EE212 Test 4

The weighting of each problem is not necessarily the same.

Test Instructions:

1. This is a closed book, closed notes examination. No additional tables, including integral tables, may be used.
2. Calculators, computers, and other electronic computational devices are not permitted.
3. You may work in the test booklet.
4. Provide only your final solutions on the test answer sheet.
5. Provide units on all answers.
6. The length of the examination is 2 hours.
7. For the final grade, only the answers on the answer sheet will be graded.
8. These problems are graded right or wrong. (In most cases, there is no partial credit.) If multiple solutions or intermediate work are provided, the solution is considered incorrect. Use parenthesis when needed.

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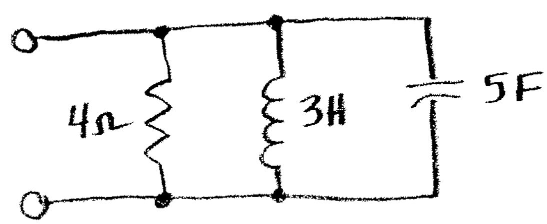
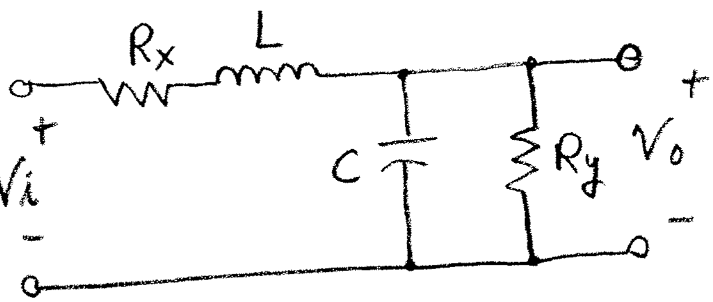
1. What is the resonant frequency for the circuit shown below?



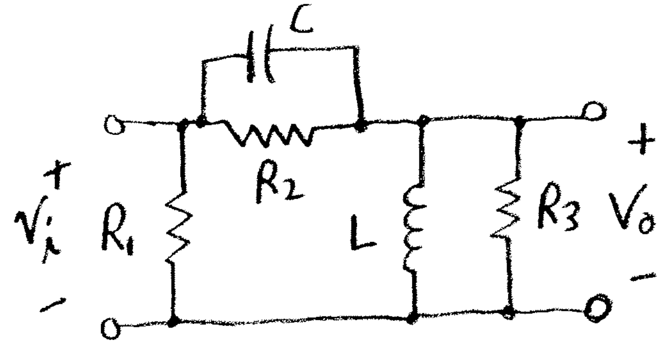
UNITS NEEDED

2. What is the impedance of a ~~parallel~~ series *RLC* circuit at resonance?

3. Is the following filter most nearly a LPF, HPF, BPF, or BRF?



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.

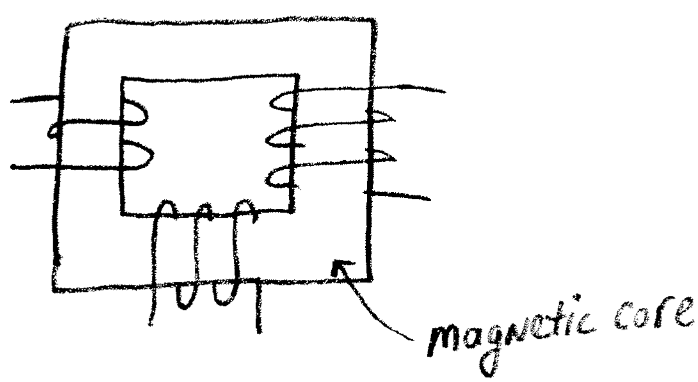


5. Determine the magnitude of the given transfer function as done in class.

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

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

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.



Printed Name: SOLN

Signature: ____________________

24 pts total

Answer Sheet (Provide Units)

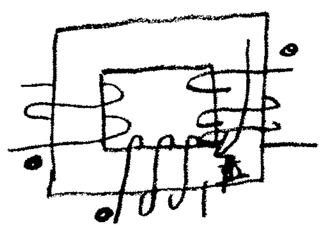
1 | 1. $\frac{1}{2\pi\sqrt{15}}$ Hz

1 | 2. R

2 | 3. LPF

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

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

1 | 6. 

