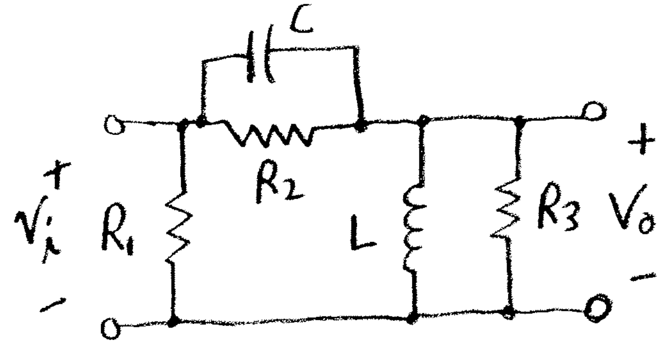
4. Determine the transfer function $H(\omega) = V_o(\omega)/V_i(\omega)$ for the given using voltage division, current division, and/or Ohm's law. Do not simplify the expression. If needed, the symbol for two elements in parallel (e.g., $R_s \| R_L$) may be used.

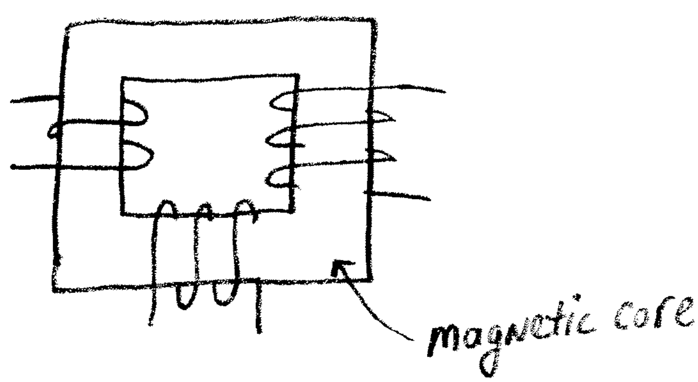


5. Determine the magnitude of the given transfer function as done in class.

$$H(\omega) = \frac{\frac{1}{j\omega C}}{R + (j\omega L // R)} \quad \text{or} \quad \frac{\frac{L}{C} - \frac{jR}{\omega C}}{R^2 + j2\omega LR}$$

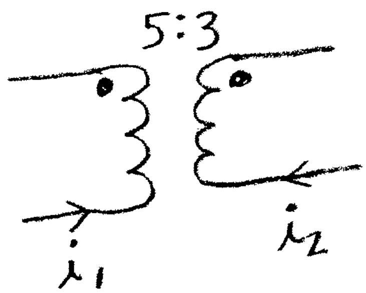
$$\frac{\frac{1}{j\omega C}}{R + \frac{j\omega LR}{j\omega L + R}} = \frac{\frac{j\omega L + R}{j\omega C}}{j\omega LR + R^2 + j\omega LR} = \frac{j\omega L + R}{-\omega^2 LCR + j\omega CR^2 - \omega^2 LCR}$$

6. The physical construction of several coupled coils is shown. Carefully redraw this diagram on the solution sheet and then show one possible location for the dot marking on each coil. Clearly show the direction of the flux in the magnetic material if current is injected into each dot.

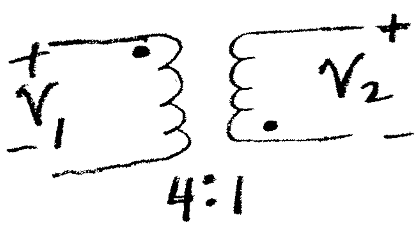


7. Name one property of ideal transformers, excluding the voltage, current, and impedance transformation relationships.

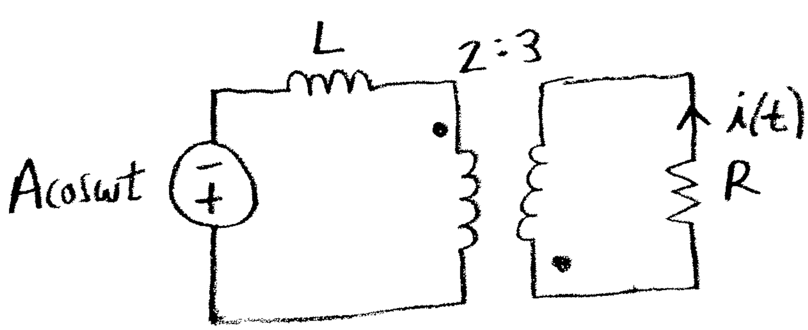
8. Determine the relationship between i_2 and i_1 (as a function of the turns ratio) for the following ideal transformer operating in sinusoidal steady state.



