EECS 562  
Homework #7

1. Drill Problem 5.5

2. 5.18

3. 6.9

4. A signal is transmitted at 1500 symbols/sec what is the minimum transmission bandwidth for this signal.

5. The bandwidth for signals $x_1(t), x_2(t), x_3(t).... x_N(t)$ is $B=90\text{kHz}$ 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 20MHz.
   a. Assuming Nyquist sampling find $N$.
   b. Compare this result to the solution of Homework 2 Problem 7.

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. Let $p(t) = \frac{\sin(2\pi Bt)\cos(2\pi a Bt)}{2\pi Bt(1-16a^2B^2t^2)}$
   a. Plot $p(t)$ and $p(t-1)$ for $a = .3$ and $B=1$.
   b. Plot $p(t) + p(t-1)$ for $a = .3$ and $B=1$.
   c. What is the transmission bandwidth for $a = .3$ and $B=1$.
   d. Is there ISI with $a = .3$ and $B=1$.
   e. Plot $p(t)$ and $p(t-1)$ for $a = .3$ and $B=1.2$.
   f. Plot $p(t) + p(t-1)$ for $a = .3$ and $B=1.2$
   g. What is the transmission bandwidth for $a = .3$ and $B=1.2$.
   h. Is there ISI with $a = .3$ and $B=1.2$
   [Use http://www.ittc.ku.edu/~frost/EECS_562/Mathematica_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?

8. What is FDMA and compare FDMA to FDM.

9. What is TDMA and compare TDMA to TDM.
10. Consider a PCM/TDM with following parameters

- \( K = \) Number of signals = 64
- \( B_s = \) Bandwidth/signal = 10 kHz
- \( \gamma = \) Number of bits/sample = 16

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 \( \gamma = 17 \). See http://classes.engineering.wustl.edu/ese488/Lectures/Lecture5a_QNoise.pdf
d. Change the number of bits/sample to \( \gamma = 17 \). 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 \((S/N)_q\).
11. A signal $x(t)$ is given as

$$x(t) = \sum_{k=-\infty}^{\infty} 8^*(t-k)^2 \text{rect}(t-k)$$

$x(t)$ is sampled at 5 samples/sec and uniformly quantized using a 3 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 12 transmitted bits?
c. What is the output bit rate in b/s?
d. What is the minimum transmission bandwidth in Hz?