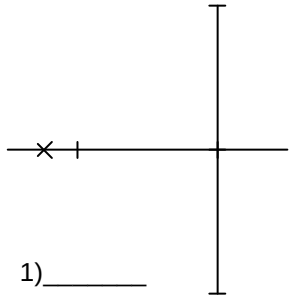
ECE 3510 Exam 1 given: Spring 15 (The space between problems has been removed.)

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

1. (45 pts) 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 may be used more than once or not at all.
   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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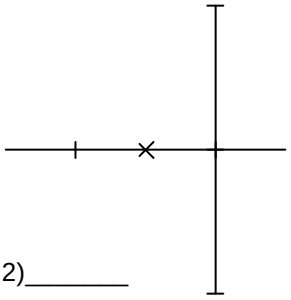
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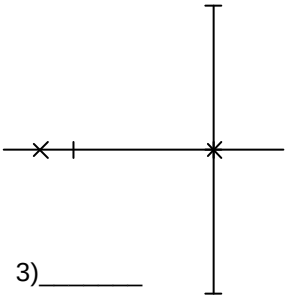
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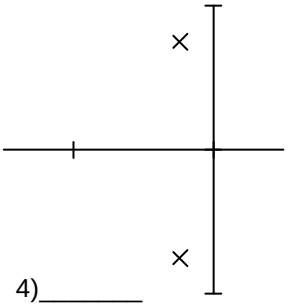
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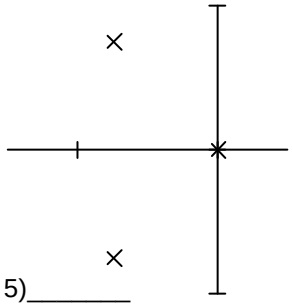
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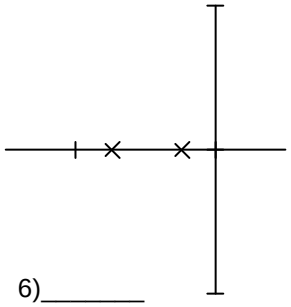
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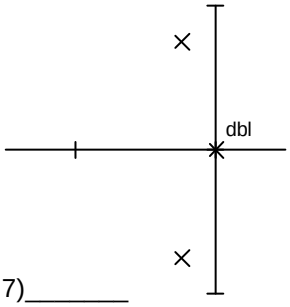

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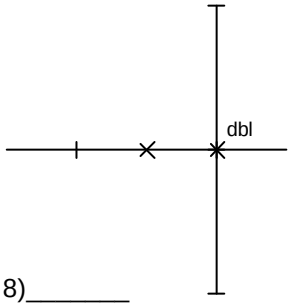

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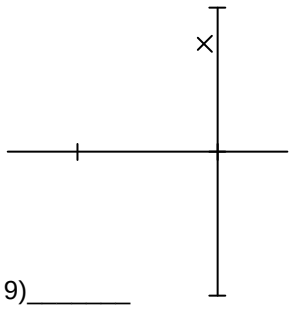
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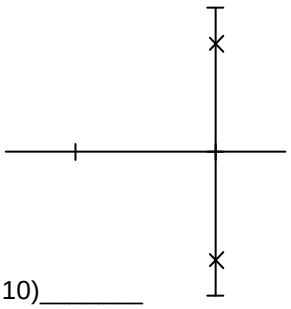
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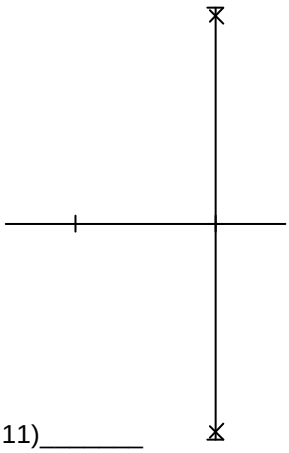
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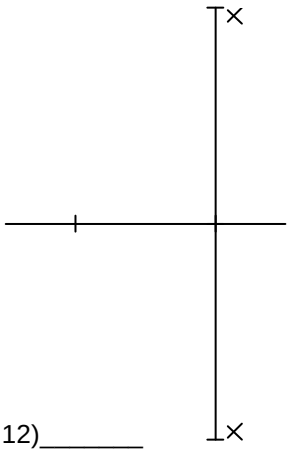
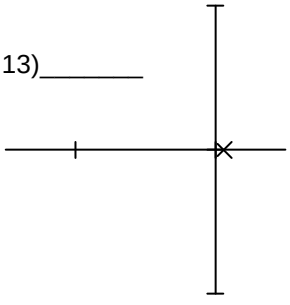
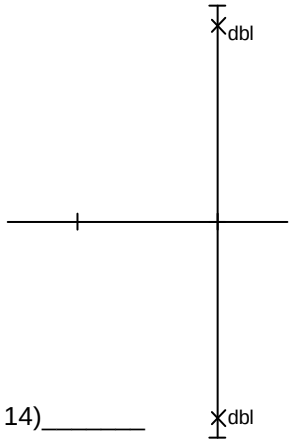