9. Determine the relationship between v_2 and v_1 (as a function of the turns ratio) for the following ideal transformer operating in sinusoidal steady state.

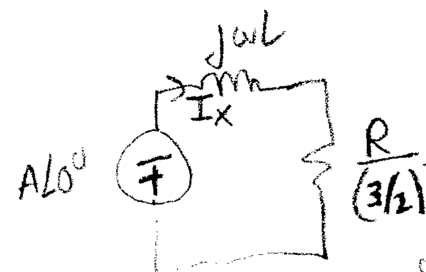


10. For the following circuit involving an ideal transformer, determine $i(t)$ (in the time domain).



$$\frac{I}{I_X} = \frac{2}{3}$$

$$I_X = \frac{2}{3} I_X$$



$$I_X = \frac{-A\angle 0^\circ}{j\omega L + \frac{R}{(3/2)^2}}$$

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Signature:

24 pts total

Answer Sheet (Provide Units)

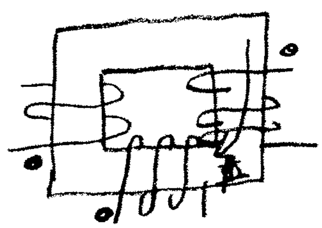
1 1. $\frac{1}{2\pi\sqrt{15}}$ Hz

1 2. R

2 3. LPF

2 4. $\frac{(j\omega L \parallel R_3)}{(j\omega L \parallel R_3) + (R_2 \parallel \frac{1}{j\omega C})}$

3 5. $\frac{\sqrt{(\omega L)^2 + R^2}}{\sqrt{(-2\omega^2 LCR)^2 + (\omega C R^2)^2}}$ OR $\frac{\sqrt{\left(\frac{L}{C}\right)^2 + \left(\frac{-R}{\omega C}\right)^2}}{\sqrt{(R^2)^2 + (2\omega L R)^2}}$

1 6. 

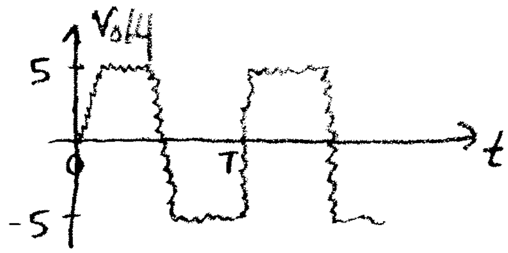
1 7. No leakage flux

1 8. $\frac{i_2}{i_1} = -\frac{5}{3}$

1 9. $\frac{V_2}{V_1} = \frac{-1}{4}$

4 10. $\frac{-2A}{3} \frac{1}{\sqrt{(\omega L)^2 + \left(\frac{R}{(3/4)^2}\right)^2}} \cos\left(\omega t - \tan^{-1}\left(\frac{\omega L}{R/(3/4)^2}\right)\right)$ A

1 11. infinite input resistance



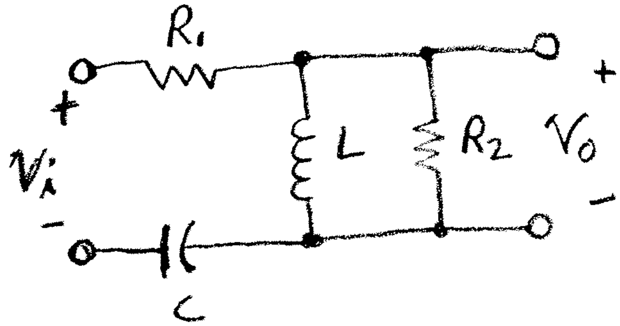
$\omega = 2\pi f = \frac{2\pi}{T}$

$T = \frac{2\pi}{\omega}$

2 12.

4 13. $\frac{-R_1}{j\omega L\left(R_1 + \frac{1}{j\omega C}\right)} = \frac{-R_1 C}{L(j\omega C R_1 + 1)}$

4. Determine the transfer function $H(\omega) = V_o(\omega)/V_i(\omega)$ for the given using voltage division, current division, and/or Ohm's law. Do not simplify the expression. If needed, the symbol for two elements in parallel (e.g., $R_s \| R_L$) may be used.



