

Physics 525 – Homework # 8

Due Apr. 17, 2024

- 8.1** (5 points) Write an equation which relates the magnetic field and the vector potential.
- 8.2** (5 points) Write an equation which relates supercurrent and the vector potential (in the vortex-free regime, i.e., when there are no vortices or any kind of phase gradients in the superconductor).
- 8.3** (20 points) Suppose you connect a capacitor ($C=1$ nF) and an inductor ($L=1$ nH) in parallel. Thus, you make an LC-circuit.
- (a) What is the oscillation frequency of such a circuit?
 - (b) What is the minimum energy of such a circuit?
 - (c) Suppose you have two such LC-circuits, as outlined above. Suppose the energy of first circuit is E_1 and the energy of the second circuit is E_2 . Suppose also that $E_2 > E_1$ but the difference $E_2 - E_1$ is as small as possible. How does the phase difference between the wave functions of the two circuits evolve in time?
 - (d) Suppose the wavefunction of the state with energy E_1 is ψ_1 and the wavefunction of the state with energy E_2 is ψ_2 . We prepare the LC-circuit in the state $\psi_1 + \psi_2$. Then we measure the energy of the system? What are possible outcomes of such measurements?
 - (e) Same question as (d), but write down the probabilities of each possible outcome of the energy measurement.