EE120, Spring 97
Midterm 2
Professor Fearing

Problem 1 (30 points)
Let m(t) = cos(2000*pi*t), n(t) = sin(2000*pi*t) and f_c = 10 ^ 6.

[1 pts.] a) Sketch M(f), labelling height/area, center frequency, and sideband frequencies.

[3pts] b) Let x_1(t) = m(t) cos(2*pi*f_c*t). Sketch X_1(f), labelling height/area, center frequency, and sideband
frequencies.

[3pts] c) Let x_2(t) = (1 + m(t))cos(2*pi*f_c*t). Sketch X_2(f), labelling height/area, center frequency, and sideband
frequencies.

[6pts] d) Let x_3(t) = [m(t)]cos(2*pi*f_c*t) + [n(t)]sin(2*pi*f_c*t). Sketch X_3(f), labelling height/area, center frequency,
and sideband frequencies.

[7pts] e) Let x_4(t) = cos(2*pi*f_c*t + m(t)/10). Sketch X_4(f), labelling height/area, center frequency, and sideband
frequencies. (Hint: Approximation may be appropriate.)

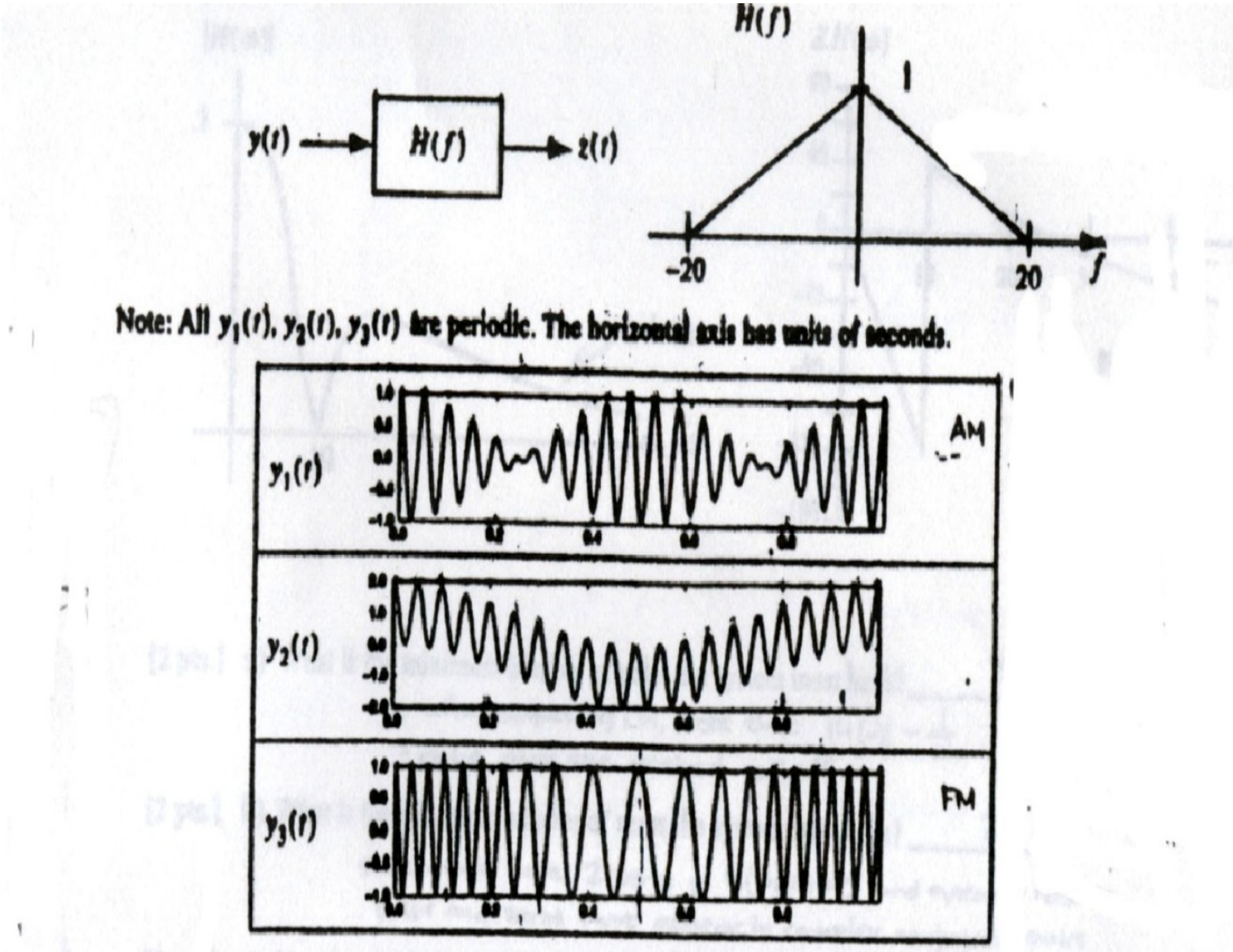
[6pts] f) Describe how you could recover m(t) and n(t) from x_3(t). Draw a block diagram of a system which has input
x_3(t) and outputs m(t) and n(t). The system should work for any m(t) and n(t), bandlimited to 10kHz.
Specify appropriate frequencies for any component you use.

