

# DSP Lab - Homework8

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```
clc;  
clear;  
close all;
```

## Section 3-3 a

```
fs = 1e3;  
t = 0:1 / fs:1;  
A = 2;  
x = A * cos(2 * pi * 50 * t);  
disp("Calculated value of MS of X:");
```

Calculated value of MS of X:

```
ms_val_x = mean(x .^ 2);  
disp(ms_val_x);
```

2.0020

```
disp(0.5*A^2)
```

2

```
mean(abs(x))
```

ans = 1.2635

```
disp(rms(x) ^ 2);
```

2.0020

```
mean_abs_x = mean(abs(x))
```

mean\_abs\_x = 1.2635

```
disp('Mean of x');
```

Mean of x

```
disp(2 * A / pi);
```

1.2732

## Section 3-3 b

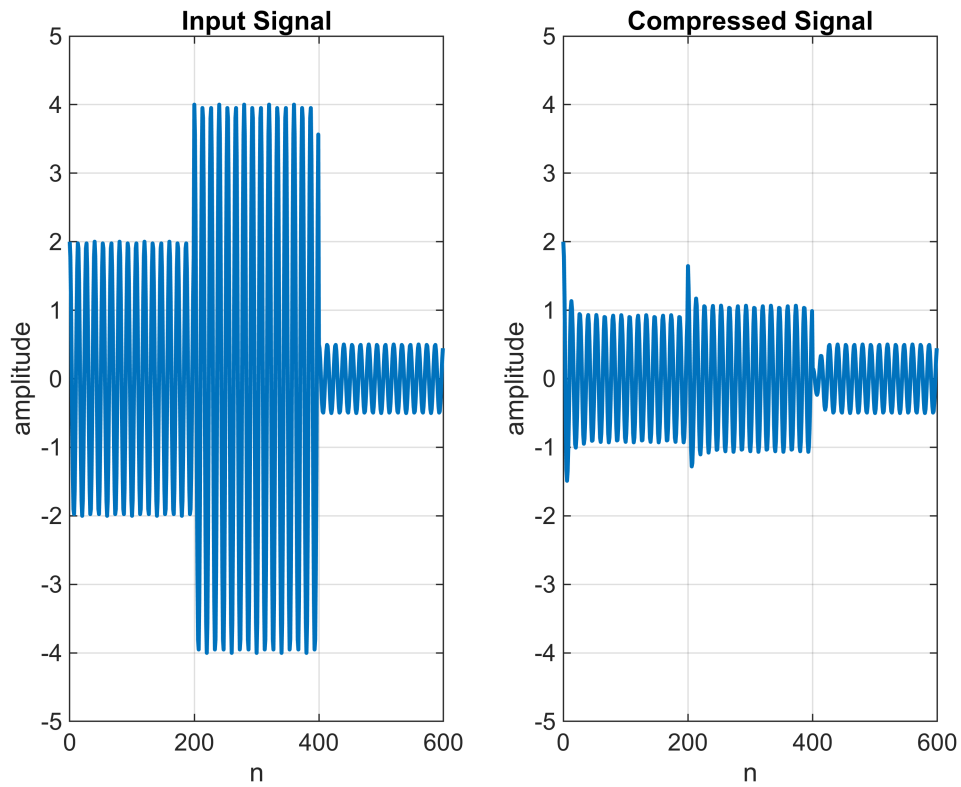
### Compressor

```
w0 = pi * 0.15;
n = [0:199; 200:399; 400:599];
A = [2 4 0.5];
x = cos(w0 * n) .* A';
x = x';
x = x(1:end);
n = n';
n = n(1:end);

