ECE 257B: Principles of Wireless Networks
Homework assignment # 3

(due on Tuesday, March 3)

Assigned Reading:

- Rappaport, Chapters 2 & 8 (8.7.2 is optional)
- D. Hong, S.S. Rappaport, "Traffic model and performance analysis for cellular mobile radio telephone systems with prioritized and non prioritized handoff procedures," *IEEE Trans. Vehicular Technology*, pp. 77–92, Aug. 1986 (you may want to skip the details of the analysis in IV.B, but do get the essence of it).

Problems to hand in:

1. Rappaport, Problem 8.1
2. Rappaport, Problem 8.2
3. Rappaport, Problem 8.3
4. Rappaport, Problem 8.7
5. Rappaport, Problem 8.12
6. Rappaport, Problem 8.13
7. Rappaport, Problem 8.14
8. There is an obvious error in Section IV.A of Hong and Rappaport's paper. Find it and fix it.

9. Consider a slotted ALOHA system in the presence of Rayleigh fading only (i.e., received signal strengths are Rayleigh distributed with unit power). If the capture ratio is b, find the maximum throughput which can be achieved by the system and the corresponding value of the offered traffic. Give numerical values for $b = 6$ and 10 dB. (Hint: the conditional throughput given the number of simultaneous transmissions, n, has been computed in class as C_n, and n is a random variable whose distribution is given by...) How would the results change in the case $C_1 = 1, C_n = Q^n, n > 1$?

10. Consider a one-dimensional cellular CDMA system (e.g., along a highway). Let $R > 0$ and suppose there is a base station, called $BS(i)$, at coordinate iR for all integers i, and that cell i is the interval $[(i - 0.5)R, (i + 0.5R)]$. Suppose that a transmitter at location x in cell i transmits with power $P_T(x)$ such that the power received at $BS(i)$ is a fixed constant P_0 (perfect power control). Assume r^{-4} propagation loss and ignore everything else. Finally, suppose that the mobiles are evenly spaced on the line, with α mobiles per unit distance (i.e., there are αR mobiles per cell).

    (a) Determine $P_T(x)$ and sketch it for x in the range $|x| \leq 3R$.

    (b) Determine the received power at $BS(0)$ for a mobile located at x. Sketch a graph of your answer for the range $|x| \leq 3R$.

    (c) Estimate or compute the expected SIR at the receiver for an additional mobile placed in cell 0. Comment on the dependence of the result on the user's location. Your answer should depend on R, but in a simple way.

    (d) Assume bit energy to interference density ratio $E_b/I_0 = 10$ dB is required for acceptable voice quality, that the system bandwidth is 6 MHz, and that the user's data rate is 12 kbps. How large can α be for acceptable performance (assume all users are active at all times and ignore thermal and background noise)?

11. Consider a cell with 20 Erlangs load of new offered calls and 10 Erlangs load of handoff calls arriving from other cells. Assume that the mean call duration-within-cell is the same for either type call. Also assume that the calls arrive according to Poisson processes and that the call duration-within-cell is exponentially distributed. We require that the blocking probability for incoming handoffs is at most 0.2% and the blocking probability for new offered calls is 2%. Find the minimum number of channels needed if (a) no distinction is made between call types, or (b) guard channels are provided for handoff calls.