[4pts] g) Identify the type of modulation used to generate each signal (e.g. AM-DSB, NBFM, etc.).

x_1(t) modulation type ________
x_2(t) modulation type ________
x_3(t) modulation type ________
x_4(t) modulation type ________

Problem 2 (10 points)

The problem considers filtering of signals by a filter H(f) with frequency response as shown:



a) What is z_1(t), the output of the filter for input y1_(t)? ___________

b) Sketch z_2(t), the output of the filter for input y_2(t).

c) BONUS: Sketch z_3(t), the output of the filter for input y_3(t).

Problem 3 (20 points)

A modulation scheme is described by

x(t) = cos (2*pi*f_c*t + 2*pi*f_m*t*m(t)) with f_C = 10 kHz and f_m = 1 kHz

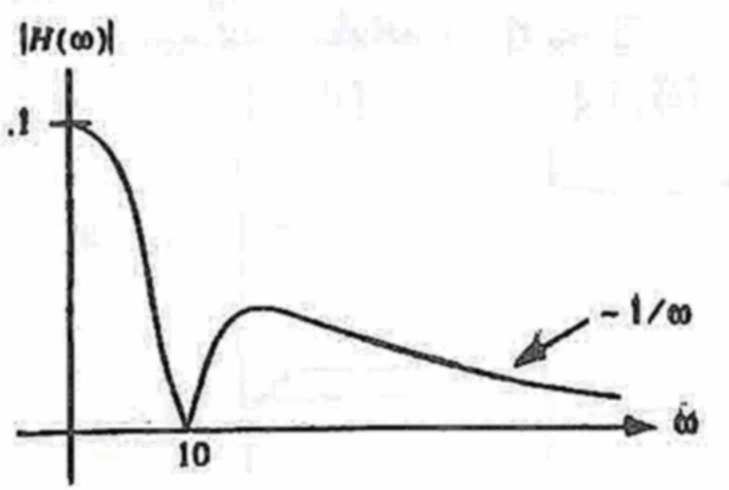
[16 pts] a) Sketch ReX(f), noting important frequencies, areas, and amplitudes.
(Hint: Express x(t) as a sum of two signals.)
(Hint: Use appropriate engineering approximation.)

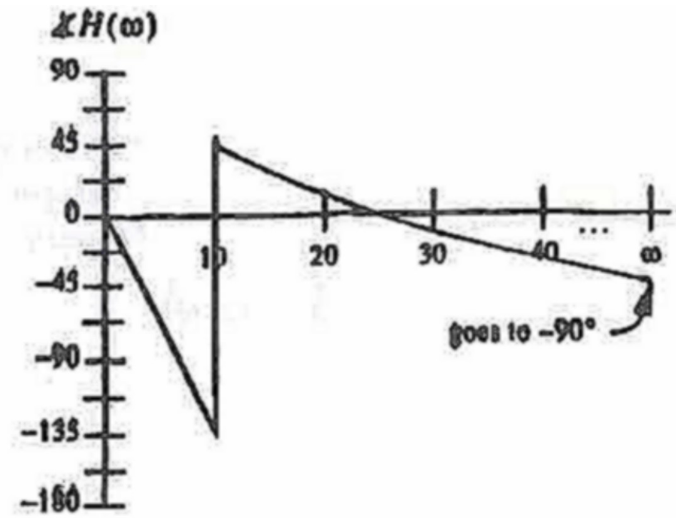
[4pts] b)What is the power in x(t)? _____________

What fraction of the power in X(f) is at the carrier frequency f_c? _________

Problem 4

Consider the frequency response of a real, stable, system shown below:





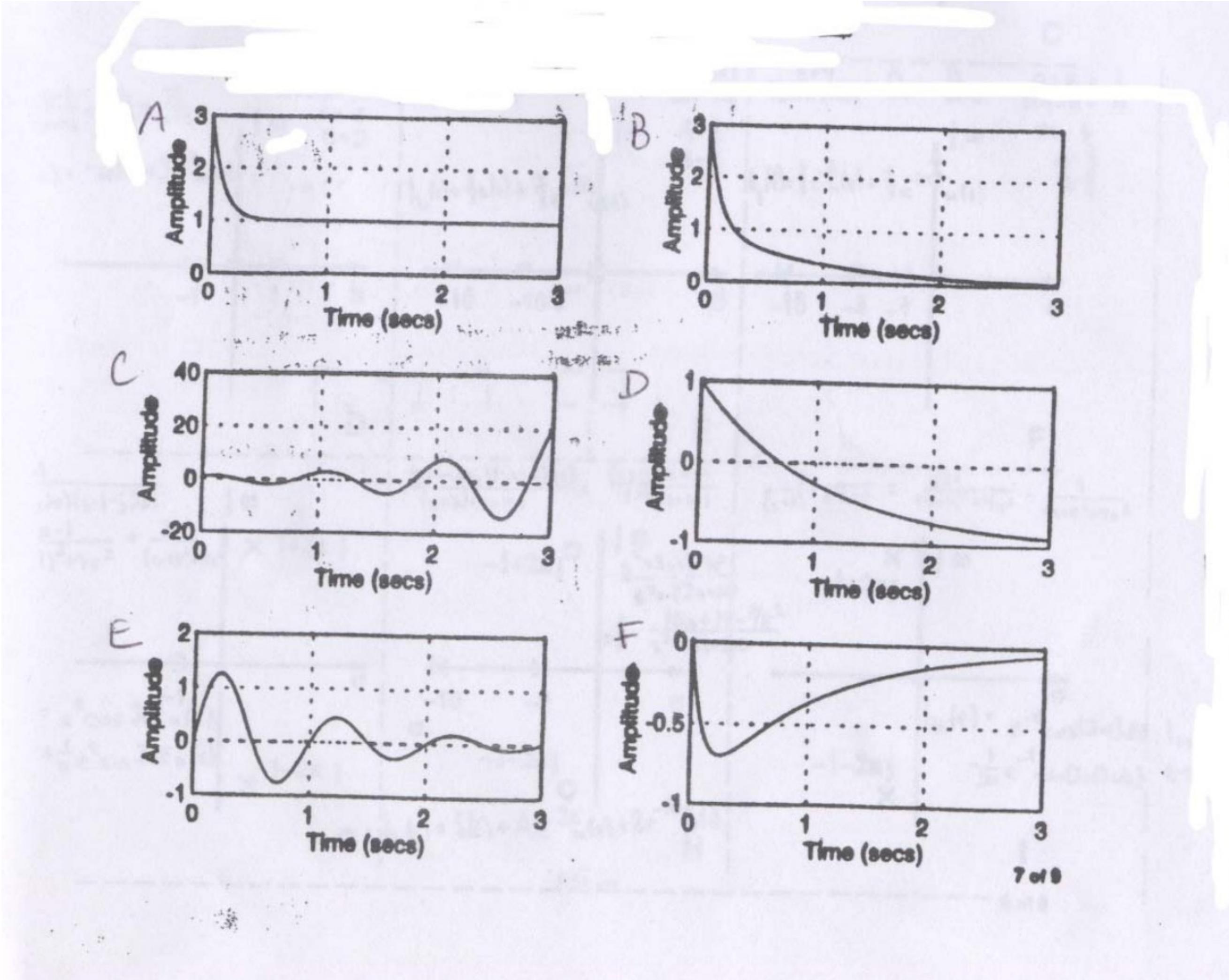
[2pts] a) What is the minimum number of poles the system must have? ______

[2 pts] b) What is the minimum number of zeros the system must have? ______

[6 pts] c) Sketch and label the pole-zero diagram for a stable system (using a minimum number of poles and zeros)
which would have the given magnitude response. Note: H(omega = 0) = 0.1. H(omega = 10) = 0.

Problem 5

For each impulse response below, choose the corresponding pole-zero diagram below and put letter next to the given impulse response.

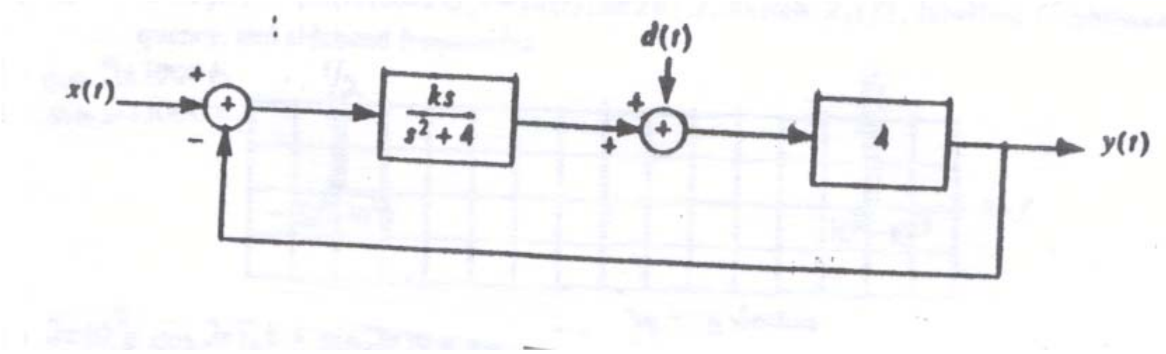


Hint 1: (a+b)/(a+c) = 1 + (b-c)/(a+c)

Hint 2: No impulse response contains delta(t).

h_1(t) = _______
h_2(t) = _______
h_3(t) = _______
h_4(t) = _______
h_5(t) = _______
h_6(t) = _______

Problem 6 (15 pts)



[3 pts] a) With d(t) = 0, compute Y(s)/X(s) =

[5 pts] b) For which values of k is the system stable?
k: _________

For parts c and d, if the limit exists, answer should be a number. Otherwise, write "does not exist."

[3 pts] c) Let d(t) = sin(2t)u(t) and x(t) = 0, with k = 1.
lim(t -> infinity) y(t) = ______________

[4 pts] d) let d(t) = 0 and x(t) = tu(t), with k = 1.
lim(t -> infinity) y(t) = ______________