

# Task\_SA

April 28, 2025

## 1 Task\_SA

### 1.1 Task description

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 6.:  $\mathbf{x}_\text{--} = [7, 2, 4, 3, 4, 5, 0, 0, 0, 0]^T$

### 1.2 Python code

```
[6]: import numpy as np
import matplotlib.pyplot as plt
```

Necessary python libraries were imported above

```
[8]: N = 10 # signal length
X = np.array([7, 2, 4, 3, 4, 5, 0, 0, 0, 0]) #DFT vector

# required DFT indices
k = np.arange(N) # sample/time indices
mu = np.arange(N) # frequency indices

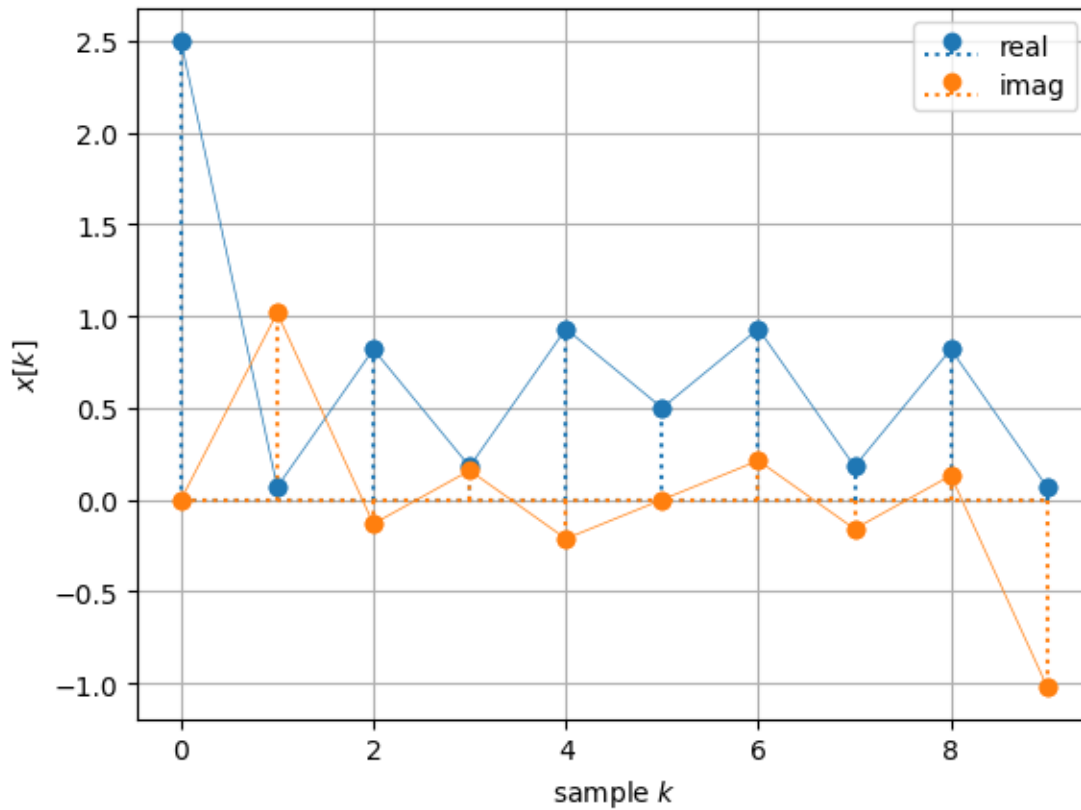
# Set up matrices
K = np.outer(k, mu) # outer product of vectors k and mu
W = np.exp(+1j * 2 * np.pi / N * K) # analysis matrix for DFT
```

```
[14]: x = 1 / N * np.matmul(W, X)
```

```
[16]: plt.stem(k, np.real(x), label="real", markerfmt="C0o", basefmt="C0:",
↳linefmt="C0:")
plt.stem(k, np.imag(x), label="imag", markerfmt="C1o", basefmt="C1:",
↳linefmt="C1:")

plt.plot(k, np.real(x), "C0o-", lw=0.5)
plt.plot(k, np.imag(x), "C1o-", lw=0.5)
plt.xlabel(r"sample $k$")
plt.ylabel(r"$x[k]$")
plt.legend()
```

```
plt.grid(True)
```



```
[18]: print("K matrix is: \n", K)
```

```
K matrix is:
[[ 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]]
```

```
[20]: print("W matrix is: \n", W)
```

```
W matrix is:
[[ 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]
[ 1.          +0.00000000e+00j  0.80901699+5.87785252e-01j
  0.30901699+9.51056516e-01j -0.30901699+9.51056516e-01j
 -0.80901699+5.87785252e-01j -1.          +1.22464680e-16j
 -0.80901699-5.87785252e-01j -0.30901699-9.51056516e-01j
  0.30901699-9.51056516e-01j  0.80901699-5.87785252e-01j]
[ 1.          +0.00000000e+00j  0.30901699+9.51056516e-01j
 -0.80901699+5.87785252e-01j -0.80901699-5.87785252e-01j
  0.30901699-9.51056516e-01j  1.          -2.44929360e-16j
  0.30901699+9.51056516e-01j -0.80901699+5.87785252e-01j
 -0.80901699-5.87785252e-01j  0.30901699-9.51056516e-01j]
[ 1.          +0.00000000e+00j -0.30901699+9.51056516e-01j
