Section 7, Homework (8) … Due Monday November 29, 2021

Part 1

Solution Hints:
Assume supersonic flow at probe and Wedge has a 10 deg. half angle, work backwards from probe...

Static pressure Measurement is ahead of shock
“Rayleigh Pitot Equation”

- Calculate Freestream Mach Number

• Assume $\gamma = 1.4$

$P_\infty = 26.436 \text{ kPa}$

$\alpha = 12^\circ$

$P_4 = 30.454 \text{ kPa}$

$P_{04\text{ sensed}} = 143.062 \text{ kPa}$
\[ \gamma = 1.4 \]
\( \gamma = 1.4 \)

M2-Theta-Mach Plot
During the late 1920s and into the 1930s, the National Advisory Committee for Aeronautics (NACA) developed a series of thoroughly tested airfoils and devised a numerical designation for each airfoil — a four digit number that represented the airfoil section's critical geometric properties.*

- First digit describing maximum camber as percentage of the chord.
- Second digit describing the distance of maximum camber from the airfoil leading edge in tenths of the chord.
- Last two digits describing maximum thickness of the airfoil as percent of the chord.

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Section 7, Homework, Part 2

- Consider NACA 0012 Airfoil at 1.5°$\alpha$.

- Calculate the critical drag rise (subsonic) Mach number for zero wing sweep.

- Re-Calculate the $M_{cr}$ assuming 30° wing sweep, $\Lambda$.

- Compare the effective fineness ratios ($t/c$), for the unswept and swept wing sections.

- What do you conclude?
NACA 0012 at $1.5^\circ \alpha$

\[ C_{p,0_{\text{min}}} \approx -0.94 \]

\[ M_\infty = 0.6 \]

\[ \alpha = 1.5^\circ \]

\[ C_{p_{\text{cr}}} = \left( \frac{2}{\gamma - 1} \right) \left( \frac{1 + \frac{\gamma - 1}{2} M_{\text{cr}}^2}{\frac{\gamma + 1}{2}} \right)^{\gamma - 1} - 1 \]

\( C_p = \frac{C_{p,0_{\text{min}}}}{\sqrt{1 - M_\infty^2}} \)

@ zero wing weep

.. Calculate $M_{\infty_{\text{cr}}}$
NACA 0012 at $1.5^\circ \alpha$ with 30 deg. Wing sweep ($\Lambda$)

$C_p, 0_{\text{min}} \sim -0.94$

$NACA\ 0012$

$M_\infty = 0.6$

$\alpha = 1.5^\circ$

What is $M_{\text{crit}}$ @ $30^\circ$ wing sweep ($\Lambda$)

$$
(M_{\text{crit}})_\Lambda = \frac{(M_{\text{crit}})^{0^\circ}}{\sqrt{1 - \sin^2 \Lambda \cdot \cos^2 \alpha}}
$$

What is Fineness Ratio @ $30^\circ$ wing sweep ($\Lambda$)

Swept $\Rightarrow$

$$
\frac{t}{c_{\text{equiv}}} = \frac{t}{c / \cos \Lambda}
$$

$MAE\ 5420$ - Compressible Fluid Flow
• Consider NACA 006 airfoil at 6 different Angles of Attack, **Incompressible flow**

• Plot $M_{crit}$ as function of Angle of Attack

• Perform Calculations using the following compressibility corrections
  
  - Prandtl-Glauret
  - Karman-Tsien
  - Laitone’s Rule

• Compare the resulting curves