SESA6061 Turbulence: Physics and Modelling
2015/16 Coursework Project I (15% of module mark)
Due Date: Fri 13 November

On blackboard, there is a compressed file called "project-1.zip". If you download this file and uncompress it, you should a folder called "project-1". In this folder, there are 2 different sub-folders. The two sub-folders contain data from two different flows. The first sub-folder titled "flow1" contains five files of hotwire anemometry data of streamwise velocity from "flow1". The second sub-folder titled "flow2" also contains five files of data obtained using the same measurement method in "flow2". Each file has data that was sampled at 60 kHz for a total time of 30 seconds. Therefore, you have a total of 150 seconds of data.

In this project, you will use the data available in these two sub-folders to calculate different turbulence quantities and answer the following questions:

1. Plot the Probability Density Function (PDF) of the streamwise velocity from both datasets and calculate its first four moments. Using the moment information, comment on type of distribution exhibited by the two sets of data.
2. Plot the Probability Density Function (PDF) of the streamwise velocity gradient (i.e. $\partial u_1/\partial x_1$) from both datasets and calculate its first four moments. Using the moment information, comment on type of distribution exhibited by gradients in the two sets of data. Use Taylor's hypothesis to convert temporal gradient to spatial gradient.
3. Using the homogenous isotropic assumptions and Taylor's hypothesis, calculate the dissipation rate from the dataset. Assume kinematic viscosity, $\nu = 1.5 \times 10^{-5}$ m^2/s.
4. Using the dissipation and kinematic viscosity, calculate the Kolmogorov scales of both flows.
5. Calculate the autocorrelation function for both datasets. Compare the two curves and comment on the results.
6. Using the autocorrelation function, calculate the Integral length scale and the Taylor micro scale for both datasets. Comment on the results obtained.
7. Using the information that the window length necessary to calculate the energy spectrum should be at least 50 integral time scales, calculate the energy spectra for both datasets.
8. Plot the pre-multiplied spectrum for both datasets and calculate the dominant time-scale (and hence length scale using Taylor's hypothesis) using this data by locating the peak in this pre-mulitplied spectrum.
9. Plot the dissipation spectrum and verify if the dissipation computed from the spectrum matches the dissipation calculated using the gradients. Comment on the match between the two methods for the two datasets.
10. Based on everything you have seen from the results, what can you say about the nature of flows in "flow1" and "flow2".