EECS 562
Homework #7

1. 5.18

2. 6.9

3. A signal is transmitted at 56,000 symbols/sec what is the minimum transmission bandwidth for this signal.

4. The bandwidth for signals $x_1(t)$, $x_2(t)$, $x_3(t)$…. $x_N(t)$ is B_i=90kHz for i=1…N. These signals are multiplexed using TDM. The resulting baseband TDM signal is then modulated using DSB-SC. The RF signal is assigned RF spectrum of 15MHz.
    a. Assuming Nyquist sampling find N.
    b. Compare this result to the solution of Homework 2 Problem 7.
    c. Given N found above and assume PCM using 8 bits/sample what is the required RF bandwidth.

5. What is frame synchronization and why is it needed and what is its cost?

6. A TDM system has a frame time = 10 ms. The frame is divided into 20 time slots. Each time slot carries 168 bits. (These are some LTE parameters).
    a. What is the slot time?
    b. What is the T_b=bit time
    c. Suppose each user gets 2 time slots, i.e., there are 10 users, what is the user bit rate (in b/s).
    d. What is the total bit rate in b/s?
    e. What is the minimum transmission bandwidth?

7. With a Nyquist bandwidth =B_o what is the transmission bandwidth
    a. using a raised cosine pulse shape with α=0
    b. using a raised cosine pulse shape with α=1
    c. What is the advantage of using a raised cosine pulse shape with α=1 over using a raised cosine pulse shape with α=0.

8. Let $p(t) = \frac{\sin(2\pi Bt)\cos(2\pi aBt)}{2\pi Bt(1-16a^2B^2t^2)}$
    a. Plot p(t) and p(t-1) for a = 0.4 and B=1.
    b. Plot p(t) + p(t-1) for a = 0.4 and B=1.
    c. What is the transmission bandwidth for a = 0.4 and B=1.
    d. Is there ISI with a = 0.4 and B=1.
    e. Plot p(t) and p(t-1) for a = 0.4 and B=1.2.
    f. Plot p(t) + p(t-1) for a = 0.4 and B=1.2
    g. What is the transmission bandwidth for a = 0.4 and B=1.2.
    h. Is there ISI with a = 0.4 and B=1.2
    [Use http://www.ittc.ku.edu/~frost/EECS_562/Mathemitica_EECS_562/Multiple_Raised-Cos_pulses.cdf.]
    i. Is p(t) a raised-cosine pulse, yes or no?
    j. Is p(t) a Nyquist waveform, yes or no?

9. What is ISI?

10. What is FDMA?

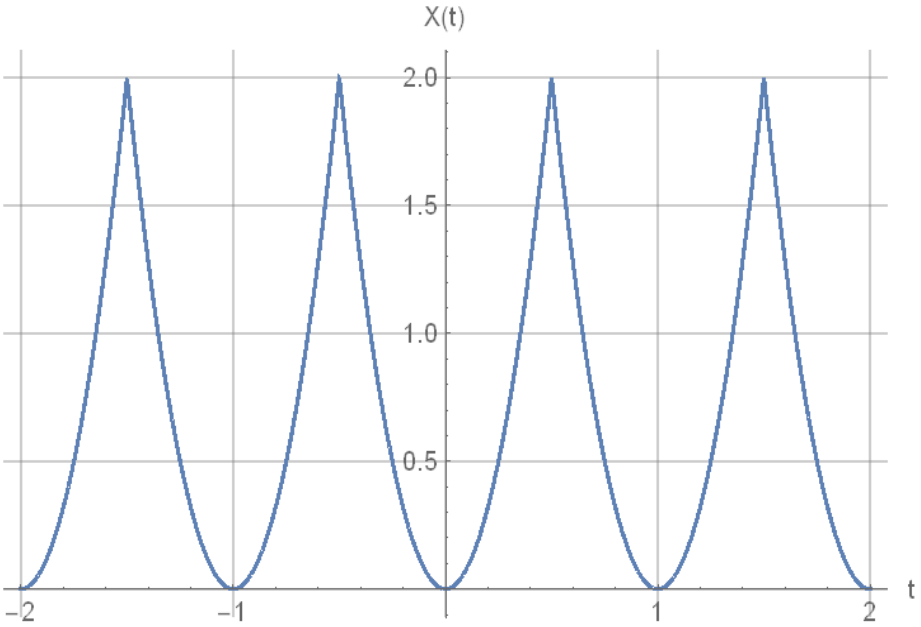
11. What is TDMA?

12. Consider a PCM/TDM with following parameters

    K= Number of signals = 128
    B_x = Bandwidth/signal = 15 kHz
    γ = Number of bits/sample = 8

    a. Assuming Nyquist sampling that is the bit rate of the PCM/TDM signal.
    b. What is the minimum transmission bandwidth of the PCM/TDM signal in Hz.
    c. Assuming a linear quantizer how much is the Signal to Quantizing noise ratio (S/N_q) in dB improved by changing the number of bits/sample to γ = 12. see http://classes.engineering.wustl.edu/ese488/Lectures/Lecture5a_QNoise.pdf
    d. Change the number of bits/sample to γ = 12. What is the minimum transmission bandwidth of the PCM/TDM signal in Hz.
    e. Discuss the trade-off between minimum transmission bandwidth Signal to Quantizing noise ratio $(S/N)_q$.

13. A signal x(t) is given as $x(t) = \sum_{k=-\infty}^{\infty} 8*(t-k)^2 \, rect(t-k)$



x(t) is sampled at 3 samples/sec and uniformly quantized using a 2 bit quantizer.

a. Specify the quantizer, i.e., the midpoints and quantizing thresholds and output codes.
b. The first sample is taken at t=0. What are the first 6 transmitted bits?
c. What is the output bit rate in b/s?
d. What is the minimum transmission bandwidth in Hz?