

EECS 562  
Homework #9

1. Explain the difference between FDD and TDD.
2. Explain how OFDM helps mitigate multipath fading effects.
3. In OFDM what is the function of the cyclic prefix?
4. LTE uses TDMA, True or False.
5. What is the purpose of pilot subcarriers in LTE?
6. How long is a radio frame in LTE.
7. In LTE the OFDM symbol time,  $T=1/15000$  sec =  $1/\Delta f$ ;  $\Delta f=15\text{kHz}$ . Here each subcarrier transmits 16-QAM (See figure 7.21 pp 298 in the class text)

Bits 1111 so  $s_1(t) = 1 \cos(2\pi(f_c + \Delta f)t) + 3 \sin(2\pi(f_c + \Delta f)t)$  for  $0 < t < T$

Bits 1000 so  $s_2(t) = -3 \cos(2\pi(f_c + 2\Delta f)t) + 1 \sin(2\pi(f_c + 2\Delta f)t)$  for  $0 < t < T$

$s(t) = s_1(t) + s_2(t)$  for  $0 < t < T$

Assume the carrier frequency,  $f_c = 900$  Mhz. Here  $s(t)$  is transmitted using two adjacent subcarriers at  $f_c + \Delta f$  and  $f_c + 2\Delta f$ . During one OFDM symbol time,  $T$ , the RF signal,  $s(t)$ , is transmitted.

- a. What is the bit rate of  $s(t)$  in b/s.
- b. Show that  $s_1(t)$  and  $s_2(t)$  are orthogonal over  $0 < t < T$ .
- c. Sketch a receiver structure for  $s_2(t)$ , what is the receiver output?

When an LTE operator uses a 20 MHz channel bandwidth in the downlink there are 1200 occupied subcarriers. In LTE the OFDM symbol time,  $T=1/15000$  sec with a subcarrier separation of 15kHz.

- d. If all 1200 subcarriers use 16-QAM what is the total bit rate of in b/s.
- e. If all 1200 subcarriers use 64-QAM what is the total bit rate of in b/s.