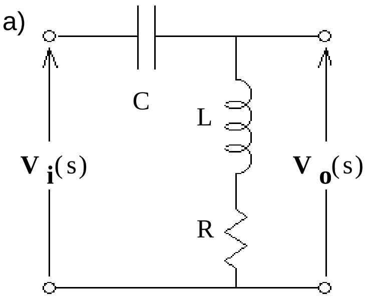
ECE 2210   Homework 2ndTr1 A.Stolp

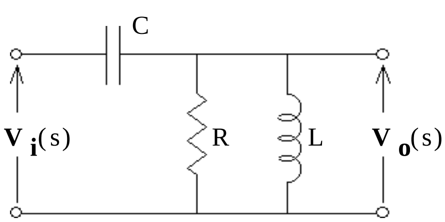
2nd - Order Transients   Name________________________________ c

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: $\mathbf{H}(\mathbf{s}) = K\cdot\frac{s^n + k_1\cdot s^{n-1} + \cdots + k_{n-1}}{s^m + c_1\cdot s^{m-1} + \cdots + c_{m-1}}$

a)



b)



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

a) b)

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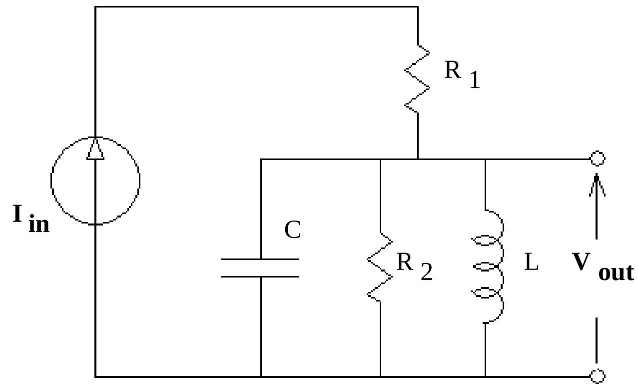
3. a) Find the s-type transfer function of the circuit shown. $\mathbf{I}_{in}$ is the input and $\mathbf{V}_{out}$ is the "output".

You <u>MUST</u> 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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<u>Answers</u>

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

2.a) $0 = s^2 + \dfrac{R}{L}\cdot s + \dfrac{1}{L\cdot C}$ b) $0 = s^2 + \dfrac{1}{C\cdot R}\cdot s + \dfrac{1}{L\cdot C}$ **(1p1)**

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

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

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

b) $240\cdot\Omega$

c) $240\cdot\Omega$

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

e) underdamped

f) R $0.1\cdot A$ L $0\cdot A$ C $0.1\cdot A$

g) R $0.1\cdot A$ L $0.1\cdot A$ C $0\cdot A$

solutions to char. eq.

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

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

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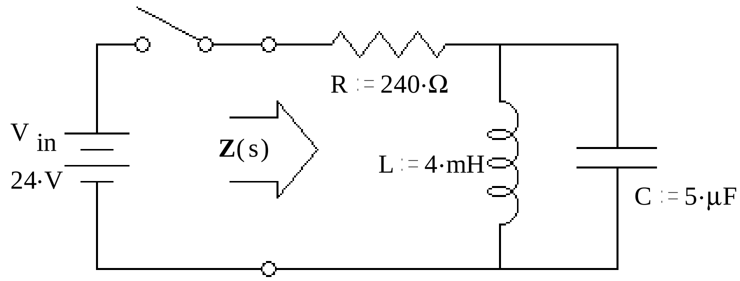
4. For the circuit shown, with a disconnected source:
   a) Find the generalized impedance of the circuit, $\mathbf{Z}(s)$.
      (This is just the equivalent impedance of R, L & C.)



   b) What is the impedance at $\mathbf{s} = 0$? (DC)

   c) What is the impedance at $\mathbf{s} = \infty$? (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