EE354 Homework #10

1. Two baseband binary communication systems are operating in an AWGN environment. System 1 is unipolar NRZ PCM, and system 2 is bipolar RZ PCM. Both waveforms use a Matched Filter (MAP) receiver. The system operates with a probability of bit error of $10^{-4}$ in the same AWGN environment, have a received signal amplitude of 5.0 mV, and a bit rate of 56 kbps.

Determine:  
(a) The energy per bit for both systems  
(b) the $\frac{E_b}{N_0}$ for both systems  
(c) the new probability of bit error if the bit rate is increased to 115.2 kbps  
(d) compare the performance of the two systems.

2. Binary information is transmitted via OOK at a bit rate of 100 kbps. The carrier frequency of the system is 20 MHz, the amplitude of the received envelope is $10^{-3}$ V, and is operating in an AWGN channel with one-sided noise spectral density of $N_0 = 10^{-12}$ W / Hz.

Determine:  
(a) Draw a block diagram of the ideal, coherent receiver (and label all pertinent information.  
(b) The BER for both the coherent and incoherent receiver.

3. Binary information is transmitted via OOK in an AWGN channel with one-sided noise spectral density of $N_0 = 10^{-7}$ W / Hz. The carrier frequency of the system is 1.94 MHz, the amplitude of the received envelope is 1.0 V, and the system is operating with a probability of bit error of $10^{-5}$. Determine the system’s bit rate.

4. A communication system uses 2-FSK and a coherent Matched Filter detector. The received signal amplitude is 100 $\mu$V, $f_0 = 3000$ kHz, $f_1 = 3002$ kHz, and the bit rate is 2.0 kbps.

Determine:  
(a) Draw a block diagram of the receiver.  
(b) The bandwidth of the FSK transmission.  
(c) Find the one-sided noise spectral density $N_0$ if $P_e = 10^{-4}$.  
(d) If the system is changed to OOK, determine the new $P_e$.

5. An FSK communication system transmits the following two signals in an AWGN channel with one-sided noise spectral density of $N_0 = 10^{-12}$ W / Hz, $A = 1$ $\mu$V and bit time $T_b = 10$ sec.

$$s_1(t) = A \cos \left( 2\pi \left( 550 \text{ Hz} \right) t + 30^\circ \right)$$
$$s_0(t) = A \cos \left( 2\pi \left( 500 \text{ Hz} \right) t + 30^\circ \right)$$

Determine: The BER for both the coherent and incoherent receiver.