EE 289 – Homework 7
Due October 14, 2010

1. In a Physics experiment to measure the acceleration of gravity, students collect the following data, which show the position of a falling object as a function of time:

y (meters)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
t (seconds)	0.000	0.079	0.132	0.174	0.212	0.244	0.271	0.301	0.325	0.349	0.373

   This data should fit the equation $y = y_0 + v_0 t + \frac{1}{2}gt^2$.

   (a) Find the best-fit values for y_0, v_0 and g by using the MATLAB `polyfit` function.

   (b) Find the best-fit values for y_0, v_0 and g by using the Octave `leasqr` function. (You can download the files `leasqr.m` and `dfdp.m` from the EE 289 website.

   (Problem adapted from *Data Reduction and Error Analysis for the Physical Sciences* by Bevington and Robinson.)

2. A silver coin is irradiated with thermal neutrons to create two short-lived radioactive isotopes of silver, ${}_{47}Ag^{108}$ and ${}_{47}Ag^{110}$ that subsequently decay by beta emission. Students count the emitted beta particles in 15 second intervals to obtain a decay curve. Data collected from the experiment are in the file `decay.mat`, where y_i is the number of counts in the 15-second interval and t_i is the time of the 15-second interval. The data should fit the curve

$$y = p_1 + p_2 e^{-t/p_4} + p_3 e^{-t/p_5}$$

   where p_1 is the background radiation, p_2 and p_3 correspond to the amounts of the two isotopes, and p_4 and p_5 are the isotope decay rates.

   (a) Use the Octave function `leasqr` to find the best-fit values for the parameters p_1, p_2, p_3, p_4 and p_5.

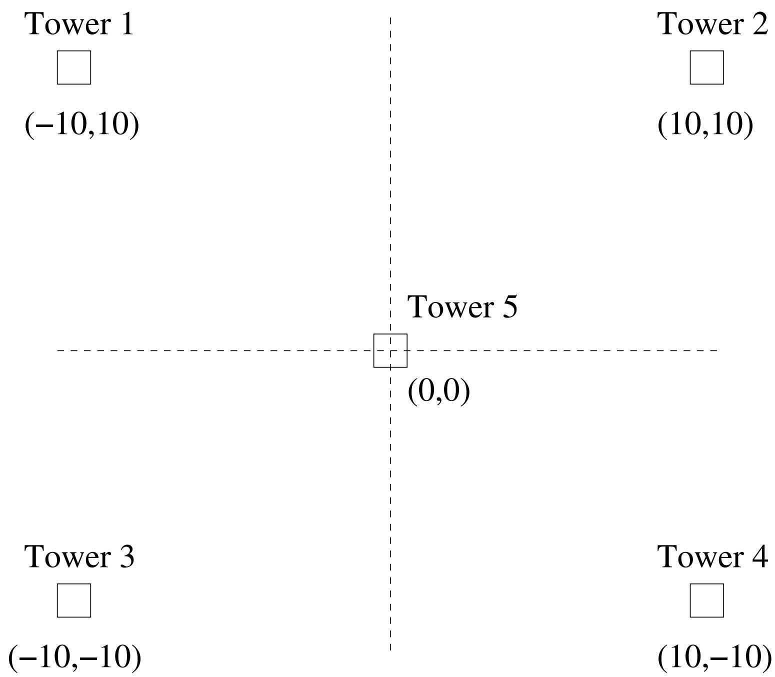
   (b) Plot the raw data (using the symbol "`*`"), and a line showing the function which fits the data. Do the plot on a semi-log scale. (Use the MATLAB `semilogy` function to plot the data.)

   (Problem adapted from *Data Reduction and Error Analysis for the Physical Sciences* by Bevington and Robinson.)

3. You can track a cell phone by measuring the times the cell phone signal arrives at a number of cell towers. The arrival times t_i can be fitted to the equation

$$t_i = t + \frac{\sqrt{(x - x_i)^2 + (y - y_i)^2}}{c}$$

   where x_i and y_i are the coordinates of the cell towers, x and y are the coordinates of the cell phone, and t is the time the signal was emitted from the cell phone. You want to solve for the parameters x, y and t given the measured data t_i (the dependent variable) and the locations of the towers x_i and y_i (the independent variables). Consider five towers with positions as shown the figure below. (The coordinates are given in kilometers.)



The times the signals arrive at the towers are:

Tower	Time (μs)
1	35.4236
2	46.3019
3	50.9556
4	59.0431
5	12.0894

Use the Octave function `leasqr` to find the best location of the cell phone which emitted the signal.

4. Develop pseudocode to do a grid search to find the best-fit values for parameters. You want to develop a function `[f,p] = gridfit(xi,yi,pin,F,dp)`, where `xi` and `yi` are the experimental data, `pin` is the initial guess for the parameters, `F` is a handle to the function you want to fit – `F` is a function of `x` and `p`, and `dp` is the initial step size for each of the parameters.

   For the psuedocode, start with reasonable steps. Starting with the first parameter, `p(1)`, step until the least-square sum starts to increase. (If it increases on the first step, you need to change the sign of the step.) Once you get to a minimum on the first parameter, repeat with the second parameter, then the third, and so on, until you step through all the parameters. Reduce the step size by a factor of two and repeat. Do this several (say about five) times.