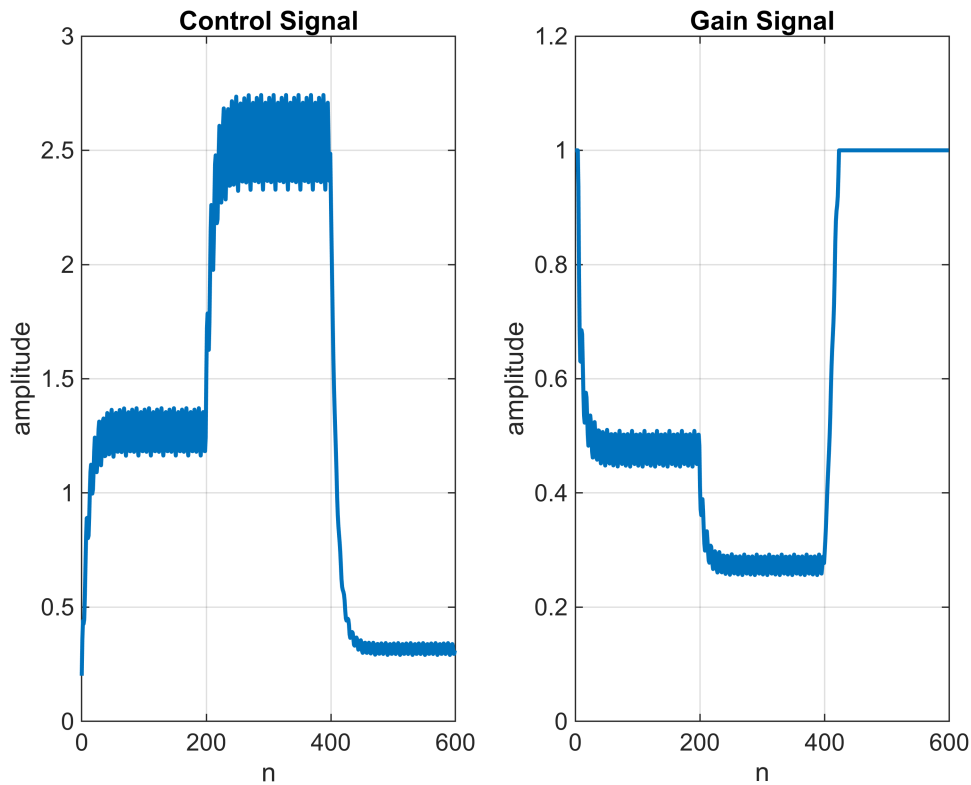
lambda = 0.9;
c0 = 0.5;
rho = 0.2;
b = 1 - lambda;
a = [1 -lambda];
cn = filter(b, a, abs(x));

gn = ones(1, length(cn));
gn(cn >= c0) = (cn(cn >= c0) / c0) .^ (rho - 1);
yn = gn .* x;

figure("Name", 'Input Signal vs Compressed Signal');
subplot(1, 2, 1);
plot(n, x, 'LineWidth', 1.5);
title('Input Signal');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([-5 5]);
grid on;
subplot(1, 2, 2);
plot(n, yn, 'LineWidth', 1.5);
title('Compressed Signal');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([-5 5]);
grid on;
```



```
figure('Name', 'Contol Signal vs Gain Signal');
subplot(1, 2, 1);
plot(n, cn, 'LineWidth', 1.5);
title('Control Signal');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([0 3]);
grid on;
subplot(1, 2, 2);
plot(n, gn, 'LineWidth', 1.5);
title('Gain Signal');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([0 1.2]);
grid on;
```



```

L = 7;
cn_smoothed = movmean(cn, [L - 1 0]);
gn_smoothed = ones(1, length(cn_smoothed));
gn_smoothed(cn_smoothed >= c0) = (cn_smoothed(cn_smoothed >= c0) / c0) .^ (rho - 1);
yn_smoothed = gn_smoothed .* x;
figure('Name', 'Smoothed Control Signal vs Smoothed Gain Signal');
subplot(1, 3, 1);
plot(n, cn_smoothed, 'LineWidth', 1.5);
title('Smoothed Control Signal');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([0 3]);
grid on;
subplot(1, 3, 2);
plot(n, gn_smoothed, 'LineWidth', 1.5);
title('Smoothed Gain Signal');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([0 1.2]);
grid on;

