MATLAB Assignment

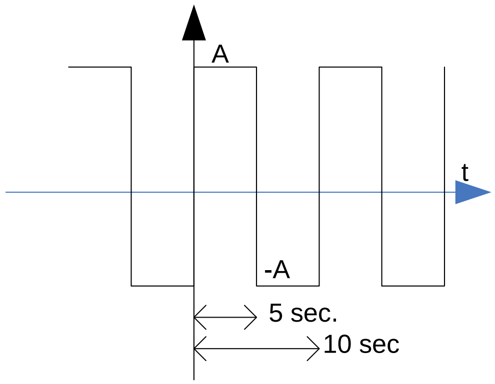
The Fourier Series

Read this carefully!

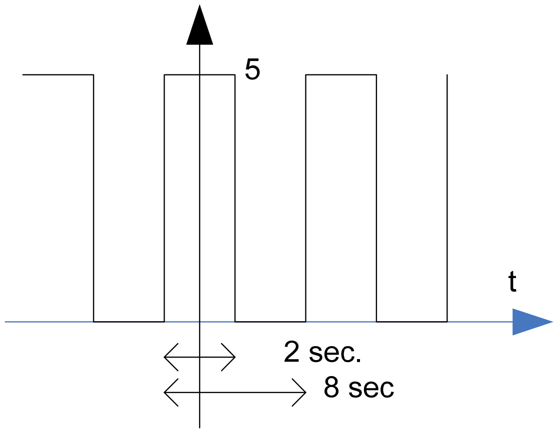
- Submit paper copy only.
- This project *could be* long if you are not very familiar with Matlab! Start as early as possible.
- This is an individual project. Don’t copy each other’s work.
- You must turn in you MATLAB Code for each section.
- Use the discussion group, if necessary, to share ideas.
- Plots which do not have legend, title, or labels will not receive grades. You MUST also make sure your LAST NAME is clearly shown on the title of EACH Matlab plot, otherwise you will not receive a grade for that plot!
- You MUST have your name on each page of your homework.
- Use multiple plots per page to avoid wasting paper.
- You must have a header sheet for your homework. Include your name, class name, data, and project number.
- Make sure you staple everything together before handing in your assignment.
- All Problems have to be done using MATLAB.

A- Square Wave

1. Download the FourierSeriesGUI MATLAB program and make sure you understand how it operates. You can use this GUI program to verify some of your answers in the next questions.
   a) Explain how error function resulting from the a truncated Fourier series can be obtained. Show the general equation.
2. Given a periodic square wave, x(t), with amplitude A=5 and period of To=10
   a) Describe the Dirichlet conditions and explain why x(t) can be expanded into a Fourier series.
   b) Express all <u>three</u> forms of the Fourier series for x(t). Must type them! Name each one.
   c) Plot ideal x(t) and compare it with Fourier series approximation with 19 harmonics (this is also referred to as the truncated Fourier series) . Use subplot to plot both functions on the same figure.
   d) On a separate figure, show the positive half-cycle of the square wave using the first 3,5, and 9 harmonics. This will be similar to Figure 4.15 in the textbook.
   e) Describe the Gibbs phenomenon and show it's impact on your figure in part (d) above.
   f) Plot the magnitude spectrum and phase spectrum for x(t) on separate plots in the same figure using subplot. This should be similar to Figure 4.6. Make sure the phase spectrum is expressed in <u>degrees</u>.
   g) On a separate figure plot the <u>envelope</u> of the magnitude characteristic of Ck.



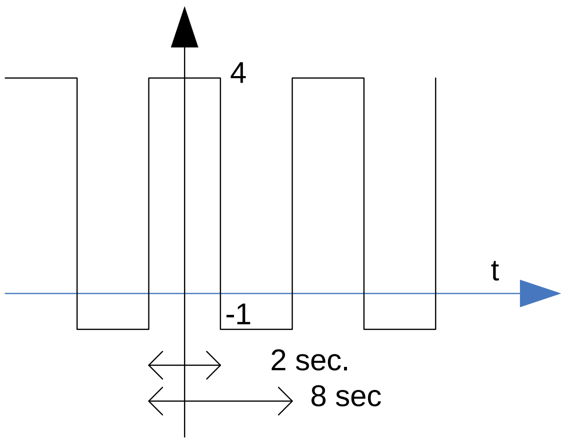
B- Rectangular Pulse Train



1. Consider a Rectangular wave with period of 8 seconds and pulse width of 2 seconds. Assume the p-to-p amplitude is 5.
   a) Using Table 4.3 express the truncated exponential form of Fourier series for this signal. Must type it!
   b) Plot this rectangular pulse train using Matlab.
   c) Plot the first 21 harmonics of the Fourier series on the same graph as part (b) above.
   d) On the same figure, using subplot, plot the magnitude spectrum for the rectangular pulse train.
   e) On the same figure, using subplot, plot the phase spectrum for the rectangular pulse train. This should be similar to Figure 4.13. Make sure the phase spectrum is expressed in degrees.
   f) On the figure above specify what the DC bias value is for the rectangular wave.
   g) On the figure above, show how one can tell how many harmonics are being used.
   h) Explain what happens as the period of the pulse increases.
   i) Explain what happens as the width of the pulse increases.

C- Rectangular Pulse Train

1. Assume the x(t) in the previous problem is shifted down by one unit due to the effect of a pull-down resistor. Let's call the new signal y(t).
   a) Express the new truncated exponential form of Fourier series for y(t)
   b) Plot magnitude spectrum of y(t).



D- Exponential Waveform

1. Consider an aperiodic function f(t)=e^-2t * u(t).
   A. Plot f(t).
   B. Express the Fourier Transform of f(t).
   C. Calculate and plot the magnitude of the frequency spectra of f(t). This will be the magnitude of Fourier transform for f(t).
   D. Calculate and plot the phase of the frequency spectra of f(t).
   E. Calculate the power for f(t).

NOTE: All plots must be on the same figure. All calculations must be shown (you DO NOT have to type)