CE5310 Numerical Methods

Homework #03

1. A boundary layer profile is created as wind passes over the surface of the earth due to terrain roughness. The Wind Science and Engineering Research Center uses a 200 m (666 ft) tower to record the wind speeds at various heights to measure the boundary layer at the Reese field site. The tower has 10 sonic anemometers at 0.9, 2.44, 3.96, 10.0, 16.8, 47.2, 74.7, 116, 158, 200 m (3, 8, 13, 33, 55, 155, 245, 382, 519, 656 ft). The provided csv file contains the recorded 30min time histories for the U and V components for each sonic anemometer in ordered pairs, e.g. (U_3ft, V_3ft, U_8ft, V_8ft, …).

To avoid systemic unit conversion and rounding errors the data acquisition system records the raw voltage output from the sonic anemometers. The output range for the sonic anemometer is 0-4V for a velocity of -40 to 40 m/s (-90 to 90 mph), i.e. at 0 m/s (0 mph) the output voltage will be 2.0V.

Write a program in MATLAB to do the following steps:

1) Prompt user for the Raw Voltage time history file path for input,
2) Open and load the provided Raw Voltage time histories,
3) Convert the RAW Voltages for each time history to engineering units, (Prompt user for desired system of units, m/s or mph),
4) Calculate a resultant wind speed time history for each U, V pair,
5) Display the wind speed means in appropriate table format,
6) Create a boundary layer plot with the mean wind speed on the X-Axis (linear scale) versus the anemometer height on the Y-Axis (log scale). The chart should be properly labeled with correct corresponding units (See Fig.1),
7) Prompt user for the processed time history file path for output,
8) Save the processed U,V and wind speed time histories to a csv file, e.g. (U_3ft, V_3ft, WS_3ft, U_8ft, V_8ft, WS_8ft, …).

At a minimum, the following portions of the program should be subdivided into separate function files:

1) Time history unit conversion
2) Resultant Wind Speed
3) Boundary layer plot

Deliverables:

1) A pdf including a title page, the problem statement, all m-file listings and example input and output. Preferably bookmarked.
2) All m-files, loaded separately, required for your solution to run.

Grading:

Your solution will be graded based on completion of the above requirements, correct performance, neatness and professionalism of pdf submittal. Your submitted m-files will be test run with a different time history file to verify your solution works as claimed by your submittal.