1 | 7. No leakage flux

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

EE212 Test 4

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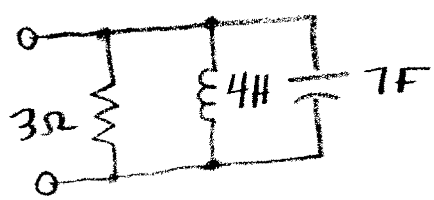
---

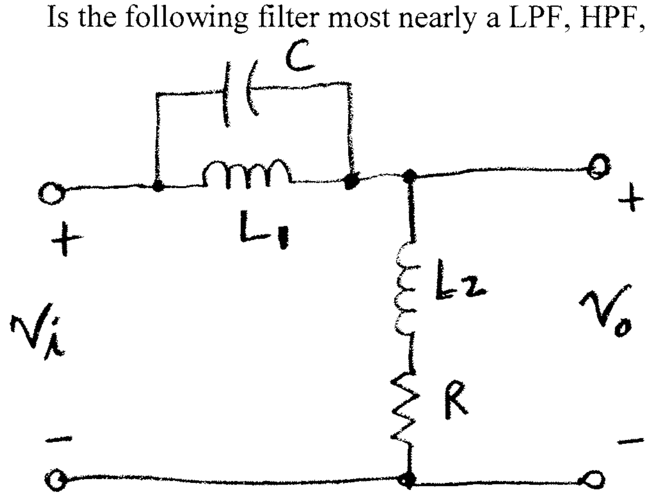
1. What is the resonant frequency for the circuit shown below?



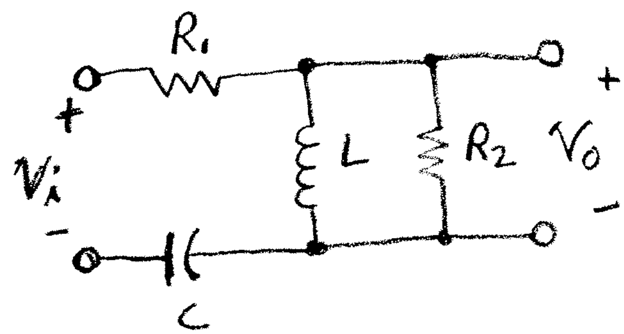
UNITS NEEDED

2. What is the impedance of a ~~parallel~~ series *RLC* circuit at resonance?

3. Is the following filter most nearly a LPF, HPF, BPF, or BRF?



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.

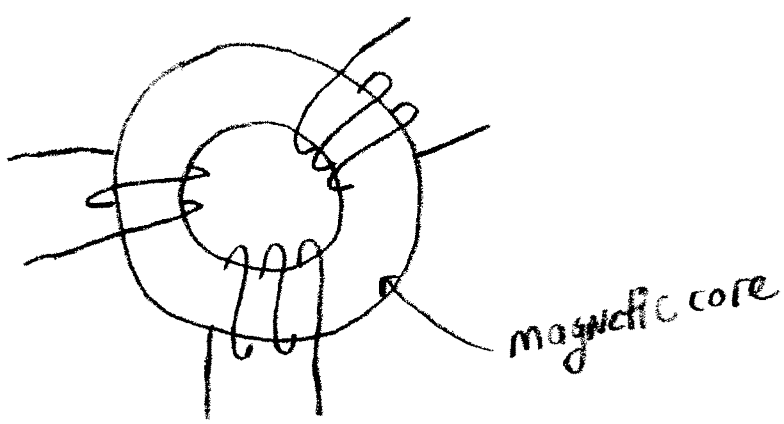
$$H(\omega) = \frac{(j\omega L // R)}{\frac{1}{j\omega C} + R} \quad \text{OR} \quad \frac{j\omega L R}{\frac{L}{C} - \frac{jR}{\omega C} + j\omega L R + R^2}$$

FASTER OR

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

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

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.



