

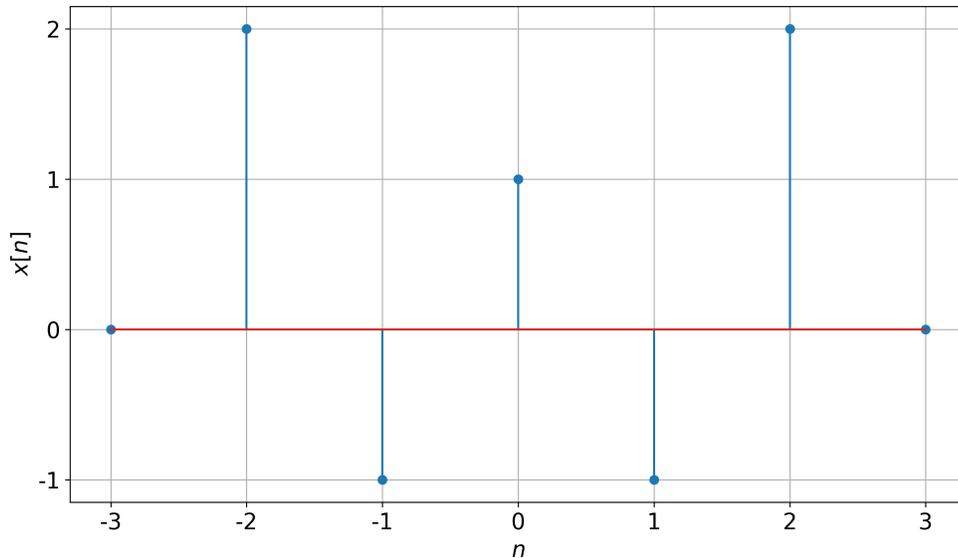
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN  
Department of Electrical and Computer Engineering  
ECE 310 DIGITAL SIGNAL PROCESSING – SPRING 2026

**Homework 5**

Prof. Snyder, Shomorony

Due: Sunday, Mar. 1, 2026, 11:59pm on Gradescope

1. Compute the discrete-time Fourier transform (DTFT) for each of the following discrete-time sequences. **Do not use DTFT table pairs unless noted otherwise.** You may use DTFT table properties, if necessary.
  - (a)  $x[n] = \{1, 0, 0, 0, -1\}$
  - (b)  $x[n] = u[n] - u[n - 4]$
  - (c)  $x[n] = \cos\left(\frac{\pi}{3}n + \frac{\pi}{4}\right)$ , you may use  $e^{j\omega_0 n} \xleftrightarrow{\mathcal{F}} 2\pi\delta(\omega - \omega_0)$ , if necessary.
  - (d)  $x[n] = \alpha^n e^{j\omega_0 n} u[n]$ , where  $|\alpha| < 1$  and  $\omega_0$  is a real constant. You may use  $e^{j\omega_0 n} \xleftrightarrow{\mathcal{F}} 2\pi\delta(\omega - \omega_0)$ , if necessary.
2. A discrete-time signal  $x[n]$  is depicted in the below figure. Without explicitly determining a closed-form expression for  $X_d(\omega)$ , find each of the following quantities.



- (a)  $X_d(0)$
- (b)  $X_d(\pi)$
- (c)  $\int_{-\pi}^{\pi} X_d(\omega) d\omega$
- (d)  $\int_{-\pi}^{\pi} |X_d(\omega)|^2 d\omega$