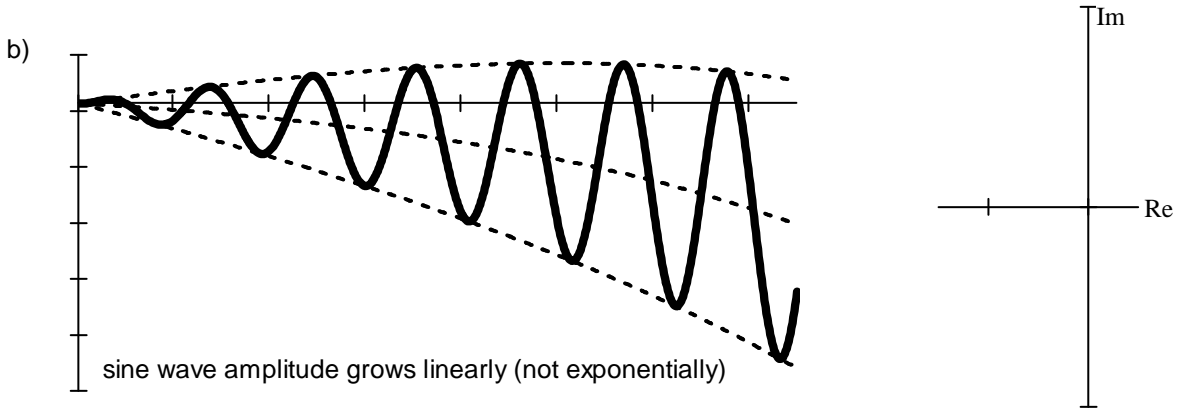
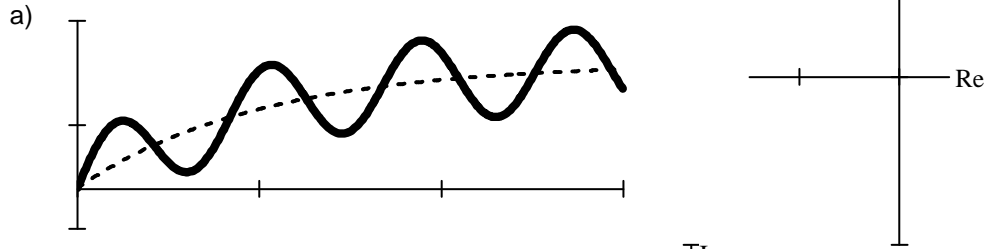
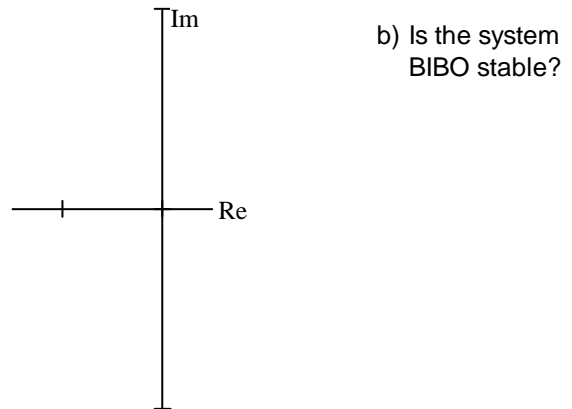
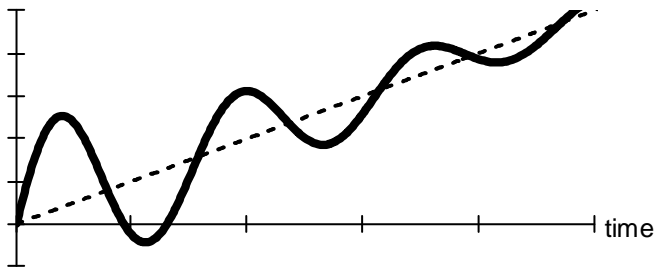


ECE 3510 Exam 1 given: Spring 21 (Most of the space between problems has been removed.)

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.



2. (7 pts) a) 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.

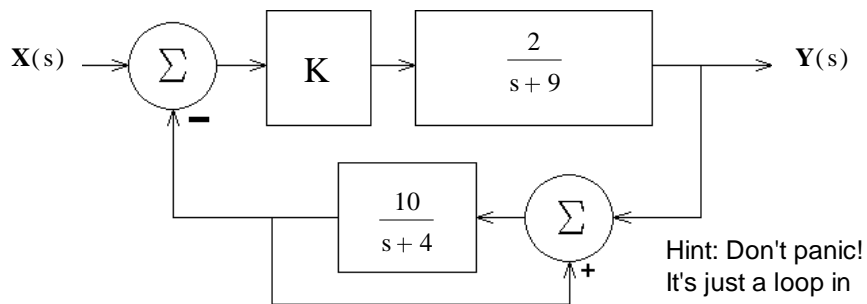


3. (20 pts) a) A feedback system is shown in the figure. What is the transfer function of the whole system, with feedback.