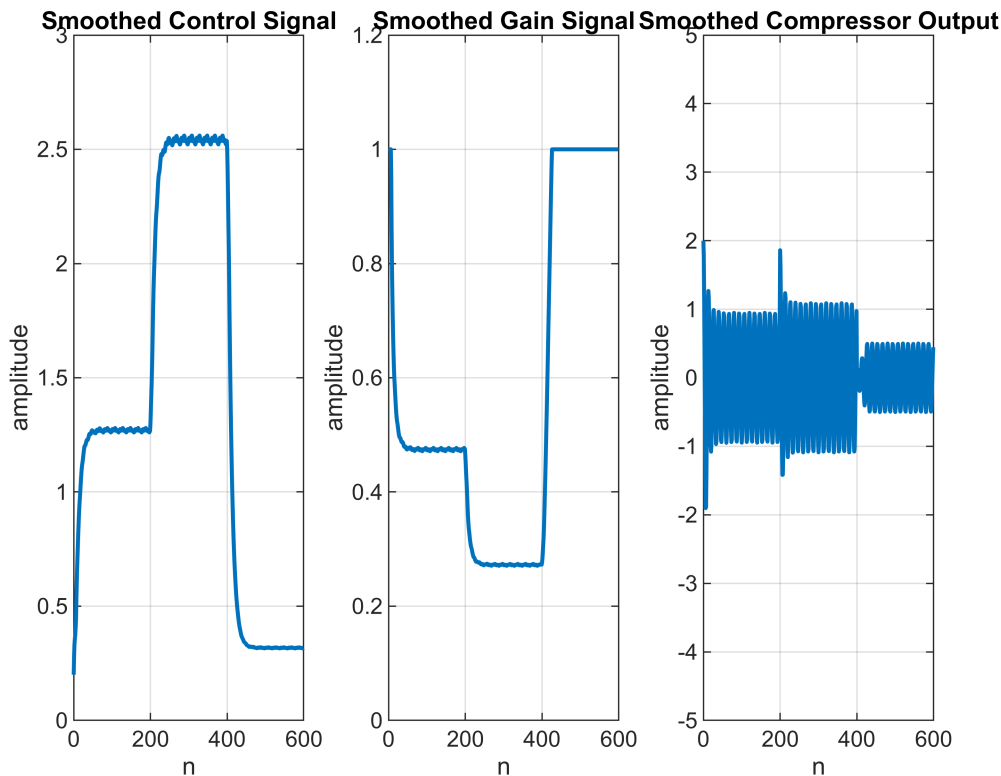
subplot(1, 3, 3);

```

```

plot(n, yn_smoothed, 'LineWidth', 1.5);
title('Smoothed Compressor Output');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([-5 5]);
grid on;

```



## limiter

```

lambda = 0.9;
c0 = 1.5;
rho = 0.1;

gn_limiter = ones(1, length(cn_smoothed));
gn_limiter(cn_smoothed >= c0) = (cn_smoothed(cn_smoothed >= c0) / c0) .^ (rho - 1);
yn_limiter = gn_limiter .* x;

figure;
subplot(1, 2, 1);
plot(n, yn_limiter, 'LineWidth', 1.5);
title('limiter Output(rho = 0.1, c0 = 1.5, l = 0.9)'); % l = lambda
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([-5 5]);

