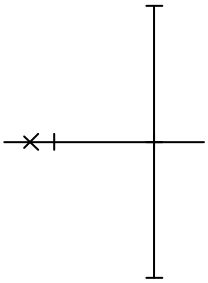
ECE 3510 Exam 1 given: Spring 10 (The space between problems has been removed.)

This part of the exam is Closed book, Closed notes, No Calculator.

1. (48pts) Each set of real and imaginary axes below show the poles of a **signal transform.**
   a) Find the best matching time-domain signal or answer on the next page.
   Answers on the next page may be used more than once or not at all.
   Answers may show effects of initial conditions which, of course, do not show in poles below.
   The axes below all have the same scaling. All time scales on the ANSWERS page are the same.
   Your answers should make sense relative to one another. dbl = double pole at that location



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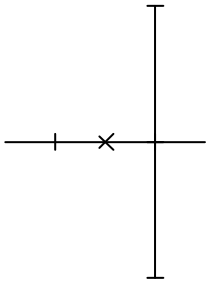

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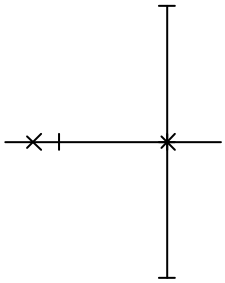

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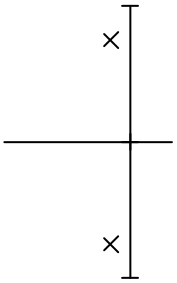

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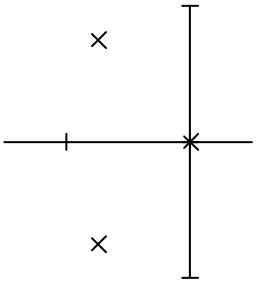

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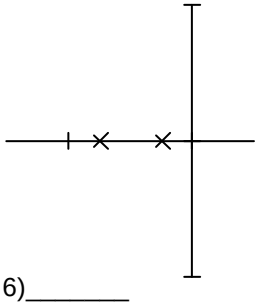

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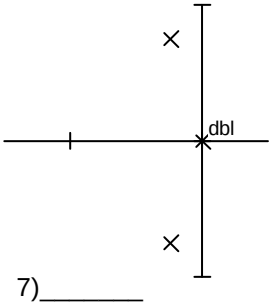

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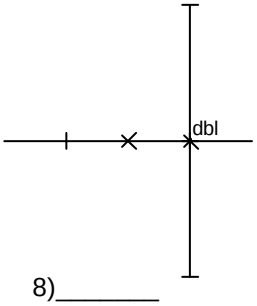

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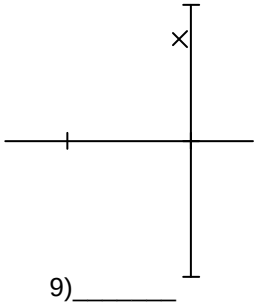
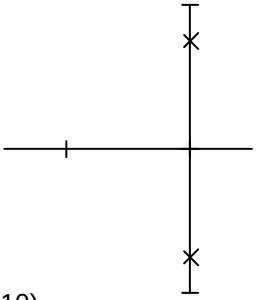


9)_____

b) List those numbers that are UNBOUNDED.

c) List those numbers that DO NOT converge



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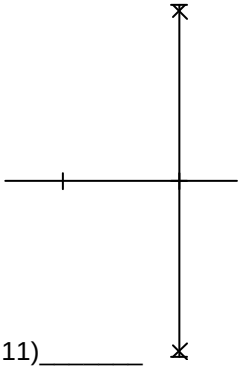

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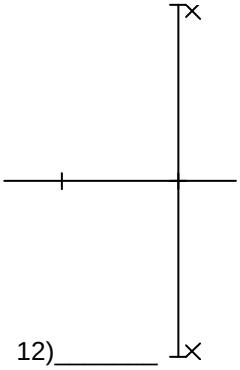
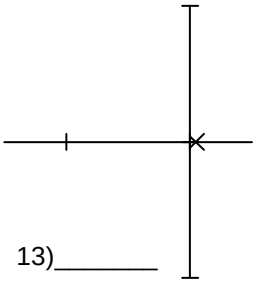


12)_____

d) List those **letters** on the answer sheet that COULD BE step responses of a BIBO system.

e) List those **numbers** on the other side and above that COULD BE sinusoidal responses of a BIBO system.



