Due date: 21 Sep 07

Assignment 3: Propeller Problems

1. An aircraft weighing 1000 lb has a propeller of 7 ft diameter and L/D = 5. The aircraft is flying at 2000 ft altitude in a 10 mph head wind. If the actual propeller efficiency is 80% (0.8) and the aircraft's relative ground speed is 90 mph, find the brake shaft horsepower (bhp) and estimate the slipstream velocity in mph. (66.6 hp, 110 mph)

2. A small sport helicopter weighs 500 lbs with a single crew member weighing 185 lbs. The rotor is 15 ft in diameter with an efficiency of 0.84. The efficiency of all mechanical linkages and shafting is 0.9. If the helicopter is in steady flight hovering at sea level answer the following:

For a helicopter in hover: $T_A = 2\rho A_{disk} v_a^2$ and $P_A = T_A v_a$ (note: $v_a = aV$)

Note: This is basically the momentum theory of propellers applied to helicopter rotors!

a. Find the velocity induced (v_a) by the rotor in ft/sec (28.5 ft/sec)
b. Find the indicated power of the engine in hp (47 hp)
c. What is the pressure rise across the rotor in psf? (3.88 psf)
d. The velocity far downstream (slipstream velocity, v_b) of the rotor? (57.11 ft/sec)

3. A propeller with diameter 15 ft. produces a thrust of 8000 lbf while moving at a speed of 400 mph at an altitude where density is 0.002 slug/ft^3. Using the momentum theory determine:

a. Induce flow through the disk (18.7 ft/sec)
b. The final wake velocity (624.4 ft/sec)

4. From Chapter 3 of the class handout do the following problems: 4, 5 and 7

5. Also from the Chapter 3, I need 2-4 volunteers per section to work out problems 6 & 9 for presentation in class.