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MANIPAL UNIVERSITY

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DEPARTMENT OF SCIENCES, M.Sc. (Physics)
IV SEMESTER - END SEMESTER EXAMINATIONS, June 2017
(Make-up EXAM)

SUBJECT: CONDENSED MATTER PHYSICS III PHY708.2

(REVISED CREDIT SYSTEM)

Time: 3 Hours Date: 14/06/2017 MAX. MARKS: 50

Note: (i) Attempt any FIVE full questions

(ii) Assume missing data, if any.

1. (a) A type II superconducting wire of radius R carries current uniformly distributed through its cross section. If a current of I is carried by the wire, show that the magnetic energy per unit length of the wire is given by $\mu_0 I^2/16\pi$.
   (b) An experiment conducted in which a current is maintained in a superconducting ring for 3 years with no observed loss in current. If the inductance of the ring is 100 nH and the sensitivity of the experiment is about 1 part in 10^{20}, determine the maximum resistance of the ring.
   (c) Show that superconductors are perfect diamagnetic materials.

   [4+4+2]

2. (a) Derive Rutger's formula.
   (b) Using appropriate thermodynamics derive the expression for critical magnetic field for a superconductor.
   (c) Derive the expression for London's penetration depth.

   [3+2+ 5]

3. (a) What are the assumptions of Gorter and Casimir theory? Derive the expression for the difference between the specific heat in normal and superconducting states.
   (b) Show how one designs a superconducting magnet.
   (c) Define critical currents.

   [6+2+2]

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. **[5+5]**

5. (a)What is superfluidity? Discuss the phase diagrams of He-3 and He-4.

   (b) Give an account of the modern classification of phase transitions.

   (c) Deliberate the chain and plane sites in $YBa_2Cu_3O_7$ unit cell. Discuss the significance of the copper sites.

   [5+3+2]

6. (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) Show how excitation from ground state happens in case of a superconductor. Derive the expression for single particle excitation energy. **[6+4]**