ECE6604 Personal & Mobile Communications

Assignment #8

Date Assigned: April 20, 2010

Date Due: April 29, 2010

1) Text problem 6.9

2) Text problem 6.10

3) Consider a selective mapping scheme to reduce the PAPR of an OFDM waveform. The technique begins by generating L different random phase vectors of length N, i.e., generate

$$\boldsymbol{\phi}_l = (\phi_{l,0}, \phi_{l,1}, \ldots, \phi_{l,N-1}), l = 1, 2, \ldots, L$$

where the $\phi_{l,i}$ are uniformly distributed random variables on the interval $[-\pi, \pi)$.

Then for each $\boldsymbol{\phi}_n$ compute the PAPR of the OFDM waveform

$$\tilde{s}_l(t) = A \sum_{n=0}^{N-1} x_n e^{j\phi_{l,n}} e^{-j\frac{2\pi nt}{T}}, l = 1, 2, \ldots, L$$

and select the waveform having the smallest PAPR for transmission.

Consider $N = 256$ and 16-QAM symbols. Compute the mean PAPR and the variance of the PAPR of the transmitted OFDM waveform for $L = 1, 2, 4$.

4) Consider an OFDM system having $N = 1024$ sub-carriers that are spaced 4 kHz apart. Suppose that the waveform channel is a linear time-invariant channel consisting of two non-faded equal rays spaced τ_d seconds apart, i.e.,

$$g(t, \tau) = g\delta(\tau) + g\delta(\tau_d)$$

where $g = \alpha e^{j\phi}$ is the gain associated with each of the two channel taps.

Find the value of the delay τ_d in the above channel model that will yield the worst possible bit error rate performance for this OFDM system.

5) An OFDM signal with a large number of sub-carriers N has a complex envelope that can be approximated as a zero-mean complex Gaussian random process. Assume an "ideal" OFDM signal spectrum, where the power spectrum is

$$S_{\tilde{s}\tilde{s}}(f) = \begin{cases} S_0 & |f| \leq 1/2T_s \\ 0 & \text{elsewhere} \end{cases}$$

where $T = NT_s$.

a) Using the above Gaussian approximation, what is the distribution of the magnitude of the complex envelope $\tilde{s}(t)$ at any time t.

b) Suppose that a power amplifier will clip the OFDM waveform if the complex envelope $\tilde{s}(t)$ will exceeds the level ΘR_{rms}, where R_{rms} is the rms envelope level $\sqrt{E[|\tilde{s}(t)|^2]}$. What is the probability that the OFDM waveform will be clipped at any time t?

b) How many times per second will the envelope be clipped?