EE 120 Fall 1994
Midterm #2
Professor Fearing

Problem #1 (10 points)

A modulation scheme is described by:

$$x(t) = cos(omega_c * t + phi_{DELTA} * m\ (t))$$

where

$omega_c = 2 * pi * 10^3$

$phi_{DELTA} = phi$

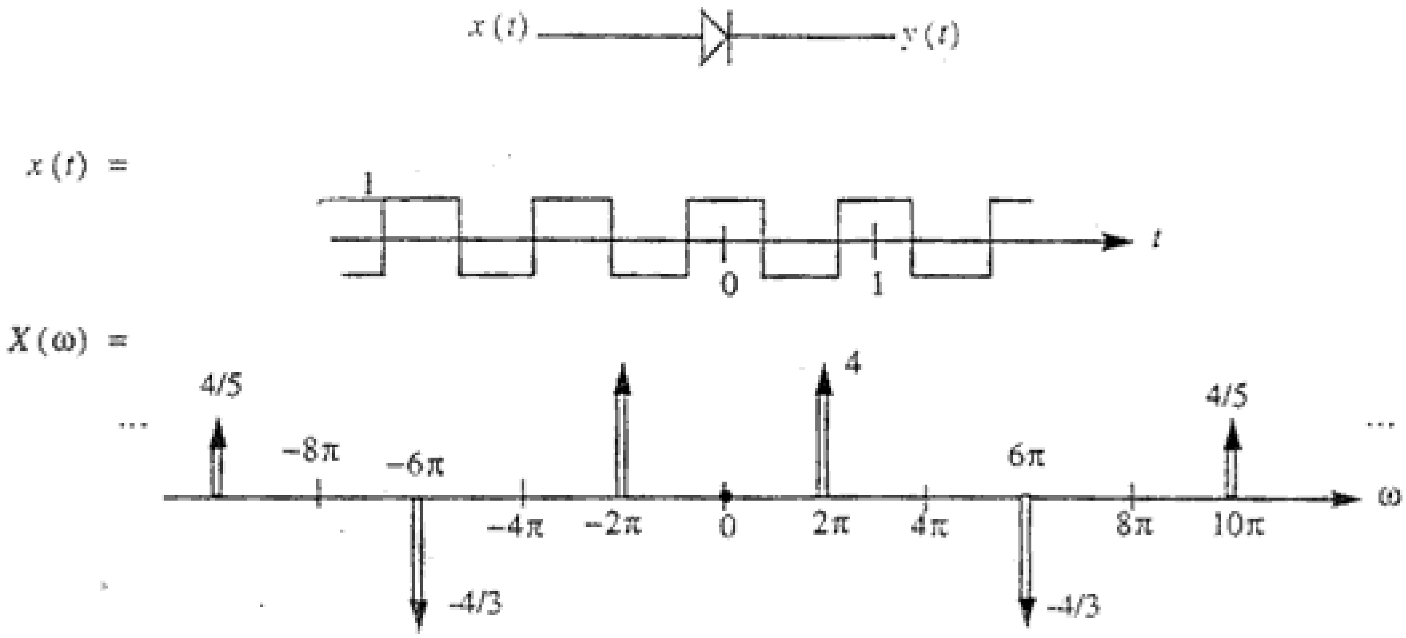
$m(t) = PI(t) = u(t + 1/2) - u(t - 1/2)$

[2 pts.] a) Sketch *x(t)*.

[8 pts.] b) Sketch Re{*X(omega)*}, noting maximum amplitudes, center frequencies, and frequency of first zero crossing.

