before blastoff to the final weight at burnout is 5.5. Calculate the burnout velocity.

14. Consider a two-stage rocket with the following design characteristics. *First stage:* propellant mass = 7200 kg; structural mass= 800 kg. *Second stage:* propellant mass= 5400 kg; structural mass = 600 kg. The payload mass is 60 kg. The specific impulse for both stages is 275s. Calculate the final burnout velocity.

P.S. If necessary, you may use the data given in the appendices A, B and D in the book *Introduction to Flight* by John D. Anderson.