**Lab 1：Introduction**

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| **Introduction**  The lab guide us to learn first-order difference equation and implement a function of first-order difference equation.  The lab test and analyze the function on some sample systems.  The lab guide us review characters and classification of systems.  **Lab results & Analysis**：  **1.5**  Question(a)  屏幕剪辑  Example test  屏幕剪辑  Here we define a = 1, x = [1, 1] and y[-1] = 1 and get a sample output  Question(b)  屏幕剪辑  Result for x1  屏幕剪辑  The y-axis is y and the x-axis is n.  Result for x2  屏幕剪辑  The y-axis is y and the x-axis is n.  Add a stem command to the initial file. Define x1 and x2 respectively and get the result.  Question(c)  屏幕剪辑  Result for x1  屏幕剪辑  The y-axis is y and the x-axis is n.  Result for x2  屏幕剪辑  The y-axis is y and the x-axis is n.  Result for 2 \* y1 – y2  屏幕剪辑  The y-axis is 2 \* y1 – y2 and the x-axis is n.  Analysis  Though x2 = 2 \* x1, the output y comes from the linear equation. Due to the value of y[-1] and a, then y1[0] = 0 and y2[0] = 1. Since x2 = 2 \* x1, then the result of 2 \* y1 – y2 is always -1  Question(d)  屏幕剪辑  Result for y[-1] = 0  屏幕剪辑  The y-axis is y and the x-axis is n.  Result for y[-1] = 1/2  屏幕剪辑  The y-axis is y and the x-axis is n.  Analysis  The signal y2 is no smaller then y1. The two output signals are significantly different when the value of n is small, like when n = 0 or n = 1. However, with the increase of n, the difference of the two signals become smaller  **1.4**  Question (a)    Result    Analysis  Because y[x1[n] + x2[n]] is not equal to y[x1[n]] + y[x2[n]], so the system is not linear.  Question (b)    Result    Analysis  Because there is a nonzero when n<0, so the system is not casual.  Question (c)    Result    Analysis  When there is a x[n1] = 0, the y[n1] tends to infinity. The system is not stable.  Question (d)    Result    Analysis  Although the inputs are different, the outputs maybe the same.  Question (e)    Result      Analysis  The system is not linear because y[x1[n] + x2[n]] is not equal to y[x1[n]] + y[x2[n]]. Besides, it is time-invariant, causal, stable, and invertible.  Question(f)    Result      Analysis  The system is not time-invariant because x[n] ->y[n] , but x[n-1] can’t infer y[n-1];  The system is not invertible the outputs maybe the same while the inputs are different.  Besides, it is linear, causal, stable.  Question (g)    Result    Analysis  The system is not time-invariant because x[n] ->y[n], but x[n-1] can’t infer y[n-1];  Besides, it is linear, causal, stable, invertible.  **Note**: Please indicate meaning of the symbols in all expressions. Please indicate the coordinate and unit in all figures. | |
| **Experience**  The lab exercises help us familiar with matlab and apply the knowledge we learnt from the lecture and we gain a deeper understanding of discrete time system. We know that the index of vectors in matlab start from 1. We also use the internet to learn the usage of matlab function like stem. | |
| **Score** |  |

Code

**1.5**

Question(a)

function y = diffeqn(a, x, ynl)

for n = 0 : size(x, 2) - 1

y(n + 1) = a \* ynl + x(n + 1);

ynl = y(n + 1);

end

Question(b)

function y = diffeqn(a, x, ynl)

for n = 0 : size(x, 2) - 1

y(n + 1) = a \* ynl + x(n + 1);

ynl = y(n + 1);

end

stem(0:size(x, 2) - 1, y)

input arguments and load the function

a = 1;

ynl = 0;

x1 = zeros(1, 31);

x1(1) = 1;

x2 = ones(1, 31);

y1 = diffeqn(a, x1, ynl);

y2 = diffeqn(a, x2, ynl);

Question(c)

input arguments and load the function

a = 1;

ynl = -1;

x1 = ones(1, 31);

x1(1) = 1;

x2 = 2 \* x1;

y1 = diffeqn(a, x1, ynl);

y2 = diffeqn(a, x2, ynl);

stem(0: 30, 2 \* y1 - y2);

Question(d)

input arguments and load the function

a = 1/2;

x = ones(1, 31);

diffeqn(a, x, 0);

diffeqn(a, x, 1/2);