Problem #2 (10 points)

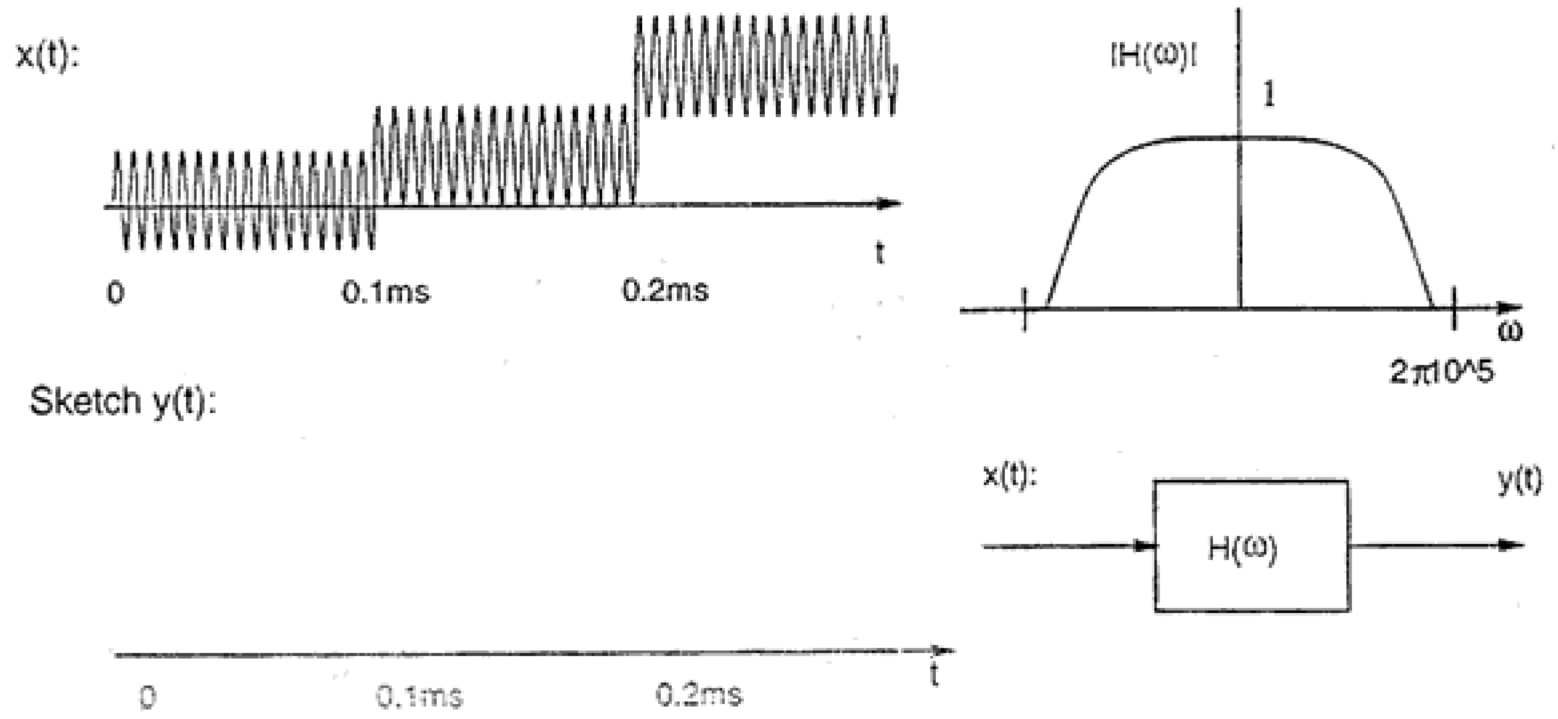
A square wave *x(t)* is passed through an ideal diode. Sketch the spectrum at the output of the ideal diode *Y(omega)*, labelling important frequencies and amplitudes. Recall for an ideal diode that v_{out} = { 0, v_{in} < 0 and v_{in}, v_{in} >= 0 }.



Sketch *Y(omega)*.

