Electronic Devices – EE090

Lecture 3-1&3-2 Quiz Solution

March 2020

Lecture 3-1

Question 3-1

a) With V_{dc} = 2V as shown in Fig.a for an ideal diode circuit. What is V_i? What is V_d? What is i_d?

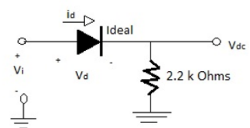


Fig. a

b) Referring to the Fig. a for ideal diode, the voltage V_i is depicted in Fig. b.

(i) Plot the voltage waveform V_{dc}.

(ii) Give values i_{dmax} and i_{dmin}.

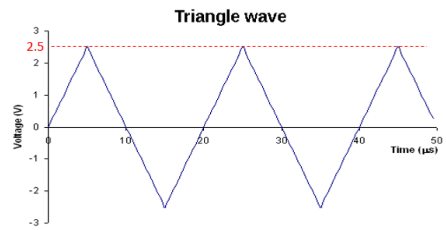


Fig. b

c) Referring to the Fig. c for ideal diodes, compute V and I

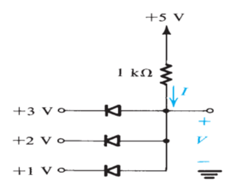


Fig. c

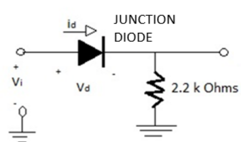
d) For a junction diode with ideality factor n = 1.

(i) Compute the diode current if the saturation current of 10^{-14}A, and diode voltage of 0.65V.

(ii) If the diode current in (i) increases twice, compute new value of diode voltage.

e) For a junction diode, Find an expression of $\Delta V_D = VD_1 - V_{D2}$ in terms of n, I_{D1} and I_{D2}.
Application: Find ΔVD if the current of a junction diode increases triple and n = 1.

f) For a junction diode circuit with ideality factor n = 1.
Compute V_i if i_d = 2mA and the saturation current of 10^{-14}A



Answer:

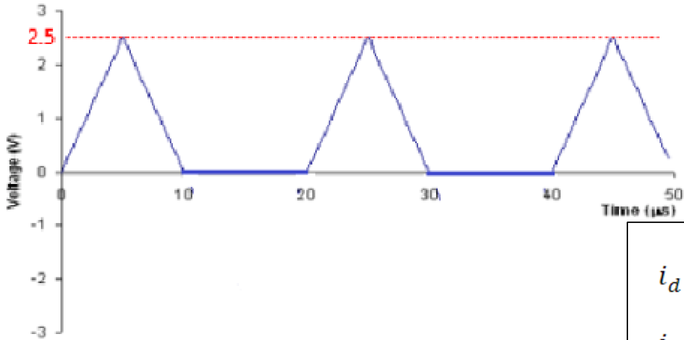
a.

⇨ $V_i = V_{dc} = 2$ V.

$V_d = 0$ V

$i_d = \frac{V_i}{R} = \frac{2}{2.2*10^3} = 0.9091\ mA$

b.



$$i_{d\ max} = \frac{V_{i\ max}}{R} = \frac{2.5}{2.2 * 10^3} = 1.1363\ m$$

$$i_{d\ min} = 0$$

c.

$$V = 1\ V\ and\ I = \frac{5-1}{1*10^3} = 4\ mA$$

d.

(i)

$$i = I_s e^{v/nV_T} = 10^{-14} e^{\frac{0.65}{1*25*10^{-3}}} = 1.96\ mA$$

(ii)

$$v = nV_T ln\frac{2i}{I_S} = 1 * 25 * 10^{-3} ln\frac{2 * 1.96 * 10^{-3}}{10^{-14}} = 0.6674\ V$$

e.

$$\Delta V_D = V_{D1} - V_{D2}$$

$$V_{D1} = nV_T \ln\left(\frac{I_{D1}}{I_s}\right)$$

$$V_{D2} = nV_T \ln\left(\frac{I_{D2}}{I_s}\right)$$

$$=> \Delta V_D = nV_T\left(\ln\left(\frac{I_{D1}}{I_s}\right) - \ln\left(\frac{I_{D2}}{I_s}\right)\right) = nV_T \ln\left(\frac{I_{D1}}{I_s} * \frac{I_s}{I_{D2}}\right)$$

$$= nV_T ln\frac{I_{D1}}{I_{D2}}$$

If the current of a junction diode increases triple and n = 1, we have:

$I_{D2} = 3 * I_{D1}$ or $I_{D_1} = 3 * I_{D_2}$

⇨ $\Delta V_D = 1 * 25 * 10^{-3} * \ln\left(\frac{1}{3}\right)$ or $25 * 10^{-3} * \ln 3$

f.

$$V_d = nV_T ln\frac{i_d}{I_s} = 1 * 25 * 10^{-3} ln\frac{2 * 10^{-3}}{10^{-14}} = 0.6505\ V$$

$$V_i = V_d + i_d * R = 0.6505 + 2 * 10^{-3} * 2.2 * 10^3 = 5.05\ V$$

Lecture 3-2

Question 3-2

a) Zinc could be used as impurity to convert intrinsic silicon to extrinsic P type silicon? If your answer is YES, please explain why?

b) Which of the following is a common application for Breakdown region of junction diode.
• Demodulation.
• AC rectification.
• Voltage regulation.
• Input protection.

c) The forward voltage drop across a silicon diode is about….
2.5 V
3 V
10 V
0.7 V

d) The reverse current in a diode is of the order of ………………
kA
mA
µA
A

Answer:

a) Yes, since Zinc has 2 valance electrons.
b) Voltage regulation.
c) 0.7 V.
d) µA.
