

LAB1 第一章 信号与系统

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通过本实验的练习，掌握了以下技能：

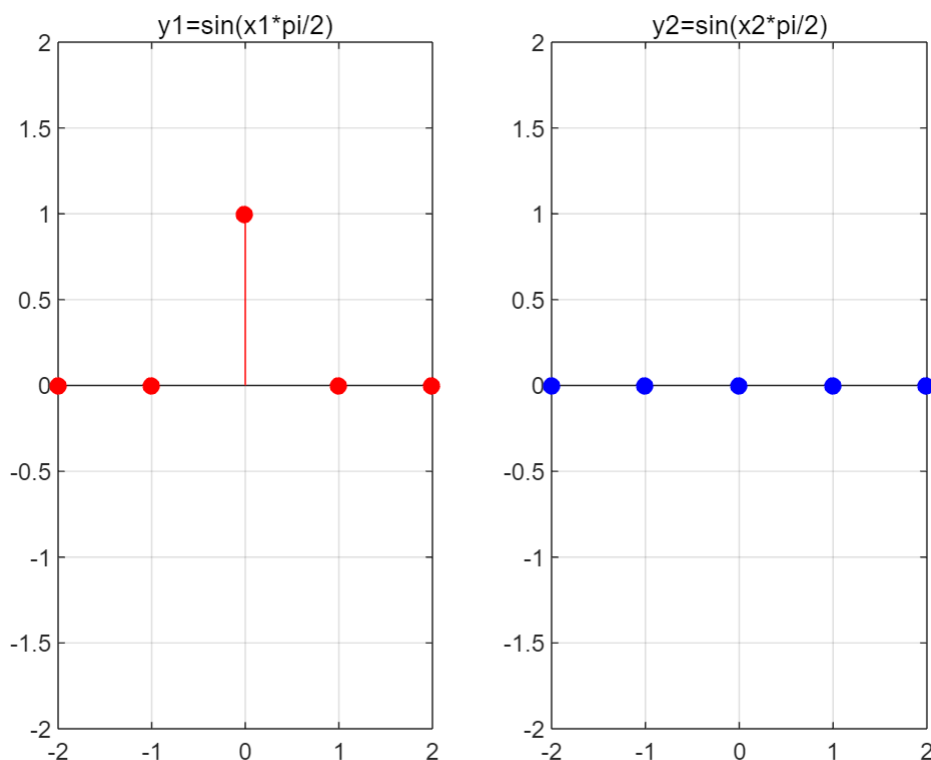
- 1.了解如何绘制函数经过时间变换的图像
- 2.了解直观表达信号处理结果以证明命题、美化图像整齐排版的合理方式

作业内容

1.4a 题目要求利用单位冲激函数证明 $y=\sin(x*\pi/2)$ 非线性。

分析： $x_2=2*x_1$ ，故对比 y_2 与 y_1

```
clc,clear,close all
%构造单位冲激函数
x1=[0 0 1 0 0];
x2=[0 0 2 0 0];
nx=-2:1:2;
%构造 $y=\sin(x*\pi/2)$ 
y1=sin(x1*pi/2);
y2=sin(x2*pi/2);
%作图比较
figure
subplot(1,2,1),stem(nx,y1,'r','filled'),title('y1=sin(x1*pi/2)');
grid on;
ylim([-2 2]);
subplot(1,2,2),stem(nx,y2,'b','filled'),title('y2=sin(x2*pi/2)');
grid on;
ylim([-2 2]);
```

