B.E. End-semester (4th Semester AE, CE, ME, Met, Min) Examination, 2013

PHYSICS (PH - 3401)

Full Marks: 70 Time: 3 hrs.

Answer any five questions:

1. a) State Bloch's theorem in one dimensional lattice.
   b) Consider the Krönig-Penney model in one dimension:
      i) Write down the potential energy of an electron stating clearly its periodicity.
      ii) Write down the Schrödinger equation in different regions of the potential and obtain the solutions using Bloch's theorem.
      iii) Write down the boundary conditions in terms of Bloch's function.
      iv) Given the following dispersion relation

$$\frac{\beta^2-\alpha^2}{2\alpha\beta}\sinh\beta b\sin\alpha a+\cosh\beta b\cos\alpha a=\cos k(a+b),$$

   Obtain its form in the narrow and large potential barrier limit and plot it as a function of αa for P =$3\pi/2$, indicating the allowed and forbidden regions of the band. Here the symbols have usual meaning.

[2+2+4+2+4]

2. a) What are paramagnetic materials? How do you distinguish a paramagnetic substance from a Diamagnetic one?
   b) Obtain an expression of paramagnetic susceptibility of substance containing N of spin J particles in unit volume on the basis of quantum theory.

[4+10]

3. a) Describe the hysteresis curve for a ferromagnetic material. What is hysteresis loss per cycle?

   b) Describe Weiss molecular field theory of a ferromagnetic substance. Show that spontaneous magnetization exists at a temperature below Curie temperature. Obtain Curie-Weiss law.

[4+ (6+4)]

4. (a) Discuss Einstein's model for heat capacity of a solid and hence obtain the expression for C_v. Show that C_v agrees with the Dulong Petit's law at high temperature.
   (b) State the discrepancies of Einstein's model that led Debye to put forward his modifications and hence show that C_v varies as T^3 at low temperatures. Also, obtain the relationship between Einstein's and Debye temperature.

[(4+1)+(2+5+2)]

5. (a) For a conducting media write down the Maxwell's equations and hence show that the free charge density vanishes at large time.
   (b) State the classical free electron theory of Lorentz and Drude. Using this theory find an expression for thermal conductivity of a metal. State Weidemann- Franz law.

[(4+2)+(2+4+2)]

6. Write short notes (any two)
   i) Meissner effect and Cooper pairs
   ii) Clausius Mosotti equation
   iii) Susceptibility of a diamagnetic substance
   iv) Propagation of EM wave in conductor. [7X2]