3.19 Determine the DTFT of each of the following finite-length sequences:

(a) $y_1[n] = \begin{cases} 1, & -N \le n \le N, \\ 0, & \text{otherwise}, \end{cases}$ (b) $y_2[n] = \begin{cases} 1, & 0 \le n \le N, \\ 0, & \text{otherwise}, \end{cases}$ (c) $y_3[n] = \begin{cases} 1 - \frac{|n|}{N}, & -N \le n \le N, \\ 0, & \text{otherwise}, \end{cases}$

(d) $y_4[n] = \begin{cases} N + 1 - |n|, & -N \le n \le N, \\ 0, & \text{otherwise}, \end{cases}$ (e) $y_f[n] = \begin{cases} \cos(\pi n/2N), & -N \le n \le N, \\ 0, & \text{otherwise}. \end{cases}$

3.24 Prove the following theorems of the discrete-time Fourier transform: (a) Linearity theorem, (b) Time-reversal theorem, (c) Time-shifting theorem, and (d) Frequency-shifting theorem.

3.30 The magnitude function $|X(e^{j\omega})|$ of a discrete-time sequence $x[n]$ is shown in Figure P3.1 for a portion of the angular frequency axis. Sketch the magnitude function for the frequency range $-\pi \le \omega < \pi$. What type of sequence is $x[n]$?

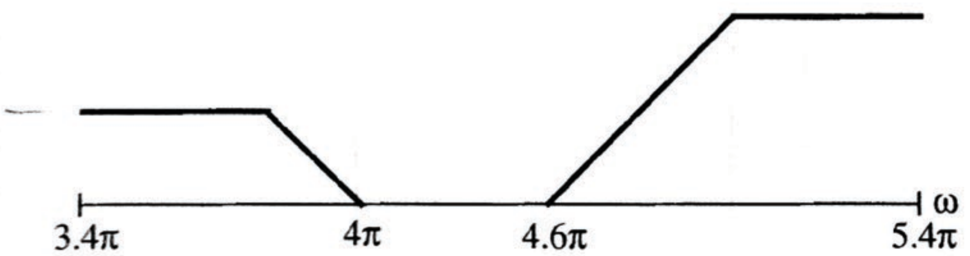

Figure P3.1

5.8 Determine the N-point DFTs of the following length-N sequences defined for $0 \le n \le N-1$:
(a) $x_a[n] = \sin(2\pi n/N)$, (b) $x_b[n] = \cos^2(2\pi n/N)$, (c) $x_c[n] = \cos^3(2\pi n/N)$.

5.15 Let $x[n], 0 \le n \le N-1$, be a length-N sequence with an N-point DFT given by $X[k], 0 \le k \le N-1$. Determine the $2N$-point DFT of each of the following length-$2N$ sequences:

(a) $g[n] = \begin{cases} x[n], & 0 \le n \le N-1, \\ 0, & N \le n \le 2N-1, \end{cases}$ (b) $h[n] = \begin{cases} 0, & 0 \le n \le N-1, \\ x[n], & N \le n \le 2N-1. \end{cases}$

$x[n-N]$ to make sense

M 3.2 Using Program 3_1, determine and plot the real and imaginary parts and the magnitude and phase spectra of the DTFTs of the sequences of Problem 3.19 for $N = 10$.

M 5.2 Write a MATLAB program to compute the circular convolution of two length-N sequences via the DFT-based approach. Using this program, determine the circular convolution of the following pairs of sequences:
(a) $g[n] = \{5,\ -2,\ 2,\ 0,\ 4,\ 3\}$, $h[n] = \{3,\ 1,\ -2,\ 2,\ -4,\ 4\}$,
(b) $x[n] = \{2 - j,\ -1 - j3,\ 4 - j3,\ 1 + j2,\ 3 + j2\}$, $v[n] = \{-3,\ 2 + j4,\ -1 + j4,\ 4 + j2,\ -3 + j\}$,
(c) $x[n] = \cos(\pi n/2)$, $y[n] = 3^n$, $0 \le n \le 4$.
Verify your result using the function `circconv`.

M 5.3 Using MATLAB, verify the symmetry relations of the DFT of a complex sequence as listed in Table 5.1.

Table 5.1: Symmetry properties of the DFT of a complex sequence.

Length-N Sequence	**N-point DFT**
$x[n] = x_{\text{re}}[n] + jx_{\text{im}}[n]$	$X[k] = X_{\text{re}}[k] + jX_{\text{im}}[k]$
$x^*[n]$	$X^*[\langle -k \rangle_N]$
$x^*[\langle -n \rangle_N]$	$X^*[k]$
$x_{\text{re}}[n]$	$X_{\text{cs}}[k] = \frac{1}{2}\{X[k] + X^*[\langle -k \rangle_N]\}$
jx_{im}	$X_{\text{ca}}[k] = \frac{1}{2}\{X[k] - X^*[\langle -k \rangle_N]\}$
$x_{\text{cs}}[n]$	$X_{\text{re}}[k]$
$x_{\text{ca}}[n]$	$jX_{\text{im}}[k]$

Note: $x_{\text{cs}}[n]$ and $x_{\text{ca}}[n]$ are the circular conjugate-symmetric and circular conjugate-antisymmetric parts of $x[n]$, respectively. Likewise, $X_{\text{cs}}[k]$ and $X_{\text{ca}}[k]$ are the circular conjugate-symmetric and circular conjugate-antisymmetric parts of $X[k]$, respectively.

3.19 Determine the DTFT of each of the following finite-length sequences:

(a) $y_1[n] = \begin{cases} 1, & -N \le n \le N, \\ 0, & \text{otherwise,} \end{cases}$ (b) $y_2[n] = \begin{cases} 1, & 0 \le n \le N, \\ 0, & \text{otherwise,} \end{cases}$ (c) $y_3[n] = \begin{cases} 1 - \frac{|n|}{N}, & -N \le n \le N, \\ 0, & \text{otherwise,} \end{cases}$

(d) $y_4[n] = \begin{cases} N + 1 - |n|, & -N \le n \le N, \\ 0, & \text{otherwise,} \end{cases}$ (e) $y_f[n] = \begin{cases} \cos(\pi n/2N), & -N \le n \le N, \\ 0, & \text{otherwise.} \end{cases}$