GEORGIA INSTITUTE OF TECHNOLOGY

SCHOOL of ELECTRICAL and COMPUTER ENGINEERING

ECE 2025 Fall 1999
Problem Set #4

Assigned: 17 September 99

Due Date: 24 September 99 (FRIDAY)

Reading: In *DSP First*, all of Chapter 4 on *Sampling.*

⟹ The **STARRED** problems will have to be turned in for grading.

Next week a solution will be posted. Some similar problems solutions can be found on the CD-ROM.

PROBLEM 4.1*:

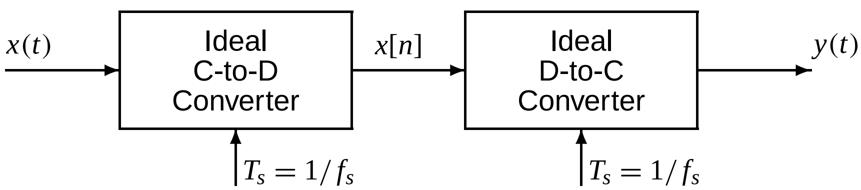
Consider the signal

$$x(t) = [10 + 20\sin(500\pi t)]\cos(1500\pi t)$$

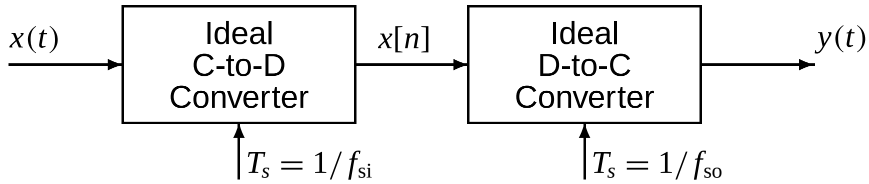
(a) Sketch the two-sided spectrum of this signal. Be sure to label important features of the plot. *Hint: Recal the AM spectrum from a previous homework set.*

(b) Is this waveform periodic? If so, what is the period?

(c) What is the minimum sampling rate f_s that can be used in the following system so that $y(t) = x(t)$?



PROBLEM 4.2*:

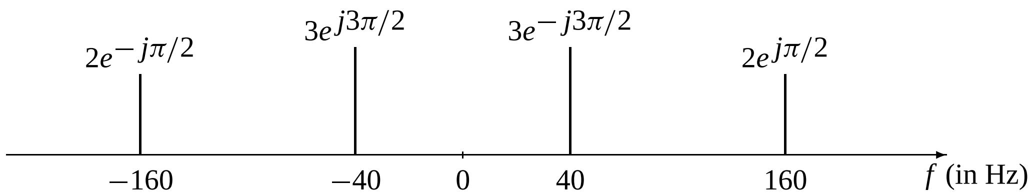


(a) Suppose that the discrete-time signal $x[n]$ is given by the formula

$$x[n] = 10\cos(0.25\pi n - \pi/4)$$

If the sampling rate of the C-to-D converter is $f_{si} = 2000$ samples/second, many *different* continuous-time signals $x(t) = x_\ell(t)$ could have been inputs to the above system. Determine two such inputs with frequency less than 2000 Hz; i.e., find $x_1(t)$ and $x_2(t)$ such that $x[n] = x_1(nT_{si}) = x_2(nT_{si})$ if $T_{si} = 1/2000$ secs.

(b) Now if the input $x(t)$ is given by the two-sided spectrum representation shown below,



Determine the spectrum for $x[n]$ when $f_{si} = 120$ samples/sec. Make a plot for your answer, but label the frequency, amplitude and phase of each spectral component.

(c) Using the discrete-time spectrum from part (b), determine the analog frequency components in the output $y(t)$ when the sampling rate of the D-to-C converter is $f_{so} = 120$ Hz.

(d) Using the discrete-time spectrum from part (b), determine the analog frequency components in the output $y(t)$ when the sampling rate of the D-to-C converter is $f_{so} = 200$ Hz. In other words, the sampling rates of the two converters are different.

PROBLEM 4.3*:

In the rotating disk and strobe demo described in Chapter 4 of *DSP First*, we observed that different flashing rates of the strobe light would make the spot on the disk stand still.

(a) Assume that the disk is rotating in the counter-clockwise direction at a constant speed of 600 rpm (revolutions per minute). Express the movement of the spot on the disk as a rotating complex phasor.

(b) If the strobe light can be flashed at a rate of n flashes *per second* where n is an integer greater than zero, determine all possible flashing rates such that the disk can be made to stand still.
NOTE: the only possible flashing rates are integers: 1 per second, 2 per second, 3 per second, etc.

(c) If the flashing rate is 11 times per second, explain how the spot will move and write a complex phasor that gives the position of the spot at each flash.

(d) Draw a spectrum plot of the discrete-time signal in part (c) to explain your answer.