5. Determine the magnitude of the given transfer function as done in class.

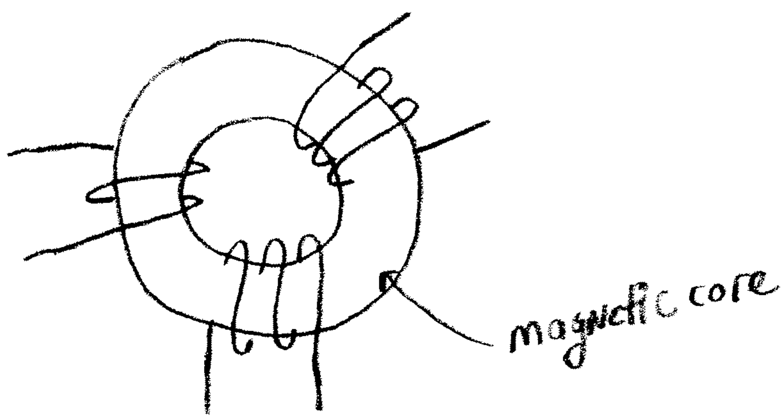
$$H(\omega) = \frac{(j\omega L // R)}{\frac{1}{j\omega C} + R} \quad \text{OR} \quad \frac{j\omega LR}{\frac{L}{C} - \frac{jR}{\omega C} + j\omega LR + R^2}$$

FASTER OR

$$\frac{\omega LR}{\sqrt{(\omega L)^2 + R^2}\sqrt{\left(\frac{1}{\omega C}\right)^2 + R^2}}$$

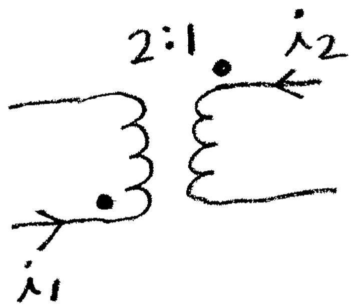
$$\frac{\frac{j\omega LR}{j\omega L + R}}{\frac{1}{j\omega C} + R} = \frac{j\omega LR}{\frac{j\omega L + R}{j\omega C} + j\omega LR + R^2} = \frac{-\omega^2 LCR}{j\omega L + R - \omega^2 LCR + j\omega R^2 C}$$

6. The physical construction of several coupled coils is shown. Carefully redraw this diagram on the solution sheet and then show one possible location for the dot marking on each coil. Clearly show the direction of the flux in the magnetic material if current is injected into each dot.

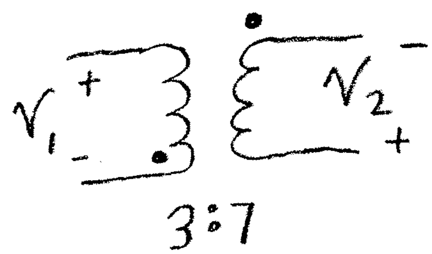


7. Name one property of ideal transformers, excluding the voltage, current, and impedance transformation relationships.

8. Determine the relationship between i_2 and i_1 (as a function of the turns ratio) for the following ideal transformer operating in sinusoidal steady state.

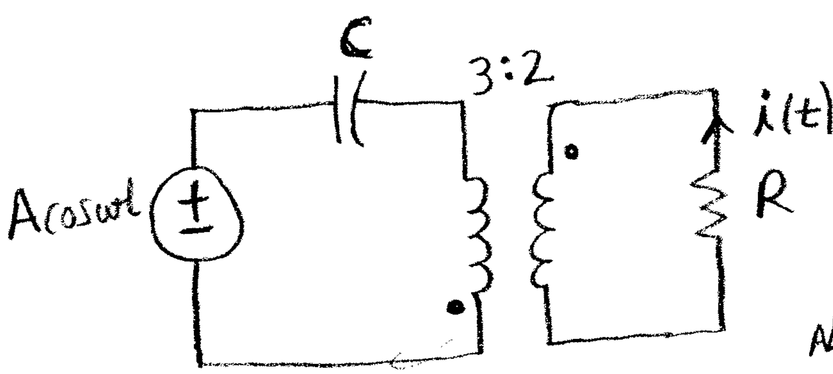


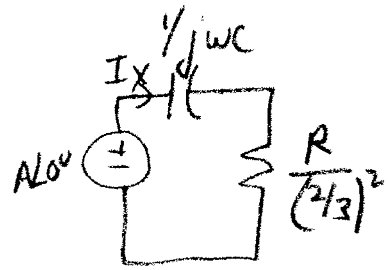
9. Determine the relationship between v_2 and v_1 (as a function of the turns ratio) for the following ideal transformer operating in sinusoidal steady state.



