IT327 Lab #5
Shannon's Law; Spectrum Analysis

Objective:

There are two main objectives to this lab. The first is to analyze the variables in Shannon's Law and how they affect the equation overall. The second objective is to analyze the spectral properties of sine, square, and triangle waves as generated by both a function generator and your own circuit with the TIMS.

Procedure, Objective 1:

The procedure for the first objective is to use the Shannon's Calculator spreadsheet (see the IT327 Labs website) to calculate and plot each of the following:

1. The capacity at BW = 100 Hz, 1 kHz, 10 kHz, and 100 kHz for signal = 85 W, noise = 0.5 W.
2. The bandwidth required to obtain a capacity of 10 kbps, 100 kbps, and 1 Mbps for signal = 10 W, noise = 5 µW.
3. The signal amplitude required to obtain a capacity of 50 kbps, 100 kbps, and 200 kbps for BW = 25 kHz, noise = 15 µW.
4. The amplitude that noise must be reduced to in order to obtain a capacity of 18 Mbps, 72 Mbps, and 144 Mbps for BW = 10 MHz and signal = 5 W.
5. In your write-up, explore and comment on the relationships you observed as you calculated and plotted these data points.

Procedure, Objective 2:

Be sure to take plenty of pictures and include them in your write-up with an appropriate caption.

Spend some time learning how to use the spectrum analyzer in the lab. It is like an oscilloscope, but has the ability to view the amplitudes of multiple frequencies at a time. The oscilloscopes we are used to working with show amplitude versus time, while the spectrum analyzer shows amplitude versus frequency and continuously refreshes with time.

In these labs, you will become very familiar with the TIMS, its modules and manuals. This lab will introduce you to the TIMS through some trial and error and creative thinking.

1. Generate a $4V_{p\text{-}p}$ 2kHz **sine wave** using a Function Generator in as your signal and view the output on both the oscilloscope and the spectrum analyzer. Take a picture and analyze what you see in your write-up. (Set span to 100 KHz)
2. Generate a **square wave** at $4V_{p\text{-}p}$ 2kHz using a Function Generator in as your signal and view the output on both the oscilloscope and the spectrum analyzer. Take a picture and analyze what you see in your write-up. <u>Identify the harmonics.</u>
3. Now analyze a **triangle wave** from the Function Generator on the oscilloscope and spectrum analyzer. Take a picture and analyze what you see in your write-up. <u>Identify the harmonics.</u>

4. With TIMS, generate a $4V_{p-p}$ 2kHz **sine wave** and view the output on both the oscilloscope and the spectrum analyzer. Take a picture and analyze what you see in your write-up. Also include what modules you used and how you set it up.
5. With TIMS, generate a **square wave** at $4V_{p-p}$ 2kHz. Take a picture and analyze what you see in your write-up. Identify the harmonics in your pictures. Also include what modules you used and how you set it up.

Equipment, Results, Conclusions, etc.

Please label all pictures, diagrams, etc… thoroughly. Also include three things that you learned from this lab in your conclusion.

EXTRA CREDIT (10 points):

Construct the circuit below with TIMS as your Signal Generator and Variable DC Power Supply. Feed the sine wave into the circuit and analyze the output with the oscilloscope and spectrum analyzer. Take a picture and analyze what you see in your write-up.