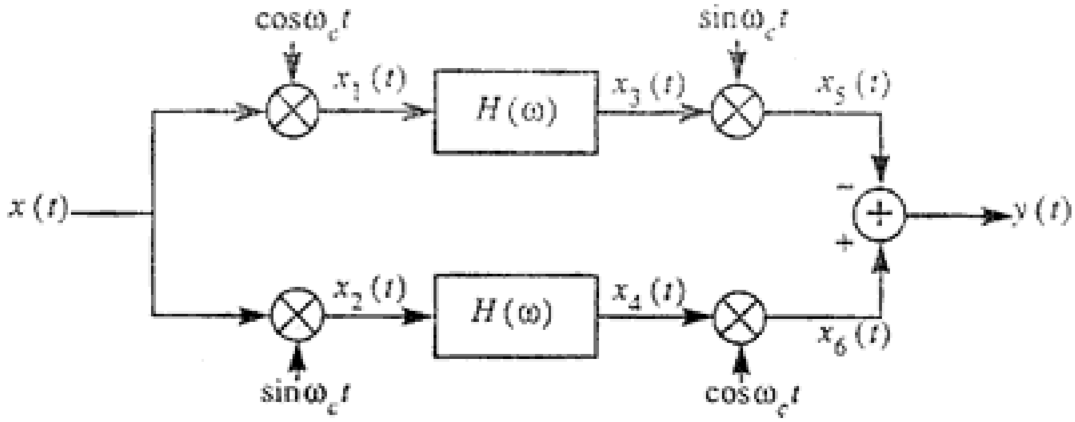
Problem #3 (5 points)

The signal *x(t)* is passed through a lowpass filter with frequency response *H(omega)*. The signal *x(t)* contains a sinusoidal component at 100 KHz. Sketch approximately *y(t)*, the output in time of the lowpass filter for the input *x(t)*.



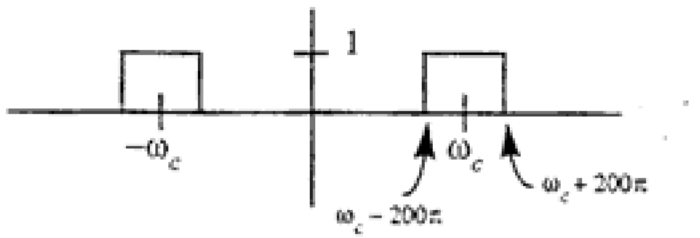
Problem #4 (25 points)

You are given the following modulation scheme:



where $H(\omega) = \begin{cases} j, & \omega > 0 \\ -j, & \omega < 0 \end{cases}$

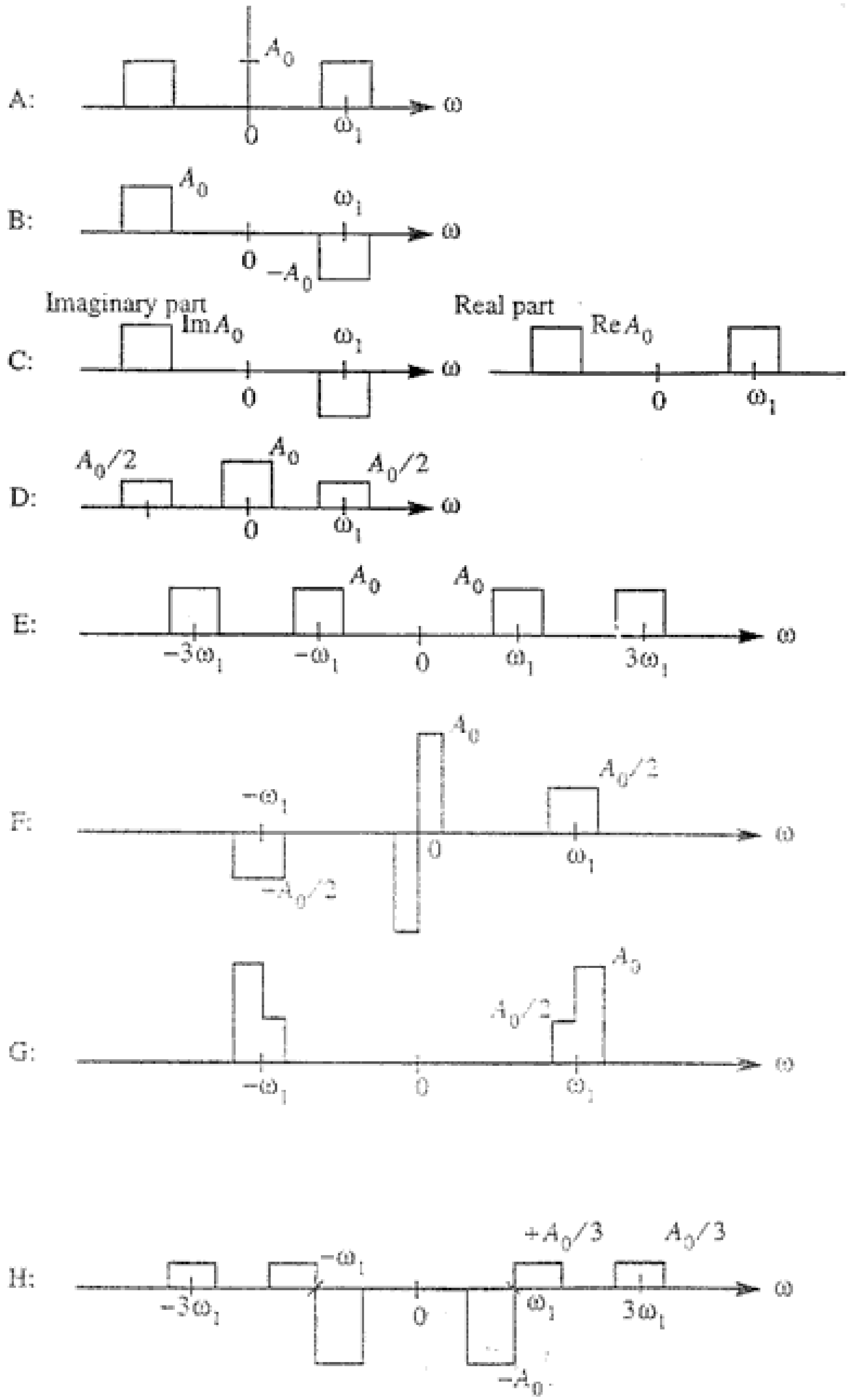
and $X(\omega) = \mathcal{F}\{x(t)\}$ is given by



