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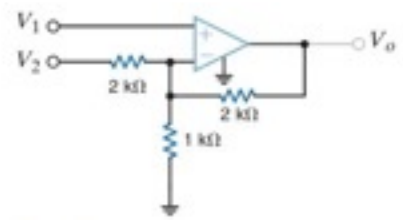
Exam II Re-Work



1. We had to derive an expression for V_o as a function of V_1 and V_2.

- This problem was an example of superposition with non-inverting op-amp. The easiest way to do this problem is to examine what happens at node A using KCL. Let see what happens when we do it:

KCL @ A: $-IV_2 - I_3 - I_1 = 0$

$$\frac{-(V_2 - V^-)}{R_2} - \frac{(V_0 - V^-)}{R_2} + \frac{V^-}{R_1}$$

$$\frac{-(V_0 + V_1)}{R_2} = \frac{(V_2 - V_1)}{R_2} - \frac{V^-}{R_1}$$

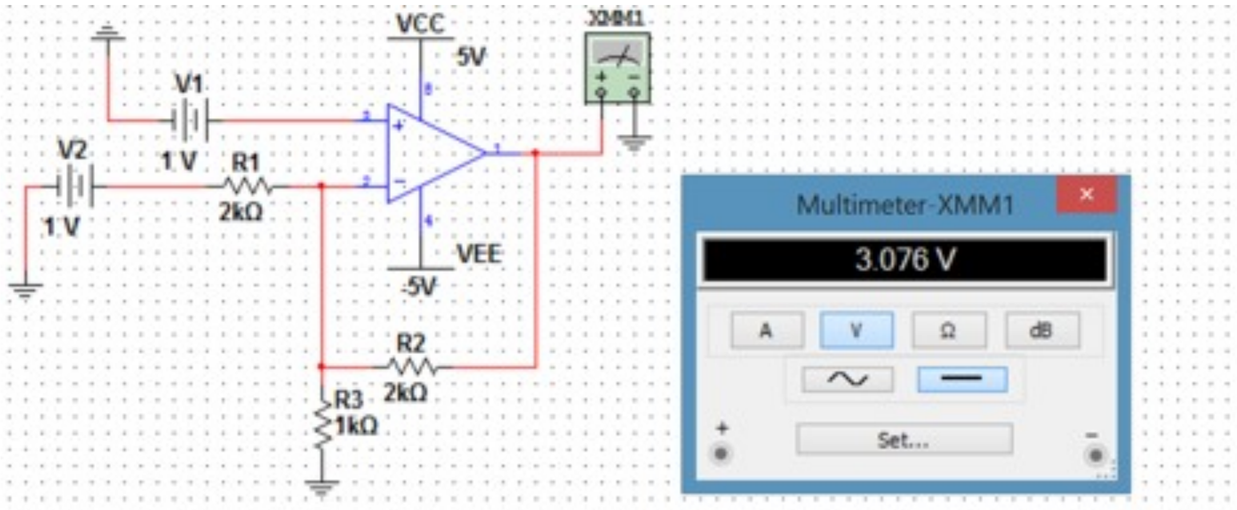
$$-V_0 = V_2 - V_1 - \frac{V_1 R_2}{R_1} - V_1$$

$$V_0 = 2V_1 + \frac{V_1 R_2}{R_1} - V_2$$

$$V_0 = 2V_1 + 2V_1 - V_2$$

$$V_0 = 4V_1 - V_2$$

Now we can verify the answer by using Multisim.

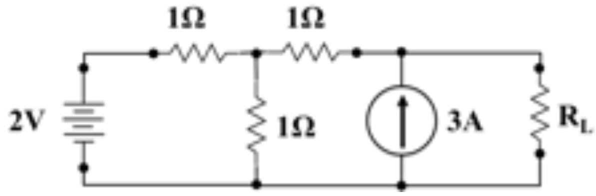


Simply plug in your input voltages in the equation that we derived used KCL. It gives us:

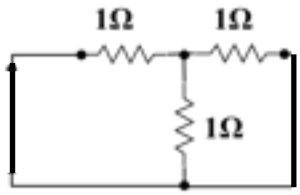
$$V_0 = 4(1) - (1)$$

$$V_0 = 3V$$

2.



We had to use superposition to find the value of RL that would maximize the power dissipate in RL. In order to have maximum power dissipated Rth has to equal to RL. So we need to find Rth. In order to find Rth we need to remove RL, remove all the sources (open circuit for current and shortage for voltage), redraw the circuit and reduce everything.

