ME/MS 260A Homework 2

Micromechanics - Spring 2013-14
Due: April 17, 2014 in class

Guidelines
The homework is due on Thursday April 17, 2014 in class. No late homeworks will be accepted without instructor's prior permission. Some problems may be open ended and left for the student to explore on their own. Standard honor code rules apply. You may refer to any Condensed Matter Physics book for this homework.

1. Landau Theory
According to Landau theory, the free energy φ can be written as a polynomial of the form $\varphi(p,\theta) = a(\theta) + b(\theta)p + c(\theta)p^2 + \dots$ where p is the order parameter. We are interested in developing a Landau (continuum) theory of square to rectangle transition in two dimensions. Show that the Landau (free) energy density can be written as $\varphi(C,\theta) = (C_{11} + C_{22} - 2)^2 + C_{12}^2 + f(C_{11} - C_{22}, \theta)$. Here $f(x,\theta)$ can be expanded using Landau's theory as $f(x,\theta) = a_1(\theta)x + a_2(\theta)x^2 + a_3(\theta)x^3 + \dots$

a. *First order transition* :

1. How many terms in f would be needed to characterize a first order transition ?
2. Can you write a suitable form for f,

b. *Second order transition* :

1. How many terms in f would be needed to characterize a second order transition ?
2. Assume that the transformation temperature is θ_c. Derive the functional form of $f(x,\theta)$ and prove that the modulus $\frac{\partial^2 f}{\partial x^2}$ at $\theta = \theta_c$ is zero. Does this correspond to an elastic modulus vanishing at θ_c?

2. Variants of Martensite
You may consult class notes or Hane, K. F., and Shield, T. W., "Microstructure in a Cubic to Orthorhombic Transition," J. Elasticity, 59, pp. 267-318, 2000.
Identify the variants of martensite and transformation stretches for cubic to orthorhombic transformation.

3. Smallest shear
Identify the smallest shear that would restore a square (2D) lattice.