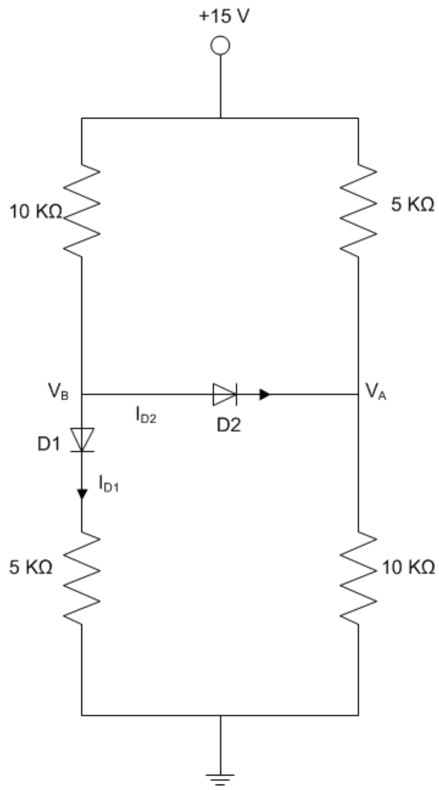
EE101
Tutorial 3 (23.-AUG-2013) Solutions



1. Consider each of the four possibilities of the diodes being ON or OFF (ON if it is forward biased and OFF if its reverse biased).

D2 and D1 both OFF

This obviously cannot happen as +15 V is being applied

D2 is ON and D1 is OFF

If this is the case, then $I_{D1}=0$, $V_B=V_A+0.7$,

$I_{D2}=(15-V_B)/10=(14.3-V_A)/10$

$$\frac{V_A}{10}=\frac{15-V_A}{5}+\frac{14.3-V_A}{10}$$

Therefore V_A=11.75 V and V_B=12.45 V

But if V_B=12.45 V then D1 will be ON (forward biased) and the current I_{D1} through it will be (12.45-0.7)/5 = 2.35 mA.

This is clearly inconsistent with our initial assumption that D1 is OFF. Therefore, this also cannot happen!

D2 and D1 are both ON

$V_B=V_A+0.7$, $\qquad I_{D1}=\frac{V_B-0.7}{5}=\frac{V_A}{5}$,

$$I_{D2}=\frac{V_A}{10}-\frac{15-V_A}{5}=\frac{3V_A-30}{10}$$

and $\quad \frac{15-V_B}{10}=I_{D1}+I_{D2} \quad \Rightarrow \quad \frac{14.3-V_A}{10}=\frac{5V_A-30}{10}$

This gives V_A=7.38 V, V_B=8.08 V I_{D1}=1.476 mA and I_{D2}=-0.786

This is clearly inconsistent with our initial assumption because the current I_{D2} cannot be negative if D2 is ON. Therefore, this also cannot happen

D2 is OFF and D1 is ON

$\mathbf{V_A}=15\left(\frac{10}{5+10}\right)$ **= 10 V and $\mathbf{V_B}$**$=\left(\frac{15-0.7}{15}\right)5+0.7=$**5.47 V**

I_{D2}=0 as D2 is OFF

I_{D1}=0.953 mA

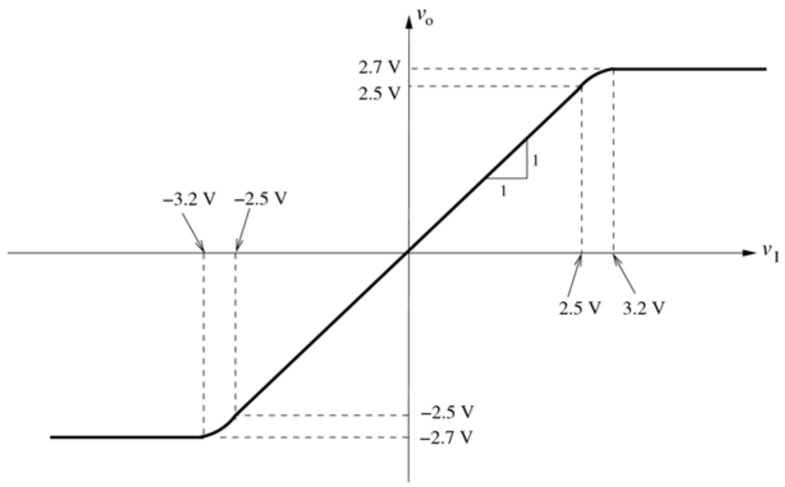
Note that this is consistent with our assumption that D2 is OFF and D1 is ON so this will be the state of the two diodes.

