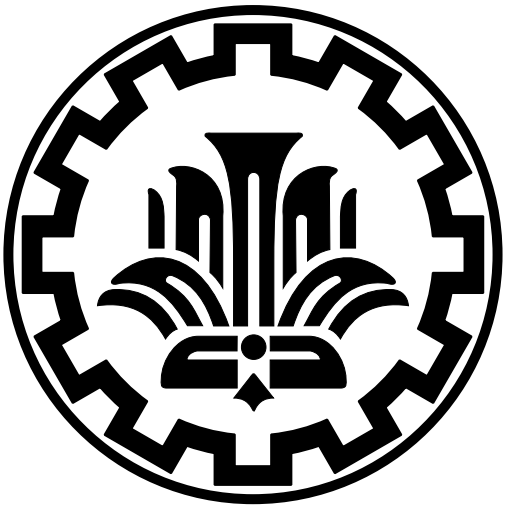

Isfahan University of Technology

ECE Department

Signals and Systems: Project

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9816743

Fall 2023

Dr. Naghsh

Contents

1

1.1

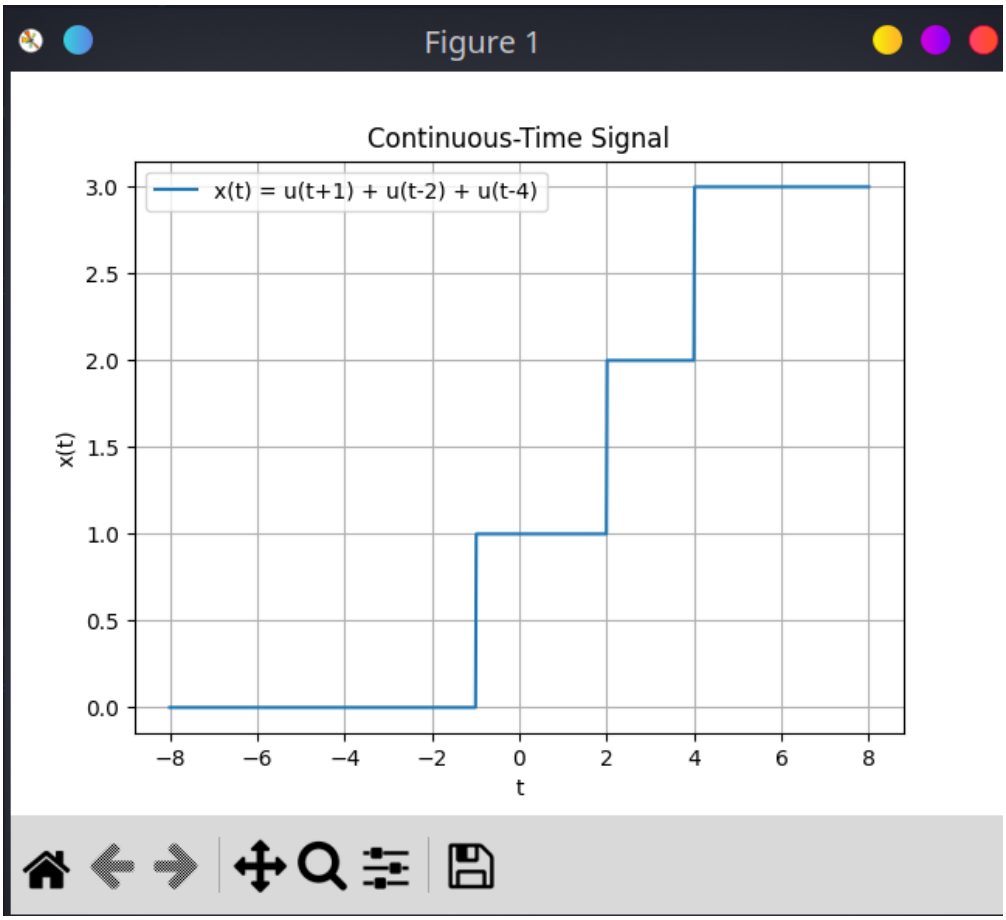
Figure 1
Continuous-Time Signal
x(t) = u(t+1) + u(t-2) + u(t-4)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
x(t)
−8
−6
−4
−2
0
2
4
6
8
t

