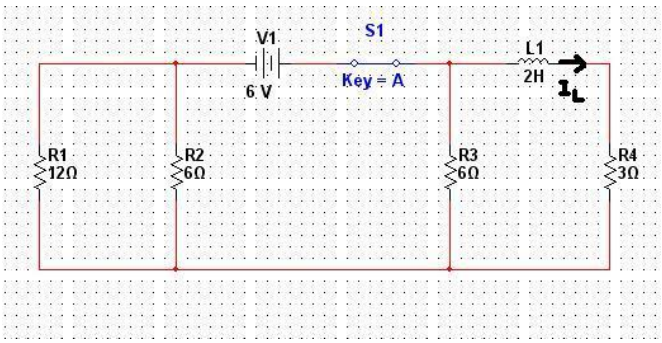
Saurav Guru

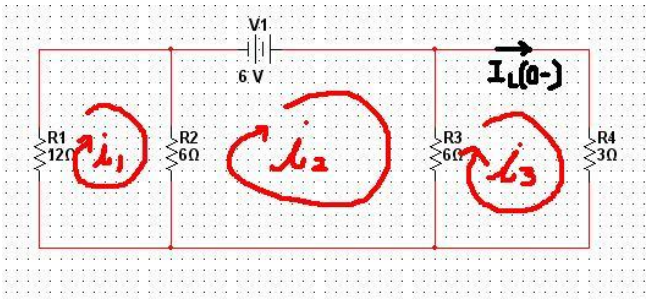
Exam 3 Rework

<u>Problem 1</u>: Find the current IL(t)



$$I_L(t) = K_1 + K_2 e^{(-t/T)}$$

At t = 0-



Do KVL

$$12i_1 + 6i_1 - 6i_2 = 0$$
$$3i_1 - i_2 = 0$$

$$6i_2 - 6i_1 + 6i_2 - 6i_3 = 6$$
$$-i_1 + 2i_2 - i_3 = 1$$

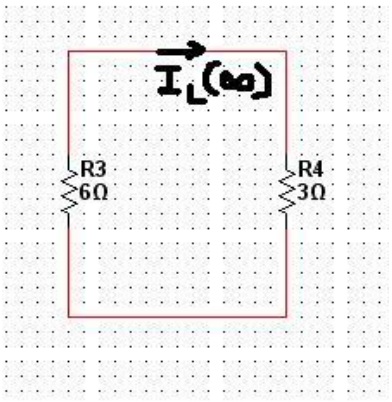
$$6i_3 - 6i_2 + 3i_3 = 0$$

$$-2i_2+3i_3=0$$

Use Matlab to find i1, i2, and i3.

$$i_1=0.33A \qquad i_2=1A$$
$$i_3=0.67A=I_L(0-)=I_L(0+)$$

At t = infinity



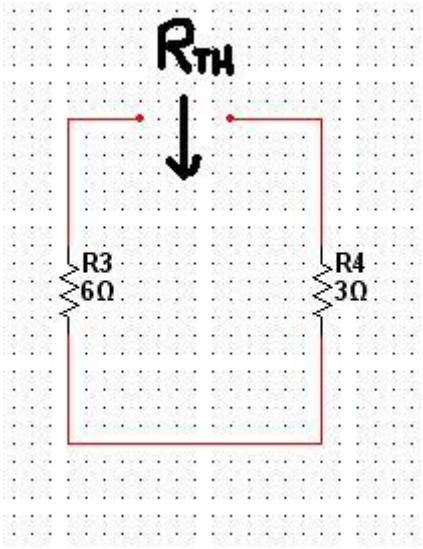
$$I_L(infinity)=0A$$

Find the constants K1 and K2.

$$I_L(infinity)=0=K_1$$

$$I_L(0+)=K_1+K_2$$
$$0.67=K_1+K_2$$
$$K_2=0.67$$

To find the time constant (T), first find the R Thevenin and then used T = L/R_th to find the time constant.