12)_____

13)_____



b) List those number(s) that represent UNBOUNDED signals.



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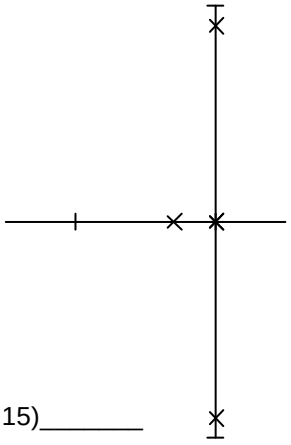

15)_____

c) List those number(s) that represent signals DO NOT converge.

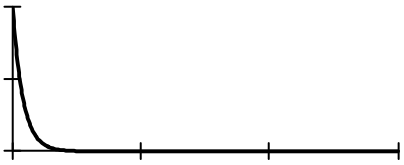
d) List those number(s) that could be the result of exciting a system at its resonant frequency?

e) List those LETTERs on the answer sheet that COULD BE step responses of a BIBO system.

ANSWERS for Problem 1

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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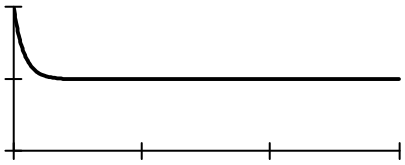

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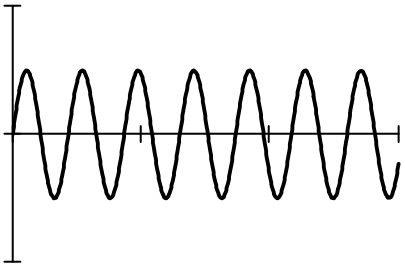
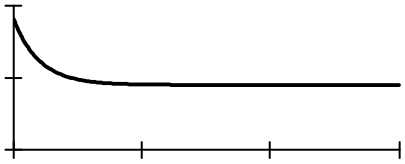


D

K



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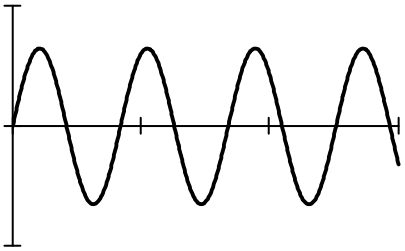

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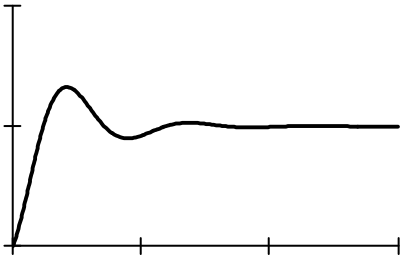

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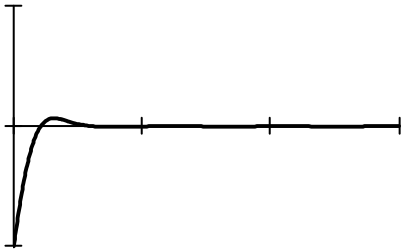

