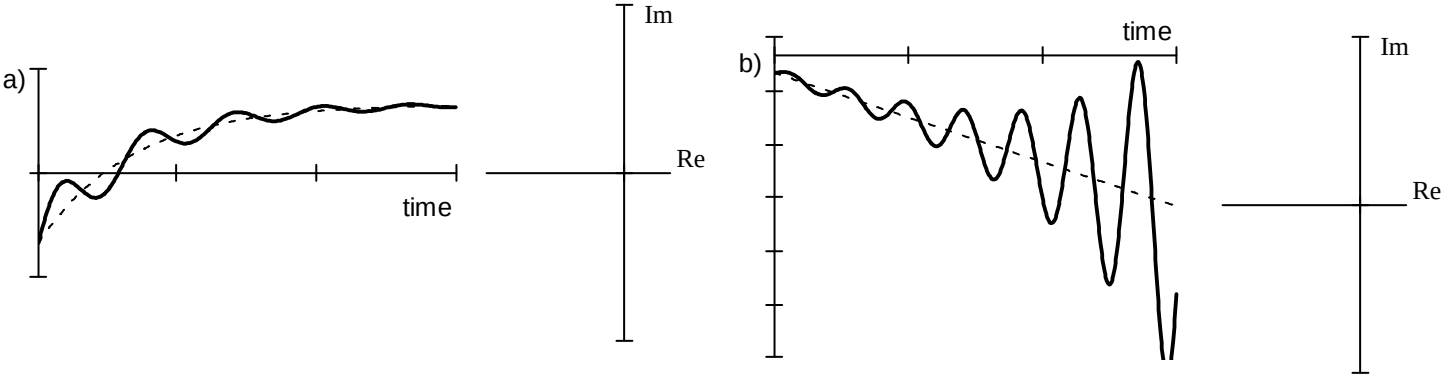
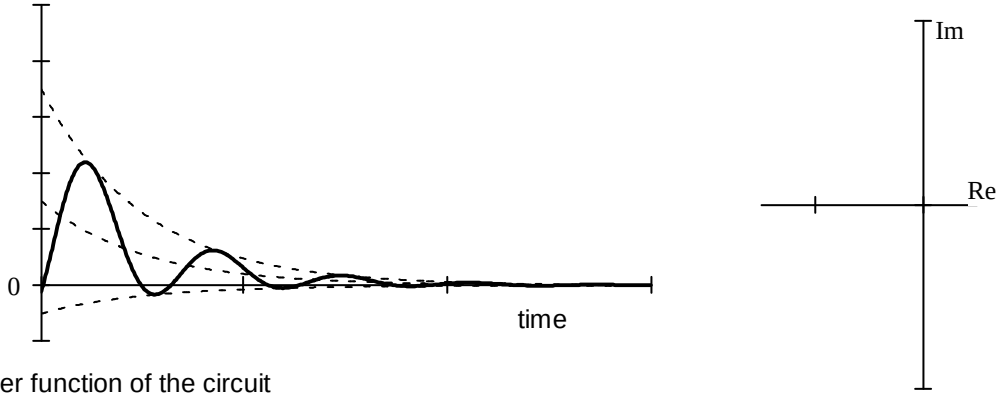
# ECE 3510 Exam 1 given: Spring 18

(Most of the space between problems has been removed.)

1. (13 pts) For each of the time-domain signals shown, draw the poles of the signal's Laplace transform on the axes provided. All time scales are the same. The axes below all have the same scaling. Your answers should make sense relative to one another. Clearly indicate double poles if there are any.

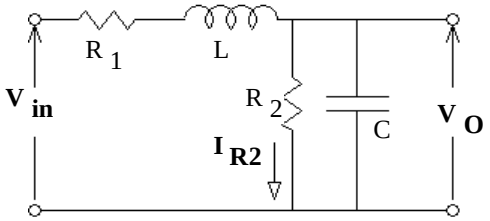



2. (7 pts) The time-domain signal shown below is the **step response** of a **SYSTEM**, draw the poles and/or zeros of the **system's** transfer function on the axes provided.




3. (22 pts) a) Find the s-type transfer function of the circuit shown. Consider $\mathbf{V_{in}}$ as the input and $\mathbf{V_O}$ as the output.

   You MUST show work to get credit. Simplify your expression for H(s) so that the denominator is a simple polynomial with no coefficient before the highest-order s term in the denominator.




$$\mathbf{H_1}(s) = \frac{\mathbf{V_O}(s)}{\mathbf{V_{in}}(s)}$$

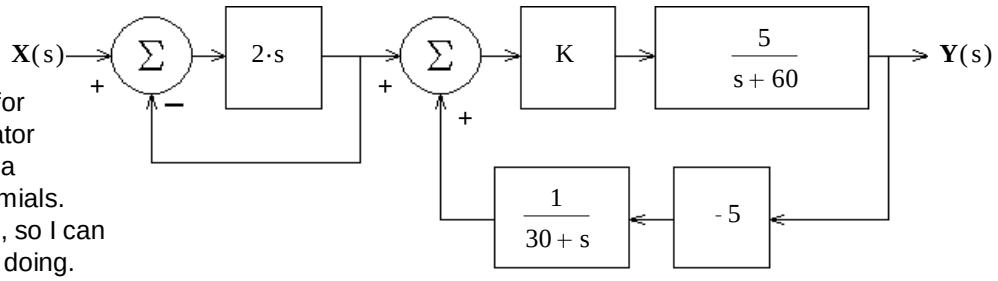
b) Modify the transfer function found in part a). Now consider $\mathbf{I_{R2}}$ as the "output". $\mathbf{H_2}(s) = \dfrac{\mathbf{I_{R2}}(s)}{\mathbf{V_{in}}(s)}$