For each signal $x_1(t)$, $x_2(t)$, ..., $x_6(t)$, $y(t)$ select one of the following sketches, specifying amplitude A_0 and frequency *omega*$_1$. (Hint: Amplitude A_0 may be complex.)

	letter of sketch	A_0	*omega*$_1$
X_1*(omega)*			
X_2*(omega)*			
X_3*(omega)*			
X_4*(omega)*			
X_5*(omega)*			
X_6*(omega)*			
Y(omega)			

The following sketches represent spectra of the signals $x_1(t)$ ... $x_6(t)$, and $y(t)$. The horizontal and vertical scale in each sketch are arbitrary, and should be considered independently.



Problem #5 (7 points)

A causal system is described by the following differential equation (with input $x(t)$ and output $y(t)$) :

$$dy/dt = d^2x/dt^2 + 3\,dx/dt + 2\,x$$

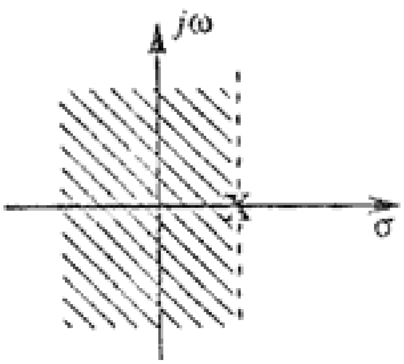
Assuming zero initial conditions,

a) Is this system BIBO stable?

b) Find $Y(s)$ and $y(t)$ for $x(t) = 0$ and $y(0^-) = -5$.

Problem #6 (3 points)

A system has Laplace Transform $X(s)$ with ROC *sigma* < 2.