1.2

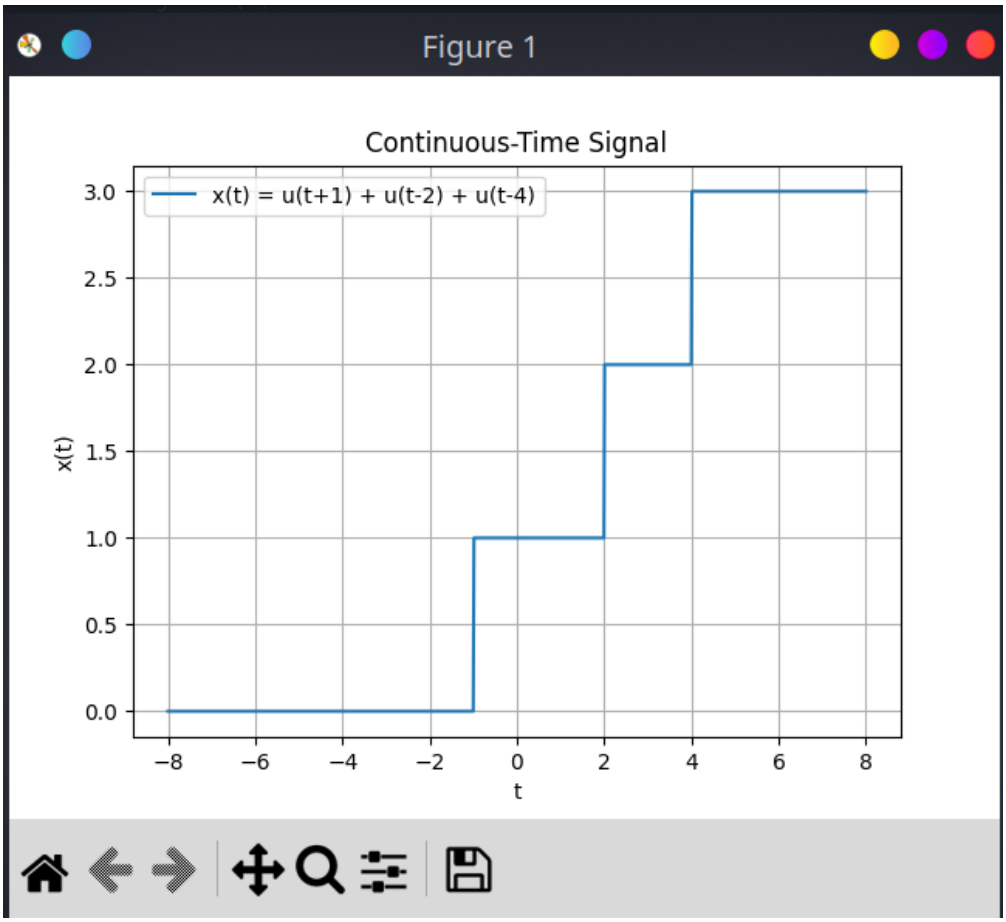
Figure 1
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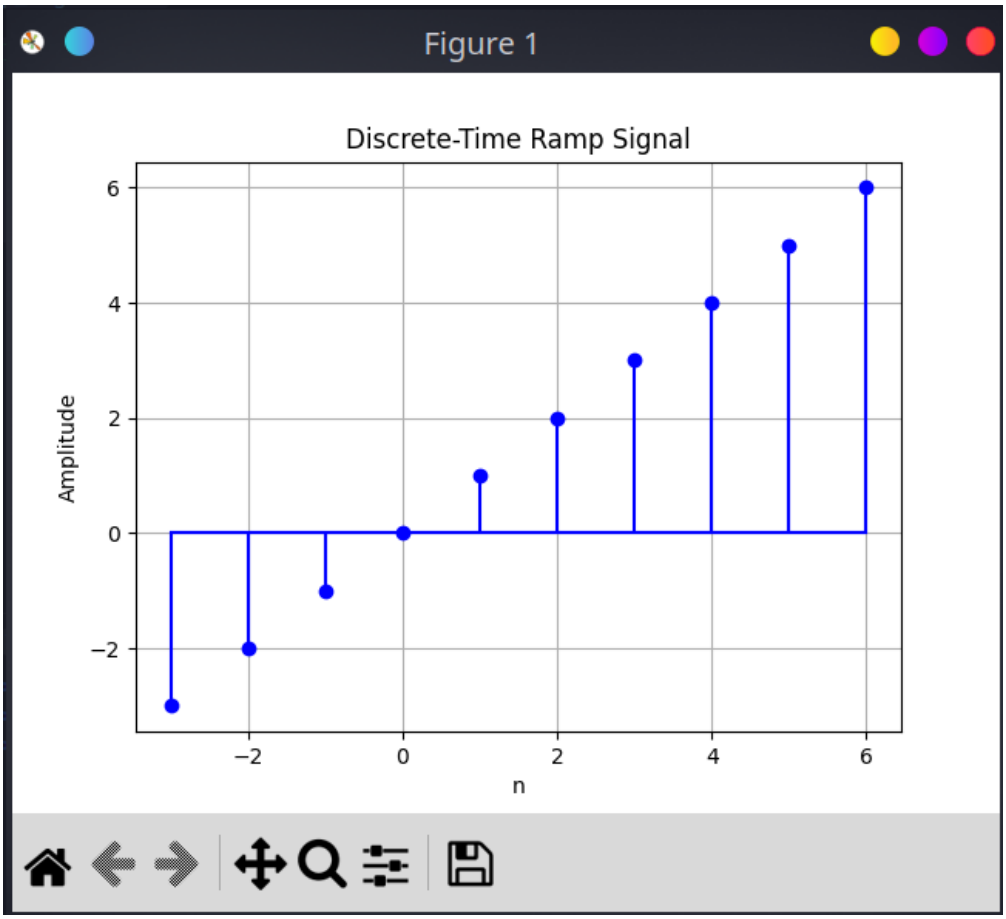
