空气动力学 HW 8

8.1

解: $a = \sqrt{\gamma RT}$, $T = 230K$

$= \sqrt{1.4 \times 287 \times 230}$

$= 304.0 \text{ m/s}$

8.3

解:

$a = \sqrt{\gamma RT} = \sqrt{1.4 \times 287 \times 300} = 347.19 \text{ m/s}$

$M = \frac{V}{a} = \frac{250}{347.19} = 0.72$

$\frac{T_0}{T} = 1 + \frac{\gamma - 1}{2} M^2$

$\Rightarrow T_0 = (1 + \frac{0.4}{2} \times 0.72^2) \times 300 = 331.1 \text{ k}$ ANS

$\frac{P_0}{P} = (\frac{T_0}{T})^{\frac{\gamma}{\gamma - 1}}$

$\Rightarrow P_0 = 1.2 \times (\frac{331.1}{300})^{\frac{1.4}{0.4}} = 1.695 \text{ atm}$ ANS

$(M^*)^2 = \frac{(\gamma + 1) M^2}{2 + (\gamma - 1) M^2}$

$\Rightarrow M^* = \sqrt{\frac{2.4 \times 0.72^2}{2 + 0.4 \times 0.72^2}} = 0.7508$ ANS

At $M = 1$, $\frac{T_0}{T^*} = \frac{\gamma + 1}{2}$

$\Rightarrow T^* = \frac{2}{\gamma + 1} T_0 = \frac{2}{2.4} \times 331.1 = 275.92 \text{ k}$ ANS

$\frac{P_0}{P^*} = (\frac{T_0}{T^*})^{\frac{\gamma}{\gamma - 1}} = (\frac{\gamma + 1}{2})^{\frac{\gamma}{\gamma - 1}}$

$\Rightarrow P^* = \frac{P_0}{(\frac{\gamma + 1}{2})^{\frac{\gamma}{\gamma - 1}}} = \frac{1.695}{1.2^{\frac{1.4}{0.4}}}$

$= 0.8954 \text{ atm}$ ANS

8.4

解: $R = 1716 \text{ ft} \cdot \text{lb}/(\text{slug} \cdot {}^\circ R)$

$a = \sqrt{\gamma RT} = \sqrt{1.4 \times 1716 \times 700} = 1296.8 \text{ ft/s}$

$M = \frac{V}{a} = \frac{2983}{1296.8} = 2.3$

$\frac{T_0}{T} = 1 + \frac{\gamma - 1}{2} M^2$

$\Rightarrow T_0 = (1 + \frac{0.4}{2} \times 2.3^2) \times 700 = 1440.6 {}^\circ R$ ANS

$\frac{P_0}{P} = (\frac{T_0}{T})^{\frac{\gamma}{\gamma - 1}}$

$\Rightarrow P_0 = 1.6 \times (\frac{1440.6}{700})^{\frac{1.4}{0.4}} = 20.01 \text{ atm}$ ANS

$(M^*)^2 = \frac{(1 + \gamma) M^2}{2 + (\gamma - 1) M^2}$

$\Rightarrow M^* = \sqrt{\frac{2.4 \times 2.3^2}{2 + 0.4 \times 2.3^2}} = 1.756$ ANS

$T^* = \frac{2}{2.4} \times 1440.6 = 1200.5 {}^\circ R$ ANS

$P^* = \frac{20.01}{1.2^{\frac{1.4}{0.4}}} = 10.58 \text{ atm}$ ANS

8.5

解: $\frac{T_0}{T} = 1 + \frac{\gamma-1}{2} M^2$

$\Rightarrow T_0 = (1 + \frac{0.4}{2} \times 4) \times 230 = 414\ K$ ANS

$\frac{P_0}{P} = (\frac{T_0}{T})^{\frac{\gamma}{\gamma-1}}$

$\Rightarrow P_0 = P \cdot (1 + \frac{\gamma-1}{2} M^2)^{\frac{\gamma}{\gamma-1}}$

$= 1 \times (1 + 0.8)^{\frac{1.4}{0.4}} = 7.824\ atm$ ANS

8.6

解: At 10000 ft.

$\rho_\infty = 1.7556$ slugs/ft^3

$P_\infty = 1455.6$ lb/ft^2

$T_\infty = 483.04$ ^0R

$\left.\begin{aligned} \frac{T_0}{T_\infty} &= 1 + \frac{\gamma-1}{2} M_\infty^2 \\ \frac{T_0}{T} &= 1 + \frac{\gamma-1}{2} M^2 \end{aligned}\right\} \Rightarrow T = T_\infty \cdot \frac{1 + \frac{\gamma-1}{2} M_\infty^2}{1 + \frac{\gamma-1}{2} M^2}$

$= 483.04 \times \frac{1 + 0.2 \times 0.8^2}{1 + 0.2 \times 1^2}$

$= 456.67\ ^\circ R$ ANS

isentropic

$\frac{P}{P_\infty} = (\frac{T}{T_\infty})^{\frac{\gamma}{\gamma-1}}$

$\Rightarrow P = (\frac{1 + \frac{\gamma-1}{2} M_\infty^2}{1 + \frac{\gamma-1}{2} M^2})^{\frac{\gamma}{\gamma-1}} \cdot P_\infty$

$= (\frac{1 + 0.2 \times 0.8^2}{1 + 0.2 \times 1^2})^{\frac{1.4}{0.4}} \times 1455.6$

$= 1195.9$ lb/ft^2 ANS