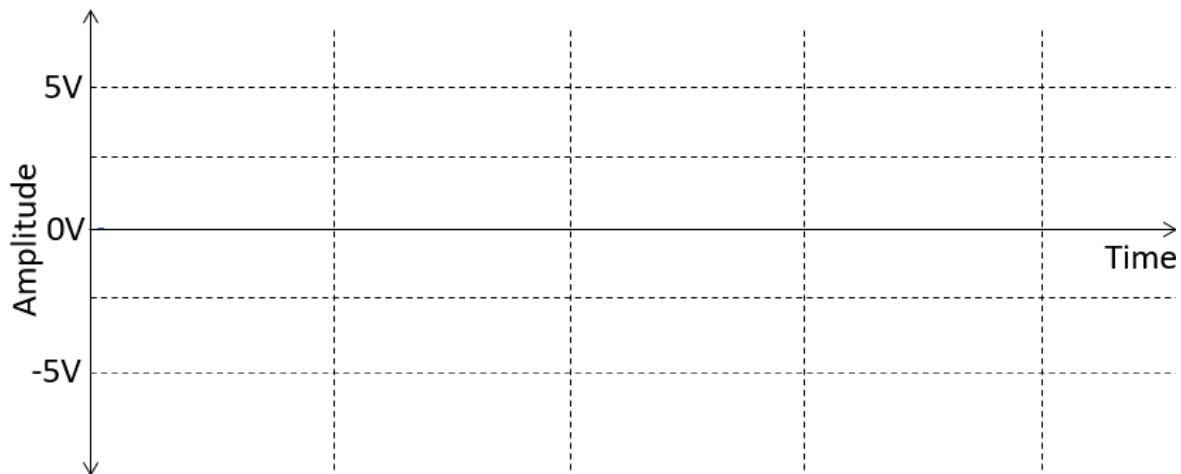

Assignment 6: Chapter 5 & 6

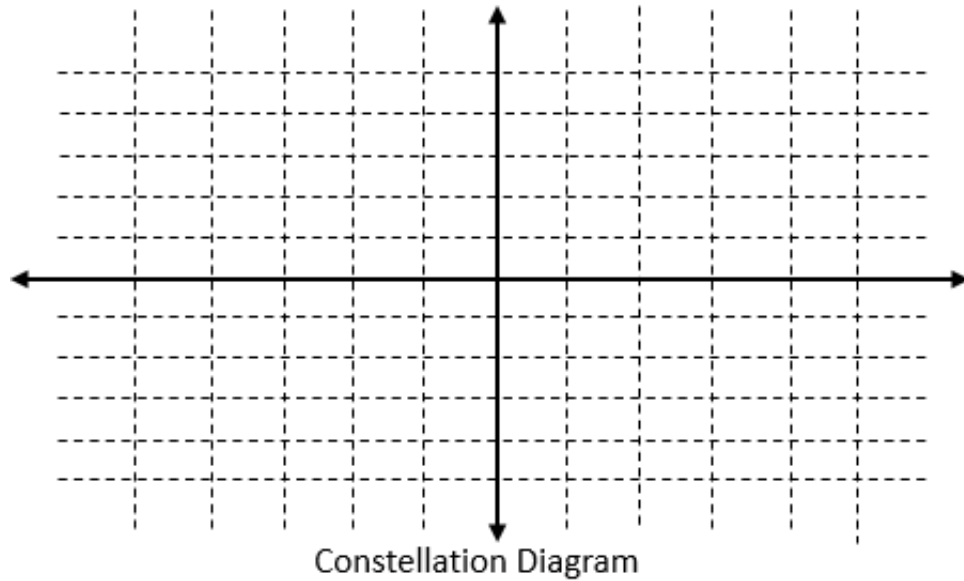
Question 1

- a) A QPSK (Quadrature Phase Shift Keying) system transmits 2 bits per signal element with the following information:

Bit Pair	Coordinates (I, Q)
00	(2, 2)
01	(2, -2)
10	(-2, 2)
11	(-2, -2)

The carrier signal contains 2 cycles for each signal element, and each cycle lasts 1 ms. Given the bit sequence **10110001**, **Draw the QPSK waveform and the constellation diagram** for an 8 ms transmission. Clearly **indicate the phase and amplitude** of the modulated waveform.

