

Hw7

1. Let $x(n) = \cos(\pi n/3)$ for $n = 0, 1, \dots, 5$ and $h(n) = \delta(n) + \delta(n-1) + \delta(n-2)$.
 - (a) Find the 6-point circular convolution of $x(n)$ and $h(n)$.
 - (b) Let $X(k)$ and $H(k)$ be the 6-point DFT of $x(n)$ and $h(n)$, respectively. Apply 6-point IDFT on $Y(k) = H(k)X(k)$ to obtain $y(n)$. Is $y(n)$ the same as that obtained in (a)?
2. Let $x(n)$ be a sequence of length N and $x(n) = 0$ for $n < 0$ and $n \geq N$. Suppose $X(k)$ is the N -point DFT of $x(n)$. Let $y(n) = x(n+2)$ and $Y(k)$ be the N -point DFT of $y(n)$.
 - (a) Express $Y(k)$ in terms of $X(k)$.
 - (b) Let $z(n)$ be the N -point IDFT of $Y(k)$, for $n = 0, 1, \dots, N-1$. Express $z(n)$ in terms of $x(n)$.
 - (c) Let $W(e^{j\omega}) = X(e^{j(\omega-2\pi/N)})$, $W(k) = W(e^{j2k\pi/N})$, for $k = 0, 1, \dots, N-1$ and $w(n)$ be the N -point IDFT of $W(k)$. Express $w(n)$ in terms of $x(n)$.
3. Let $x(n)$ be a discrete time sequence of length L , with $x(n) = 0$ for $n < 0$ and $n \geq L$, and let $X(k)$ be the N -point DFT of $x(n)$. Let $y(n)$ be the N -point IDFT of $X(k)$.
 - (a) How is $y(n)$ related to $x(n)$ when $N > L$?
 - (b) How is $y(n)$ related to $x(n)$ when $L = N + 1$? Can we obtain $x(n)$ from $X(k)$ in this case?
4. * **MATLAB bonus problem.** In the previous Matlab problem, you were asked to find the pitch of a recording. Use the same recording for this experiment. Extract a segment from the recording that is approximately periodic. Let it be $x(n)$ with length L .
 - (a) Apply N -point DFT on $x(n)$ using $X(k) = \sum_{n=0}^{L-1} x(n)e^{-2\pi kn/N}$. Plot $|X(e^{j\omega})|$ and $\angle X(e^{j\omega})$ for the range $|\omega| \leq \pi$ using $|X(k)|$ and $\angle X(k)$. What is your choice of DFT size N and why it is appropriate? (Two useful MATLAB commands: `abs`, `angle`)
 - (b) Can we determine the pitch using (a)? How does the answer compare with what you obtained in the previous Matlab experiment using a time-domain approach?