VIT

Vellore Institute of Technology

Slot: A2+TA2

SCHOOL OF ELECTRONICS ENGINEERING

Continuous Assessment Test – 1 Winter 2022-23 Semester

BECE201L –Electronic Materials and Devices

Max. Marks: 50 Duration: 90 min

Programme: **B. Tech**

Class Number: VL2022230504646

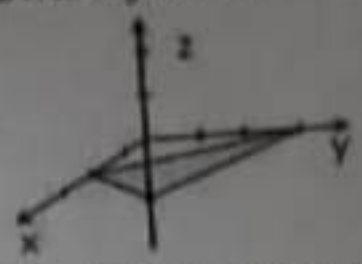
Faculty Members: Dr. Penchalaiah Palla

General Instructions: **Answer All Questions**

Silicon: $m^*=0.26\ m_0$ $N_C = 2.8\times10^{19}$ cm^{-3}, $N_V = 1.04\times10^{19}$ cm^{-3}, $n_i = 1.5\times10^{10}$ cm^{-3}, E_g =1.1 eV, Relative permittivity ε_r=11.8, μ_n= 1350 cm^2/V-s, μ_p= 480 cm^2/V-s. *Other Constants:* kT=0.026 eV at 300K, Boltzmann's constant k= 8.66×10^{-5} eV/K, ε_0=8.854×10^{-14} F/cm, q=1.6×10^{-19} C, m_0=9.1×10^{-31} kg

1 (a) Write a short note on various types of crystal defects and their significance [4]

(b) Write the Miller Indices for the shown crystal Plane with all procedural steps [3]



(c) List the names of 3D crystal Bravais Lattice structures [3]

2 (a) Derive an expression for DC electrical conductivity of a metal using Drude's theory [5]

(b) A specimen of metal has 7.87×10^{28} free electrons per cubic meter. The mobility of electrons in the metal is 35.2 cm^2/V-s (i) Compute the conductivity of the metal (ii) if an electric field of 30 V/cm is applied across the specimen, find the drift velocity of the free electrons and the current density. [5 M]

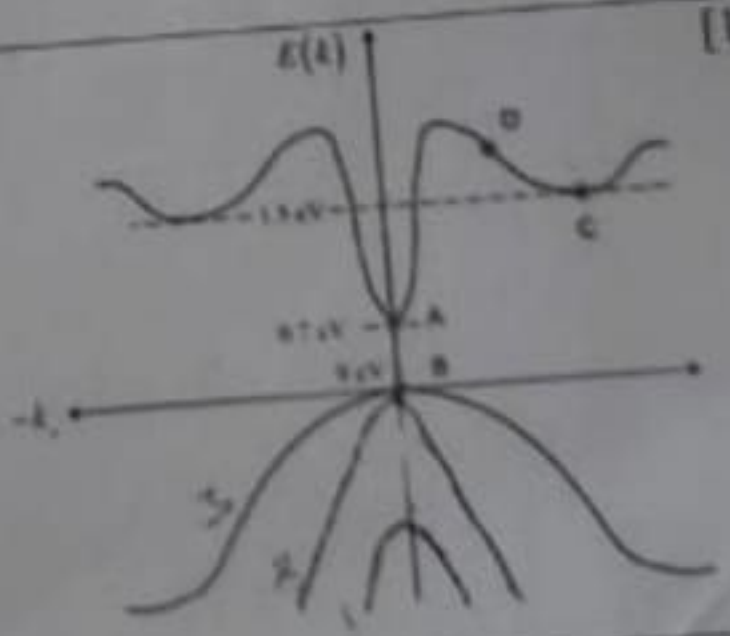
3 A hypothetical semiconductor, with bandgap of 2.7 eV, has $N_C = 10^{19}$ cm^{-3}, $N_V = 5\times10^{18}$ cm^{-3}. If the material is doped with 10^{17} cm^{-3} donors (fully ionized), calculate: [10]

(i)Intrinsic carrier concentrations at 300 K (ii)Carrier concentration of Majority carriers at 400 K

(iii) Carrier concentration of Minority carriers at 500 K

4 An n-type Si wafer with donor concentration of 10^{16} /cm^3 is available. In a region, p-type impurity of concentration 5×10^{18} cm^{-3} is doped uniformly. Compute the following: (i) Position of Fermi-level with respect to E_C and E_V in n-type and p-type regions respectively (ii) Sketch the model energy band diagram with proper labels (iii) Calculate the drift current for the applied field of 2.1 V/cm across the p-region area 10 μm^2. [10]

5 An $E(k)$ plot is shown for a semiconductor. Answer the following questions with reference to the $E(k)$.



(i) Is this a direct or indirect bandgap semiconductor?

(ii) What is the bandgap of this semiconductor?

(iii) Where is the largest effective mass for electrons, **(point A or C)**?

(iv) Where is the negative effective mass for electrons, **(point A, B, or C)**? (v) What is the velocity of an electron at point D **(positive, zero, or negative)**?

(vi) Compare the density-of-states in energy, D (E), at **points A and C**. Which one is larger?

(vii) For common, cubic semiconductors, what is the shape of the constant energy surface near point A? **(Spherical or ellipsoidal)**

(viii) For common, cubic semiconductors, what is the shape of the constant energy surface near point C? **(Spherical or ellipsoidal)**