

College of Engineering, Pune.

(An autonomous Institute of Government of Maharashtra, Pune 411005).

End Semester Examination November 2011

Second Year B. Tech.

MT 225 (ILE 201) Device Materials

Time 3 hours]

[Max. Marks 50

Instructions to candidates:

- 1) Solve any five questions.
- 2) Write within the limits of lines, whenever stated.
- 3) Neat diagrams must be drawn wherever necessary.
- 4) Assume suitable data if necessary.

1. (a) What is the difference between the conduction of current in metals and that in ionic solids, with reference to factors such as mobility, effect of temperature etc.? (10 lines). (5 marks)

(b) Calculate the drift velocity of electrons in silicon at room temperature, with a field 500 V/m. Under this condition, how long does it take an electron to traverse a 25 mm length? Assume mobility of $0.135 \text{ m}^2/\text{V.s}$. (5 marks)

2. (a) Show, only by sketches, the material layers as used in micro-electronics for (i) npn transistor and (ii) a MOSFET. Indicate overall approximate dimensions of the region shown. (4 marks)

(b) For intrinsic GaAs, the values are as follows: conductivity $8.9 \times 10^4 (\Omega\text{-m})^{-1}$, electrons $8.7 \times 10^{23}/\text{m}^3$ and holes $8.7 \times 10^{23}/\text{m}^3$. For the corresponding p-type GaAs, the respective values are $2.3 \times 10^5 (\Omega\text{-m})^{-1}$, $7.6 \times 10^{22}/\text{m}^3$ and holes $1.0 \times 10^{25}/\text{m}^3$. Find the electron and hole mobilities. $q = 1.6 \times 10^{-19} \text{ C}$. (6 marks)

3. (a) What is magnetic anisotropy, magnetic domain walls and magnetostriction? What is their role in the magnetization behavior of materials? (12 lines). (6 marks)

(b) Iron has a saturation magnetization of $1.71 \times 10^6 \text{ A/m}$. What is its average magnetic moment in Bohr magnetons/atom? Iron has B.C.C. structure (2 atoms/cell) with cell parameter 0.287 nm. Bohr magneton is $9.27 \times 10^{-24} \text{ A.m}^2$. (4 marks)

4. (a) Derive the relation between displacement, electric field and polarization in a dielectric. State the corresponding equation in magnetization of materials. (10 lines). (5 marks)

(b) The polarization P of a dielectric material in a parallel plate capacitor is to be $4 \times 10^{-6} \text{ C/m}^2$. If the field applied is 10^5 V/m , what should be the dielectric constant ϵ_r and value of D? $\epsilon_0 = 8.854 \times 10^{-12} \text{ F/m}$.

5. (a) State the main active materials used in: –a fluorescent light, LCD and LED. Does the LED monitor need an LCD? (10 lines). (5 marks)

(b) How do the optical fibers work? State their 3 important applications. (10 lines). (5 marks)

6. Write short notes (less than 10 lines each) on any two of the following:

(a) Action of laser in 3 types of CDs.

(b) Thermocouple materials.

(c) Ferroelectric materials. (10 marks).