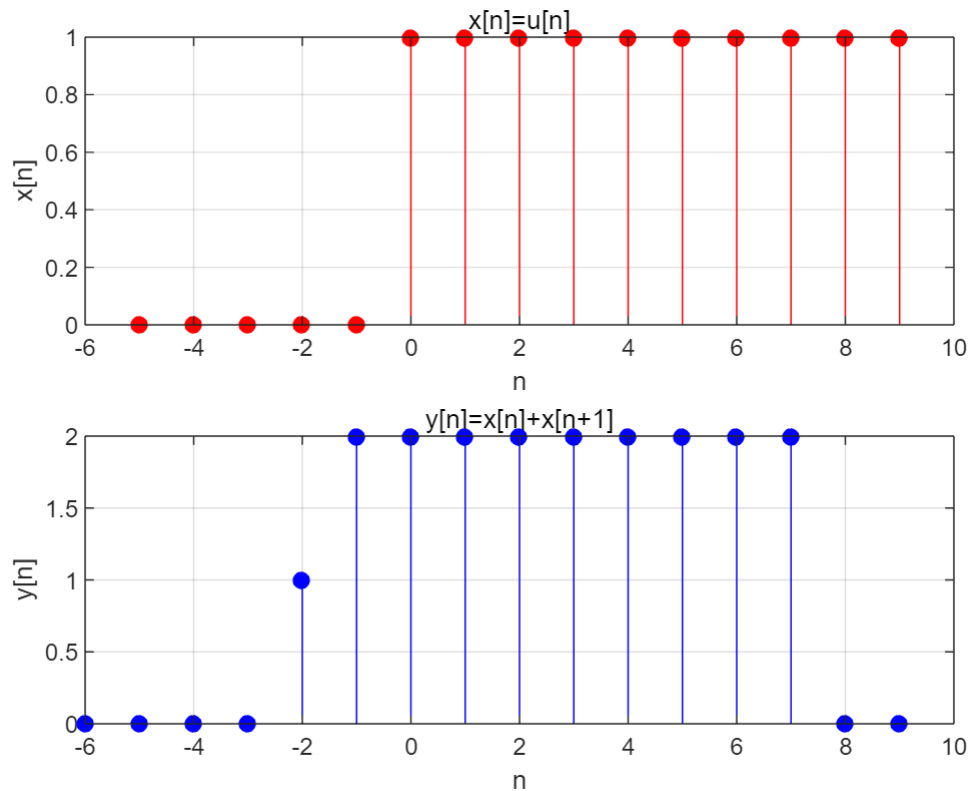


结论：若 $y=\sin(x*\pi/2)$ 线性，则 $y_2=2*y_1$ ，但根据图像，事实并非如此，故 $y=\sin(x*\pi/2)$ 非线性。

1.4(b) Use $u[n]$ to prove $y[n]=x[n]+x[n+1]$ not causal.

Draw $x[n]$ and $y[n]$ together to compare.

```
clc,clear,close all
nx=-5:1:9;
ny=-6:1:9;
x=(nx>=0);%构造阶跃函数
y = zeros(size(ny));
%给y赋值
for i = 1:length(nx)-1
    y(i) = x(i) + x(i + 1);
end
figure;
subplot(2,1,1);
stem(nx,x,'r','filled');
xlabel('n');
ylabel('x[n]');
title('x[n]=u[n]');
grid on;
xlim([-6 10]);
subplot(2,1,2);
stem(ny,y,'b','filled');
xlabel('n');
ylabel('y[n]');
title('y[n]=x[n]+x[n+1]');
grid on;
xlim([-6 10]);
```



because $y(-1)=1, x(-1)=0, x(0)=1$, which means $y(-1)$ depends on $x(0)$, the system is not casual.

