

Problem set:

```
1.import numpy as np

import matplotlib.pyplot as plt


# Parameters for the sine wave

sampling_rate = 1000 # Samples per second

frequency = 5      # Frequency of the sine wave in Hz

duration = 1       # Duration in seconds


# Time array

t = np.linspace(0, duration, int(sampling_rate * duration), endpoint=False)


# Create a sine wave signal

signal = np.sin(2 * np.pi * frequency * t)


# Perform Fast Fourier Transform (FFT)

fft_result = np.fft.fft(signal)

fft_magnitude = np.abs(fft_result) # Magnitude of the FFT

frequencies = np.fft.fftfreq(len(fft_magnitude), 1/sampling_rate)


# Plot the original sine wave signal

plt.figure(figsize=(12, 6))

plt.subplot(2, 1, 1)

plt.plot(t, signal, label='Sine Wave (5 Hz)')

plt.title('Original Sine Wave Signal')

plt.xlabel('Time (s)')

plt.ylabel('Amplitude')

plt.grid()

plt.legend()


# Plot the frequency spectrum
```

Problem set:

```
plt.subplot(2, 1, 2)

plt.plot(frequencies[:len(frequencies)//2], fft_magnitude[:len(frequencies)//2], color='orange',
label='Frequency Spectrum')

plt.title('Frequency Spectrum')

plt.xlabel('Frequency (Hz)')

plt.ylabel('Magnitude')

plt.xlim(0, 50) # Limit x-axis for better visualization

plt.grid()

plt.legend()


plt.tight_layout()

plt.show()
```

```
2.import numpy as np
from scipy.integrate import quad

def f(x):
    return x**2

a = 0
b = 5

result, error = quad(f, a, b)
```

```
print(f"The integral of  $f(x) = x^2$  from {a} to {b} is approximately {result:.4f}")
print(f"Estimated error in the result: {error:.4e}")
```

output:

```
The integral of  $f(x) = x^2$  from 0 to 5 is approximately 41.6667
Estimated error in the result: 4.6259e-13
```

```
3. import numpy as np
from scipy.optimize import minimize
```

```
# Define the function to minimize

def f(x):
```

Problem set:

```
return (x - 3)**2 + 2
```

```
x0 = 0
```

```
# Perform the minimization
```

```
result = minimize(f, x0)
```

```
# Output the result
```

```
print(f"The minimum value occurs at x = {result.x[0]:.4f}")
```

```
print(f"The minimum value of the function is f(x) = {result.fun:.4f}")
```

```
output:
```

```
The minimum value occurs at x = 3.0000
```

```
The minimum value of the function is f(x) = 2.0000
```

```
4. import numpy as np
```

```
# Coefficient matrix
```

```
A = np.array([[2, 3],  
              [4, 1]])
```

```
# Right-hand side vector
```

```
b = np.array([5, 6])
```

```
# Solve the system of equations
```

```
solution = np.linalg.solve(A, b)
```

```
# Output the result
```

```
x, y = solution
```

```
print(f"The solution is x = {x:.4f}, y = {y:.4f}")
```

```
output:
```

```
The solution is x = 1.3000, y = 0.8000
```