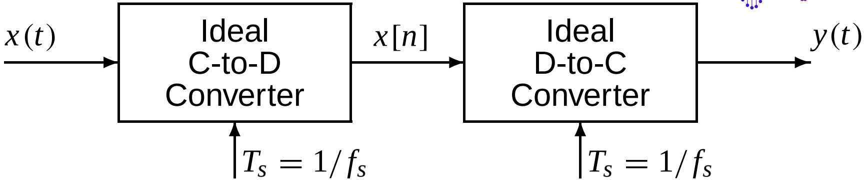
PROBLEM:



Chirps are very useful signals for probing the behavior of sampling operations and illustrating the "folding" type of aliasing.

(a) If the input to the ideal C/D converter is $x(t) = 7\cos(1800\pi t + \pi/4)$, and the sampling frequency is 1000 Hz, then the output $y(t)$ is a sinusoid. Determine the formula for the output signal.

(b) Suppose that the input signal is a chirp signal defined as follows:

$$x(t) = \cos(2000\pi t - 400\pi t^2) \qquad \text{for } 0 \le t \le 5 \text{ sec.}$$

If the sampling rate is $f_s = 1000$ Hz, then the output signal $y(t)$ will have time-varying frequency content. Draw a graph of the resulting analog *instantaneous* frequency (in Hz) versus time of the signal $y(t)$ **after reconstruction.** Hint: this could be done in MATLAB by putting a sampled chirp signal into the MATLAB function `specgram()`, or the SP-First function `plotspec()`.

McClellan, Schafer and Yoder, *Signal Processing First*, ISBN 0-13-065562-7.
Prentice Hall, Upper Saddle River, NJ 07458. © 2003 Pearson Education, Inc.

SOLUTION

(a) $x[n] = x\left(\frac{n}{1000}\right) = 7\cos(1.8\pi n + \pi/4)$

$= 7\cos(-0.2\pi n + \pi/4) = 7\cos(0.2\pi n - \pi/4)$

$\Rightarrow y(t) = 7\cos(0.2\pi(1000)t - \pi/4)$

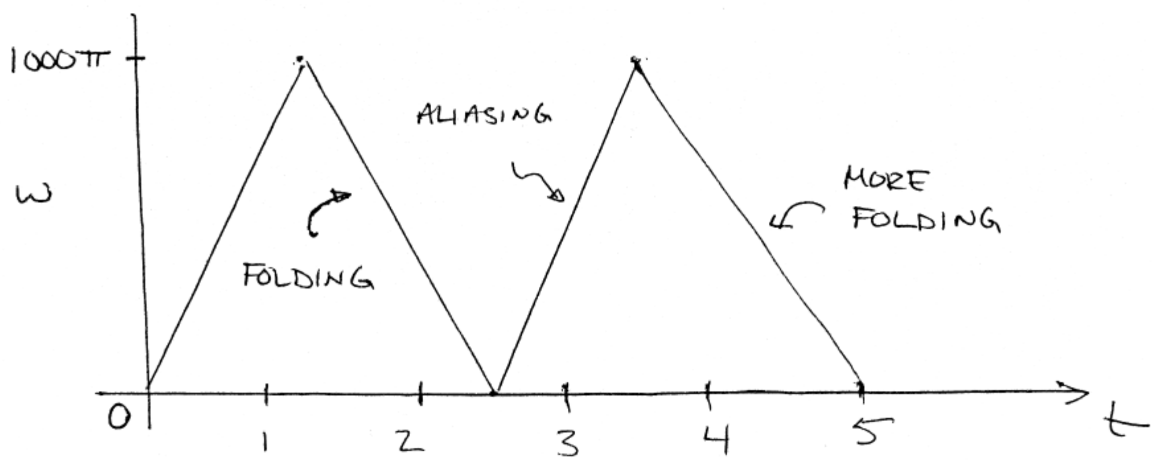
$= 7\cos(200\pi t - \pi/4)$

(b) $x(t) = \cos(2000\pi t - 400\pi t^2)$

$= \cos(400\pi t^2 - 2000\pi t)$

$\omega_i(t) = 800\pi t - 2000\pi$

At $t=0$, $\omega_i(0) = -2000\pi$. For $f_s = 1000$ Hz, THIS ALIASES TO LOOK LIKE 0 Hz.



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