Assignment 1

Due Tuesday, February 13. Submit your assignment using the appropriate dropbox on the course web site. Assignments submitted after the solutions are made available will be given a mark of zero.

Question 1

The course web site has the chapter of the Atmel AT-mega328 (used in the popular Arduino boards) microcontroller datasheet that describes the operation of its UART.

Based on this datasheet, answer the following questions:

(a) What UBRRn setting is required in Asynchrnous Normal mode for a baud rate of 40 kbps if the oscillator frequency is 16 MHz?

(b) What register would you have to read and what bit would you need to check to detect a framing error in the received data?

(c) Assume the microcontroller's digital I/O is using 3.3V logic levels, how do the serial port input and output signal levels compare to the RS-232 levels?
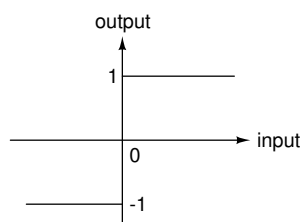
Question 2

The power spectrum of a signal whose center frequency is zero is given by $\left(\frac{\sin(x)}{x} \right)^2$. What is the 80% power bandwidth?

Hints: You may find the answer numerically. Since there is equal power at positive and negative frequencies, integrate from zero to a frequency that contains 40% of the total power.

Question 3

A sine wave is applied to a non-linear device with the following input-output characteristic:

What is the THD?

Question 4

This question asks you to demonstrate the Central Limit Theorem.

Write a computer program that generates and plots the histogram for 1000 random values. Each random value is created by adding up N values that are randomly chosen to be either -1 or 1 with equal probability and dividing the sum by N.

Plot the histogram for $N = 1$, $N = 4$ and $N = 12$.

In Matlab (or Octave), you can generate random -1/+1 values using the expression `2*(rand(N,1)>0.5)-1` , you can add the values using `sum()` and you can plot the histogram using `hist()`