$$R_{TH} = 6 + 3 = 9 ohms$$

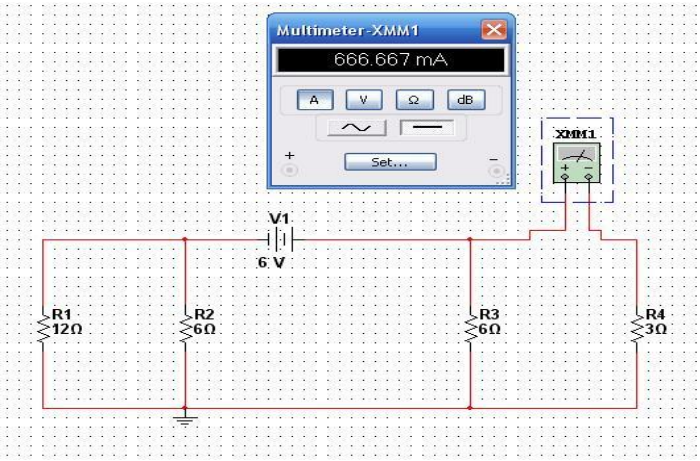
$$T = L / R_{TH} = 2/9 = 0.22 s$$

Now we can combine everything to get the final answer.

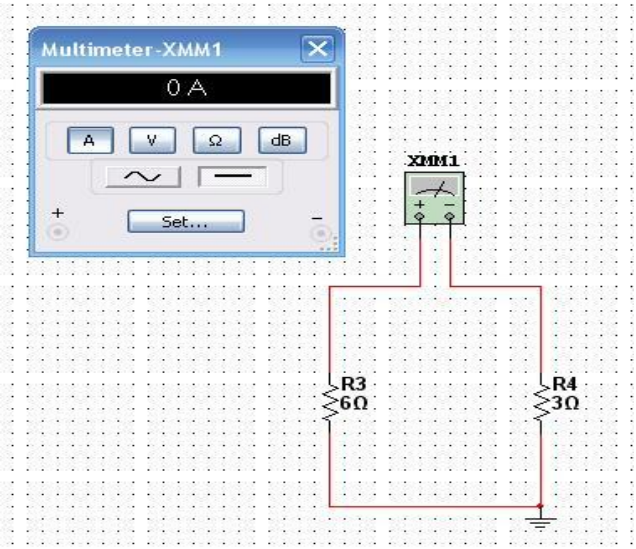
$$I_L(t) = 0.67 e^{(-t/0.22)} A \quad \text{OR} \quad I_L(t) = 0.67 e^{(-4.5t)} A$$

