TUTORIAL-2

PRE-TUTORIAL ASSIGNMENT- SOLUTION

1(a). Corresponding to RMS voltage of $V_{rms} = 25V$, the peak voltage will be $V_m = \sqrt{2}V_s = 35.36V$.
Taking into account the forward voltage drops across two diodes, we get –

$$V_{dc} = \frac{2}{\pi}(V_m - 2\times 0.7) = \frac{2}{\pi}(33.96) = 21.62\,V$$

Therefore,

$$I_{dc} = \frac{V_{dc}}{R_L} = \frac{21.62}{100} = 0.2162A$$

1(b). Each diode should have a PIV rating higher than (V_m-0.7) =34.66 V

TUTORIAL-2: 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}=(V_A-0.7)/10

$$\frac{15-V_A}{10} = \frac{V_A}{5} + \frac{V_A - 0.7}{10}$$

Therefore V_A=3.925 V and V_B=3.225 V
But if V_B=3.225 V then D1 will be ON (forward biased) and the current I_{D1} through it will be (15-0.7-3.225)/5 = 2.215 mA. This is clearly inconsistent with our assumption that D1 is OFF. Therefore, this also cannot happen!

D2 and D1 are both ON — V_B=V_A-0.7

and

$$\frac{15-V_A}{10} = I_{D2} + \frac{V_A}{5} \qquad (a)$$

$$\frac{15-0.7-(V_A-0.7)}{5} + I_{D2} = \frac{V_A - 0.7}{10} \qquad (b)$$

Solving (a) and (b), we get I_{D2}= - 0.786 mA
This is clearly inconsistent with our initial assumption that D2 is ON. (The current I_{D2} has to be positive if D2 is ON.)
Therefore, this also cannot happen

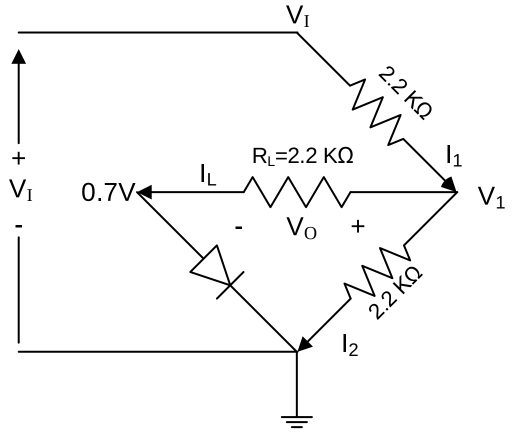
D2 is OFF and D1 is ON — **V_A=** $15\left(\frac{5}{5+10}\right)$ **= 5 V and V_B=** $\left(\frac{15-0.7}{15}\right)10$ **=9.533 V**

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.
I_{D2}=0 as D2 is OFF
I_{D1}=0.9533 mA

2. We need to consider the following cases

(i) **For $|V_I| \leq 0.7$ V,** the current through the load resistance will be zero as the source voltage is not enough to forward bias the diode. Therefore **$V_O = 0$ V**

(ii) For V_I which is high enough and positive (we figure out later how high!), the circuit will effectively be as shown below



$$\frac{V_I - V_1}{2.2} = \frac{V_1 - 0.7}{2.2} + \frac{V_1}{2.2} \quad \Rightarrow \quad V_I = 3V_1 - 0.7 \quad \Rightarrow \quad V_1 = \frac{1}{3}(V_I + 0.7)$$

$$I_L = \frac{V_1 - 0.7}{2.2}\,mA = \frac{V_I - 1.4}{6.6}\,mA \quad \Rightarrow \quad V_O = 2.2 I_L = \frac{1}{3}(V_I - 1.4)\,V$$

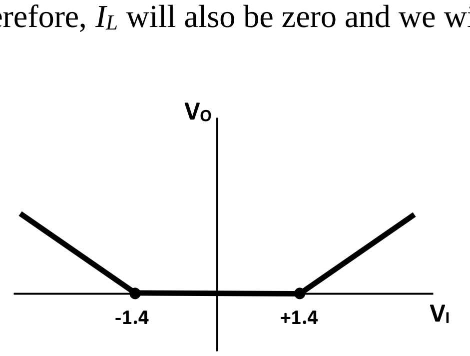
Looking at the above, $I_L \geq 0$ will be needed for the diode to conduct in the above circuit. So the above expression for V_O will only be valid if **$V_I \geq 1.4$ V**.

