**Lab 1：Introduction**

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| **Introduction**  In this LAB session, the most important task for us is to learn how to use matlab to analysis basic signals, we will use matlab to explore the property of the functions and write a different function in a Discrete-time System.  The many requirements of this lab are listed here:   1. Learn to construct a input signal to test the property of the system. 2. Learn the analysis the property of a system.   **Lab results & Analysis**：  **Problem 1.4**  Discrete-time systems are often characterized in terms of a number of properties such as linearity, time invariance, stability, causality, and invertibility. It is important to understand how to demonstrate when a system does or does not satisfy a given property. MATLAB can be used to construct counter-examples demonstrating that certain properties are not satisfied. In this exercise, you will obtain practice using MATLAB to construct such counterexamples fcr a variety of systems and properties.  **Basic Problems**  For these problems, you are told which property a given system does not satisfy, and the input sequence or sequences that demonstrate clearly how the system violates the property. For each system, define MATLAB vectors representing the input(s) and output(s). Then, make plots of these signals, and construct a well reasoned argument explaining how these figures demonstrate that the system fails to satisfy the property in question.  **Task (a):**    **Solution:**  Chart, line chart  Description automatically generated  As shown in the figure, in Figure 1.4(a) is applied to system and is applied to system  Here we have but we can’t obtain so the system is not linear.  **Task (b):**    **Solution:**  Chart  Description automatically generated  Fig 1.4(b)-1 demonstrate the signal , Fig 1.4(b)-2 demonstrate the signal , Fig 1.4(b)-3 demonstrate the signal output of system .  Because in Fig 1.4(b)-3 y[-1]≠0, so the system is not causal.  **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.  **Task(c):**    **Solution:**  Chart, histogram, scatter chart  Description automatically generated  For the given interval (0,2), the range of the function is , so the system is not stable.  **Task(d):**    **Solution:**  Timeline  Description automatically generated  Fig 1.4(d)-1 is the signal , Fig 1.4(d)-2 is the signal , and in Fig 1.4(d)-3 and Fig 1.4(d)-4 we apply and to the system  We found that though but so different input obtain the same output, the system is not invertible.  For each of the following systems, state whether or not the system is **linear, time-invariant, causal, stable,** and **invertible**. For each property you claim the system does not possess, construct a counter-argument using MATLAB to demonstrate how the system violates the property in question.  **Advanced Problems**  For each of the following systems, state whether or not the system is linear, time-invariant, causal, stable, and invertible. For each property you claim the system does not possess, construct a counter-argument using MATLAB to demonstrate how the system violates the property in question.  **Task(e):**  **Solution:**  The system does not satisfy linearity.    In the figure we apply and to the system  We found that though , we cannot obtain here so the system is not linear.  **Task(f):**  **Solution:**  Stability, time-invariant and invertibility not satisfied.  Chart, calendar  Description automatically generated  Figure 1.4(f)-1 indicates the output of the system with , Figure 1.4(f)-2 indicates the output of the system with , Figure 1.4(f)-3 indicates the output of the system with , and in Figure 1.4(f)-4, we apply , .  We found that y[n] will grow without bound so the system is not stable, though but we obtain so the system is not invertible, also, we found that so the system does not satisfy time-invariant.  **Task(g):**  **Solution:**  The system is not causal, time-invariant, stability.  Diagram  Description automatically generated  Firstly, Figure 1.4(g1)-1 indicates [n+2], Figure 1.4(g1)-2 indicates , then Figure 1.4(g1)-3 indicates , Figure 1.4(g1)-4 indicates , and Figure 1.4(g1)-5 indicates so the system is not time invariant.    Secondly, we found that if as shown in Figure 1.4(g2)-1 and which means the future x is used as input, so the system is not causal.  Chart, box and whisker chart  Description automatically generated  Thirdly, Figure 1.4(g3)-1 indicate the signal , Figure 1.4(g3)-2 indicate the signal , Figure 1.4(g3)-3 indicate the signal , Figure 1.4(g3)-1 indicate the signal , we can found that with different input signal , we will obtain same output, so the system is not invertible.  **Problem 1.5**A picture containing text  Description automatically generated  **Task(a)**  Text, letter  Description automatically generated    **Task(b)**  Text  Description automatically generated  **Solution:**  Chart  Description automatically generated  In Figure 1.5(b)-1, we apply to the differential function and we get a stable output with , and in Figure 1.5(b)-2, we apply to the differential function and we get the output with .  **Task(c):**  **Text  Description automatically generated**  **Solution:**  **Chart  Description automatically generated**  Figure 1.5(c)-1 indicate the output with input , Figure 1.5(c)-2 indicate the output with input , and Figure 1.5(c)-3 indicates the result of difference .  We can found that the difference is always equal to -1, not identically equal to 0, because that here we have in the differential function, so we have and , obviously the system is not linear.  **Task(d):**    **Solution:**  Chart, scatter chart  Description automatically generated  Figure 1.5(d)-1 indicates the with , and a=0.5, we can found that the y[n] begins at 1 and gradually close to 2, and Figure 1.5(d)-2 indicates the with , and a=0.5, we can found that the y[n] begins at 1.25 and gradually close to 2.  We found that for    We have  So for and the only difference at each item is which will decrease as n increase while |a|<1  Appendix: MATLAB Code  Problem 1.4:  Task a:  n = -5:1:5;  x1=[zeros(1,5) 1 zeros(1,5)];  x2=2\*x1;  y1=sin((pi/2)\*x1);  y2=sin((pi/2)\*x2);  %Plot  stem(n,y1,'g--\*');  hold on;  stem(n,y2,'r--s');  legend('y\_1=sin((\pi/2) x\_1[n]','y\_2=sin((\pi/2) x\_2[n]')  title('1.4 (a)');  xlabel('n');  ylabel('y[n])');  saveas(gcf, "LAB1/P1\_4\_a\_out.png")  Task b:  n1=-5:9;  n2=-6:9;  x1=[zeros(1,5),ones(1,10)];  x2=[zeros(1,4),ones(1,11)];  subplot(3,1,1);  stem(n1,x1,'b--^');  xlim([-6 10]);  title('1.4(b)-1');  xlabel('n');  ylabel('x[n]=u[n]');  subplot(3,1,2);  stem(n1,x2,'b--^');  xlim([-6 10]);  title('1.4(b)-1');  xlabel('n');  ylabel('x[n+1]=u[n+1]');  y1=[0 x1+x2];  subplot(3,1,3);  stem(n2,y1,'r--p');  xlim([-6 10]);  title('1.4(b)-2');  xlabel('n');  ylabel('y[n]=x[n]+x[n+1]');  saveas(gcf, "LAB1/P1\_4\_b\_out.png")  Task c:  x=0:0.03:2;  y=log(x);  stem(x,y,'m--h');  title('1.4(c)');  xlabel('x');  ylabel('y[n]=log(x[n])');  saveas(gcf, "LAB1/P1\_4\_c\_out.png")  Task d  n= -5:1:5;  x1=[zeros(1,5) 1 zeros(1,5)];  x2=5\*[zeros(1,5) 1 zeros(1,5)];  y1=sin((pi/2)\*x1);  y2=sin((pi/2)\*x2);  subplot(3,1,1);  stem(n,x1);  title('1.4 (d)-1');  xlabel('n');  ylabel('x\_1[n]');  subplot(3,1,2);  stem(n,x2);  title('1.4 (d)-2');  xlabel('n');  ylabel('x\_2[n]');  subplot(3,1,3);  stem(n,y1,'b--s');  hold on;  stem(n,y2,'r--h');  legend('(sin(\pi/2) x\_1[n])','(sin(\pi/2) x\_2[n])');  title('1.4 (d)-3');  xlabel('n');  ylabel('y[n]');  saveas(gcf, "LAB1/P1\_4\_d\_out.png")  Task e:  % Linearity not satified  n=-5:1:5;  x1=n>=0;  x2=3\*x1;  y1=x1.^3;  y2=x2.^3;  stem(n,y1);  hold on  stem(n,y2,'r');  title('1.4(e)');  legend({'x[n]=u[n]','x[n]=3u[n]'}, 'Location', 'northeast');  xlabel('x[n]');  ylabel('y[n]=x^3[n]');  saveas(gcf, "LAB1/P1\_4\_e\_out1.png")  Task f  % Stability analysis  n=-5:1:5;  x1=n;  y1=n.