Problem #1 Discrete Fourier Transform (DFT) (40 points)

As discussed in class and in the DFT handout, the block diagram below represents the operations involved in finding t
DFT of a time signal *x(t).*

Recall that the DFT of length *N* sequence x[*n*] is X[*k*] = sum(x[n]**e^(-j*2*pi*n*k/N),n=0,n=N-1).* X[*k*] values can be found by using the block diagram

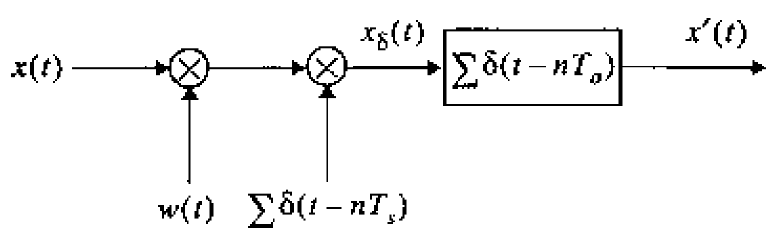
to find X'(w) and then noting that X[*k*] = To/(2*pi)*area{X'(*k**2*pi/To)}. For each part below, with Ts = 1 second, To
seconds, match the time samples

x[*n*] (= area{x'(nTs)} *(1 pt. each)* and DFT samples X[*k*] *(4 pts. each)* with the time signal *x(t).*

The window function: w(t) = { 0 if *t*<0-, 1 if 0-<= *t*< 16-, 0 if 16-<=*t*

Hint: *w(t) ~= PI[(t-To/2)/To]*

For each part, pick the letter of the matching plot from the next pages. Hint #1: All X[*k*] are real. Hint #2: x[*n*] are A-H
X[*k*] are I-P.



a) x1(*t*) = cos(pi**t*/8)

---->x1[*n*] is plot:

---->X1[*k*] is plot:

b) x2(*t*0 = cos(pi**t*/4)

---->x2[*n*] is plot:

---->X2[*k*] is plot:

c) x3(*t*) = cos(pi**t*/2)

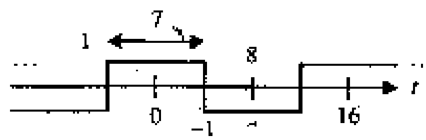
---->x3[*n*] is plot:

---->X3[*k*] is plot:

d) x4[*n*] = {cos(*n**pi/8) if *n even*, 0 if *n odd*

---->x4[*n*] is plot:

---->X4[*k*] is plot:



e) x5(*t*) =

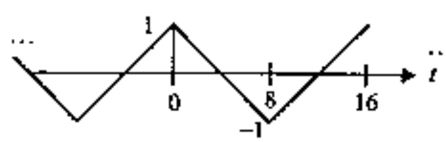
---->x5[*n*] is plot:

---->X5[*k*] is plot:

f) x6(*t*) = cos[pi/3*(*t*-To/2)]

---->x6[*n*] is plot:

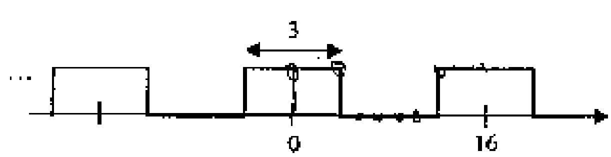
---->X6[*k*] is plot:



g) x7(*t*) =

---->x7[*n*] is plot:

---->X7[*k*] is plot:

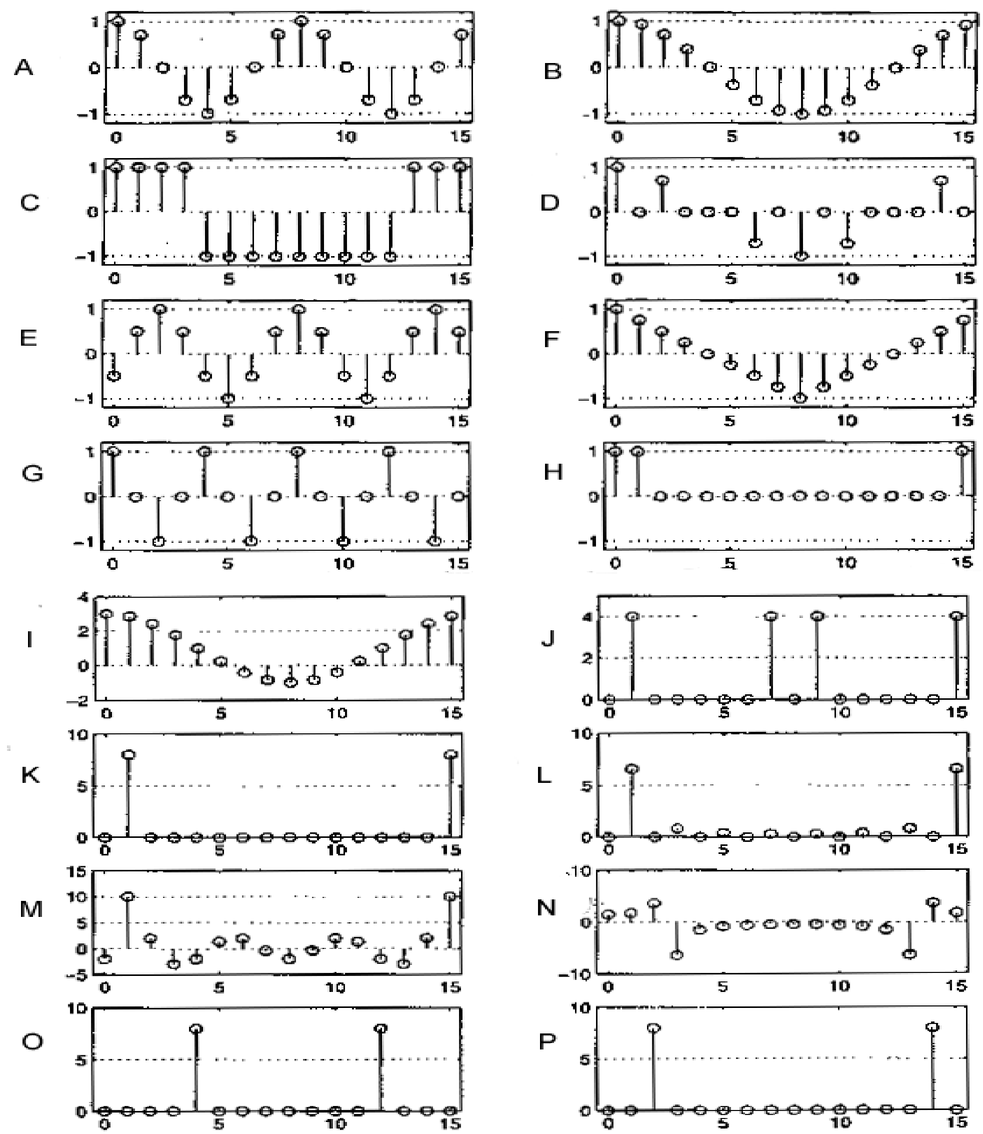


h) x8(t) =

---->x8[*n*] is plot:

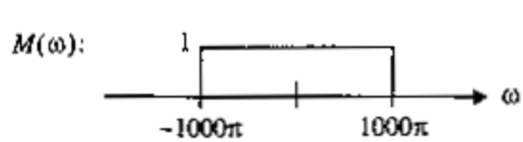
---->X8[*k*] is plot:

<u>Plots for Prob 1:</u>



Problem #2 (42 points)

Let $m(t) = \dfrac{\sin 1000\pi t}{1000\pi t}$. $F\{m(t)\} = M(\omega) = \Pi\left(\dfrac{\omega}{2000\pi}\right)$



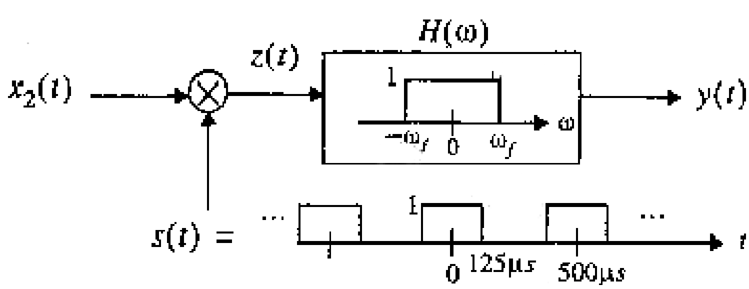
(10 pts.) a) Let x1(t) = m(t)cos(4000*pi*t). Sketch x1(t) for 0<=t<=2*10^-3 sec, labeling peak height and accurately indicating zero crossings.

Sketch X1(w), labeling height/area, center frequency, and sideband frequencies.

(10 pts.) b) Let x2(*t*) = (1+*m*(*t*))cos(4000*pi*t). Sketch x2(*t*) for 0<=t<=2*10^-3 sec, labeling peak height and accurat
indicating zero crossings.

Sketch X2(w), labeling height/area, center frequency, and sideband frequencies.

(6 pts.) c) x2(*t*) = (1+*m*(*t*))cos(4000*pi*t) is passed through the system shown, with wf = 1500*pi

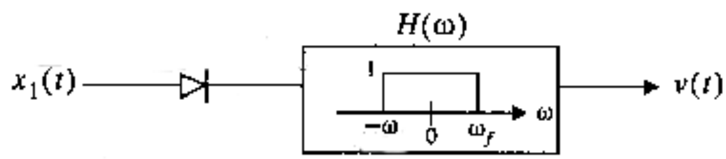


Hint: S(w) = sum((2*sin(*k**pi/2)/*k*)*delta(w-4000*pi***k*)),*k*=-infinity to +infinity)

Sketch Z(w), labeling height area/area, center frequencies, and sideband frequencies for 0<=w<=12000*pi

[Hint: Z(w) is real and even]

(8 pts.) d) x1(*t*) = *m*(*t*)cos(4000*pi**t*) is passed through an ideal diode and ideal low pass filter *H*(w), with wf = 1500*



