

EECS 3602 Lab 1 : Review of Fourier series

Submission details: Write your responses to the following questions and submit them electronically as a lab report, along with any code that you write. If your responses are handwritten, scan them for electronic submission. Submission is via Moodle. Due date: October 1, 2015.

Grading details: 70% of your lab grade is for correctly completing the lab requirements; 20% is for clear writing and good presentation, including readable and well-documented code; 10% is for extra work or analysis that expands on or goes beyond the lab requirements.

Part 1. The following periodic signals have period $T = 1$, and are defined below over a single period. Obtain their trigonometric and exponential Fourier series.

1.

$$x(t) = \sin(\pi t), \quad 0 \leq t < 1$$

2.

$$x(t) = \begin{cases} 1, & 0 \leq t < \frac{1}{2} \\ -1, & \frac{1}{2} \leq t < 1 \end{cases}$$

3.

$$x(t) = \begin{cases} 4x - 1, & 0 \leq t < \frac{1}{2} \\ -4x + 3, & \frac{1}{2} \leq t < 1 \end{cases}$$

Part 2. Using MATLAB or Python, generate plots of the trigonometric Fourier series of each of the above signals up to frequency k/T (or $2\pi k/T$ angular frequency, i.e., the $\sin(2\pi k/T)$ terms). For each signal, plot the original signal, as well as the Fourier series result for $k = 4, 8, 12, 16, 20$.

For which of the signals do the series seem to converge fastest? Discuss.

Do the same thing with the exponential Fourier series. What difficulty, if any, do you encounter, and can you find a way to solve it?

Submit any code you write for this part.

Part 3. Using MATLAB or Python, write a function `fourierSeries()` that takes, as arguments, a signal (discretized as a vector) and an integer k , and returns the exponential Fourier series coefficients from $-k$ to $+k$ ($2k + 1$ coefficients in total). You may make any reasonable design assumptions in creating your function, but state these assumptions clearly.

Give two examples calculations of Fourier series coefficients for different signals.

Submit the function you write for this part.