Printed Name: SOLN   24 pts total

Signature: ____________________

Answer Sheet (Provide Units)

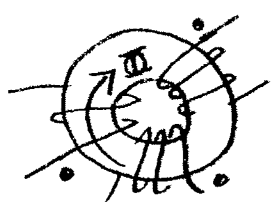
1   1. $\frac{1}{2\pi\sqrt{28}}$ Hz

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

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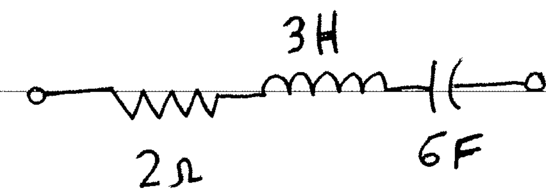
---

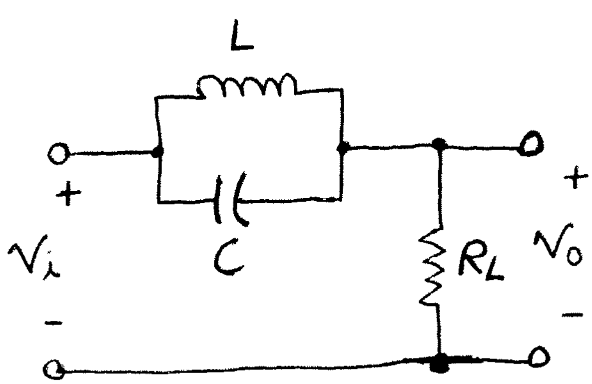
1. What is the resonant frequency for the circuit shown below?



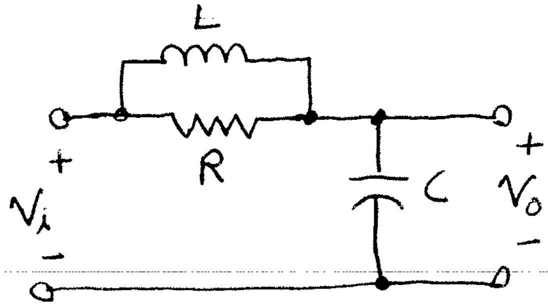
UNITS NEEDED

2. What is the impedance of a series *RLC* circuit at resonance?

3. Is the following filter most nearly a LPF, HPF, BPF, or BRF?



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.

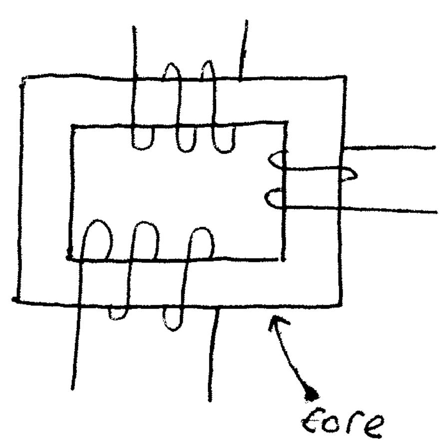


5. Determine the magnitude of the given transfer function as done in class.

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

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

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.



Printed Name: SOLUTION

22 pts total

Signature: ____________________

Answer Sheet (Provide Units)

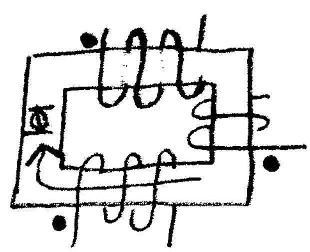
1 1. $\frac{1}{\sqrt{18}}$ rad/sec or $\frac{1}{2\pi\sqrt{18}}$ Hz

1 2. R

2 3. BRF

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

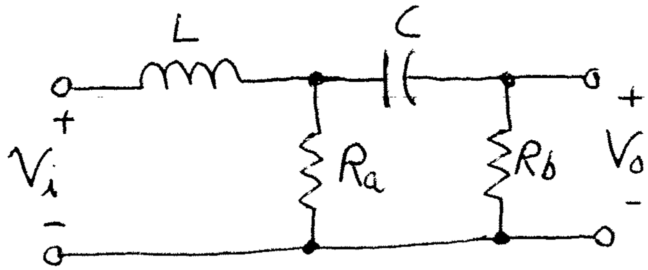
2 5. $\dfrac{|R(1-\omega^2 LC)|}{\sqrt{[R(1-\omega^2 LC)]^2 + (\omega L)^2}}$

1 6. 