The system is (circle one) :

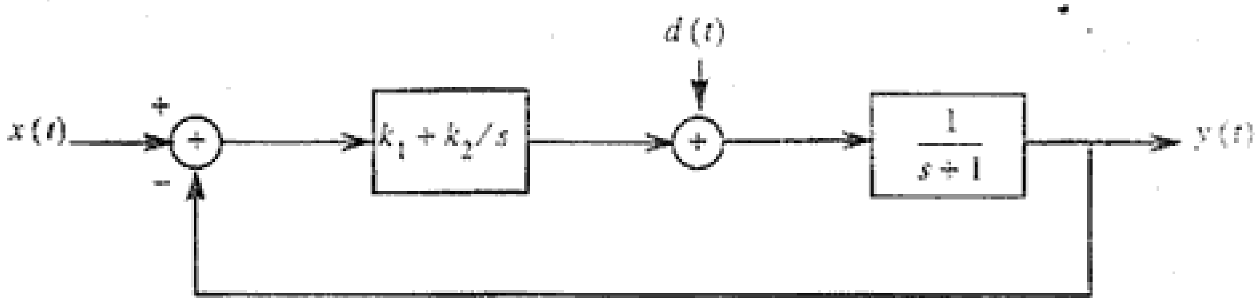
a) stable but not causal

b) causal but not stable

c) stable and causal

d) neither stable nor causal

Problem #7 (15 points)



a) With $d(t) = 0$, compute $Y(s)/X(s)$.

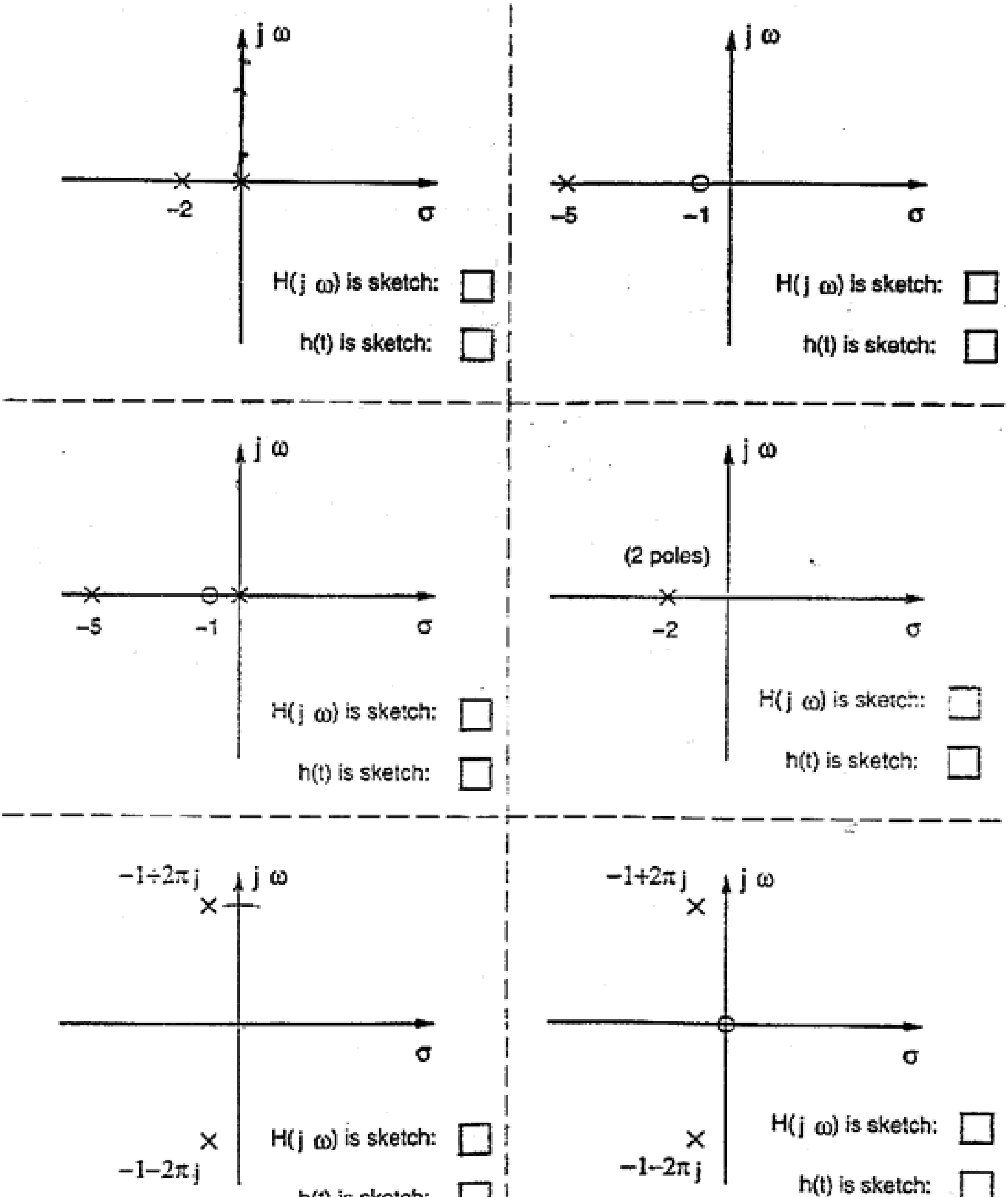
b) For which values of k_1 and k_2 is the system stable?