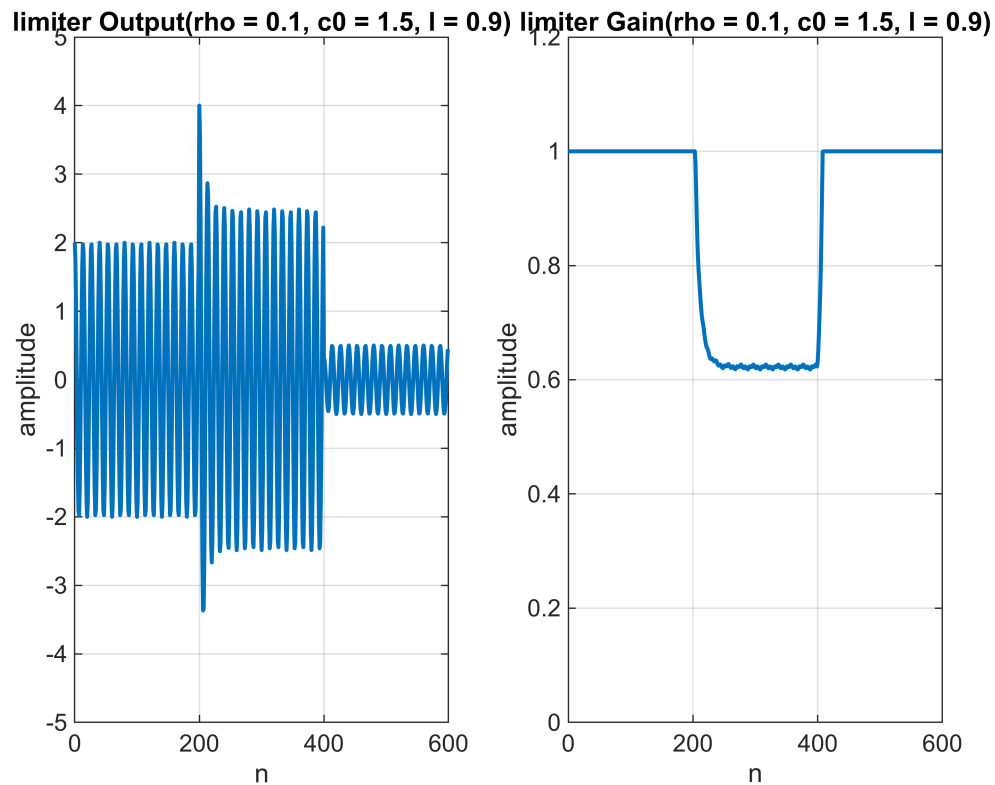
```

```

grid on;

subplot(1, 2, 2);
plot(n, gn_limiter, 'LineWidth', 1.5);
title('limiter Gain(rho = 0.1, c0 = 1.5, l = 0.9)'); % l = lambda
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([0 1.2]);
grid on;

```



## Expander

```

lambda = 0.9;
c0 = 0.5;
rho = 2;

gn_expander = ones(1, length(cn_smoothed));
gn_expander(cn_smoothed < c0) = (cn_smoothed(cn_smoothed < c0) / c0) .^ (rho - 1);
yn_expander = gn_expander .* x;

figure;
subplot(1, 2, 1);
plot(n, yn_expander, 'LineWidth', 1.5);
title('Expander Output(rho = 2, c0 = 0.5, l = 0.9)');

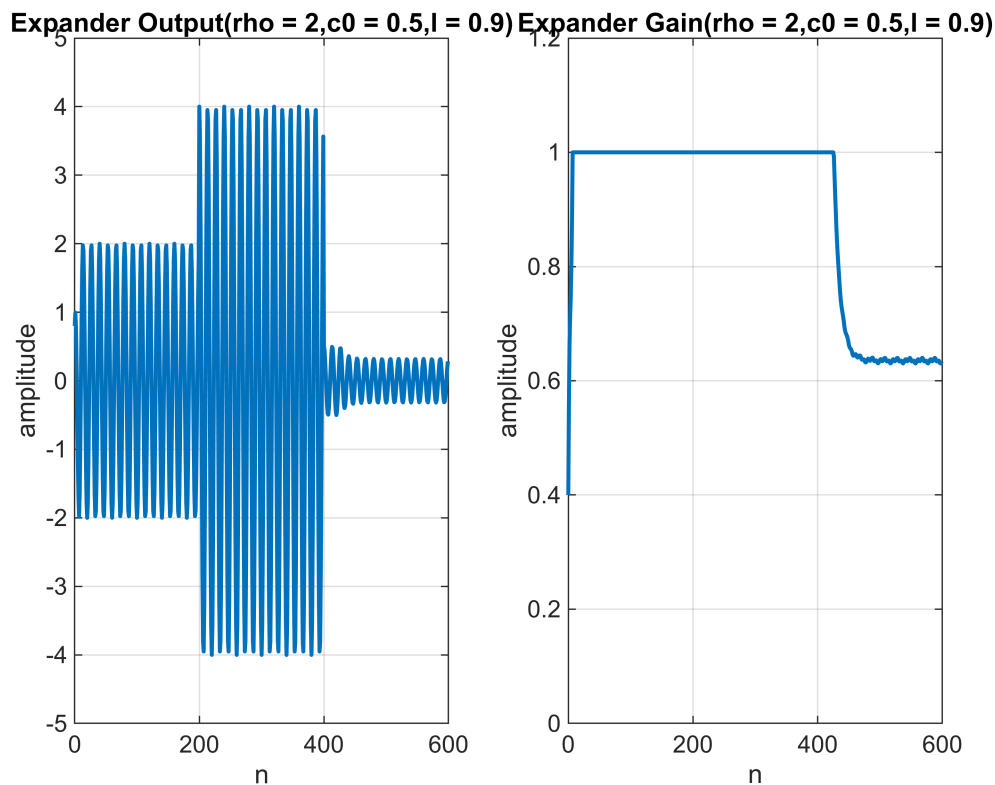
```

```

xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([-5 5]);
grid on;

subplot(1, 2, 2);
plot(n, gn_expander, 'LineWidth', 1.5);
title('Expander Gain(rho = 2,c0 = 0.5,l = 0.9)');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([0 1.2]);
grid on;

```



