REPORT

Subject: Digital Signal Processing
Lecturer: prof. dr hab. Vasyl Martsenyuk

Laboratory #1 Date: 27.09.2024 Topic: Wprowadzenie do narzędzi i środowiska pracy w przetwarzaniu sygnałów cyfrowych: Python + biblioteki. Analiza sygnałów deterministycznych: implementacja podstawowych operacji na sygnałach czasowych. Second variant (2)	Krzysztof Świerczek IT Science II degree, 1 semester, gr.A

1. Task:

Synthesize a discrete-time signal by using the IDFT in matrix notation for different values of N. Show the matrices W and K. Plot the signal synthesized.

Variant #14: [6,2,4,3,4,5,0,0,0]

2. Code Github

https://github.com/Krzycho165/STUDIA/tree/main/DSP

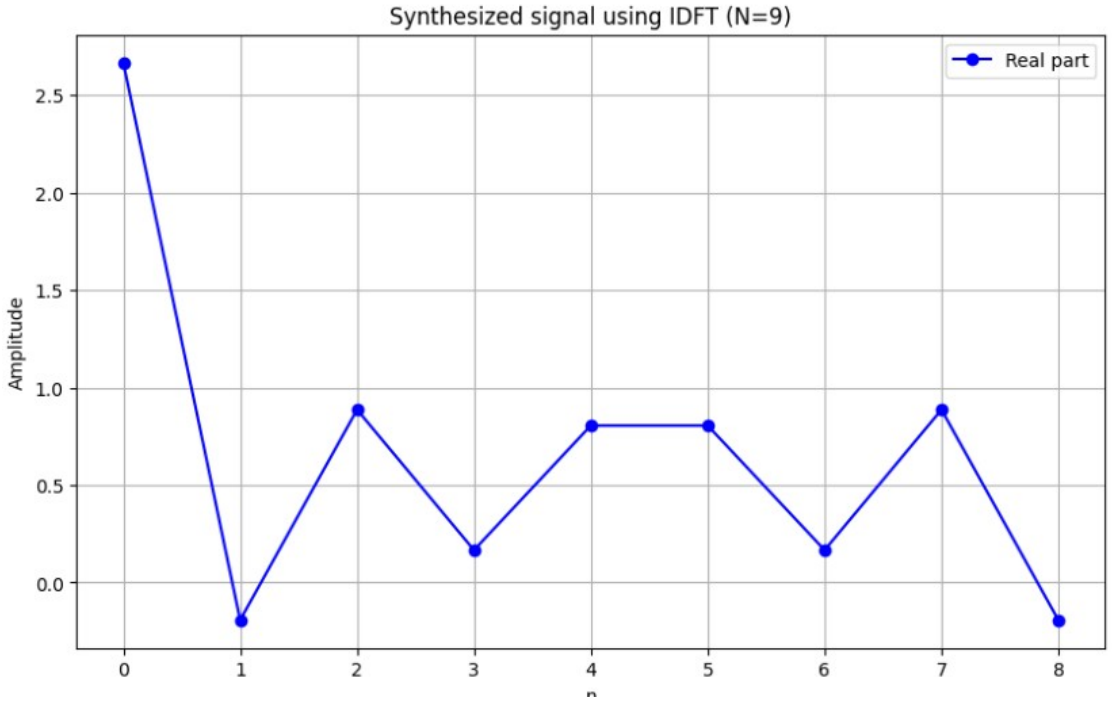
x_mu: This is the variable of frequency-domain signal provided by task variant.

W: This matrix represents the N-th root of unity. We create it using numpy's np.outer() method to generate the complex exponentials.

x: The time-domain signal is obtained by performing the matrix multiplication between WW and the frequency-domain signal Xμ.

Plotting: We use matplotlib to visualize the real part of the synthesized time-domain signal.