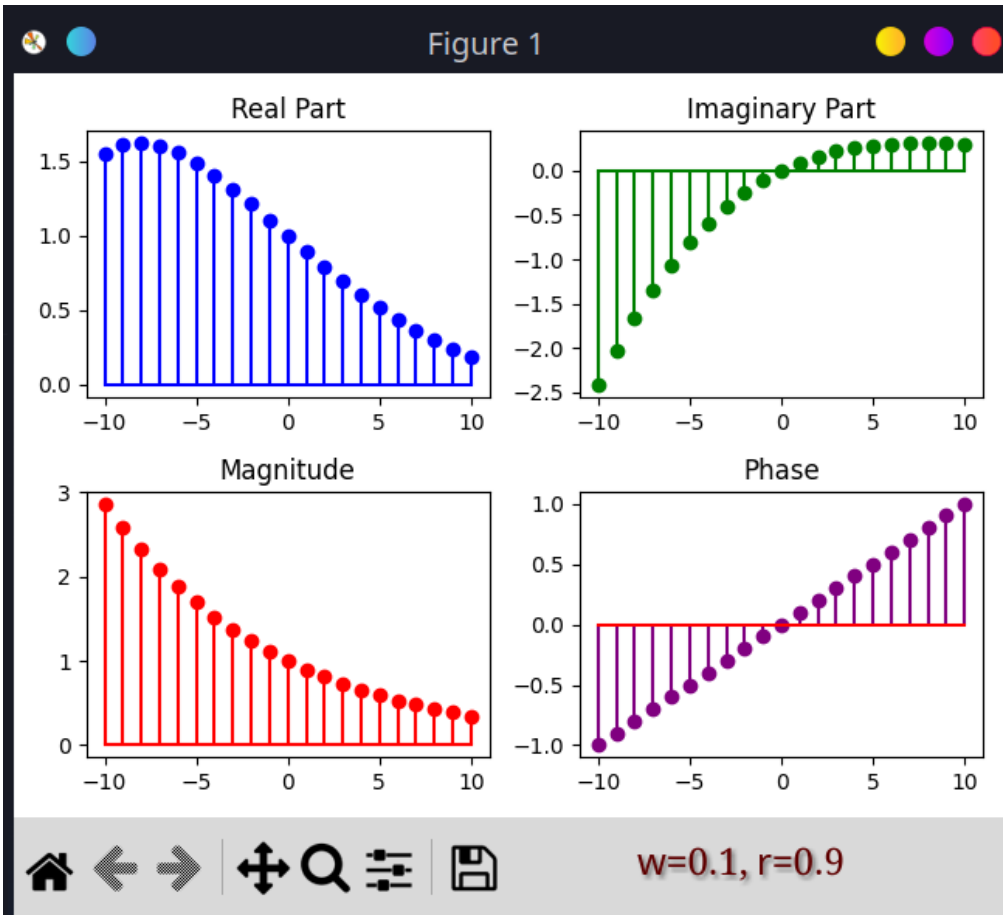
x(t) = u(t+1) + u(t-2) + u(t-4)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
x(t)
−8
−6
−4
−2
0
2
4
6
8
t

