

PHYSICS 140A : STATISTICAL PHYSICS
HW ASSIGNMENT #5
PRACTICE MIDTERM EXAM

(1) A nonrelativistic gas of spin- $\frac{1}{2}$ particles of mass m at temperature T and pressure p is in equilibrium with a surface. There is no magnetic field in the bulk, but the surface itself is magnetic, so the energy of an adsorbed particle is $-\Delta - \mu_0 H \sigma$, where $\sigma = \pm 1$ is the spin polarization and H is the surface magnetic field. The surface has N_s adsorption sites.

- (a) Compute the Landau free energy of the gas $\Omega_{\text{gas}}(T, V, \mu)$. Remember that each particle has two spin polarization states.
- (b) Compute the Landau free energy of the surface $\Omega_{\text{surf}}(T, H, N_s)$. Remember that each adsorption site can be in one of three possible states: empty, occupied with $\sigma = +1$, and occupied with $\sigma = -1$.
- (c) Find an expression for the fraction $f(p, T, \Delta, H)$ of occupied adsorption sites.
- (d) Find the surface magnetization, $M = \mu_0(N_{\text{surf},\uparrow} - N_{\text{surf},\downarrow})$.