MANIPAL
ACADEMY of HIGHER EDUCATION
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DEPARTMENT OF SCIENCES, IV SEMESTER M.Sc (PHYSICS)
END SEMESTER EXAMINATIONS, APRIL 2018

Subject: Condensed Matter Physics -III [PHY: 708.2]
(REVISED CREDIT SYSTEM-2017)

Time: 3 Hours   Date: 25 April 2018   MAX. MARKS: 50

Note: (i) Answer **ANY FIVE** questions

(ii) Draw diagrams, and write equations wherever necessary

1. (A) Distinguish between magnetic behavior of a perfect conductor and a superconductor.

    (B) Show how one can use the property of a superconductor to generate a magnetic field. Demonstrate how division of currents happens in a superconducting ring.

    (C) A type II superconducting wire of radius r carries current uniformly distributed through its cross section. If the total current carried by the wire is I, show that the magnetic energy per unit length of the wire is $\mu_o I^2/(16\pi)$.   [2+4+4]

2. (A) Using the postulates of London's theory, derive the expression for penetration depth in a superconductor. Also discuss the temperature dependence of penetration depth. What are the limitations of London's theory?

    (B) What are the assumptions of Gorter-Casimir two fluid model? Using this theory derive the expression for the difference in normal state and superconducting state specific heat.

    (C) A superconducting solenoid magnet is to be fabricated to generate a 10 T magnetic field. If the winding has 2000 turnings/m, what is the required current? What force per meter does   the magnetic field exert on the inner windings?

                                                                    [4+4+2]

3. (A) Derive the expression for ground state energy of a system of Cooper pairs. Show that the superconducting state is more stable than the normal state.

    (B) When a metal enters the superconducting state, it becomes more ordered and its free energy decreases. What is the nature of the new ordering?   [6+4]

4. (A) Show the energy level diagram of a superconductor. In the context of tunneling process, show how tunneling takes place between two identical superconductors.
(B) What is a SQUID? Giving essential mathematical details show how one can measure very small changes in magnetic field.
(C) What is an electron pair wave? Derive the expression for fluxon.

[3+3+4]

5. (A) Deliberate the chain and plane sites in $YBa_2Cu_3O_7$ unit cell. Discuss the significance of the copper sites.
(B) What is superfluidity? Discuss the phase diagrams of He-3 and He-4.
(C) Give an account of the modern classification of phase transitions. [4+4+2]

6. (a) What are the assumptions of Ginzburg-Landau theory? Derive the two G.L. equations.
(b) Describe the salient features of thermal conductivity and electrical of high temperature superconductors. Draw the necessary graphs. [5+5]