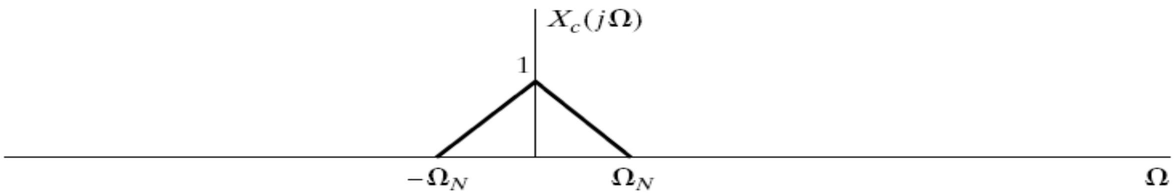
Practice Examples
Chapter-4 Sampling Theorem

Practice

1. What is f in terms of time t?
2. What is f_s, sampling frequency in hertz in terms of time?
3. What is Ω, analogue frequency in rad/s?
4. What is Ω_s, analogue sampling frequency?
5. What is discrete time frequency ω in radians in terms of Ω?
6. What is ω_s, discrete time sampling frequency in terms of Ω_s?
7. What is the general rule of finding spectrum of any analogue periodic signal? Find the spectrum of analogue periodic impulse train.
8. Why is the spectrum of discrete-time signal $x[n]$ is periodic with $\omega = 2\pi$ radians, the cliché we learned in Chapter-2?
9. Draw the analogue Sinc function $x(t) = \frac{\sin(\pi t/_2)}{(\pi t/_2)}$ and $x(t) = \frac{\sin(5\pi t/_2)}{(\pi t/_2)}$
10. Why we choose the reconstruction filter as low pass filter of cut-off $\frac{\pi}{T}$. Is this filter an analogue filter or discrete filter? Why/Why not? What mathematical operation the reconstruction filter performs?
11. What is the condition of being a band-limited signal in Ω and ω in the scope of sampling theorem.
12. Perform downsampling for $M = 2$ and $\omega_N = \frac{\pi}{4}$, repeat this for $M = 5$



13. Perform upsampling for $L = 3$ and $\omega_N = \frac{\pi}{2}$ for the above spectrum.

14.

The sequence

$$x[n] = \cos\left(\frac{\pi}{4}n\right), \qquad -\infty < n < \infty,$$

was obtained by sampling a continuous-time signal

$$x_c(t) = \cos(\Omega_0 t), \qquad -\infty < t < \infty,$$

at a sampling rate of 1000 samples/s. What are two possible positive values of Ω_0 that could have resulted in the sequence $x[n]$?

15.

A simple model of a multipath communication channel is indicated in Figure P4.7-1. Assume that $s_c(t)$ is bandlimited such that $S_c(j\Omega) = 0$ for $|\Omega| \geq \pi/T$ and that $x_c(t)$ is sampled with a sampling period T to obtain the sequence

$$x[n] = x_c(nT).$$

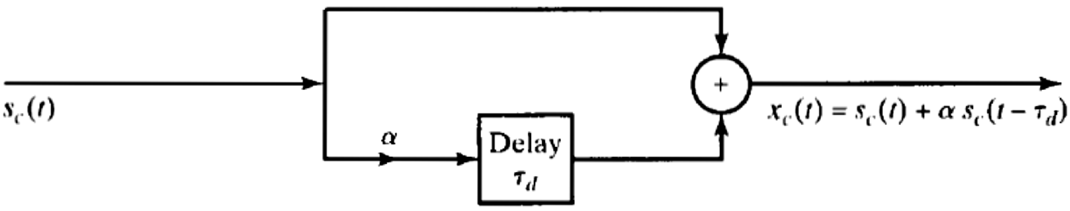


Figure P4.7-1

(a) Determine the Fourier transform of $x_c(t)$ and the Fourier transform of $x[n]$ in terms of $S_c(j\Omega)$.

16.

A continuous-time signal $x_c(t)$, with Fourier transform $X_c(j\Omega)$ shown in Figure P4.22-1, is sampled with sampling period $T = 2\pi/\Omega_0$ to form the sequence $x[n] = x_c(nT)$.

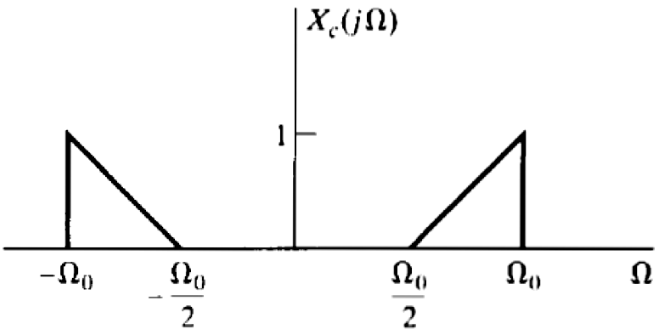


Figure P4.22-1

(a) Sketch the Fourier transform $X(e^{j\omega})$ for $|\omega| < \pi$.

(b) The signal $x[n]$ is to be transmitted across a digital channel. At the receiver, the original signal $x_c(t)$ must be recovered. Draw a block diagram of the recovery system and specify its characteristics. Assume that ideal filters are available.

(c) In terms of Ω_0, for what range of values of T can $x_c(t)$ be recovered from $x[n]$?

Do problem 4.29, 4.38