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:


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 $\sigma^2$.

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

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

Since $Z_1,Z_2$ independent.

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

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

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

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

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

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

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

With correlated fading, we get $P_{\text{out}} = 0.1316$. Conclusion: Independent shadowing is preferable for diversity.
Solution 2.2

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

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

(c) \((\Delta t)_c = 10s\)

(d) \( 3 \text{ KHz} < B_c \Rightarrow \text{Flat} \)
\( 30 \text{ KHz} < B_c \Rightarrow \text{Frequency selective} \)