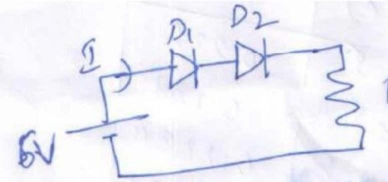
CSET102

Tutorial Sheet - 8 (Solutions)

SNO	Answers
1	Given $I_D = 150\mu A$ $I_s = 10^{-11} A$ $V_D = ?$ $V_D = V_t \ln\left(\frac{I_D}{I_s} + 1\right) = \underline{0.43V}$
2	Given $I_D = -0.9 I_s$ $V_D = ?$ $-0.9 I_s = I_s (e^{V_D/V_t} - 1)$ $V_t = 0.026V = 26\ mV$ $V_D = \underline{-0.06V}$ (∵ in reverse bias I_D is opposite to that of original current direction) $I_D = 0.9 I_s$ results $V_D = +0.017V$ which is forward bias.

3	$V_D = 0.2V$ $I_D = I_S(e^{V_D/V_T} - 1) = 2192.4 I_S$ $V_D = -0.2$ $I_D \approx -0.9995 I_S$ $\left\| \frac{I_D @ 0.2V}{I_D @ -0.2V} \right\| = 2193.4$
4	 Given $V = 0.7V$ (i) Applying KVL, $V_{R_1} = 2 - 0.7 = 1.3V$ $V_{R2} = 0.7V$. $V_{R2} = \frac{2 \cdot R_2}{R_1 + R_2} = 0.7V$ $R_2 = 0.35R_1 + 0.35R_2 \Rightarrow R_2 = 538\,\Omega$ (ii) $R_2 = 1k\Omega$ $V_{R2} = 0.7V = \frac{2 \cdot R_2}{R_1 + R_2} \Rightarrow R_2 = 0.35R_1 + 0.35R_2$ $\Rightarrow R_1 = 1.86\,k\Omega$

5



$I = 15\,mA$

$I_0(D_1) = 5\,nA$

$I_0(D_2) = 10\,nA$

$I = I_0(e^{V_D/V_t} - 1) \Rightarrow V_D = V_t \ln\left(\frac{I}{I_0} + 1\right)$

$V_t = 26\,mV$ at $\underline{300K}$

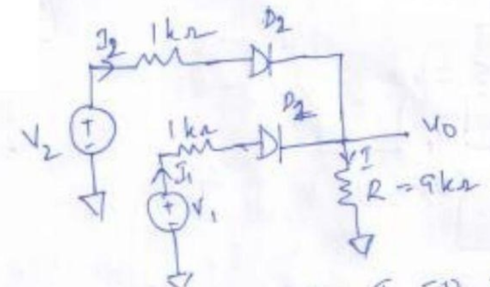
for D_1 : $V_{D1} = 0.026 \ln\left(\frac{15\times10^{-3}}{5\times10^{-9}} + 1\right) = 0.388V$

for D_2 : $V_{D2} = 0.37V$.

