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In [ ]: # Wojciech Kasolik LAB 01
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```
import numpy as np
import matplotlib.pyplot as plt
```

```
Xu = [7, 2, 4, 3, 4, 5, 0, 0, 0, 0]
N = len(Xu)
```

```
In [ ]: k = np.arange(N)
mu = np.arange(N)
K = np.outer(k, mu)
W = np.exp(+1j*2*np.pi/N*K)
```

```
In [ ]: np.set_printoptions(precision=2, suppress=True)
display(K)
display(W)
```

```
array([[ 0,  0,  0,  0,  0,  0,  0,  0,  0,  0],
       [ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9],
       [ 0,  2,  4,  6,  8, 10, 12, 14, 16, 18],
       [ 0,  3,  6,  9, 12, 15, 18, 21, 24, 27],
       [ 0,  4,  8, 12, 16, 20, 24, 28, 32, 36],
       [ 0,  5, 10, 15, 20, 25, 30, 35, 40, 45],
       [ 0,  6, 12, 18, 24, 30, 36, 42, 48, 54],
       [ 0,  7, 14, 21, 28, 35, 42, 49, 56, 63],
       [ 0,  8, 16, 24, 32, 40, 48, 56, 64, 72],
       [ 0,  9, 18, 27, 36, 45, 54, 63, 72, 81]])
array([[ 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 ,  0.81+0.59j,  0.31+0.95j, -0.31+0.95j, -0.81+0.59j,
       -1. +0.j , -0.81-0.59j, -0.31-0.95j,  0.31-0.95j,  0.81-0.59j],
       [ 1. +0.j ,  0.31+0.95j, -0.81+0.59j, -0.81-0.59j,  0.31-0.95j,
        1. -0.j ,  0.31+0.95j, -0.81+0.59j, -0.81-0.59j,  0.31-0.95j],
       [ 1. +0.j , -0.31+0.95j, -0.81-0.59j,  0.81-0.59j,  0.31+0.95j,
       -1. +0.j ,  0.31-0.95j,  0.81+0.59j, -0.81+0.59j, -0.31-0.95j],
       [ 1. +0.j , -0.81+0.59j,  0.31-0.95j,  0.31+0.95j, -0.81-0.59j,
        1. -0.j , -0.81+0.59j,  0.31-0.95j,  0.31+0.95j, -0.81-0.59j],
       [ 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 , -0.81-0.59j,  0.31+0.95j,  0.31-0.95j, -0.81+0.59j,
        1. -0.j , -0.81-0.59j,  0.31+0.95j,  0.31-0.95j, -0.81+0.59j],
       [ 1. +0.j , -0.31-0.95j, -0.81+0.59j,  0.81+0.59j,  0.31-0.95j,
       -1. +0.j ,  0.31+0.95j,  0.81-0.59j, -0.81-0.59j, -0.31+0.95j],
       [ 1. +0.j ,  0.31-0.95j, -0.81-0.59j, -0.81+0.59j,  0.31+0.95j,
        1. -0.j ,  0.31-0.95j, -0.81-0.59j, -0.81+0.59j,  0.31+0.95j],
       [ 1. +0.j ,  0.81-0.59j,  0.31-0.95j, -0.31-0.95j, -0.81-0.59j,
       -1. +0.j , -0.81+0.59j, -0.31+0.95j,  0.31+0.95j,  0.81+0.59j]])
```

```
In [ ]: signal = 1/N * np.matmul(W, Xu)
display(signal)
```

```
array([2.5 +0.j , 0.07+1.02j, 0.82-0.13j, 0.18+0.16j, 0.93-0.21j,
       0.5 +0.j , 0.93+0.21j, 0.18-0.16j, 0.82+0.13j, 0.07-1.02j])
```

```
In [ ]: plt.stem(k, np.real(signal), label='real', markerfmt='C0o', basefmt='C0:', linefmt='C0:')
plt.stem(k, np.imag(signal), label='imag', markerfmt='C1o', basefmt='C1:', linefmt='C1:')

plt.plot(k, np.real(signal), 'C0o-', lw=0.5)
plt.plot(k, np.imag(signal), 'C1o-', lw=0.5)
```

```
plt.xlabel(r'sample  $x[k]$ ')  
plt.ylabel(r' $x[k]$ ')  
plt.legend()  
plt.grid(True)
```

