Aer E 160 Homework 1

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DUE November 1, 11:59 pm

Homework 1 will be a review of all the python concepts you learned in both lab and lecture. It will consist of two problems. It will be due on November 1st at 11:59 pm.

Submission Requirements: Just like the lab assignments, upload both the edited .tex file as well as the compiled PDF in your submission branch. See the Homework 0 Guide on Blackboard for instructions on how to clone, create branches, and upload back to GitHub.

1 Atmospheric Conditions

The properties of air change with altitude in a predictable manor. The calculations below are used by engineers to model "standard day" atmospheric conditions for a given altitude. This allows for reproducible calculations and testing of engine and vehicle performance.

Write a code that will prompt the user for the altitude (in meters), calculate the air properties (pressure, density, and temperature) for that altitude, and clearly display the results back to the user.

1.1 Tropospheric Equations:

For altitudes less than 11,000 m

Use these equations to calculate the temperature, pressure, and density for altitudes less than 11,000m.

$$T = 15.04 - 0.00649 * h \tag{1}$$

Where:

h: the altitude in m

T: the temperature in Celsius

$$P = 101.29 * \left[\frac{T + 273.1}{288.08}\right]^{5.256} \tag{2}$$

Where:

P: the pressure in kPa

1.2 Lower Stratospheric Equations:

For altitudes between 11,000m and 25,000m

$$T = -56.46 \tag{3}$$

$$P = 22.65 * e^{1.73 - 0.000157h} \tag{4}$$

1.3 Upper Stratospheric Equations:

For altitudes greater than 25,000

$$T = -131.21 + 0.00299h \tag{5}$$

$$P = 2.488 * \left[\frac{T + 273.1}{216.6}\right]^{-11.388} \tag{6}$$

1.4 Density

Though the equations for temperature and pressure vary depending on the altitude, the density equation remains constant. Is is given below.

$$\rho = \frac{P}{2.869 * (T + 273.1)} \tag{7}$$

Where

ρ : the density in $\frac{kg}{m^3}$

2 Reynold's Number

Reynold's Number (Re) is a dimensionless quantity that is used to describe the ratio of inertia forces to viscous forces of a fluid as it moves around an object. It is used to predict the transition from laminar (straight flow with no swirls or disturbances) to turbulent flow. For this problem you will be looking at the airflow pass a sphere. This can be described in equation 8 below.

$$Re = \frac{V * l * \rho}{\mu} \tag{8}$$

Where:

V: the velocity of the fluid

ρ: the air density (use 1.225 $\frac{kg}{m^3}$)

l: the reference length (in this case it is the sphere's diameter)

μ: viscosity coefficient (take the viscosity at 15 ° C which is $1.81 * 10^5 \frac{kg}{m*s}$)

Write a code that will calculate the Reynold's number for user prompted metric inputs of velocity and sphere diameter and clearly display the results back to the user.