Applying KVL, $6 = 0.388 + 0.37 + I.R$

$\Rightarrow R = \underline{350\Omega}$

6



$V_0 = IR$

$I = I_1 + I_2$

(i) $V_1 = V_2 = 0 \Rightarrow I_1 = I_2 = 0 \Rightarrow V_0 = \underline{0V}$

(ii) $V_1 = 10V \quad V_2 = 0 \Rightarrow I_2 = 0. \quad I_1 = ?$

$I = I_1 + I_2 = I_1$

Applying KVL,

$I_1 = \frac{10 - 0.6}{1k + 9k} = 0.94\,mA$

$V_0 = I.R = 0.94 \times 9k = \underline{8.46V}$

(iii) $V_1 = 10V \quad V_2 = 10V.$

$I = I_1 + I_2 \Rightarrow I_1 = I_2 = \frac{I}{2}$

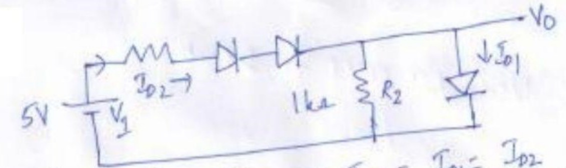
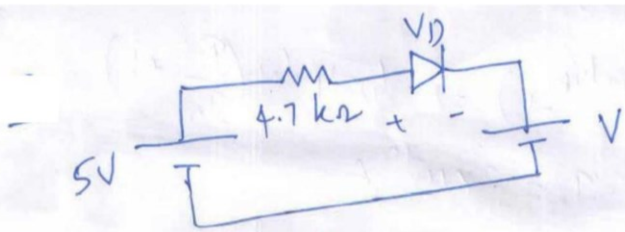
$I_1 = I_2$

writing KVL,

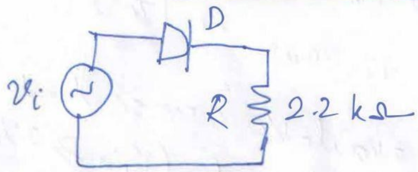
$10 = \frac{I}{2} \times 1k + 0.6 + I.9k$

$9.5k.I = 9.4 \Rightarrow I = 0.989\,mA$

$V_0 = IR = 0.989 \times 9 = \underline{8.91V}$

7)	 given $I_{D1} = \frac{I_{D2}}{2} \Rightarrow I_{R2} = I_{D1} = \frac{I_{D2}}{2}$. $I_{D1} = I_{R2} = \frac{0.65V}{1k\Omega} = 0.65mA$ $\therefore I_{D2} = 1.3 mA$ (i) Applying KVL, $I_{D2} = \frac{V_S - 2V_D - V_D}{R_1}$ $\Rightarrow 1/R_1 = \frac{1.3\times10^{-3}}{5-2\times0.65-0.65} \Rightarrow R_1 = 2.35 k\Omega$ (ii) $V_S = 8V$ $\quad I_{R2} = 0.65mA$ $I_{D2} = \frac{8-2\times0.65-0.65}{2k\Omega} = 3.025 mA$ $I_{D1} = I_{D2} - I_{R2} = 2.375 mA$
8)	 $V_D = 0.7V$ $I_D = 0.4 mA$ writing KVL, $5 = 4.7k I_D + 0.7 + V$ $\Rightarrow V = 2.42$ **2.42 V** P=V X I = 0.7 V X 0.4 mA = 0.28 mW

9)

