COMP 3721: Assignment #2

General Instruction

- To receive any credit, the answers for this assignment must be **handwritten** and need to be legible by the grader.
- When you solve a problem, show all the steps and add comments as necessary to make sure your answers are clear and unambiguous to the grader.
- You may discuss questions in broad terms with others but ultimately your answers should demonstrate your own individual thought process and effort.
- All work submitted is subject to the standards of conduct as specified in BCIT Policy 5104.

Submission

- This assignment is due on **October 17, 2019** by **1630** at the latest. No late assignments will be accepted.
- Submit your completed assignment to your lab instructor's assignment box in the SW2/SW3 connector.
- Your submissions must include a **cover page** clearly specifying your **name**, **student number** and **set**.

Marking

- This assignment consists of **5 questions** totaling **40 marks**.

Problems

(1) [8 marks] Draw the following line coding schemes, as defined in Forouzan, B.A., Data Communications and Networking, 5th Ed. New York, NY: McGraw-Hill, 2013, for the 16-bit data stream **0110010001101110**. Use **+V** for the positive voltage, **-V** for the negative voltage. If applicable, assume that the previous data bit transmitted prior to this 16-bit data stream was **0** at **+V**.

a) [2 marks] Polar NRZ-L
b) [2 marks] Polar biphase Manchester
c) [2 marks] Polar biphase Differential Manchester
d) [2 marks] Polar NRZ-I

(2) [8 marks] Consider a composite analog signal composed of simple waves with frequencies of 35 kHz, 42 kHz, 70 kHz and 140 kHz is sampled for digital transmission using Pulse Code Modulation (PCM).

a) [1 mark] Determine the bandwidth of the composite signal.
b) [1 mark] Determine the minimum sampling rate required such that the original analog signal can be accurately reproduced.
c) [3 marks] Determine the minimum number of uniform quantization levels required to achieve a quantizing SNR of no less than 28 dB.
d) [3 marks] Determine the SNR required, in dB, if the PCM signal, with sampling rate obtained in part (b) and number of uniform quantization levels obtained in part (c), is to be transmitted over a noisy channel with a channel bandwidth of 0.15 MHz.

(3) [8 marks] Consider a system with 6 signals to be time-division multiplexed onto a single link. Analog signals are baseband and quantized using 16 bits per sample. The signals are as follows:

Signal 1:	Analog, 2 kHz bandwidth
Signal 2:	Analog, 3 kHz bandwidth
Signals 3-4:	Digital, 29.5 kbps each
Signal 5:	Digital, 126 kbps
Signal 6:	Digital, 62 kbps

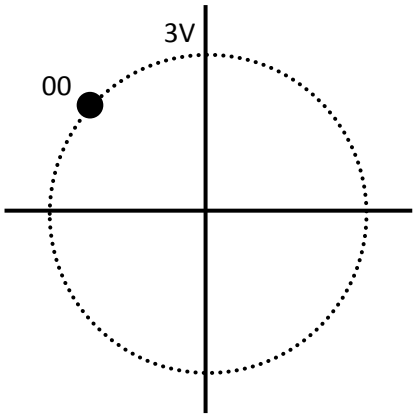
Draw a block diagram depicting the TDM system and specify the bit rates at each point in the system. Depict the output timeslots in the final TDM output frame.

(4) [11 marks] Phase shift keying (PSK) is a modulation technique that transmits data by changing the phase of the carrier signal. Consider the following QPSK modulation scheme defined by

$$s(t) = \begin{cases} 3\cos(2\pi f_c t + \frac{3\pi}{4}), & \text{for data bits} = 00 \\ 3\cos(2\pi f_c t + \frac{5\pi}{4}), & \text{for data bits} = 01 \\ 3\cos(2\pi f_c t + \frac{\pi}{4}), & \text{for data bits} = 10 \\ 3\cos(2\pi f_c t + \frac{7\pi}{4}), & \text{for data bits} = 11 \end{cases},$$

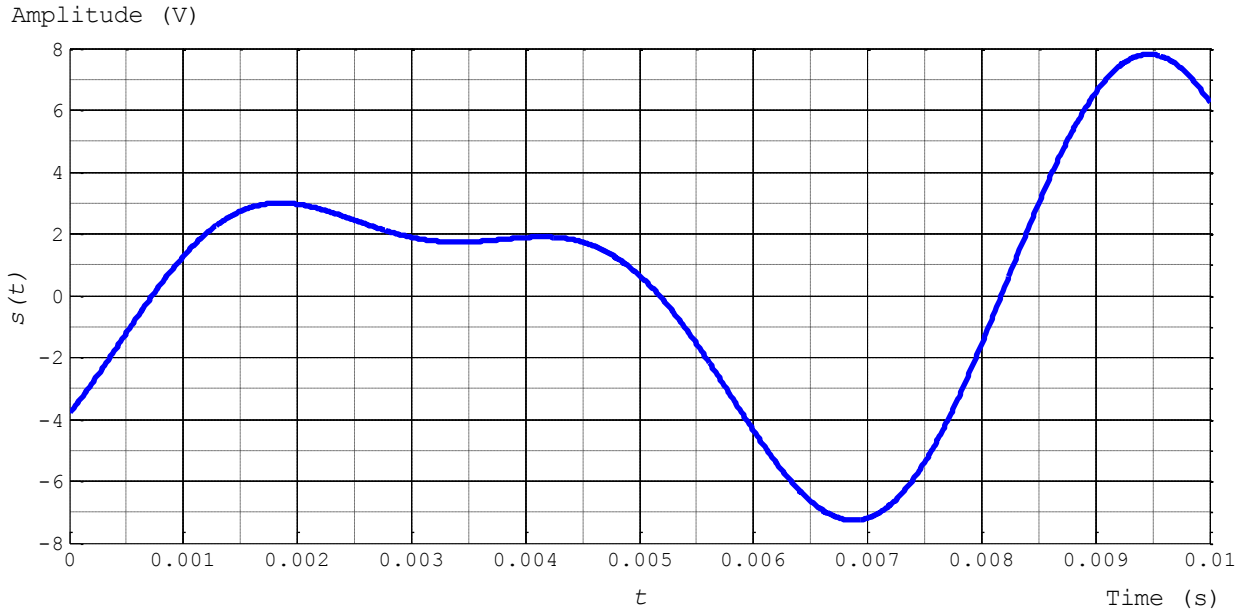
where f_c is the carrier frequency. Assume f_c = 2.4 kHz and the baud rate = 800 symbol/s.

a) [3 marks] Complete the following signal constellation diagram for this modulation scheme. Label the axes and for each symbol, indicate the associated data bits.



b) [1 mark] Determine the period of the carrier signal.
c) [1 mark] Determine the symbol duration.
d) [5 marks] Plot the modulated signal for the data stream **0110101100**. Clearly indicate the beginning and the end of each symbol and the associated data bits in the plot.
e) [1 mark] Determine the bit rate of the modulated signal.

(5) [5 marks] Consider the following analog signal, $s(t)$, with minimum and maximum amplitudes of -8 V and +8 V, respectively. The signal, $s(t)$, is sampled for digital transmission using Pulse Code Modulation (PCM) with a sampling rate of 400 samples/s and 8 uniform quantization levels.



Assuming that the first sample is taken at 0.001 s, determine both the quantization codes and the resulting encoded words of the PCM signal for t = [0, 0.01] s.