Problems of Chapter 8
(Linearized flows)

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9.2 The low-speed lift coefficient for a NACA 2412 airfoil at an angle of attack of 4^o is 0.65. Using the Prandtl -Glauert rule, calculate the lift coefficient for $M_\infty = 0.7$.

9.3 In low-speed flow, the pressure coefficient at a point on an airfoil is -0.9. Calculate the value of C_p at the same point for $M_\infty = 0.6$ by means of:
(a) The Prandtl-Glauert rule
(b) Laitone's correction
(c) The Karman-Tsien rule

9.4 Consider a flat plat with chord length c at an angle of attack α to a supersonic free stream of Mach number M_∞. Let L and D be the lift and drag per unit span, $S = c(1)$. Using linearized theory, derive the following expression for the lift and drag coefficients (where $C_L \equiv \frac{L}{\frac{1}{2}\rho_\infty V_\infty^2 S}$ and $C_D \equiv \frac{D}{\frac{1}{2}\rho_\infty V_\infty^2 S}$):

(a)$C_L = \frac{4\alpha}{\sqrt{M_\infty^2 - 1}}$

(b)$C_D = \frac{4\alpha^2}{\sqrt{M_\infty^2 - 1}}$

9.5 For the flat plate in Problem 9.4, the quarter-chord point is located, by definition, at a distance equal to $c/4$ from the leading edge. Using linearised theory, derive the following expression for the moment coefficient about the quarter-chord point for supersonic flow:

$$C_{M_{c/4}} = \frac{-\alpha}{\sqrt{M_\infty^2 - 1}}$$

where $C_{M_{c/4}} \equiv M_{c/4}/\frac{1}{2}\rho_\infty V_\infty^2 Sc$, and as usual in aeronautical practice, a positive moment by convention is in the direction of the increasing angle of attack.

9.7 Consider a diamond-shaped airfoil such as that sketched in Fig 4.35. The half angle is ϵ, thickness is t, and chord length is c. For supersonic flow, use linearized theory to derive the following expression for C_D at $\alpha = 0$.

$$C_D = \frac{4}{\sqrt{M_\infty^2 - 1}}(\frac{t}{c})^2$$

9.11 At $\alpha = 0^o$, the minimum pressure coefficient for a NACA 0009 airfoil in low-speed flow is -0.25. Calculate the critical Mach number for this airfoil using
(a) The Prandtl-Glauert rule.
(b) The (more accurate) Karman-Tsien rule.