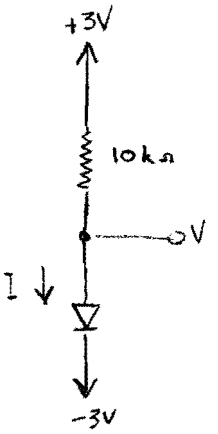
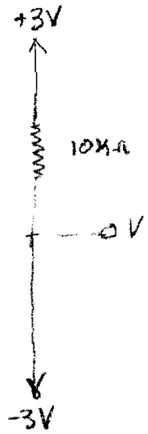
Problem 4.2

(a)

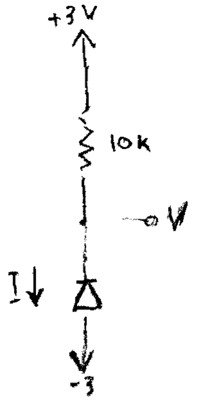


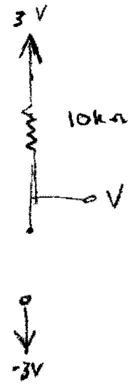


$V = \underline{-3V}$

$I = \dfrac{3-(-3)}{10k} = \underline{0.6\ mA}$

(b)

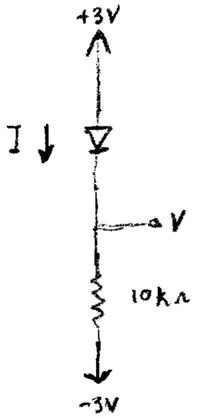


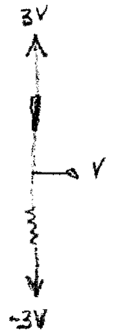


$V = \underline{3V}$

$I = \underline{0\ A}$

(c)

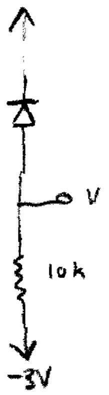


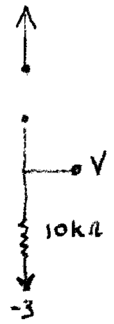


$V = \underline{3V}$

$I = \dfrac{3-(-3)}{10k} = \underline{0.6\ mA}$

(d)





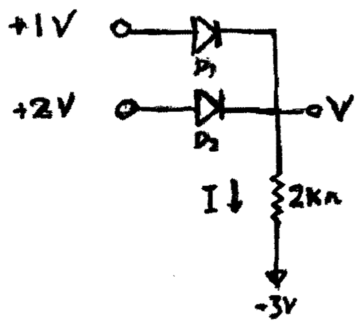
$V = \underline{-3\ V}$

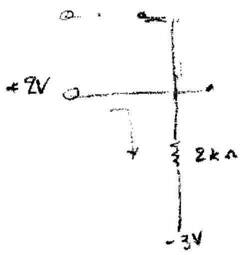
$I = \underline{0\ A}$

EE320 Homework 2

PROBLEM 4.3

(a)



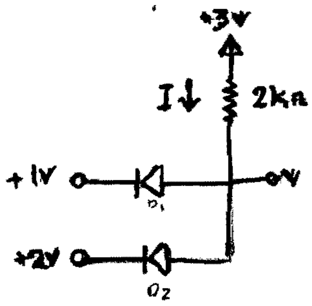


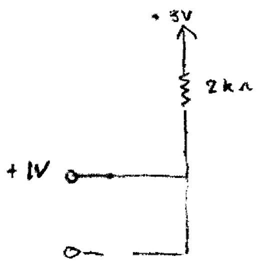
$\frac{2-(-3)}{2\,k\Omega} > \frac{1-(-3)}{2\,k\Omega}$ So D_1 is cutoff AND D_2 is conducting

$V = \underline{2V}$

$I = \frac{2-(-3)}{2k} = \underline{2.5\text{ mA}}$

(b)





$V = \underline{1V}$

$I = \frac{3-1}{2k} = \underline{1\text{ mA}}$

D_1 is Conducting

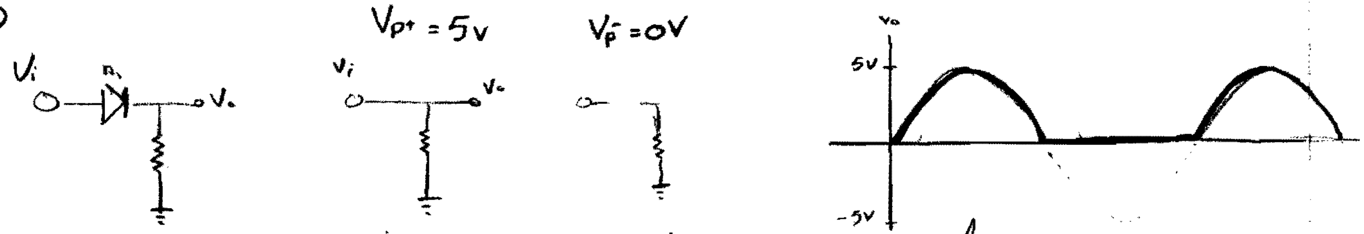
D_2 is cutoff

EE320 — Homework 2

Problem 4.4 V_i is 1 kHz, 1 V_{peak} Sin wave V_o — V_i ---

(a)