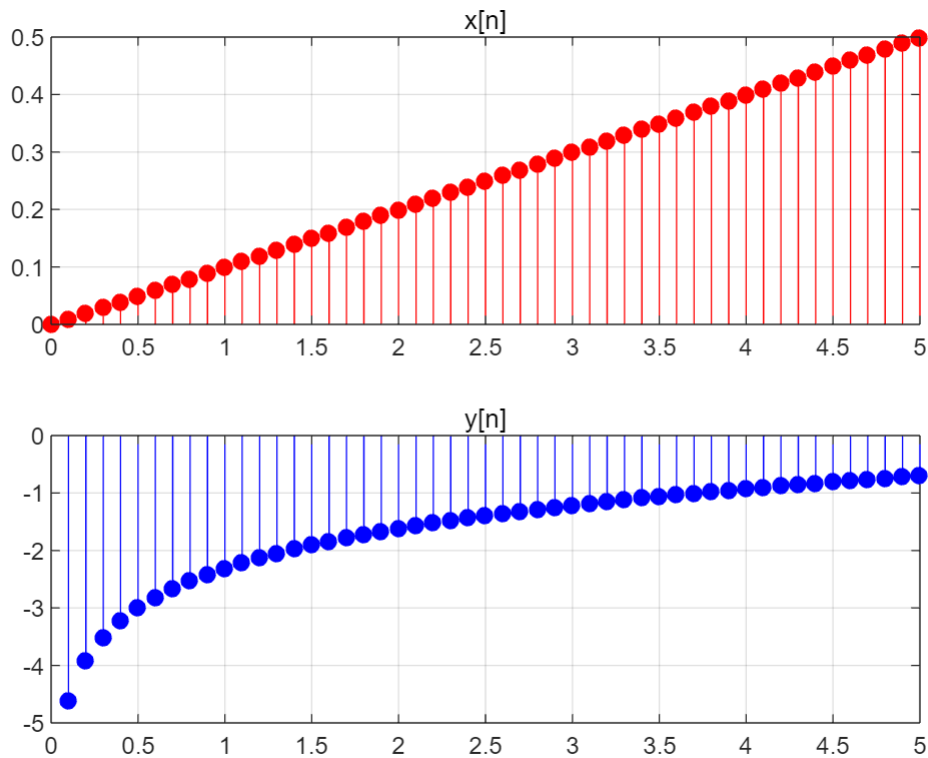
1.4c 证明 $y[n]=\log(x[n])$ 不稳定。

分析：根据理论知识已知，在 x 趋近于0时 $\log(x)$ 趋近于负无穷，取 $x[n]=0.01:0.5$ 观察 $\log(x[n])$

```

clc,clear,close all
n=0:0.1:5;
x=0.1*n;
y=log(x);
subplot(2,1,1),stem(n,x,'r','filled'),title('x[n]');
grid on;
subplot(2,1,2),stem(n,y,'b','filled'),title('y[n]');
grid on;

```



当 $x[n]$ 从 x 轴正方向趋近于0时, $y[n]$ 快速下降且无界, 故系统不稳定。

1.4d Prove $y[n]=\log(x[n])$ not invertible.

Consider two different input signals:

$x_1[n]=1, x_2[n]=5$

if y_1 for x_1 equals to y_2 for x_2 , then the system is not invertible

```

clc,clear,close all
n = -3:3;
x1 = ones(length(n));
x2 = 5*ones(length(n));
y1 = sin(pi/2 * x1);
y2 = sin(pi/2 * x2);
figure;

subplot(2,1,1);
stem(n, y1, 'r','filled');
xlabel('n');
ylabel('y1[n]');
title('y1[n] for x1[n]');
grid on;

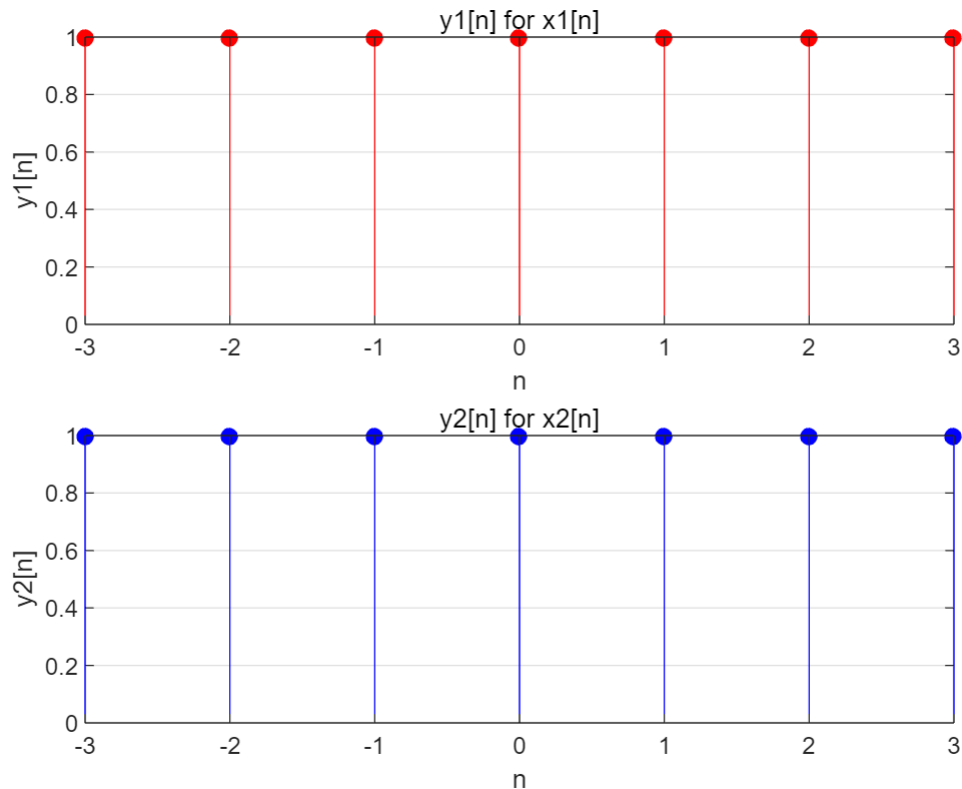
subplot(2,1,2);

