Midterm Exam:

Time Allowed: 1hr 15mins

Total Marks= 50

1. Use Hund's rule to determine the values of S, L and J for an isolated Ni atom with electronic structure $4s^2 3d^8$. What are the allowed values of magnetic moment along the field axis for Ni atom? (5)
2. Suppose $N^+ = \left(\frac{1}{2}\right) N(1+\eta)$, $N^- = \left(\frac{1}{2}\right) N(1-\eta)$ be the concentration of spin up and spin down electrons respectively.

   a) show that in a magnetic field B, the total energy of spin up band in a free electron gas is

   $$E^+ = E_0(1+\eta)^{5/3} - \left(\frac{1}{2}\right) N\mu B(1+\eta)$$

   where $E_0 = \frac{3}{10} E_f$ in terms of Fermi energy in zero magnetic field. Find similar expression for E^-. (10)

   b) Minimize $E_{total} = E^+ + E^-$ w.r.t η and solve for the equilibrium value of η in the approximation η <<1. (5)

3. The dispersion relation of a ripple on the surface of a liquid is given by

   $$E = \alpha k^{\frac{3}{2}}$$

   Where α is a constant. Calculate the density of states in 2-D. (10)
4. Consider a two dimensional electron gas in a magnetic field that is strong enough so that all of the particles can be accommodated in the lowest Landau level. Taking into account only diamagnetic contribution, find the magnetization at temperature T = 0K. (20)