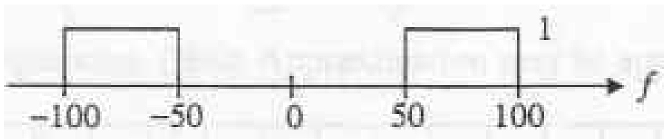
EECS 120, Fall/2001
Midterm #2
Professor Fearing

- Closed book. Two 8.5x11 sides of notes. No calculators.
- There are 4 problems worth 100 points total. The problems on this exam may have several solution methods. One method may be much more time efficient compared to the others. Points are proportional to amount of time problem may take, using an efficient approach.

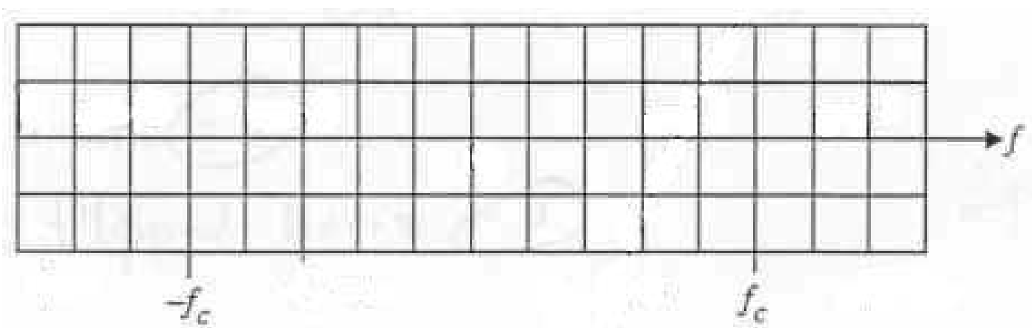
In the real world, unethical actions by engineers can cost money, careers, and lives. The penalty for unethical actions on this exam will be a grade of zero.

Problem #1 (25 points)

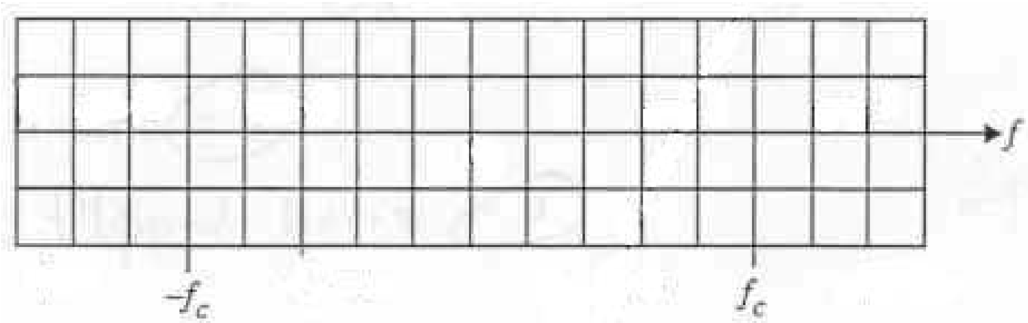
Let m(t) = sin(200*pi*t)/(pi*t) - sin(100*pi*t)/(pi*t) and fc = 10^4[Hz]
Thus, M(f) is as shown:



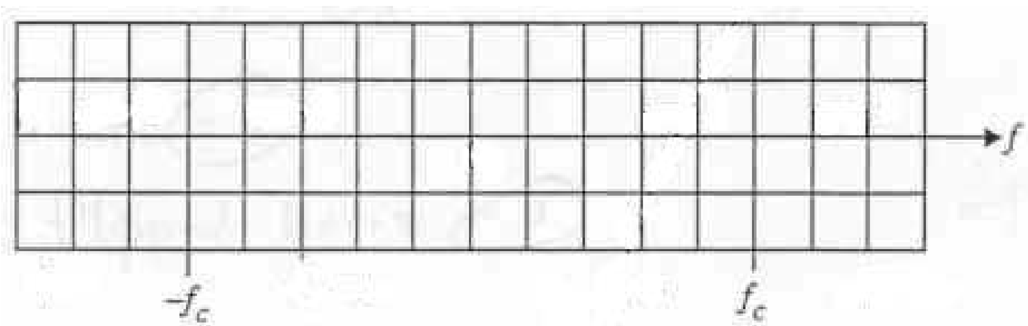
[3 pts.] a) Let x1(t) = m(t)*cos(2*pi*fc*t). Sketch X1(f) in indicated range, labelling height/area and sideband frequencies.



[5 pts.] b) Let x2(t) = m(t)*cos(2*pi*fc*t) - (m(t)/(pi*t))*sin(2*pi*fc*t). Sketch X2(f) in indicated range, labelling height/area and sideband frequencies.



