Chapter 3

1. Derive $\sigma(\omega)=\dfrac{\sigma_0}{1-i\omega\tau}$, in which $\sigma_0=\dfrac{ne^2\tau}{m}$ and show that when $\tau\to\infty$, the impedance becomes “inductive”.

2. Estimate the portion of normal current in the two-fluid model when applied an AC electric field at 1MHz. Use the result L(Henry)~$10^{-12}R_N$(Ohm).

3. Estimate the number density of superelectrons by using the London theory. For example, the penetration depth of Pb at zero temperature is experimentally found to be $3.9\text{x}10^{-6}$cm.

Chapter 4

1. Use the definition of Gibbs free energy $G=U-TS+PV-\mu_0H_aM$ to show the Gibbs free energy change due to a magnetic field H_a is given by.

$$\Delta g\left(H_a\right)=-\mu_0\int_0^{H_a} MdH_a$$

Chapter 5

1. Apply Sommerfeld’s theory to show that the electronic specific heat of the metals is proportional to the temperature, i. e.

$$C_{el}=\gamma T$$

in which the constant γ is proportional to the density of states at Fermi surface.

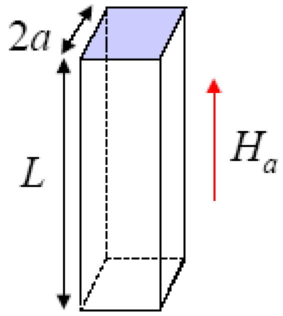
2. Do the same calculation by assuming an energy gap Δ forming at the Fermi surface and show that

$$C_{el}=ae^{-e\Delta/kT}$$

at low temperature, $kT<<\Delta$

Chapter 6

1. Show that the demagnetizing factor of a sphere is 1/3.2. Evaluate the surface energy per area by assuming that the position dependence of the n_s obeys the exponential law, i. e. $n_s \sim n_s(0)\left(1-e^{-x/\xi}\right)$, in which x is the distance from the NS boundary and $n_s(0)$ is the number density deep inside the superconduting region. **Chapter 8**1.Calculate the correction of critical field, due to the effect of penetration, for a long square bar with a length a for each side.



(hint: Solve $\nabla^2 B - \frac{1}{\lambda^2} B = 0$ with the boundary conditions: $B\left(x=\pm a, y\right) = B\left(x, y=\pm a\right) = \mu_0 H_a$. Then integrate the total moment and calculate the magnetic contribution of the Gibbs free energy)2. Complete the derivation of the flux density $B = -\mu_0 \lambda J(a) \frac{\sinh\left(x/\lambda\right)}{\cosh\left(a/\lambda\right)}$ for the slab carrying a transport current $J(x)$.