1.3



1.4



2

2.1

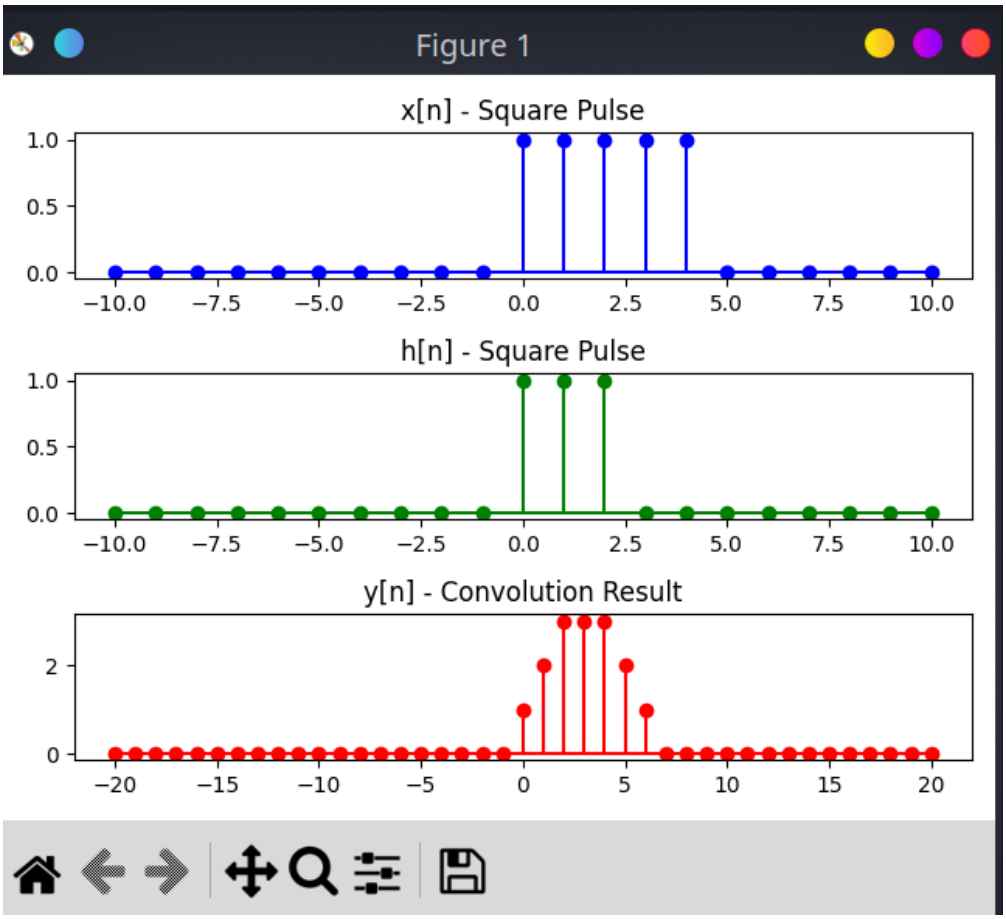
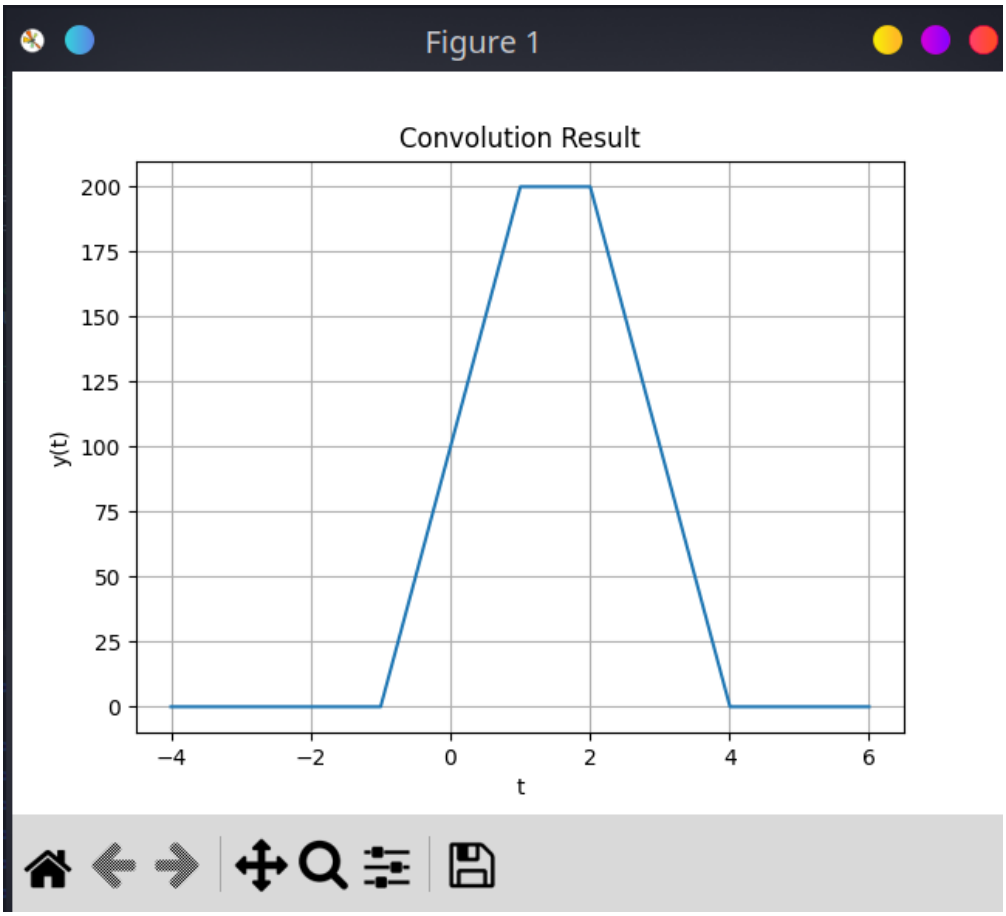


Figure 1
x[n] - Square Pulse
1.0
0.5
0.0
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0
h[n] - Square Pulse
1.0
0.5
0.0
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0
y[n] - Convolution Result
2
0
−20
−15
−10
−5
0
5
10
15
20

2.2



Consider two square pulses $x(t)$ and $h(t)$ with widths L_1 and L_2, respectively. The convolution $y(t) = x(t) * h(t)$ is given by:

$$y(t) = \int_{-\infty}^{\infty} x(\tau)h(t-\tau)\,d\tau$$

Let's denote L_1 as the width of the first pulse and L_2 as the width of the second pulse.