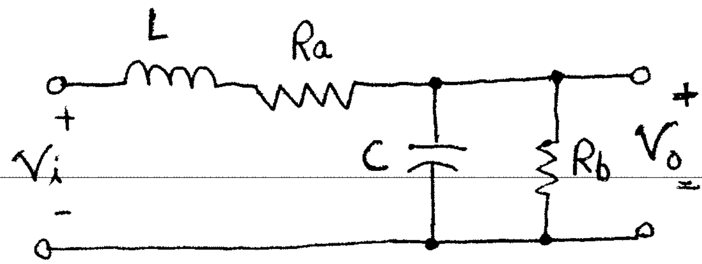
1 7. No leakage flux, infinite permeability, No R losses, ...

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

13. Is the following filter most nearly a LPF, HPF, BPF, or BRF?



14. 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.



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

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

$$= \frac{\frac{R}{1+j\omega RC}}{R+\frac{1}{j\omega C}+j\omega L} = \frac{R}{(1+j\omega RC)\left(R+j\left(\omega L-\frac{1}{\omega C}\right)\right)}$$

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

2 7. $\frac{A}{R+j\omega L} + B \times \frac{R}{R+j\omega L}$

$V_3 - 0 = -A \quad , \quad \frac{V_4-0}{j\omega L} + \frac{V_4-V_3}{R_b} = 0$

$\frac{V_2-V_3}{1/j\omega L} - B = 0 \quad , \quad \frac{V_1-0}{R_a} + B = 0$

2 8.

$I_1 = -B$

1 9. $R_b I_2 + j\omega L (I_2 + I_1) + \frac{1}{j\omega C} I_2 - A = 0$

2 10. $S = \frac{j72}{5^2+8^2}$ VA

2 11. $\cos\left[\tan^{-1}\left(\frac{-1}{2}\right) - \tan^{-1}\left(\frac{-1}{5}\right)\right]$

1 12. $4\sqrt{3}\angle -90^\circ$ Vrms

1 13. BPF

1 14. $\frac{R_b // \frac{1}{j\omega C}}{\left(R_b // \frac{1}{j\omega C}\right) + R_a + j\omega L}$

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

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

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

EE212 Test 4

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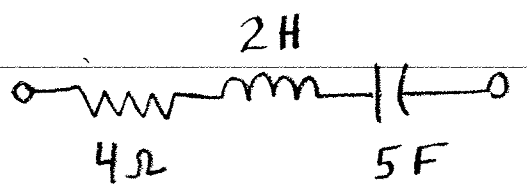
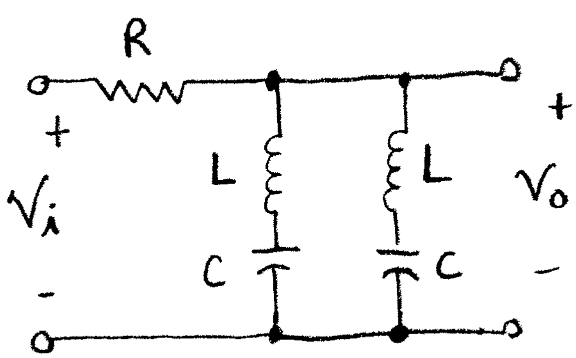
---

1. What is the resonant frequency for the circuit shown below?

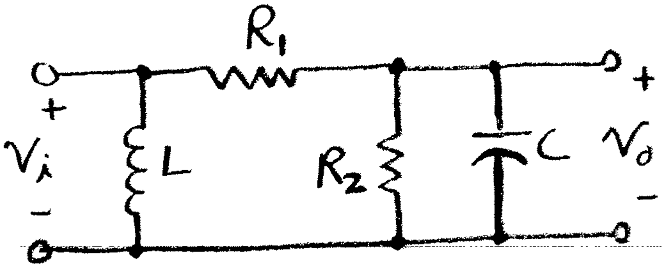


2. What is the impedance of a parallel *RLC* circuit at resonance?

3. Is the following filter most nearly a LPF, HPF, BPF, or BRF?



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.

