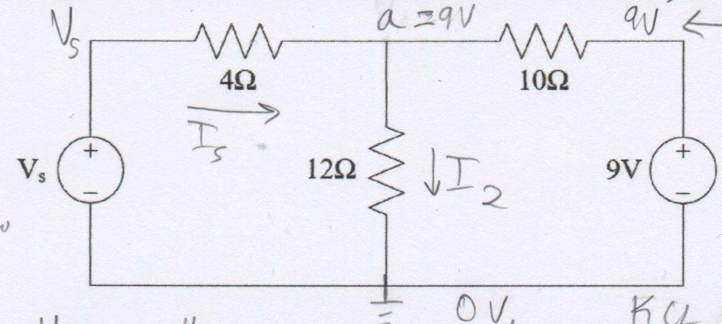
ECE 110 Exam 2 Review Worksheet

1. Find the value of the voltage source V_S such that the 9V source neither absorbs nor ~~dissipates~~ supplies power.

- If the 9V source neither absorbs nor supplies power, $P=0$, and thus its current must be zero!
- By Ohm's Law, we know the $10\,\Omega$ resistor must then have no voltage drop. Thus, $a = 9V$.



- We can then use node method to compute V_s! ⇒

KCL @ node a

$I_S + I_1 = I_2$

$I_S = I_2 \rightarrow \frac{V_s - a}{4} = \frac{a}{12}$

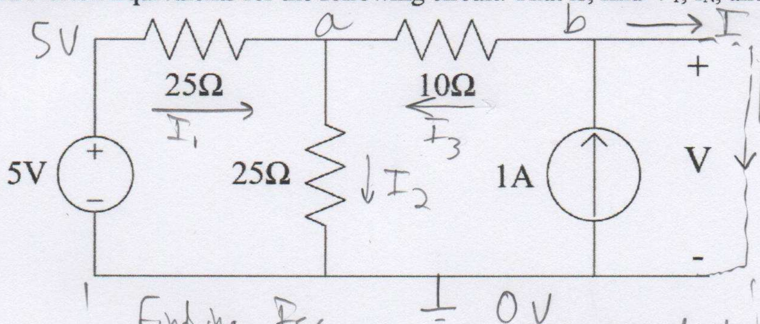
$I_1 = 6$

$3V_s = 4a$

$V_s = \frac{4}{3}a$

$\boxed{V_s = 12V}$

2. Obtain the Thevenin and Norton Equivalents for the following circuit. That is, find V_T, I_N, and R_T.



All three values agree by Ohm's Law!

Finding V_{oc}

- Want to find node voltage b.
- First, Let's find a.

KCL @ node a

$I_1 + I_3 = I_2$

$\frac{5-a}{25} + 1 = \frac{a}{25}$

$a = 15V \rightarrow I_3 = 1 = \frac{b-a}{10}$

$\hookrightarrow b = \boxed{V_{oc} = 25V}$

Finding I_{sc}

- $b = 0$ now
- Let's find node a

KCL @ node a

$I_1 + I_3 = I_2$

$\frac{5-a}{25} + \frac{0-a}{10} = \frac{a}{25}$

$a = \frac{10}{9}$

KCL @ node b

$1 = I_3 + I_{sc}$

$I_{sc} = 1 - I_3$

$I_{sc} = 1 - \frac{0-a}{10}$

$\boxed{I_{sc} = \frac{10}{9}}$

Finding R_{eff}

Source Suppression

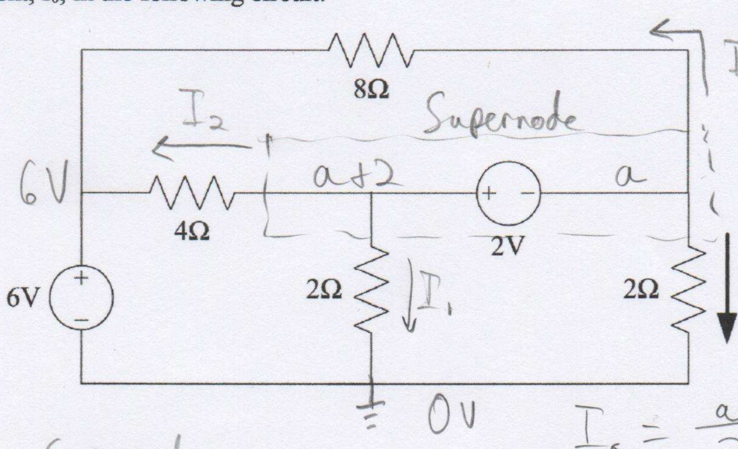
25, 25, 10, R_{eff}

$R_{eff} = (25 \| 25) + 10$

$\boxed{R_{eff} = 22.5\,\Omega}$

3. Find the labeled current, I_0, in the following circuit.

- Finding node a will make finding I_0 trivial.
- We will place a supernode around the 2V source because it is a floating source!