10. For the following circuit involving an ideal transformer, determine *i*(*t*) (in the time domain).

$$\frac{I}{I_x} = \frac{3}{2}$$





$$I = \frac{3}{2}\,\frac{A}{\frac{1}{j\omega C} + \frac{R}{(2/3)^2}}$$

$$I_x = \frac{A\angle 0^\circ}{\frac{1}{j\omega C} + \frac{R}{(2/3)^2}}$$

Printed Name: SOLN

24 pts total

Signature: ____________________

Answer Sheet (Provide Units)

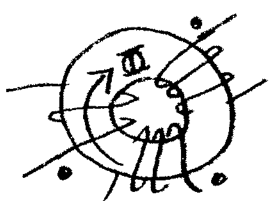
1   1. $\frac{1}{2\pi\sqrt{28}}$ Hz

1   2. R

2   3. BRF

2   4. $\frac{(j\omega L // R_2)}{(j\omega L // R_2) + R_1 + \frac{1}{j\omega C}}$

3   5. $\frac{\sqrt{(-\omega^2 LCR)^2}}{\sqrt{(R-\omega^2 LCR)^2 + (\omega L + \omega R^2 C)^2}}$ OR $\frac{\omega LR}{\sqrt{\left(\frac{L}{C}+R^2\right)^2 + \left(\omega LR - \frac{R}{\omega C}\right)^2}}$



1   6.

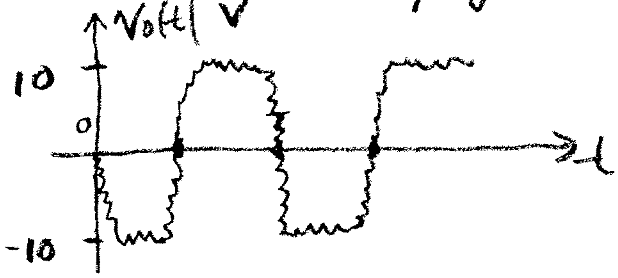
1   7. zero leakage flux

1   8. $\frac{i_2}{i_1} = \frac{-2}{1}$

1 9. $\frac{V_2}{V_1} = \frac{7}{3}$

4 10. $\left(\frac{3}{2}A \Big/ \sqrt{\left(\frac{-1}{\omega C}\right)^2 + \left(\frac{R}{(2/3)^2}\right)^2}\right) \cos\left(\omega t - \tan^{-1} \frac{-1/\omega C}{R/(2/3)^2}\right)$ A

1 11. infinite open-loop gain ✓



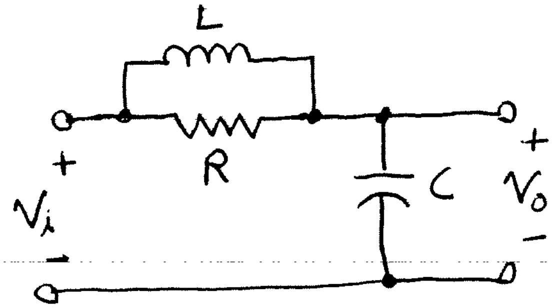
$\omega = 2\pi f = 2\pi/T$

$T = 2\pi/\omega$

2 12.

4 13. $\frac{j\omega L}{R_2(j\omega L + R_1)}$

4. Determine the transfer function $H(\omega) = V_o(\omega)/V_i(\omega)$ for the given using voltage division, current division, and/or Ohm's law. Do not simplify the expression. If needed, the symbol for two elements in parallel (e.g., $R_s \| R_L$) may be used.

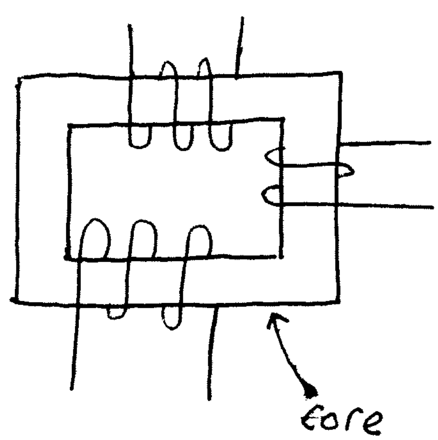


5. Determine the magnitude of the given transfer function as done in class.

$$H(\omega) = \frac{R}{R + \left(j\omega L \middle\| \frac{1}{j\omega C} \right)}$$

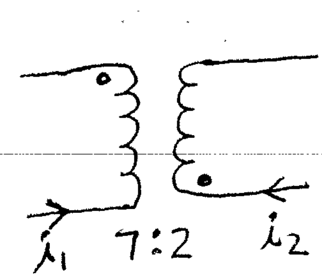
$$\frac{R}{R + \frac{j\omega L \frac{1}{j\omega C}}{j\omega L + \frac{1}{j\omega C}}} = \frac{R}{R + \frac{j\omega L}{-\omega^2 LC + 1}} = \frac{R(1-\omega^2 LC)}{R(1-\omega^2 LC) + j\omega L}$$

6. The physical construction of several coupled coils is shown. Carefully redraw this diagram on the solution sheet and then show one possible location for the dot marking on each coil. Clearly show the direction of the flux in the magnetic material if current is injected into each dot.