[7 pts.] c) Let x3(t) = cos[2*pi*fc*t + (2*pi/100)*integral(m(tau)dtau, -infinity to t)]. Sketch X3(f) in indicated range, labelling height/area and sideband frequencies. (Hint: Approximation may be appropriate.)



[5 pts.] d) Describe how you could recover m(t) from x2(t). Draw a block diagram of a system which has input x2(t) and output m(t). The system should work for any m(t), bandlimited to 1.0kHz. Specify appropriate frequencies for any component you use.

[3 pts.] e) Identify the type of modulation used to generate each signal (e.g., AM-DSB, NBFM, etc).

x1(t) modulation type:	
x2(t) modulation type:	

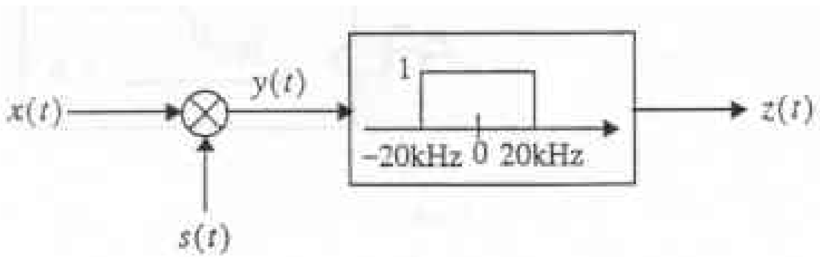
x3(t) modulation type:	

[2 pts.] f)

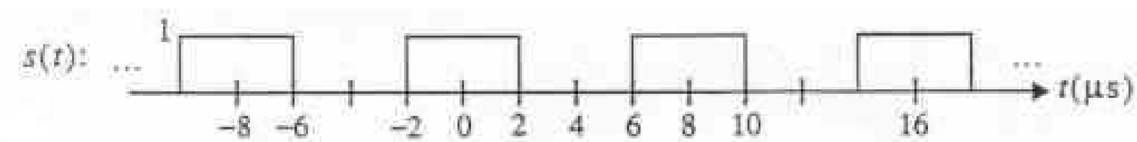
What is the power in x1(t)?	

Problem #2 (25 points)

A system is described by the following block diagram:



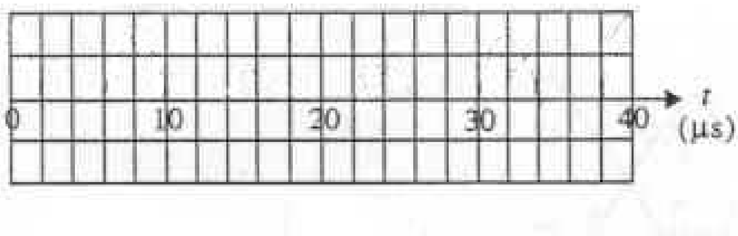
where x(t) = m(t)*cos(2*pi*fc*t), m(t) = cos(2*pi*fm*t), fc = 125[kHz], fm = 12.5[kHz], and s(t) is a square wave with duty cycle 50% and period 8[us].

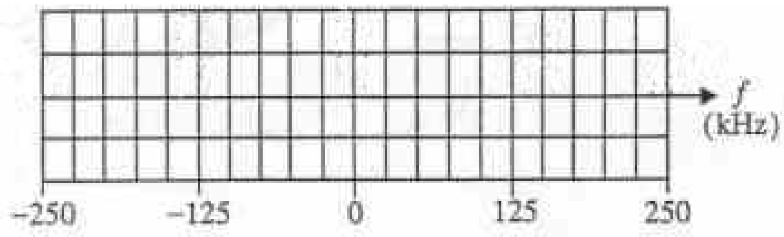


$$S(f) = \sum^{\infty} \frac{\sin k\pi/2}{k\pi}\,\delta(f - 125\times 10^3 k)$$

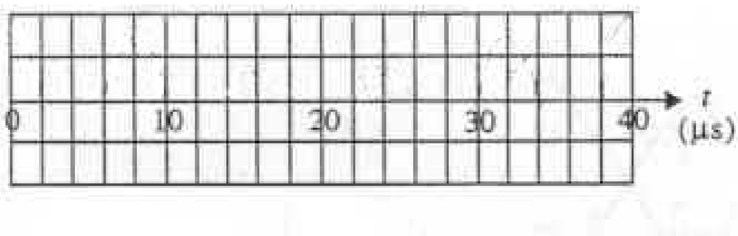
[18 pts.] a) Sketch x(t), y(t), z(t), X(f), Y(f), and Z(f) in the provided boxes, in indicated range, labeling key heights/areas.