```

```

stem(n, y2, 'b','filled');
xlabel('n');
ylabel('y2[n]');
title('y2[n] for x2[n]');
grid on;

```



1.5b

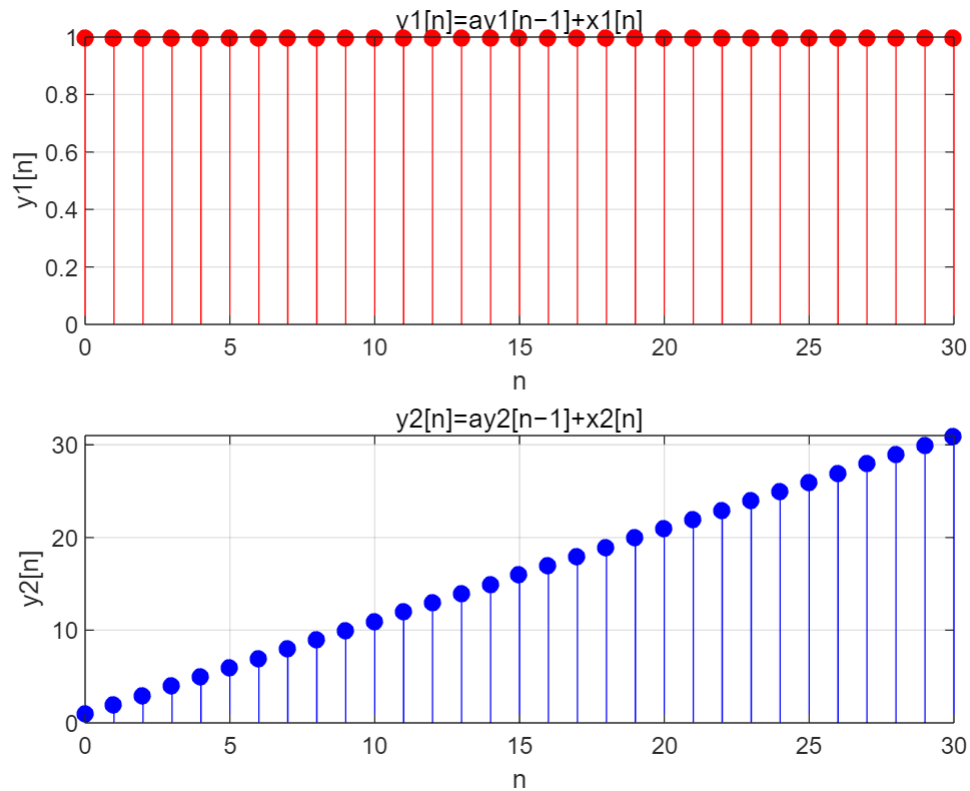
分析：根据构造好的函数，代入题目所给的值，绘图

```

clc,clear,close all
a = 1;
yn1 = 0;
n=0:30;
x1 = (n==0);
x2 = (n>=0);
y1 = diffeqn(a, x1, yn1);
y2 = diffeqn(a, x2, yn1);
figure;
subplot(2,1,1);
stem(n, y1, 'r','filled');
xlabel('n');
ylabel('y1[n]');
title('y1[n]=ay1[n-1]+x1[n]');
grid on;

subplot(2,1,2);
stem(n, y2, 'b','filled');
xlabel('n');
ylabel('y2[n]');
title('y2[n]=ay2[n-1]+x2[n]');
grid on;

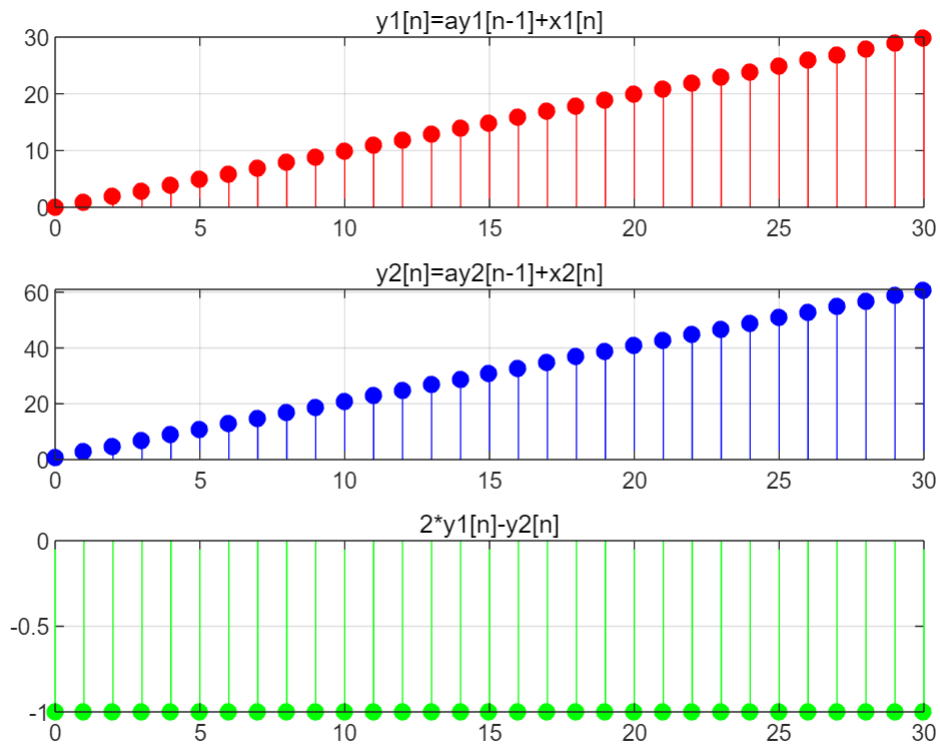
```



