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DEPARTMENT OF AEROSPACE AND MECHANICAL ENGINEERING

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Advanced Aerodynamics

Homework 9

1. The potential function for a subsonic flow is given by

$$\phi(x,y) = V_\infty x + \frac{v}{\sqrt{1-M_\infty^2}} e^{-2\pi\sqrt{1-M_\infty^2}y}\ sin 2\pi x. \tag{1}$$

   If the freestream properties are given by $V_\infty = 220m/s$, $v = 20m/s$, $p_\infty = 1atm$, and $T_\infty = 289^o K$, calculate at the location $(x,y) = (0.06m, 0.03m)$ M, p, and T.

2. Using the Prandtl-Glauert rule, calculate the lift coefficient for an NACA 2412 airfoil at 5^o angle of attack in a Mach 0.6 freestream. Hint: Use data for the incompressible flow and compare with the lift formula $C_\ell = 2\pi(\alpha + 2m)(1 + 0.77\theta)$.

3. In low-speed incompressible flow, the pressure coefficient at the minimum pressure point on an airfoil is -0.41. Estimate the critical Mach number for this airfoil, using

   (a) The Prandtl-Glauert rule.

   (b) The Karman-Tsien rule.

   (c) The Laitone rule.