Length of the Legs:

- One leg of the trapezoid will have a length equal to $L_1 + L_2$ because the square pulses overlap completely.
- The other leg will have a length equal to the longer of L_1 and L_2 because one of the pulses extends beyond the other.

Height of the Trapezoid:

- The height of the trapezoid is equal to 1, as both square pulses have amplitudes of 1.

Now, let's calculate the lengths of the legs and the height:

- Length of the longer leg: $\max(L_1, L_2)$
- Length of the shorter leg: $L_1 + L_2$
- Height of the trapezoid: 1

So, the result is a trapezoid with one leg length $\max(L_1, L_2)$, the other leg length $L_1 + L_2$, and a height of 1.

2.3

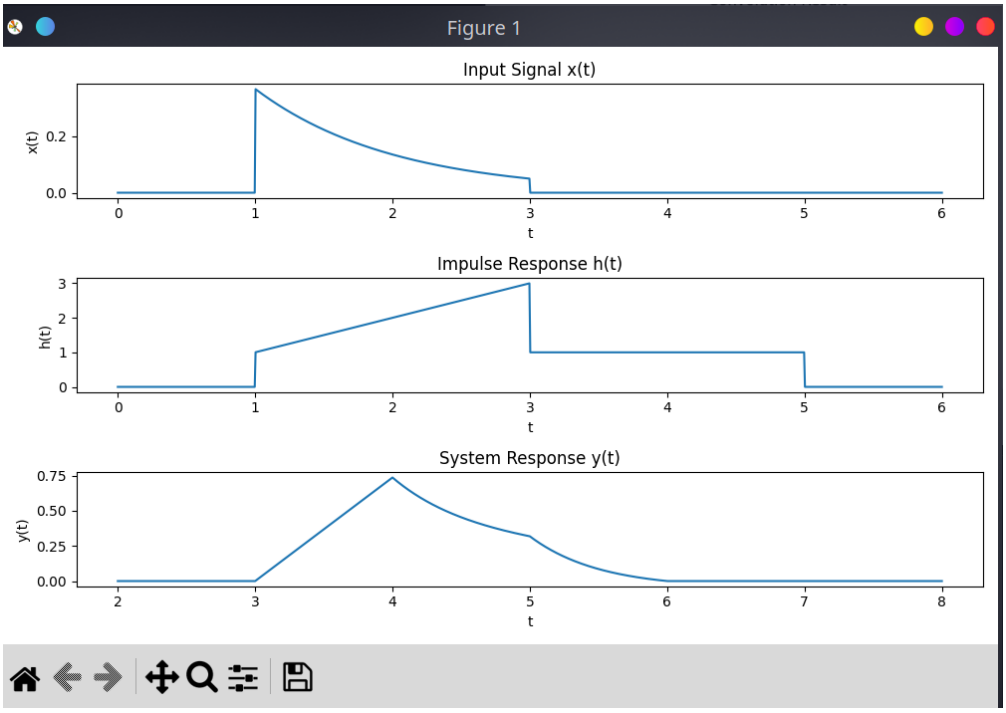


Figure 1
Input Signal x(t)
x(t)
0.0
0.2
0
1
2
3
4
5
6
t
Impulse Response h(t)
h(t)
0
1
2
3
0
1
2
3
4
5
6
t
System Response y(t)
y(t)
0.00
0.25
0.50
0.75
2
3
4
5
6
7
8
t