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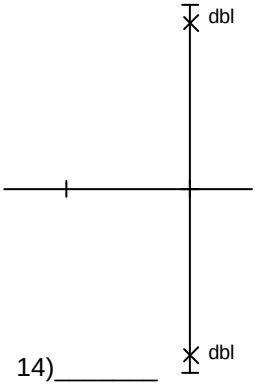

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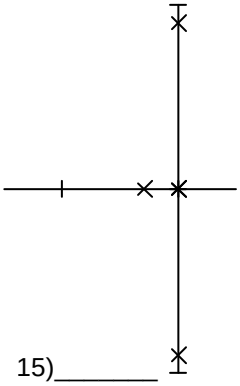

15)_____

ANSWERS to Problem 1

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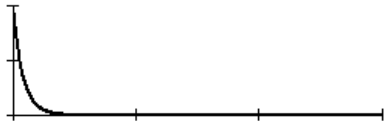
A No real time-domain answer could match these pole(s)

B None of these time-domain answers match these poles

C



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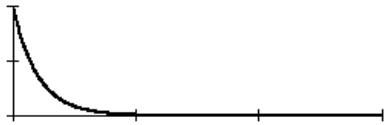

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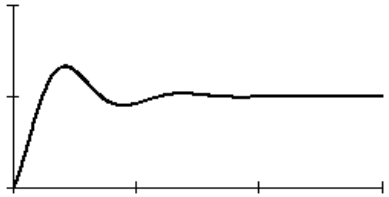

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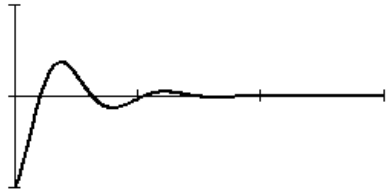

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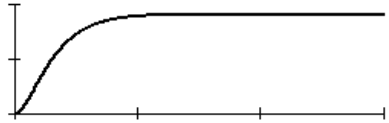

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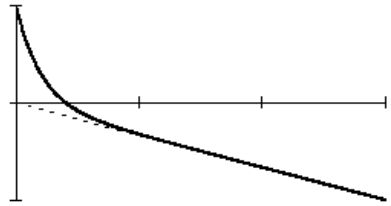

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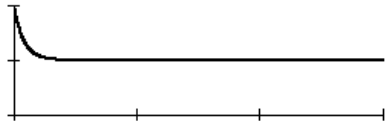

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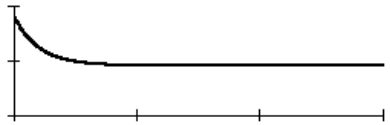

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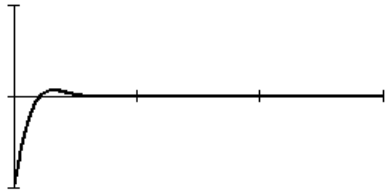

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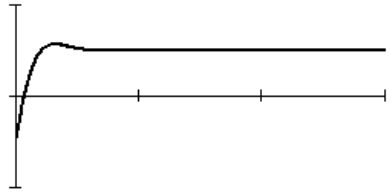

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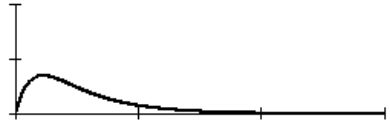

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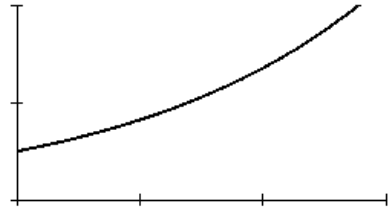

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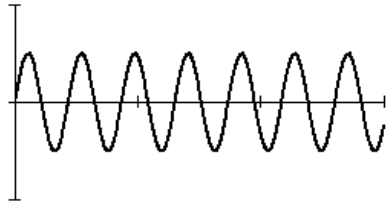

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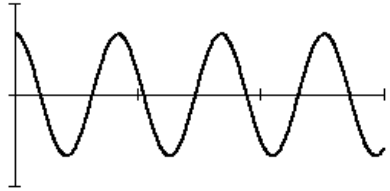

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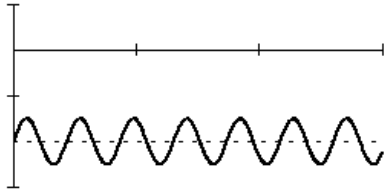

