MAE 214A, Winter 2009
Takehome Exam, Due on Thursday, March 19, before 5 PM

Turn in your own work.
Use notes & published material as required, giving all steps and assumptions.
Use primarily analysis and, if required, supporting experimental data to solve the problems.
No late submissions, please!

1. Consider channel flow of water with mean centerline velocity, $U_c = 1m/s$, and half-width, $h = 0.1m$. Take $\nu = 10^{-6}\, m^2/s$. A data acquisition system is to be designed to measure all dynamically important scales of the velocity. Estimate numerically the highest frequency that the design must account for.

2. Consider a flow with spatially uniform mean shear, $d < u_1 > /dx_2 = S$. All other mean velocity gradients are zero. The turbulence is homogeneous in both parts below, i.e. the turbulence statistics do not have any spatial gradients.

a. Let S be a constant. Show that the asymptotic (long-time) state corresponds to turbulent kinetic energy, $K(t)$, that increases exponentially with time. Use data in the literature to obtain the exponent.

b. Let $S = S_0 \cos(\omega t)$ where S_0 and ω are constants. Quantify the asymptotic state of turbulent kinetic energy in this case.