4.14.2014

Supplement to Handout #20

Properties of DFT (examples in Matlab)

Time reversal

n	0	1	2	3
$(-n)_N$	0	3	2	1
$x(n)$	0	1	2	3
$x((-n)_N)$	0	3	2	1

Matlab:

```
x = [0  1  2  3]
xr = [0  3  2  1]  %% reversed
fft(x)  -->  [6; -2+2j; -2; -2-2j]
fft(xr) -->  [6; -2-2j; -2; -2+2j]
```

Circular time shift ($\ell=1$)

n	0	1	2	3
$(n-\ell)_N$	3	0	1	2

```
x2 = [3  0  1  2]
x2f = fft(x2)
ff(x) .* exp(-j*2*pi/N*l*[0:3])
```

Both print [6 2+2j 2 2-2j]

Circular frequency shift ($\ell = 3$)

```
x3 = x. * exp(j*2*pi/N *l *[0:3])
```

It prints [0 -j -2 3j]

```
fft(x3)
```

It prints [-2+2j -2 -2-2j 6]

This is the shifted version of fft(x).