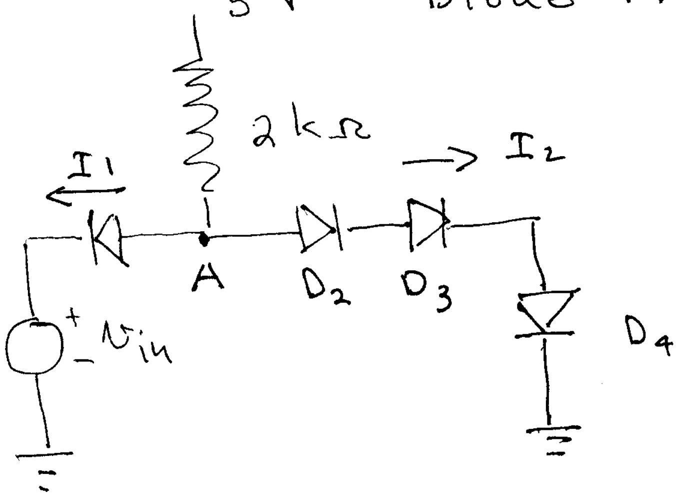
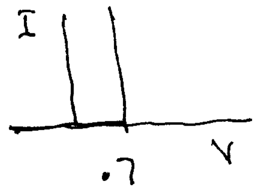
Example 1   Diode Problem



V_{in} 0 − 5 V

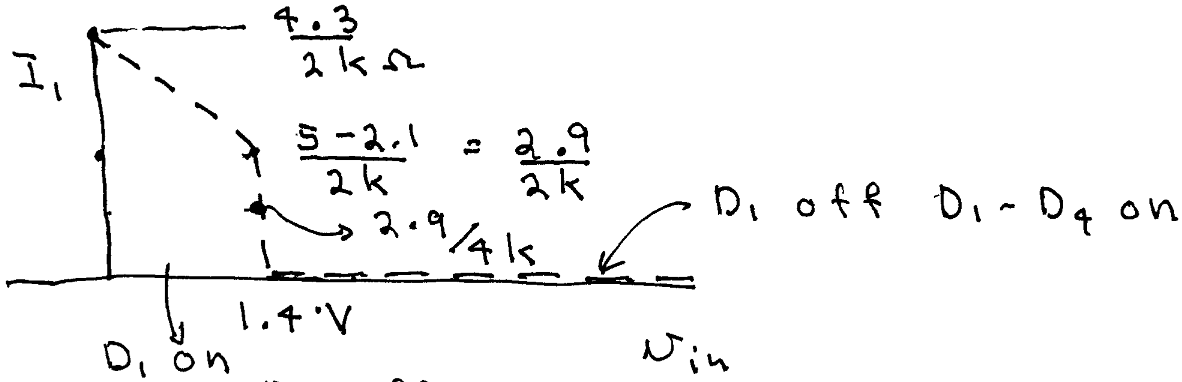
$V_D = .7$ V

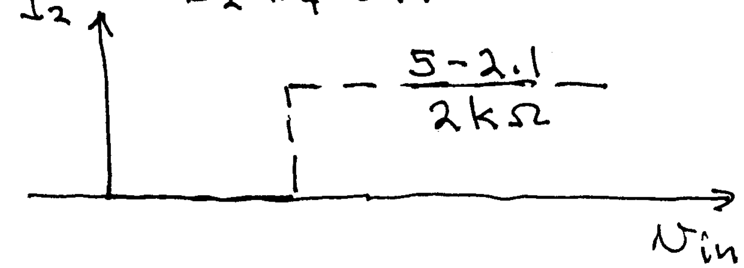


Break points

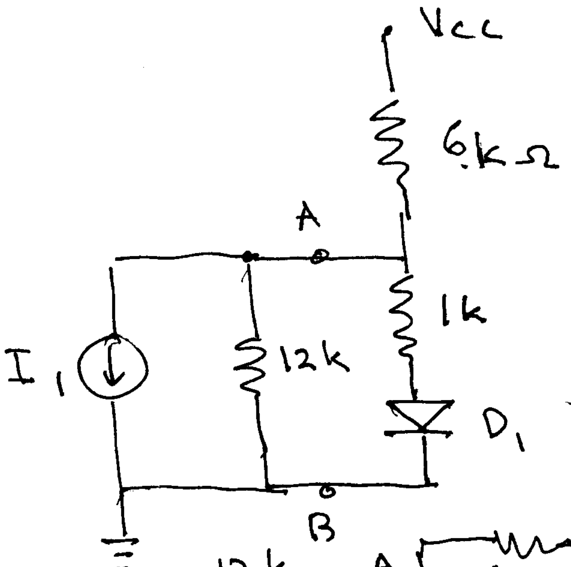
- $v_{in} = 4.3$ V   then $v_A = 5$ V if D_1 is on
- But then D_2, D_3, D_4 are then on $v_A = 2.1$ V. contradiction. Thus D_1 is off
- $v_{in} = 2.1 - .7 = 1.4$ V is a break point
- $v_{in} = 1.4$ V   All diodes are on
- $I_1 = I_2 = \frac{1}{2}\,\frac{5-1.4}{2k\Omega}$ at $v_{in} = 1.4$
- $v_{in} < 1.4$ V $v_A < 2.1$ V D_2, D_3, D_4 off   only D_1 on $I_2 = 0$ $I_1 = \frac{5-(v_{in}+.7)}{2k}$

