Feedback — RLC Circuit Exercises

You submitted this homework on **Wed 3 Apr 2013 2:06 PM CDT -0500**. You got a score of **0.00** out of **9.00**. You can attempt again, if you'd like.

Question 1

Checking units of expressions is an important way of achieving correct answers for impedances. The "secret" is to note that R, Ls and $\frac{1}{Cs}$ all have units of ohms (Ω). What are the units of $RLCs^2$?

Your Answer	Score	Explanation
siemens (Ω^{-1})		
ohms		
dimensionless		
Total	0.00 / 1.00	

Question Explanation

LCs^2 is dimensionless, making $RLCs^2$ have units of ohms.

Question 2

Is this expression correct: $LCs^2 + R$?

Your Answer	Score	Explanation
No		
Yes		

Total	0.00 / 1.00

Question Explanation

No. LCs^2 is dimensionless and R has units of ohms.

Question 3

Can the following answer be correct?

$$Z = \frac{R_1 R_2 Cs + R_3}{LCs^2 + RCs + 1}$$

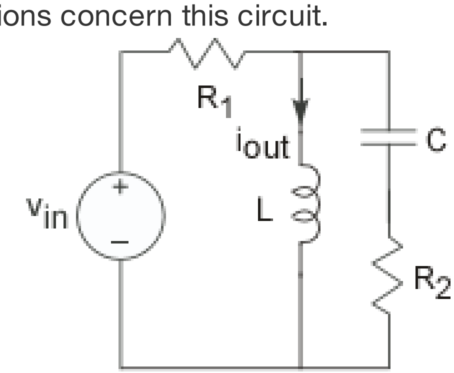
Your Answer	Score	Explanation
No		
Yes		
Total	0.00 / 1.00	

Question Explanation

Numerator has units of ohms and the denominator is dimensionless. So, yes!

Question 4

The following two questions concern this circuit.



What is the impedance of the circuit the voltage source "sees"?

Express your answer in terms of $s = j2\pi f$. Use `R1`, `R1`, `L`, `C` for the element values, R_1, R_2, L and C. For example, if

$$Z = \left.\frac{R_1LCs^2 + R_1R_2Cs + 2R_2}{LCs^2 + R_1Cs}\right|_{s=j2\pi f}$$ is your answer, type

`(R1*L*C*s^2+R1*R2*C*s+2*R2)/(L*C*s^2+R1*C*s)`. Because the expression is complicated, check units!

You entered:

Preview Help

Your Answer		Score	Explanation
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Total		0.00 / 1.00	

Question Explanation

$$Z = R_1 + Ls || \left(\frac{1}{Cs} + R_2\right) = \frac{(R_1 + R_2)LCs^2 + (R_1R_2C + L)s + R_1}{LCs^2 + R_2Cs + 1}$$

Question 5

Find the transfer function between the complex amplitude V_{in} of the source and the output current's complex amplitude I_{out}.

Express your answer in terms of $s = j2\pi f$. For example, if

$$\frac{I_{\text{out}}}{V_{\text{in}}} = \left.\frac{LCs^2 + R_1Cs}{R_1LCs^2 + R_1R_2Cs + 2R_2}\right|_{s=j2\pi f}$$ is your answer, type

`(L*C*s^2+R1*C*s)/(R1*L*C*s^2+R1*R2*C*s+2*R2)`. Because the expression is complicated, check units!

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Your Answer	Score	Explanation
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Total	0.00 / 1.00	

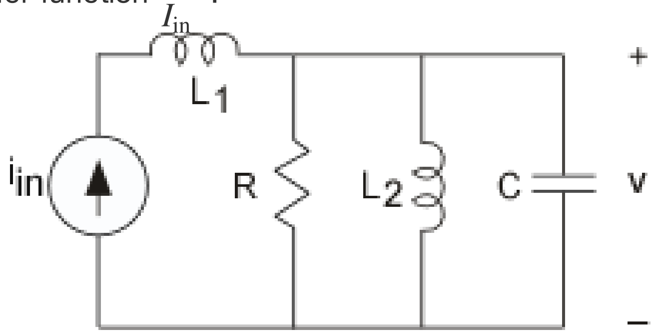
Question Explanation

We can use voltage divider to find the voltage across the inductor-RC combination, then divide by the impedance of the inductor to find the current we need.

$$I_{\text{out}} = V_{\text{in}} \cdot \frac{Ls \| \left(R_2 + \frac{1}{Cs}\right)}{R_1 + Ls \| \left(R_2 + \frac{1}{Cs}\right)} \cdot \frac{1}{Ls} = V_{\text{in}} \cdot \frac{R_2 Cs + 1}{(R_1 + R_2)LCs^2 + (R_1 R_2 C + L)s + R_1}$$

Question 6

What is the transfer function $\frac{V}{I_{\text{in}}}$?



