Essentials of Turbulence
ME 724
Spring 2020

HW2 Due 19/3/20

March 6, 2020

1. Consider a signal given by

$$u = \sin(x)$$

   1. Calculate the Fourier transform of u using any fast Fourier transform (FFT) software and plot the result, i.e. $\hat{u}$.
   2. Calculate the inverse FFT of $\hat{u}$ to obtain back u and compare the result with the original signal (from the above equation). You can demonstrate the consistency by plotting the difference.
   3. Calculate the derivative of u by using FFT methods, i.e.

$$\frac{du}{dx} = \mathcal{F}^{-1}\{\mathcal{F}\{\frac{du}{dx}\}\} = \mathcal{F}^{-1}\{ik\hat{u}\}$$

2. Refer to the paper, Kang *et al.*, J. Fluid. Mech., Vol 480, 129-160, 2003. Use the equation for the model spectrum (Equation 6) to plot the energy spectra at $x_1/M = 20, 30, 40$ and 48 and verify that it matches with Figure 5 in the paper. For plotting these spectra you will need to use the parameters listed in Table 1 for the corresponding locations.
   1. Calculate the turbulent kinetic energy, k from the energy spectra at the 4 locations, and compare them with the symbols in Figure 14.
   2. Calculate the dissipation, ϵ from the energy spectra at the 4 locations, and compare them with the values in Table 1.