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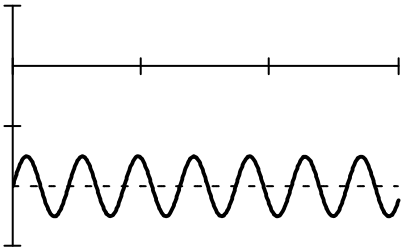

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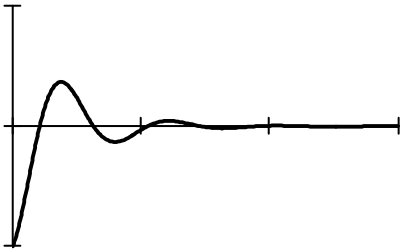

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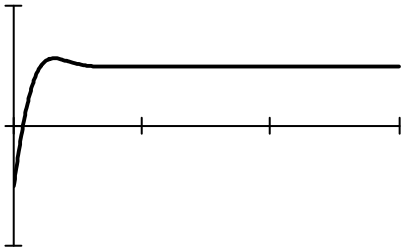
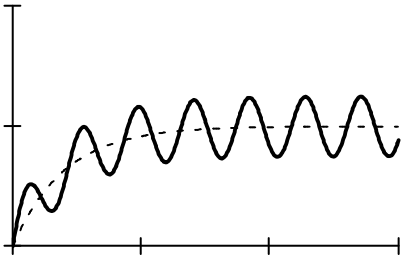


T



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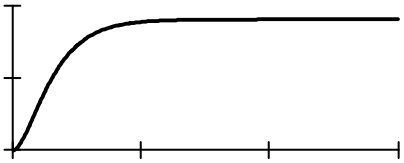

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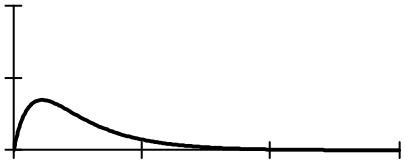

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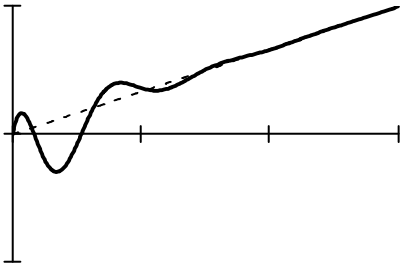
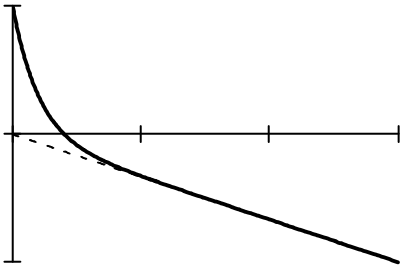


H



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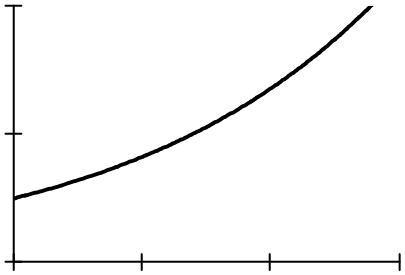

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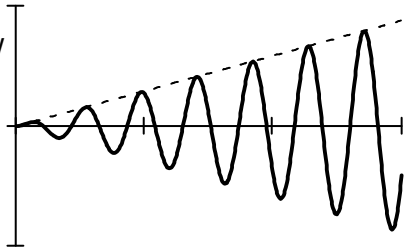
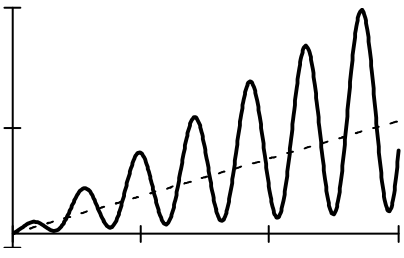
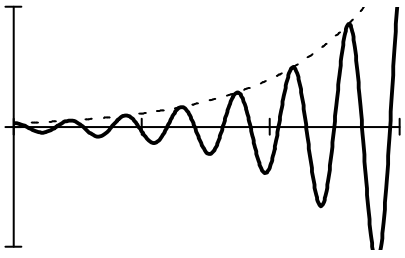


