

# ME EN 7960-003 Large-Eddy Simulation of Turbulent Flows

## Homework #2: Filtering, Due Thursday Oct. 2<sup>nd</sup>

1. Using the isotropic turbulence direct numerical simulation (DNS) data `iso_vel128.mat` posted online under Homework/Projects (or directly at [http://www.eng.utah.edu/~rstoll/LES/Homework/iso\\_vel128.mat](http://www.eng.utah.edu/~rstoll/LES/Homework/iso_vel128.mat)) from Lu et al. (2008) calculate the 3D energy spectrum function  $E(k)$  where  $k = \sqrt{k_1^2 + k_2^2 + k_3^2}$ . Make a log-log plot of  $E(k)$  vs.  $k$ . On the plot indicate the isotropic scaling range, the production range and the dissipation range.
2. Using the data from problem #1 develop a program(s) that applies a 3D filter to the data in real space at two different scales (of your choice) using:
  - (a) a 3D spatial box filter
  - (b) a 3D Gaussian filter

Present your results by plotting the 3D energy spectrum for each filter type at both filter scales along with the original (unfiltered) energy spectrum from problem #1. Make a separate plot for each filter type.

3. Using the data from problem #1 develop a program(s) that applies 3D filters to the data in Fourier space at two different scales using:
  - (a) a spatial box filter
  - (b) a Gaussian filter
  - (c) a spectral cutoff filter

Present your results by plotting the 3D energy spectrum for each filter type at both filter scales along with the original (unfiltered) energy spectrum from problem #1. Make a separate plot for each filter type. For the spatial box filter and the Gaussian filter, compare the execution time for your programs from problems #2 and #3.