EECS 120, Fall 1993
Final
Professor Fearing

Problem #1 (23 points)

Classify the following systems. In each column, write "yes", "no", or "?" (use "?" if not decidable with given information). The input to the system is x(t) and the output is y(t). (Note: do not fill in an answer in the blacked out space for letter (e)/BIBO stable.)

	Causal	Linear	Time-invariant	BIBO stable
a. y(t) = 2x(t) + 1				
b. y`(t) + y(t) = tx(t)				
c. y(t) = x(t)cos(w_c * t)				
d.Y(w) = X^2(w), x(t) = 0 for (t<0)				
e. y`^2(t) + y(t) = x(t+2)				
f. y(t) = h(t) * x(t) * d(t+2)				

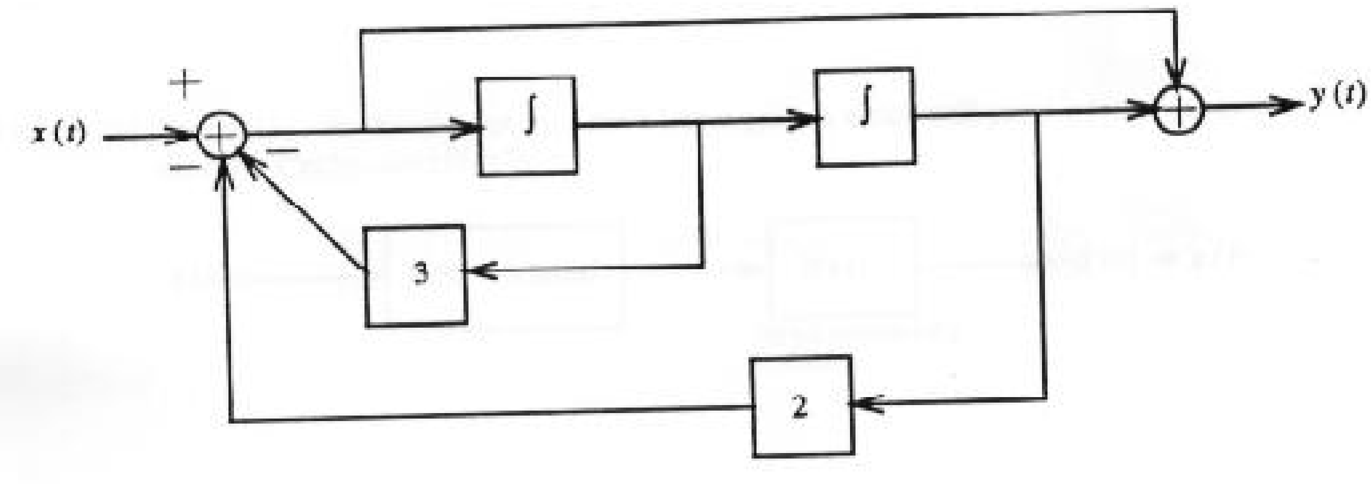
Problem #2 (12 points)

Which of the following are eigen functions for LTI systems? (Recall: x(t) is an eigen function if h(t) * x (t) = A * x(t), where A is a coplex constant.) Circle the boldface letter(s) for which the above is true.

a. sin(w_0 * t) u(t)
b. e^(s_0 * t)
c. t^(1/2)
d. t + 1
e. cos(w_0 * t) + sin(w_0 * t)
f. sin(w_1 * t) + sin(w_2 * t)

Problem #3 (10 points)

[5 pts.] a) Consider the following block diagram:



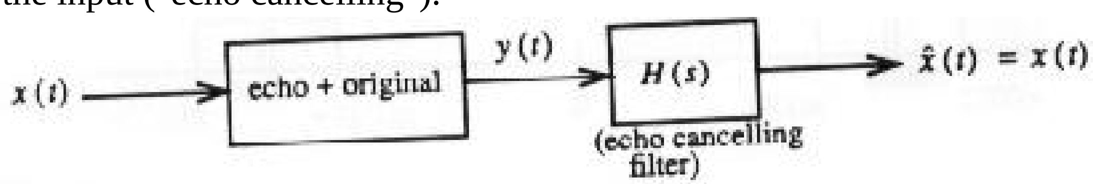
Determine the transfer function for the system:
H(s) = Y(s)/X(s) = _________

[5 pts.] b) A system has transfer function H(s) = 4+[(2s+3)/(s^2+6s+9)].
What is the impulse response? h(t) = _________
Is this system BIBO stable?