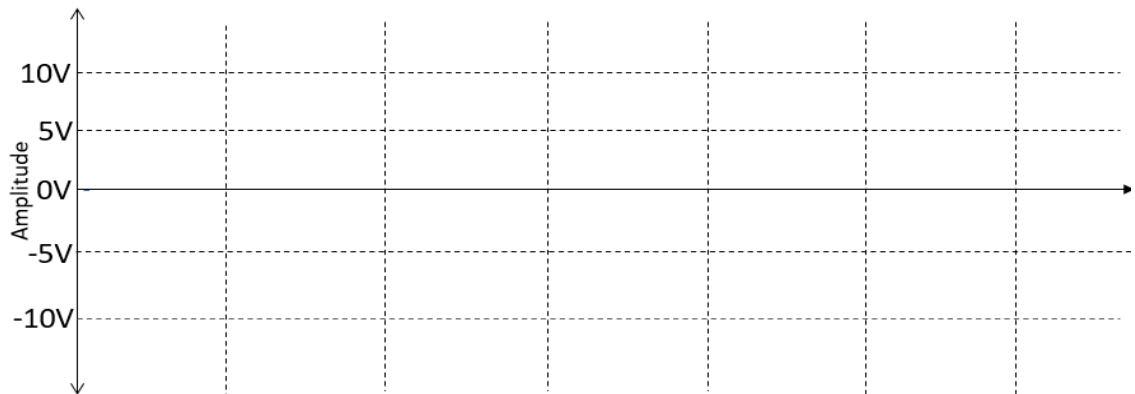




- b) During another transmission, the phase sequence of a received signal was **315°**, **135°**, **225°**, and **45° respectively**. Using the above table, **decode** these phases into their corresponding bit pairs and **find** the resulting bit sequence.
- c) Design a FSK (Frequency Shift Keying) system to transmit the binary data stream **101101** under the following conditions:

Each signal element has a carrier frequency **$f_c=2$ Hz** and a frequency shift **$\Delta f=1$ Hz**. The peak amplitude is **5V**, the phase is **180°**, and the duration of each signal element is **1s**.

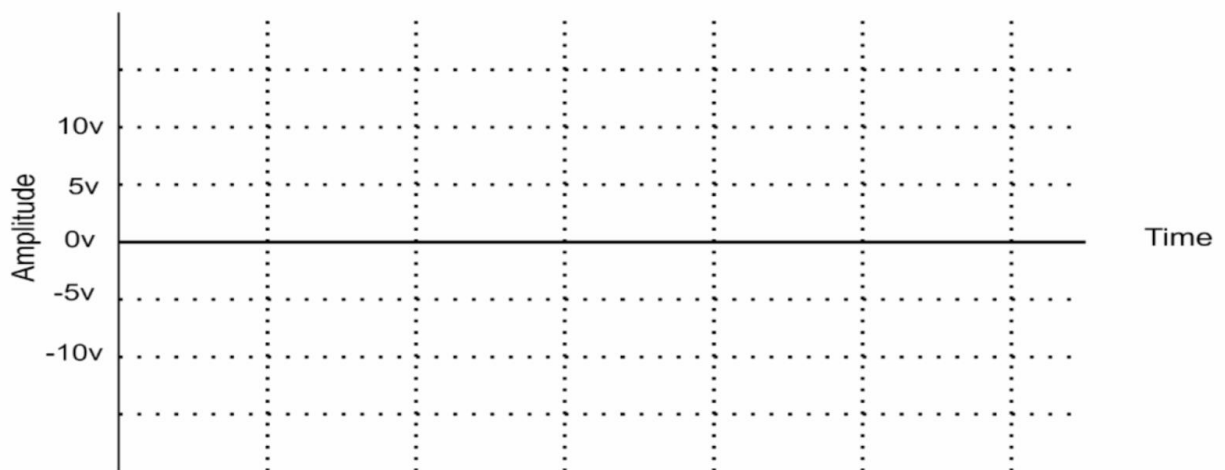
- **Calculate** the frequencies **f_1** (for binary 1) and **f_0** (for binary 0).
- **Draw the FSK modulated signal** for the given binary data stream **101101**. Make sure to indicate the frequency changes for each signal element.