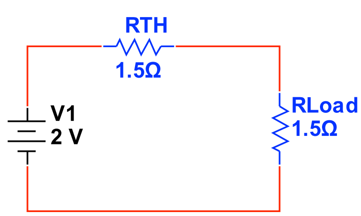
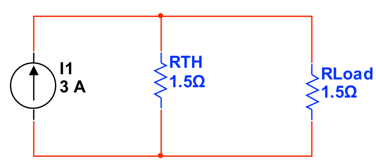


We can clearly see that 2 resistors are in parallel and the third one is in series. So we get:

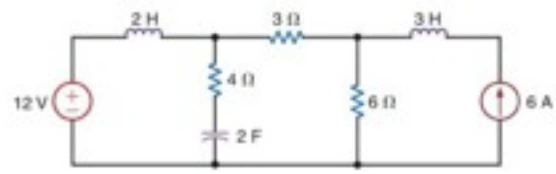
$$R_{th} = \frac{R_1 R_2}{R_1 + R_2} + R_3$$

$$R_{th} = \frac{3}{2}$$

Now, since we know Rth we need to use superposition. First, we need to find the power contribution of the voltage source and then we find the power contribution of the current.

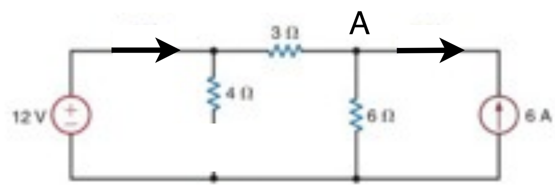
Voltage	Current
	
$I = \frac{2}{1.5+1.5} = \frac{2}{3}$ $P = I^2 R_L = (\frac{4}{9})(\frac{3}{2}) = \frac{2}{3} W$	$I = \frac{3}{2}$ $P = I^2 R_L = (\frac{9}{4})(\frac{3}{2}) = \frac{27}{8} W$

3.



In this problem we had to find the energy stored in the 2F capacitor and 3H inductor. We are going to redraw the circuit at time equals infinity.

$t = \infty$



at $t = \infty$ the capacitor becomes an open circuit and the voltage across it equals to the voltage source. The inductors get shorted. The simplest way to do this problem is to analyze node A using KCL.

KCL @ A:

$$-I_{l1} + I_{l2} + I_3 = 0$$

$$I_3 = I_{l1} - I_{l2}$$

Since we know I3 we can just use KVL for outside loop.

KVL @ outside loop

$$-12V + I_{l1}(3) + I_3(6) = 0$$

$$-12V + I_{l1}(3) + (I_{l1} - I_{l2})(6) = 0$$

$$3I_{l1} + (I_{l1} + 6)(6) = 12V$$

$$9I_{l1} + 36 = 12$$

$$I_{l1} = \frac{-24}{9}$$

Since now we know the Il1 and Il2, we can easily find I3.

$$I_3 = I_{l1} - I_{l2}$$

$$I_3 = \frac{-24}{9} + \frac{54}{9}$$

$$I_3 = \frac{10}{3}$$

We have all the voltages and the currents now; we can simply use the equations that were derived for us in the book.

Inductor	Capacitor
$W_{l2} = \frac{1}{2} L_2 (I_{l2})^2$	$W_{c1} = \frac{1}{2} C (V)^2$