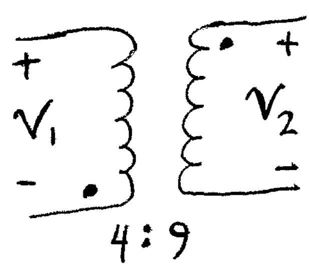


7. Name one property of ideal transformers, excluding the voltage, current, and impedance transformation relationships.

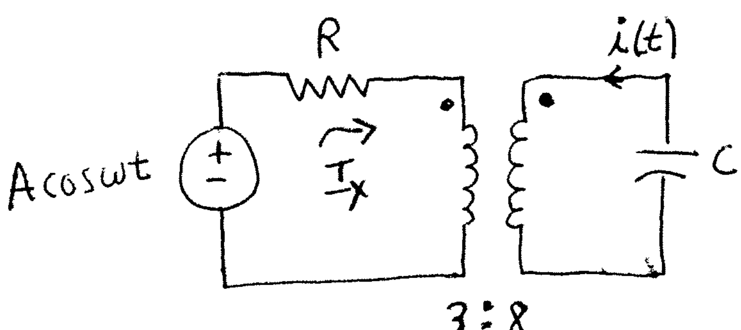
8. Determine the relationship between i_2 and i_1 (as a function of the turns ratio) for the following ideal transformer operating in sinusoidal steady state.



9. Determine the relationship between v_2 and v_1 (as a function of the turns ratio) for the following ideal transformer operating in sinusoidal steady state.



10. For the following circuit involving an ideal transformer, determine $i(t)$ (in the time domain).



$$\frac{i}{i_x} = \frac{-3}{8}$$

$$i = -\frac{3}{8} i_x$$

$$I_x = \frac{A\angle 0^\circ}{R + \frac{1}{j\omega C} / \left(\frac{8}{3}\right)^2} = \frac{A\angle 0^\circ \, j\omega C}{\frac{9}{64} + j\omega RC}$$

OR

$$I_x = \frac{A\angle 0^\circ}{R - \frac{j}{\omega C} / \left(\frac{8}{3}\right)^2}$$

$$i_x(t) = \frac{A\omega C}{\sqrt{\left(\frac{9}{64}\right)^2 + (\omega RC)^2}} \cos\left(\omega t + 90 - \tan^{-1} \frac{\omega RC}{9/64}\right)$$

$$i_x(t) = \frac{A}{\sqrt{R^2 + \left(\frac{9}{64\omega C}\right)^2}} \cos\left(\omega t - \tan^{-1} \frac{9}{64 \omega C R}\right)$$

22 pts total

Printed Name: SOLUTION

Signature: ______________________

Answer Sheet (Provide Units)

1 1. $\frac{1}{\sqrt{18}}$ rad/sec or $\frac{1}{2\pi\sqrt{18}}$ Hz

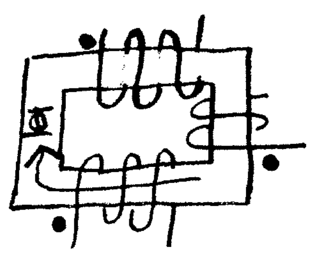
1 2. R

2 3. BRF

2 4. $\dfrac{\frac{1}{j\omega C}}{\frac{1}{j\omega C} + (R // j\omega L)}$

2 5. $\dfrac{|R(1-\omega^2 LC)|}{\sqrt{[R(1-\omega^2 LC)]^2 + (\omega L)^2}}$

1 6.



1 7. No leakage flux, infinite permeability, No R losses, ...

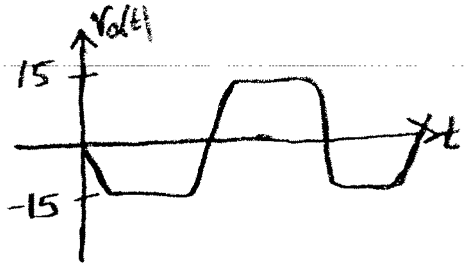
1 8. $\frac{i_2}{i_1} = +\frac{7}{2}$

1 9. $\frac{V_2}{V_1} = \frac{-9}{4}$

3 10. $-\frac{3}{8}\frac{A\omega C}{\left(\frac{9}{64}\right)^2+(\omega RC)^2}\cos\left(\omega t + 90^\circ - \tan^{-1}\frac{\omega RC}{9/64}\right)$