1.5c

分析：根据构造好的函数，代入题目所给的值，绘图

```
clc,clear,close all
a=1;
yn1=-1;
n=0:1:30;
x1=(n>=0);
x2=2*(n>=0);
y1 = diffeqn(a, x1, yn1);
y2 = diffeqn(a, x2, yn1);
figure
subplot(3,1,1),stem(n,y1,'r','filled'),title('y1[n]=ay1[n-1]+x1[n]');
grid on;
subplot(3,1,2),stem(n,y2,'b','filled'),title('y2[n]=ay2[n-1]+x2[n]');
grid on;
subplot(3,1,3),stem(n,2*y1-y2,'g','filled'),title('2*y1[n]-y2[n]');
grid on;
```

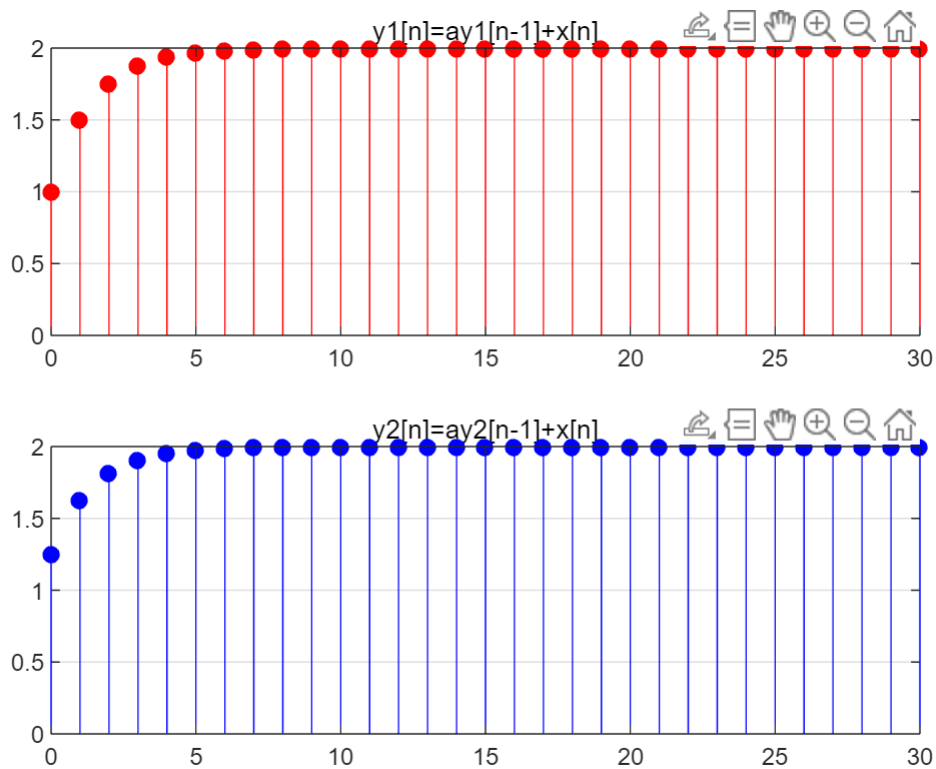


在本节操作中， y_{n1} 应当也翻倍，才能够呈现线性系统的特点，而对于 $y_1[n]$ 和 $y_2[n]$ ，其 $y[-1]$ 的初值相同，故 $2*y_1[n]-y_2[n]$ 不等于0。

1.5d 证明对于较大的 n ，初值不影响结果

分析：按题目要求绘制两图像比较

```
clc,clear,close all
a=0.5;
n=0:1:30;
x=(n>=0);
yn1=0;
yn2=0.5;
y1=diffeqn(a,x,yn1);
y2=diffeqn(a,x,yn2);
figure
subplot(2,1,1),stem(n,y1,'r','filled'),title('y1[n]=ay1[n-1]+x[n]');
grid on;
subplot(2,1,2),stem(n,y2,'b','filled'),title('y2[n]=ay2[n-1]+x[n]');
grid on;
```



根据图像可以观察到，当 n 较大时，不同的 $y[-1]$ 不影响 $y[n]$ 的值。

1.5a 写函数实现 $y[n]=a*y[n-1]+x[n]$

```
function y=diffeqn(a,x,yn1)
    y = zeros(1, length(x));
    y(1)=a*yn1+x(1);
    for i=2:length(x)
        y(i)=a*y(i-1)+x(i);
    end
    N=length(x);
    n=0:N-1;
end
```

课堂参与证明：

112.主观题 (10分)

主观题 10分

$$x(t) = \begin{cases} \sin(t), t = -2:0.1:2 \\ 0, \text{ otherwise} \end{cases}$$

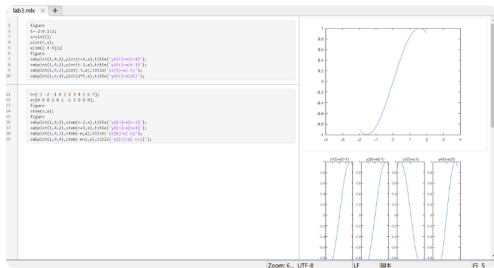