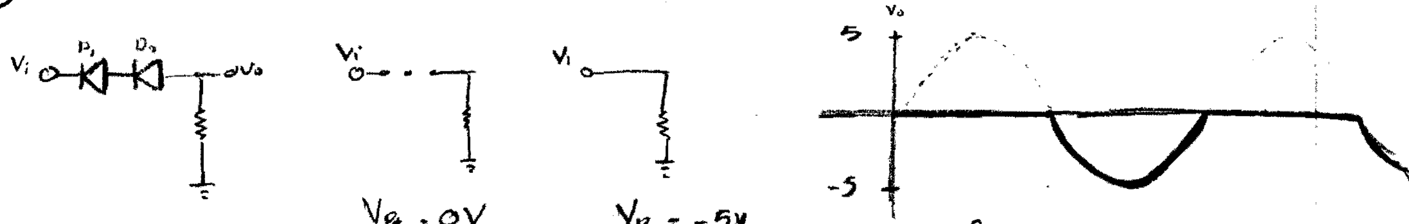
$V_{p^+} = 5V$ $V_{p^-} = 0V$



when $V_i > 0$ when $V_i < 0$

$f = 1$ kHz

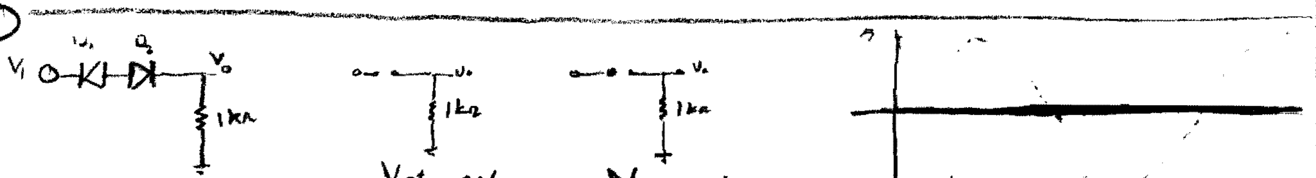
(b)



$V_{p+} = 0V$ $V_{p-} = -5V$

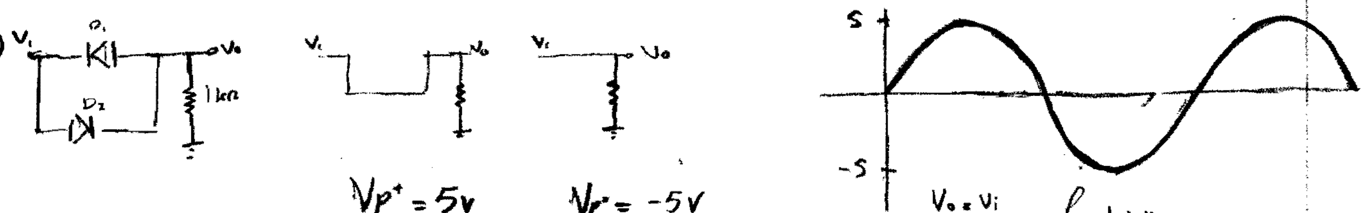
$f = 1$ kHz

(c)



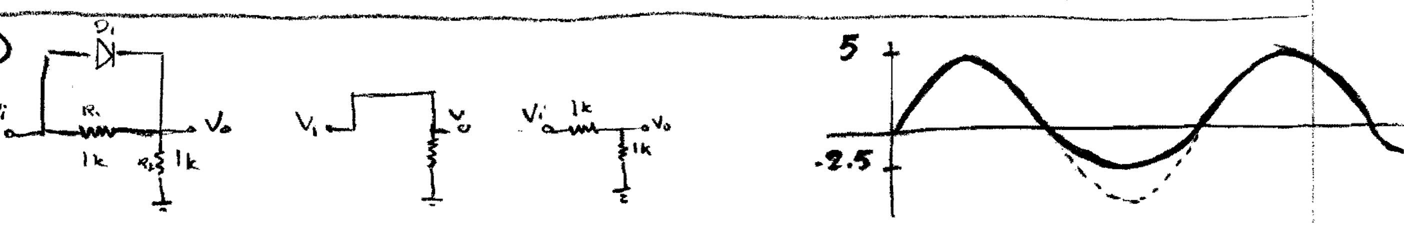
$V_{p^+} = 0V$ $V_{p^-} = 0V$ $V_o = 0$

(e)



