UNIVERSITY OF TEXAS AT DALLAS
Department of Electrical Engineering

EE 6391 - Signaling and Coding for Wireless Communication Systems
Solutions to Problem Set #2:

Date assigned:
Date due:

Reading: "Propagation measurements and models for wireless communication channels," J. Andersen. T. Rappaport, S. Yoshida, IEEE Comm. Mag, Han. 1995.

Solution 2.1

a) W = average received power, Z_i = Shadowing over link i, $P_{r,i}$ = Received power in dBW, which is Gaussian with mean W, variance σ^2.

(b)

$$P_{outage} = P[P_{r,1} < T \cap P_{r,2} < T] = P[P_{r,1} < T]P[P_{r,2} < T]$$

$$\left[Q\left(\frac{W-T}{\sigma}\right)\right]^2 = \left[Q\left(\frac{\triangle}{\sigma}\right)\right]^2$$

Since Z_1,Z_2 independent.

(c)

$$P_{out} = \int_{-\infty}^{\infty} P[P_{r,1} \le T, P_{r,2} < T | Y = y] f_y(y) dy$$

$$P_{r,1}|Y = y \quad \sim \quad N(W + by, a^2\sigma^2), \quad \text{and} \quad [P_{r,1}|Y = y] \perp [P_{r,2}|Y = y]$$

$$P_{out} = \int_{-\infty}^{\infty} \left[Q\left(\frac{W+by-T}{a\sigma}\right)\right]^2 \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{y^2}{2\sigma^2}} dy$$

let $y/\sigma = u$, then,

$$= \int_{\infty}^{\infty} \frac{1}{\sqrt{2\pi}} \left[Q\left(\frac{W-T+bu\sigma}{a\sigma}\right)\right]^2 e^{\frac{u^2}{2}} du = \int_{\infty}^{\infty} \frac{1}{\sqrt{2\pi}} \left[Q\left(\frac{\triangle + by\sigma}{a\sigma}\right)\right]^2 e^{\frac{y^2}{2}} dy$$

(d) Let $a = b = 1/\sqrt{2}$, $\sigma = 8$, $\triangle = 5$. With independent fading, we get

$$P_{out} = \left[Q\left(\frac{5}{8}\right)\right]^2 = 0.0708$$

With correlated fading, we get $P_{out} = 0.1316$. Conclusion: Independent shadowing is preferable for diversity.

Solution 2.2

(a) $T_m \approx 0.1\text{msec} = 100\mu$ sec
$B_d \approx 0.1\text{Hz}$

(b) $B_c \approx \frac{1}{T_m} = 10$ KHz, $\triangle f > 10$ KHz, for $u_1 \perp u_2$.

(c) $(\triangle t)_c = 10\text{s}$

(d) 3 KHz $< B_c \Rightarrow$ Flat
30 KHz $< B_c \Rightarrow$ Frequency selective