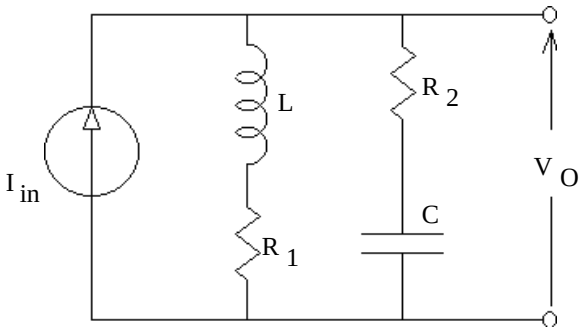
X



Y



1. (16 pts) a) Find the transfer function of the circuit shown.



I_{in} is the input and V_O is the "output".

You MUST show work to get credit.
Simplify your expression for **H**(s) so that the denominator is a simple polynomial in standard form.

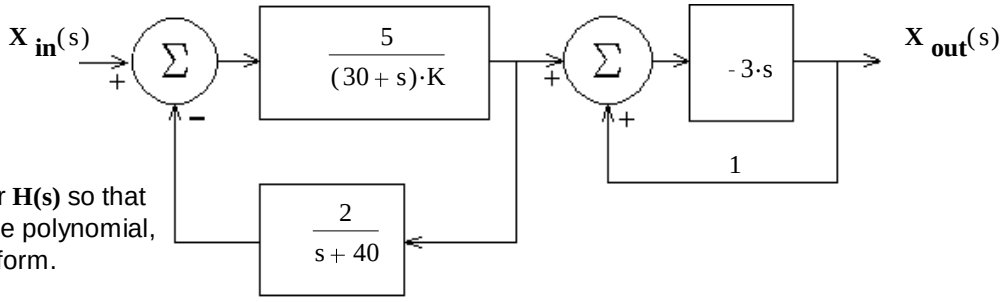
H(s) = ?

b) How many zeroes does the transfer function have?

c) How many poles does this transfer function have?

If it has 1 or more, express them (probably in terms of R_1, R_2, L and C).

2. (20 pts) a) A feedback system is shown in the figure. What is the transfer function of the whole system, with feedback.



$$\mathbf{H}(s) = \frac{\mathbf{X_{out}}(s)}{\mathbf{X_{in}}(s)} = ?$$

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

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

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

d) Does the transfer function have a pole that doesn't depend on K? Answer no or find the s value of that pole.

3. (5 pts) A system has this transfer function: $\mathbf{H}(s) = \frac{5\cdot s + 80}{s^2 + 0.4\cdot s + 16}$

a) What is the steady-state response ($y_{ss}(t)$) of this system to the input: $x(t) = \left(6 + 2\cdot e^{-4\cdot t}\right)\cdot u(t)$

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

4. (14 pts) The input to a system is: $x(t) = 0.5\cdot e^{-5t}\cdot u(t)$

The output of this system is: $y(t) = \left(2 + 4\cdot e^{-5\cdot t} + e^{-10\cdot t}\right)\cdot u(t)$

a) Find system transfer function, **H**(s).

b) Find the poles of **H**(s). You can find this even If you can't find **H**(s).

c) Is **H**(s) BIBO stable?

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 15) T

b) 7 8 12 13 14 c) 7 8 10 11 12 13 14 15 d) 14 (W or X) e) E G J K M Not S or T, they aren't BIBO

Open Book Part

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

b) 2

c) 2 $\frac{-\frac{R_2 + R_1}{L} \pm \sqrt{\left(\frac{R_2 + R_1}{L}\right)^2 - \frac{4}{L\cdot C}}}{2}$

2. $\frac{\frac{-15\cdot s}{K}\cdot(s + 40)}{\left(s^2 + 70\cdot s + 1200 + \frac{10}{K}\right)\cdot(1 + 3\cdot s)}$

b) 0.4

c) s = 0 s = - 40

d) s = $-\frac{1}{3}$

3. a) $30\cdot u(t)$ b) 0.05

4. a) $\frac{14\cdot s^2 + 150\cdot s + 200}{s\cdot(s + 10)}$

b) origin - 10 c) NO