c) Transfer functions have units based on the units of the output and the units of input. What are the units of $\mathbf{H_2}(s)$

d) What are the units of $\mathbf{H_1}(s)$

4. (22 pts) a) A feedback system is shown in the figure. What is the transfer function of the whole system, with feedback.

$\mathbf{H}(s) = \dfrac{\mathbf{Y}(s)}{\mathbf{X}(s)} = ?$




Simplify your expression for $\mathbf{H}(s)$ so that the denominator is a simple polynomial or a multiple of simple polynomials. Be clear about your signs, so I can tell you know what you're doing.

b) Find the value of $K$ to make the transfer function (or part of it) critically damped.

c) If $K = 205$ , find **all** the poles of this system:

d) Does the transfer function have a zero? Answer no or find the s value(s) of the zero(s).

5 is on next page

6. (10 pts) This system: $H(s) = \dfrac{26}{s+4}$ Has this Cosine input: $x(t) = \cos(6 \cdot t) \cdot u(t)$ $\mathbf{X}(s) = \dfrac{s}{s^2 + \omega_o^2}$

Resulting in this output: $\mathbf{Y}(s) =$

Separate this output into 3 partial fractions that you can find in the laplace transform table. Show what they are above, but don't find the coefficients.

Continue with the partial fraction expansion just far enough to find the **transient** coefficient.

5. (6 pts) A system has this transfer function: $\mathbf{H}(s) = \dfrac{2\cdot(s+18)}{s^2+6\cdot s+12}$

   What is the steady-state response ($y_{ss}(t)$) of this system to the input: $x(t) = \left(8+2\cdot e^{-5\cdot t}\cdot\cos(4\cdot t)\right)\cdot u(t)$

7. (20 pts) The input to a system is: $x(t) = \left(1+0.5\cdot e^{-5\cdot t}\right)\cdot u(t)$

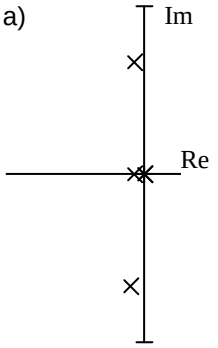
   The output of this system is: $y(t) = \left(3\cdot e^{-5\cdot t} - 2\cdot\cos(4\cdot t)\right)\cdot u(t)$

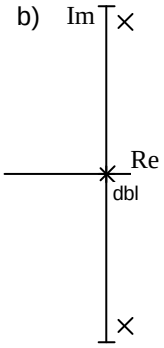
   a) Find system transfer function, $\mathbf{H}(s)$. Simplify into the standard form.

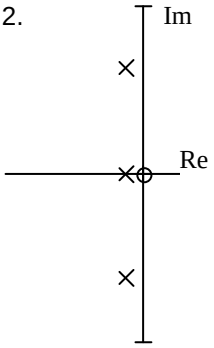
   b) Find the poles of $\mathbf{H}(s)$. NOTE: You can do this even if you can't find $\mathbf{H}(s)$.

   c) Is $\mathbf{H}(s)$ BIBO stable?

**Answers**

1. a) 


b) 


2. 


3. a) $\dfrac{\frac{1}{L\cdot C}}{s^2+\left(\frac{R_1}{L}+\frac{1}{R_2\cdot C}\right)\cdot s+\frac{1}{L\cdot C}\cdot\left(\frac{R_1}{R_2}+1\right)}$

   b) $\dfrac{\frac{1}{L\cdot C\cdot R_2}}{s^2+\left(\frac{R_1}{L}+\frac{1}{R_2\cdot C}\right)\cdot s+\frac{1}{L\cdot C}\cdot\left(\frac{R_1}{R_2}+1\right)} = \dfrac{\mathbf{H_1}(s)}{R_2}$

   c) $\dfrac{1}{\Omega}$ d) none, unitless, or volt/volt

4. a) $\dfrac{10\cdot K\cdot s\cdot(s+30)}{(1+2\cdot s)\cdot\left(s^2+90\cdot s+1800+25\cdot K\right)}$ b) 9 c) $-\dfrac{1}{2}$ $-45+70\cdot j$ $-45-70\cdot j$

5. $24\cdot u(t)$ d) 0 -30

6. $\dfrac{A}{s+4} + \dfrac{B\cdot s}{\left(s^2+6^2\right)} + \dfrac{C\cdot 6}{\left(s^2+6^2\right)}$ $A = -2$

7. a) $\dfrac{\left(s^2-10\cdot s+48\right)\cdot s}{\left(s^2+16\right)\cdot(1.5\cdot s+5)}$ b) $4\cdot j$ $-4\cdot j$ -3.333 c) NO