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 $I_D = -0.9 I_s$ $V_D = ?$ $-0.9 I_s = I_s\left(e^{V_D/V_t} - 1\right)$ $V_t = 0.026V = 26\ mV$ $V_D = \underline{-0.06V}$ ($\because$ 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.

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$V_D = 0.2\,V \quad I_D = I_s\left(e^{V_D/V_T} - 1\right) = 2192.4\,I_s$

$V_D = -0.2 \quad I_D \approx -0.9995\,I_s$

$\left|\dfrac{I_D @ 0.2V}{I_D @ -0.2V}\right| = \underline{2193.4}$

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Given $V = 0.7V$

(i) Applying KVL, $V_{R_1} = 2 - 0.7 = 1.3\,V$

$V_{R2} = 0.7V.$

$V_{R2} = \dfrac{2 \cdot R_2}{R_1 + R_2} = 0.7V$

$R_2 = 0.35R_1 + 0.35R_2 \Rightarrow R_2 = \underline{538\,\Omega}$

(ii) $R_2 = 1k\Omega$

$V_{R2} = 0.7V = \dfrac{2 \cdot R_2}{R_1 + R_2} \Rightarrow R_2 = 0.35R_1 + 0.35R_2$

$\Rightarrow R_1 = \underline{1.86\,k\Omega}$

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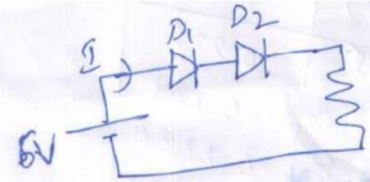
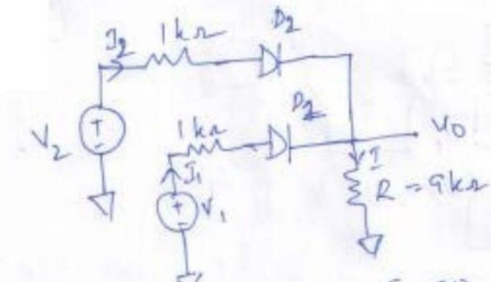
5	 $I = 15\,mA$ $I_0(D_1) = 5\,nA$ $I_0(D_2) = 10\,nA$ $I = I_0\left(e^{V_D/V_t} - 1\right) \Rightarrow V_D = V_t \ln\left(\frac{I}{I_0} + 1\right)$ $V_t = 26\,mV$ at $\underline{300K}$ for D_1: $V_{D1} = 0.026 \ln\left(\frac{15\times10^{-3}}{5\times10^{-9}} + 1\right) = 0.388V$ for D_2: $V_{D2} = 0.37V$. Applying KVL, $6 = 0.388 + 0.37 + I.R$ $\Rightarrow R = \underline{350\Omega}$
6	(3  $V_0 = IR$ $I = I_1 + I_2$ (i) $V_1 = V_2 = 0 \Rightarrow I_1 = I_2 = 0 \Rightarrow V_0 = \underline{0V}$ (ii) $V_1 = 10V$ $V_2 = 0 \Rightarrow I_2 = 0$. $I_1 = ?$ $I = I_1 + I_2 = I_1$ Applying KVL, $I_1 = \frac{10 - 0.6}{1k + 9k} = 0.94\,mA$ $V_0 = I_1 R = 0.94 \times 9k = \underline{8.46V}$ (iii) $V_1 = 10V$ $V_2 = 10V$. $I = I_1 + I_2 \Rightarrow I_1 = I_2 = \frac{I}{2}$ $I_1 = I_2$ writing KVL, $10 = \frac{I}{2} \times 1k + 0.6 + I.9k$ $9.5k.I = 9.4 \Rightarrow I = 0.989\,mA$ $V_0 = IR = 0.989 \times 9 = \underline{8.91V}$