2. When $-2.5\text{V} \le v_I \le 2.5\text{V}$, both D1 and D2 would be OFF, so $v_O = v_I$

For $v_I \ge 2.5\text{V}$, D1 would be ON while D2 would be OFF.

Given that $v_D = 0.7\text{V}$ for $i_D \ge 1\text{mA}$, so $v_o = 2.7\text{V}$ for $v_I \ge 2.7\text{V}+0.5\times 1 = 3.2\text{V}$

By symmetry, $v_o = -2.7\text{V}$ for $v_I \le -3.2\text{V}$



3.

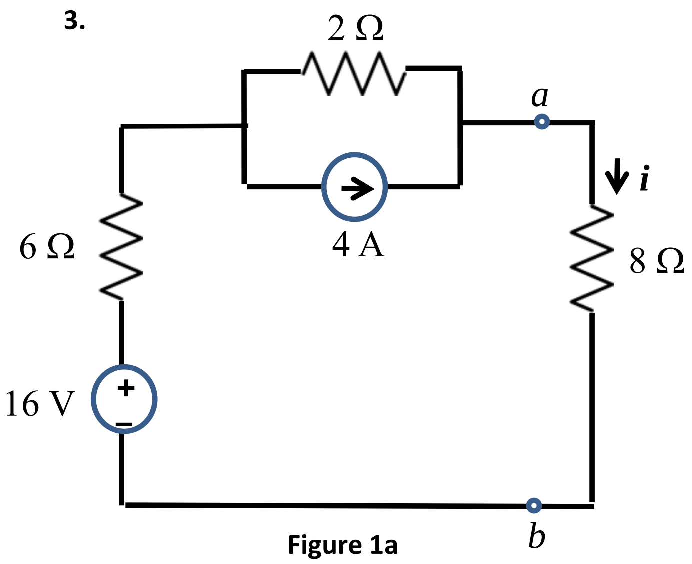


Figure 1a

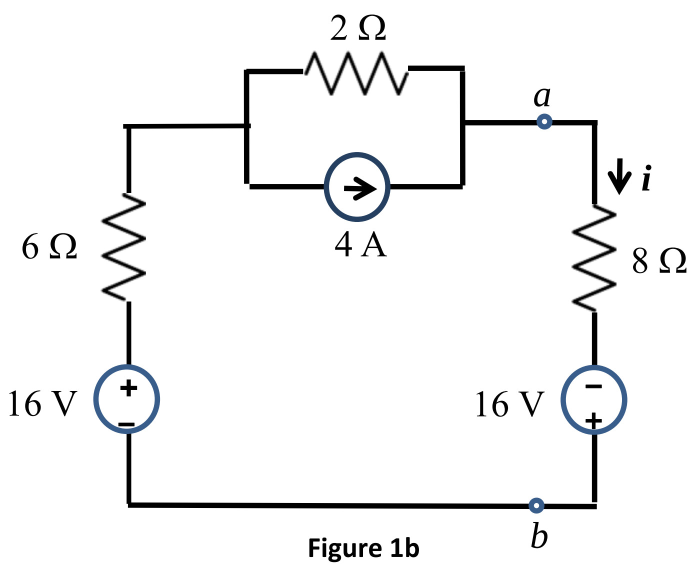
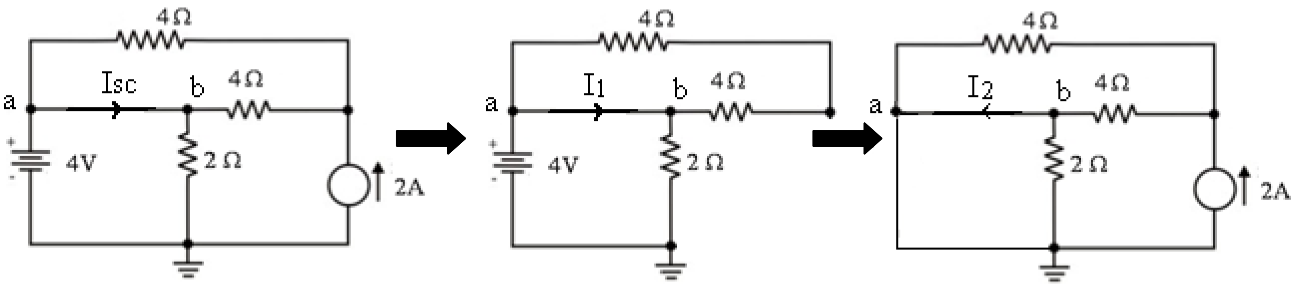


Figure 1b

(a) With terminals a-b open,
The open circuit voltage is: $V_{th} = 16+2\times4 = 24$ V
The Thevenin resistance is: $R_{th} = 6+2 = 8\ \Omega$
The required current is: $i = 24/(8+8) = 1.5$ A
(b) The current due to the additional source alone is:
