ECE6604 Personal & Mobile Communications

Assignment #2

Date Assigned: January 27, 2009

Date Due: February 5, 2009

1) A wireless channel is characterized by the time-variant impulse response

$$\begin{aligned} g(t,\tau) &= u_T(\tau)\sin(\Omega t+\phi_0), \qquad 0 \le \tau \le T \\ u_t(\tau) &= \begin{cases} 1, & 0 \le \tau \le T \\ 0, & \text{elsewhere} \end{cases} \end{aligned}$$

where $T = 10\ \mu$s, $\Omega = 10\pi$, and $\phi_0 \in [-\pi, +\pi]$ is a constant.

a) Determine the channel time-variant transfer function.

b) Given the complex channel input signal

$$\tilde{s}(t) = \begin{cases} 1, & 0 \le t \le T_s \\ 0, & \text{otherwise} \end{cases} ,$$

where $0 \le T_s \le T$, determine the complex channel output signal, $\tilde{r}(t)$.

2) The power delay profile of a WSSUS channel is given by

$$\phi_g(\tau) = \begin{cases} 0.5[1+\cos(2\pi\tau/T)], & 0 \le \tau \le T/2 \\ 0, & \text{otherwise} \end{cases}$$

a) Find the channel frequency correlation function

b) Calculate the mean delay, the multipath delay spread, and the coherence bandwidth

c) If $T = 0.1$ ms, determine whether the channel exhibits frequency-selective fading to the GSM system.

3) Suppose that a fading simulator is constructed using low-pass filtered white Gaussian noise as shown in Figure 2.29 of the textbook. Assume that the white Gaussian noise generators that produce $g_I(t)$ and $g_Q(t)$ are uncorrelated, and have power density spectrum $\Omega_p/2$ watts/Hz. The low-pass filters that are employed have the transfer function

$$H(f) = \frac{A}{1 + j2\pi\beta f}$$

- **a)** What is the Doppler power spectrum $S_{gg}(f)$ and autocorrelation function $\phi_{gg}(\tau)$?
- **b)** Find A such that the envelope power is equal to Ω_p.
- **b)** What is the joint probability density function of the output $g(t)$ and $g(t + \tau)$?

4) Text Problem 2.19