ENSC 180: Introduction to Engineering Analysis

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Assignment #2 – Red Bull Stratos Jump – Parts 1 to 3

Part 1:

Use ode45 and the simple freefall function from Section 10.3 of Physical Modeling in MATLAB to model Felix Baumgartner's altitude, velocity, and acceleration for the first minute after he jumped from 38,969.4 meters above sea level. Compare by plotting modeled altitude, absolute value of velocity, and acceleration with the measured data*. Write a function that takes as parameters at least the end time (in seconds) for a plot (60 seconds for Part 1), a title, and the modelled altitude and velocity, and plots the altitude, absolute value of velocity, and acceleration for both the modeled and measured/calculated data. How accurate is the model for the first portion of the minute? How accurate is the model for the last portion of that first minute? Comment on the acceleration calculated from the measured data. Is there any way to smooth the acceleration calculated from the data?

Part 2:

Now consider section 10.4 on air resistance. Use the modified acceleration function, but do some research to determine what mass, m, should be used in the function. Estimate your uncertainty in the mass that you have chosen. How sensitive is the velocity and altitude reached after 60 seconds to changes in the chosen mass?

Compare by plotting again the measured data with the modeled data. Use your plotting function from Part 1 and plot for the first 60 seconds again. How accurate is the revised model? What is good and bad about the revised model?

Part 3:

Felix was wearing a pressure suit and carrying oxygen? Why? What can we say about the density of air in the stratosphere? Exercise 10.5 on page 122 gives a more-complete model of drag due to air resistance, and gives a reference to a Wikipedia article.

https://en.wikipedia.org/wiki/Drag_(physics)

How is the density of air different at around 39,000 meters than it is on the ground?

Can we include the changes in the density of air in our model? Update the model by filling in a function to calculate the density of air. Consider the product AC_d in the equation for drag due to air resistance. What methods can we employ to estimate that product? Given the definitions of A and

C_d, does the estimate seem reasonable? Compare the measured data with our updated model by plotting for the first 4.5 minutes using your plotting function. Now how accurate is the model?

Part 4, 5, …

To be continued, including what happens when Felix opens his parachute.

Titles, labels and legends should be included in all figures.

* Measured data: You will initially be provided with a draft spreadsheet containing data pulled out of the video below. We would like some volunteers to fill in some data that we want to see. Please let us know if you are willing to help. The video is at:

https://youtu.be/raiFrxbHxV0