1. For an ASCII ‘Z,’ sketch both the On-Off Keying (OOK) binary waveform and the modulated signal, where the amplitude of the carrier is modulated to either 10V or 0V and $T_b=100\text{ms}$. Hint: use the ASCII table from Chapter 1 of the course notes to determine the bits that represent ‘Z’.

2. Given the following FSK transmission in a scheme where only two frequencies are used and individual symbols are denoted by vertical lines:
   a. Draw the corresponding binary transmission, assuming that the higher frequency represents a 1:
   b. Determine the bit rate.
   c. How many bits per symbol could be conveyed if four different frequencies were used to transmit data instead of two?

3. The following is a BPSK transmission. The dashed vertical lines separate the bits.

   On this plot, a binary ‘1’ is represented by this signal:
   a. Determine the transmitted bits.
b. Determine the bit rate.

c. What is the bandwidth for this transmission?

4. QAM is a combination of which two types of modulation?

5. The “forward” signal transmitted to control an RC car is captured on an oscilloscope and displayed below.

Answer the following questions with regards to this signal:

a. Given that the frequency and phase of the carrier remain constant, what type of modulation does it use?

b. What is the bit rate? (Hint: \( t_b \) is equivalent to \( \Delta X = 496 \mu s \), obtained from the lower right display)

c. What bit sequence is represented by the O-scope display?
6. 8-PSK can be used for higher data rate transmissions.
   a. How many different phases are used in 8-PSK?
   b. How many bits per symbol are transmitted?
   c. Label each point of the constellation diagram with a specific bit sequence starting with the symbol with 0 phase and working sequentially counter-clockwise.
   d. If the bit rate associated with this 8-PSK system was 1.2 Mbps, what is the bandwidth of the transmission?

7. For a given bandwidth system, what is the advantage and disadvantage of using a multi-symbol encoding scheme?

8. A communication system transmits 100 kbps. For each of the following modulation types, determine the bandwidth of the transmission.
   a. Binary FSK, with frequency deviation 200 kHz.
   b. OOK.
   c. QPSK.
   d. 16-PSK.
   e. 16-QAM.
   f. 512-QAM.