Name: _____ Student Id _____

CS 420/520 Spring 2015
Homework 1
Due: tba

Attach this sheet as a cover sheet when handing in the homework. Homework is due in class. Also, since I had problems reading homework in the past (scribbling, unreadable handwriting, no derivation/explanation etc.) use the following rule: *If I cannot read it, I cannot give points for it*, i.e., the format has to be reasonable. Also, no derivation, no points! EO students, you can submit electronic copies, but please not faxes, as the quality is painful.

1) We have seen that thermal noise is a phenomenon we inherit from physics. But how big of an issue is it in real applications? Calculate the thermal noise level of a channel with bandwidth 40kHz carrying 1000 Watts of power at 70o C?

2) Given is a channel with a capacity of 100Mbps and a bandwidth of 10Mhz. What signal to noise ratio is required to achieve this capacity?

3) A digital signaling system operates at 19,200bps.
   a) If a signal element encodes a 4-bit word, what is the minimum required bandwidth of the channel?
   b) Repeat part a) for the case of 8-bit words.

4) We are asked to investigate the feasibility of designing an old fashion modem for one telephone channel, which has 4KHz bandwidth. To goal is to produce more contemporary bit rates, say of 1Mbps, which is not even that much. What would it take to make this happen, i.e., what is the minimum number of signaling levels we would need? What is your conclusion? It this doable or is this unrealistic to achieve?

5) What is the *skin effect*? Why is this a problem for our high frequency digital signal? Hint: the book does not answer this question. You need to resolve what the term means and then argue in terms of Fourier Analysis.

6) Consider optical fiber cables. Why does the bandwidth increase as the core diameter of the optical fiber becomes smaller? Do not "hand wave" your answer, but give a solid reason based on the properties of the media.

7) What is the difference between "white" noise and "pink" noise and what is the bandwidth of the human ear?

8) With respect to an adaptive NEXT canceller?
   a) Why does it improve the data transmission rate?
   b) Where should one place this device? The locations to consider are from the transmitter, through the entire media, all the way to the receiver. **Justify each answer**!
      i) What is the best location?
      ii) What is the worst place to position it?