**Lab 3：Fourier Series Representation of Periodic Signals**

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| Introduction  In this lab, we will explore the Fourier Series representation of periodic signals. We have totally four problems in this lab:  In problem 3.5, we will first synthesize a periodic discrete-time signal, then examine the DTFS representation of several different square waves and finally write a function which computes the DTFS coefficients of a periodic signal.  Lab results & Analysis：  3.5 Synthesizing Signals with the Discrete-Time Fourier Series  Text  Description automatically generated      Text, letter  Description automatically generated    From the coefficient given, we found that is real, and and , and are conjecture with each other, so the imaginary part will offset each other, so is real.  Text  Description automatically generated  For N=5, we can derive that, , , so here we have  Text  Description automatically generated  We define and we get the plot, the real and imaginary part of signal, from the plot we can see that signal has only nonzero real part, so our prediction is verified.  Chart  Description automatically generated  Table  Description automatically generated  Text, letter  Description automatically generated  Here the plots of three signals are shown below.  Diagram  Description automatically generated with medium confidence  Text  Description automatically generated  The plots of DTFS coefficients of three signals are shown below. We can derive that , so for for for , and we can extract the same result from the plot, which also verify our predict.  A picture containing chart  Description automatically generatedText, letter  Description automatically generated  Chart, histogram  Description automatically generated  The signal which fewer coefficient synthesized are shown in the plot, we found that with more coefficient, the synthesized signal is more similar to the original signal .    Chart  Description automatically generated  Form the plot of real and imaginary part of the signal we can found that the imaginary part of is 0 so the signal is real.  Text  Description automatically generated  Diagram  Description automatically generated  The Gibb’s phenomenon is the peculiar manner in which the Fourier series of a piecewise continuously differentiable periodic function behaves at a jump discontinuity. From the plots we can find several significantly higher point before the signal jump from 1 to 0, and several significantly lower point after the jump, which is called the Gibb’s phenomenon. We can also find that the range of the phenomenon is much wider when we synthesized less coefficient, and if we let more coefficient involved the phenomenon is hard to identify due to the low accuracy of the plot.  Text, letter  Description automatically generated  function a=dtfs(x,n\_init);  a=[];  w=2\*pi/length(x); %fundamental frequency  **for** k=n\_init:n\_init+length(x)-1 %period from 0+n0 to N-1+n0  a\_k=0;  **for** n=1:length(x)  a\_k=a\_k+x(n)\*exp(-j\*k\*w\*(n+n\_init-1));  end  a=[a a\_k/length(x)];  end    **if** n\_init<0  **for** i=1:-n\_init  a=[a a(i)];  end  a=a(1-n\_init:length(a));  **else** **if** n\_init>0  **for** i=i:n\_init  a=[a(length(a)-i+1) a];  end  a=a(1:length(x));  end  end  3.8 First-Order Recursive Discrete-Time Filters  Text  Description automatically generated  Diagram, schematic  Description automatically generated    Text  Description automatically generated  Note: Please indicate meaning of the symbols in all expressions. Please indicate the coordinate and unit in all figures. | |
| Experience  You can write your experience with this project. Any comment and suggestion on this course are also very welcome. | |
| Score |  |

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