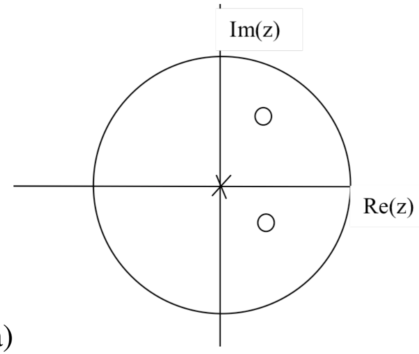
Due Wednesday Sept. 16, 2009 at 5:00 PM
in TA's dropbox on Rhea
(hard copies can be handed in in class)

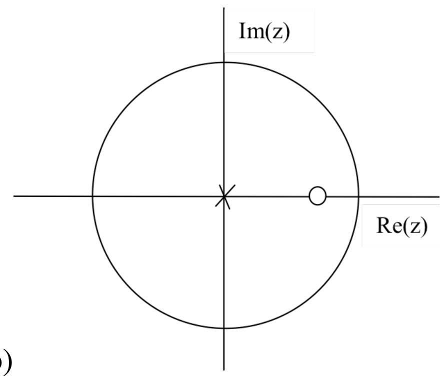
ECE 438 **Assignment No. 2** **Fall 2009**

Note: Plagiarism shall be severely punished.

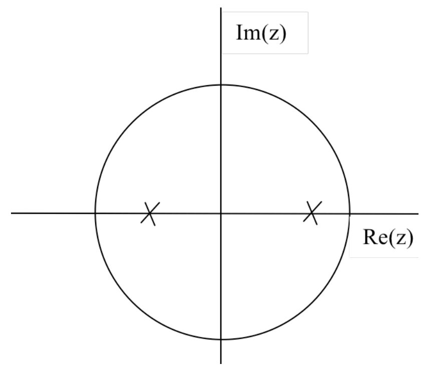
1. Each of the following graphs represents the complex plane. The large circle drawn is the unit circle. Each "O" represents the location of a zero, and each "x" represents the location of a pole of the z-transform of a signal. Sketch a graph of the magnitude of the Fourier transform of these signals.



a)



b)

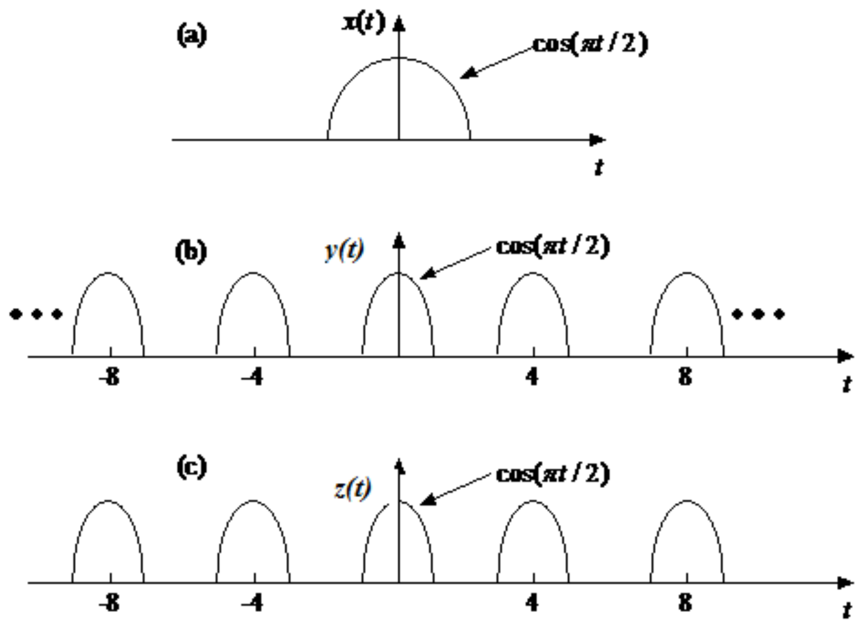


c)

2. For each signal $x(t), y(t)$, and $z(t)$ given in parts a - c below, do the following:

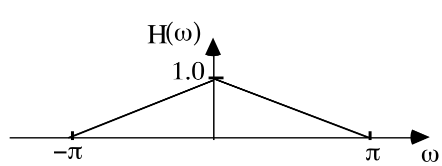
    i. Find an expression for its CTFT. (Use transform relations including comb function and the results of previous parts of the problem wherever possible. In particular, for part (a), you should use the product theorem and known transform pairs, rather than evaluating the Fourier integral directly.)

    ii. Carefully sketch the CTFT.