Problem #4 (20 points)

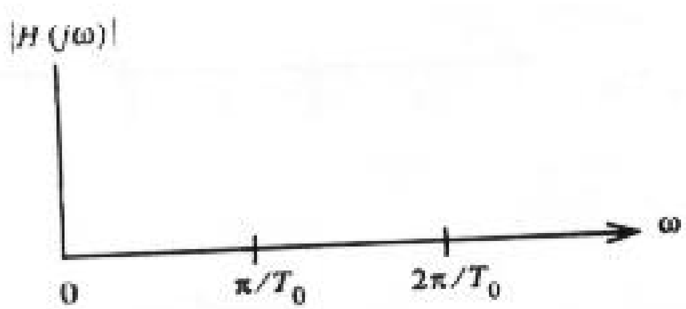
A signal x(t) is corrupted by an echo. The observed signal y(t) then has the form:
y(t) = x(t) + kx(t - T_0); |k|<1

[10 pts.] a) Find H(s), the transfer function for a linear system which will yield x(t) as its output if y(t) is the input ("echo cancelling").



H(s) = ___________

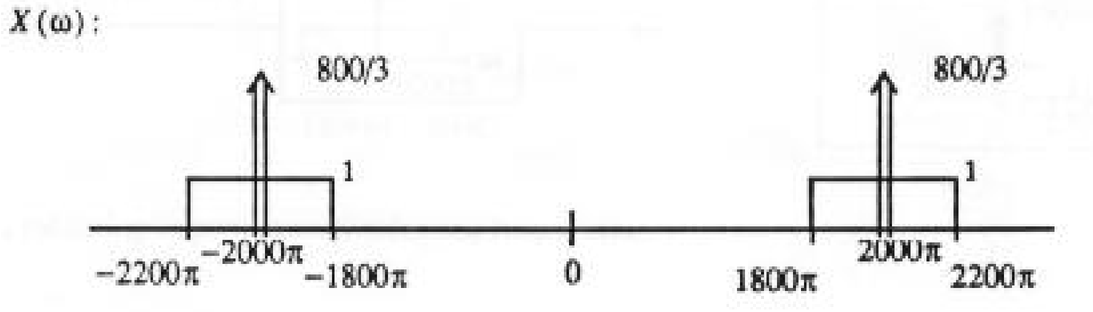
[8 pts.] b) Sketch



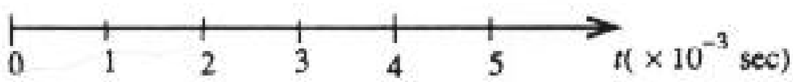
[2 pts.] c) [Harder] Consider the pole locations for H(s). Is H(s) BIBO stable? If yes, explain why. If no, find a bounded input y(t) which gives rise to an unbounded output x(t).

Problem #5 (30 points)

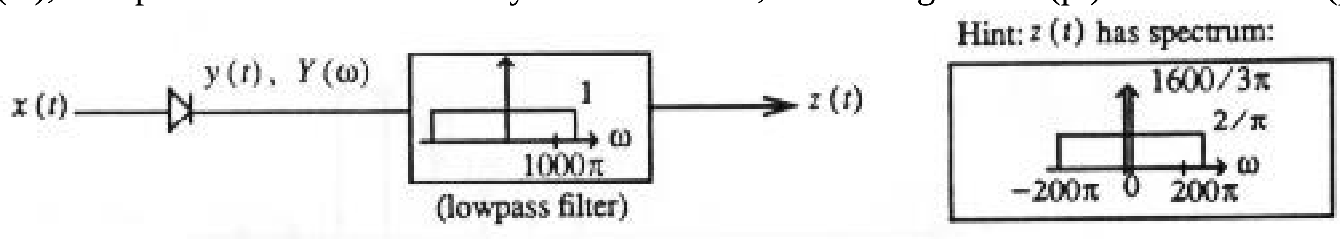
You receive an AM (DSB-LC) signal with spectrum X(w):



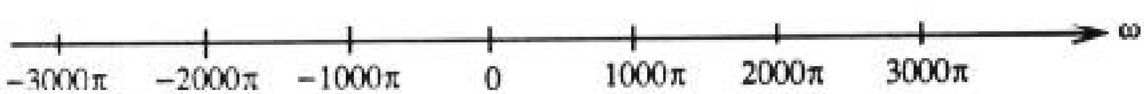
[15 pts.] a) Sketch x(t) in the range 0 <= t <= 5*10^-3 sec. (Specify amplitude at 0 sec. and 5 msec.)



