Name:_____

Section:_____

EE322 Fall 2012 Exam 1: Part 2

- You will have the remainder of the lab period to take Part 2 of the exam.
- This portion of the exam is closed book/notes/calculators, but you are free to use MATLAB help as needed.

1. (10 pts) Calculations. Determine the following values **USING MATLAB**. Write the lines of code you used to find your answers.

   a. π^e = _____

   b. The average value of 5.5, 8.992, 3.657 and 21 = _____

   c. The cube root of -43.48 = _____

   d. 9! = _____ (Note: *!* is the factorial)

   e. In microwave communications, the loss factor incurred by an electromagnetic wave as it propagates in a straight line thru a vacuum w/no absorption or reflection of energy from nearby objects is called the "Free Space Path Loss". Free space path loss (L_p) is calculated as:

   $$L_p = \left(\frac{4\pi f\ D}{c} \right)^2$$

   where D is distance in meters, f is frequency in Hertz, and c is the speed of light ($3\text{x}10^8$ meters/sec). Note: L_p is unitless.

   Find the value of L_p in dB if the EM wave has a frequency of 6 GHz and the distance is 50 km. $\left(L_p\right)_{dB} = 10\log_{10}\left(L_p\right)$

   L_p = _____dB

(Turn this sheet over for Problem 2)

2. (20 pts) Programming.

   a. In *Information Theory*, the Shannon–Hartley theorem defines the maximum rate at which information can be transmitted over a noisy communication channel in a specified bandwidth, with a given signal-to-noise ratio. This value is referred to as *Channel Capacity*. The channel capacity can be calculated as:

   $$C = B\log_2(1+S/N)$$

   where B is channel bandwidth in Hz, S is signal power and N is noise power, and the ratio S/N is the signal-to-noise ratio.

   Write a MATLAB function that will compute the channel capacity. The function only computes the value, does NOT do any plotting. This function has two inputs: bandwidth in Hz, and signal-to-noise ratio (<u>not</u> in dB). It also has one output, channel capacity in bits/sec. Call this function *ChannelCapacity*. Include help comments.

   Determine C if B=1 MHz and S/N = 19.7 dB. C = _____ bits/sec

   b. Using your *ChannelCapacity* function, write a MATLAB program that will create the following two plots on a 2-row x 1-column subplot:

   -- plot the channel capacity for a 50 kHz communication channel when S/N varies from 0 dB to 30 dB in 1 dB increments. Note that $(S/N)_{dB} = 10\log_{10}(S/N)$.

   -- plot the channel capacity for a communication channel that has a 25 dB S/N as bandwidth varies from 1 kHz to 10 MHz in 1 kHz increments. Since this range of frequencies involved, and the resulting range of bit rates is very large, put the x-axis and the y-axis on a log-log scale (loglog).

   Properly label your plots, give it a grid and give it a suitable title that includes your name.

   Print out your code for the function (part a), the code for the plot (part b), and the figure. Be sure that your name is displayed somewhere on your printouts. Your name is important if multiple midshipmen are printing at the same time.