

Signal Process and Spectral Analysis

Test time: from 10:10AM to 11:40AM (90mins)

- The signal with the amplitude frequency spectrum shown in Figure 1 is to be sampled with an ideal sampler.
 - Sketch the spectrum of the resulting signal for $|\omega| \leq 120\pi \text{ rad/s}$ when sampling periods of 20, 40, and 100 ms are used. (15%)
 - Which of the sampling frequencies is acceptable for use if the signal is to be reconstructed with an ideal filter? (10%)

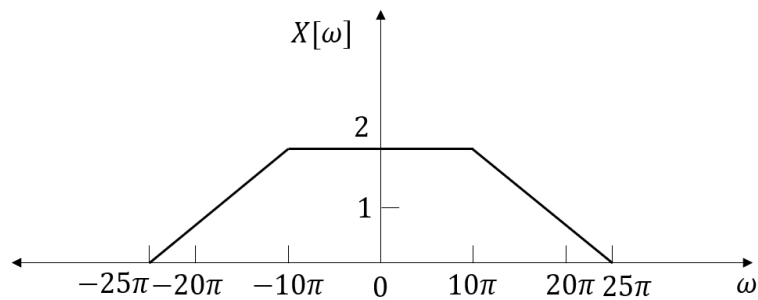
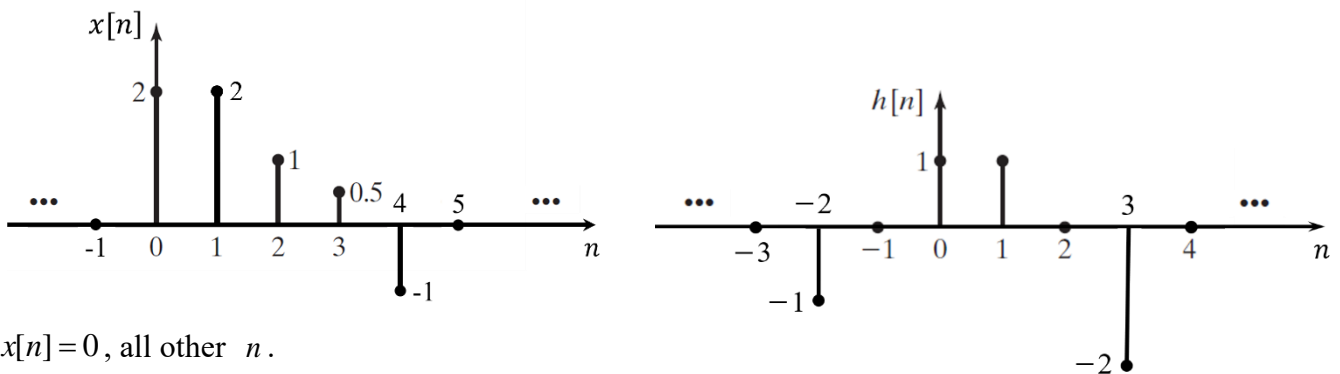


Figure 1

- Give signal $x[n]$ and unit response function $h[n]$ as shown in Figure 2, please calculate the convolution sum $y[n] = x[n] * h[n]$. (25%)



$x[n] = 0$, all other n .

Figure 2

3. Given the following unilateral z-transform, find the corresponding inverse z-transform using partial fraction by Table 1: (25%)

$$X(z) = \frac{0.5 - 7z^{-1} + 2z^{-2}}{1 - 4z^{-1} + 3z^{-2}}$$

Table 1

$f[n], n \geq 0$	$F(z)$	ROC
1. $\delta[n]$	1	All z
2. $\delta[n - n_0]$	z^{-n_0}	$z \neq 0$
3. $u[n]$	$\frac{z}{z - 1}$	$ z > 1$
4. n	$\frac{z}{(z - 1)^2}$	$ z > 1$
5. n^2	$\frac{z(z + 1)}{(z - 1)^3}$	$ z > 1$
6. a^n	$\frac{z}{z - a}$	$ z > a $
7. na^n	$\frac{az}{(z - a)^2}$	$ z > a $
8. n^2a^n	$\frac{az(z + a)}{(z - a)^3}$	$ z > a $
9. $\sin bn$	$\frac{z \sin b}{z^2 - 2z \cos b + 1}$	$ z > 1$
10. $\cos bn$	$\frac{z(z - \cos b)}{z^2 - 2z \cos b + 1}$	$ z > 1$
11. $a^n \sin bn$	$\frac{az \sin b}{z^2 - 2az \cos b + a^2}$	$ z > a $
12. $a^n \cos bn$	$\frac{z(z - a \cos b)}{z^2 - 2az \cos b + a^2}$	$ z > a $

4. Given the two four-point time series:

$$x[n] = [-4, 1, -1, 5]; y[n] = [3, 2, -4, 11]$$

- (a) Find the linear convolution $x[n] * y[n]$. (10%)
 (b) Find the circular convolution $x[n] \odot y[n]$ with concentric circles. (10%)
 (c) Prove that the linear convolution can be obtain by circular convolution with zero-padding technique. (5%)