A similar approach can be taken when V_I is large and negative and combining the two we get that **for $|V_I| \geq 1.4$ V, $V_O = (|V_I - 1.4|)/3$ V**

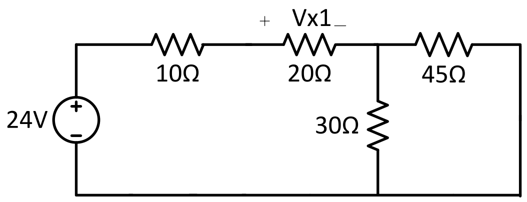
(iii) For **$0.7 < V_I < 1.4$ V**, the diode still cannot be forward biased. Since we are assuming an ideal diode which does not conduct any current unless the forward bias voltage reaches 0.7 V, the current through it will remain zero. Therefore, I_L will also be zero and we will have **V_O=0**.

Summarizing the above,

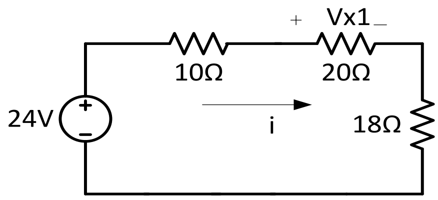
$|V_I| \leq 1.4$ V $V_O = 0$ V
$|V_I| \geq 1.4$ V $V_O = (|V_I - 1.4|)/3$ V



3. Considering only 24 V source,



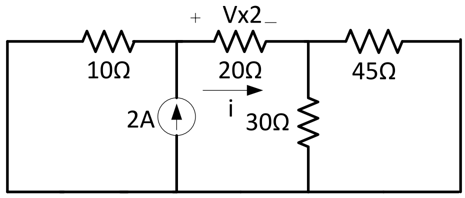
30||45= $\dfrac{30 \times 45}{30+45}$ = 18Ω

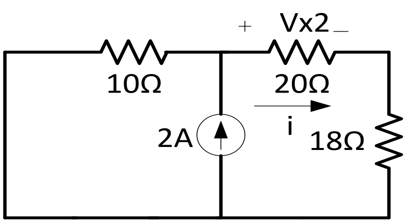


i = $\frac{24}{10+20+18}$ = 0.5 A

Vx1= 0.5 × 20 = 10 V

Similarly, considering only the 2 A current source,



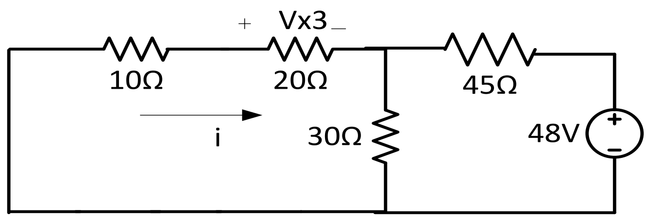


i = 2A × $\dfrac{10}{10+(20+18)}$ = 2A × $\dfrac{10}{48}$

= 0.42 A

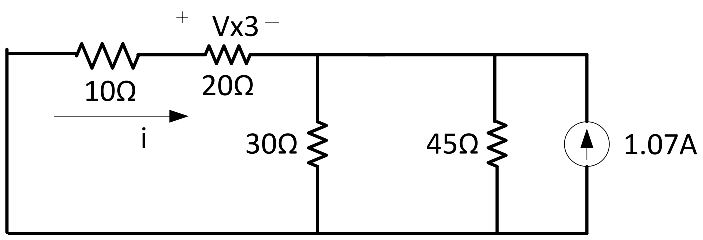
Vx2 = i × 20 = 0.42 × 20 = 8.4 V.

