ECE 371 NHV
Fall 2002

Homework 1
Due: Tuesday 9/17/2002

1) Area Reliability. We showed in class that the area reliability of a cell of radius R is given by

$F_u = 2/R^2 * \int_0^R Q(a + b \ln \rho)\, \rho d\rho$ where a and b are as defined in class.

(a) Show that F_u has the following closed-form expression:

$F_u = Q(a + b \ln R) + ((\exp (2/b^2 – 2a/b))/R^2) * (1 – Q (a + b \ln R – 2/b))$

Hint: Use integration by parts

(b) Plot F_u versus R (in meters) for R ranging from 100 m to 10 km.
a = -15, b = 1.4, $\sigma = 8$, and $P_{thresh} = 23$ dBm

Hint: Here is the Matlab code that plots the curve. Please spend some time learning basic Matlab functions, since we will not provide the code for you in the future.

```
a=-15;
b=1.4;
sigma=8;
Pthresh=23;

for i = 1:100
   R(i,1:100) = 100*i;
   Q(i) = a+b*log(R(i));
   Fu(i) = 1 - cdf('norm', Q(i),0,1) + ((exp((2/b^2) -
(2*a/b)))/R(i)^2)*(cdf('norm',Q(i)-2/b,0,1));
end

plot(R,Fu);
```

2) Parity check matrix for an (8,4) binary code is given below.

$$H = \begin{bmatrix} 0&0&0&0&1&1&1&1 \\ 0&0&1&1&0&0&1&1 \\ 0&1&0&1&0&1&0&1 \\ 1&1&1&1&1&1&1&1 \end{bmatrix}$$

(a) Determine the Hamming distance of this code.

(b) If this code is used for single error correction, determine the decoded codeword when the received word is 0110111.

(c) If the received codeword is 0110000, how many errors have occurred in the received word?

3) Design a code that can detect any unidirectional errors, which may only change a 0 bit to a 1 bit but not vice versa. Your codeword should contain 4 bits, and the code must contain atleast 4 code words. Explain why you believe you code detects unidirectional errors.

Hint: This code may not necessarily be linear

4) If P_t = 10W, G_t = 0 dB, G_r = 0 dB, and f_c = 900 MHz, find P_r in Watts at a free space distance of 1 km.

5) Assume a receiver is located 10 km from a 50 W transmitter. The carrier frequency is 6 GHz and free space propagation is assumed, G_t = 1, G_r = 1. Find the power at the receiver.

6)
(a) Explain an advantage and a disadvantage of the two-ray ground reflection model in the analysis of path loss.

(b) In the following cases, tell whether the two-ray model could be applied, and explain why or why not:

(i) h_t = 35 m, h_r = 3 m, d = 40 m
(ii) h_t = 30 m, h_r = 1.5 m, d = 1000 m

7) Using the two-ray ground reflection model, derive an expression for the distance d (as a function of h_t and h_r) where signal nulls occur, when the coefficient of reflection = -1. (Signal nulls occur when the signals along the two paths add to 0)

8) Given an indoor path loss model of the form:

$$\overline{PL(d)}\ \text{dB} = 40 + 20\log d + \sum \text{FAF} \qquad d \geq 1\ \text{m}$$

where d is measured in meters, find the mean received power between three floors of a building if FAF is 15 dB per floor. Assume the transmitter radiates 20 dBm and unity gain antennas are used at both the transmitter and the receiver, and that the straight-line path between the transmitter and the receiver is 15 m through the floors.