**REPORT**

Zajęcia: Analog and digital electronic circuits

Teacher: prof. dr hab. Vasyl Martsenyuk

**Lab 1**

Date: 11.10.2025

Topic: " Discrete-time signal synthesis using the Inverse Discrete Fourier Transform (IDFT) in matrix notation. Visualization of W and K matrices and time-domain signal reconstruction"

Variant: All given xₘ vectors (10 variants)

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2 semestr,

Gr. 1b

1. **Problem statement:**

**The goal of this laboratory exercise was to synthesize discrete-time signals using the Inverse Discrete Fourier Transform (IDFT) written in matrix form.  
The task required:**

**building matrices K and W according to their mathematical definitions,**

**reconstructing the signal for different ,**

**displaying both matrices and ,**

**and plotting the synthesized discrete-time signals for the given input vectors .**

**This exercise aimed to deepen understanding of the relationship between the frequency and time domains in digital signal processing and how the Fourier matrix enables inverse spectral reconstruction.**

1. **Input data:**

**The following input vectors were provided for different values of :**

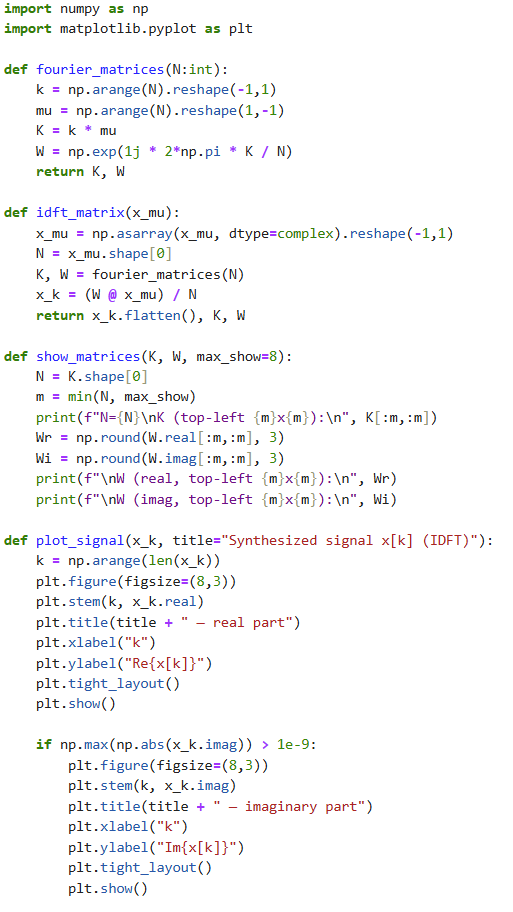
**Each vector defines a frequency-domain representation of a discrete signal.  
The length of each vector determines the dimension of matrices and .**

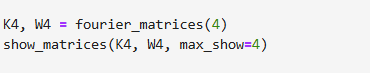
1. **Commands used (or GUI):**
2. source code

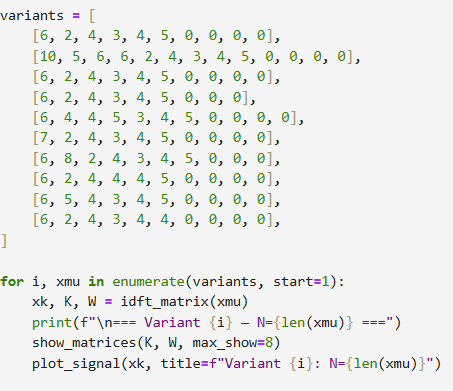
**The code was implemented in** Python **within** JupyterLab **(Anaconda environment).  
Libraries used: numpy, matplotlib.**

