Homework 5.2

• Recall that this analysis assumes a sonic nozzle

• How would an Expanded (Supersonic) Nozzle Buy in Terms of Performance

• Find the Optimal Expansion Ratio and Exit Mach Number

• By What ratio does this Optimal expansion ratio Increase the thrust and specific Impulse of the Engine
Homework 5.2 (2)

\( M_{\text{exit}} > 1 \)

- Hints:
  \[
  \frac{F_{\text{thrust}}}{p_\infty \cdot A_\infty} = \frac{F_{\text{thrust}}}{p_\infty \cdot A_\infty} = \gamma \cdot M_\infty^2 \left( \frac{V_{\text{exit}}}{V_\infty} - 1 \right) + \frac{A_{\text{exit}}}{A_\infty} \left( \frac{p_{\text{exit}}}{p_\infty} - 1 \right) = \gamma \cdot M_\infty^2 \left( \frac{M_{\text{exit}}}{M_\infty} \sqrt{\frac{T_{\text{exit}}}{T_\infty}} - 1 \right) + \frac{A_{\text{exit}}}{A_\infty} \left( \frac{p_{\text{exit}}}{p_\infty} - 1 \right)
  \]

- Making these substitutions the normalized thrust can be written in terms of exit Mach number

- Graph Normalized Thrust and Exit expansion ratio as a function of exit Mach Number

- Verify that \( \frac{p_{\text{exit}}}{p_\infty} = 1 \) at the optimal performance condition?