**1.4**

**Question(a)**

Clc;  
clear;  
  
nx1 = -5:5;  
x1 = [zeros(1,5) 1 zeros(1,5)];  
  
x2 = [zeros(1,5) 2 zeros(1,5)];  
  
y1 = sin((pi/2)\*x1);  
  
y2 = sin((pi/2)\*x2);  
  
y\_temp = sin((pi/2)\*(x1 + x2));  
  
subplot(3,1,1)  
stem(nx1,y1)  
title('y1[n]')  
subplot(3,1,2)  
stem(nx1,y2)  
title('y2[n]')  
subplot(3,1,3)  
stem(nx1,y\_temp)  
title('ytemp[n]')

**Question(b)**

Clc;  
clear;  
  
nx1 = -5:9;  
x = [zeros(1,5) ones(1,10)];  
  
xn1 = [zeros(1,4) ones(1,11)];  
  
ny = -5:9;  
  
y = x + xn1;  
  
subplot(3,1,1)  
xlim([-5,9])  
stem(nx1,x)  
title('x[n]')  
subplot(3,1,2)  
xlim([-5,9])  
stem(nx1,xn1)  
title('x[n+1]')  
subplot(3,1,3)  
xlim([-5,9])  
stem(ny,y)  
title('y[n]')

**Question(c)**

clc;  
clear;  
  
nx = -5:5;  
x = [ones(1,5) (eps)^10 ones(1,5)];  
  
y = log(x);  
  
subplot(2,1,1)  
stem(nx,x)  
title('x')  
subplot(2,1,2)  
stem(nx,y)  
title('y')

**Question(d)**

clc;  
clear;  
  
nx1 = -5:5;  
x1 = [zeros(1,5) 1 zeros(1,5)];  
  
x2 = [zeros(1,5) 5 zeros(1,5)];  
  
y1 = sin((pi/2)\*x1);  
  
y2 = sin((pi/2)\*x2);  
  
  
subplot(4,1,1)  
stem(nx1,x1)  
title('x1')  
subplot(4,1,2)  
stem(nx1,x2)  
title('x2')  
subplot(4,1,3)  
stem(nx1,y1)  
title('y1')  
subplot(4,1,4)  
stem(nx1,y2)  
title('y2')

**Question(e)**

clc;  
clear;  
  
% nonlinear  
nx1 = -5:5;  
x = [zeros(1,5) 1 zeros(1,5)];  
  
x1 = x;  
  
x2 = 2\*x;  
  
y1 = (x1).^3;  
  
y2 = (x2).^3;  
  
y\_temp = (x1 + x2).^3;  
  
subplot(3,1,1)  
stem(nx1,y1)  
title('y1[n]')  
subplot(3,1,2)  
stem(nx1,y2)  
title('y2[n]')  
subplot(3,1,3)  
stem(nx1,y\_temp)  
title('ytemp[n]')

**Question(f)**

clc;   
clear;  
  
  
%not time invariant  
nx = 0:5;  
x = [1 2 3 4 5 6];  
  
nx1 = 0:5;  
x1 = x;  
y1 = nx.\*x;  
  
nx2 = 1:6;  
y = nx2.\*x;  
  
  
  
y2 = nx.\*x;  
  
figure  
subplot(5,1,1)  
stem(nx,x)  
title('x[n]')  
subplot(5,1,2)  
stem(nx2,x1)  
title('x[n-1]')  
subplot(5,1,3)  
stem(nx2,y)  
title('n\*x[n-1]')  
subplot(5,1,4)  
stem(nx1,y1)  
title('y[n]=n\*x[n]')  
subplot(5,1,5)  
stem(nx2,y2)  
title('y2[n]=(n-1)\*x[n-1]')  
  
%not invertible  
x\_1 = [0 0 2 1 0 0];  
n = -1:4;  
y\_1 = n.\*x\_1;  
  
figure  
subplot(2,1,1)  
stem(n,x\_1)  
title('x[n]')  
subplot(2,1,2)  
stem(n,y\_1)  
title('y[n]=n\*x[n]')

Question(g)

clc;  
clear;  
  
  
%not time invariant  
nx = -10:11;  
x = [1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0];  
  
nx1 = -5:5;  
x1 = ones(1,11);  
y1 = x1;  
  
nx2 = -5:5;  
x2 = zeros(1,11);  
  
y2 = y1;  
  
  
subplot(5,1,1)  
stem(nx,x)  
title('x[n]')  
subplot(5,1,2)  
stem(nx1,x1)  
title('x[2n]')  
subplot(5,1,3)  
stem(nx1,x2)  
title('x[2n-1]')  
subplot(5,1,4)  
stem(nx1,y1)  
title('y[n]=x[2n]')  
subplot(5,1,5)  
stem(nx1,y2)  
title('y2[n]=x[2(n-1)]')