SHOW YOUR WORK

Simplify your expression for $H(s)$ so that the denominator is a simple polynomial, or better still, in a factored form.

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



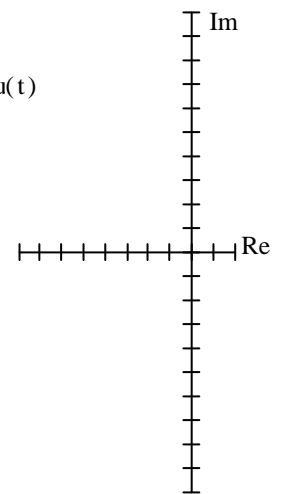
Hint: Don't panic! It's just a loop in the feedback of another loop.

b) Find the value of K to make the transfer function critically damped.

c) Does the transfer function have any zeros? Answer no or find the s value(s) of the zero(s).

4. (20 pts) A system has this transfer function: $\mathbf{H}(s) = \frac{3 \cdot (s + 50)}{s^2 + 6 \cdot s + 25}$

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



The poles of the output **signal**, not the system.

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**?

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?

5. (21 pts) This system: $H(s) = \frac{12 \cdot (s + 8)}{s \cdot (s + 5)}$

Has this input:
 $x(t) = 4 \cdot \cos(10 \cdot t) \cdot u(t)$

a) Express the output, and separate into partial fractions that you can find in the Laplace transform table without using complex numbers. Show what they are, but don't find the coefficients. Don't include coefficients that wouldn't exist because of a cancellation.

$Y(s) =$

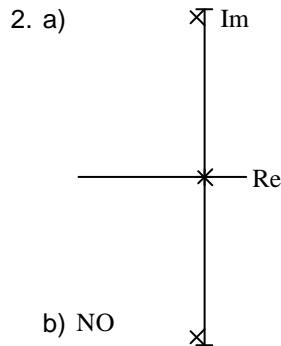
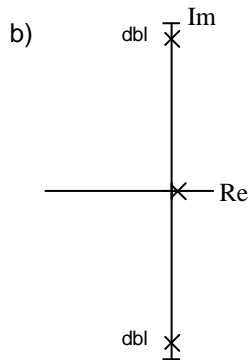
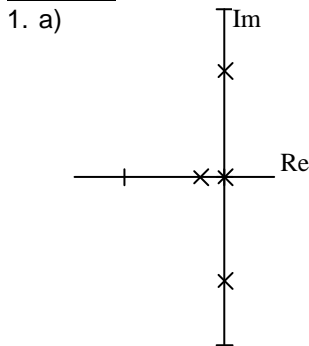
b) Continue with the partial fraction expansion just far enough to find the **transient** coefficient as a number. DON'T find coefficients for the sinusoidal parts.

c) Use steady-state AC analysis to find the **time-domain** representation of the **sinusoidal steady-state** output.

d) Use steady-state AC analysis to find the **time-domain** representation of the **sinusoidal steady-state** output.

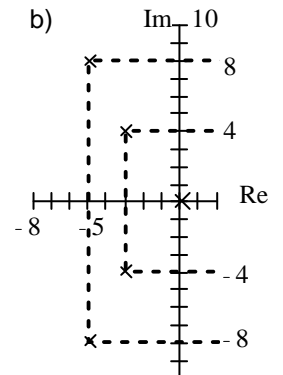
if the input were $x(t) = 4 \cdot \cos(10 \cdot t + 42 \cdot \text{deg}) \cdot u(t)$ instead of the input shown above.

Answers



3 is below

4. a) $24 \cdot u(t)$ b)
 c) 5
 d) 0.6
 e) 9.5%



3. a) $\frac{2 \cdot K \cdot (s - 6)}{s^2 + 3 \cdot s + 20 \cdot K - 54}$
 b) 2.81 c) 6

5. a) $\frac{A}{s + 5} + \frac{B \cdot s}{(s^2 + 100)} + \frac{C \cdot 10}{(s^2 + 100)}$

Accidentally made this an 80-point exam

- b) 1.152 c) $5.5 \cdot \cos(10 \cdot t - 102.1 \cdot \text{deg}) \cdot u(t)$
 d) $5.5 \cdot \cos(10 \cdot t - 60.1 \cdot \text{deg}) \cdot u(t)$