Lecture 5 – Homework Examples

Constant Voltage Drop Model

- Forward Bias Example
- Reverse Bias Example
- Diode OR-ing Example
- Thevenin Equivalent Example

Exponential Model

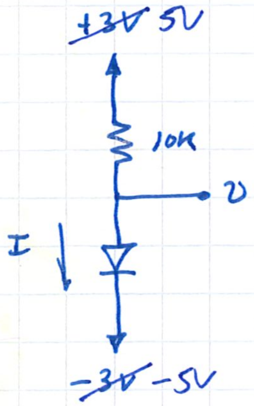
Q: What change in diode voltage corresponds to a factor of 10 change in current?

LECTURE 5

HOMEWORK EXAMPLES

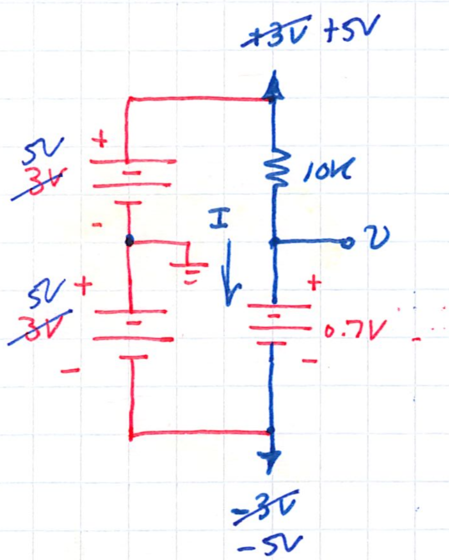
HW#1. 1) P3.2 (a)

a)



- FIND I, V (USING 0.7 VOLT MODEL)
- Q1. IS THE DIODE ON OR OFF? (i.e. F.B. or R.B.)

  ON
- OK, REDRAW FOR ANALYSIS



- KVL

$$\overset{5V}{\cancel{+3V}} - I(10K) - 0.7 \overset{+5V}{\cancel{+3V}} = 0$$

$$\overset{9.3V}{\cancel{5.3V}} - I(10K) = 0$$

$$I = \frac{\overset{9.3}{\cancel{5.3V}}}{10K} = \boxed{\overset{0.93}{\cancel{0.53}}\ mA}$$

- FIND v:

$$\overset{+5V}{\cancel{+3V}} - \overbrace{(10K)I}^{V_R} = v$$

$$\overset{+5V}{\cancel{3V}} - (10K)(\overset{0.93mA}{\cancel{0.53mA}}) = v$$

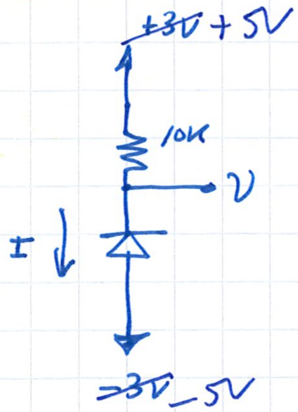
$$\overset{5V}{\cancel{3V}} - \overset{-9.3V}{\cancel{5.3V}} = v$$

$$\boxed{v = -4.3V}$$

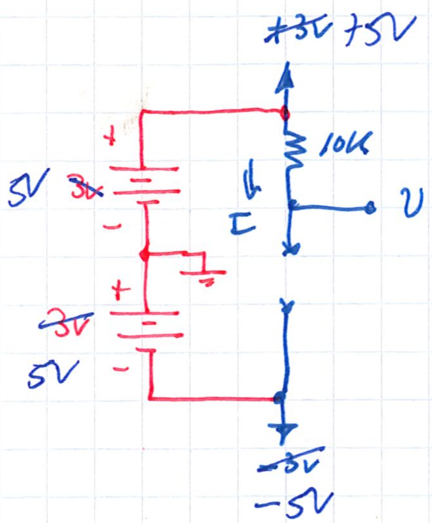
W.R.T. GROUND!

HW#1. 1) P.3.2 (b) Reverse the direction of the diode.

b)



- Q_1: On or off? off (R.B.)
- Model? open circuit!
- Redraw



$I = ?$ $\underline{\underline{0}}$! Why?

$V = ?$

$+3V \cancel{- (10k) I} = V$ (0)

$\therefore \boxed{V = \cancel{+3V}}$ +5V

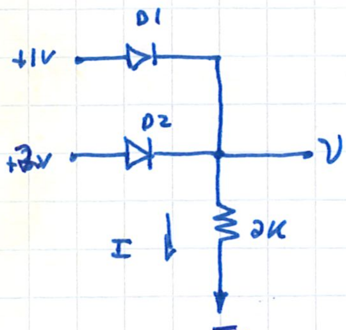
No voltage drop across the resistor!

$I = 0$!

P 3.3

FIND I, v :

a)



Q. IF D1 IS ON, WHAT WOULD v BE?

$v = 1 - 0.7 = 0.3V$

Q. WOULD D2 BE F.B. OR R.B ?

F.B.

Q. WHAT WOULD THE VOLTAGE ACROSS D2 BE?

$2V - 0.3V = \underline{1.7 \text{ VOLTS}}$ ⇐

Q. DOES THIS MAKE SENSE OR NOT? NO!

Q. IF D2 IS ON, WHAT WOULD v BE ?

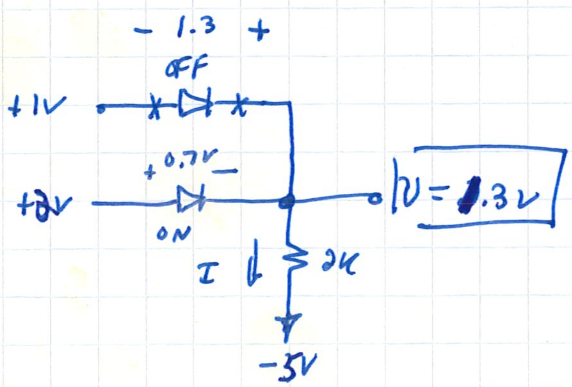
$v = 2 - 0.7 = 1.3v$

Q. WOULD D1 BE F.B. OR R.B. ? **RB.**

IS THIS OK? YES!

