Assignment 1

The following questions are taken from Chapters 3 and 4 of the Wireless Communications *texbook by Rappaport (first edition). Assignment is due Wednesday, March 6 at 11:30AM.*

Question 1

3.10 If P_t = 10 W, G_t = 10 dB, G_r = 3 dB, and L = 1 dB at 900 MHz, compute the received power for the knife-edge geometry shown in Figure P3.10. Compare this value with the theoretical free space received power if an obstruction did not exist. What is the path loss due to diffraction for this case?

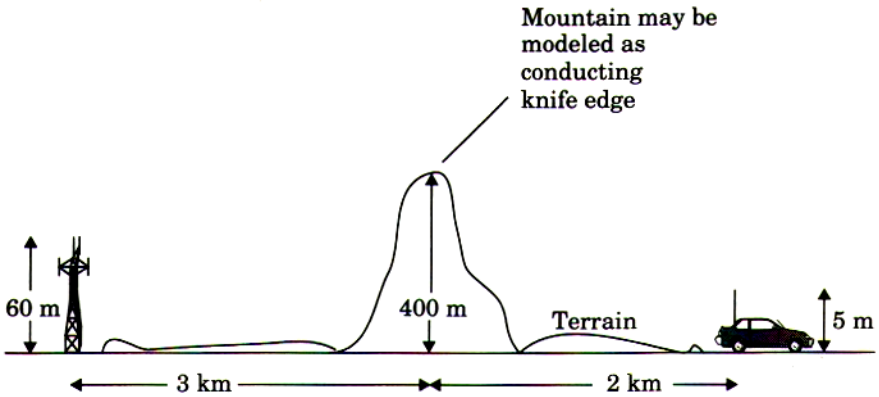

Figure P3.10 Knife-edge geometry for Problem 3.10.

Compute the overall path loss as the free-space path loss for the total distance plus the diffraction loss. For values of $\nu > 2.4$ you can use the approximation that the diffraction gain $G_d(\text{dB}) \approx 20\log(\frac{0.225}{\nu})$.

Question 2

3.13 If the received power at a reference distance d_0 = 1 km is equal to 1 microwatt, find the received powers at distances of 2 km, 5 km, 10 km, and 20 km from the same transmitter for the following path loss models: (a) Free space; (b) n = 3; (c) n = 4; (d) 2-ray ground reflection using the exact expression; (e) extended Hata model. Assume f =1800 MHz, h_t = 40m, h_r = 3m, G_t = G_r = 0 dB. Plot each of these models on the same graph over the range of 1 km to 20 km.

Question 3

3.16 A transmitter provides 15 W to an antenna having 12 dB gain. The receiver antenna has a gain of 3 dB and the receiver bandwidth is 30 kHz. If the receiver system noise figure is 8 dB and the carrier frequency is 1800 MHz, find the maximum T-R separation that will ensure that a SNR of 20 dB is provided for 95% of the time. Assume $n = 4$, $\sigma = 8$ dB, and $d_0 = 1$ km.

The noise power in dBm is given by $-173 + F + B$ where F in the noise figure in dB and B is the bandwidth in dB-Hz ($10\log(B)$).

σ is the parameter of a loss due to shadowing by buildings and other obstructions called "log-normal shadowing." Its value in dB is a normally-distributed random value with standard deviation σ.

Question 4

4.8 An automobile moves with velocity $v(t)$ shown in Figure P4.8. The received mobile signal experiences multipath Rayleigh fading on a 900 MHz CW carrier. What is the average crossing rate and fade duration over the 100 s interval? Assume $\rho = 0.1$ and ignore large-scale fading effects.

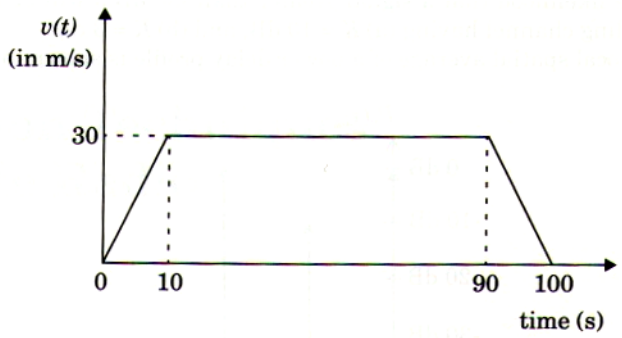

Figure P4.8 Graph of velocity of mobile.