3

3.1

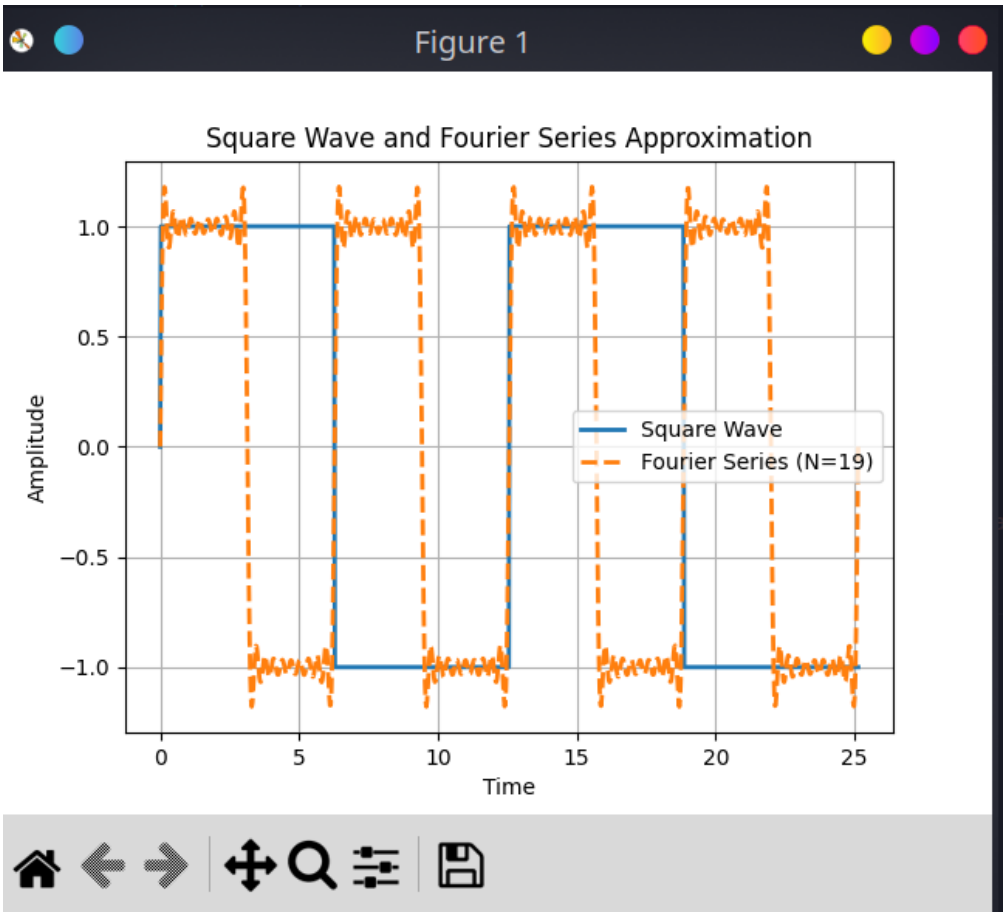


Figure 1
Square Wave and Fourier Series Approximation
Amplitude
1.0
0.5
0.0
−0.5
−1.0
0
5
10
15
20
25
Time
Square Wave
Fourier Series (N=19)