x(t) **X(f)**

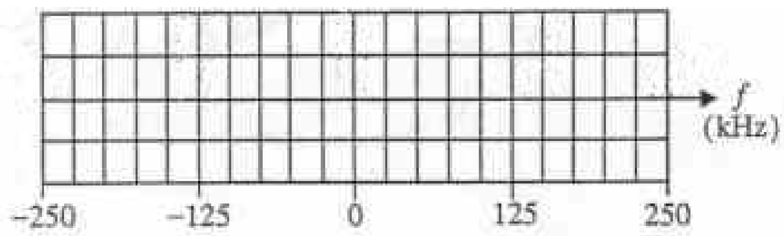




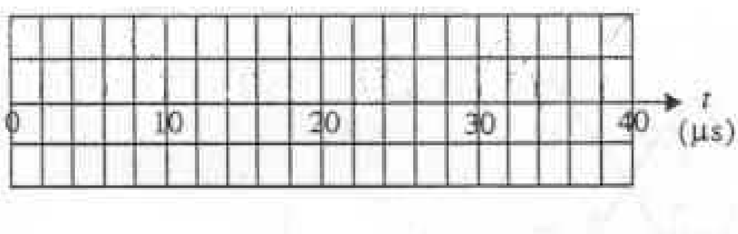
y(t)



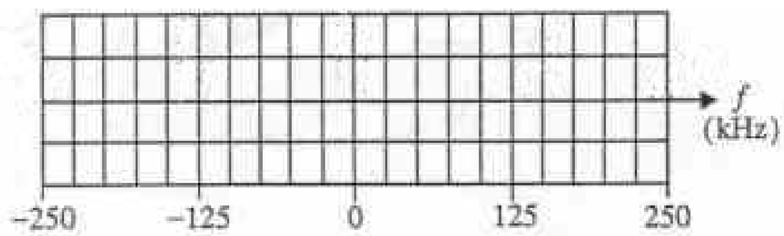
Y(f)



z(t)



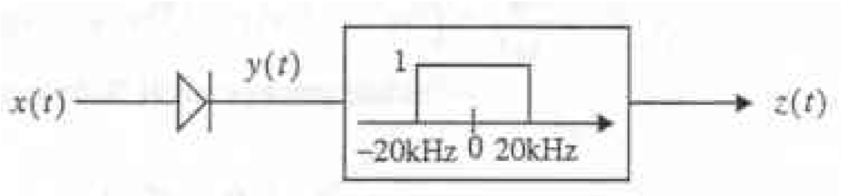
Z(f)



[2 pts.] b) For which m(t) does z(t) = a*m(t), where a is a scale factor? What is a?

a:

[3 pts.] c) Consider the system with a diode instead of a multiplier:



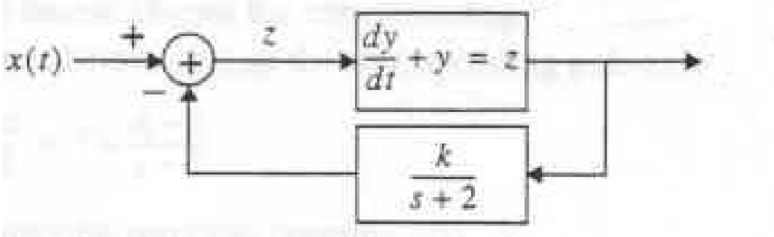
with x(t) = n(t)*cos(2*pi*fc*t).
For which n(t) does z(t) = a*n(t), where a is a scale factor?:

List constraints on n(t):

[2 pts.] d)

What is the power in x(t)?	
What is the energy in x(t)?	

Problem #3 (26 points)



[4 pts.] a) With y(0-) = 0, compute Y(s)/X(s):

[6 pts.] b) With y(0-) = 1, K = -2, x(t) = 0, determine y(t), t >= 0:

[6 pts.] c) For which values of K is the system stable?:

[4 pts.] d) With K = 1, x(t) = u(t), y(0-) = 0, what is y(t) as t->infinity?:

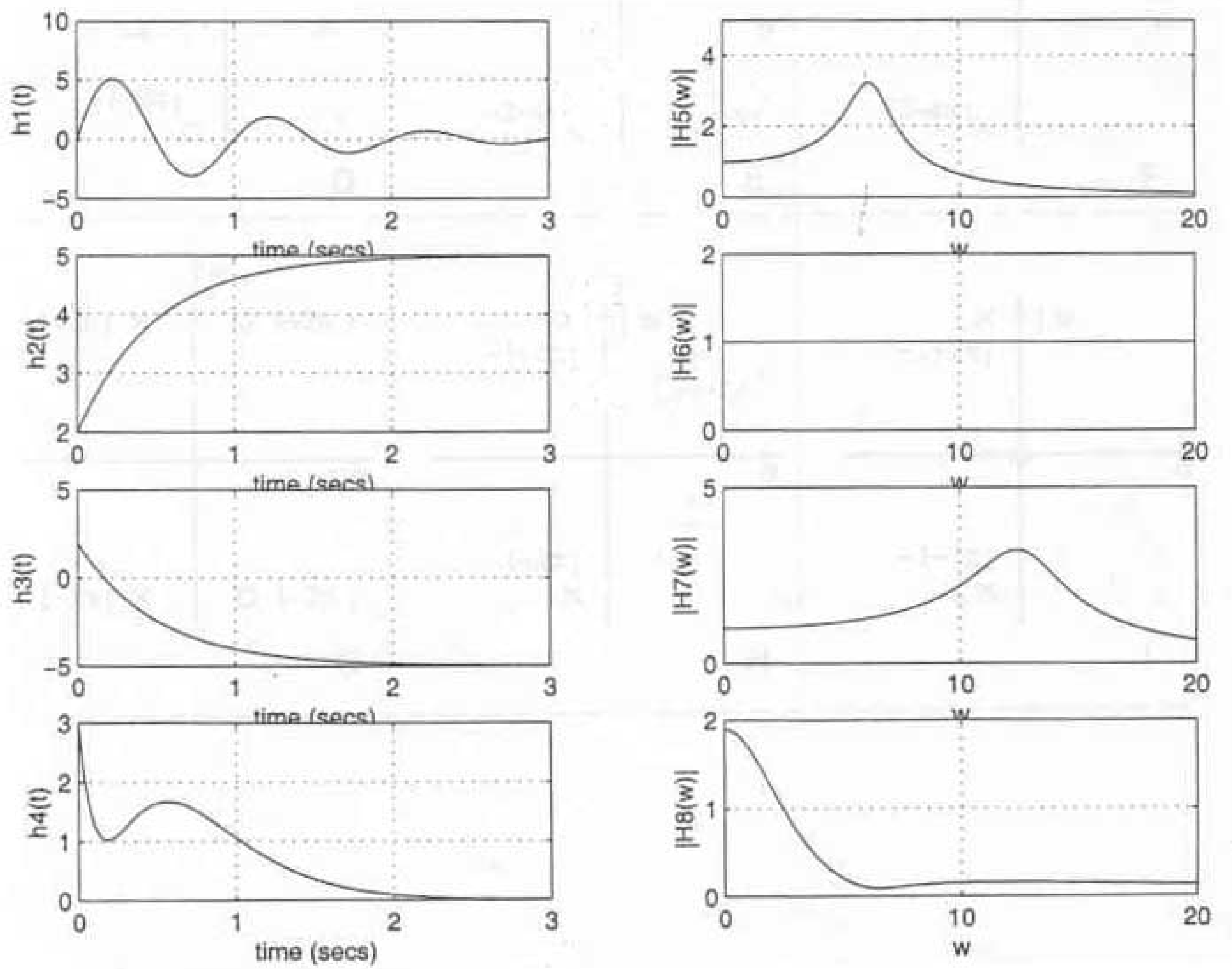
[6 pts.] e) With K = 3, estimate the phase margin for the closed-loop system. (An approximate answer is sufficient.):

Problem #4 (24 points)

