MAJOR EXAM

PYL 102- PRINCIPLES OF ELECTRONIC MATERIALS

(19th Nov, 2016)

Answer all questions

Time **Two** Hours

Maximum Marks: **40**

1. Some of the following statements are **right or wrong**. Give the correct statement with proper justification. **No marks if there is no justification.**
   - (a) Fill-factor of a solar cell can take maximum value of 2.
   - (b) Hard ferromagnetic magnetic materials can be used for making transformer core.
   - (c) Helium gas is diamagnetic.
   - (d) A temperature sensor can be a fabricated from piezoelectric material.
   - (e) A solid with cubic structure will not exhibit induced polarization when subjectd to an external stress.   [5]

2. (a) In a linear one dimensional lattice, 7 ions (magnetic moment as L) are arranged with inter distance as 'a' and each magnetic moments are aligned in up direction. Assuming the nearest neighbours interaction, obtain the total energy of the system. What will be the change in the energy of the system if one of the corner ion magnetic moment flips to down direction.   [4]

   (b) A system consist of N atoms. Each atom has eight valence electrons in the d-orbitals. Obtain the magnetic moment of an individual atom in terms of Bohr Magnetron. What will be value of saturarion Magnetization (M_s) in the absence of external field if (i) there is a exchange interaction (with J positive) or (ii) no interaction between these atoms.   [3]

   (c) Draw variation of M with external field (H) for a soft and hard ferromagnetic materials in the first quardent of M-H graph. For which case initial permeability (μ_i) will be large.   [3]

3. (a) Sample 'A' is a dielectric polar gas and sample 'B' is a dielectric polar solid. Both are subjected to electric field E. What will be local field (E local), polarisation and dielectric constant (ε_r) for both the sample (α_o and α_e are orientation polarizability and electronic polarizability).   [4]

   (b) Obtain a relationship between Polarization (P) and surface polarizability charge density.   [2]

   (c) A cylindrical piezoelectric spark generator is fabricated from a piezo material with $\varepsilon_r = 100$, area = 1 cm^2, length = 10cm piezocoefficient (d) = $300 \times 10^{-12} mV^{-1}$. It is subjected a force of 10N. Obtain the value of polarization and surface charge density.   [2]

4. (a) Draw I-V characteristics of a solar cell in dark and light and obtain the expression for open circuit voltage (V_{oc}) of the solar cell.   [3]

   (b) On what factors domain wall thickness of a ferromagnetic material depends. For a domain rotation of $\Theta = \pi/2$, obtain the width of domain wall.   [5]

   (c) For a two dimensional electron gas with N as total number of electrons, obtain density of states (number of states per unit energy) and average energy of this two-dimensional electron gas.   [4]

5. Illustrate the difference by drawing graphs.
   (a) I-V curve of a tunnel junction and a normal P-N junction operating in reverse bias.
   (b) M-H curve for a paramagnet and a ferromagnetic material.
   (c) $1/\chi$ vs. T for a paramagnet and a ferromagnetic material. (χ = susceptibility)
   (d) Arrangement of a magnetic moment in domains of a ferromagnetic material at H = 0 and for H>>0.
   (e) Variation of magnetic susceptibility with temperature of a paramagnetic liquid and a paramagnetic metallic solid.   [5]