```

lambda = 0.9;
c0 = 0.5;
rho = 10;

gn_noise = ones(1, length(cn_smoothed));
gn_noise(cn_smoothed < c0) = (cn_smoothed(cn_smoothed < c0) / c0) .^ (rho - 1);
yn_noise = gn_noise .* x;

figure;
subplot(1, 2, 1);
plot(n, yn_noise, 'LineWidth', 1.5);

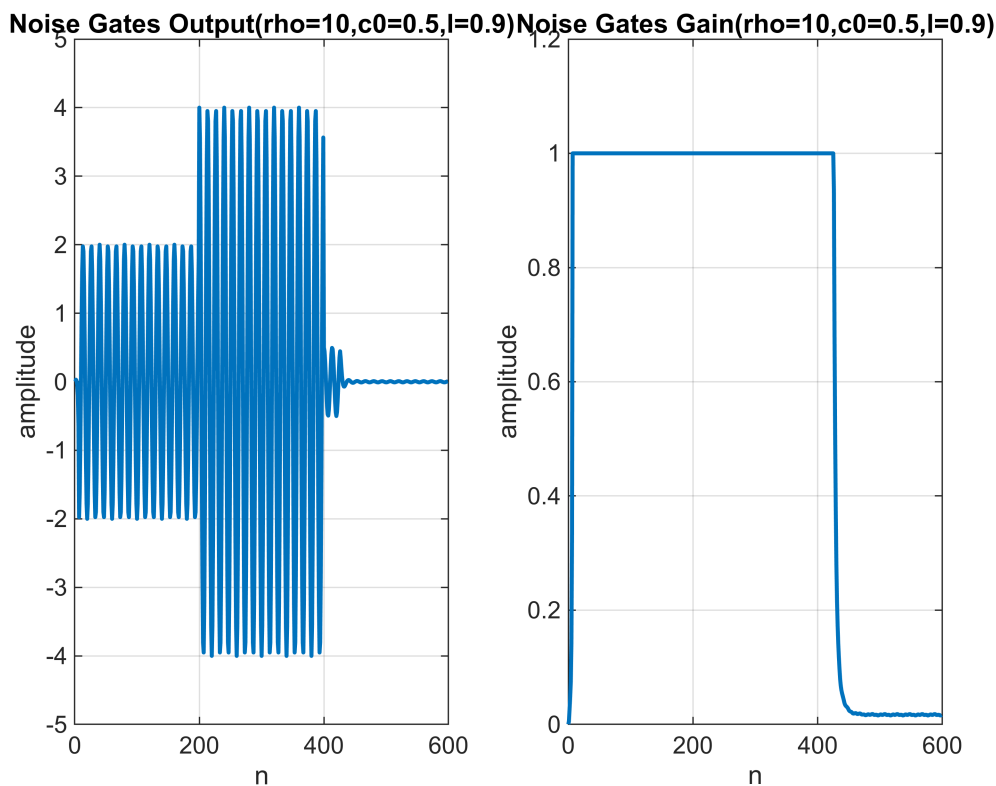
```

```

title('Noise Gates Output(rho=10,c0=0.5,l=0.9)');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([-5 5]);
grid on;

subplot(1, 2, 2);
plot(n, gn_noise, 'LineWidth', 1.5);
title('Noise Gates Gain(rho=10,c0=0.5,l=0.9)');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([0 1.2]);
grid on;

```



## Section 3-3 c

```

c0 = 0.5;
rho = 0.25;

gn_1 = ones(1, length(cn));
gn_1(cn >= c0) = (cn(cn >= c0) / c0) .^ (rho - 1);
yn_1 = gn_1 .* x;

figure("Name", 'Input Signal vs Compressed Signal');