[15 pts.] b) The message is received using asynchronous detection in the following system. Sketch Y (w), the spectrum after detection by the ideal diode, in the range -3000(pi) <= w <= 3000(pi)

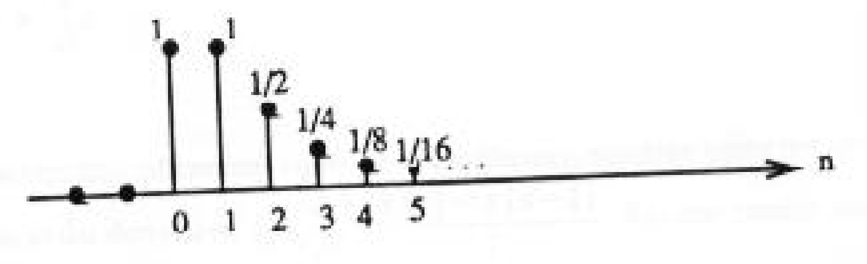


Sketch Y(w), indicating important amplitudes and frequencies.



Problem #6 (15 points)

The impulse response h[n] of a discrete time LTI system is given:



Find g[n], the impulse response of the inverse system, i.e., find a g[n] such that g[n] * h[n] = d[n].
(Note: g[n] should be in closed form.)

d[n] ---> [h[n]] ---> [g[n]] ---> d[n]

g[n] = ___________

Problem #7 (20 points)

A system is described by the following differential equation with input x(t) and output y(t):
(d^2y/dt^2) + y = (d/dt)x

[5 pts.] a) Conver this differential equation to a defference equation using the backward difference approximation to the derivative, i.e., dx/dt =~ (x[n] - x[n-1])/T. Assume sample rate T = 0.5 sec.

[5 pts.] b) Given the following difference equation, find H(z), the z-transform of the unit pulse response
[n-2] + 3y[n-1] + 2y[n] = x[n-1]
H(z) = _____________

[5 pts.] c) For the difference equation in part b, above, find y[n] for x[n] = 0,
(ZIR) with y[-1] = 1 , y[-2] = 0.
(Note: y[n] should be in closed-form.)
y[n] = _____________

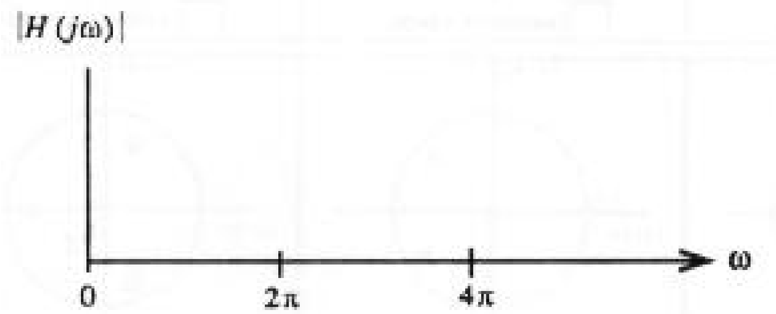
[5 pts.] d) For the difference equation in part b, find y[n] for x[n] = u[n],
(ZSR) with y[-1] = 0 and y[-2] = 0.
y[n] = _____________

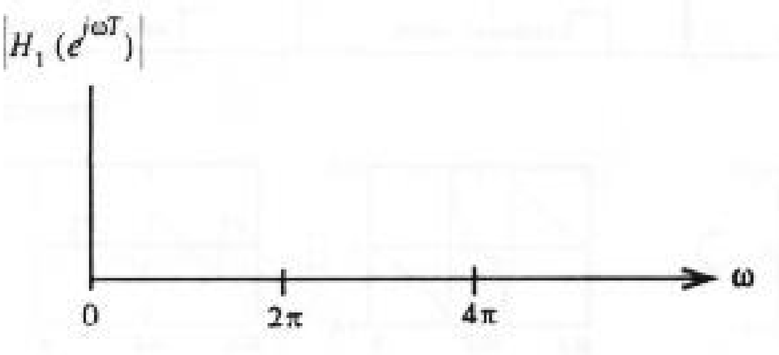
Problem #8 (15 points)

A continuous time system has impulse response h(t) = u(t).