Question 2

- Explain the difference between coherent and non-coherent Frequency Division Multiplexing (FSK). Why do we use Voltage controlled oscillators?
- What are the advantages of Phase Shift Keying over Amplitude Shift Keying?
- In a Multi-level FSK, for each signal element, we want to send 2 bits at a time. We have used a carrier signal that has an amplitude of 10v and phase is 180 degree. If the frequency changes according to the following table, draw the modulated signal for the bit sequence 0110001101. [answer this question in the given graph below]

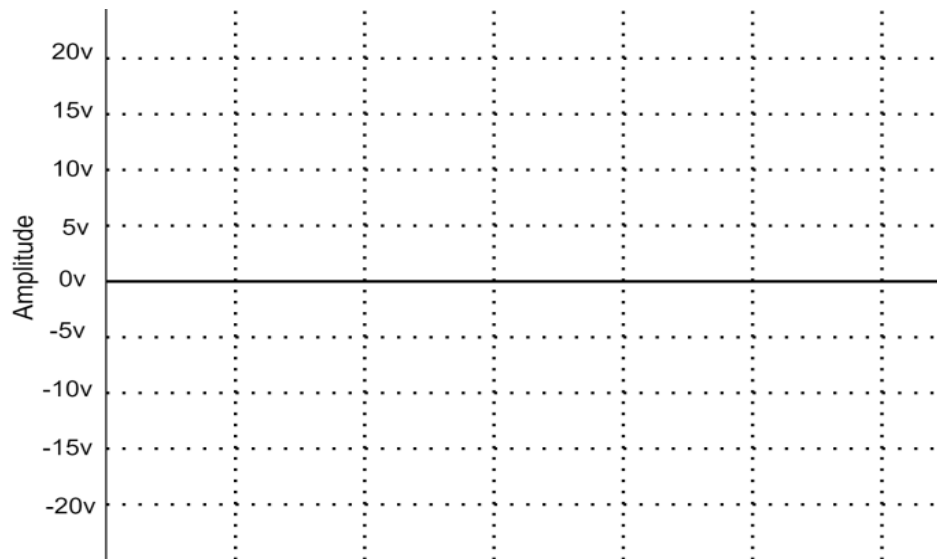
Bit Pattern	Number of cycles per signal element
00	1
01	3
10	5
11	7



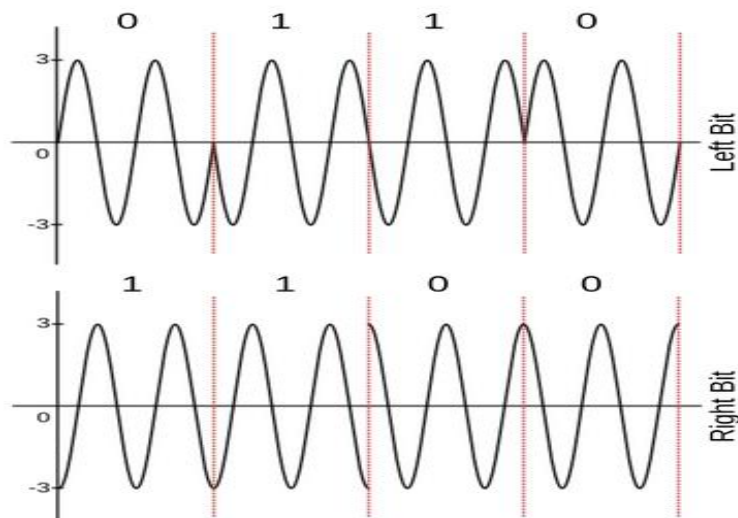
- Draw the analog signal for the bit stream 0110001101 using the constellation diagram given below [frequency = 1 for each signal element]

Question 3

- a. Consider a multi-level ASK where 2 bits are sent in each baud. The carrier signal has 2 full-cycles in each signal element, and a phase of 0° . Amplitude for each 2-bits pattern is given as: **00** \rightarrow **5V**, **01** \rightarrow **10V**, **10** \rightarrow **15V**, **11** \rightarrow **20V**. Based on this, draw the modulated signal for the bit sequence **111010000100**.