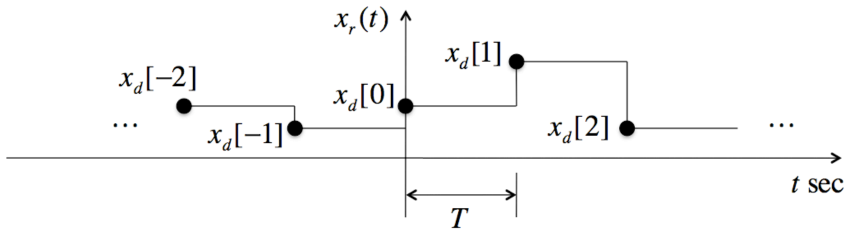
3. The signal $x(t) = \cos(2\pi(50)t)\text{sinc}(50t)$ is sampled with period T = 0.005 sec. to generate a discrete-time signal $x[n]$.
   a. Sketch $x(t)$ and $x[n]$.
   b. Derive and sketch the CTFT $X(f)$ for $x(t)$.
   c. Derive and sketch the CTFT $X_s(f)$ for $x_s(t) = \text{comb}_T[x(t)]$
   d. Using your results from part c. above, find the DTFT $X(\omega)$ for $x[n]$

4. A non-negative unit amplitude square wave with period P sec. and 50% duty cycle is filtered with an ideal low pass analog filter with cutoff at f_c kHz, and then sampled with an ideal sampler at a rate of 20 kHz, filtered with a digital filter having the frequency response $H(\omega)$ shown below, and then reconstructed as an analog signal $y(t)$ with an ideal D/A convertor with a cutoff frequency of 10 kHz.



Find the output $y(t)$ for the following values of T and f_c
   a. P = 0.2 msec, f_c = 10 kHz
   b. P = 0.2 msec, f_c = 20 kHz

5. In class, we discussed a method for converting a discrete-time signal $x_d[n]$ to a continuous-time representation $x_r(t)$ by using *zero-order hold* interpolation, as illustrated below:

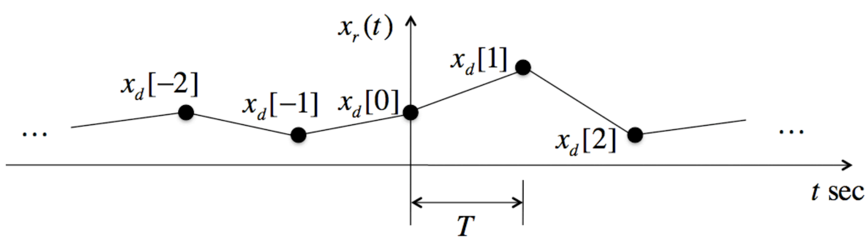


a. Use special functions and standard CTFT transform relations to find an expression for the CTFT $X_r(f)$ of the above signal $x_r(t)$ in terms of the CTFT $X_a(f)$ of the signal $x_a(t)$. Here $x_d[n] = x_a(nT)$.

b. Carefully sketch $X_r(f)$ for the case where

$$X_a(f) = \begin{cases} 1 - 2T|f|, & |f| < (2T)^{-1} \\ 0, & \text{else} \end{cases}$$

Zero-order hold interpolation results in a discontinuous reconstructed signal $x_r(t)$. An alternative is to use first-order or piecewise linear interpolation, illustrated below:



c. Use special functions and standard CTFT transform relations to find an expression for the CTFT $X_r(f)$ of the above signal $x_r(t)$ in terms of the CTFT $X_a(f)$ of the signal $x_a(t)$. Here $x_d[n] = x_a(nT)$.

d. Carefully sketch $X_r(f)$ for the case where

$$X_a(f) = \begin{cases} 1 - 2T|f|, & |f| < (2T)^{-1} \\ 0, & \text{else} \end{cases}$$