$$\begin{aligned}y_1(t) &= x(t+1) \\ y_2(t) &= x(t-1) \\ y_3(t) &= x(-t) \\ y_4(t) &= x(2t)\end{aligned}$$

Draw the above figures when $t \in [-4, 4]$ and observe them.



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提交答案



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122.主观题 (10分)

(b). The system $y[n] = x[n] + x[n+1]$ is not causal. Use the signal $x[n] = u[n]$ to demonstrate this. Define the MATLAB vectors x and y to represent the input on the interval $-5 \leq n \leq 9$, and the output on the interval $-6 \leq n \leq 9$, respectively.

Intermediate Problems

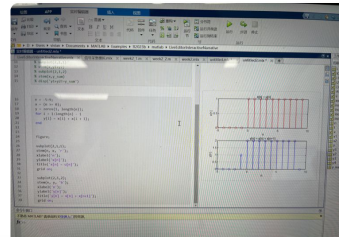
For these problems, you will be given a system and a property that the system does not satisfy, but must discover for yourself an input or pair of input signals to base your argument upon. Again, create MATLAB vectors to represent the inputs and outputs of the system and generate appropriate plots with these vectors. Use your plots to make a clear and concise argument about why the system does not satisfy the specified property.

(c). The system $y[n] = \log(x[n])$ is not stable.

(d). The system given in Part (a) is not invertible.

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提交答案



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自我评分:

应逸雯: 10/10

陈薇羽: 10/10