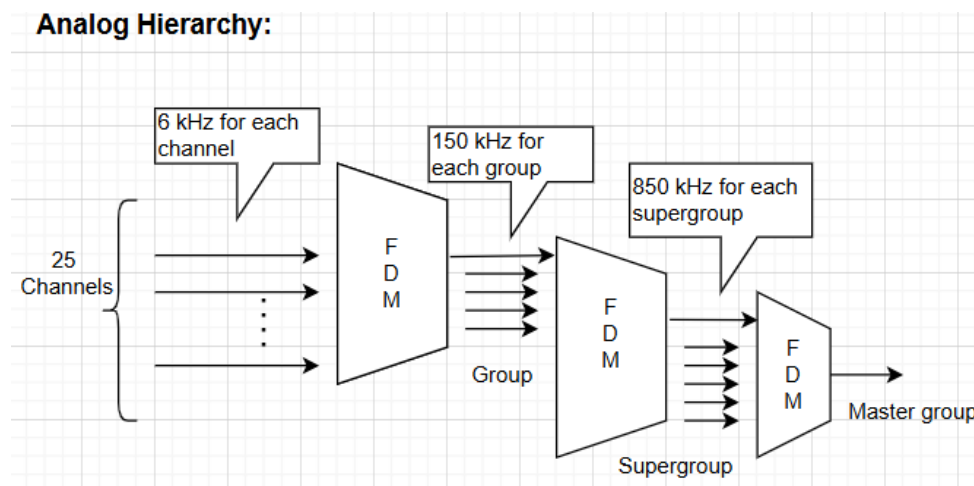
- b. For the QPSK-modulated signal given below, draw the **constellation diagram**, and find the **amplitude** and **phase** of the modulated signal.



Question 4

- a) Suppose 5 data sources with data rates of 140 Kbps, 280 Kbps, 140 Kbps, 560 Kbps, and 280 Kbps are to be multiplexed. **Show** the visual representation of MUX input and output without adding extra pulses in the input channels and the number of input channels will remain the same. If a character at a time is interleaved using the concept of TDM with 1 synchronizing bit, then **answer the following questions**:

- I. What is the frame duration?
- II. What is the input bit duration?
- III. What is the frame rate?
- IV. What is the output data rate?
- V. What is the output bit duration?