[5 pts.] a) Determine the equivalent discrete time filter H(z) using the Impulse Invariance method using sampling rate T = 1.0 second.
H_1(z) = _______________

[5 pts.] b) Sketch the magnitude of the frequency response for the continuous time and discrete time filters:

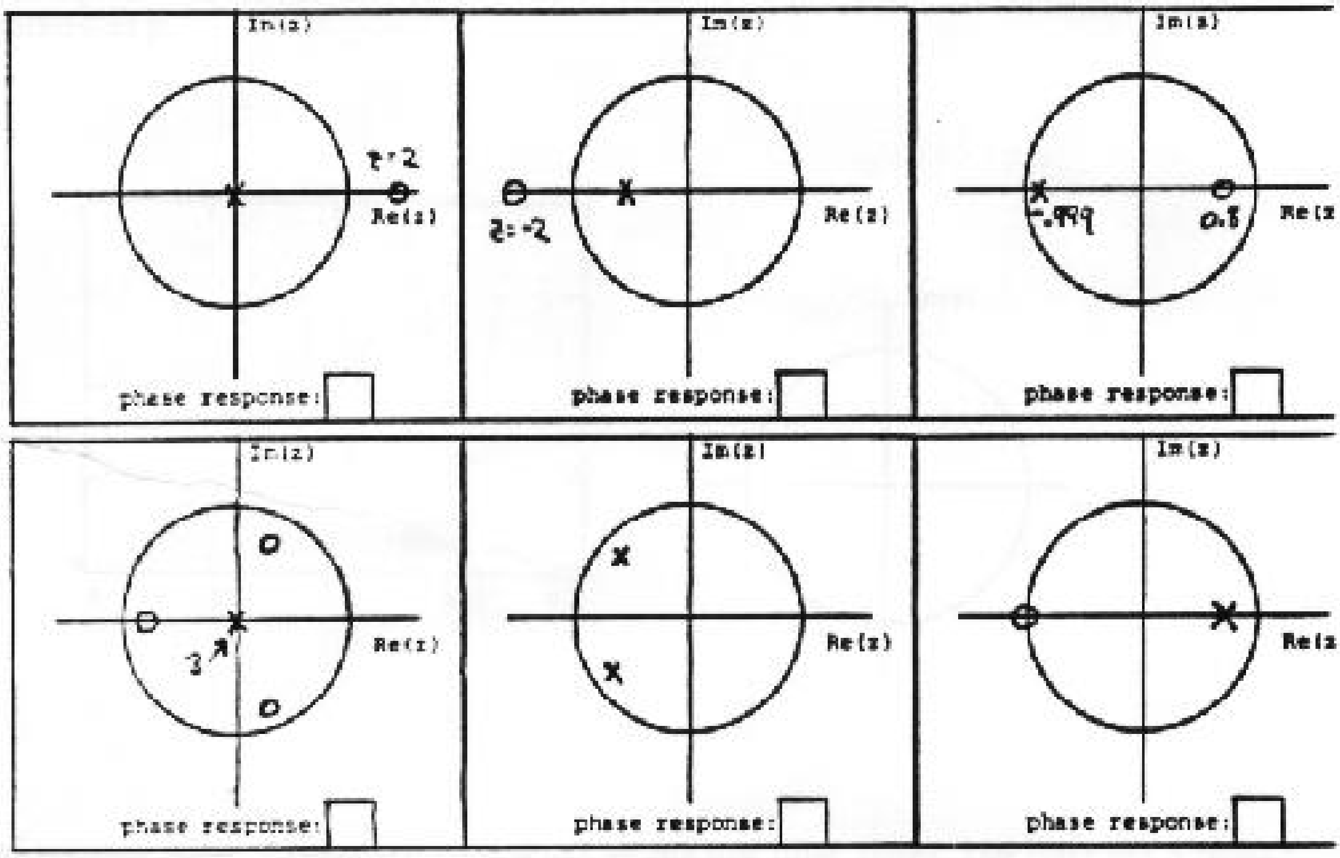




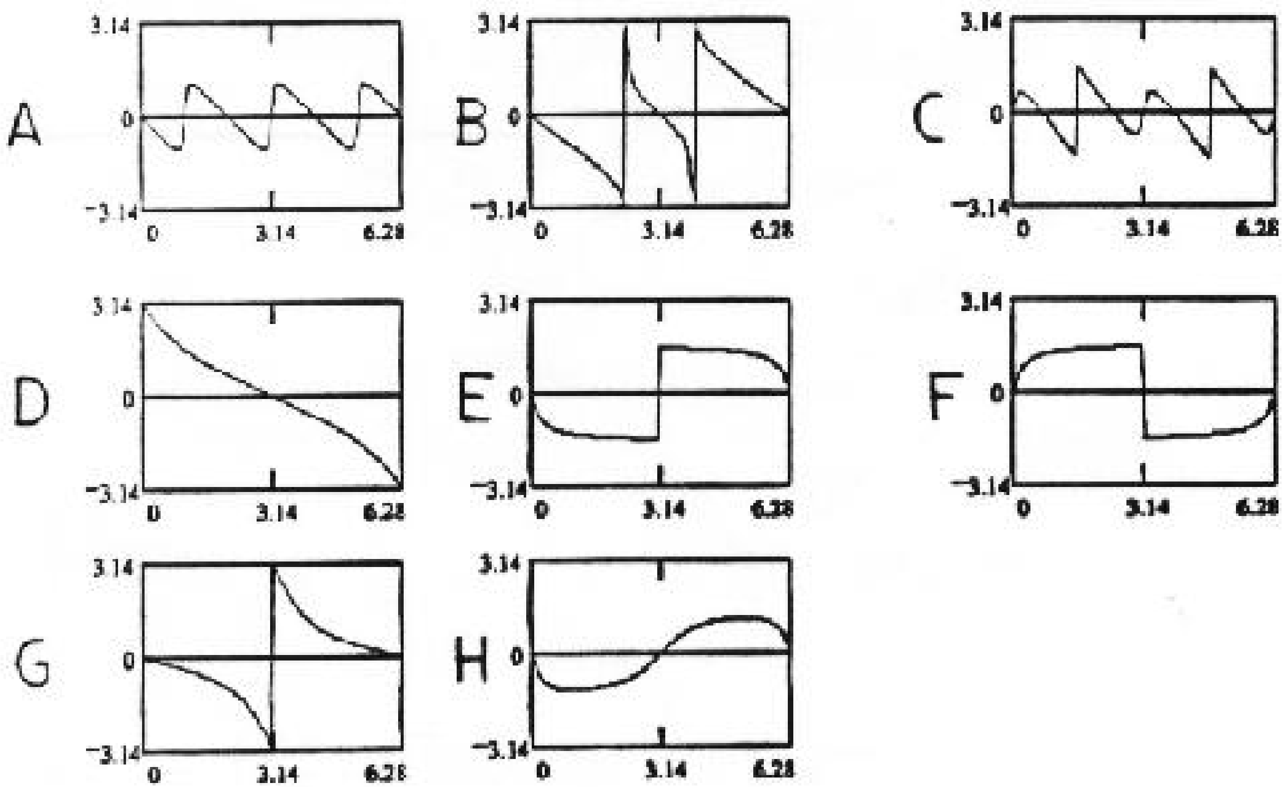
[5 pts.] Explain the reason(s) for differences (if any) between the two sketches in part b.

Problem #9 (24 points)

For each pole-zero diagram belo, fill in the blank with the letter corresponding to the closest phase spectrum below. (Spectrums may be used more than once.) (Note: The angle function is defined from -(pi) to +(pi).) Assume T = 1.0.

