B.E. End-semester (3rd Semester ETC, CST, EE, IT) Examination, 2012

PHYSICS (PH - 3401)

Full Marks: 70 Time: 3 hrs.

Answer any five questions:

1. a) What are the different types of polarization in materials? What is polarizability?
   b) Show that the electronic polarizability is given by $\alpha_e = 4\pi\varepsilon_0 R^3$, where R is the radius of an atom.
   c) What is internal field in solids? Assuming the Lorentz field, deduce Clausius-Mosotti relation.

[4+5+5]

2.a) Deduce the expression for concentration (n) of electrons in the conduction band of an intrinsic semiconductor at a temperature T.
   b) Show that the product (np) of electron and hole concentrations are independent of the Fermi level.
   c) Find out the position of the Fermi level in an intrinsic semiconductor. Draw the position of the Fermi level when the semiconductor is doped to make an n-type semiconductor.

[6+4+4]

3. a) What is magnetization (M)? Show that $\mathbf{B} = \mu_0(\mathbf{H}+\mathbf{M})$, the symbols have usual meaning.
   b) Show that an electron orbiting round a nucleus along a circular path is equivalent to magnetic dipole of moment $\mu_m = -(e/2m)\,\mathbf{L}$, where **L** is its angular momentum, e the charge and m the mass.
   c) Show that if a magnetic field B is applied at an angle with the plane of orbiting electron, the plane executes a precessional motion about the direction of the magnetic field with a frequency $\omega_L = eB/(2m)$.

[4+3+7]

4.a) Show that application of magnetic field to an atom changes the frequency of revolution of an electron round the nucleus. Hence deduce an expression for susceptibility of a diamagnetic material.

[14]

5. a) Assuming that the dipole moment of an atom to be μ_B, where μ_B is the Bohr magneton, and that the dipole may orient itself parallel and anti-parallel to an external field, find an expression for magnetization of a paramagnetic material.
   b) Using the above expression and assuming a Weiss type internal field in a ferromagnetic material, deduce Curie-Weiss law and find expression for the Curie point and Curie constant.

[8+6]

6. a) What is Meissner effect? Show that this effect is not consistent with Maxwell's equations. Using the two fluid model of a superconductor, show how London equations may be arrived at and that Meissner effect may be explained from them.
   b) Using London equations, find an expression for London penetration length.

[(2+2+5)+5]

7.a) Show that the free charge density in a conductor changes with time as $\rho_f(t) = \rho_f(0)\exp(-t/\tau)$, where τ is the charge dissipation time. Explain the significance of dissipation term in distinguishing conductivity of materials.
   b) What is skin depth? Using Maxwell's equations describing electromagnetic wave propagation obtain an expression for skin depth.

[7+7]

8. Write short notes on any two:
   i) Ferroelectricity,
   ii) Kronig=Penney model,
   iii) Cooper pair and BCS theory of superconductivity.
   iv) Wiedemann-Franz law.

[2×7]