ECE 3510 Exam 1   given: Spring 17   (The space between problems has been removed.)

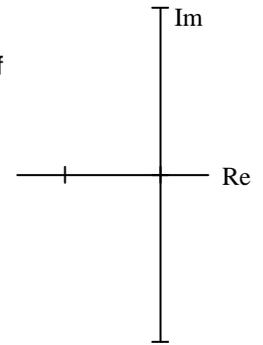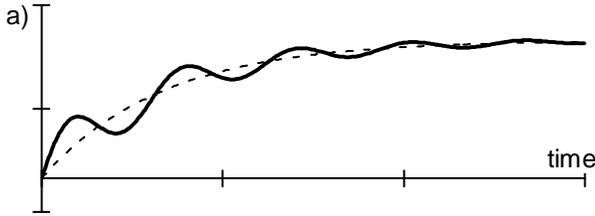1. (12 pts) For each of the time-domain signals shown, draw the poles of the signal's Laplace transform on the axes provided. All time scales are the same. The axes below all have the same scaling. Your answers should make sense relative to one another. Clearly indicate double poles if there are any.

a)

b)
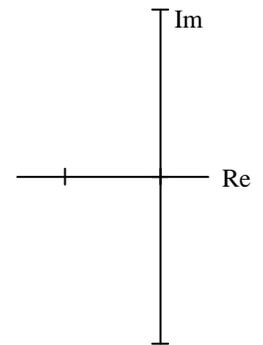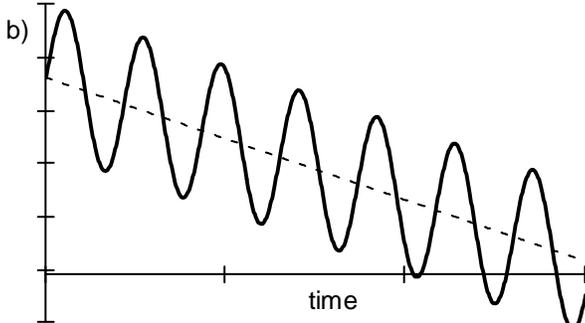
2. (6 pts) The time-domain signal shown below is the **step response** of a **SYSTEM**, draw the poles and/or zeros of the **system's** transfer function on the axes provided.
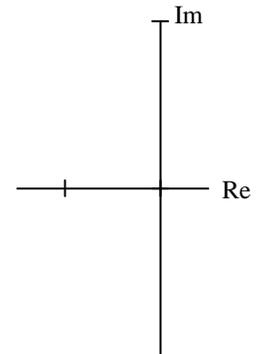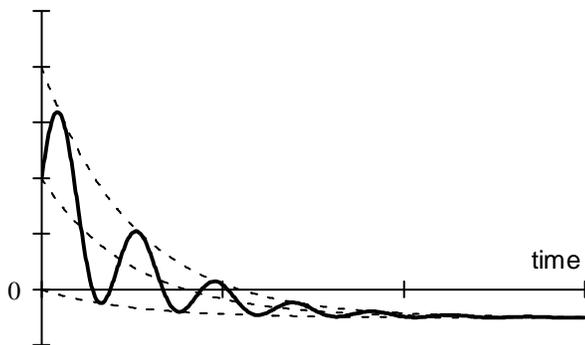
3. (15 pts) a) Find the s-type transfer function of the circuit shown. Consider $\mathbf{I_{in}}$ as the input and $\mathbf{V_C}$ as the "output".

You <u>MUST</u> 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.
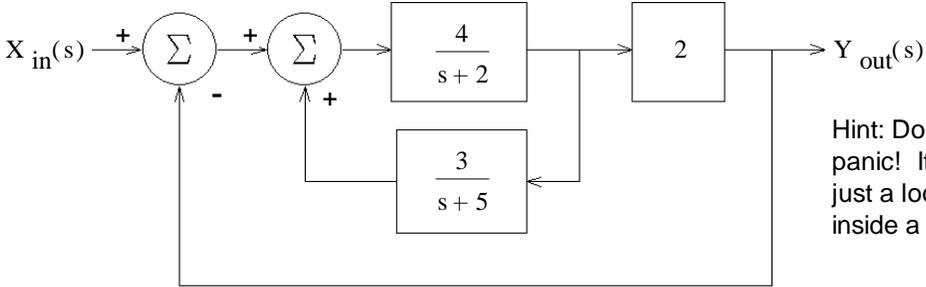
$\mathbf{H}(s) = ?$
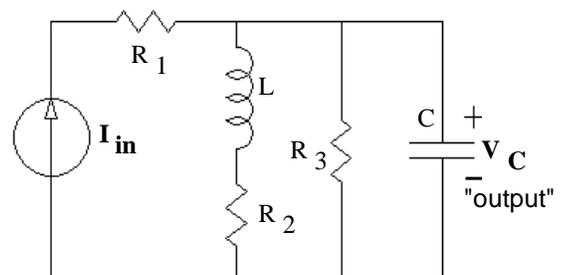
b) How many zeroes does this transfer function have?
If it has 1 or more, express them (probably in terms of R_1, R_2, R_3, L and C).   **ECE 3510   Exam 1   Spring 17   p1**

4. (21 pts) For the feedback system shown below, find the transfer function of the whole system, with feedback.