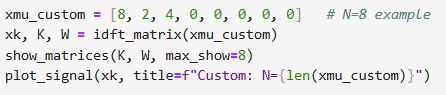
**Key formulas implemented:**

1. screenshots



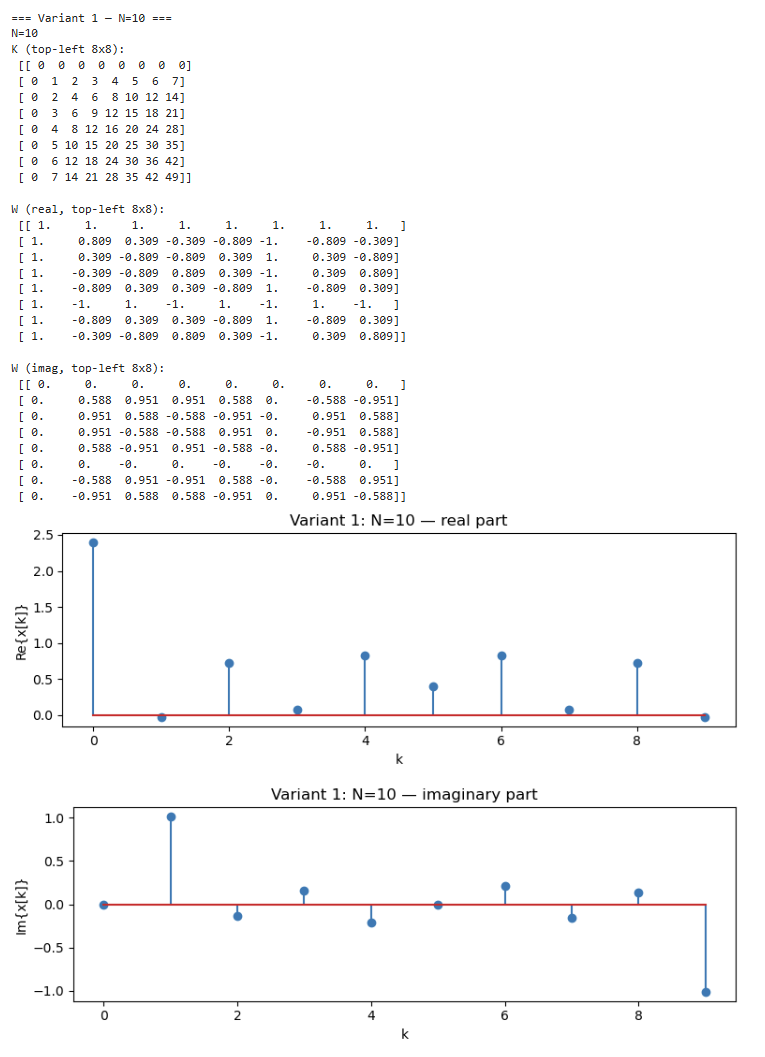


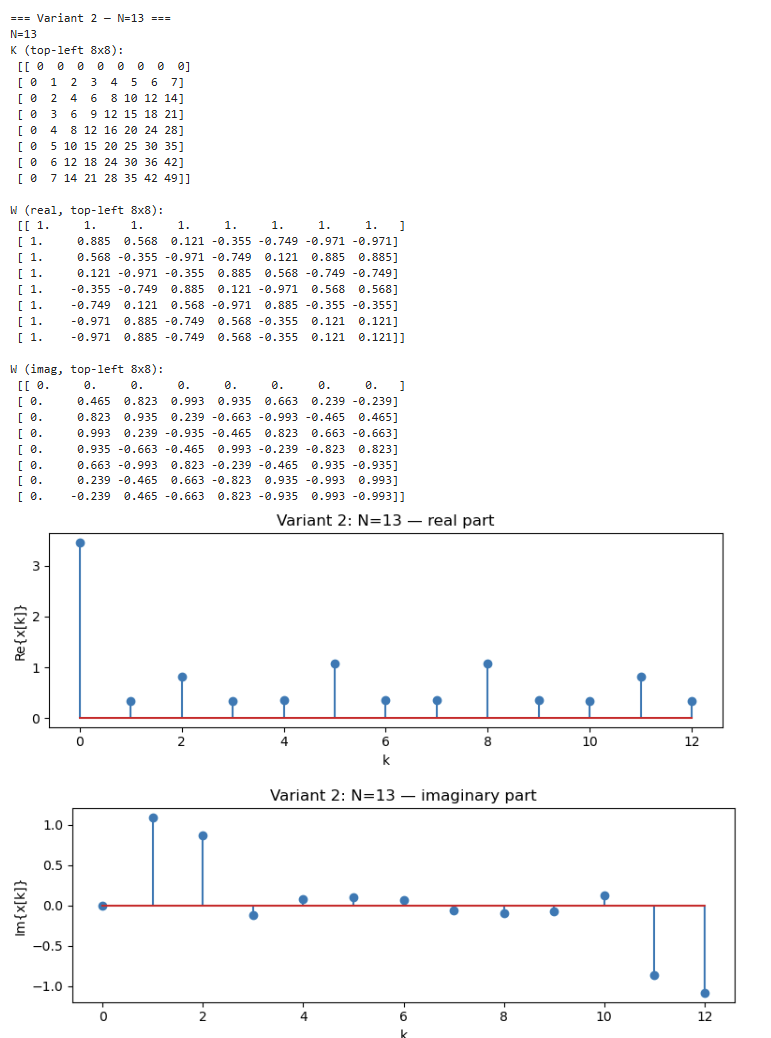


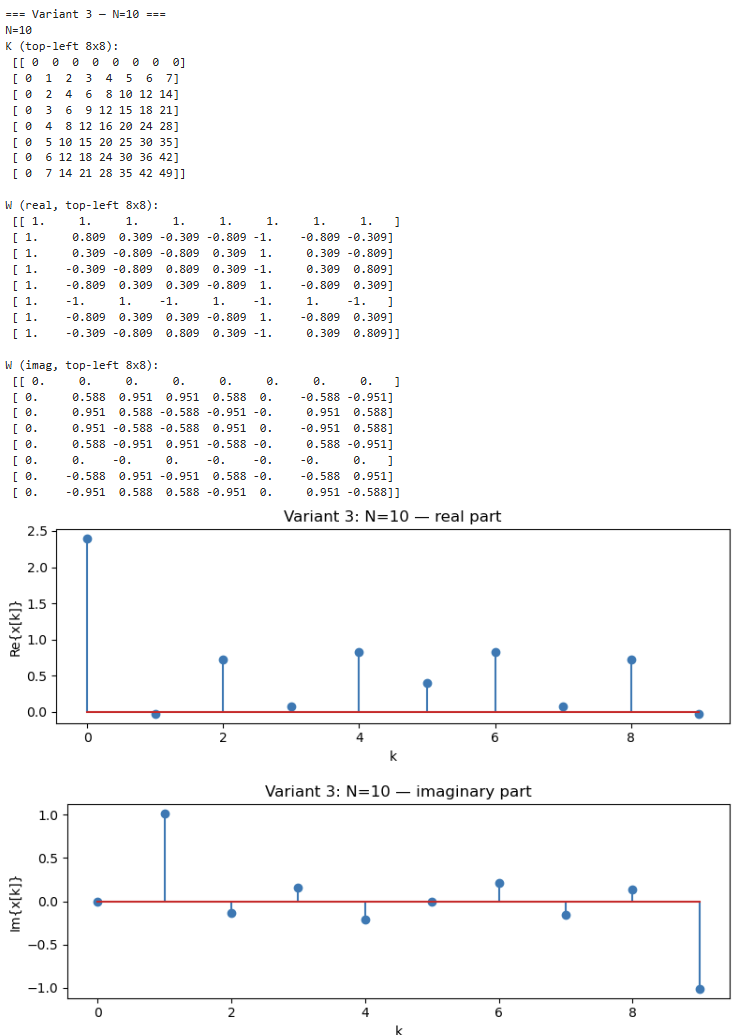