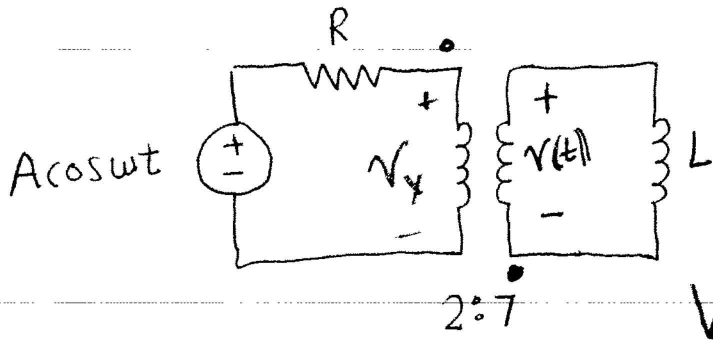
1 11. infinite input resistance, zero input current, zero input Δ, ...

2 12.



4 13. $\frac{V_o}{V_i} = \frac{1-j\omega RC}{1+j\omega RC} = \frac{2}{1+j\omega RC} - 1$

16. For the following circuit involving an ideal transformer, determine $v(t)$ (in the time domain).



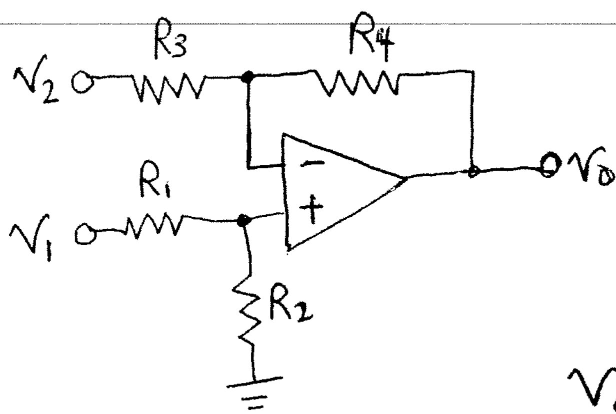
$$\frac{V}{V_x} = -\frac{7}{2}$$

$$V = -\frac{7}{2} V_x$$

$$V_x = A \times \frac{j\omega L / (7/2)^2}{[j\omega L / (7/2)] + R}$$

$$V_x(t) = \frac{A \times \frac{4}{49}\omega L}{\sqrt{R^2 + \left(\frac{\omega L 4}{49}\right)^2}} \cos\left(\omega t + 90^\circ - \tan^{-1}\frac{\frac{\omega L 4}{49}}{R}\right)$$

17. For the following circuit involving an ideal-op, determine the relationship for V_o as a function of V_1, V_2, and the R's



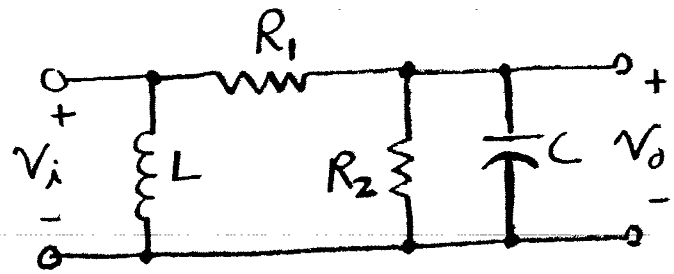
$$V_o = V_1 \frac{R_2}{R_1 + R_2}\left(1 + \frac{R_4}{R_3}\right) - V_2\left(\frac{R_4}{R_3}\right)$$

2 15. $$\frac{R}{\sqrt{1+(\omega RC)^2}\sqrt{R^2+\left(\omega L-\frac{1}{\omega C}\right)^2}}$$

2 16. $$-\frac{7}{2}\,\frac{A\frac{4}{49}\omega L}{\sqrt{R^2+\left(\frac{\omega L4}{49}\right)^2}}\cos\left(\omega t+90^\circ-\tan^{-1}\frac{\frac{\omega L4}{49}}{R}\right)\ V$$

3 17. $$v_0 = v_1\frac{R_2}{R_1+R_2}\left(1+\frac{R_4}{R_3}\right)-v_2\left(\frac{R_4}{R_3}\right)$$

4. Determine the transfer function $H(\omega) = V_o(\omega)/V_i(\omega)$ for the given using voltage division, current division, and/or Ohm's law. Do not simplify the expression. If needed, the symbol for two elements in parallel (e.g., $R_s \| R_L$) may be used.

