Digital Signal Processing

Discrete Fourier Transform

a) Write a function N-point DFT of a sequence x[n]. Name it *dft*

b) Let $x[n]$ be a 4-point sequence:

$$x[n] = \begin{cases} \cos n\pi, & 0 \le n \le 3 \\ 0, & otherwise \end{cases}$$

i. Compute the discrete-time Fourier transform $X(e^{j\omega})$ and plot its magnitude and phase.

ii. Compute and plot the 4-point DFTs of $[n]$. Use your function *dft.*

iii. Compute and plot 8-point and 16-point DFTs of $[n]$.

Circular Properties

Let $x[n] = \frac{(-1)^n}{n+1}$, $0 \le n \le 10$

a) Determine and plot $x\,[((-n))_{11}]$

b) Verify the circular folding property.

c) Decompose and plot $x_{ep}[n]$ and $x_{op}[n]$

d) Using *dft* function you wrote in previous part, verify the equation below for 11 point DFT:

$$DF(x_{ep}[n]) = Re\{X[k]\} = Re\{X[((-k))_N]\}$$
$$DF(x_{op}[n]) = jIm\{X[k]\} = -jIm\{X[((-k))_N]\}$$

e) Sketch $[((n+4))_{11}]$, that is, a circular shift by 4 samples toward the left. Sketch also periodic shift by 4 samples toward the left in the same plot.

f) Sketch $[((n-3))_{15}]$, that is, a circular shift by 3 samples toward the right, where $x[n]$ is assumed to be a 15-point sequence. Sketch also periodic shift by 3 samples toward the right in