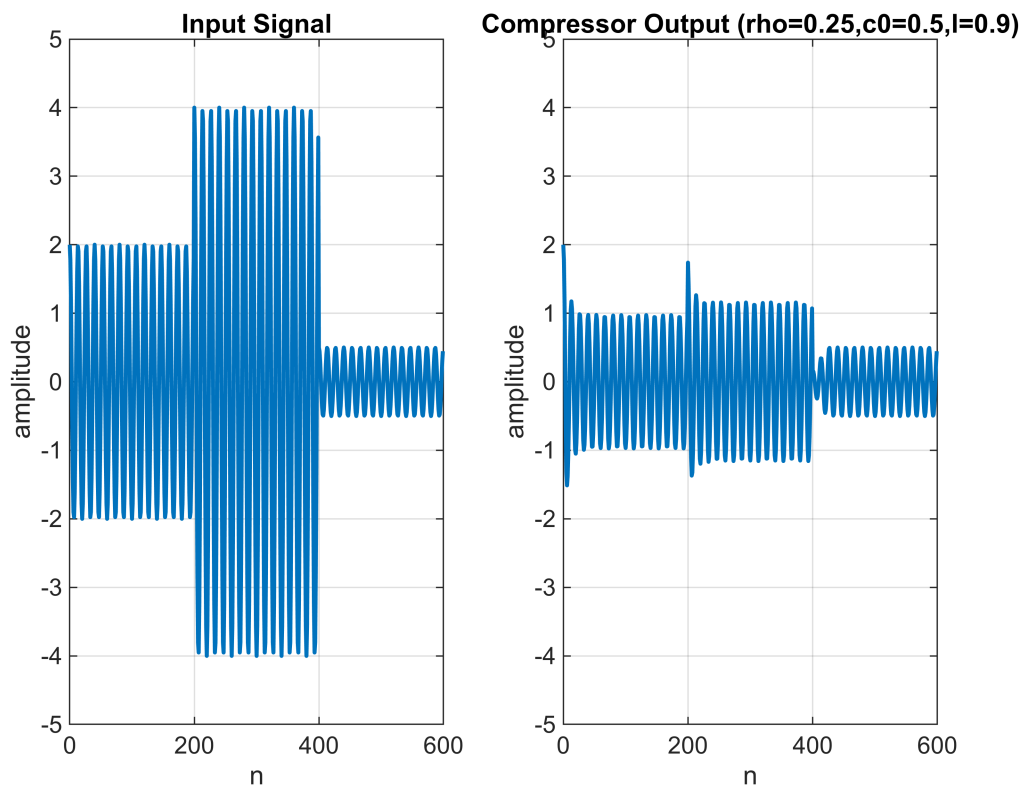
```



```

subplot(1, 2, 1);
plot(n, x, 'LineWidth', 1.5);
title('Input Signal');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([-5 5]);
grid on;
subplot(1, 2, 2);
plot(n, yn_1, 'LineWidth', 1.5);
title('Compressor Output (rho=0.25,c0=0.5,l=0.9)');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([-5 5]);
grid on;

```



```

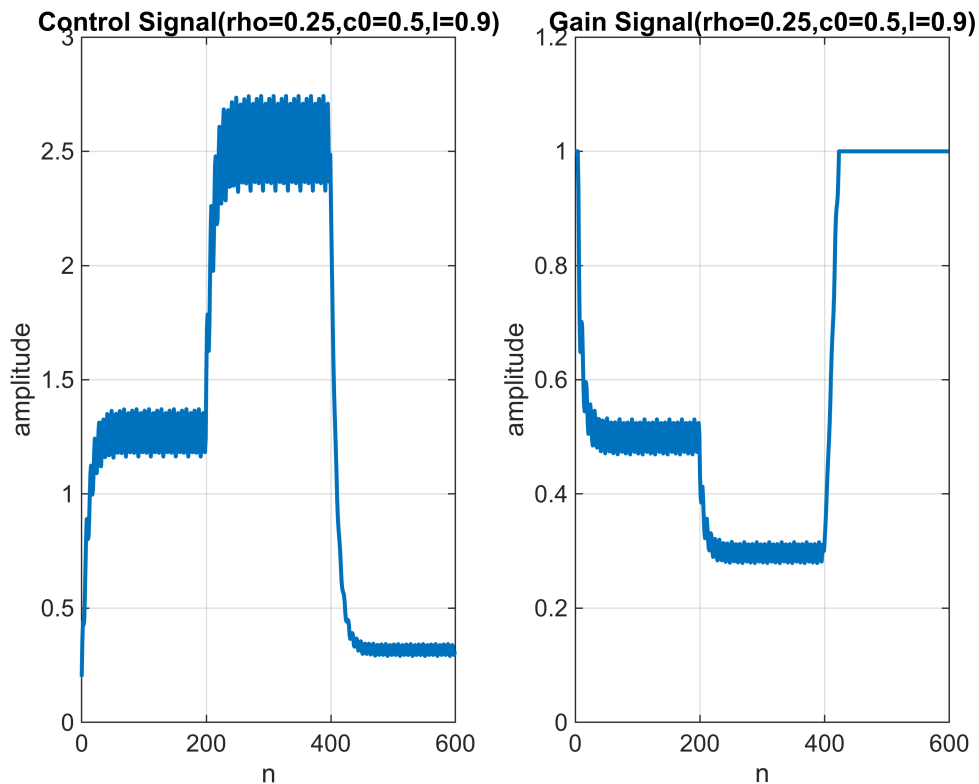
figure('Name', 'Contol Signal vs Gain Signal'); % Control and Gain signal with new parameters
subplot(1, 2, 1);
plot(n, cn, 'LineWidth', 1.5);
title('Control Signal(rho=0.25,c0=0.5,l=0.9)');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([0 3]);
grid on;
subplot(1, 2, 2);

```