Matrix Printout: The code prints the WW matrix and the frequency-domain signal for verification. The result of plotting shows technical drawing number two:



TD. 3. Source code

The IDFT matrix WW contains complex numbers corresponding to the N-th roots of unity. The matris is shown down below:

```
Matrix W (N x N):
[[ 1.        +0.00000000e+00j  1.        +0.00000000e+00j
   1.        +0.00000000e+00j  1.        +0.00000000e+00j
   1.        +0.00000000e+00j  1.        +0.00000000e+00j
   1.        +0.00000000e+00j  1.        +0.00000000e+00j
   1.        +0.00000000e+00j]
 [ 1.        +0.00000000e+00j  0.76604444-6.42787610e-01j
   0.17364818-9.84807753e-01j -0.5       -8.66025404e-01j
  -0.93969262-3.42020143e-01j -0.93969262+3.42020143e-01j
  -0.5       +8.66025404e-01j  0.17364818+9.84807753e-01j
   0.76604444+6.42787610e-01j]
 [ 1.        +0.00000000e+00j  0.17364818-9.84807753e-01j
  -0.93969262-3.42020143e-01j -0.5       +8.66025404e-01j
   0.76604444+6.42787610e-01j  0.76604444-6.42787610e-01j
  -0.5       -8.66025404e-01j -0.93969262+3.42020143e-01j
   0.17364818+9.84807753e-01j]
 [ 1.        +0.00000000e+00j -0.5       -8.66025404e-01j
  -0.5       +8.66025404e-01j  1.        +2.44929360e-16j
  -0.5       -8.66025404e-01j -0.5       +8.66025404e-01j
   1.        +4.89858720e-16j -0.5       -8.66025404e-01j
  -0.5       +8.66025404e-01j]
 [ 1.        +0.00000000e+00j -0.93969262-3.42020143e-01j
   0.76604444+6.42787610e-01j -0.5       -8.66025404e-01j
   0.17364818+9.84807753e-01j  0.17364818-9.84807753e-01j
  -0.5       +8.66025404e-01j  0.76604444-6.42787610e-01j
  -0.93969262+3.42020143e-01j]
 [ 1.        +0.00000000e+00j -0.93969262+3.42020143e-01j
   0.76604444-6.42787610e-01j -0.5       +8.66025404e-01j
   0.17364818-9.84807753e-01j  0.17364818+9.84807753e-01j
  -0.5       -8.66025404e-01j  0.76604444+6.42787610e-01j
  -0.93969262-3.42020143e-01j]
 [ 1.        +0.00000000e+00j -0.5       +8.66025404e-01j
  -0.5       -8.66025404e-01j  1.        +4.89858720e-16j
  -0.5       +8.66025404e-01j -0.5       -8.66025404e-01j
   1.        +9.79717439e-16j -0.5       +8.66025404e-01j
  -0.5       -8.66025404e-01j]
 [ 1.        +0.00000000e+00j  0.17364818+9.84807753e-01j
  -0.93969262+3.42020143e-01j -0.5       -8.66025404e-01j
   0.76604444-6.42787610e-01j  0.76604444+6.42787610e-01j
  -0.5       +8.66025404e-01j -0.93969262-3.42020143e-01j
   0.17364818-9.84807753e-01j]
 [ 1.        +0.00000000e+00j  0.76604444+6.42787610e-01j
   0.17364818+9.84807753e-01j -0.5       +8.66025404e-01j
  -0.93969262+3.42020143e-01j -0.93969262-3.42020143e-01j
  -0.5       -8.66025404e-01j  0.17364818-9.84807753e-01j
   0.76604444-6.42787610e-01j]]

Frequency-domain signal (X_mu):
[6 2 4 3 4 5 0 0 0]
```

TD. 3. Output of the program

3. Conclusions

In this report, we have explored the process of synthesizing discrete-time signals using the Inverse Discrete Fourier Transform (IDFT) in matrix notation. By representing the IDFT as a matrix multiplication, we were able to efficiently compute the time-domain signal from the frequency-domain components for various signal variants.

The results of the IDFT computations were visualized through the plotting of the synthesized signals, showing the real parts of the time-domain sequences. The plots confirmed that the IDFT is capable of accurately reconstructing the original signals from their frequency-domain representations.