Fourier Series Analysis via Computer Simulation (w/ Python)

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**Date: 2/04/2019**

**TCET 3102-E316 (Analog and Digital Com) Lab 1**

**Spring 2019, Section: E316, Code: 37251**

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# Objective

* Experimentally analyze the spectra of various periodic signals and synthesize a square wave form using a programming language.

# Equipment

* MATLAB (I used Python)

# Theory

* Telecommunications Systems use digital signals for Transmission of Electrical Signals. However, digital signals cannot propagate through the subscriber loop, so conversion from digital to analog and vice versa is necessary. The overarching question to answer is why digital signals cannot propagate through the subscriber loop. Spectral Analysis can answer that, and for this lab we look at the spectra for a Fourier Series.
* Fourier Series is a way to represent a function as the sum of simple sine waves. More formally, it decomposes any periodic function or periodic signal into the weighted sum of a (possibly infinite) set of simple oscillating functions, namely sines and cosines (or, equivalently, complex exponentials) (definition taken from Wikipedia). It is given by the following Function:



# Procedure

* Used a programming language (Python) to simulate the Fourier Series
  + First we evaluated the Fourier Series using 3 (odd) Harmonics
  + Then we generalized and evaluated the Fourier Series using “n” (odd) Harmonics
  + We then scaled the sampling and signal frequency
  + We then evaluated the Fast Fourier Transform which plots over Frequency Domain

# Conclusion

* I was successful in completing this lab. There were some issues calculating the Fast Fourier Transform, something I’m looking to remedy. We saw that adding more harmonics makes a squarer wave. Additionally, we also determined that scaling the signal frequency is okay as long as the sampling frequency is proportional to the signal frequency. In other words, you must scale your sampling frequency by the same weight, *“K”*, as you do for the signal frequency.