$v_{in} > 1.4$ D_1 is off D_1, D_2, D_3 on





Example 2 . Diode Problem

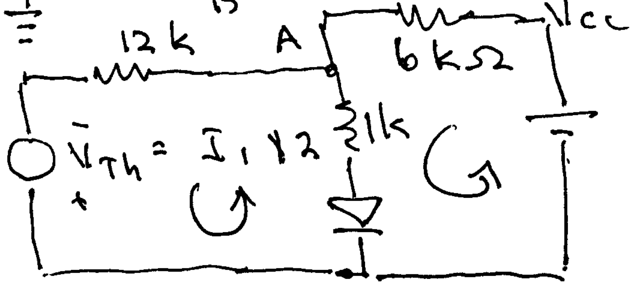


a) $V_{cc} = 12V$ $I_1 = 1.25$ mA

D_1 on.

Nort. to Thev.

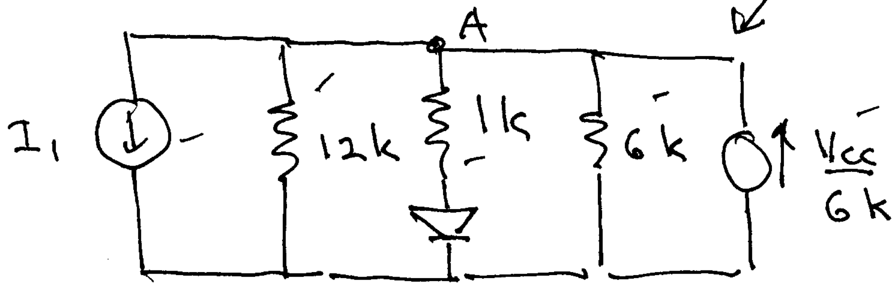
or Thev. to Norton



KCL

$$V_A\left(\frac{1}{6}+\frac{1}{12}\right)$$

$$+\frac{V_A - .7}{1k} + I_1 - \frac{V_{cc}}{6k} = 0$$



$$V_A\left(\frac{1}{6}+\frac{1}{12}+1\right)$$

$$= \frac{.7}{1} - I_1 + \frac{V_{cc}}{6}$$

Is this positive

a) $\frac{V_{cc}}{6} = 2\ mA > I_1 (1.25 mA)$ so diode is on

$$V_A = \frac{.7 - 1.25 + 2}{\left(\cancel{\frac{15}{12}}\frac{5}{4}\right)} = (2.7 - 1.25) \times \frac{4}{5}$$

$$= \frac{1.45}{} \times \frac{4}{5} = .29 \times 4 = \underline{1.16\ V}$$

$\therefore\ I_D = (1.16 - .7)/_1\ mA = .46\ mA$

b) $V_{cc} = -6 \quad I_1 = -1.25$ diode on

$$V_A = (.7 + 1.25 - 1) \times 4/_5 = \overset{.19}{.95} \times \frac{4}{\cancel{5}} = .76$$

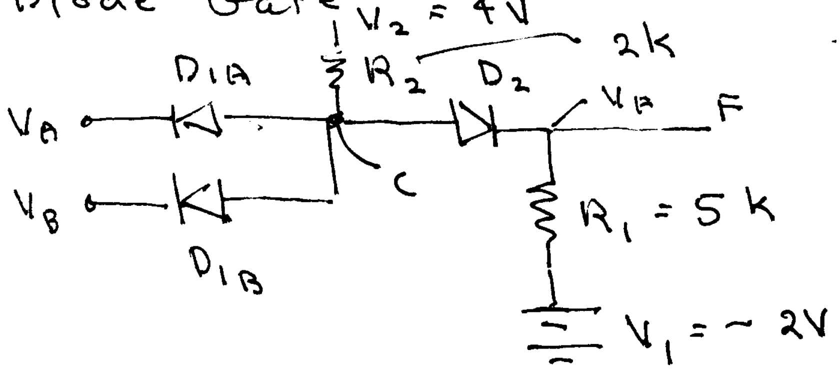
Note Condition for Diode to be on : $I_D = .04\ mA$