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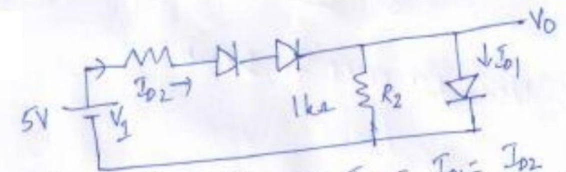

given $I_{D1} = \frac{I_{D2}}{2} \Rightarrow I_{R2} = I_{D1} = \frac{I_{D2}}{2}$.
$I_{D1} = I_{R2} = \frac{0.65V}{1k\Omega} = \underline{0.65\,mA}$
(i) $\therefore I_{D2} = \underline{1.3\,mA}$
Applying KVL, $I_{D2} = \frac{V_S - 2V_D - V_0}{R_1}$
$\Rightarrow 1/R_1 = \frac{1.3\times10^{-3}}{5 - 2\times0.65 - 0.65} \Rightarrow R_1 = \underline{2.35\,k\Omega}$

(ii) $V_S = 8V$ $\quad I_{R2} = 0.65\,mA$
$I_{D2} = \frac{8 - 2\times0.65 - 0.65}{2k\Omega} = 3.025\,mA$
$I_{D1} = I_{D2} - I_{R2} = \underline{2.375\,mA}$
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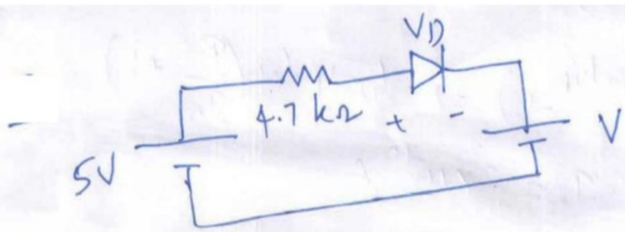

$V_D = 0.7\,V$
$I_D = 0.4\,mA$
writing KVL,
$5 = 4.7k\,I_D + 0.7 + V$
$\Rightarrow V = \underline{2.42}$
2.42 V
P=V X I = 0.7 V X 0.4 mA = 0.28 mW
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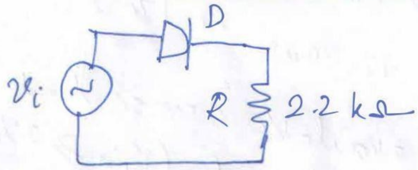
9)



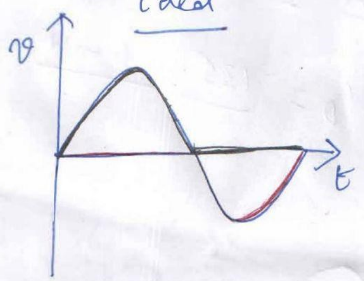
$v_i = 10 \sin(\omega t)$

$f = 60$ Hz $= \omega$

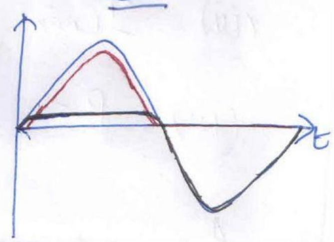
Ideal diode: no voltage drop in forward bias. So voltage drops across R. Entire voltage drops across D in reverse bias.

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

ideal



Real



—: input (v_i)
—: V_R
—: V_D

—: v_i
—: across diode
—: across R

10)

$V_{RMS} = 120V$

$V_{peak} = \sqrt{2}\, V_{RMS} \sim 170V$

(i) Voltage available across load

$v_{in} - 2V_D$ for $(v_{in} \geq 2V_D)$

else 0

$V_{Lmax} = 170 - 2 \times 0.6 = 168.8V$

(ii) Each reverse biased diode should hold a maximum of $\frac{V_{Lmax}}{2} = \underline{84.4V}$ in reverse bias

(iii) $I_{Lmax} = \frac{V_{Lmax}}{R} = 168.8\,mA$ $(R = 1k\Omega)$

(iv) $P = I_{Lmax} \cdot V_D = \underline{135.04\,mW}$

11)