MAE 158 2022
Recommended Homework 3

From Shevell, *Fundamentals of Flight*
Problems 8.2, 9.1, 9.2, 9.6

8.2. An airplane is cruising at a density altitude of 38,000 ft at a speed of 500 mph. The ambient temperature is 409°R.

(a) At a point on the wing the local velocity is 14% higher than the freestream velocity. What is the pressure coefficient at this point? If the C_p is equal to the average upper surface C_p, and if the upper surface provides three-quarters of the lift, what is the wing lift coefficient? Note that at this Mach number the compressible fluid equations must be used.

We will learn these equations in future lectures. For this homework, you may assume the pressure on the upper surface is 404 lb/ft^2.

9.1. An airplane with a wing planform area of 650 ft^2 and a span of 80 ft is flying at a density altitude of 38,000 ft at a speed of 500 mph. The ambient temperature is 409°R. The gross weight is 52,000 lb. Determine:

(a) Lift coefficient.

(b) Induced drag in pounds, assuming that the drag due to lift differs from that for the ideal elliptical distribution only by having $u = 0.99$.

(c) What is the wing angle of attack (above zero lift). Assume $\eta = 0.95$.

9.2. An airplane with a wing area of 350 ft^2 and a span of 56 ft is flying at a pressure altitude of 10,000 ft at a speed of 320 mph. The ambient temperature is 495°R. The wing has a geometric angle of attack of 4 degrees, above the angle for zero lift. Assume the two-dimensional lift curve slope is 95% of the theoretical value. Determine:

(a) Lift in pounds.

(b) Induced drag in pounds.

9.6. An airplane with a wing area of 450 ft^2 and a span of 70 ft is flying at a pressure altitude of 8000 ft at a speed of 280 mph. The ambient temperature is 500°R. The wing has a geometric angle of attack of 4 degrees above the angle for zero lift. Assume the two-dimensional lift curve slope is 95% of the theoretical value. Determine:

(a) Lift in pounds.

(b) Parasite drag (lb) if the value of C_{D_p} is 0.0190.

(c) The induced drag coefficient.

(d) The induced drag in pounds.

(e) The total drag in pounds.

(f) The ratio of lift to drag.