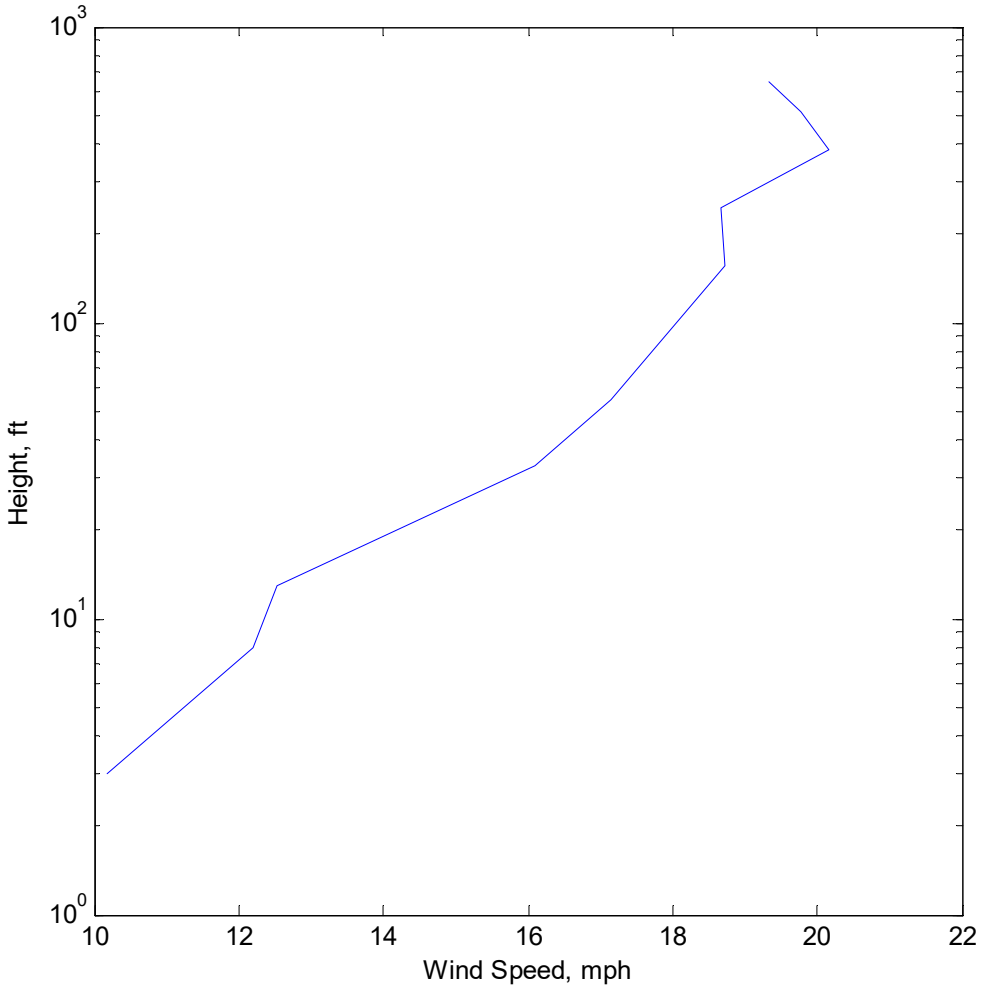

Fig. 1. Boundary Layer Plot

Grading Rubric

Required Program Components:

Prompt user for the Raw Voltage time history file path for input	5pnts	_____
Open and load the provided Raw Voltage time histories	5pnts	_____
Prompt user for desired system of units, m/s or mph	10pnts	_____
Convert the RAW Voltages for each time history to engineering units	10pnts	_____
Calculate a resultant wind speed and wind direction time histories for each U, V pair	10pnts	_____
Display the wind speed and wind direction means in an appropriate table format	10pnts	_____
Create a boundary layer plot	10pnts	_____
Prompt user for the processed time history file path for output	5pnts	_____
Save the processed U, V and wind speed time histories to a csv file	5pnts	_____

Required Functions:

Time history unit conversion	10pnts	_____
Resultant wind speed calculation	5pnts	_____
Resultant wind direction calculation	5pnts	_____
Boundary layer plot	10pnts	_____

Deductions:

Properly formatted PDF		
Title Page	-2pnts	_____
Table of Contents/pdf Bookmarks	-2pnts	_____
Problem Statement	-2pnts	_____
m-files		
Main program, m-file listing	-2pnts	_____
Time history unit conversion, m-file listing	-2pnts	_____
Resultant wind speed calculation, m-file listing	-2pnts	_____
Resultant wind direction calculation, m-file listing	-2pnts	_____
Boundary layer chart, m-file listing	-2pnts	_____
Example command line Input/Output	-5pnts	_____
Mean resultant wind speed and wind direction tables		
Table format	-1pnt	_____
Table title	-1pnt	_____
Column headers	-2pnt	_____
Column header units	-2pnts	_____
Boundary layer chart		
Chart title	-1pnt	_____
Height on Y-axis, wind speed on X-axis	-1pnt	_____
Axis labels	-1pnt	_____
Axis label units	-1pnt	_____
Y-axis log scale	-1pnt	_____
m-files		
Main program	-2pnts	_____
Time history unit conversion function	-2pnts	_____
Resultant wind speed calculation function	-2pnts	_____
Boundary layer chart function	-2pnts	_____
Program Runs and completes required tasks:	-10pnts	_____
Overall Presentation:	-10pnts	_____
Total Grade:	100pnts	_____