Considering only the 48 V source

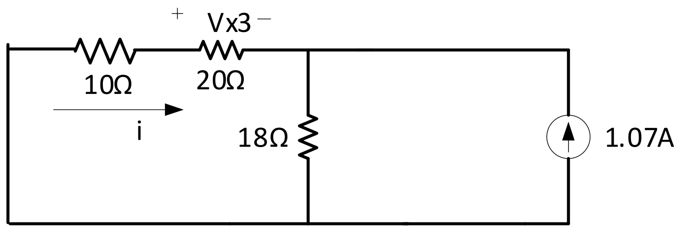


Using source transformation,

$$\frac{48}{45} = 1.07\text{A}$$



$$\frac{45 \times 30}{45 + 30} = 18\ \Omega$$

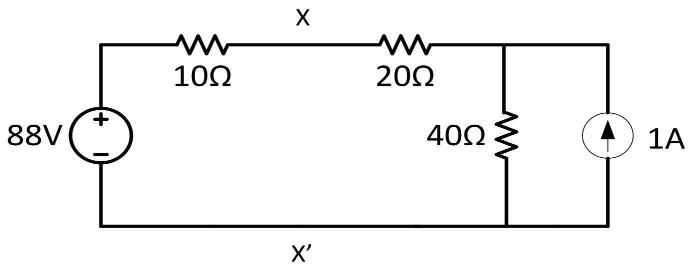


$i = -1.07 \times \frac{18}{18+(10+20)} = -0.4\text{A}$

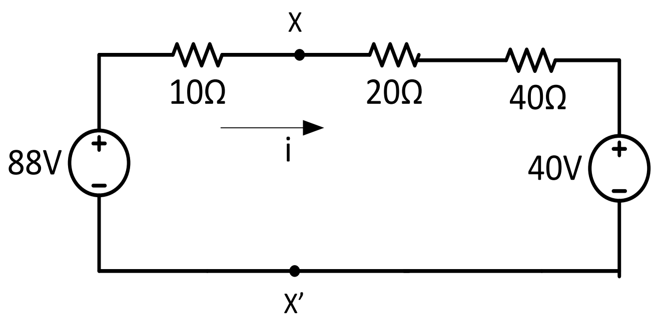
Vx3 = i × 20 = -8V

Using superposition, Vx = Vx1 + Vx2 + Vx3 = 10 + 8.4 – 8 = 10.4 V . [Ans]

4. For Thevenin equivalent circuit



By Source transformation of 1A source,



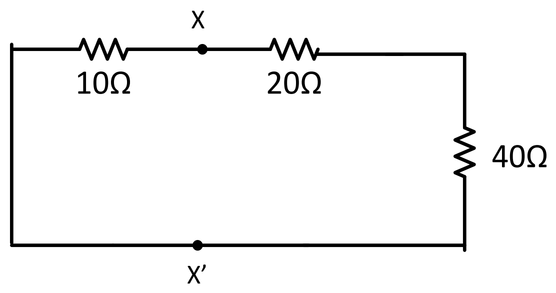
$\Rightarrow$ $i = \frac{88-40}{10+20+40} = 0.6857A$

Voltage across X X' = $V_{XX'}$ = 88 – 10 i

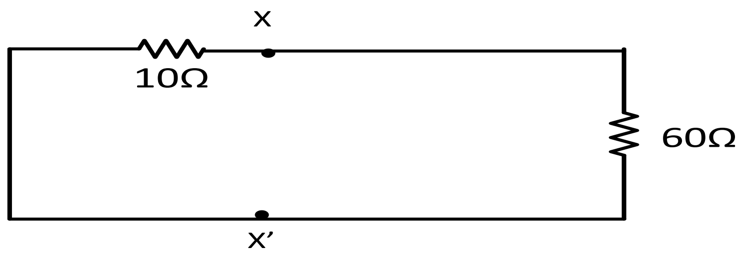
= 88 – 10 x 0.6857 = 81.143 V

Vth = Vthevenin = Vxx' = 81.143 V.

For Rth: setting the independent sources to zero,

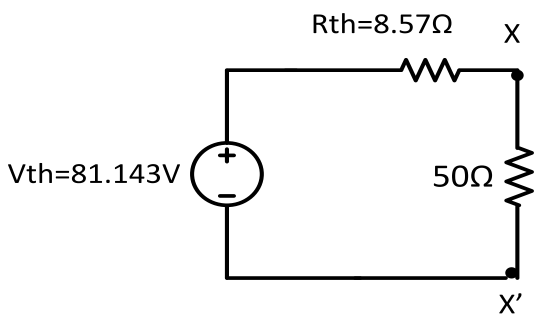


⇒ $20\Omega + 40\Omega = 60\Omega$



Rth = 10||60 = 8.57Ω

Thevenin equivalent circuit is,



Voltage across xx' = Vth $\times \frac{50}{50+8.57}$ = 81.143 $\times \frac{50}{50+8.57}$ = 69.27V [Ans]