

Consider Signal

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HW5

1, -2, 3, -4

of length $N=4$ Compute DFT by using DFT formula and simplify.

$$X(l) = \sum_{k=0}^{N-1} x[k] e^{-j \frac{2\pi k l}{N}}$$

(calculator used, but is doable by hand.)

$$\begin{aligned} X(0) &= x[0]e^0 + x[1]e^0 + x[2]e^0 + x[3]e^0 \\ &= 1 - 2 + 3 - 4 = -2 \end{aligned}$$

$$\begin{aligned} X(1) &= x[0]e^0 + x[1]e^{-j\frac{2\pi}{4}} + x[2]e^{-j\frac{4\pi}{4}} + x[3]e^{-j\frac{6\pi}{4}} \\ &= 1 - 2e^{-j\frac{\pi}{2}} + 3e^{-j\pi} - 4e^{-j\frac{3\pi}{2}} \\ &= -2 - 2j \end{aligned}$$

$$\begin{aligned} X(2) &= x[0]e^0 + x[1]e^{-j\frac{4\pi}{4}} + x[2]e^{-j\frac{8\pi}{4}} + x[3]e^{-j\frac{12\pi}{4}} \\ &= 1 - 2e^{-j\pi} + 3e^{-j2\pi} - 4e^{-j3\pi} \\ &= 10 \end{aligned}$$

$$\begin{aligned} X(3) &= x[0]e^0 + x[1]e^{-j\frac{6\pi}{4}} + x[2]e^{-j\frac{12\pi}{4}} + x[3]e^{-j\frac{18\pi}{4}} \\ &= 1 - 2e^{-j\frac{3\pi}{2}} + 3e^{-j3\pi} - 4e^{-j\frac{9\pi}{2}} \\ &= -2 + 2j \end{aligned}$$

DFT is $\{-2, -2-2j, 10, -2+2j\}$