```

plot(n, gn_1, 'LineWidth', 1.5);
title('Gain Signal(rho=0.25,c0=0.5,l=0.9)');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([0 1.2]);
grid on;

```



## Section 3-3 d

```

c0 = 1.3;
rho = 0.5;

gn_2 = ones(1, length(cn));
gn_2(cn >= c0) = (cn(cn >= c0) / c0) .^ (rho - 1);
yn_2 = gn_2 .* x;

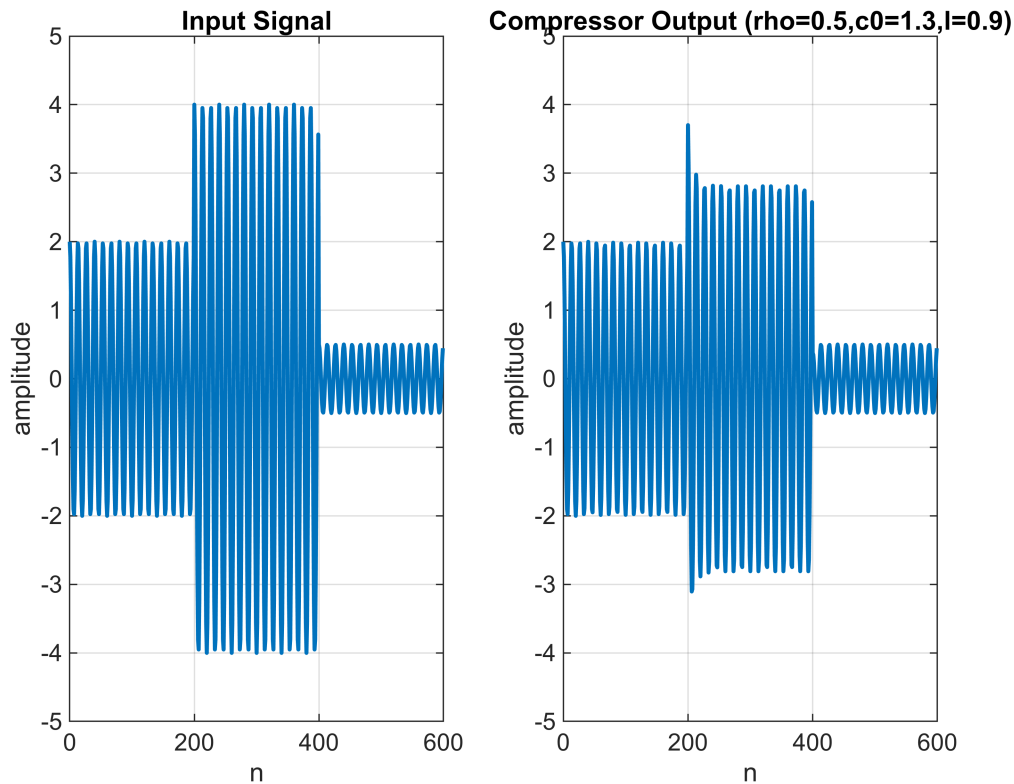
figure("Name", 'Input Signal vs Compressed Signal');
subplot(1, 2, 1);
plot(n, x, 'LineWidth', 1.5);
title('Input Signal');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([-5 5]);
grid on;

```