c) Let $d(t) = u(t)$ and $x(t) = 0$, with $k_1 = 1$ and $k_2 = 1$. What is the limit of $y(t)$ as t approaches infinity? (answer should be a **number**)

d) Let $d(t) = 0$ and $x(t) = u(t)$, with $k_1 = 1$ and $k_2 = 1$. What is the limit of $y(t)$ as t approaches infinity? (answer should be a **number**)

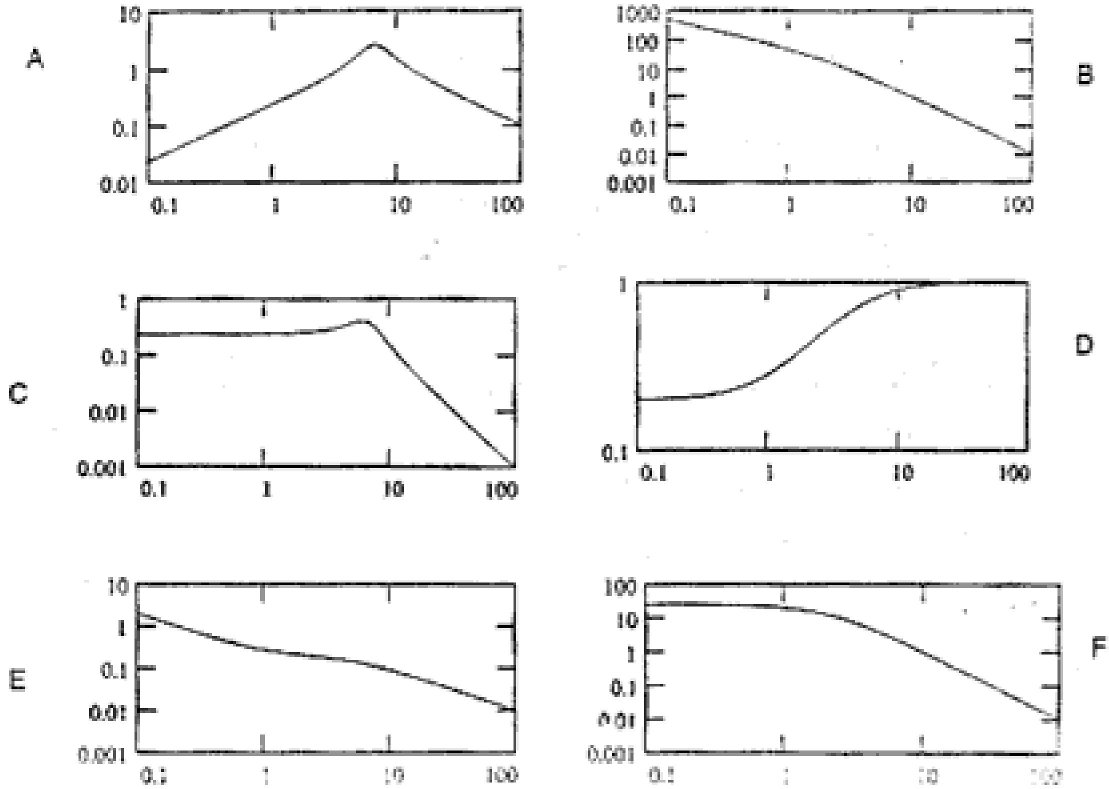
Problem #8 (25 points)

For each pole-zero diagram below, fill in the box with the letter of the corresponding frequency response and impulse response that follow. All diagrams represent causal systems.

