PG/IS/ELC-103/19

M.Sc. 1st Semester Examination, 2019

ELECTRONICS

(*Electronic Materials*)

PAPER – ELC-103

Full Marks : 50

Time : 2 hours

The figures in the right hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

Illustrate the answers wherever necessary

1. Answer any *four* questions : 2×4

(*a*) Mention different levels of structure of materials. 2

(*b*) What is a Burgers vector ? 2

(*c*) State the drawbacks of classical free electron theory *of metals.* 2

(*d*) How does the Hall mobility differ from the drift mobility ? 2

(*e*) Explain dielectric relaxation. 2

(*f*) How are ferrites superior to magnetic metals ? 2

(*g*) What is photoluminescence ? 2

(*h*) Explain T-H-I diagram for superconductors. 2

2. Answer any *four* questions : 4 × 4

(*a*) Show that the number of Frenkel defects in equilibrium at a given temperature is proportional to $(NN_i)^{1/2}$, where N be number of atoms and N_i be the interstitial atoms. 4

(*b*) Obtain a general expression for Fermi energy of electrons in solids at absolute zero. 4

(*c*) Establish the Boltzmann transport equation. 4

(*d*) Derive the Clausius-Mossotti expression for dielectric materials in a static field. 4

(*e*) Consider a gas containing N similar atoms per m^3 of a polarizability α. For the induced dipole moment resulting from an alternating field, show that the dielectric constant of the gas is given by

$$\epsilon_r^* = 1 + \frac{Ne^2/m\epsilon_0}{w_0^2 - w^2 + j\,2bw/m};$$ where the symbols have their usual meanings. 4

(*f*) Explain the absorption of light by interband and intraband transitions. 4

(*g*) What are the characteristics of ferromagnetic substances ? The saturation magnetization of iron is $1{\cdot}75 \times 10^6$ A/m. Assuming that the iron has a body-centred cubic structure with an edge-length of 2·87 Å, find the average number of Bohr magnetons contributing to the saturation magnetization per atom. $1\frac{1}{2} + 2\frac{1}{2}$

(*h*) Show that the magnetic flux is confined to a hole in a superconductor. 4

3. Answer any *two* questions : 8×2

(*a*) What is meant by crystal imperfections ? Describe with suitable diagrams edge dislocations and screw dislocations in crystal lattice. $2 + 6$

(*b*) (*i*) Give a schematic sketch of the variation of the total polarizability of an atom as a function of the frequency, explaining the physical origin of the various contributions and the relevant frequency ranges.

(*ii*) Explain absorption of energy in dielectric and dielectric loss. $(1 + 3) + 4$

(*c*) (*i*) Describe the structure of ferrites. How is the magnetic moment of ferrite molecule calculated ?

(*ii*) Give reason why in Fe_3O_4, some of the magnetic Fe^{2+} ions are replaced by non-magnetic ions such as Zn^{2+} or Cd^{2+}, the magnetization increases. $(3 + 3) + 2$

(*Continued*)