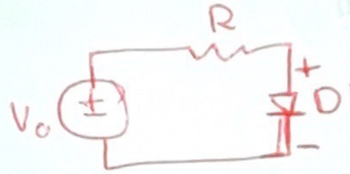
Maria Peregrina　　Homework #11　　ECE-30C

(1)



$V_{Th} = 26mV$
$I_S = 1\times10^{-12}A$
$n = 1$

(a) $V_0 = 5V$　　$R = 50\Omega$　　$V_{D_1} = 0.5V$

$$\frac{V = IR}{R} \qquad I_{R_1} = \frac{V}{R_1} = \frac{5-0.5V}{50} = \frac{4.5V}{50} = 0.09A$$

(b) and (c)

$I_D = I_{R_1} = 0.09A$

$$I_D = I_S\left(e^{\frac{V_D}{nV_{Th}}} - 1\right) \Rightarrow \frac{I_D}{I_S} = e^{\frac{V_D}{nV_{Th}}} - 1 \qquad \ln\left(\frac{I_D}{I_S}\right) = \frac{V_D}{nV_{Th}} - 1$$

$$\left[\ln\left(\frac{I_D}{I_S} + 1\right) = \frac{V_D}{nV_{Th}}\right] nV_{Th} \Rightarrow nV_{Th}\left[\ln\left(\frac{I_D}{I_S} + 1\right)\right] = V_D$$

$$(1)(26mV)\left[\ln\left(\frac{0.09}{1\times10^{-12}} + 1\right)\right] = V_D$$

$0.66 = V_D$

(c) and (d)

$I_{R1} = \frac{5-0.66V}{50} = 0.0869A$ for

①

d) $I_{R1} = I_D = 0.0869\,A$

$$V_D = (26mV)\left[Ln\left(\frac{0.0869}{10^{-12}}\right)\right] = 0.654$$

$$I_{R1} = \frac{5-0.654}{50} = 0.0869\,A$$

$$V_D = (26mV)\left(\ln\left(\frac{0.0869}{10^{-12}}\right)\right) = 0.655$$

$$I_{R1} = \frac{5-0.655}{50} = 0.0869\,A$$ far enough 3 sig fig.

e) $$r_D = \frac{nV_{Th}}{I_{DC}} = \frac{(1)(26mV)}{0.0869} = 0.29\,\Omega$$

$$\frac{1}{r_D} = \frac{1}{0.29\,\Omega} = 3.45 \text{ : slope}$$

$$I = 3.45V$$

$$I_{DC\,bias} = 3.45\,(V_{Do} - V_{DC\,bias})$$

$$0.0869 = 3.45\,(V_{Do} - 0.655)$$

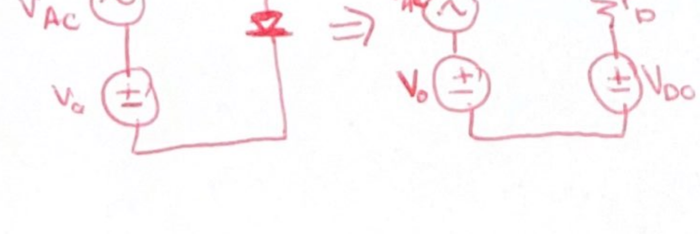
$$0.0869 = 3.45V_{Do} - 3.45(0.655)$$

$$0.0869 = 3.45V_{Do} - \cancel{2.26}$$
$$+2.26 \qquad\qquad \cancel{+2.26}$$

$$\frac{2.35 = 3.45V_{Do}}{3.45}$$

$$V_{Do} = 0.681\,V$$

f)



(g) $V_{D_{AC}} \sin(\omega t) = \frac{r_D}{r_D + R} V_{AC} \sin(\omega t)$

$V_{D_{AC}} = \frac{r_D}{r_D + R} V_{AC} = \frac{0.29}{0.29 + 50}(0.1) = 5.77 \times 10^{-4}\ V$

(h) $V_{D_{AC}} << (1)(26mV)$

$5.77 \times 10^{-4}\ V << 26mV$, AC

The AC voltage is sufficiently small that the variation of the diode voltage can be considered linear.

(i) $V_o = 0.8V$

$I_{R_1} = \frac{V_o}{R_1} = \frac{0.8-0.5}{50} = 0.006A$ $\quad I_{R_1} = I_D = 0.006A$

$V_D = nV_{Th}\ln\left(\frac{I_D}{I_S}\right) = (1)(26mV)\ln\left(\frac{0.006}{10^{-12}}\right) = 0.585$

$I_{R_1} = \frac{0.8-0.585}{50} = 0.0043A$ $\quad r_D = \frac{(1)(26mV)}{0.0043} = 6.047\Omega$

$V_{D_{AC}} = \frac{6.047}{6.047+50}(0.1) = 0.018 \ll 26mV$

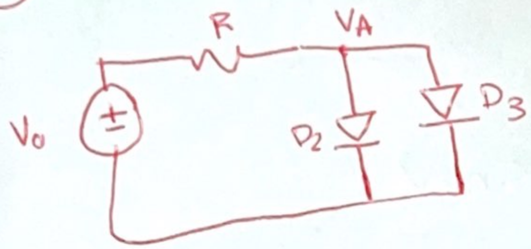
$V_D = (26mV)\ln\left(\frac{0.0043}{10^{-12}}\right) = 0.5768$ $\quad I_{R_1} = \frac{0.8-0.5768}{50} = 0.00445$

$r_D = \frac{(1)(26mV)}{0.00445} = 5.843\Omega$ $\quad V_{D_{AC}} = \frac{5.843}{5.843+50}(0.1) = 0.0105 \ll 26mV$

$V_D = (26mV)\ln\left(\frac{0.00445}{10^{-12}}\right) = 0.578$ $\quad I_{R_1} = \frac{0.8-0.578}{50} = 0.00444$

$r_D = \frac{26mV}{0.00444} = 5.856$ $\quad V_{D_{AC}} = \frac{5.856}{5.856+50}(0.1) = 0.0105 \ll 26mV$

②



ⓐ $V_o = 5V \quad R = 50\Omega$

$V_D = 0.5V \qquad I_{R1} = \frac{V}{R_1} = \frac{5-0.5}{50} = 0.09\,A$

ⓑ KCL at node A: $\quad I_{R1} + I_{D2,3} = 0$

$0.09 - 2I_{D2,3} = 0$

$I_{D2} = +0.09A/2 = 0.045\,A$

ⓒ $V_D = nV_{th}\ln\left(\frac{I_D}{I_S}\right) = (1)(26mV)\ln\left(\frac{0.045}{10^{-12}}\right) = 0.638\,V$

ⓓ $I_{R1} = \frac{5-0.638}{50} = 0.0872\,A$

ⓔ $\cancel{V_D = (26mV)\ln\left(\frac{0.0872}{10^{-12}}\right) = 0.655V}$

$I_{R1} - I_{D2,3} = 0$

$0.0872 - 2I_{D2,3} = 0$

$I_{D2} = 0.0872/2 = 0.0436$

$V_D = (26mV)\ln\left(\frac{0.0436}{10^{-12}}\right) = 0.637\,V$

$I_{R1} = \frac{5-0.637}{50} = 0.0873\,A$

$I_{R1} - I_{D2,3} = 0$

$0.0873 - 2I_{D2,3} = 0$

$I_{D2} = 0.0873/2 = 0.0437$

$V_D = (26mV)\ln\left(\frac{0.0437}{10^{-12}}\right) = 0.637\,V$

$I_{R1} = \frac{5-0.637}{50} = 0.0873\,A$

Three digits of accuracy.