SURPRISE TEST

1. The electron concentration in Si at T = 300 K is $n_o = 5 \times 10^4$/cc

   (a) Determine p_o. Is this an n or a p type material?
   (b) Determine the position of the Fermi level w.r.t. the intrinsic Fermi level.

   Answer :
   a. $4.5 \times 10^{15}\ cm^{-1}$
   b. 0.3266 eV

2. The value of p_o in Si at T = 300K is 10^{15}/cc. Determine (a)E_c - E_f and (b) n_o.

   Answer: a. 0.88 eV b. $4.9 \times 10^4\ cm^{-3}$

3. The thermal equilibrium hole concentration in Si at T = 300K is $p_o = 2 \times 10^5$/cc. Determine the thermal equilibrium electron concentration. Is the material n-type or p-type?

   Answer: n type , $1.125 \times 10^{15}\ cm^{-3}$

4. Three volts is applied across a 1-cm-long semiconductor bar.

   (a) Determine mobility when the drift velocity equals 10^4 cm/s.

   (b) Determine drift velocity when the average electron mobility equals 800 cm^2/ Vs.

   Answer :
   a. 3333 cm^2/Vs
   b. 2.4×10^3 cm/s

5. The intrinsic carrier concentration of a silicon sample at 300 K is 1.5×10^{16} / m^3 If after doping, the number of majority carriers is 5×10^{20} / m^3, the minority carrier density is

(a) 4.5×10^{11} /m^3

(b) 3.33×10^4 /m^3

(c) 5×10^{20} /m^3

(d) 3×10^{-5} /m^3

Answer: (a) 4.5×10^{11} /m^3

6. Silicon is doped with boron to a concentration of 4×10^{17} atoms/cc. Assume that the intrinsic carrier concentration of silicon is 1.5×10^{10}/cc and the value of kT/q = 25 mV at 300 K. Compared to undoped silicon, the Fermi level of doped silicon

(a) goes down by 0.13 eV

(b) goes up by 0.13 eV

(c) goes down by 0.427 eV

(d) goes up by 0.427 Ev

Answer: (c) goes down by 0.427 eV

7. A diode current is 0.6 mA when applied voltage is 400 mV, and 20 mA when applied voltage is 500 mV. Find η.

Answer: 1.096

8. In the CB configuration of a transistor, the current amplification factor is 0.95. Calculate the base current when the emitter current is 2 mA.

Answer: I_B = 0.1 mA

9. An n-p-n transistor has an emitter area of 10 μm x 10 μm. The doping concentrations are as follows: in the emitter, $N_D = 10^{19}$ / cm^3, in the base $N_A = 10^{17}$/ cm^3 and in the collector, $N_D = 10^{15}$ / cm^3. The transistor operates at T = 300K, where $n_i = 1.5 \times 10^{10}$ / cc for electrons diffusing in the base, L_n = 19 μm and D_n = 21.3 cm^2 / s. For holes diffusing in the emitter L_p = 0.6 μm and D_p = 1.7 cm^2/s. Calculate I_s and β, assuming that the base width W is

(a) 1 µm

(b) 2 µm

(c) 5 µm.

Answer:

a. $I_s = 7.7 \times 10^{-17}$ A and $\beta = 368$
b. $I_s = 3.8 \times 10^{-17}$ A and $\beta = 122$
c. $I_s = 1.5 \times 10^{-17}$ A and $\beta = 24.2$

10. A p-n-p power transistor operates with an emitter-to-collector voltage of 5 V, an emitter current of 10 A, and V_{EB} =0.85 V. For β = 15, what base current is required? What is I_s for this transistor? Compare the emitter-base junction area of this transistor with that of a small signal transistor that conducts i_c = 1 mA with V_{EB} =0.70 V. How much larger is it?

Answer :

I_B = 0.625 Ma

$I_{s1} = 1.608 \times 10^{-14}$ A

$I_{s2} = 6.914 \times 10^{-16}$ A

23.3 times larger