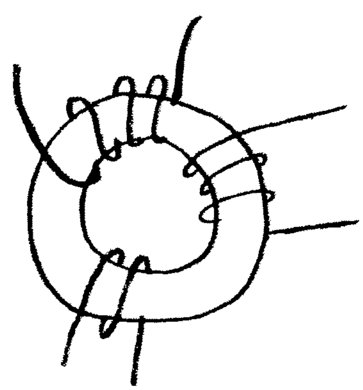


5. Determine the magnitude of the given transfer function as done in class.

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

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

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.



25 pts total

Printed Name: SOLN

Signature: ______________________

Answer Sheet (Provide Units)

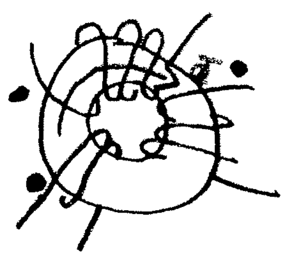
1 1. $\frac{1}{\sqrt{10}}$ rad/s

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

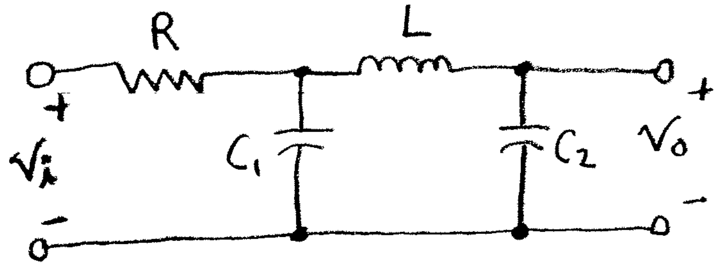


1 6. ______________________

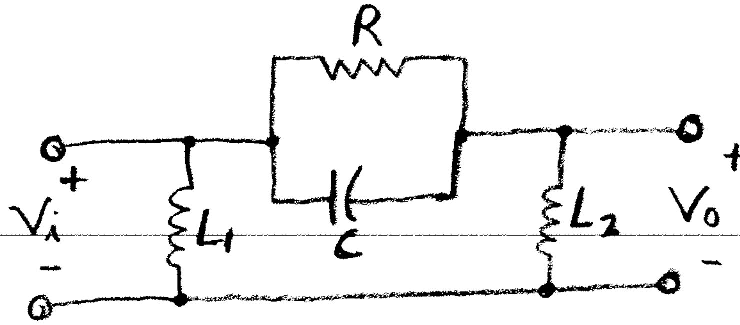
1 7. infinite permeability of core

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

13. Is the following filter most nearly a LPF, HPF, BPF, or BRF?



14. 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.



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

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

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

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

4 7. $-B\angle 0^\circ \times \frac{1/j\omega C}{R+\frac{1}{j\omega C}} + \frac{A\angle 0^\circ}{R+\frac{1}{j\omega C}}$

(1) $V_1 - V_2 = A\angle 0^\circ$

(2) $\frac{V_3-0}{j\omega L} + \frac{V_3-0}{R_b} - B\angle 0^\circ + \frac{V_3-V_2}{R_a} = 0$

(3) $\frac{V_2-V_3}{R_a} + \frac{V_1-0}{1/j\omega C} = 0$

3 8.

(1) $R_a I_1 - A\angle 0^\circ + I_1 \frac{1}{j\omega C} + (I_2+I_3)R_b = 0$ OR $-I_3 j\omega L$

(2) $I_1 - I_2 = B\angle 0^\circ$

(3) $I_3 j\omega L + (I_2+I_3)R_b = 0$

3 9.

4 10. $\frac{256}{\sqrt{32}}\angle 45^\circ = \frac{256}{\sqrt{32}}\left(\frac{1}{\sqrt{2}}+\frac{j}{\sqrt{2}}\right)$ VA, $\cos 45^\circ = 1/\sqrt{2}$, $\sin 45^\circ = 1/\sqrt{2}$

$\sqrt{32}\sqrt{2} = \sqrt{16\cdot 2}\sqrt{2} = 4\cdot 2 = 8$

3 11. $\cos\left(\tan^{-1}\frac{-12/11}{7}\right)$

2 12. $2\sqrt{3}\angle 90^\circ$ V

1 13. LPF

2 14. $\frac{j\omega L_2}{j\omega L_2 + (R \parallel \frac{1}{j\omega C})}$

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

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

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

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