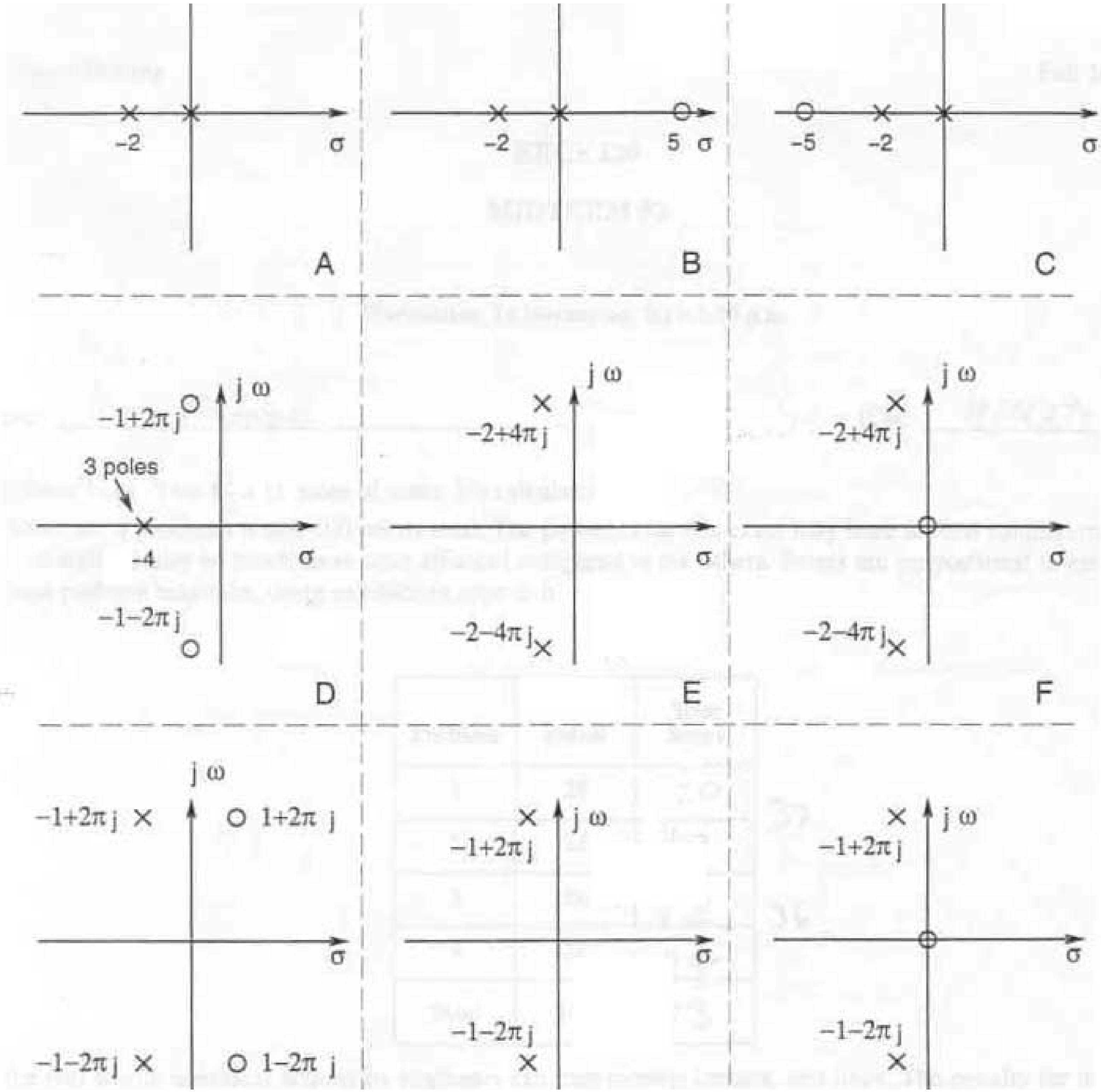
For each impulse below, choose the corresponding pole-zero diagram on the following page and put a letter in box. For each magnitude response below, choose the corresponding pole-zero diagram on the following page and put letter in box.

Hint#1: (s + alpha) / (s + beta) = 1 + [(alpha - beta) / (s + beta)]
Hint#2: No impulse response contains delta(t).

Impulse response	Matching pole-zero plot	Magnitude of frequency response	Matching pole-zero plot
$h_1(t)$	☐	$\lvert H_5(\omega)\rvert$	☐
$h_2(t)$	☐	$\lvert H_6(\omega)\rvert$	☐
$h_3(t)$	☐	$\lvert H_7(\omega)\rvert$	☐
$h_4(t)$	☐	$\lvert H_8(\omega)\rvert$	☐



These pole-zero diagrams are possible answers for the questions of Problem 4. All diagrams represent causal systems.


-2
σ
A
-2
5 σ
B
-5
-2
σ
C
j ω
-1+2π j
3 poles
-4
σ
-1-2π j
D
j ω
-2+4π j
σ
-2-4π j
E
j ω
-2+4π j
σ
-2-4π j
F
j ω
-1+2π j
1+2π j
σ
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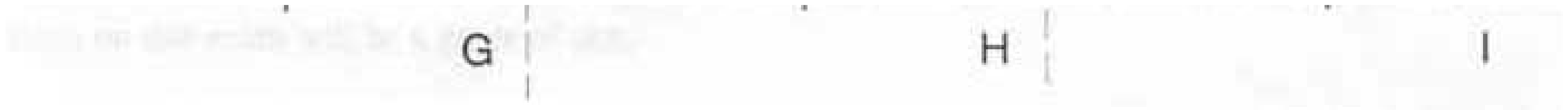
σ
-1-2π j



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