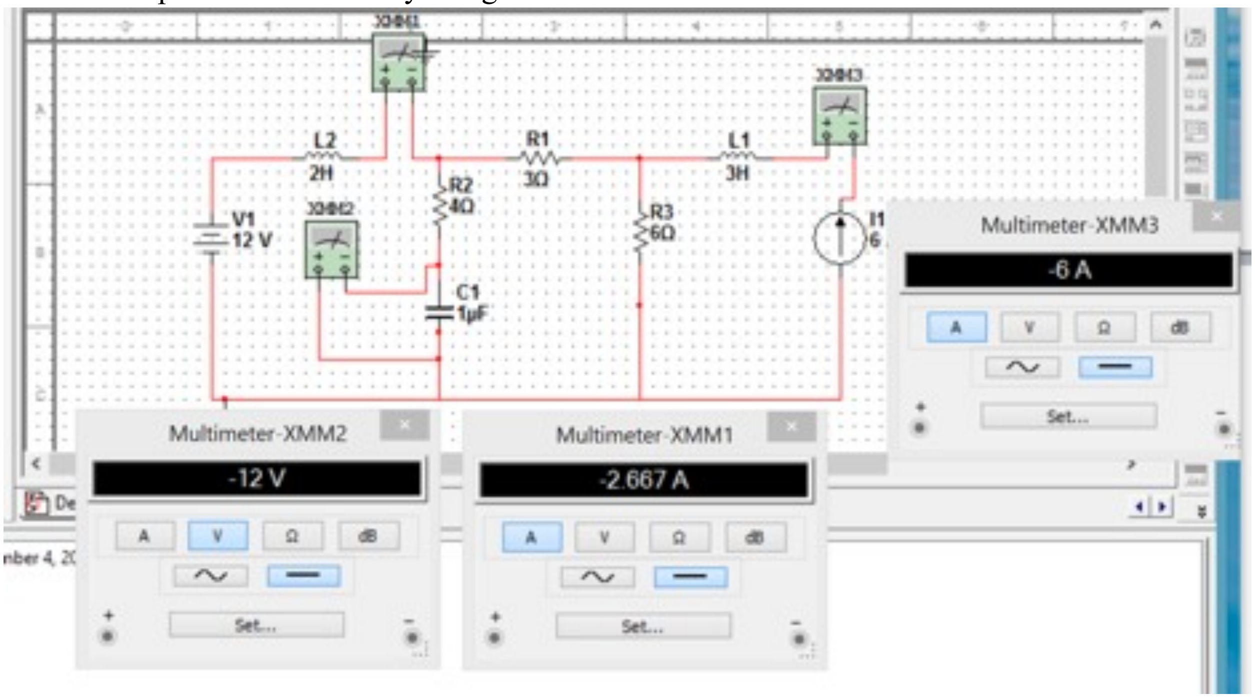
$$W_{c1} = \frac{1}{2}(2F)(12)^2$$

$$W_{c1} = 144J$$

$$W_{l2} = \frac{1}{2}(3H)(-6)^2$$

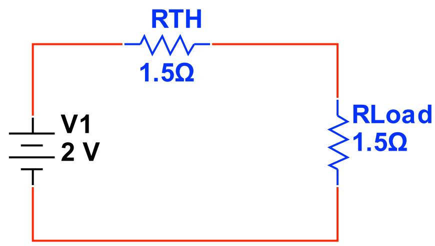
$$W_{l2} = 54J$$

3. Now lets prove our answer by using Multisim.

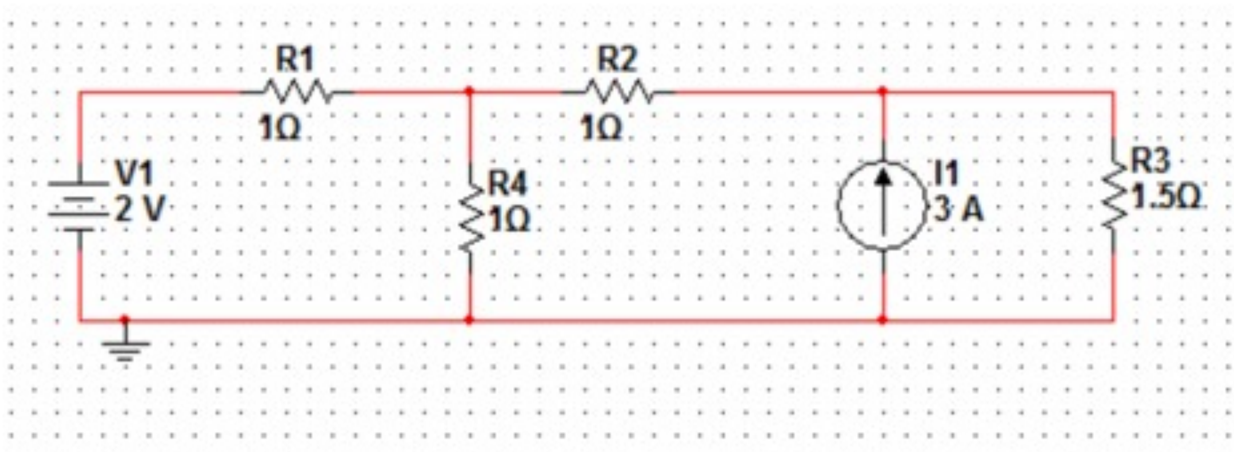


The picture above proves us that we were right about the capacitor. The voltage across capacitor does equal the actual voltage source. Also, we verified all the currents. So, we can plug in the currents into the equations that we derived for us from the book.

2b) The values should be the same because of the theory of superposition. If we just remove the current source and treat it as an open circuit we will get the same results we got in part A. The circuit will look like this:



Now, we can use Miltisim to prove that $R_{th} = R_L$.



Now simply by using a Parameter Sweep in Multisim we can prove that when $R_L = R_{th}$ we get the maximum power dissipated.