$16/(6+2+8) = 1$ A, which is in the same direction.
Therefore, total current = 1.5 + 1 = 2.5 A

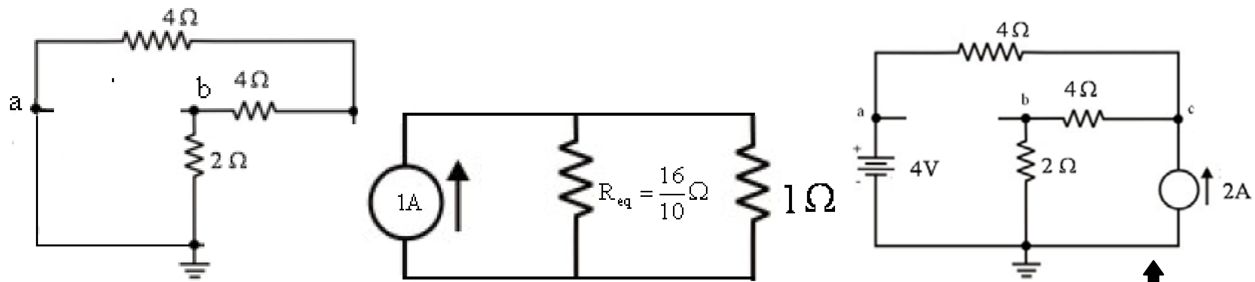
4. In order to apply Norton's theorem, we need to first find I_{SC} in the circuit shown below:



I_{SC} can be calculated using superposition as $I_{SC} = I_1 - I_2$ from the circuits shown below:

$I_{SC} = 2 - 1 = 1\text{A}$

R_{eq} between a and b can be calculated from the circuit shown below:



$R_{eq} = \dfrac{16}{10}\Omega$ Therefore the Norton equivalent circuit is

and the current through 1 Ω resistance is $\dfrac{8}{13}$ A.

Verification by Thevenin's equivalent circuit:

$V_{OC} = \dfrac{8}{5}$ V and equivalent Thevenin's series resistance is $R_{eq} = \dfrac{16}{10}\Omega$. Therefore the current is

$$\frac{8/5}{1+16/10} = \frac{8}{13}\text{A}$$