$V_{p^+} = 5V$ $V_{p^-} = -5V$ $V_o = V_i$ $f = 1$ kHz

(J)



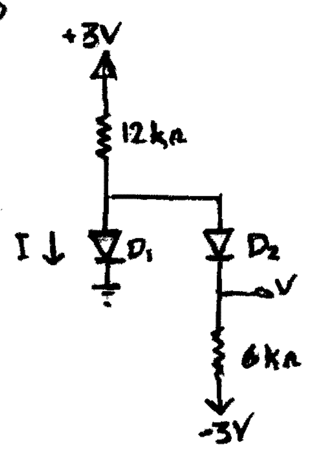
$V_{p^+} = 5V$ $V_{p^-} = V_p \frac{R_2}{R_1 + R_2} = -2.5V$

$f = 1$ kHz

EE320 | Homework 2

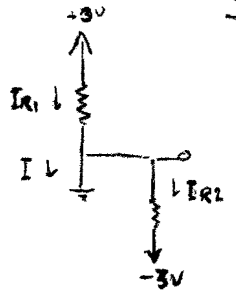
Problem 4.9

(a)



if we assume that both D_1 and D_2 are conducting

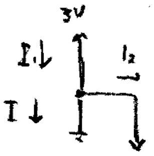
then



$V_o = 0V$

$I_{R2} = \frac{0-(-3)}{6k\Omega} = 0.5\,mA$

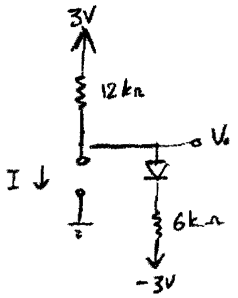
$I_{R1} = \frac{3-0}{12k\Omega} = 0.25\,mA$



making $I = -0.25\,mA$

and that is not Right, because current can't be generated from ground!

if D_1 is conducting and D_2 is off

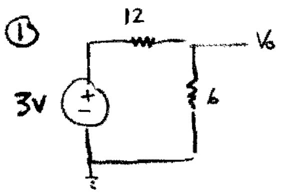


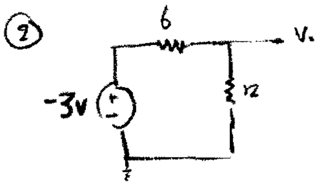
$I = 0$

$I = 0$, $I_{R1} = I_{R2} = 0.33\,mA$

$V_o = 3 \times \frac{6}{12+6} + (-3) \times \frac{12}{12+6}$ (① , ②)

$= -1\,V$

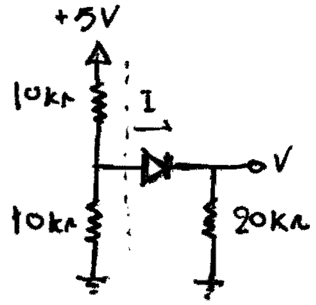


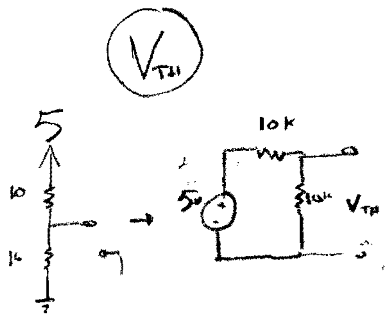


EE320 Homework 2

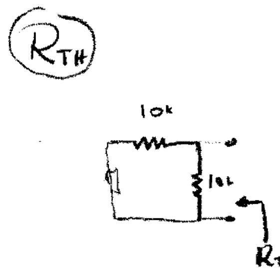
Problem 4.10 .a

Utilize Thevenin's theorem to simplify the Circuits

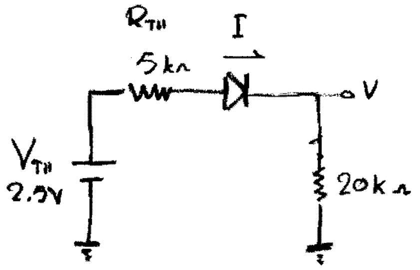




$$V_{TH} = 5 \times \frac{10}{10+10} = 2.5\,V$$



$$R_{TH} = (10 // 10) = \frac{10 \times 10}{10+10} = 5\,k\Omega$$



$$I = \frac{2.5\,V}{5k + 20k} = 0.1\,mA$$

$$V = 0.1 \times 20 = 2V$$

Problem 4.19

A diode for which the forward voltage drop is 0.7 V at 1 mA is operated at 0.5 V. What is the value of the current?

