PROBLEMS

1. Consider a subsonic compressible flow in cartesian coordinates where the velocity potential is given by

\[ \phi(x, y) = V_\infty x + \frac{70}{\sqrt{1 - M_\infty^2}} e^{-2\pi \sqrt{1 - M_\infty^2} y} \sin 2\pi x \]

If the freestream properties are given by \( V_\infty = 700 \text{ ft/s}, \ p_\infty = 1 \text{ atm}, \) and \( T_\infty = 519^\circ R, \) calculate the following properties at the location \((x, y) = (0.2 \text{ ft, 0.2 ft})\): \( M, p, \) and \( T. \)
3. Under low-speed incompressible flow conditions, the pressure coefficient at a given point on an airfoil is \(-0.54\). Calculate $C_p$ at this point when the freestream Mach number is 0.58, using

(a) The Prandtl-Glauert rule

(b) The Karman-Tsien rule

(c) Laitone’s rule
4. In low-speed incompressible flow, the peak pressure coefficient (at the minimum pressure point) on an airfoil is \(-0.41\). Estimate the critical Mach number for this airfoil, using the Prandtl-Glauert rule.