∴

D1 OFF
D2 ON



3.15 mA

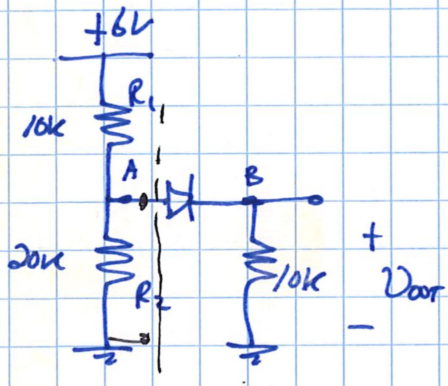
∴ $I = (1.3V - (-5V))/2k = 6.3V/2k = \boxed{~~2.65 mA~~}$

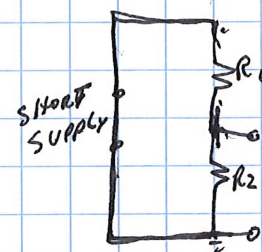
∀ OBSERVATION, THIS CIRCUIT FOLLOWS THE "HIGHER" VOLTAGE . . .

Q. PART b) ... WHAT DO YOU THINK IT WILL DO . . .

HW EXAMPLES:

1) ILLUSTRATING USE OF THEVENIN EQUIVALENT





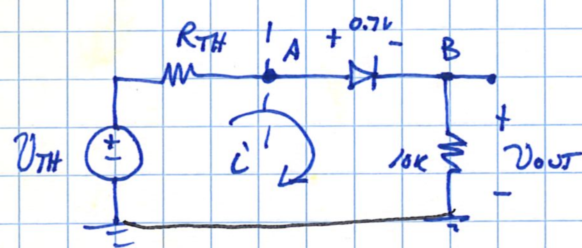
To Find R_{TH},

1) Set $V_{SOURCE} = 0$

2) FIND R_{TH} BETWEEN OUTPUT NODES.

3) $R_{TH} = R_1 || R_2$

FIND V_{OUT}!



$$V_{TH} = V_{OPEN\ CIRCUIT} = \left(\frac{20K}{10K + 20K}\right) \cdot 6V = \left(\tfrac{2}{3}\right) 6V = \underline{\underline{4V}}$$

$$R_{TH} = R_1 || R_2 = 10K || 20K = \underline{\underline{6.67K\Omega}}$$

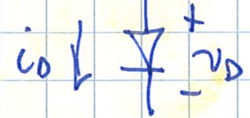
KVL:

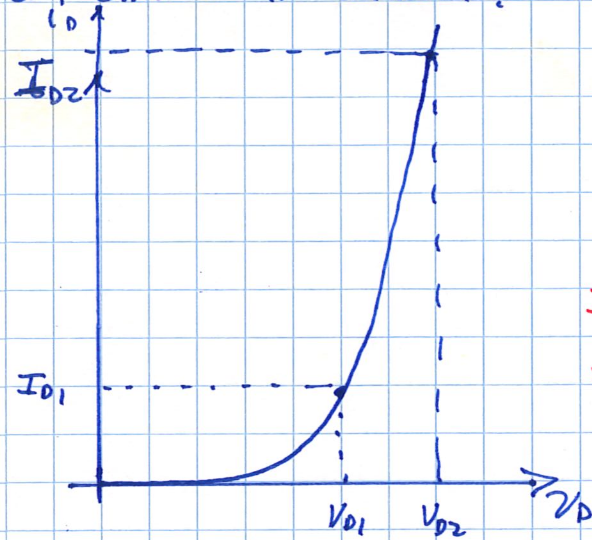
$$4V = \overset{(6.67K)}{\cancel{R_{TH}}} \cdot i + 0.7V + 10K \cdot i$$

$$\therefore \quad i = \frac{3.3V}{16.67K} = \underline{\underline{0.198mA}}$$

$$\therefore \quad V_{OUT} = (10K)(0.198mA) = \underline{\underline{1.98V}}$$

2) WHAT CHANGE IN DIODE VOLTAGE CORRESPONDS TO A FACTOR OF 10 CHANGE IN CURRENT?





$$i_D \cong I_S\left(e^{v_D/nV_T} \cancel{-1}\right)$$

$$I_{D2} \cong I_S\, e^{V_{D2}/nV_T}$$

$$I_{D1} \cong I_S\, e^{V_{D1}/nV_T}$$

RATIO FORM OF EQ:

$$\frac{I_{D2}}{I_{D1}} \cong e^{\overbrace{(V_{D2}-V_{D1})}^{\Delta V}/nV_T}$$

$$\Delta V = nV_T \ln\left(\frac{I_{D2}}{I_{D1}}\right)$$

$$= (1)(25\,mV)\underbrace{\ln(10)}_{2.3} = 57.6\,mV \quad \text{FOR } n=1$$

$$= (2)(25\,mV)(2.3) = 115.1\,mV \quad \text{FOR } n=2$$

CONCLUSION:

- A SMALL CHANGE IN v_D CORRESPONDS TO A LARGE CHANGE IN i_D!

FOR $\Delta V = 60\,mV$ FACTOR OF 10 CHANGE IN i_D!