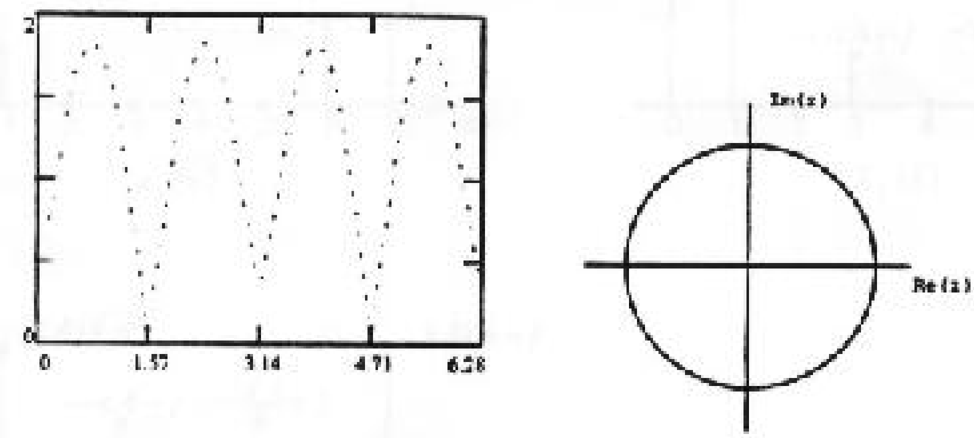


Phase Responses:



Problem #10 (16 points)

[8 pts.] a) Sketch a pole-zero diagram in the z-plane for a stable, causal FIR filter with the following magnitude spectrum. You may make reasonable engineering approximations for your diagram. (Hint: The filter has four poles.) Don't worry about the exact height at 0 or (pi). You may leave locations in terms of parameter p.



[8 pts.] b) Determine the unit pulse response h[n] of the FIR filter. (Hint: The filter has 4 poles.)

h[n] = ____________

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