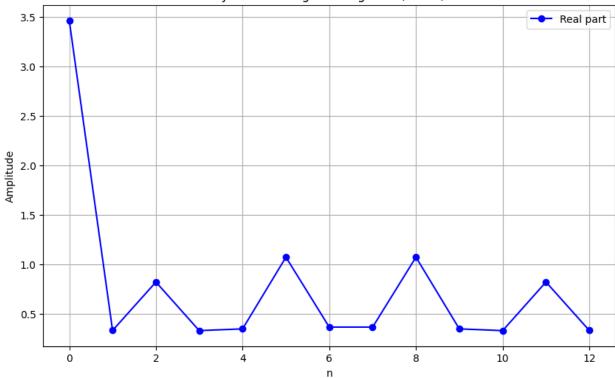
```
# Zadanie 1
# Synthesize a discrete-time signal by using the IDFT in matrix
notation for different values of N. Show the matrices W and K. Plot
the signal synthesized.
import numpy as np
import matplotlib.pyplot as plt
# Given signal in the frequency domain
x mu = np.array([10, 5, 6, 6, 2, 4, 3, 4,5,0, 0, 0, 0])
# Number of points (length of the signal)
N = len(x mu)
# Create the W matrix (N \times 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.i
                                      +0.j
   1.
             +0.j
                            1.
                                                     1.
                                                                +0.j
   1.
             +0.j
                            1.
                                      +0.j
                                                                +0.i
   1.
             +0.j
                            0.88545603-0.46472317j
 [ 1.
             +0.j
                                                     0.56806475-
0.82298387i
   0.12053668-0.99270887j -0.35460489-0.93501624j -0.74851075-
0.66312266j
  -0.97094182-0.23931566j -0.97094182+0.23931566j -
0.74851075+0.663122661
  -0.35460489+0.93501624j
                            0.12053668+0.99270887j
0.56806475+0.822983871
   0.88545603+0.46472317j]
                            0.56806475-0.82298387j -0.35460489-
 [ 1.
             +0.j
0.93501624j
  -0.97094182-0.23931566j -0.74851075+0.66312266j
0.12053668+0.99270887j
   0.88545603+0.46472317j 0.88545603-0.46472317j 0.12053668-
0.99270887i
  -0.74851075-0.66312266j -0.97094182+0.23931566j -
0.35460489+0.93501624j
   0.56806475+0.82298387j]
 [ 1.
                            0.12053668-0.99270887j -0.97094182-
             +0.i
```

```
0.23931566i
  -0.35460489+0.93501624j 0.88545603+0.46472317j 0.56806475-
0.82298387j
  -0.74851075-0.66312266j -0.74851075+0.66312266j
0.56806475+0.822983871
   0.88545603-0.46472317j -0.35460489-0.93501624j -
0.97094182+0.239315661
   0.12053668+0.99270887j]
             +0.j
                          -0.35460489-0.935016241 -
0.74851075+0.663122661
   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]
             +0.j
 [ 1.
                          -0.74851075-0.66312266j
0.12053668+0.992708871
   0.56806475-0.82298387j -0.97094182+0.23931566j
0.88545603+0.46472317
  -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]
             +0.i
                          -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+0.935016241
   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-
0.93501624i
   0.56806475+0.82298387j -0.74851075-0.66312266j
0.88545603+0.46472317j
  -0.97094182-0.23931566j]
                  -0.74851075+0.66312266j 0.12053668-
 [ 1.
             +0.j
0.99270887j
   0.56806475+0.82298387j -0.97094182-0.23931566j 0.88545603-
0.46472317j
  -0.35460489+0.93501624j -0.35460489-0.93501624j
```

```
0.88545603+0.46472317i
  -0.97094182+0.23931566j 0.56806475-0.82298387j
0.12053668+0.99270887j
  -0.74851075-0.66312266j]
 [ 1.
                          -0.35460489+0.93501624; -0.74851075-
             +0.j
0.66312266j
   0.88545603 - 0.46472317 0.12053668 + 0.99270887 -0.97094182 -
0.23931566j
   0.56806475-0.82298387j 0.56806475+0.82298387j -
0.97094182+0.239315661
   0.12053668-0.99270887j 0.88545603+0.46472317j -
0.74851075+0.66312266j
  -0.35460489-0.9350162411
                           0.12053668+0.99270887j -
             +0.i
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 + 0.46472317 -0.35460489 + 0.93501624 -0.97094182 -
0.23931566j
   0.12053668-0.99270887j]
 [ 1.
             +0.j
                           0.56806475+0.822983871 -
0.35460489+0.93501624j
  -0.97094182+0.23931566j -0.74851075-0.66312266j 0.12053668-
0.99270887i
   0.88545603-0.46472317j 0.88545603+0.46472317j
0.12053668+0.99270887j
  -0.74851075+0.66312266j -0.97094182-0.23931566j -0.35460489-
0.93501624i
   0.56806475-0.82298387j]
             +0.i
                           0.88545603+0.46472317i
0.56806475+0.82298387j
   0.12053668+0.99270887j -0.35460489+0.93501624j -
0.74851075+0.663122661
  -0.97094182+0.23931566j -0.97094182-0.23931566j -0.74851075-
0.66312266j
  -0.35460489-0.93501624j 0.12053668-0.99270887j 0.56806475-
0.82298387j
   0.88545603-0.46472317;]]
Frequency-domain signal (X mu):
[10 5 6 6 2 4 3 4 5 0 0 0 0]
```