KCL @ Supernode

$I_0 + I_1 + I_2 + I_3 = 0$

$\frac{a}{2} + \frac{a+2}{2} + \frac{(a+2)-6}{4} + \frac{a-6}{8} = 0 \rightarrow 4a + 4a + 8 + 2a - 8 + a - 6 = 0$

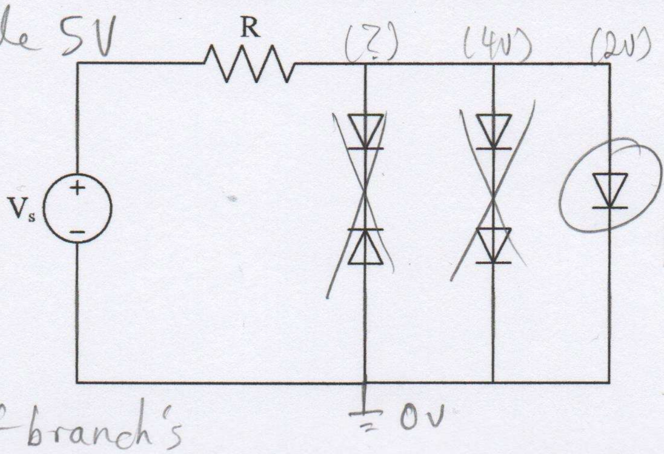
$11a = 6 \rightarrow a = \frac{6}{11}V$

$I_0 = \frac{a}{2}$

$\boxed{I_0 = \frac{3}{11}A}$

4. In the following circuit, $V_s = 5V$ and the V_{ON} for the diodes is 2V. Determine how many diodes are on.

- Only far right diode 5V is on because the middle branch needs $2 \cdot V_{on} = 4V$, while the right branch restricts the shared parallel voltage to 2V.
- Furthermore, the left branch's diodes cannot be on since they point in opposite directions!



$\boxed{\text{1 Diode}}$

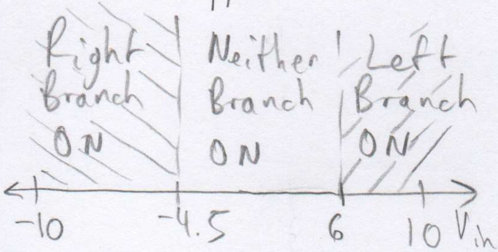
5. In the following circuit, $V_{clip} = -3V$ and the V_{ON} for the diodes is 1.5V. Determine the minimum and maximum values of the output voltage, V_{out}, and sketch the output waveform.

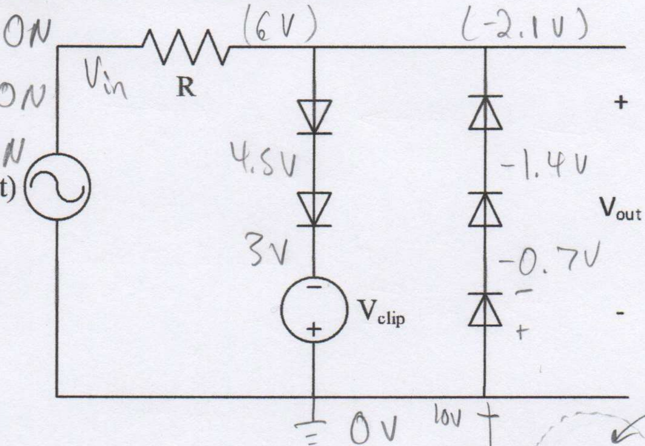
$$V_{out} = \begin{cases} 6V, & \text{if left branch ON} \\ V_{in}, & \text{if neither branch ON} \\ -4.5V, & \text{if right branch ON} \end{cases}$$

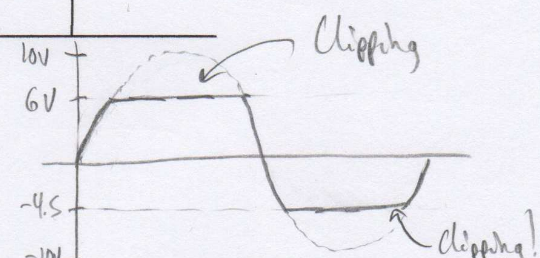
$\Downarrow$

$\boxed{\therefore V_{max} = 6V,\ V_{min} = -4.5V}$

$\Uparrow$





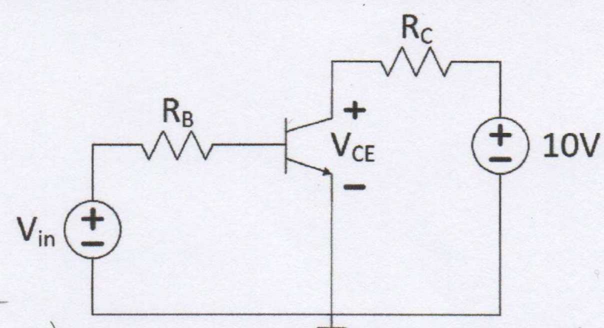


6. For the following circuit, $V_{BE,ON} = 0.4V$, $V_{CE,SAT} = 0.2V$, $R_B = 20k\Omega$, $R_C = 2k\Omega$ and $\beta = 100$. Find V_{CE} for the following input voltages.

a) $V_{in} < V_{BE,ON}$ ↳ Off!

$\boxed{V_{CE} = V_{CC} = 10V}$

a. $V_{in} = 0.3V$
b. $V_{in} = 1.0V$
c. $V_{in} = 1.4V$
d. What is the smallest value of V_{in} that puts the transistor into saturation?



b) $I_B = \dfrac{V_{in} - V_{BE,ON}}{R_B} = 30\mu A$

$I_C = \beta I_B = 3mA$

$V_{CE} = V_{CC} - I_C R_C = 4V$

$\boxed{V_{CE} = 4V}$

c) $I_B = \dfrac{V_{in} - V_{BE,ON}}{R_B} = 50\mu A$

$I_C = \beta I_B = 5mA$

$V_{CE} = V_{CC} + I_C R_C = 0!$

- Not possible to have $V_{CE} < V_{CE,SAT}$, must be in saturation $\rightarrow$ $\boxed{V_{CE} = 0.2V}$

d) - We can use both active and sat. assumptions: - $I_C = \dfrac{V_{CC} - V_{CE,SAT}}{R_C} = 4.9mA$

- $I_B = \dfrac{I_C}{\beta} = 49\mu A$
- $V_{in} = I_B R_B + V_{BE,ON}$

$\boxed{V_{in} = 1.38V}$