$$V_A = (.7 - I_1 + V_{cc}/_6)\ /\ (5/_4)$$

$$I_D = (V_A - .7)/_1 = (4(\cancel{.7} - I_1 + \frac{V_{cc}}{6}) - .\cancel{7 \times 4})/_5 > 0$$

$$= \frac{4}{5}\left(-I_1 + \frac{V_{cc}}{6}\right) > 0$$

3) Diode Gate



$V_2 + V_1 > 0$

F 2, 9

And Gate

Determine V_F for

a) $V_A = .2V \quad V_B = .2V$

$D_{1A}, D_{1B} =$ ~~off~~ on $\quad V_c = .9V \quad D_2$ off

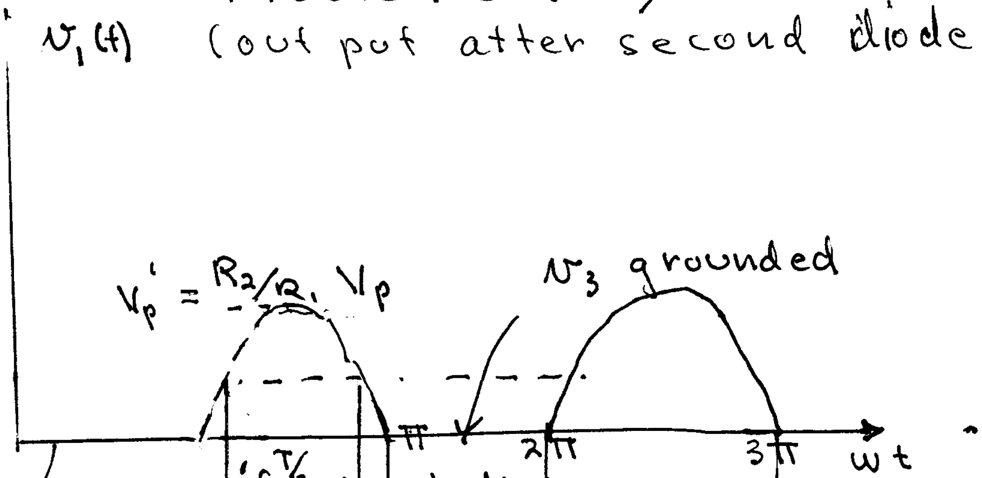
$V_F = -2V$

b) $V_A = 4 = V_B = 4\ V \quad D_{1A}, D_{2A} =$ off.

$I_{D_2} = (\cancel{6} - .7)/_7\ ;\ V_F = -2 + 5 \times 5.3/_7 = 1.8\ V$

Problem No 2: (Reference Sedra/Smith page 1020 Problem Set 5/

$v_1(t)$ (output after second diode) (before filter)

