EECS 562
Homework #8

1. 7.11

2. 7.13

3. 7.14 but use a carrier frequency of 5 MHz.

4. Explain the operation of the QPSK coherent detector in Figure 7.7 page 276.
5. Using http://demonstrations.wolfram.com/DigitalModulationQuadraturePhaseShiftKeyingQPSKSignalConstel/ Explain the impact in terms of the eye diagram, transmission bandwidth, and signal quality of the following parameter changes:

    a. Changing the raised cosine roll-off factor from .1 to 0.9.

    b. Changing the I/Q phase error from 0 to 25^o.

    c. Explain what happened when you click on the trajectory.

6. A BPSK system needs to transmit 256kbit/sec and provide a 10^{-5} BER. Let N_0=-107 dB_W/Hz. The path loss is 67dB.

    a. Find the required RF transmission bandwidth, B_{RF}; assume Raised-Cosine pulse shape with a roll off factor α of 1 and Nyquist Bandwidth of ½.

    b. Find the required transmitter power.

7. The signal constellation for 16-QAM is given below:

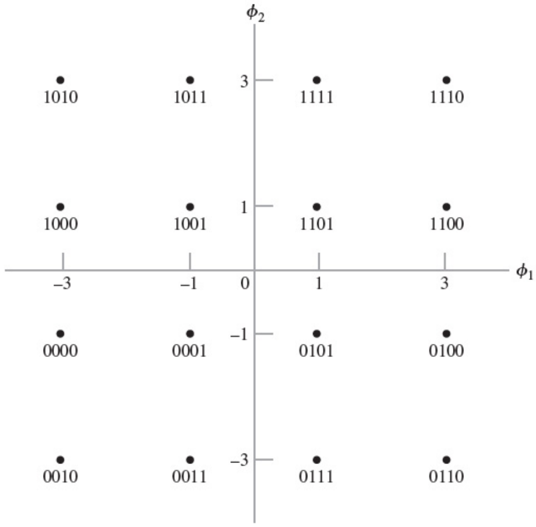
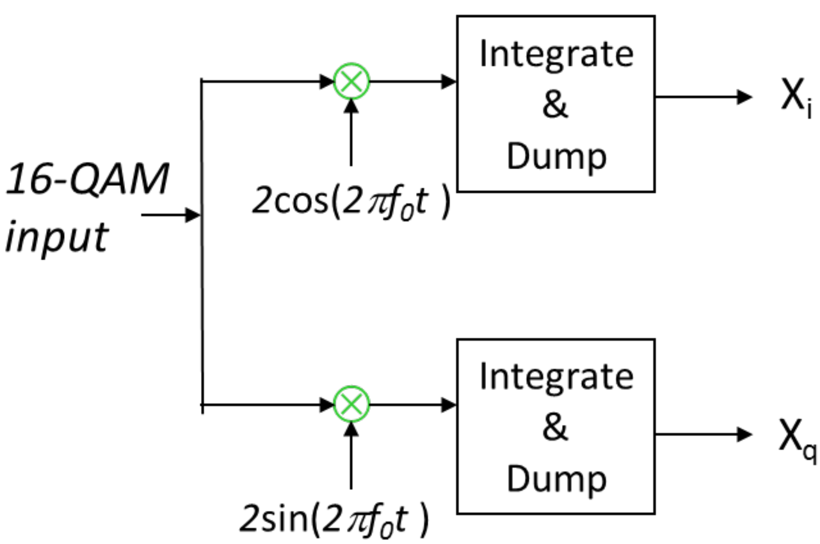


FIGURE 7.21 Signal-space diagram of Gray-encoded M-ary QAM for $M = 16$.

In this case 16-QAM is used. The following sequence of bits arrive at a rate of 40 kb/s.

11100000111100111010

a) What is the symbol time, T_s, and symbol rate.
b) If raised cosine pulses are used with B_0=.5 and α=1 what is the required transmission bandwidth?
c) What is the spectral efficiency in this case?
d) What are the first five complex baseband symbols?
e) What is the transmitted RF signal for $0<t<T_s$
f) The received 16-QAM signal is processed by the system shown below. What is the integration time of the Integrate and Dump.
g) The received 16-QAM signal is processed by the system shown below. For X_i=-2.9 and X_q= -0.9 what bits were transmitted.



8. Explore the system trade-off between spectral efficiency and required RF transmission bandwidth for M-QAM. In this case let N_0=-107 dB_W/Hz and assume a required bit rate of 256kbit/sec and Raised-Cosine pulse shape with a roll off factor α of 1 and Nyquist Bandwidth of ½.
   a. To provide a 10^{-2} BER find the required E_b and RF transmission bandwidth, B_{RF}, for QPSK, and 64-QAM
   b. To provide a 10^{-3} BER find the required E_b and RF transmission bandwidth, B_{RF}, for QPSK and 64-QAM
   c. To provide a 10^{-4} BER find the required E_b and RF transmission bandwidth, B_{RF}, for QPSK and 64-QAM
   d. That is, fill out the table below and comment on the BER, required E_b and required RF transmission bandwidth trade-offs; specifically discuss the trade-off with respect the spectral efficiency defined as the $\eta=r_b/B_{RF}$ (bits/Hz).

Modulation	BER	E_b	B_{RF}	η (bits/Hz)
QPSK	10^{-2}			
QPSK	10^{-3}			
QPSK	10^{-4}			
64-QAM	10^{-2}			
64-QAM	10^{-3}			
64-QAM	10^{-4}			

Use the theoretical BER performance for M-QAM assuming Gray coding given below and at http://www.ittc.ku.edu/~frost/EECS_562/QAM_Theoretical_BER.jpeg (4-QAM=QPSK)