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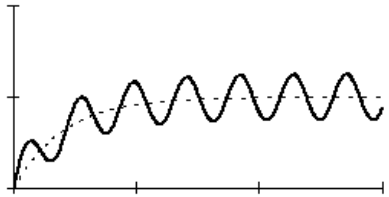

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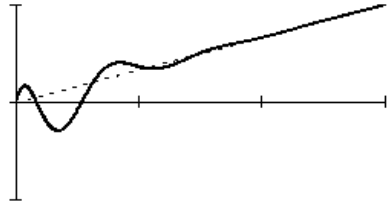

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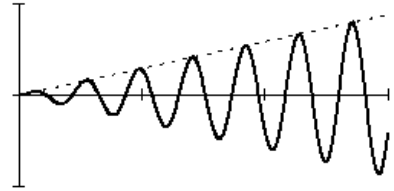
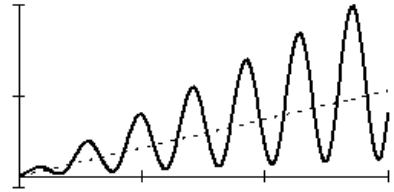


X



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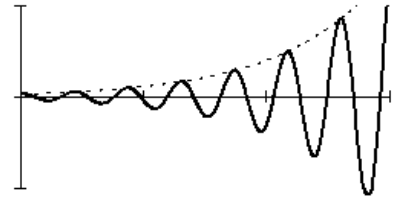

2. (10 pts) System transfer functions are given below. For each, determine if the sytem is BIBO stable. You may assume that there are no pole-zero cancellations.

a) $H(s) = \frac{s^2 + 22\cdot s + 72}{s^2 - 5\cdot s + 6} = \frac{(s+18)\cdot(s+4)}{(s-2)\cdot(s-3)}$ b) $H(s) = \frac{s^2 - 14\cdot s - 72}{s^2 - 5\cdot s - 6} = \frac{(s-18)\cdot(s+4)}{(s-6)\cdot(s+1)}$

c) $H(s) = \frac{s^2 + 14\cdot s - 72}{s^2 + 5\cdot s + 6} = \frac{(s+18)\cdot(s-4)}{(s+2)\cdot(s+3)}$

3. (24 pts) This system: $H(s) = \frac{17\cdot s}{s^2 + 4\cdot s + 20}$ Has this input: $x(t) = 2\cdot\sin(5\cdot t)\cdot u(t)$ $X(s) = \frac{10}{\left(s^2 + 5^2\right)}$

a) Find the resulting output Y(s) and separate that into partial fractions that you can find in the Laplace transform table. Show what they are, but don't find the coefficients.

b) Continue with the partial fraction expansion just far enough to find the **transient** coefficients.

c) Express the transient part(s) you just found as a function of time. $y_{tr}(t)$ =?

4. (6 pts) A system has this transfer function: $H(s) = \frac{2\cdot s^2 + 4\cdot s - 18}{s^2 + 5\cdot s + 6}$

What is the steady-state response ($y_{ss}(t)$) of this system to the input: $x(t) = \left(4 + 2\cdot e^{-4\cdot t}\cdot\cos(12\cdot t)\right)\cdot u(t)$

5. (12 pts) A 2nd-order system has the following characteristics:

The natural frequency (ω_n) is: 15 The damping factor (ζ) is: 0.6

a) What are the poles of this system. (watch your signs)

b) If this system had a step input, what % overshoot would the output have?

Answers

1. a) 1) C 2) D 3) J 4) F 5) M 6) N 7) U 8) H 9) A 10) R 11) Q 12) Y 13) P 14) W

b) 7 8 12 13 14 c) 7 8 10 11 12 13 14 15 d) E G J K M e) 10 11

2. a) NOT BIBO b) NOT BIBO c) YES, this system is BIBO

3. a) $\frac{A\cdot(s+2)}{s^2 + 4\cdot s + 20} + \frac{B\cdot 4}{s^2 + 4\cdot s + 20} + \frac{C\cdot s}{\left(s^2 + 25\right)} + \frac{D\cdot 5}{\left(s^2 + 25\right)}$

b) 2 & 9 c) $y_{tr}(t) = 2\cdot e^{-2\cdot t}\cdot\cos(4\cdot t) - 9\cdot e^{-2\cdot t}\cdot\sin(4\cdot t)$

4. $-12\cdot u(t)$

5. a) $-9 + 12\cdot j$ and $-9 - 12\cdot j$ b) 9.5%