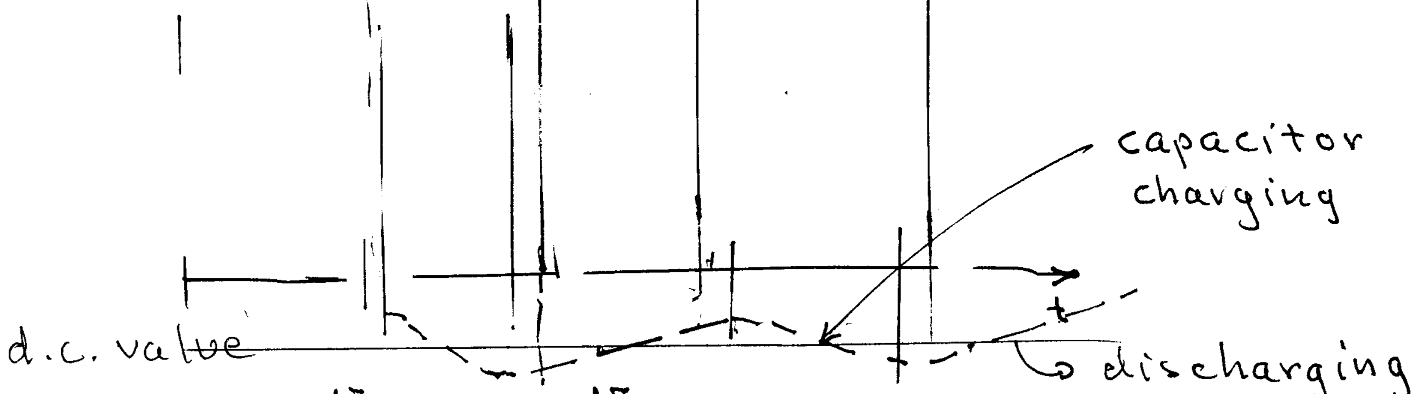


Diodes on so v_3 is grounded

$$\text{Avg} = V_p' \int_0^{T/2} \sin \omega t \, dt \, \frac{1}{T}$$

$$= \frac{V_p'}{\omega T} \int_0^{\pi} \sin \alpha \, d\alpha = V_p' \frac{2}{\omega T} = \frac{V_p'}{\pi}$$

$v_2(t)$ (output after RC filtering)



$$\frac{v_2}{\frac{1}{pC} \parallel R_4} = -\frac{v_1}{R_3}$$

$$\therefore v_2 = -\frac{R_4}{1 + R_4 pC} \frac{v_1}{R_3}$$

$R_4 C$ is large

Governing D.E.

$$(1 + R_4 C p) v_2 = -\frac{R_4}{R_3} v_1$$

$$\therefore \left(\frac{1}{R_4 C} + \frac{d}{dt}\right) v_2 = -\frac{1}{R_3 C} v_1$$

$$\frac{d}{dt}\left(v_2 e^{+t/R_4 C}\right) = -\frac{1}{R_3 C} e^{t/R_4 C}$$

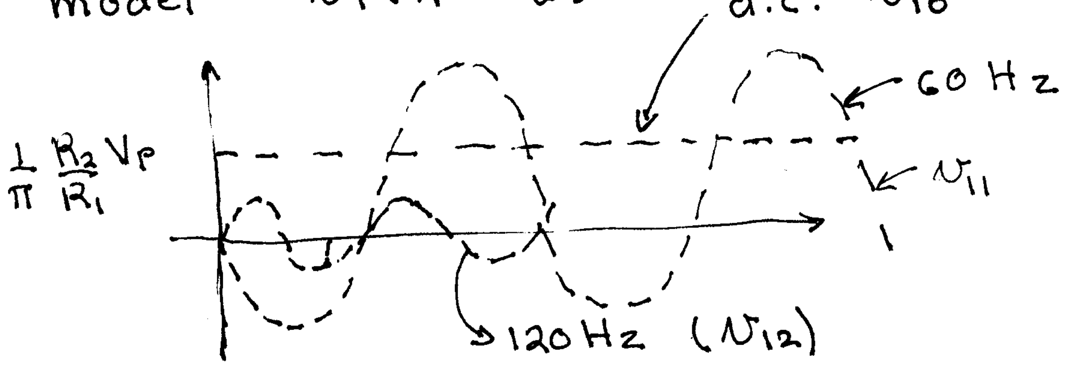
Consider signal $v_1(t)$ above

The average of the signal $v_1(t)$

$$= V_p \int_0^{T/2} \sin \omega t \, dt \omega \times \frac{1}{\omega T} \frac{R_2}{R_1} = V_p \frac{R_2}{R_1} \times \frac{1}{\underset{\overset{\uparrow}{2\pi/\omega}}{\omega T}} 2 = V_p \frac{R_2}{R_1} \times \frac{1}{\pi}$$

This is the d.c. component.
which gets filtered out

model $v_1(t)$ as d.c. v_{10} $\quad v_{10} + v_{11} + v_{12} + \cdots$



Now look at v_2 for <u>each of these</u>

$p = 0$ for d.c.

$$v_{20} = -\frac{R_4}{R_3} v_{10} = -\frac{R_4}{R_3} \frac{R_2}{R_1} \times \frac{1}{\pi}$$

$$v_{21} = -\frac{R_4}{1 + R_4 j\omega C} \frac{v_{11}}{R_3} \quad \text{for} \quad 60 \text{ Hz} \quad \omega = 2\pi 60$$

$$\simeq -\frac{1}{j\omega C} \frac{v_{12}}{R_3} = -\frac{R_4}{R_3} \frac{R_2}{R_1} \frac{1}{j(\omega C R_4)}$$

$\omega C R_4 >> \pi$

Thus v_{21} is small. (example $1 k\Omega \times 50 \mu F \times 60 \text{ Hz}) = 50 \times 10^{-3} \times 2\pi \times 60 = 6\pi$

And output is close to a constant v_{20}

$$= -\frac{R_4}{R_3} \frac{R_2}{R_1} \times \frac{1}{\pi}$$