ECE 2210 Homework 2ndTr1

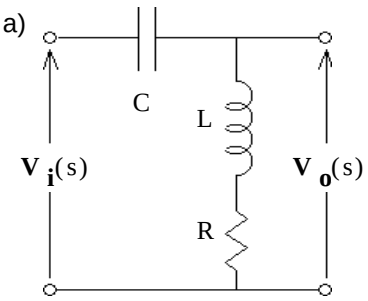
2nd - Order Transients Name_____

Due: Sat, 10/28/23

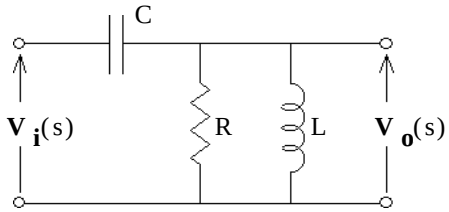
A.Stolp
c

1. Find the transfer function $\mathbf{H}(s) = \frac{\mathbf{V_o}(s)}{\mathbf{V_i}(s)}$ for these circuits.
   Write $\mathbf{H}(s)$ in the normal form: $\mathbf{H}(s) = K \cdot \frac{s^n + k_1 \cdot s^{n-1} + \cdots + k_{n-1}}{s^m + c_1 \cdot s^{m-1} + \cdots + c_{m-1}}$

a)



b)



2. Write the characteristic equation for each of the circuits in problem 2.

a) b)

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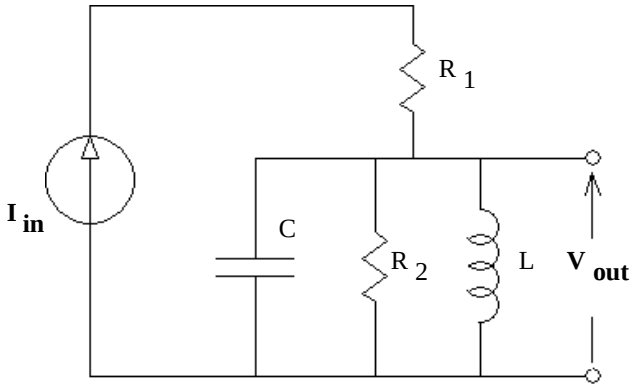
3. a) Find the s-type transfer function of the circuit shown. $\mathbf{I_{in}}$ is the input and $\mathbf{V_{out}}$ is the "output".

   You MUST show work to get credit. Simplify your expression for $\mathbf{H}(s)$ so that it is a ratio of simple polynomials just like my examples.

   a) $\mathbf{H}(s)$ = ?



b) Find the solutions to the characteristic equation and express them in terms of the circuit parts.

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Answers

1.a) $\mathbf{H}(s) = \dfrac{s^2 + \frac{R}{L}\cdot s}{s^2 + \frac{R}{L}\cdot s + \frac{1}{L\cdot C}}$ b) $\mathbf{H}(s) = \dfrac{s^2}{s^2 + \frac{1}{C\cdot R}\cdot s + \frac{1}{L\cdot C}}$

2.a) $0 = s^2 + \frac{R}{L}\cdot s + \frac{1}{L\cdot C}$ b) $0 = s^2 + \frac{1}{C\cdot R}\cdot s + \frac{1}{L\cdot C}$

3.a) $\dfrac{\frac{1}{C}\cdot s}{s^2 + \frac{1}{C\cdot R_2}\cdot s + \frac{1}{C\cdot L}}$

3.b) $-\frac{1}{2\cdot C\cdot R_2} \pm \frac{1}{2}\cdot\sqrt{\left(\frac{1}{C\cdot R_2}\right)^2 - 4\cdot\frac{1}{C\cdot L}}$

4.a) $\dfrac{240\cdot\Omega\cdot s^2 + 2\cdot 10^5\cdot\frac{\Omega}{\text{sec}}\cdot s + 1.2\cdot 10^{10}\cdot\frac{\Omega}{\text{sec}^2}}{s^2 + 5\cdot 10^7\cdot\frac{1}{\text{sec}^2}}$

b) $240\cdot\Omega$

c) $240\cdot\Omega$

d) $\dfrac{\frac{1}{240\cdot\Omega}\cdot s^2 + 2.083\cdot 10^5\cdot\frac{1}{\Omega\cdot\text{sec}^2}}{s^2 + 833.333\cdot\frac{1}{\text{sec}}\cdot s + 5\cdot 10^7\cdot\frac{1}{\text{sec}^2}}$

e) underdamped

f) R 0.1·A L 0·A C 0.1·A

g) R 0.1·A L 0.1·A C 0·A

solutions to char. eq.

$-417 + 7059\cdot j$ 1/sec

$-417 - 7059\cdot j$ 1/sec

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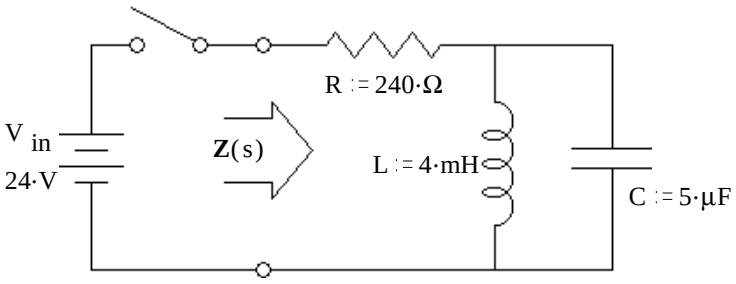
4. For the circuit shown, with a disconnected source:
   a) Find the generalized impedance of the circuit, **Z**(s). (This is just the equivalent impedance of R, L & C.)



   b) What is the impedance at **s** = 0 ? (DC)

   c) What is the impedance at **s** = ∞ ? (infinite frequency)

d) When the switch is closed, current will begin to flow. The voltage source is the input and the current through R can be considered the "output" (i.e. caused by the input). Find the transfer function of the circuit and the s-solutions to the characteristic equation.

e) What is the character of the response? i) undamped **ii) underdamped** iii) critically damped iv) overdamped

f) Find the initial values of all three currents.

g) Find the final values of all three currents

Answers on page 2