Homework 6
Due: Tuesday, April 11, 5 PM

1. 11.5 (a,b)

2. 11.12

3. 12.7

4. 12.10

5. 12.11

6. You are designing an OFDM system over a passband bandwidth of 10 MHz at a carrier frequency of 1 GHz. Assume that you are in outdoor environment with a maximum delay spread of 15 microseconds.

   (a) What length cyclic prefix is needed for this system?
   (b) What is the efficiency of a system using 1024 tones?
   (c) Repeat parts (a) and (b) for an indoor environment with a maximum delay spread of 1 microsecond.
   (d) If the number of OFDM tones is fixed, how does the efficiency change as a function of the bandwidth? How does the efficiency change as a function of the delay spread?

7. In order for OFDM tones to remain orthogonal, the channel must be fixed for the duration of an OFDM symbol. Therefore, we require that an OFDM symbol be no longer than the coherence time of the channel. Consider the same system as in the previous problem, i.e., 10 MHz bandwidth, 1 GHz carrier, 15 microseconds maximum delay spread.

   (a) What is the maximum number of OFDM tones such that tone orthogonality is maintained, assuming that users have a maximum velocity of 30 meters/sec. What is the efficiency if this many tones are used?
   (b) Repeat part (a) for a carrier frequency of 5 GHz.
   (c) Derive a simple expression for the maximum possible efficiency of an OFDM system as a function of coherence time and delay spread. What happens to the maximum efficiency as the carrier frequency is taken to infinity?
   (d) At what carrier frequency (again assuming a maximum velocity of 30 meters/sec) is the maximum efficiency equal to 90 %, assuming a delay spread of 15 microseconds?

8. 13.11

9. 13.12