3.2

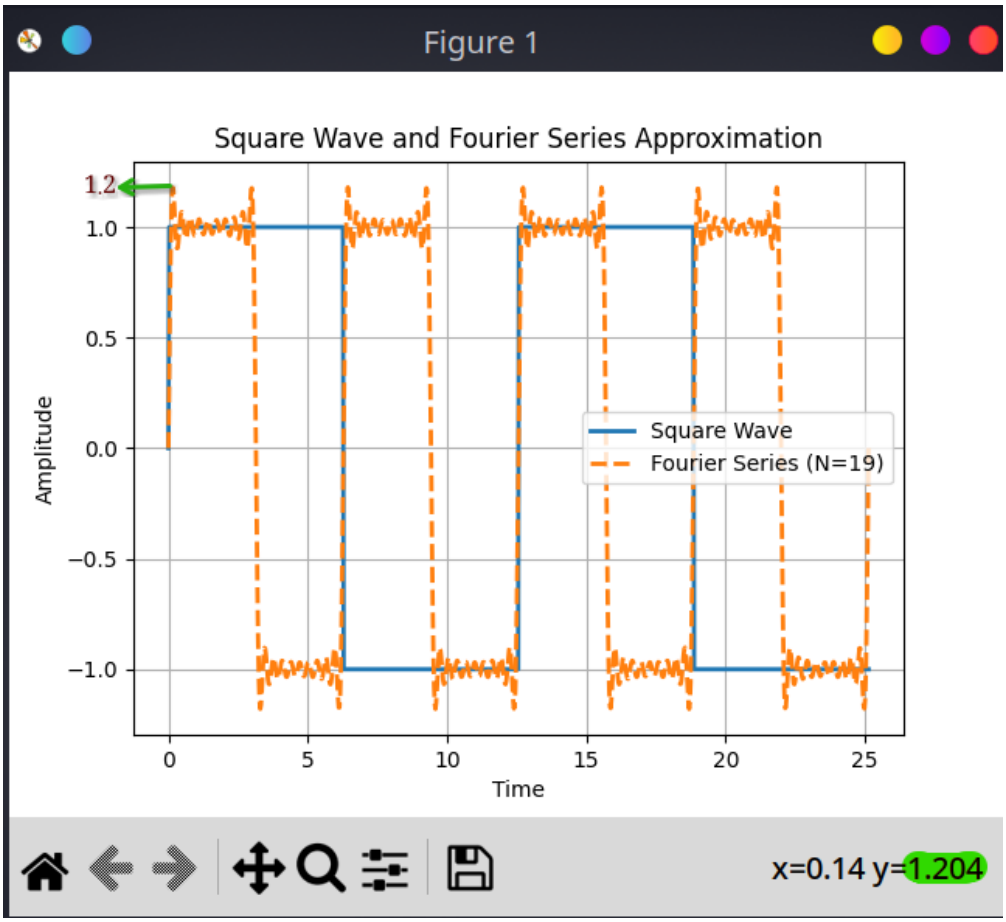
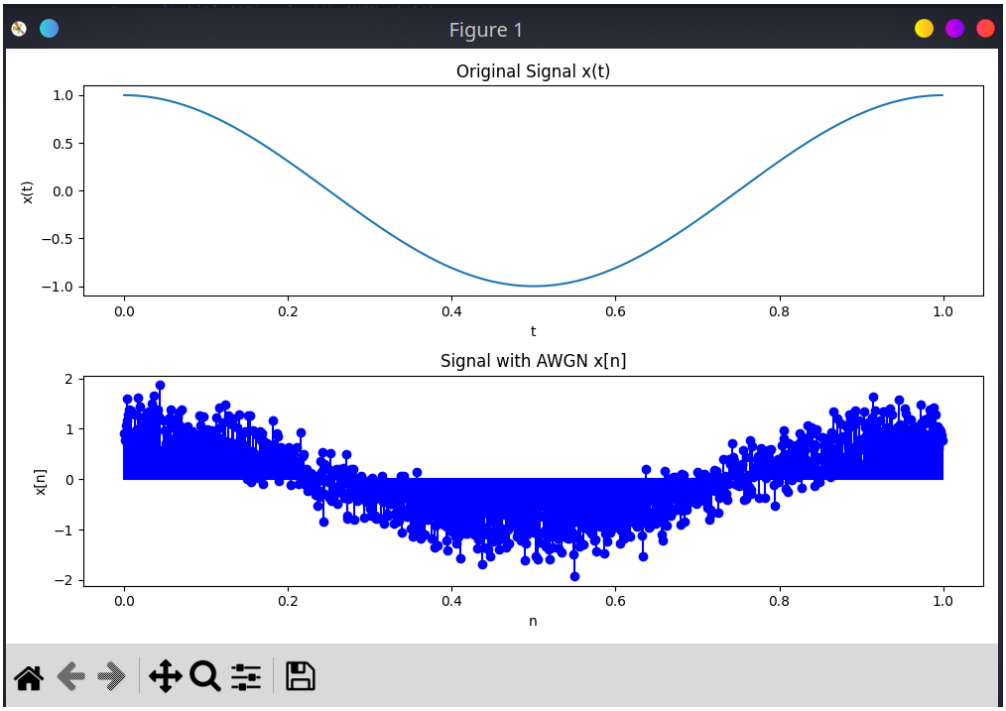


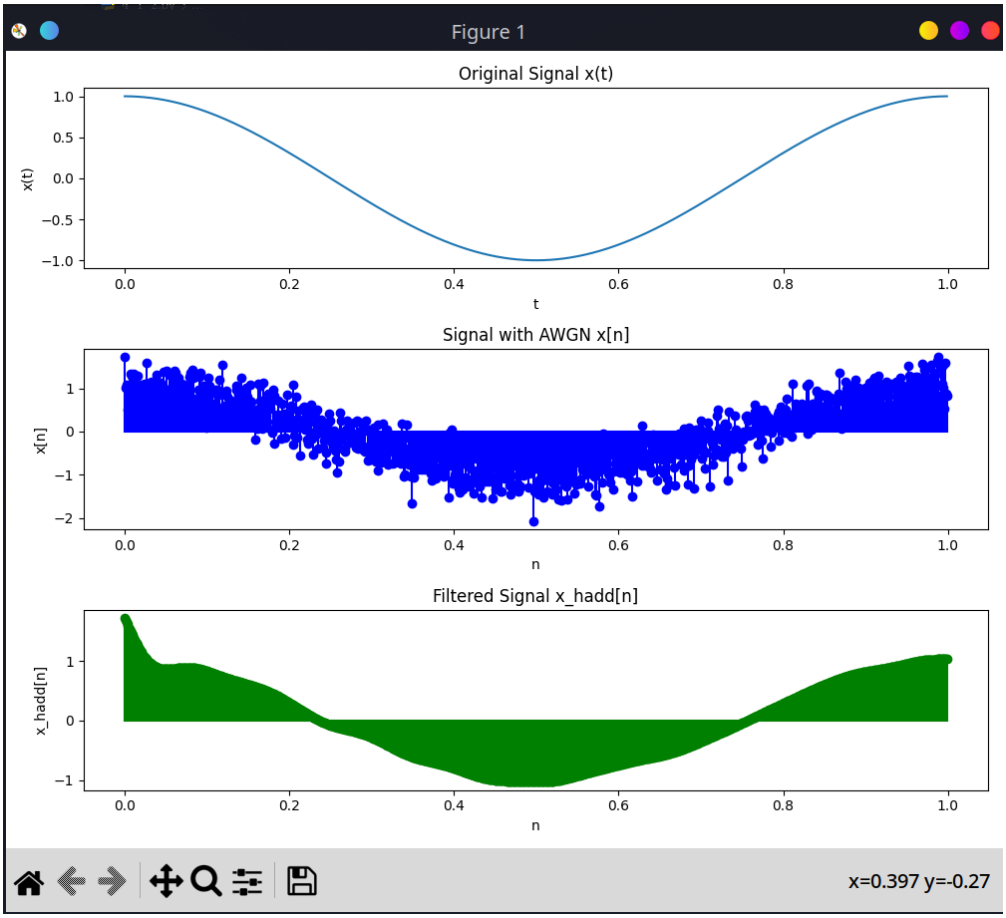
Figure 1
Square Wave and Fourier Series Approximation
Amplitude
Time
Square Wave
Fourier Series (N=19)
1.2
1.0
0.5
0.0
−0.5
−1.0
0
5
10
15
20
25
x=0.14 y=1.204