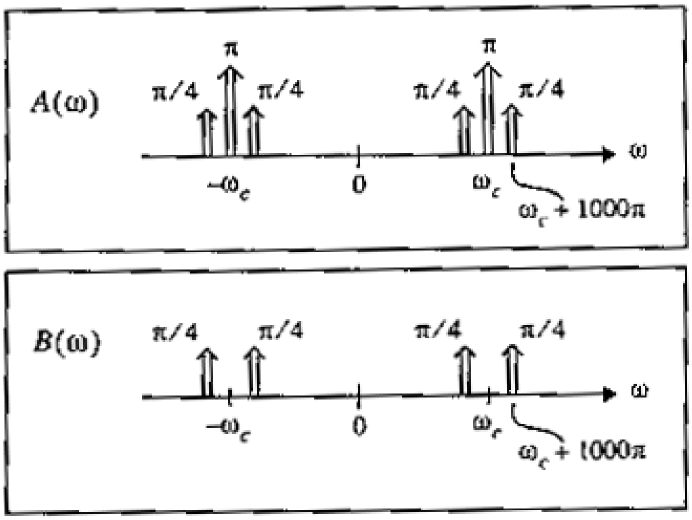
Approximately sketch *v*(*t*), for 0<=*t*<=2*10^-3 sec

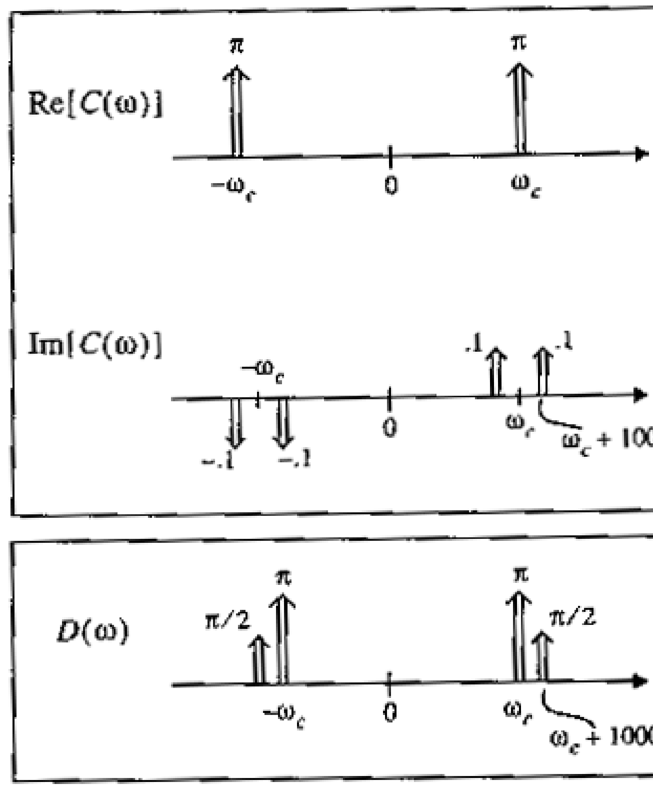
Is *v*(*t*) an accurate estimate of the form of *m*(*t*)? Why or why not?

(8 pts.) e) Let x3(*t*) = *m*(*t*)cos(4000*pi**t*) + (*m*(*t*) * 1/(pi*t))sin(4000*pi**t*). Sketch X3(w), labeling height/area, center frequency, and sideband frequencies.

Problem #3 (12 points)

You are given modulation *m*(*t*) = cos(1000*pi**t*), which drives 4 transmitters a, b, c, and d. Each transmietter generate new signals *a*(*t*),*b*(*t*),*c*(*t*),*d*(*t*) with spectra A(w), B(w), C(w), D(w) using *m*(*t*), as shown below:



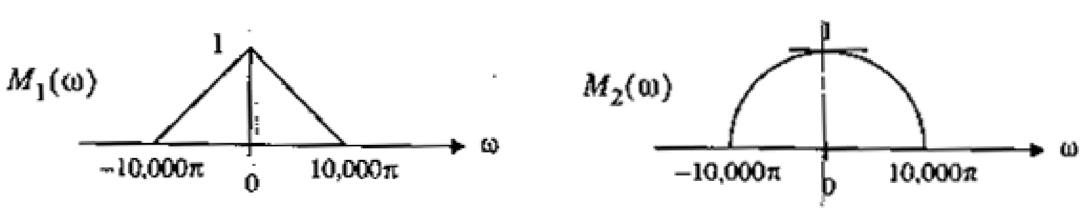


For each transmitter, identify the modulation method used (for example, AM - DSB - LC, WB FM, etc.), the channel bandwidth used, and the power efficiency (fraction of power transmitting useful information).

	Modulation Method	Channel BW	Power Efficiency
A(w)			
B(w)			
C(w)			
D(w)			

Problem #4 (6 points)

The Federal Communications Commission has assigned you a transmission channel from 1.000 MHz to 1.010 MHz. You have two bandlimited message signals *m*1(*t*) and *m*2(*t*) with spectra *M*1(*w*)and *M*2(*w*), as shown:



Draw a block diagram for a transmitter that could send both messages simultaneously in the given channel bandwidth. Your transmitter contains multiplier blocks, oscillators, and summers only.
