Only correctness of the final answers will be checked. You may box the final answer.

1. The electron-electron interaction in presence of phonons is given by,

\[ V(\vec{q}, \omega) = \frac{U_{\vec{q}}}{\epsilon(\vec{q}, \omega)} + \frac{2\omega_D M^2_{\vec{q}}}{\epsilon(\vec{q}, \omega) [\omega^2 - \omega_D^2]} \]

symbols have usual meaning as discussed in class. The first term is the familiar Coulomb (repulsive) term and the second term (conditionally attractive) arises owing to the electron-phonon interaction. Present a qualitative plot for \( V(\vec{q}, \omega) \) vs \( \omega \) showing the region responsible for superconductivity.

2. Calculate the distribution of flux density \( B(x) \) inside a superconducting slab of thickness \( 2a \) in the \( x - y \) plane and extending infinitely in the \( y \)-direction. Assume uniform flux density \( B_a \) is applied parallel to the sides (see Fig. 1). Express your result in terms of \( B_a \) and London penetration depth \( \lambda_L \).

3. For a type-I superconductor, find the jump in entropy and specific heat across the transition from a superconductor to a normal state. Given the free energy variation between the normal \((F_N)\) and superconducting \((F_S)\) phases at zero magnetic field is given by,

\[ F_N - F_S = \mu_0 \frac{H_c^2(T)}{2} \]

where \( \mu_0 \) is the permeability of the free space and \( H_c \) is the critical magnetic field whose temperature variation is given by,

\[ H_c(T) = H_c(0) \left[ 1 - \left( \frac{T}{T_c} \right)^2 \right] \]

\( T_c \) being the transition temperature. Express your answer in terms of \( H_c(0), T, T_c \) and \( \mu_0 \).

4. What is the value of \( \frac{2\Delta}{k_B T_c} \) for a BCS superconductor? What is roughly the value for the same for high temperature superconductors?

5. Write down the familiar form for BCS gap equation.
Figure 1: Superconducting slab of thickness 2a. Flux density outside is $B_a$.

Your Submission:

Due Date Exceeded.
As per our records you have not submitted this assignment.