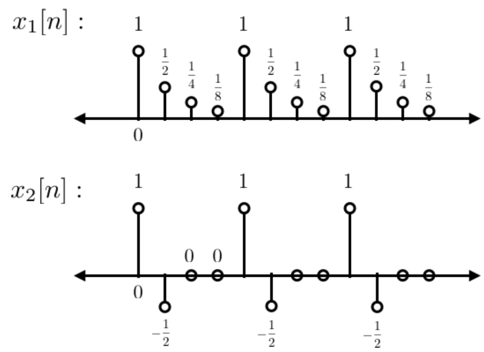
# ECEN 4632 Chapter 8.1-5 Self-Test

**Sec. 8.1-2: Discrete-Time Fourier Series and Circular Convolution**

Consider the following two signals $x_1[n]$ and $x_2[n]$, each periodic with period 4.




Find the circular convolution $y[n]$ of these two signals two ways:
1) Find the circular convolution $y[n]$ by directly evaluating the expression

$$y[n] = \sum_{m=0}^{N-1} x_1[m]x_2[n-m] \tag{1}$$

2) Find the circular convolution $y[n]$ by multiplying the Fourier series coefficients of $x_1[n]$ and $x_2[n]$.

**Sec. 8.3: Relationships Between Fourier Transforms and Fourier Series Coefficients**

Sketch the discrete-time Fourier transform $X_1(e^{j\omega})$ of the above $x_1[n]$. Label all important quantities in your sketch.

**Sec. 8.4: Sampling the Fourier Transform**

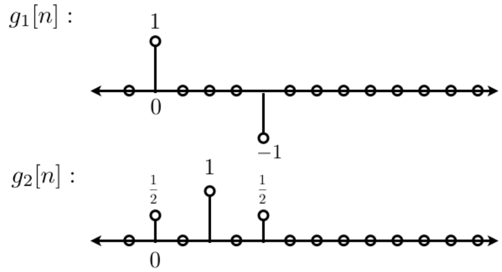
Consider the signal $x[n]$ shown below, which has discrete-time Fourier transform $X(e^{j\omega})$. Suppose we sample its Fourier transform every $\frac{2\pi}{5}$. That is, suppose we form $Y(e^{j\omega}) = X(e^{j\omega})P(e^{j\omega})$ where

$$P(e^{j\omega}) = \sum_{k=-\infty}^{\infty} \delta\left(\omega - \frac{2\pi k}{5}\right)$$

Sketch $y[n]$, the inverse discrete-time Fourier transform of $Y(e^{j\omega})$. *(Hint: You should not need to find $X(e^{j\omega})$ or $Y(e^{j\omega})$ in order to find your solution.)*

**Sec. 8.4: Implementing Discrete-Time Convolution By Multiplication of Discrete-Time Fourier Series Coefficients**

Consider the following finite-length signals $g_1[n]$ and $g_2[n]$.




Form the P-periodic signals $g_1^{per}[n]$ and $g_2^{per}[n]$ by convolving $g_1[n]$ and $g_2[n]$ respectively with the P-periodic impulse train $p[n] = \sum_{m=-\infty}^{\infty} \delta[n + mP]$.

(a) What is the minimum $P$ such that the circular convolution $g_1^{per}[n] \circledast_P g_2^{per}[n]$ is exactly equal to the normal convolution $g_1[n] * g_2[n]$ on the indices $n = 0, \ldots, P-1$?

(b) For this $P$, find the discrete-time Fourier series coefficients of the periodic signal $g_1^{per}[n] \circledast_P g_2^{per}[n]$. You do not have to evaluate the expression you obtain for specific values of $k$.