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MANIPAL UNIVERSITY, MANIPAL

FOURTH SEMESTER M.SC (Physics) END SEMESTER EXAMINATION, May, 2016

SUB: Condensed Matter Physics-III (PHY – 708.2)
(CREDIT SYSTEM)

Time: 3 Hrs. **Max. Marks: 50**

Note: a) Answer any FIVE full questions. B) All questions carry equal marks.

1. (a) What are superconductors? Define superconducting transition temperature.
   (b) In an experiment conducted by Collins and co-workers, a current was maintained in a superconducting ring for 2.5 years with no observed loss in current. If the inductance of the ring was 0.314 *nH* and the sensitivity of the experiment was about 1 part in 10^9, determine the maximum resistance of the ring in the superconducting state.
   (c) The isotopes of mercury, ^{199}Hg and ^{204}Hg, have different transition temperatures. It is given that the former has transition temperatures of 4.161 *K*. Using this data calculate the transition temperature of the latter given that α=0.34. **[4+4+2]**

2. (a) Derive the expression for difference in entropies in normal and superconducting states.
   (b) Distinguish between a superconductor and a perfect conductor.
   (c) Consider a thin and long superconductor and let an external magnetic field be applied along the length of the superconductor, derive the expression for magnetic field inside the superconductor along the length. Also derive the expression for critical magnetic field when there is penetration of magnetic flux. **[3+2+ 5]**

3. (a) What are the assumptions of Ginzburg-Landau theory? Derive the two G.L. equations.
   (b) What are the assumptions of London's theory? Derive the expression for London's penetration length. **[5+5]**

4. (a) Give a brief account of the discovery of high temperature superconductors. Draw the unit cell structure of $YBa_2Cu_3O_7$ compound. Discuss various substitutions of elements at different sites and deliberate the importance of copper site.

   (b) Describe the salient features of thermal conductivity and electrical of high temperature superconductors. Draw the necessary graphs.

   [6+4]

5. (a) What is a phase transition? On the basis of Ehrenfest classification, distinguish between first order and second order phase transitions.

   (b) Display the energy level diagram for a superconductor. In the context of tunneling process, show how tunneling takes place between a metal and a superconductor.

   [6+4]

6. (a)What are the assumptions of BCS theory? Starting from the Hamiltonian, show that a bound state exists irrespective of smallness of V (the attractive interaction term).

   (b) Show how critical temperature, latent heat and critical magnetic fields are explained using BCS theory. **[6+4]**