$V_D = 0.7\text{ V}$

$$V_2 - V_1 = nV_T \ln\left(\frac{I_2}{I_1}\right) \Rightarrow \frac{I_2}{I_1} = e^{\frac{V_2 - V_1}{nV_T}}$$

(4.1) $$I_1 = I_S e^{0.7/V_T} = 10^{-3}$$

$$I_2 = I_S e^{0.5/V_T}$$

$$0.5 - 0.7 = n(25\text{mV}) \ln\left(\frac{I_2}{10^{-3}}\right) \Rightarrow$$

$$\left(\frac{-0.2}{25\text{mV}}\right) = \ln\left(\frac{I_2}{10^{-3}}\right)$$

$$e^{\frac{-0.2}{0.025}} = I_2/10^{-3}$$

$$I_2 = \underline{0.3355\ \mu A}$$ ← very small, as expected.

For 0.65 V & $n = 1$, $\frac{I_2}{I_1} = e^{\frac{V_2 - V_1}{nV_T}}$

or $I_2 = I_1 e^{\frac{V_2 - V_1}{nV_T}} = 0.001\, e^{\frac{0.65 - 0.7}{1 \cdot 25\times10^{-3}}}$

$\underline{I_2 = 0.135\text{ mA}}$.

↑ much larger than 0.3355 μA, but still not approaching 1 mA yet. Just 0.05 V more forward bias and current will increase substantially.

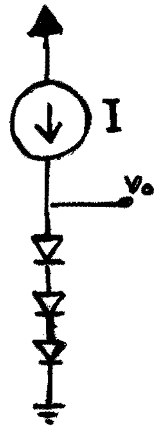
EE320 Homework 2

Problem 4.23

Three identical diodes $I_S = 10^{-14}$ A, find I required to obtain an

$V_o = 2.0V.$

if current of 1 mA is drawn away from the output terminal by load what is the change in output Voltage.



So $V_o = 2 \rightarrow V_D = V_o/3 = 0.6667V$

(4.1) $I_D = I_S e^{V_D/V_T}$ $I_S = 10^{-14}$ Satration Current

$V_T = 25$ mV Thermal Voltage

$I_D = 10^{-14} \times e^{\frac{(2/3)}{25 \times 10^{-3}}} = 0.00386$ A OR $\underline{3.812 \text{ mA}}$

$I_{D_{NEW}} = I_D - 1mA = 2.812$ mA

$2.812 = 10^{-14} e^{\frac{V_D}{25mV}}$ $\times 10^{+14}$

$\ln(2.812 \times 10^{14}) = \frac{V_{D_{new}}}{25 mV}$, $V_{D_{new}} = \ln(2.812 \times 10^{14}) \times \frac{25}{1000}$

$= 0.6591$ V

$V_{O_{new}} = 3 \times V_D = \underline{1.977 \text{ V}}$

Change in $V_o = 1.977 - 2 = \underline{-22 \text{ mV}}$

EE320 Homework 2

PROBLEM 4.35

Find I_d and V_d at diode using iterative-analysis $V_{DD} = 1V$, $R = 1k\Omega$ and $I_S = 10^{-15}$ A

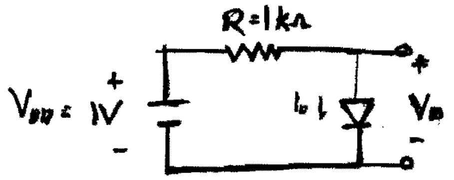


Fig (4.10)

$I_S = 10^{-15}A = 10^{-12}mA$

Use the

① $V_D = 0.7V$, $I_D = \frac{1-0.7}{1k} = 0.3mA$

② $V_D = V_T \ln\left(\frac{I_D}{I_S}\right) = 0.025 \ln\left(\frac{0.3}{10^{-12}}\right) = 0.66067V$

$I_D = \frac{1-0.6607}{1k} = 0.3393 mA$

③ $V_D = 0.025 \ln\left(\frac{0.3393}{10^{-12}}\right) = 0.66375V$

$I_D = \frac{1-0.66375}{1k} = 0.3362 mA$

④ $V_D = 0.025 \ln\left(\frac{0.3362}{10^{-12}}\right) = 0.6635V$

$I_D = \frac{1-0.6635}{1k} = 0.3365 mA$

⑤ $V_D = 0.025 \ln\left(\frac{0.3365}{10^{-12}}\right) = 0.6635V$

```
In[72]:= ClearAll[VDD, R, IS, n, VD, Vt, ID]
VDD := 1.
R := 1000.
IS := 10^-15
n := 1.
Vt := 0.025
FindRoot[{ID == IS Exp[VD/(n Vt)], ID == (VDD - VD)/R}, {{VD, 0.7}, {ID, 0.001}}]
Out[78]= {VD → 0.663543, ID → 0.000336457}
```

using Mathematica

← exact answers.