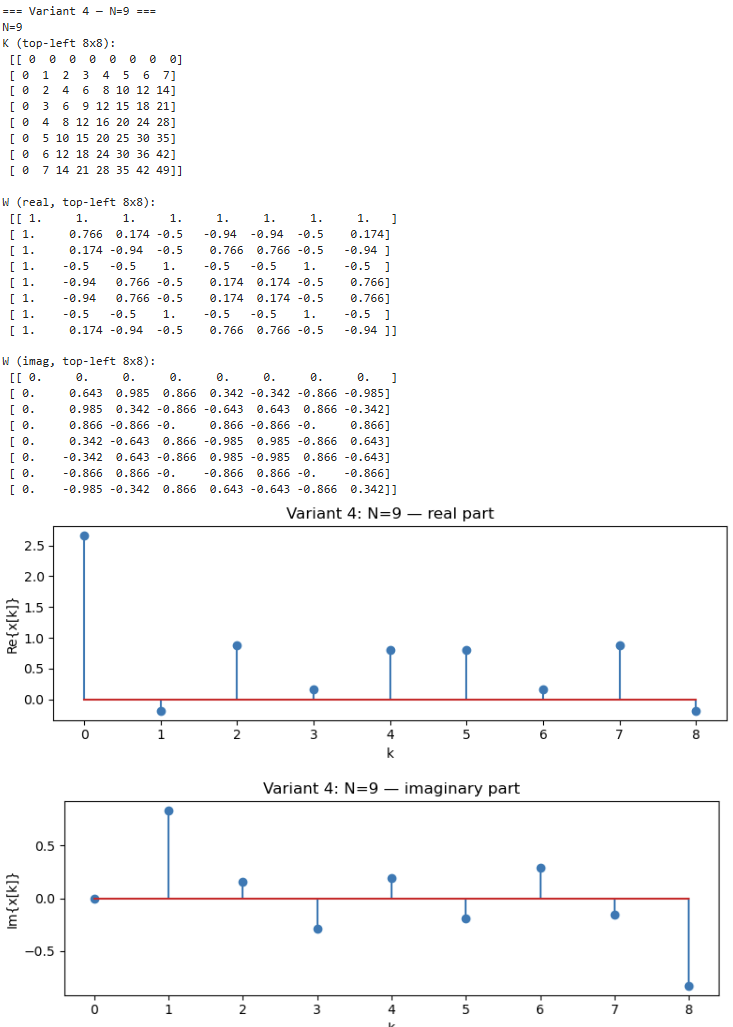
Link to remote repozytorium (e.g. GitHub)