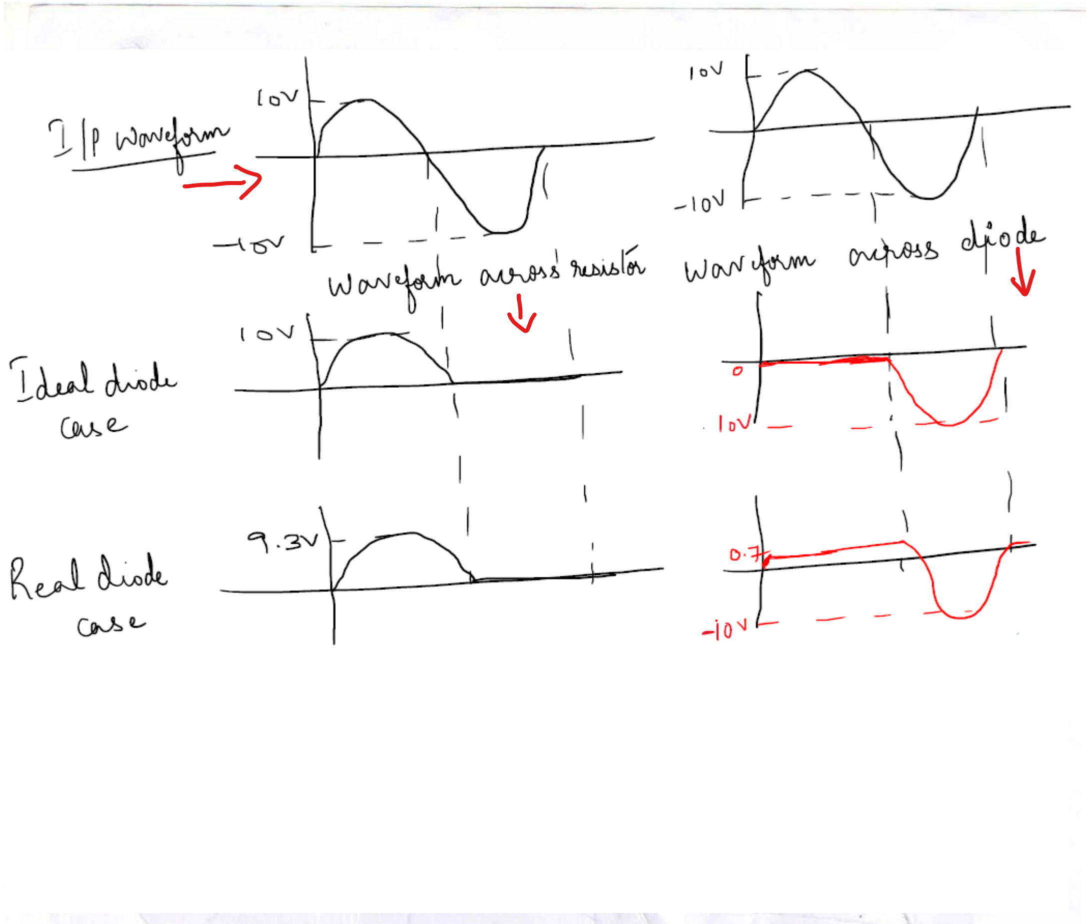


$v_i = 10 \sin(\omega t)$

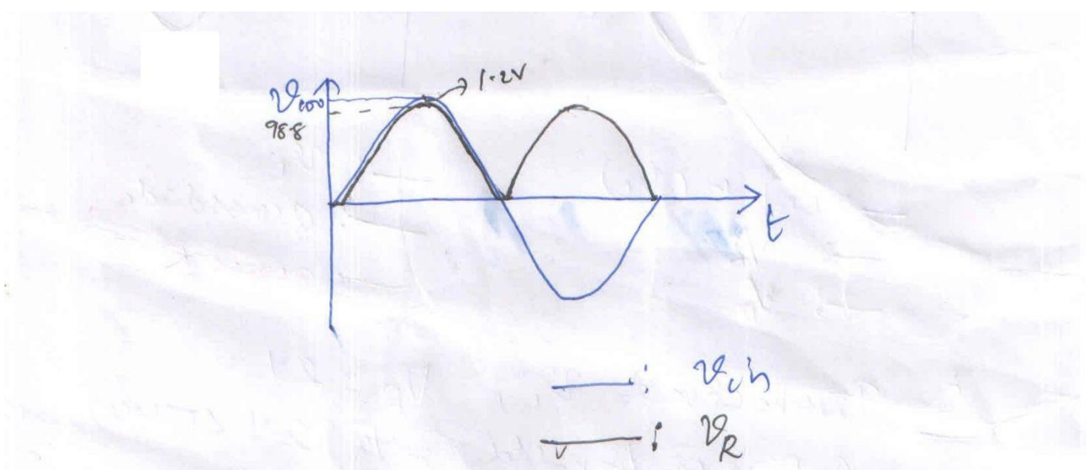
$f = 60$ Hz $= \omega$

Ideal diode: no voltage drop in forward bias. So voltage drops across R
entire voltage drops across D in reverse bias.

Real diode, V_D is fixed at 0.7V (for Si)
when $v_i \geq 0.7$ else $V_D = v_i$


I/P waveform
10V
-10V
10V
-10V
Waveform across resistor
Waveform across diode
10V
Ideal diode case
0
10V
9.3V
Real diode case
0.7
-10V

10)


1.2V
9.8
t
: v_{in}
: v_R