**AMIETE – ET (OLD SCHEME)** **JUNE 2009**

**Code: AE04** **Subject: MATERIALS AND PROCESSES**
**Time: 3 Hours** **Max. Marks: 100**

**NOTE: There are 9 Questions in all.**

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

**Q.1 Choose the correct or the best alternative in the following:** **(2 × 10)**

a. Ionic bonding in solids depend primarily on

**(A)** Van der waal's forces. **(B)** electrical dipoles.
**(C)** sharing of electrons. **(D)** transfer of electrons.

b. Schottky effect describes

**(A)** effect of intensive electric field on the rate of electron emission from a cathode.
**(B)** current in temperature limited region.
**(C)** current in space charge region.
**(D)** Both **(B)** and **(C).**

c. Bragg's equation for X-ray diffraction from crystal planes is given by

**(A)** $d = \frac{n\lambda}{2}\sin\theta$. **(B)** $n\lambda = 2d\sin\theta$.
**(C)** $\lambda = \frac{2dn}{\sin\theta}$. **(D)** $n = \frac{d}{2\lambda}\sin\theta$.

d. $d_{100}:d_{110}:d_{111}$ for simple cubic lattice stand in the ratio

**(A)** $\sqrt{2}:\sqrt{3}:\sqrt{6}$. **(B)** $\sqrt{6}:\sqrt{3}:\sqrt{2}$.
**(C)** $\sqrt{3}:\sqrt{2}:\sqrt{6}$. **(D)** $\sqrt{2}:\sqrt{6}:\sqrt{3}$.

e. For germanium the forbidden energy gap is

**(A)** 0.7 ev. **(B)** 0.15 ev.
**(C)** 0.3 ev. **(D)** 0.5 ev.

f. Which of the following materials are piezoelectric?

1. Barium titanate 2. Alumina
3. Silica 4. Cadmium sulphide

**(A)** 1, 2 and 4 **(B)** 1, 3 and 4
**(C)** 1, 2 and 3 **(D)** 2, 3 and 4

g. The following can be grown epitaxially on Si without creating significant distortion or imperfections

**(A)** $SiO_2$ **(B)** GaAs
**(C)** Si of a different doping **(D)** Sb

h. Electromigration in an IC chip refers to

**(A)** Grain boundary diffusion of Al in Al interconnections.
**(B)** Grain boundary diffusion of Cu in Al interconnections.
**(C)** Diffusion of Si in Al interconnections.
**(D)** Diffusion of oxygen in Si.

i. The units of $\varepsilon_0$ are

**(A)** C-$m^2$. **(B)** $Hm^{-1}$.
**(C)** $Fm^{-1}$. **(D)** Dimensionless.

j. The degree of freedom when ice, water and water vapour co-exists in equilibrium are

**(A)** 1 **(B)** Triple point
**(C)** –1 **(D)** 0

**Answer any FIVE Questions out of EIGHT Questions.**
**Each question carries 16 marks.**

**Q.2** a. What are deficiencies of Rutherford's nuclear model? How these deficiencies were overcome by Bohr's atomic model? **(8)**

b. Find atomic packing factor for FCC. Also calculate number of atoms per $mm^2$ surface area in a plane for copper which has FCC structure and a lattice constant a = $3.61 \times 10^{-7}$cm **(8)**

**Q.3** a. Explain with simple sketches the arrangement of atom around an edge dislocation and a screw dislocation. Also illustrate Burgers vector on the sketches. **(8)**

b. State and explain the utility of Gibb's phase rule? **(8)**

**Q.4** a. State Fick's first and second law of diffusion. How diffusion coefficient is influenced by temperature? **(8)**

b. A copper wire of area = $5 \times 10^{-6}$ sq-m carries a steady current of 50A. Assuming one free electron per atom calculate

(i) density of free electrons
(ii) average drift velocity of electrons and
(iii) relaxation time of electrons

[$\sigma_e$ for Cu = $5.85 \times 10^7$ mho/m and $\rho_{Cu}$ =$8.9 \times 10^3$ kg/$m^3$]

Permittivity of free space = $8.85 \times 10^{-12}$ fd/m
. **(8)**

**Q.5** a. What is Hall effect? What are the applications of Hall effect? How the concentration of charge carriers (electrons or holes) in a semiconductor can be found from measurement of Hall coefficient? **(8)**

b. If the carrier concentration for silicon is $1.6 \times 10^{10} / cm^3$ at 300K, determine its conductivity and resistivity. Also calculate drift velocity of holes and electrons if the applied electric field is 50 V/cm. Given that $\mu_p = 500\ cm^2 / V - sec$, $\mu_n = 1500\ cm^2 / V - sec$ for silicon and the electronic charge, $e = 1.6 \times 10^{-19}$ coulomb. **(8)**

**Q.6** a. Explain Dielectric strength of a dielectric material. On what factors dielectric strength of a dielectric

depends? **(8)**

b. What is Ferroelectric material? Write a brief note on any two ferroelectric materials? **(8)**

**Q.7** a. Explain the following magnetic parameters:

(i) Magnetic moment.
(ii) Magnetization.
(iii) Magnetic susceptibility. **(8)**

b. Name the magnetic material desirable for the core of the transformer listed below? Also explain why?

(i) 60 Hz power transformer
(ii) AF power transformer
(iii) RF power transformer
(iv) Pulse transformer **(8)**

**Q.8** a. What do you understand by ION implantation? Give at least two applications where the process of ion implantation is used. **(8)**

b. Distinguish between cold and hot forging. Write their advantages and disadvantages. **(8)**

**Q.9** Write short notes on any **TWO**:-

(i) Soldering and Brazing.
(ii) Photolithography.
(iii) Hardening and tempering. **(8 × 2=16)**