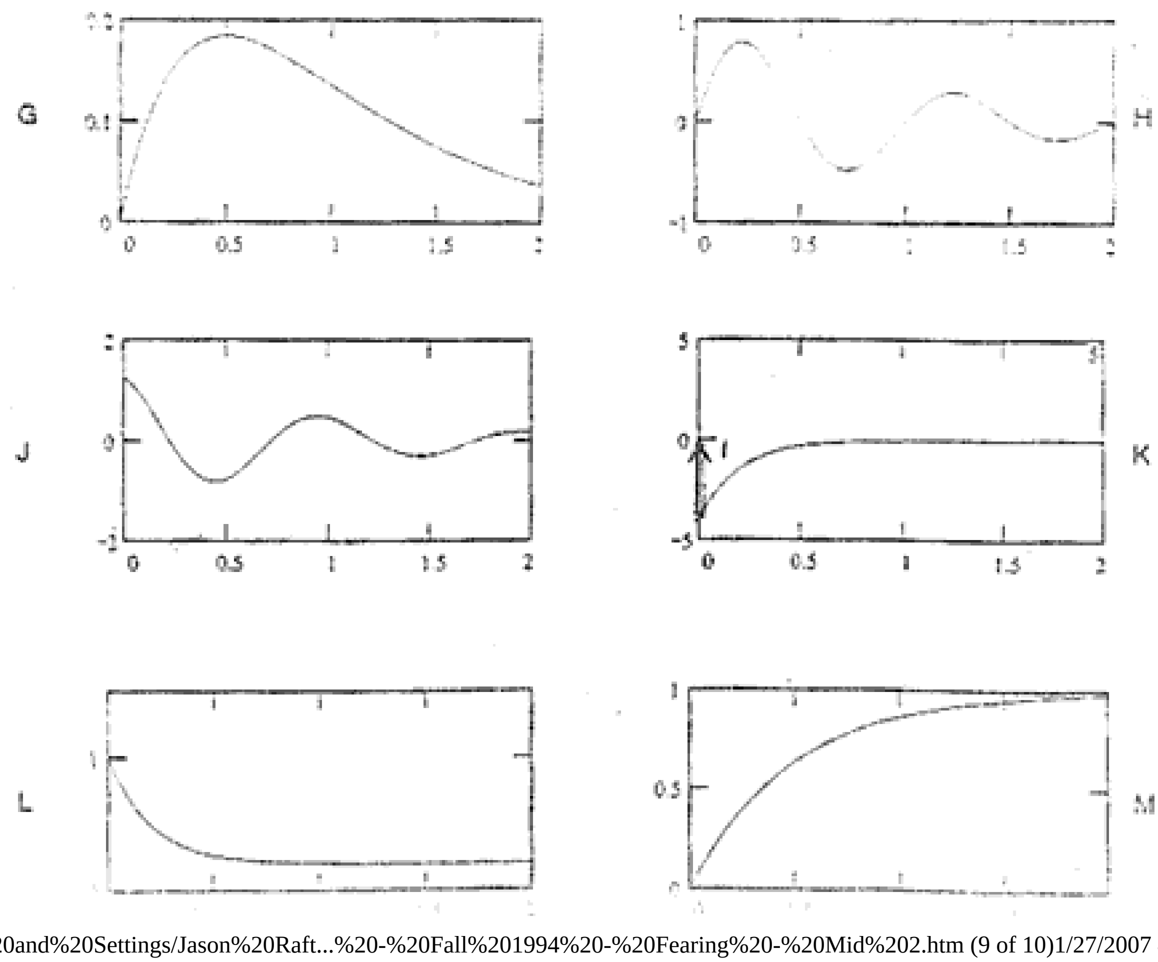


Sketches to be used as answers for problem #8.

Magnitude of the frequency response |H(jω)|:



Impulse Responses



Solutions (page 1)
Solutions (page 2)
