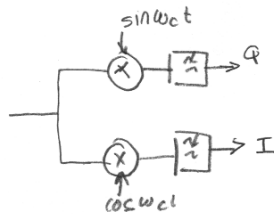


Assignment 3

1. A bit-oriented framing format uses the flag sequence 01111110 to indicate the start and end of a frame. Bit stuffing is used to escape sequences of 6 consecutive '1' bits within the data. If the characters ?~ (question mark and tilde) are to be transmitted in the frame encoded as 8-bit MS-bit first ASCII values, what sequence of bits is transmitted, including the flags?
2. A 16-QAM signal is transmitted at a rate of 2400 symbols per second. What is the bit rate? What is the minimum overall bandwidth (including transmit pulse shaping, transmitter filter, channel and receive filter) if there is to be no ISI? What is the overall bandwidth if a raised-cosine filter with excess bandwidth of $\alpha = 1$ is used?
3. Consider the quadrature down-converter shown below:



The RF input signal input to the two mixers is $\cos(\omega_c t + \phi)$, and the two LO signals are $\cos(\omega_c t)$ and $\sin(\omega_c t)$. Derive the equation of the signals at the two mixer outputs in terms of the sinusoidal signal components. What are the requirements for the low-pass filters in order to recover the baseband I and Q values?

Hints:

$$\cos(A)\cos(B) = \frac{1}{2}[\cos(A+b) + \cos(A-B)]$$

$$\sin(A)\cos(B) = \frac{1}{2}[\sin(A+b) + \sin(A-B)].$$

4. How many bits per symbol can be transmitted using an 8-level ASK signal? Show a table with two different gray-coded mappings for the binary values encoded by the eight levels.
5. A GMSK signal has a bit rate of 200 kHz. The lower of the two frequencies used by the frequency modulator is 10 MHz. What is the other frequency?
6. Assume you are using the 16-QAM 802.11n constellation given in lecture 9 that has been scaled so that the maximum amplitude of any transmitted symbol is 1 volt and that a phase of zero degrees corresponds to the positive I (in-phase or real) axis. What bits were transmitted if the transmitted symbol had an amplitude of 0.33 volts and a phase of -135 degrees?
7. You need to select a protocol that transmits 1024-byte frames over a 100Mb/s link with a 50ms propagation delay. Would you choose a protocol that uses stop-and-wait ARQ? Why or why not?
A different data link has about one error per day. If you had a choice, would you configure this link to use go-back-N ARQ or selective-repeat ARQ? Why?
8. Compute the CRC to be appended to a data frame consisting of the bits 100101 (in that order) if the CRC's generator polynomial is $x^3 + x + 1$.

If this were to be described as an (n, k) block code, what are the value of n and k ?

If transmission over a channel resulted in an error in the third bit, what bits would be received? What is the Hamming distance between the transmitted and received codewords?

What would be the remainder if the received bits (with the error) were divided by the generator polynomial?