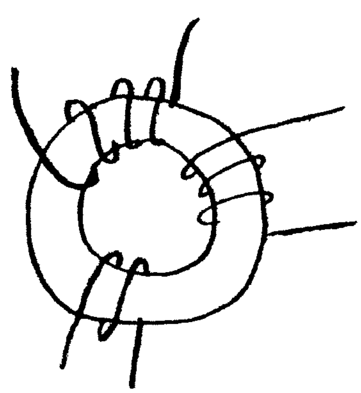


5. Determine the magnitude of the given transfer function as done in class.

$$H(\omega) = \frac{R + \frac{1}{j\omega C}}{R + (j\omega L \| R)}$$

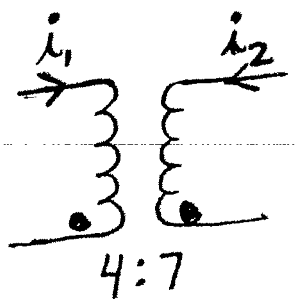
$$\frac{R + \frac{1}{j\omega C}}{R + \frac{j\omega L R}{R + j\omega L}} = \frac{(R + j\omega L)(R - \frac{j}{\omega C})}{R^2 + j\omega L R + j\omega L R}$$

6. The physical construction of several coupled coils is shown. Carefully redraw this diagram on the solution sheet and then show one possible location for the dot marking on each coil. Clearly show the direction of the flux in the magnetic material if current is injected into each dot.

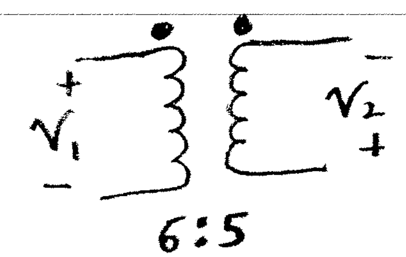


7. Name one property of ideal transformers, excluding the voltage, current, and impedance transformation relationships.

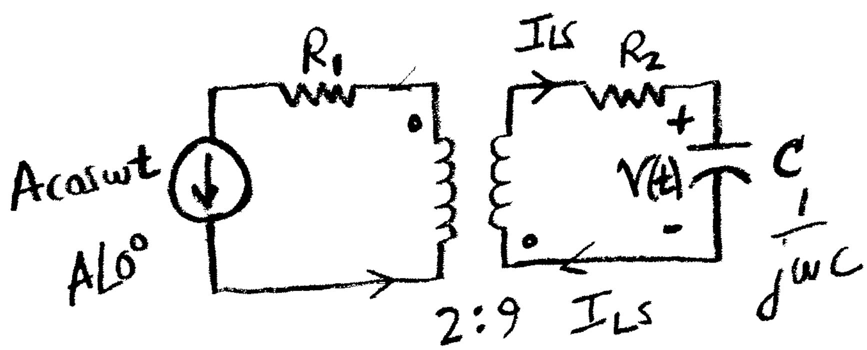
8. Determine the relationship between i_2 and i_1 (as a function of the turns ratio) for the following ideal transformer operating in sinusoidal steady state.



9. Determine the relationship between v_2 and v_1 (as a function of the turns ratio) for the following ideal transformer operating in sinusoidal steady state.



10. For the following circuit involving an ideal transformer, determine ~~i(t)~~ $v(t)$ (in the time domain).



$I_{LS} = \frac{2}{9} A\angle 0^\circ$

$\frac{I_{LS}}{A\angle 0^\circ} = \frac{2}{9}$

$V_s = I_{LS} \frac{1}{j\omega C} = \frac{2}{9} A \frac{1}{\omega C\angle 90^\circ}$

25 pts total

Printed Name: SOLN

Signature: ____________________

Answer Sheet (Provide Units)

1 1. $\frac{1}{\sqrt{10}}$ rad/s

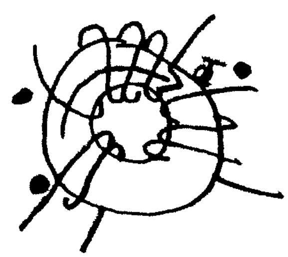
1 2. R

2 3. BRF

3 4. $\dfrac{\frac{1}{j\omega C} \| R_2}{\left(\frac{1}{j\omega C} \| R_2\right) + R_1}$

3 5. $\dfrac{\sqrt{R^2 + (\omega L)^2}\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}}{\sqrt{(R^2)^2 + (2\omega L R)^2}}$

1 6.