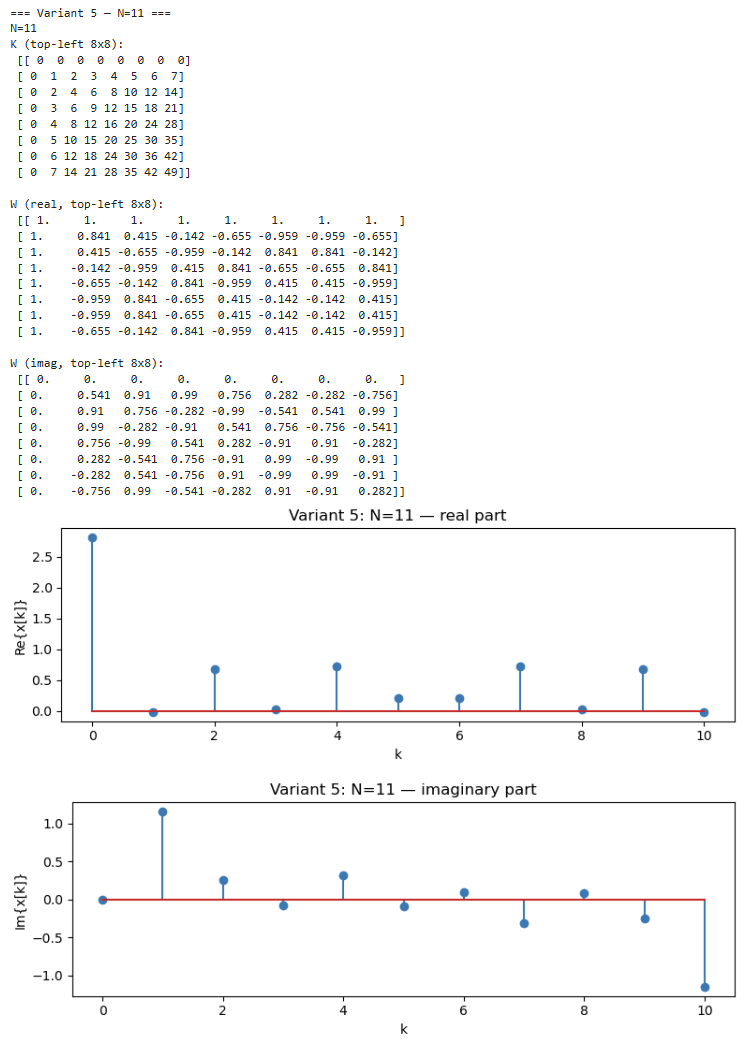
**4. Outcomes:**

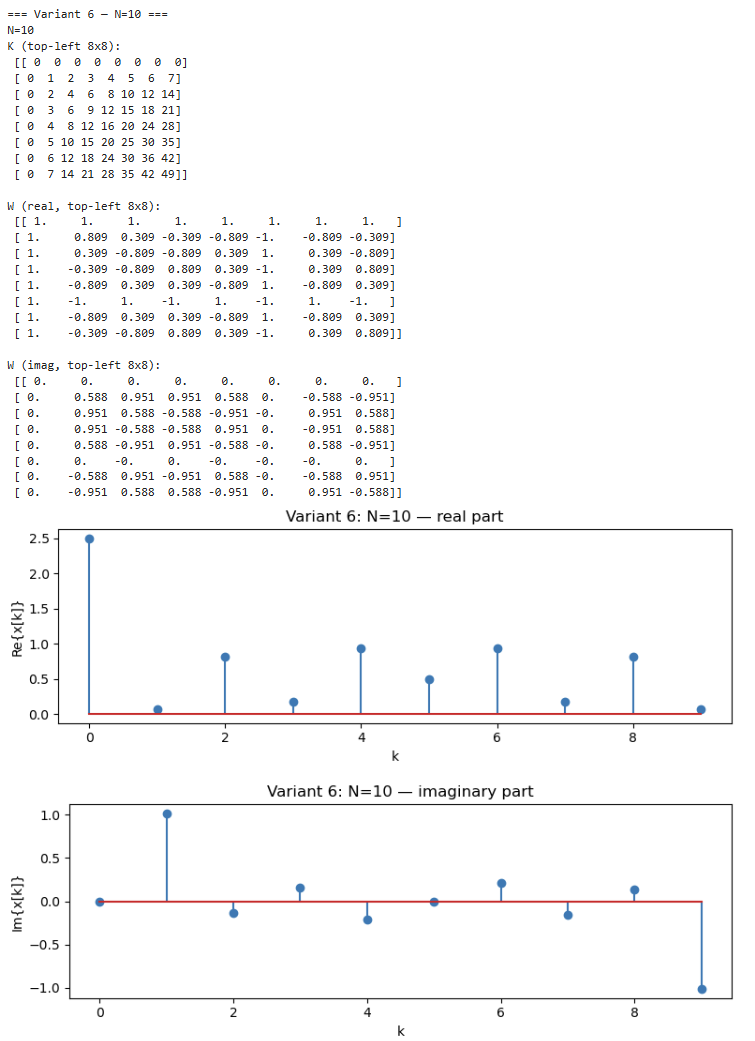


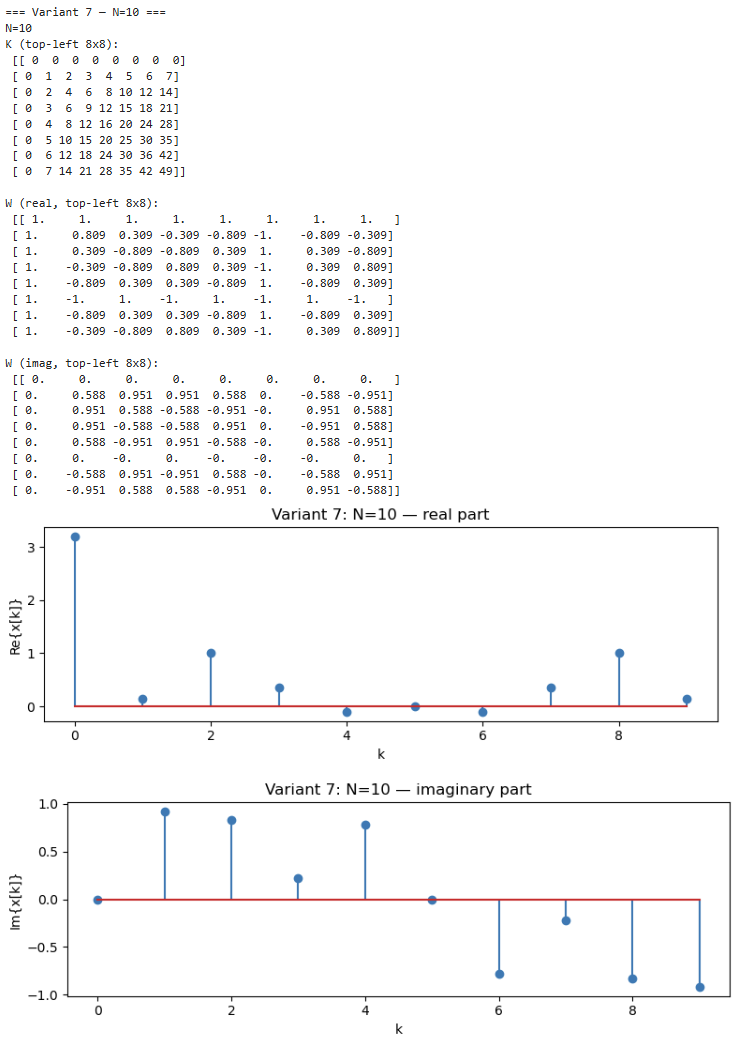


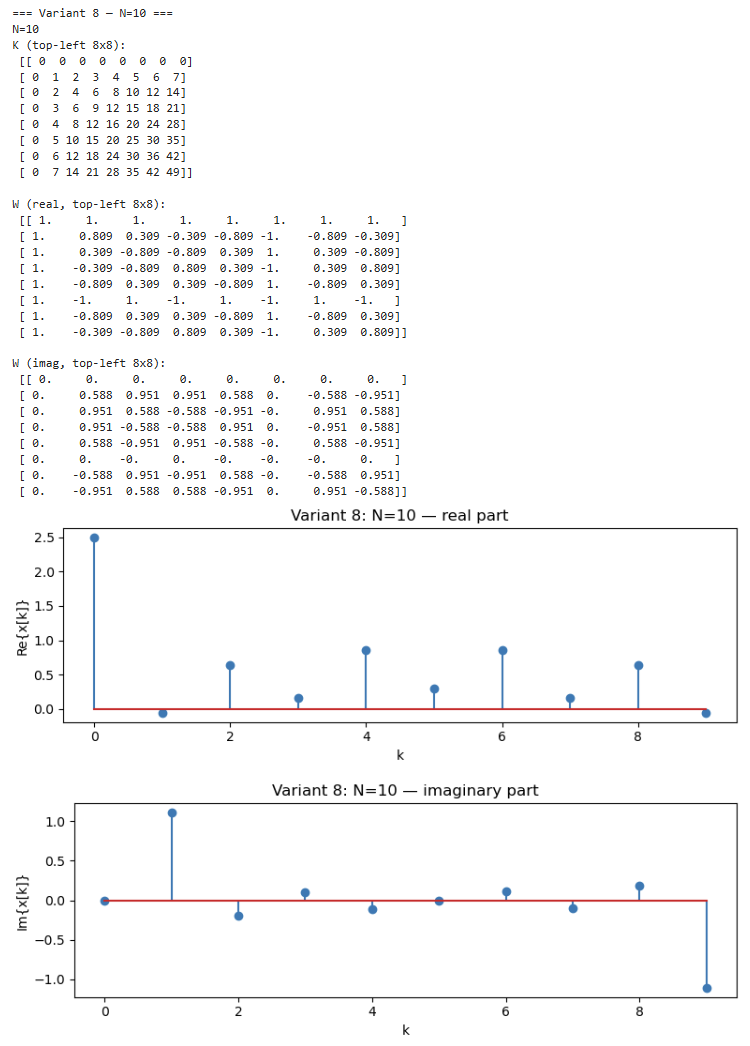


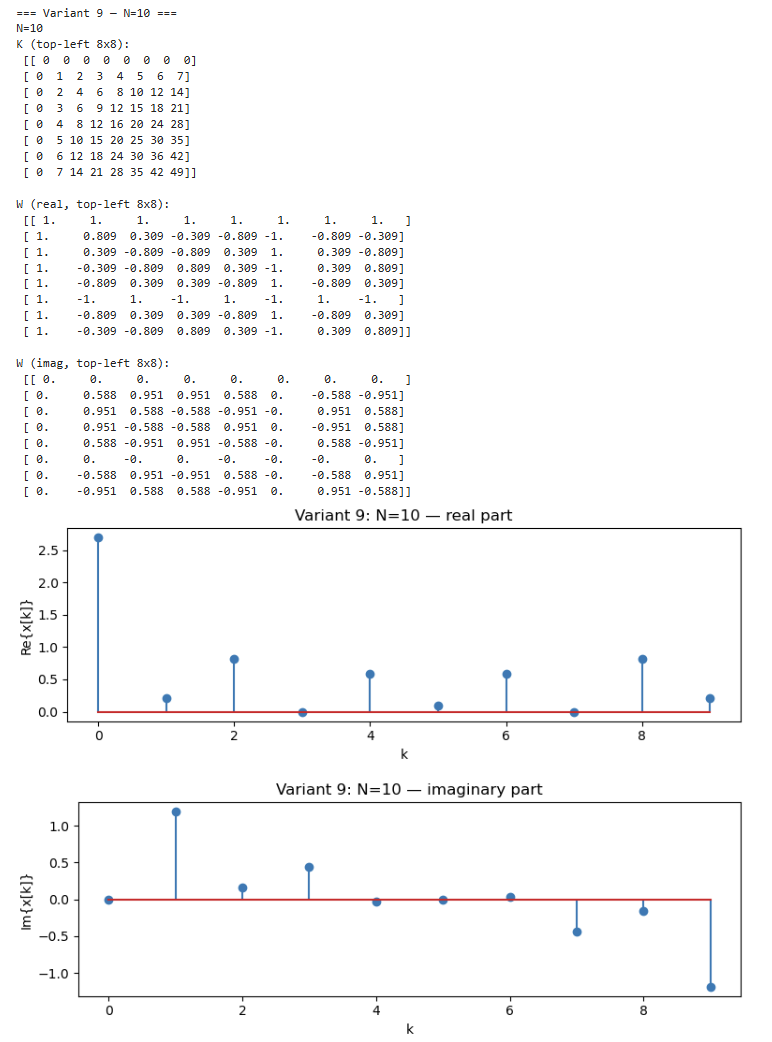


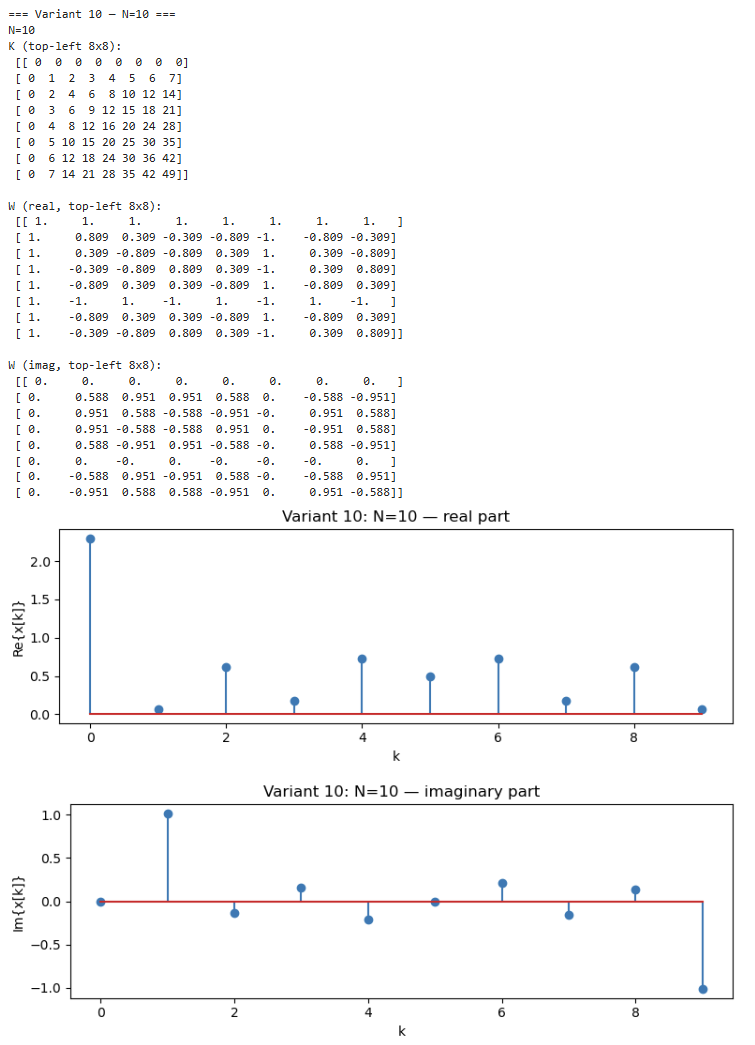


