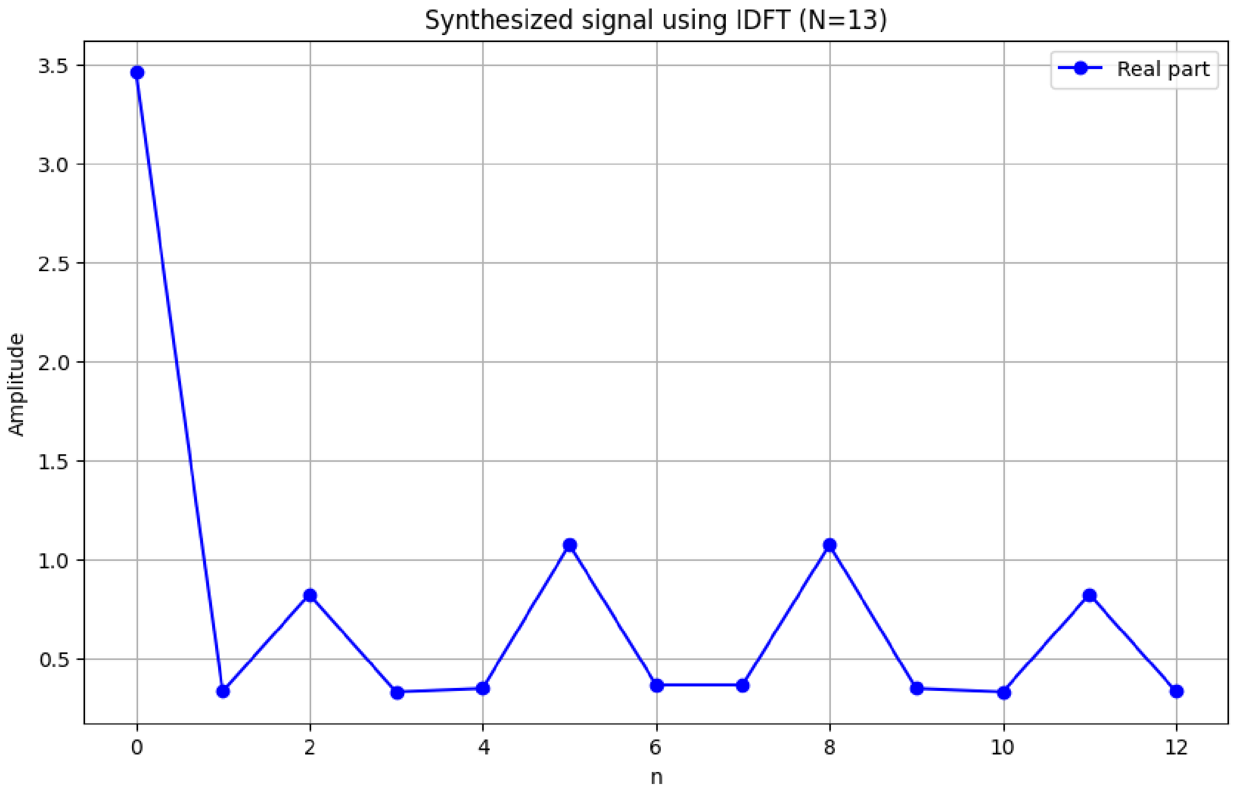
```
# Zadanie 1
# Synthesize a discrete-time signal by using the IDFT in matrix
notation for different values of N. Show the matrices W and K. Plot
the signal synthesized.

import numpy as np
import matplotlib.pyplot as plt

# Given signal in the frequency domain
x_mu = np.array([10, 5, 6, 6, 2, 4, 3, 4,5,0, 0, 0, 0])

# Number of points (length of the signal)
N = len(x_mu)

# Create the W matrix (N x N)
W = np.exp(-2j * np.pi / N * np.outer(np.arange(N), np.arange(N)))

# Compute the IDFT (inverse discrete Fourier transform)
x = (1 / N) * np.dot(W, x_mu)

# Plot the synthesized signal (real part)
plt.figure(figsize=(10, 6))
plt.plot(np.arange(N), np.real(x), marker='o', linestyle='-',
color='b', label="Real part")
plt.title(f"Synthesized signal using IDFT (N={N})")
plt.xlabel("n")
plt.ylabel("Amplitude")
plt.grid(True)
plt.legend()
plt.show()

# Print W and K matrices
print("Matrix W (N x N):")
print(W)
print("\nFrequency-domain signal (X_mu):")
print(x_mu)
```



```
Matrix W (N x N):
[[ 1.        +0.j          1.        +0.j          1.        +0.j
   1.        +0.j          1.        +0.j          1.        +0.j
   1.        +0.j          1.        +0.j          1.        +0.j
   1.        +0.j          1.        +0.j          1.        +0.j
   1.        +0.j        ]
 [ 1.        +0.j          0.88545603-0.46472317j  0.56806475-
0.82298387j
   0.12053668-0.99270887j -0.35460489-0.93501624j -0.74851075-
0.66312266j
  -0.97094182-0.23931566j -0.97094182+0.23931566j -
0.74851075+0.66312266j
  -0.35460489+0.93501624j  0.12053668+0.99270887j
0.56806475+0.82298387j
   0.88545603+0.46472317j]
 [ 1.        +0.j          0.56806475-0.82298387j -0.35460489-
0.93501624j
  -0.97094182-0.23931566j -0.74851075+0.66312266j
0.12053668+0.99270887j
   0.88545603+0.46472317j  0.88545603-0.46472317j  0.12053668-
0.99270887j
  -0.74851075-0.66312266j -0.97094182+0.23931566j -
0.35460489+0.93501624j
   0.56806475+0.82298387j]
 [ 1.        +0.j          0.12053668-0.99270887j -0.97094182-
```

```
0.23931566j
  -0.35460489+0.93501624j  0.88545603+0.46472317j  0.56806475-
0.82298387j
  -0.74851075-0.66312266j -0.74851075+0.66312266j
0.56806475+0.82298387j
   0.88545603-0.46472317j -0.35460489-0.93501624j -
0.97094182+0.23931566j
   0.12053668+0.99270887j]
 [ 1.        +0.j         -0.35460489-0.93501624j -
0.74851075+0.66312266j
   0.88545603+0.46472317j  0.12053668-0.99270887j -
0.97094182+0.23931566j
   0.56806475+0.82298387j  0.56806475-0.82298387j -0.97094182-
0.23931566j
   0.12053668+0.99270887j  0.88545603-0.46472317j -0.74851075-
0.66312266j
  -0.35460489+0.93501624j]
