Assignment 1, CSL838 (Wireless Networks)

Due date: Feb. 27, 2015, 5pm (Fri)

Note: You may verbally discuss solutions to the various problems among yourselves. However, each student must write up the entire solution **on his/her own**. No copying of code or written solutions is allowed. You may use matlab or any other equivalent tool for problem 1. Your assignment solution must consist of matlab plots and hand-written solutions to problems. **Attach a print out of your matlab code to the solution as an appendix before submitting it.**

1. Plot the probability density functions of the following random variables. (3 marks)
   (a) Rayleigh random variable with expectation (mean) 50.
   (b) Random variable with Rice distribution with Rice Factor 2 and mean-squared value 3.
   (c) Lognormal random variable with expectation 5 and standard deviation 3.

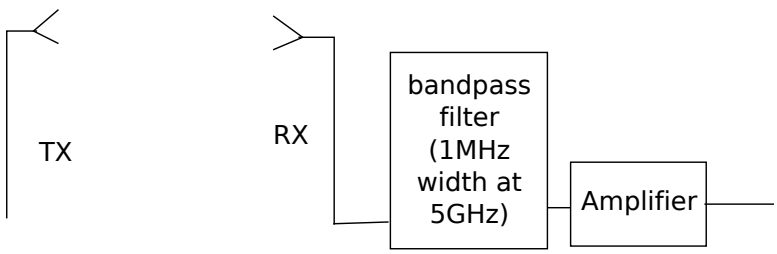

Figure 1: Radio System

2. A radio system uses spectrum of 1 MHz bandwidth centered at 5 GHz (see Figure **??**). The receiver consists of an antenna, a bandpass filter, and an RF amplifier. We will ignore components following the RF amplifier. Assume that there is thermal noise with spectral density -174 dBm/Hz at the input of the filter. The bandpass filter retains the input signal (and noise) present in the 1MHz band of interest and removes any signal (and noise) not present in this band. Assume that it does not add any noise of its own. The noise figure of the receiver amplifier is 18 dB (corresponding to the noise input to the amplifier by the filter). The required minimum operating signal-to-noise ratio (SNR) at the output of the receiver RF amplifier is 16 dB. Assume that attenuation of the signal over the wireless channel from transmitter to receiver is 130 dB.
   (a) (marks: 1) What is the minimum operating SNR (in dB) required at the <u>input</u> of the receiver RF amplifier?
   (b) (marks: 1) What is minimum signal power (in dBm) needed at the input of the bandpass filter?
   (c) (marks: 1) What is the minimum signal power (in units of dBm <u>and</u> watts) to be transmitted assuming 0 dB antenna gain at both transmitter and receiver, and 0 dB fading margin?
   (d) (marks: 1) What is the minimum signal power (in units of dBm <u>and</u> watts) to be transmitted assuming 24 dB transmit antenna gain, 4 dB receiver antenna gain, and 4 dB fading margin?

3. (marks: 2) You are given a wireless channel which is a linear time-invariant (LTI) system with impulse response:

$$h(t) = \begin{cases} 1 - t & \text{if } 0 \leq t \leq 1 \\ 0 & \text{elsewhere} \end{cases}$$

Plot the output, $y(t)$, of the wireless channel when the following signal, consisting of impulses, is input to it:

$$x(t) = 2\delta(t+2) - \delta(t+1) + 3\delta(t) - \delta(t-0.5)$$

You need not give a mathematical expression for the output. It is sufficient to plot the output and indicate in the plot the values of $y(t)$ at $t = -2, -1, 0, 0.5, 1, 1.5$.