Homework 2

Due: Friday, 10/23/15

Objective: To learn how to program various Phase-Field models for simulating basic microstructure processes, including phase separation in multi-component alloys and grain growth.

Part A:

Write a two-dimensional Cahn-Hilliard model code to simulate phase separation of a conserved order parameter representing concentration. Use the semi-implicit spectral method for your numerical solution. Evolve the system for at least 15,000 time steps using a time step size of 1.0 and a grid size of at least 256×256 (similar to what we discussed in class). Execute simulations with two average concentrations: $c_A = 0.5$ and $c_A = 0.25$. For each concentration, determine the time-dependent average domain size L(t), and make a L(t) vs. t plot for each concentration. Fit the data to the following function: $A*L(t)^n$. Clearly state the values of 'A' and 'n'.

Hint: L(t) can be calculated using the following Matlab code:

```
co_FFT = fft2(c-co)/nxy;      % co is the average concentration
Sk = abs(co_FFT).*abs(co_FFT);
kx2 = sum(sum(KX.*KX.*Sk))/sum(sum(Sk));
ky2 = sum(sum(KY.*KY.*Sk))/sum(sum(Sk));
Lx = 2*pi/kx2^0.5;
Ly = 2*pi/ky2^0.5;
Lstep = (Lx + Ly)/2
L(step) = Lstep;
```

Part B:

Write a two-dimensional Allen-Cahn model code to simulate grain growth in a polycrystalline material. Use at least 10 order parameters (ϕ_i) and a similar grid size as Part A. Make a plot of the average grain size versus time (here, you do not have to use the above algorithm, rather just the values of ϕ_i).