$x = [-1, 4, 3, 1]$, LASICE DFT $N = 4$

$$X[k] = \sum_{n=0}^{N-1} x[n]\, e^{-\frac{i2\pi}{N} \cdot k \cdot n}$$

$k = 0$

$$X[0] = \sum_{n=0}^{N-1} x[n]\, e^{-\frac{i2\pi}{N} \cdot 0 \cdot n} = x[0] + x[1] + x[2] + x[3] = -1 + 4 + 3 + 1 = 7$$

$e^{-\frac{i2\pi}{N} \cdot 0 \cdot n} = 1$, kosica $e^0 = 1$

$k = 1$

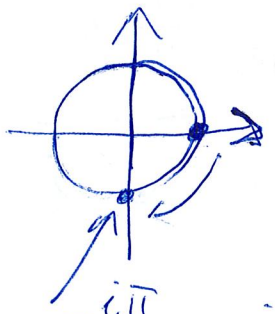
$$X[1] = \sum_{n=0}^{N-1} x[n]\, e^{-\frac{i2\pi}{N} \cdot 1 \cdot n}$$

$e^{-i\pi} = -1$

$$= x[0] e^{-\frac{i2\pi}{4} \cdot 1 \cdot 0} + x[1] e^{-\frac{i2\pi}{4} \cdot 1 \cdot 1} + x[2] e^{-\frac{i2\pi}{4} \cdot 1 \cdot 2} + x[3] e^{-\frac{i2\pi}{4} \cdot 1 \cdot 3}$$

$e^{-\frac{i2\pi}{4} \cdot 1 \cdot 0} = 1$

$e^{-\frac{i3\pi}{2}} = i$



$$X[1] = x[0] \cdot 1 + x[1] \cdot (-i) + x[2] \cdot (-1) + x[3] \cdot i$$

$$= -1 + 4i - 3 + i = -4 - 3i$$

$e^{-\frac{i\pi}{2}} = -i$

TAI

$$e^{-\frac{i\pi}{2}} = \cos\left(\frac{\pi}{2}\right) - i \sin\left(\frac{\pi}{2}\right) = 0 - i \cdot 1 = -i$$

$\cos\left(\frac{\pi}{2}\right) = 0$, $\sin\left(\frac{\pi}{2}\right) = 1$

## K=2

$$X[2] = \sum_{n=0}^{N-1} x[n] e^{-\frac{i2\pi}{N} \cdot 2 \cdot n}$$

$$= x[0] \underbrace{e^{-\frac{i2\pi}{4} \cdot 2 \cdot 0}}_{=1} + x[1] \underbrace{e^{-\frac{i2\pi}{4} \cdot 2 \cdot 1}}_{=-1} + x[2] \underbrace{e^{-\frac{i2\pi}{4} \cdot 2 \cdot 2}}_{=1} + x[3] \underbrace{e^{-\frac{i2\pi}{4} \cdot 2 \cdot 3}}_{=-1}$$

$$= -1 - 4 + 3 - 1 = \underline{-3}$$

## K=3

$$X[3] = \sum_{n=0}^{N-1} x[n] e^{-\frac{i2\pi}{4} \cdot 2 \cdot n}$$

$$= x[0] \underbrace{e^{-\frac{i2\pi}{4} \cdot 3 \cdot 0}}_{=1} + x[1] \underbrace{e^{-\frac{i2\pi}{4} \cdot 3 \cdot 1}}_{=i} + x[2] \underbrace{e^{-\frac{i2\pi}{4} \cdot 3 \cdot 2}}_{=-1} + x[3] \underbrace{e^{-\frac{i2\pi}{4} \cdot 3 \cdot 3}}_{=-i}$$

$$= -1 + 4i - 3 - i = \underline{-4 + 3i}$$

$$X[k] = [7, -4 - 3i, -3, -4 + 3i]$$

TOISTENSE KOMPLEKSIKONJUGAATTEJA