4

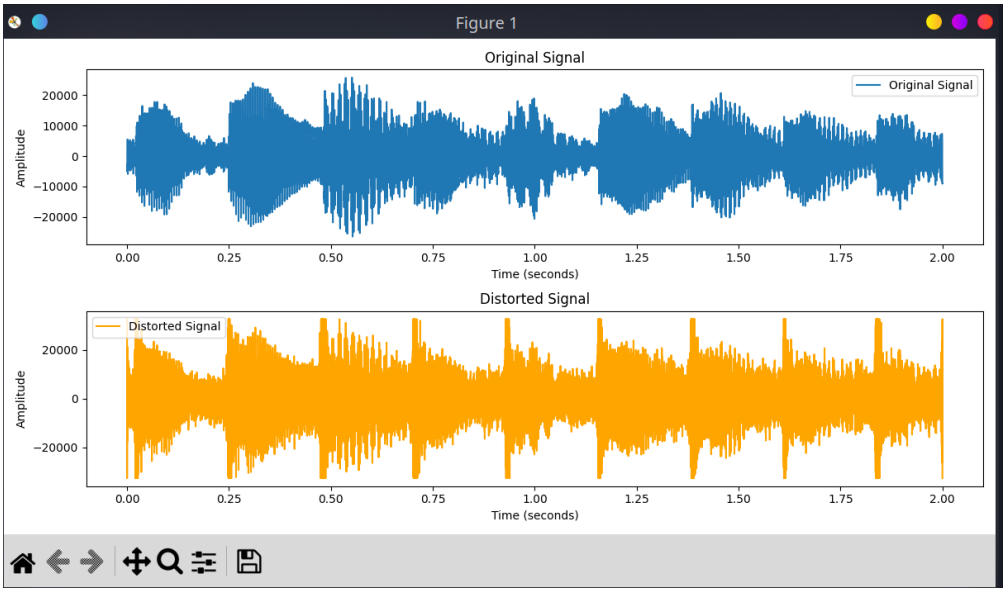
4.1 Part 1 Question 1



4.2 Part 1 Question 2



4.3 Part 2 Question 1



4.4 Part 2 Question 2

Mean Squared Error (MSE) between original and distorted signals: 63.29512471655329

4.5 Part 2 Question 3

The choice between designing the system in the frequency domain or time domain depends on the specific characteristics of the distortion you are dealing with and the nature of the signals. Here are some considerations:

Frequency Domain:

- **Advantages:**
  - Distortions often manifest as changes in frequency components.
  - If the distortion involves frequency-specific effects (e.g., filtering), working in the frequency domain might be more intuitive.
- **Disadvantages:**
  - Processing in the frequency domain might be computationally more intensive.
  - Frequency domain techniques may not be as effective for certain types of time-domain distortions.

Time Domain:

- **Advantages:**
  - If the distortion primarily affects the temporal characteristics of the signal, time-domain processing could be more suitable.
  - Techniques in the time domain might be computationally less complex.
- **Disadvantages:**
  - Time-domain techniques might not handle frequency-specific distortions as effectively.

Choice: Considering that you are dealing with audio signals and LTI systems, both time-domain and frequency-domain approaches can be effective. However, since you are using an LTI system, the time-domain may be more intuitive for designing a system to play back the original signal from the distorted signal.

In practice, you may choose the domain that aligns with the characteristics of the distortion you are dealing with and the ease of implementation based on the nature of your signals. After implementing the system, you can evaluate its performance and make adjustments as needed.

4.6 Part 2 Question 4

Mean Squared Error (MSE) between original and recovered signals: 1336.8513378684806. Yes, My system improved MSE.

4.7 Part 2 Question 5

The noise was canceled, but the quality was reduced.