DECEMBER 2004

Code: A-04
Subject: MATERIALS AND PROCESSES
Time: 3 Hours Max. Marks: 100

NOTE: There are 11 Questions in all.

Question 1 is compulsory and carries 16 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.
Answer any THREE Questions each from Part I and Part II. Each of these questions carries 14 marks.
Any required data not explicitly given, may be suitably assumed and stated.

Q.1 Choose the correct or best alternative in the following: (2x8)

a. The atomic diameter of an FCC crystal having lattice parameter a is

(A) $\frac{a\sqrt{2}}{2}$. **(B)** $\frac{a\sqrt{2}}{4}$.
(C) $\frac{a\sqrt{3}}{4}$. **(D)** $\frac{a}{2}$.

b. A pair of one cation and one anion missing in a crystal of the type AB is called
(A) Schottky defect. **(B)** Frenkel defect.
(C) Pair of vacancies. **(D)** None of these.

c. The maximum number of co-existing phases in a C-component system is

(A) C P + 2. **(B)** P(C 1).
(C) F C +2. **(D)** C + 2.

d. The Fermi level is
(A) an average value of all available energy levels.
(B) the highest occupied energy level at $0^{\circ}K$.
(C) an energy level at the top of the valence band.
(D) the largest available energy level.

e. Pure silicon at zero K is an
(A) intrinsic semiconductor. **(B)** extrinsic semiconductor.

(C) metal. **(D)** insulator.

f. The dielectric strength of a material is the highest

(A) current which can pass through it.
(B) voltage that can be applied to it.
(C) field (voltage per meter thickness) that can be with-stood by it.
(D) current density that can be transmitted by it.

g. Hard magnetic material is characterised by

(A) high coercive force and low residual magnetic induction.
(B) low coercive force and high residual magnetic induction.
(C) high coercive force and magnetic induction.
(D) only low coercive force.

h. Fine grain sizes are obtained by

(A) slow cooling. **(B)** increasing nucleation rate.
(C) decreasing growth rate. **(D)** fast cooling.

PART I
Answer any THREE Questions. Each question carries 14 marks.

Q.2 a. Explain with suitable examples the ionic, covalent and metallic bonds. Explain Madelung constant? **(6 + 2)**

b. What are Miller indices? What are their significances? Draw a (110) and a $(\bar{1}\bar{1}1)$ plane inside a cubic unit cell. **(2 + 4)**

Q.3 a. Illustrate the point, line and surface imperfections found in solid materials with suitable sketches. Does the Burgers vector change with the size of the Burgers circuit? Explain. **(6 + 3)**

b. Find the maximum radius of the interstitial sphere that can just fit into the void between the body centred atoms of bcc structure. **(5)**

Q.4 a. Explain with suitable diagrams the atomic model of diffusion. What is Einsteins relation? **(6 + 2)**

b. What are the total variables and degrees of freedom of a system of two components, when the number of phases is one, two, three etc.? **(6)**

Q.5 a. Derive an expression for the electrical conductivity of a metal on the basis of free electron theory. Explain why nichrome and not copper is used as a heating element. **(6 + 4)**

b. The Fermi level for potassium is 2.1ev. Calculate the velocity of the electrons at the Fermi level. **(4)**

Q.6 a. What is an energy band? Why does the Fermi level in an intrinsic semiconductor lies in the middle of the energy gap? **(2 + 6)**

b. Distinguish between doping and alloying. Which of the two should be resorted to for changing the mechanical properties and why? **(6)**

PART II

Answer any THREE Questions. Each question carries 14 marks.

Q.7 a. Show that the electronic polarizability is proportional to the volume of the atom. What is the effect of temperature on the polarization of ferroelectric material? **(5 + 3)**

b. What is dielectric strength? Discuss the reasons for dielectric break down. **(3 + 3)**

Q.8 a. Explain domain theory of ferromagnetism. **(6)**

b. Draw a typical hysteresis loop for a ferromagnetic material. Show which part is reversible and which is not. What procedure would you recommend for making the material required for magnetic memories? **(4 + 4)**

Q.9 a. What are the functions of oxide layer in a high quality IC? Explain. **(6)**

b. Differentiate ion implantation and metallization processes in the fabrication of ICs. **(8)**

Q.10 a. Explain with sketch the process of forging. **(7)**

b. What are the objectives of annealing? Explain annealing and spheroidising processes. **(4 + 3)**

Q.11 a. What are the properties and applications of bakelite and transformer oil? **(6)**

b. Compare and differentiate the properties of common semi-conducting materials and common dielectric materials. **(8)**