1 7. infinite permeability of core

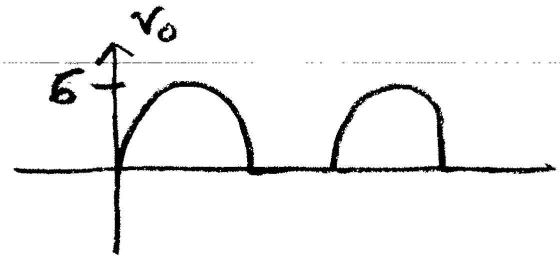
1 8. $i_2 / i_1 = -4/7$

1 9. $v_2/v_1 = -5/6$

3 10. $v(t) = \frac{2}{9}\frac{A}{\omega C}\cos(\omega t - 90°)$ V

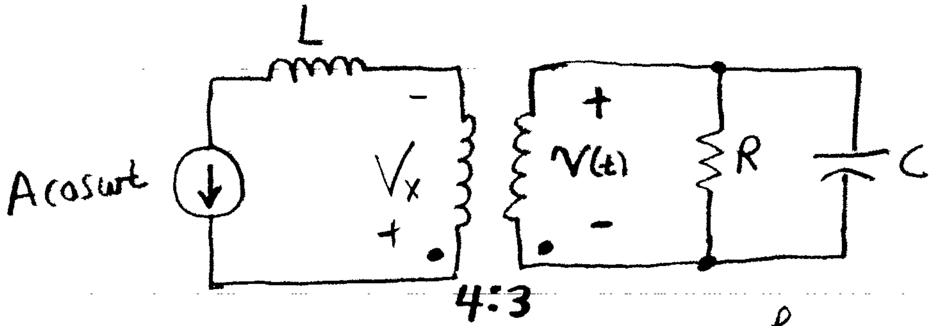
1 11. $V_- - V_+ = 0$ with feedback

2 12.



5 13. $\frac{I_2}{V_i} = \frac{1}{R_1 R_2}\left(\frac{1}{j\omega C} \| R_2\right) = \frac{1}{R_1}\frac{1}{1+j\omega C R_2}$

16. For the following circuit involving an ideal transformer, determine $v(t)$ (in the time domain).



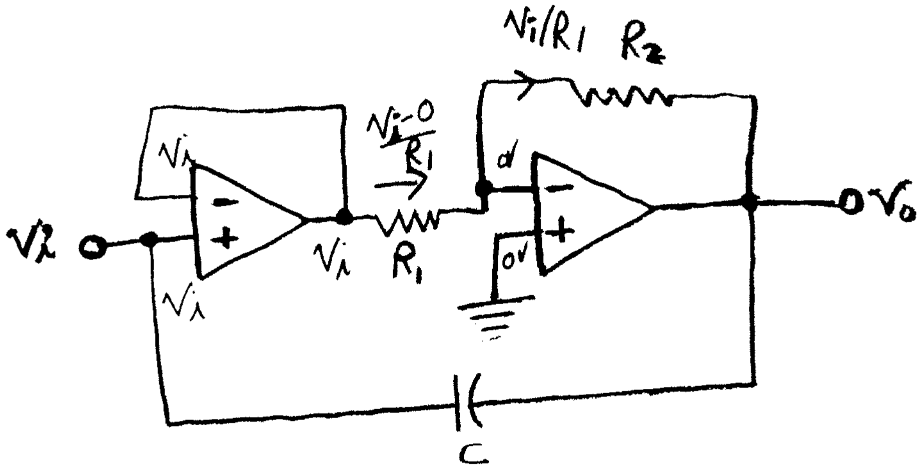
$$R \| \frac{1}{j\omega C} = \frac{R\frac{1}{j\omega C}}{R+\frac{1}{j\omega C}} = \frac{R}{1+j\omega RC}$$

$$V_X = (A\angle 0^\circ)\frac{\frac{R}{1+j\omega RC}}{(3/4)^2}$$

$$V/V_X = -3/4$$

$$V = -\frac{3}{4}V_X = -A\frac{R}{1+j\omega RC}\left(\frac{4}{3}\right)$$

17. For the following circuit involving ideal-ops, determine the relationship $\frac{V_o(\omega)}{V_i(\omega)}$



$$0 + \frac{V_i}{R_1}R_2 + V_o = 0$$

$$\frac{V_o}{V_i} = -\frac{R_2}{R_1}$$

$$\frac{R\omega L}{\frac{\sqrt{R^2+(\omega L)^2}}{\sqrt{R^2+\left(\frac{1}{\omega C}\right)^2}}}$$

3 15. $\frac{\omega LR}{\sqrt{R^2+(\omega L)^2}\sqrt{R^2+\left(\frac{1}{\omega C}\right)^2}}$, $\frac{\omega LR}{\sqrt{\left(R^2+\frac{L}{C}\right)^2+\left(\omega LR-\frac{R}{\omega C}\right)^2}}$

5 16. $-\frac{4R}{3}\frac{1}{\sqrt{1+(\omega RC)^2}}\cos(\omega t-\tan^{-1}\omega RC)$

3 17. $\frac{V_0}{V_i}=\frac{-R_2}{R_1}$