<u>Multisim Result for iL(t):</u>

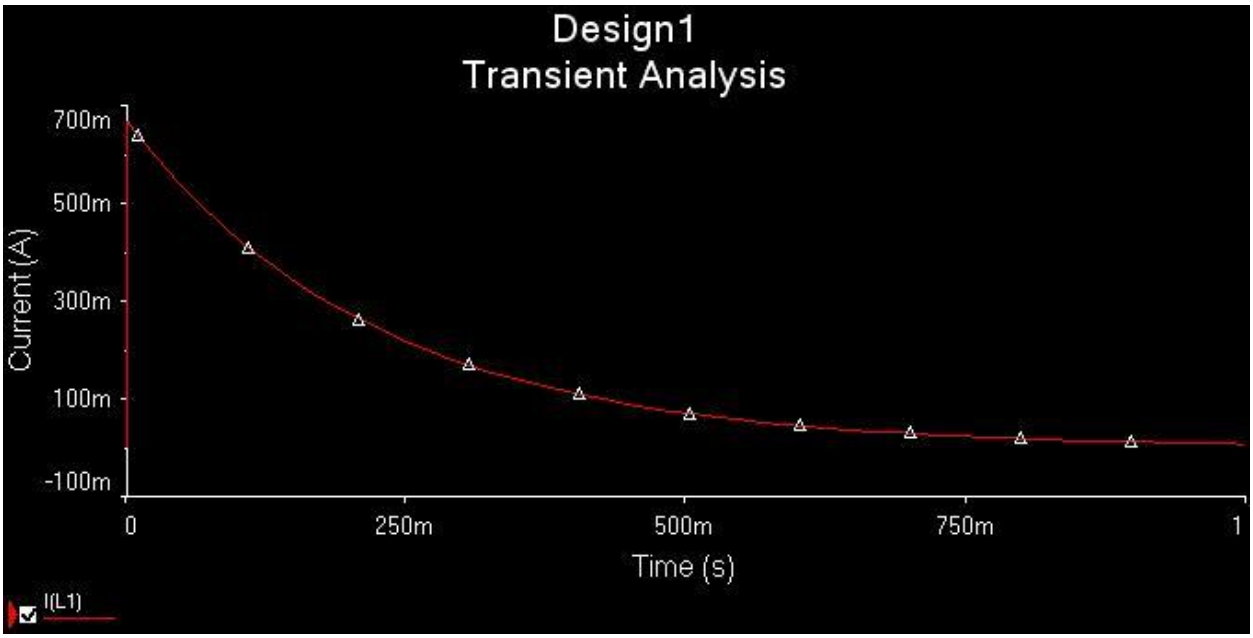
At t = 0-



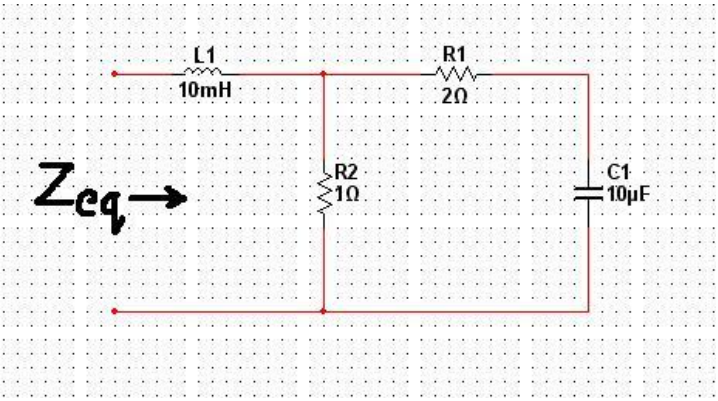
At t = infinity



Final result:



<u>Problem 2</u>: Find the equivalent input impedance assuming a frequency of 60 Hz



$$Z_L = jwL = j(377)(10*10e^{(-3)}) = j3.77ohms$$

$$Z_C = -j/wL = -j(1/(377)(10*10e^{(-3)})) = -j265.25ohms$$

C1 is in series with R1:

$$-j265.25+2 = 2-265.25johms$$

(C1 + R1) is parallel with R2:

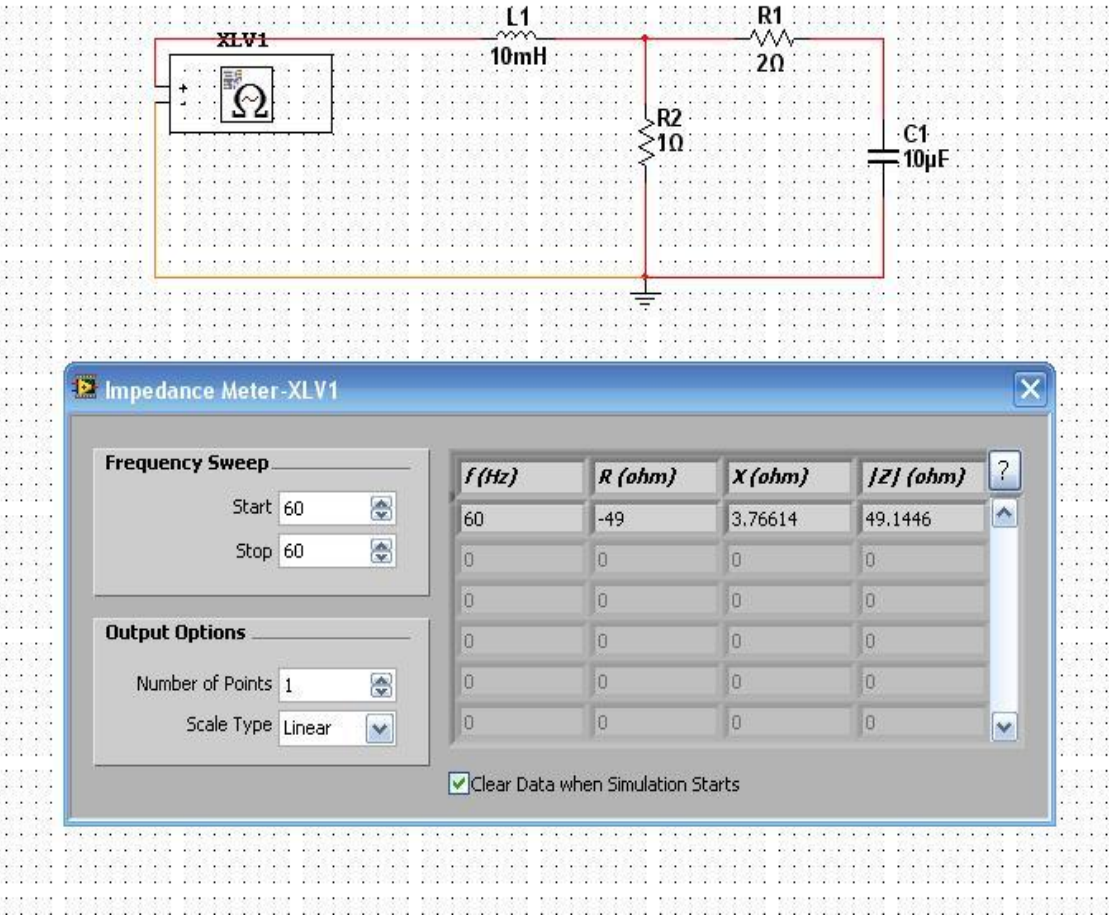
$$2-j265.25 \| 1 = 1-j0.0038ohms$$

((C1 + R1) || R2) is in series with L1:

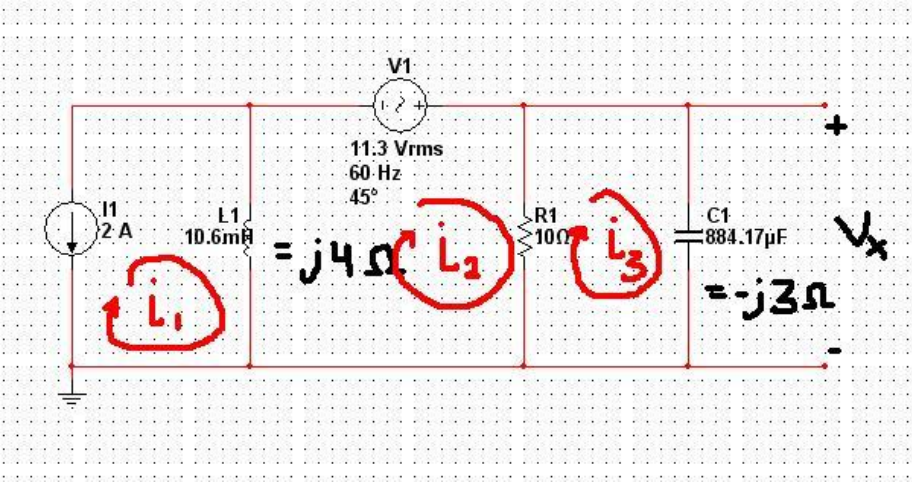
$$1-j0.0038+j3.77 = 1+j3.77ohms$$

$$Z_{eq} = 1+j3.77ohms$$

Multisim Result for equivalent Impedance:



Problem 3: Find Vx



Do KVL:

$$i_1 = -2A$$

$$j4i_2 - j4i_1 + 10i_2 - 10i_3 = 8 + j8$$
$$-j4i_1 + (10 + j4)i_2 - 10i_3 = 8 + j8$$
$$(10 + j4)i_2 - 10i_3 = 8$$

$$10i_3 - 10i_2 - j3i_3 = 0$$
$$-10i_2 + (10 - j3)i_3 = 0$$

Use Matlab to solve for i2 and i3.

$$i_2 = 2.95 - j4.46A$$
$$i_3 = 3.93 - j3.28A$$

Now that we have i3, we can compute Vx using Ohm's Law.

$$V_x = i_3(-j3) = -9.83 - j11.79V$$

Multisim Result for Vx

(Assuming a frequency of 60 Hz and omega of 377)