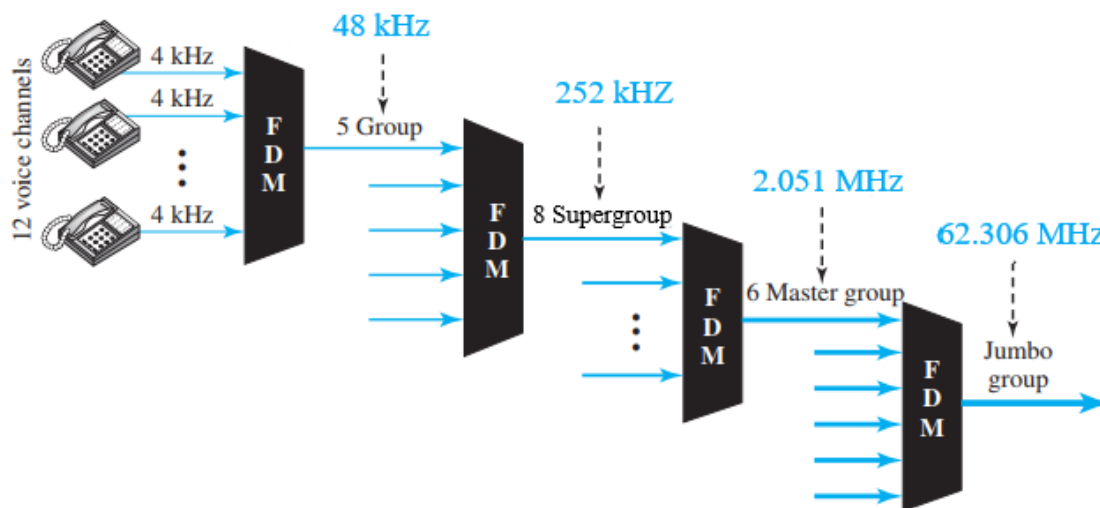


- b) In the given analog hierarchy, 25 channels are multiplexed using Frequency Division Multiplexing (FDM), where each channel occupies a bandwidth of **6 kHz**, forming a group with a bandwidth of **150 kHz**. Five groups are further multiplexed to form a **supergroup** with a bandwidth of **850 kHz**. Finally, six supergroups are combined to form a **master group**.
- I. Calculate the bandwidth allocated to each guard band before forming the supergroup.
 - II. Calculate the total bandwidth of the master group if the guard band between each supergroup is **180 kHz**

Question 5

- a. FOUR channels, with bit rates of 500 kbps, 300 kbps, 150 kbps, and 150 kbps respectively, are to be multiplexed, with 2 interleaved bits, and 1 synchronization bit per frame. **You can use pulse stuffing for ONE input channel only.** Based on this, answer the following questions.
 - I. Draw the TDM scheme.
 - II. Find the frame size, frame rate, and frame duration.
 - III. Find the output bit rate.

The following figure shows an analog hierarchical system used by a telephone company for multiplexing. The bandwidths of each link are shown in blue.

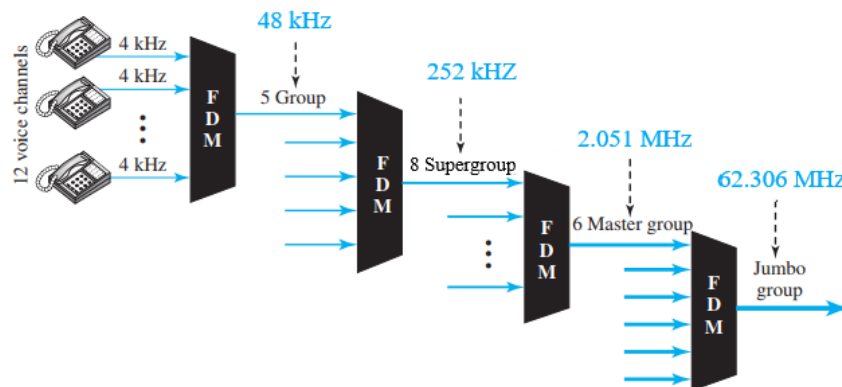


- b. Based on this hierarchy, find the following.
 - I. Total number of channels in the hierarchy
 - II. Guard band used between the groups, supergroups, and master groups
- c. Suppose we have **an analog radio signal, a digital signal, and a fiber-optic signal.** Which multiplexing technique to use for which signal?

Question 6

- a. FOUR channels, with bit rates of 500 kbps, 300 kbps, 150 kbps, and 150 kbps respectively, are to be multiplexed, with 2 interleaved bits, and 1 synchronization bit per frame. **You can use pulse stuffing for ONE input channel only.** Based on this, answer the following questions.
- Draw the TDM scheme.
 - Find the frame size, frame rate, and frame duration.
 - Find the output bit rate.

- b. The following figure shows an analog hierarchical system used by a telephone company for multiplexing. The bandwidths of each link are shown in blue.



- c. Based on this hierarchy, find the following.
- Total number of channels in the hierarchy
 - Guard band used between the groups, supergroups, and master groups.
- d. Suppose we have **an analog radio signal, a digital signal, and a fiber-optic signal.** Which multiplexing technique to use for which signal?