\*x1;  subplot(4,1,1)  stem(n,y1,'g--s');  title('1.4(f)-1');  xlabel('x\_1[n]=n');  ylabel('y\_1[n]=nx\_1[n]');  % invertibility and time-invariant analysis  x2=[zeros(1,5) 1 zeros(1,5)];  x3=3 .\* x2  y2=n .\* x2;  y3=n .\* x3;  y4=(n+1) .\* x2;  subplot(4,1,2);  stem(n,y2,'r--h');  title('1.4(f)-2');  xlabel('x\_2[n]');  ylabel('y\_2[n]');  subplot(4,1,3);  stem(n,y3,'r--h');  title('1.4(f)-3');  xlabel('x\_3[n]');  ylabel('y\_3[n]');  subplot(4,1,4);  stem(n,y4,'m--^');  title('1.4(f)-4');  xlabel('x\_2[n]');  ylabel('y\_4[n]');  saveas(gcf, "LAB1/P1\_4\_f\_out2.png")  Task g  %不满足时不变性、因果性、可逆性  %时不变性分析,由3，4图的对比可知.  % Time invariant  n=-5:1:5;  x1=n>=-2;  y1=n>=-1;  x2=n>=-4;  y2=n>=-2;  y3=n>=-3;  subplot(3,2,1);  stem(n,x1);  title('1.4(g1)-1');  xlabel('n')  ylabel('x\_1[n]=u[n+2]');  subplot(3,2,2);  stem(n,y1);  title('1.4(g1)-2');  xlabel('n')  ylabel('y\_1[n]=u[n+1]');  subplot(3,2,3);  stem(n,x2);  title('1.4(g1)-3');  xlabel('n')  ylabel('x\_2[n]=x\_1[n+2]=u[n+4]');  subplot(3,2,4);  stem(n,y2);  title('1.4(g1)-4');  xlabel('n')  ylabel('y\_2[n]=x\_2[2n]=u[n+2]');  subplot(3,2,5);  stem(n,y3);  title('1.4(g1)-5');  xlabel('n')  ylabel('y\_1[n+2]');  saveas(gcf, "LAB1/P1\_4\_g1\_out2.png")  %因果性分析,x[n]超前了  % Causal  n=-5:1:5;  x1=[zeros(1,7) 1 zeros(1,3)];  y1=[zeros(1,6) 1 zeros(1,4)];  subplot(2,1,1);  stem(n,x1);  title('1,4(g2)-1');  xlabel('x[n]=δ[n-2]')  subplot(2,1,2);  stem(n,y1);  title('1.4(g2)-2');  xlabel('y[n]=x[2n]=δ[n-1]')  saveas(gcf, "LAB1/P1\_4\_g2\_out.png")  % Invertable analysis  n=-5:1:5;  x1=[zeros(1,4) 1 zeros(1,6)]  y1=[zeros(1,11)]  x2=[zeros(1,2) 1 zeros(1,8)]  y2=[zeros(1,11)]  subplot(2,2,1);  stem(n,x1);  title('1.4(g3)-1');  xlabel('x\_1[n]=δ[n+1]');  subplot(2,2,2);  stem(n,y1);  title('1.4(g3)-2');  xlabel('y\_1[n]');  subplot(2,2,3);  stem(n,x2);  title('1.4(g3)-3');  xlabel('x\_2[n]=δ[n+3]');  subplot(2,2,4);  stem(n,y2);  title('1.4(g3)-4');  xlabel('y\_2[n]');  saveas(gcf, "LAB1/P1\_4\_g3\_out2.png")  Problem 1.5:  Task a  function y=diffeqn(a,x,yn1)  y=zeros(length(x));  y(1)=a\*yn1+x(1);  if length(x)>=2  for i=2:length(x)  y(i)=a\*y(i-1)+x(i);  end  end  end  Task b:  n=0:1:30;  x1=n==0;  x2=n>=0;  a=1;  yn1=0;  y1=diffeqn(a,x1,yn1);  y2=diffeqn(a,x2,yn1);  subplot(2,1,1);  stem(n,y1,'r--p');  title('1.5(b)-1')  xlabel('x1[n]=δ[n]');  subplot(2,1,2);  stem(n,y2,'m--s');  title('1.5(b)-2')  xlabel('x2[n]=u[n]');  saveas(gcf, "LAB1/P1\_5\_b\_out.png")  Task c:  n=0:1:30;  x1=n>=0;  x2=2.\*x1;  a=1;  yn1=-1;  y1=diffeqn(a,x1,yn1);  y2=diffeqn(a,x2,yn1);  y3=2.\*y1-y2;  subplot(3,1,1);  stem(n,y1,'r--p');  title('1.5(c)-1');  xlabel('x\_1[n]=u[n]');  subplot(3,1,2);  stem(n,y2,'m--s');  title('1.5(c)-1');  xlabel('x\_2[n]=2\*u[n]');  subplot(3,1,3);  stem(n,y3,'^');  title('1.5(c)-1');  xlabel('2\*y\_1[n]-y\_2[n]');  saveas(gcf, "LAB1/P1\_5\_c\_out.png")  Task d:  n=0:1:30;  x=n>=0;  a=0.5;  yn1=0;  y1=diffeqn(a,x,yn1);  yn1=0.5;  y2=diffeqn(a,x,yn1);  stem(n,y1,'r--p');  legend('y[-1]=0');  hold on;  stem(n,y2,'b--s');  legend('y[-1]=0.5');  title('1.5(d)');  saveas(gcf, "P1\_5\_d\_out.png")  **Note**: Please indicate meaning of the symbols in all expressions. Please indicate the coordinate and unit in all figures. | |
| **Experience**  In this LAB session we firstly established the workflow of the computational research for signal and system with matlab, which ensure our efficiency of research, secondly we learnt more operations of matlab which we did not use in the past, and finally we learnt how to analysis the property of a system seriously.  Also, at first we have some difficulty in analysis some of the properties like causality though we draw the right plots to prove it, but after discussion we finally get it.  More details could be found [here](https://github.com/Tonanguyxiro/EE205_Signal_and_System_LAB). | |
| **Score** |  |

字体：英文Times new Roman；中文宋体，正文五号