 [ 1.        +0.j         -0.74851075-0.66312266j
0.12053668+0.99270887j
   0.56806475-0.82298387j -0.97094182+0.23931566j
0.88545603+0.46472317j
  -0.35460489-0.93501624j -0.35460489+0.93501624j  0.88545603-
0.46472317j
  -0.97094182-0.23931566j  0.56806475+0.82298387j  0.12053668-
0.99270887j
  -0.74851075+0.66312266j]
 [ 1.        +0.j         -0.97094182-0.23931566j
0.88545603+0.46472317j
  -0.74851075-0.66312266j  0.56806475+0.82298387j -0.35460489-
0.93501624j
   0.12053668+0.99270887j  0.12053668-0.99270887j -
0.35460489+0.93501624j
   0.56806475-0.82298387j -0.74851075+0.66312266j  0.88545603-
0.46472317j
  -0.97094182+0.23931566j]
 [ 1.        +0.j         -0.97094182+0.23931566j  0.88545603-
0.46472317j
  -0.74851075+0.66312266j  0.56806475-0.82298387j -
0.35460489+0.93501624j
   0.12053668-0.99270887j  0.12053668+0.99270887j -0.35460489-
0.93501624j
   0.56806475+0.82298387j -0.74851075-0.66312266j
0.88545603+0.46472317j
  -0.97094182-0.23931566j]
 [ 1.        +0.j         -0.74851075+0.66312266j  0.12053668-
0.99270887j
   0.56806475+0.82298387j -0.97094182-0.23931566j  0.88545603-
0.46472317j
  -0.35460489+0.93501624j -0.35460489-0.93501624j
```

```
0.88545603+0.46472317j
  -0.97094182+0.23931566j  0.56806475-0.82298387j
0.12053668+0.99270887j
  -0.74851075-0.66312266j]
 [ 1.        +0.j         -0.35460489+0.93501624j -0.74851075-
0.66312266j
   0.88545603-0.46472317j  0.12053668+0.99270887j -0.97094182-
0.23931566j
   0.56806475-0.82298387j  0.56806475+0.82298387j -
0.97094182+0.23931566j
   0.12053668-0.99270887j  0.88545603+0.46472317j -
0.74851075+0.66312266j
  -0.35460489-0.93501624j]
 [ 1.        +0.j          0.12053668+0.99270887j -
0.97094182+0.23931566j
  -0.35460489-0.93501624j  0.88545603-0.46472317j
0.56806475+0.82298387j
  -0.74851075+0.66312266j -0.74851075-0.66312266j  0.56806475-
0.82298387j
   0.88545603+0.46472317j -0.35460489+0.93501624j -0.97094182-
0.23931566j
   0.12053668-0.99270887j]
 [ 1.        +0.j          0.56806475+0.82298387j -
0.35460489+0.93501624j
  -0.97094182+0.23931566j -0.74851075-0.66312266j  0.12053668-
0.99270887j
   0.88545603-0.46472317j  0.88545603+0.46472317j
0.12053668+0.99270887j
  -0.74851075+0.66312266j -0.97094182-0.23931566j -0.35460489-
0.93501624j
   0.56806475-0.82298387j]
 [ 1.        +0.j          0.88545603+0.46472317j
0.56806475+0.82298387j
   0.12053668+0.99270887j -0.35460489+0.93501624j -
0.74851075+0.66312266j
  -0.97094182+0.23931566j -0.97094182-0.23931566j -0.74851075-
0.66312266j
  -0.35460489-0.93501624j  0.12053668-0.99270887j  0.56806475-
0.82298387j
   0.88545603-0.46472317j]]

Frequency-domain signal (X_mu):
[10  5  6  6  2  4  3  4  5  0  0  0  0]
```