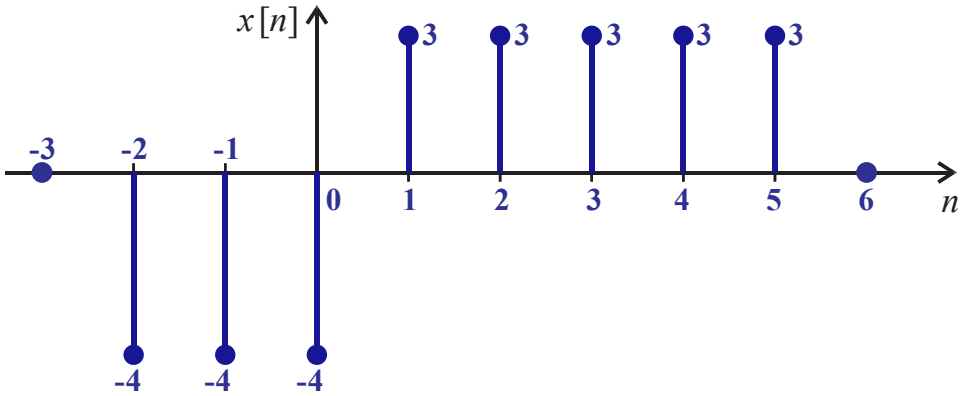
Homework 7
EE 313 Signals and Systems (Fall 2024)
Monday, October 28, 2024

1) 4.9efg Do parts e & f by hand.
2) Manually compute (show work) the IDFT of the DFT points X_k where $X_0 = 5$, $X_1 = 1 + j2$, $X_2 = -15$, and $X_3 = 1 - j2$. Plot input $x[n]$ with each of the stems labeled.
3) 4.14a Also, plot $x[n]$ for $0 \le n \le 31$ and $|X_k|$ for $0 \le k \le 31$
4) Use the DFT with $N = 12$ to approximate the DTFT of the signal $x[n]$ shown below. Plot the amplitude and phase spectrum (rad) of the exact DTFT and DFT approximation for $0 \le \Omega \le 2\pi$. Use solid lines for the exact DTFT and dots for the DFT approximation to the DTFT on the plots. Repeat for $N = 32$.



Hints: Signal $x[n]$ begins at $n = -2$, but the DFT is defined starting at $n = 0$. A solution is to compute the DFT of the time-delayed input $x[n-2]$ which starts at $n = 0$. Per the right/left shift DTFT property, $x[n-2] \leftrightarrow X(\Omega)\, e^{-j2\Omega}$. To get $X(\Omega)$, multiply the DFT output by $e^{+j2\Omega}$ at each DTFT/DFT frequency $\Omega_k = 2\pi k/N$ corresponding to the indices k, i.e., $X(\Omega_k) = X_k\, e^{+j2\Omega k}$.

5) Examine using the FFT to approximate the continuous-time Fourier transform (CTFT) of $x(t) = 4e^{-4t}\cos(10t)\, u(t)$.
   a) Find the CTFT of $x(t)$.
   b) Using Matlab, create a sampled version $x[n]$ of $x(t)$ where $t_n = nT$. For each case below, plot $x(t)$ (solid line) and $x[n]$ (dots) for $0 \le t \le (N-1)T$ and vertical scale of -1.5 to 4. On the same page, plot $|X(\omega)|$ (solid line) and the FFT approximation (use contfft() function) to the CTFT (dots) for $0 \le \omega \le 60$ rad/s and vertical scale of 0 to 0.7. Compute and list $\Gamma = \Delta\omega_k$ and $\max(\omega_k)$. Cases: (i) $T = 0.04$ s and $N = 32$, (ii) $T = 0.02$ s and $N = 64$, (iii) $T = 0.02$ s and $N = 128$, and (iv) $T = 0.01$ s and $N = 512$.
   c) Comment on how the accuracy and resolution of the FFT approximation to the CTFT change with respect to sampling rate and number of data points.

- For problems using MATLAB, include both m-file(s) (put your name in a comment line) as well as output figures (put your name in title) for each problem and/or problem section.

Due Friday, November 1, 2024