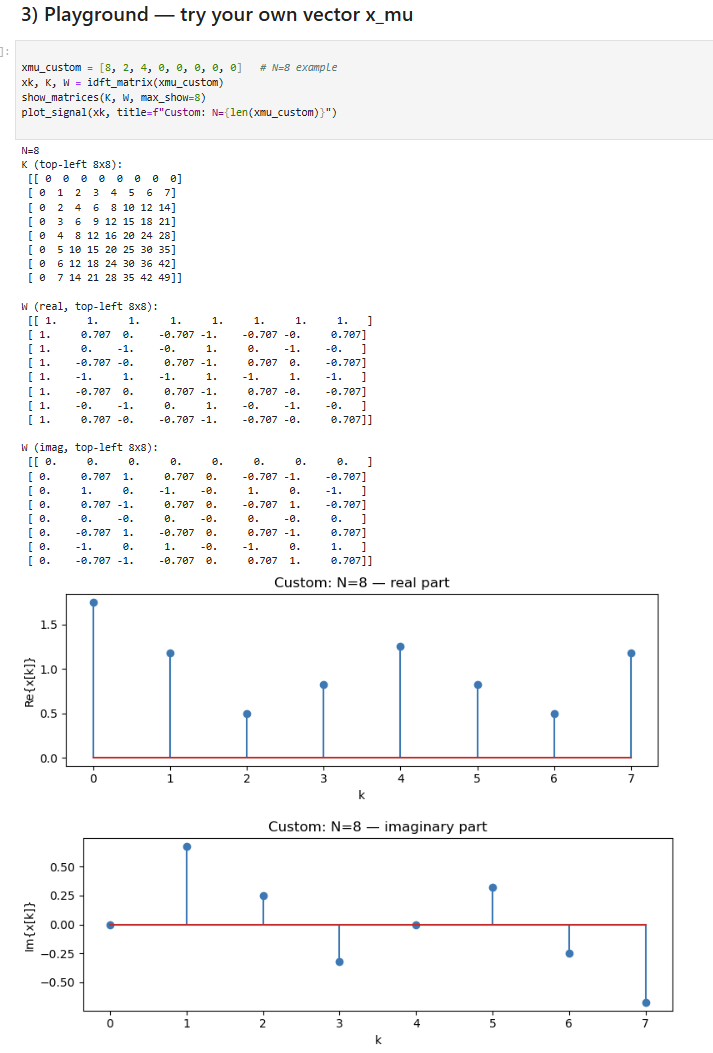












1. **Conclusions:** For the reasons given, we conclude that:

**The experiment confirmed that the IDFT in matrix notation accurately reconstructs discrete-time signals from their spectral representations.  
The matrices and play a crucial role in connecting the frequency and time domains:**

**defines the frequency-time index mapping,**

**represents the complex exponential basis vectors.**

**For different , the synthesized signals show distinct resolutions and sampling effects, demonstrating how IDFT converts frequency coefficients into time-domain samples.**

**Therefore, we conclude that the matrix formulation of IDFT is a valid and efficient approach to understand the mathematical structure of the Fourier transform and signal reconstruction in DSP.**