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Exam 3 Rework

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





Do KVL

$$\begin{array}{c} 12i_1\!+\!6i_1\!-\!6i_2\!=\!0\\ 3i_1\!-\!i_2\!=\!0 \end{array}$$

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

 $-i_1 + 2i_2 - i_3 = 1$

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

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

Use Matlab to find i1, i2, and i3.

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

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.



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

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

Now we can combine everything to get the final answer.

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

Multisim Result for iL(t):

At t = 0-



At t = infinity



Final result:



Problem 2: 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:

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

(C1 + R1) is parallel with R2:

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

((C1 + R1) || R2) is in series with L1: $1 - j0.0038 + j3.77 = 1 + j3.77 o\,h\,m\,s$

 $Z_{eq} \!=\! 1 \!+\! j 3.77 ohms$

Multisim Result for equivalent Impedance:

XLV1		1.1.1.1.1.1.1.1			:::
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				C1 ==10μF	
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					:::
					
Impedance Meter-XLV1					
Frequency Sween	1		-	1	-
Trequency Sweep	f (Hz)	R (ohm)	X (ohm)	Z (ohm)	1
Start 60 🚖	60	-49	3.76614	49.1446	
Stop 60 😪	0	0	0	0	
-	0	0	0	0	
		0	0	0	1
Output Options	U	U	0		
Output Options Number of Points 1	0	0	0	0	
Output Options Number of Points Scale Type			0	0	~
Output Options Number of Points Scale Type Linear	0 0 0 VClear Data	0 0 when Simulation S	0 0 tarts	0	~

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)