```

subplot(1, 2, 2);
plot(n, yn_2, 'LineWidth', 1.5);
title('Compressor Output (rho=0.5,c0=1.3,l=0.9)');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([-5 5]);
grid on;

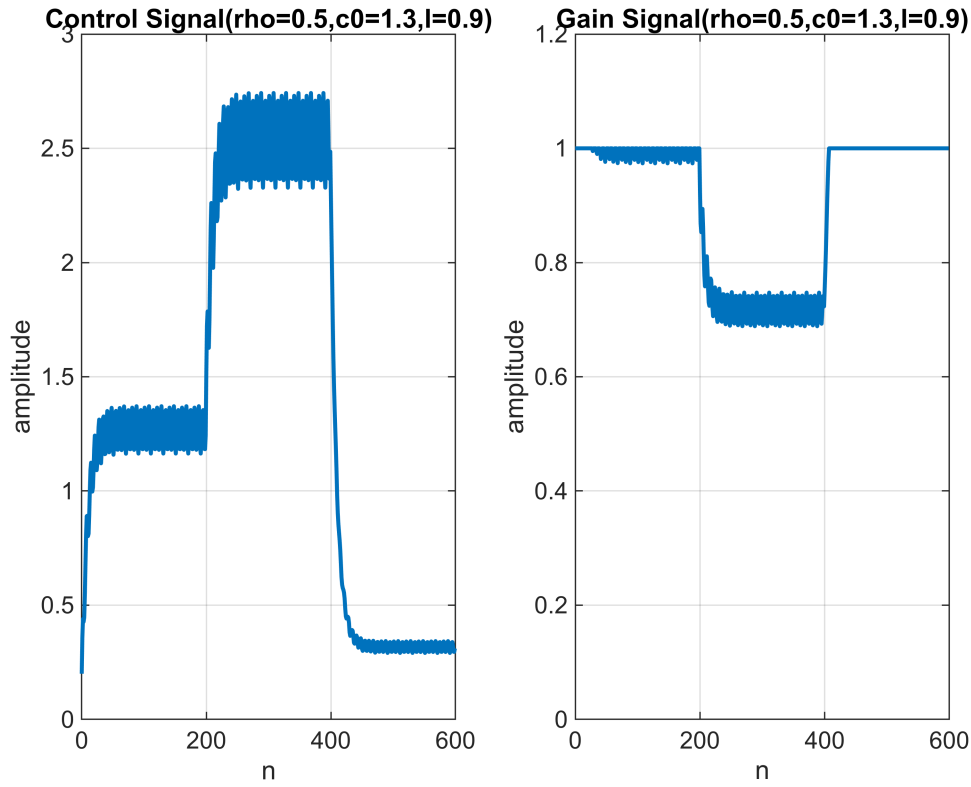
```



```

figure('Name', 'Contol Signal vs Gain Signal'); % Control and Gain signal with new parameters
subplot(1, 2, 1);
plot(n, cn, 'LineWidth', 1.5);
title('Control Signal(rho=0.5,c0=1.3,l=0.9)');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([0 3]);
grid on;
subplot(1, 2, 2);
plot(n, gn_2, 'LineWidth', 1.5);
title('Gain Signal(rho=0.5,c0=1.3,l=0.9)');
xlabel('n');
ylabel('amplitude');
xlim([0 600]);
ylim([0 1.2]);
grid on;

```



With the parameters set to:

$c_0 = 1.3$ ,  $\rho = 0.5$ , and  $\lambda = 0.9$ ,

only the middle part of the signal is compressed.

This happens because the gain function is defined as:

$$G_n = (c_n / c_0)^{(\rho-1)} \quad \text{if } c_n \geq c_0,$$

$$G_n = 1 \quad \text{otherwise.}$$

Here,  $c_n$  is the smoothed control signal based on the input amplitude.

For the three signal segments with amplitudes  $A = [2, 4, 0.5]$ ,

the effective values of  $|x_n|$  are approximately:

$$[1.27, 2.55, 0.32]$$

Only the last segment ( $A = 4$ ) produces a control signal above the threshold  $c_0 = 1.3$ ,

which activates the compressor and reduces the gain ( $G_n < 1$ ).

The first two segments stay below the threshold, resulting in  $G_n = 1$ , so they pass uncompressed.

Therefore, compression is applied only to the high-amplitude (middle) segment of the signal.