Express your answer in terms of $s = j2\pi f$. Represent the element values R, L_1, L_2 and C by `R`, `L1`, `L2` and `C` respectively.

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Your Answer	Score	Explanation
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Total	0.00 / 1.00	

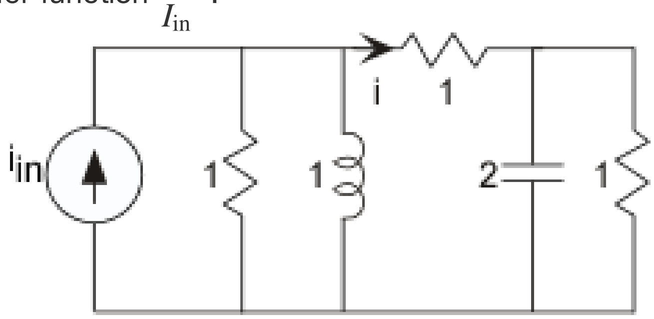
Question Explanation

Because the inductor L_1 is in series with the current source, it does not affect the behavior of the circuit. That leaves an RLC parallel combination. To find the voltage, we simply need the impedance. This impedance is the transfer function we seek.

$$Z = R \| L_2 s \| \frac{1}{Cs} = \frac{1}{\frac{1}{R} + \frac{1}{L_2 s} + Cs} = \frac{RL_2 s}{RL_2 C s^2 + L_2 s + R}$$

Question 7

What is the transfer function $\frac{I}{I_{\text{in}}}$?



Express your answer in terms of $s = j2\pi f$.

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Your Answer	Score	Explanation
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Total	0.00 / 1.00	

Question Explanation

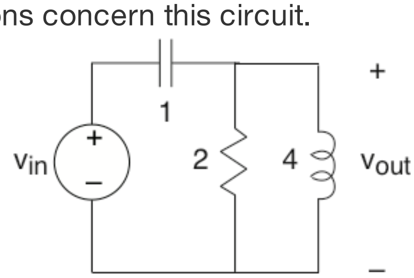
Perhaps the simplest approach is to use current divider expressed in terms of *admittance* Y. The admittance for an element is defined to be the reciprocal of impedance, just as conductance is the reciprocal of resistance. Here,

$$I = \frac{\frac{1}{1+1\|\frac{1}{2s}}}{1+\frac{1}{s}+\frac{1}{1+1\|\frac{1}{2s}}} \cdot I_{\text{in}}$$

The term $\frac{1}{1+1\|\frac{1}{2s}}$ equals $\frac{2s+1}{2s+2}$. Consequently, the transfer function is $\frac{\frac{2s+1}{2s+2}}{1+\frac{1}{s}+\frac{2s+1}{2s+2}} = \frac{s(2s+1)}{4s^2+5s+2}$.

Question 8

The following two questions concern this circuit.



Find the transfer function between the source and the indicated voltage.

Express your answer in terms of $s = j2\pi f$.

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Your Answer	Score	Explanation
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Total	0.00 / 1.00	

Question Explanation

Using voltage divider, we have $\dfrac{2\|4s}{\frac{1}{s}+2\|4s} = \dfrac{8s^2}{8s^2+4s+2} = \dfrac{4s^2}{4s^2+2s+1}$.

Question 9

When the source is $v_{\text{in}}(t) = 10\sin\left(\frac{t}{2}\right)$, what is the output voltage $v(t)$?

Express your answer as a sinusoid: if $4\sin(2\pi t + \pi/4)$ is your answer, enter it as `4*sin(2*pi*t+pi/4)`.

You entered:

Preview Help

Your Answer		Score	Explanation
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Total		0.00 / 1.00	

Question Explanation

The frequency of the source is $\dfrac{1}{2\pi \cdot 2}$, making $s = j/2$. Substituting this result into the transfer function, we have

$$\left.\frac{4s^2}{4s^2+2s+1}\right|_{s=j/2} = \frac{4\cdot\left(-\frac{1}{4}\right)}{4\cdot\left(-\frac{1}{4}\right)+2\left(\frac{j}{2}\right)+1} = \frac{-1}{-1+j+1} = -\frac{1}{j} = j$$

Expressing the source as $\text{Im}[10e^{jt/2}]$, the output is given by $\text{Im}[10je^{jt/2}] = 10\cos\left(\frac{t}{2}\right)$.