Find $H(s) = \dfrac{Y_{out}(s)}{X_{in}(s)}$

Simplify your expression for $H(s)$ so that he numerator and denominator are both simple polynomials

$X_{in}(s) \xrightarrow{\ +\ } \Sigma \xrightarrow{\ +\ } \Sigma \longrightarrow \boxed{\dfrac{4}{s+2}} \longrightarrow \boxed{2} \longrightarrow Y_{out}(s)$

$-$ $+$

$\boxed{\dfrac{3}{s+5}}$

Hint: Don't panic! It's just a loop inside a loop.

5. (20 pts) A system has this transfer function: $H(s) = \dfrac{2\cdot(s+39)}{s^2+6\cdot s+13}$

a) What is the steady-state response $(y_{ss}(t))$ of this system to the input: $x(t) = \left(8 + 5\cdot e^{-5\cdot t}\cdot\cos(7\cdot t)\right)\cdot u(t)$

b) Show **all** the poles of the output **signal** on the axis provided.
   Make sure I can tell the values of the real & imaginary parts.

c) What is the natural frequency (ω_n) of this **system** of problem 2?

d) What is the damping factor (ζ) of this **system**?

e) If this **system** had a **step input** instead of the input above,
   what % overshoot would the output have?

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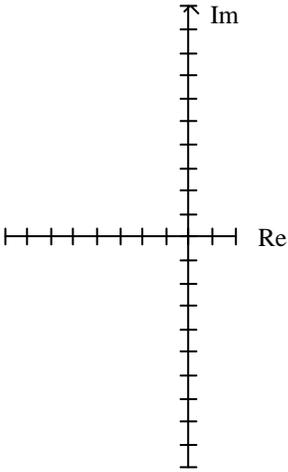
The poles of the output
signal, not the system.

6. (15 pts) The input to a system is: $x(t) = 3 \cdot e^{-4t} \cdot u(t)$

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

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

   If you can't find $\mathbf{H}(s)$, at least find the poles of $\mathbf{H}(s)$.

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

7. (11 pts) This system: $H(s) = \dfrac{k}{s+a}$ Has this Cosine input: $x(t) = \cos\left(\omega_o \cdot t\right) \cdot u(t)$ $X(s) = \dfrac{s}{s^2 + \omega_o^2}$

   Resulting in
   this output: $Y(s) = \dfrac{k}{(s+a)} \cdot \dfrac{s}{\left(s^2 + \omega_o^2\right)} =$

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

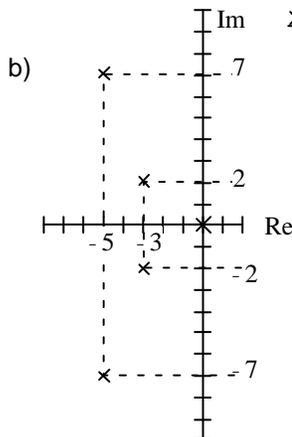   Continue with the partial fraction expansion just far enough to find the **transient** coefficient.

Answers

1. a)

b)

2.
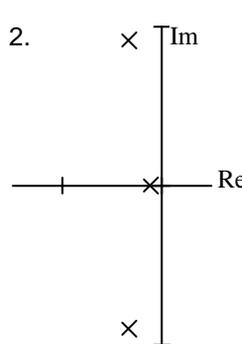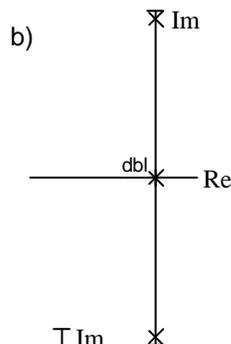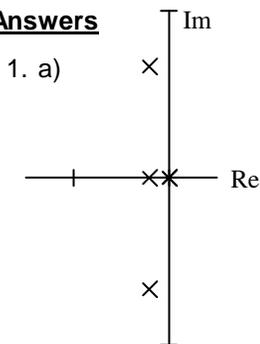
3. a)

$$\dfrac{\dfrac{1}{C} \cdot s + \dfrac{R_2}{L \cdot C}}{s^2 + \left(\dfrac{1}{R_3 \cdot C} + \dfrac{R_2}{L}\right) \cdot s + \dfrac{1}{L \cdot C} \cdot \left(\dfrac{R_2}{R_3} + 1\right)}$$

b) $1 \quad -\dfrac{R_2}{L}$

4. $\dfrac{8 \cdot (s+5)}{s^2 + 15 \cdot s + 38}$

5. a) $48 \cdot u(t)$ b)

c) $\sqrt{13}$

d) 0.832

e) $0.9 \cdot \%$

6. a) $\dfrac{11 \cdot s^2 + 46 \cdot s + 24}{3 \cdot s \cdot (s+3)}$ poles: origin -3 b) NO

7. $\dfrac{A}{s+a} + \dfrac{B \cdot s}{\left(s^2 + \omega_o^2\right)} + \dfrac{C \cdot \omega_o}{\left(s^2 + \omega_o^2\right)}$ $A = \dfrac{-k \cdot a}{a^2 + \omega_o^2}$