MAE 158 2022
Recommended Homework 4

From Shevell, *Fundamentals of Flight*
Problems 7.1, 7.2, 12.1 (a,e,f only), 12.3

7.1. An airfoil is moving through the air at 540 mph at 15,000-ft pressure altitude. The temperature is 45°F. At a point on the airfoil upper surface, the local velocity is 630 mph. What is the pressure at that point? If this is the average pressure on the surface, how much lift per square foot is being provided by the top surface? If the average speed on the lower surface is 495 mph, what is the pressure and average lift per square foot on the lower surface? What is the total lift per square foot of wing area?
(a) Solve using *incompressible* equations.
(b) Solve using *compressible* equations.
(c) What are the percentage differences in the lift value determined by parts (a) and (b)?
(d) Find the local Mach number on the upper surface of the wing.

7.2. A Boeing 727 is cruising at its assigned altitude at a Mach number of 0.82. The outside air temperature is 227 K. At a given point on the upper surface of the wing, the pressure is measured at 19,000 N/m^2. The temperature at this point is 216 K. How much lift per square meter (referred to ambient pressure) is provided by the upper surface at this point? What is the assigned pressure altitude? What is the density altitude? What is the true speed of the airplane? (Use SI units, except also give the upper surface lift in lb/ft^2.)

12.1. An airplane with an unswept, 12% thick wing, a wing planform area of 450 ft^2, a span of 60 ft, and a mean aerodynamic chord (m.a.c.) of 8 ft is flying at a density altitude of 28,000 ft at a speed of 400 mph. The ambient temperature is 430°R. The gross weight is 30,000 lb. The exposed wing area is 80% of the total wing area. The wing parasite drag is 35% of the total parasite drag. The airfoil is a conventional peaky type. Determine
(a) Lift coefficient.
(e) Crest critical Mach number, M_{cc}.
(f) Compressibility drag

12.3. A straight wing supersonic fighter with a circular arc airfoil is flying at $M = 2.0$ at 45,000 ft on a standard day. It has a wing area of 320 ft^2 and a span of 36 ft. The total weight is 21,000 lb. Eighty percent of the wing area is exposed. Assume only the exposed wing carries lift supersonically. Neglect tip effects. The total wing wave drag due to thickness and lift is 1630 lb. What is the wing thickness ratio?

Graphs Needed for 12.1:

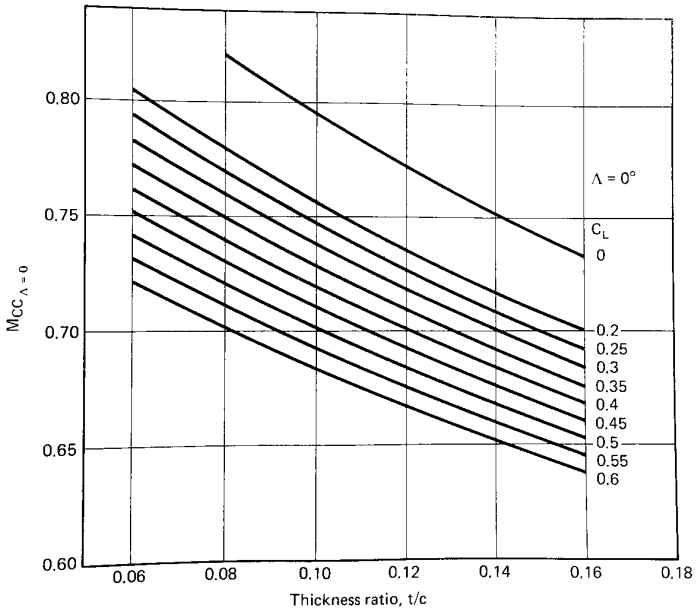

Figure 12.7 Crest critical Mach number, zero sweep.

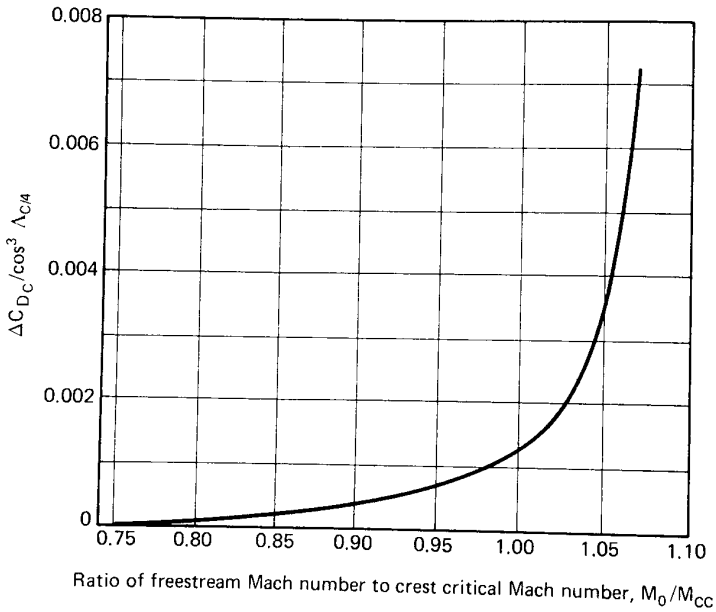

Figure 12.13 Incremental drag coefficient due to compressibility.