Luke Verlangieri | AA 311 HW 2 | 10/6/2025

3.41 Given

Find
T

Pressure Altitude : 33,500 ft
density Altitude : 32,000 ft

properties

pressure Altitude = pressure at 33,500 ft
density Altitude = density at 32,000 ft

$R_{Air} = 0.3704 \frac{psia \cdot ft^3}{lbm \cdot R^o}$ $P = \rho R T$

Analysis

pressure at 33,500 ft (geometric Altitude)

$P = 5.3589 \cdot 10^2\ psfa = 3.7214\ psia$ } Appendix B

$\rho = 8.2704 \cdot 10^{-4} \frac{slug}{ft^3} = 0.0266 \frac{lbm}{ft^3}$

Unit Analysis

$$T = \frac{P}{\rho \cdot R^o} = \frac{[3.7214\ psia]}{\left(0.266 \frac{lbm}{ft^3}\right) \cdot \left(0.3704 \frac{psia \cdot ft^3}{lbm \cdot R^o}\right)}$$

$$\boxed{\rightarrow T = 377.3\ R^o}$$

Luke Verlangieri | AA 311 HW 2 | 10/6/2025

3.15

Given

$r_e = 6.356766 \cdot 10^6$ m

$h \rightarrow$ geopotential alt

$h_g \rightarrow$ geometric alt

Find

Where the difference in geopotential altitude and geometric altitude is 1%

Assumptions

latitude of 45° → corresponds to the given radius

properties

$$h = 0.99 \cdot h_g \qquad h = \left(\frac{r_e}{r_e + h_g}\right) h_g$$

Analysis

$$0.99 \cdot \cancel{h_g} = \left(\frac{r_e}{r_e + h_g}\right) \cancel{h_g}$$

$$r_e + h_g = \frac{r_e}{0.99}$$

$$\rightarrow h_g = \frac{r_e}{0.99} - r_e = \frac{(6.356766 \cdot 10^6 \text{ m})}{0.99} - 6.356766 \cdot 10^6 \text{ m}$$

$$\boxed{\rightarrow h_g = 64.210 \text{ Km}}$$

AA 311 HW 2 | Luke Verlangieri

4.6

Given

$V = 130 \frac{mi}{h}$

Standard altitude = 5,000 ft = geopotential Altitude

At a point on the wing: $p = 1750$ lb/ft^3

Find

velocity at this point

Assumptions

Incompressible flow

Properties

Bernoullis Eqn → $p_1 + \rho_1 \frac{V_1^2}{2} = p_2 + \rho_2 \frac{V_2^2}{2}$

Incompressible $\rho_1 = \rho_2$

Pressure at 5000 ft = $1.7609 \cdot 10^3 \ \frac{lb}{ft^2}$

$\rho = 2.048 \cdot 10^{-3} \ \frac{slug}{ft^3}$

Analysis

$$V_2 = \sqrt{\frac{2}{\rho}\left((p_1 - p_2) + \rho \frac{V_1^2}{2}\right)}$$

$V_1 = 130 \frac{mi}{h} = 190.667 \ \frac{ft}{s}$

$P_1 = 1.7609 \cdot 10^3$ psf

$P_2 = 1750$ psf

$\rho = 2.048 \cdot 10^{-3} \ \frac{slug}{ft^3}$

plugging in the values to the right into the above eqn

$$V_2 = \sqrt{\frac{2}{(2.048 \cdot 10^{-3})}\left((17609 \text{ psf} - 1750 \text{psf}) + (2.048 \cdot 10^{-3} \frac{slug}{ft^3})\left(\frac{(190.67 \frac{ft}{s})^2}{2}\right)\right)}$$

$$\boxed{V_2 = 216.81 \ \frac{ft}{s}}$$

AA 311 HW 2 | Luke Verlangieri

4.19|

given

Velocity of 200 mi/h

a: Nozzle with $\partial A = 0$ (No diffuser)

b: Conventional Nozzle, test section, diffuser

a: $A_{inlet} = 20\ ft^2$
$A_{Test} = 4ft^2$

b: A_{inlet} & A_{test}
$A_{exit} = 15\ ft^2$

Find

for A and B calculate the pressure differences across the wind tunnel required to operate them so as to have the given flow conditions in the test section

Assumptions

Incompressible flow

Properties

$$A_1 V_1 = A_2 V_2 = A_3 V_3$$

$$P_1 + \rho \frac{V_1^2}{2} = P_2 + \rho \frac{V_2^2}{2}$$

Analysis

$$V_{Test} = \frac{A_{exit} V_{exit}}{A_{Test}}$$

for A $A_{Test} = A_{exit}$
$V_{Test} = V_{exit}$

$$(P_1 - P_2) = \frac{\rho}{2}\left(V_2^2 - V_1^2\right)$$

$$V_{inlet} = \frac{V_{Test} A_{Test}}{A_{inlet}}$$

$$\boxed{\Delta P_A = 19200\rho} = \frac{\rho}{2}\left(200^2 - 40^2\right)$$

$$V_{inlet} = \frac{(200\ mi/h)(4ft^2)}{(20\ ft^2)} = 40\ \frac{mi}{h}$$

$$\Delta P_B = \frac{\rho}{2}\left(44.4^2 - 40^2\right)$$

for b

$$V_{exit} = \frac{V_{Test} A_{test}}{A_{exit}} = 44.4\ \frac{mi}{h}$$

$$\boxed{\Delta P_B = 185.6\rho}$$

$$\boxed{\frac{\Delta P_A}{\Delta P_B} = 103.4}$$

TOPS