 -0.80901699-5.87785252e-01j  0.80901699-5.87785252e-01j
  0.30901699+9.51056516e-01j -1.          +3.67394040e-16j
  0.30901699-9.51056516e-01j  0.80901699+5.87785252e-01j
 -0.80901699+5.87785252e-01j -0.30901699-9.51056516e-01j]
[ 1.          +0.00000000e+00j -0.80901699+5.87785252e-01j
  0.30901699-9.51056516e-01j  0.30901699+9.51056516e-01j
 -0.80901699-5.87785252e-01j  1.          -4.89858720e-16j
 -0.80901699+5.87785252e-01j  0.30901699-9.51056516e-01j
  0.30901699+9.51056516e-01j -0.80901699-5.87785252e-01j]
[ 1.          +0.00000000e+00j -1.          +1.22464680e-16j
  1.          -2.44929360e-16j -1.          +3.67394040e-16j
  1.          -4.89858720e-16j -1.          +6.12323400e-16j
  1.          -7.34788079e-16j -1.          +8.57252759e-16j
  1.          -9.79717439e-16j -1.          +1.10218212e-15j]
[ 1.          +0.00000000e+00j -0.80901699-5.87785252e-01j
  0.30901699+9.51056516e-01j  0.30901699-9.51056516e-01j
 -0.80901699+5.87785252e-01j  1.          -7.34788079e-16j
 -0.80901699-5.87785252e-01j  0.30901699+9.51056516e-01j
  0.30901699-9.51056516e-01j -0.80901699+5.87785252e-01j]
[ 1.          +0.00000000e+00j -0.30901699-9.51056516e-01j
 -0.80901699+5.87785252e-01j  0.80901699+5.87785252e-01j
  0.30901699-9.51056516e-01j -1.          +8.57252759e-16j
  0.30901699+9.51056516e-01j  0.80901699-5.87785252e-01j
 -0.80901699-5.87785252e-01j -0.30901699+9.51056516e-01j]
[ 1.          +0.00000000e+00j  0.30901699-9.51056516e-01j
 -0.80901699-5.87785252e-01j -0.80901699+5.87785252e-01j
  0.30901699+9.51056516e-01j  1.          -9.79717439e-16j
  0.30901699-9.51056516e-01j -0.80901699-5.87785252e-01j
 -0.80901699+5.87785252e-01j  0.30901699+9.51056516e-01j]
[ 1.          +0.00000000e+00j  0.80901699-5.87785252e-01j
  0.30901699-9.51056516e-01j -0.30901699-9.51056516e-01j
 -0.80901699-5.87785252e-01j -1.          +1.10218212e-15j
 -0.80901699+5.87785252e-01j -0.30901699+9.51056516e-01j
  0.30901699+9.51056516e-01j  0.80901699+5.87785252e-01j]]

```