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Department: BS (CS)

Semester: 8th

Course: Data communication and networks

Question no 1

Part a : Assume that a voice channel occupies a bandwidth of 4 kHz. We need to multiplex 10 voice channels with guard bands of 500 Hz using FDM. Calculate the required bandwidth.

Answer:

To multiplex 10 voice channels we need nine guard bands the required bandwidth is the

B = (4KHz) x 10 + (500 Hz) x 9

= 44.5 KHz

Part b : An analog signal carries 4 bits per signal element. If 3000 signal elements are sent per second, find the bit rate?

Answer:

In this case, r = 4, S =3000, and N is unknown. We can find the value of N from.

S = N x $\frac{1}{r}$ or N = S x r = 3000 x 4

12000bps

Part c : Distinguish between a signal element and a data element. (2 marks)

Answer:

"A data element is the smallest entity that can represent a piece of information (a bit).

A signal element is the shortest unit of a digital signal. Data elements are what we need to send; signal elements are what we can send. Data elements are being carried; signal elements are the carriers."

Part d : Distinguish between a link and a channel in multiplexing

Answer:

In multiplexing, link refers to the physical path. Channel refers to the portion of a link that carries a transmission between a given pair of lines. One link can have many (n) channels.

Part e : List three different techniques in serial transmission and explain the differences.

Answer:

The three different techniques in serial transmission are:

1. Asynchronous - In this, we send 1 start bit at the beginning and 1 or more stop bits at the end of each byte. i.e irregular intervals.

2. Synchronous - In this, We send bits in a serial order with out any gaps. i.e regular intervals

3.isynchrounous - It sends a block of data asynchronously.

Question no 2

Part a : Find the 8-bit data stream for the following case:

Answer:

Deferential Manchester : 11000100

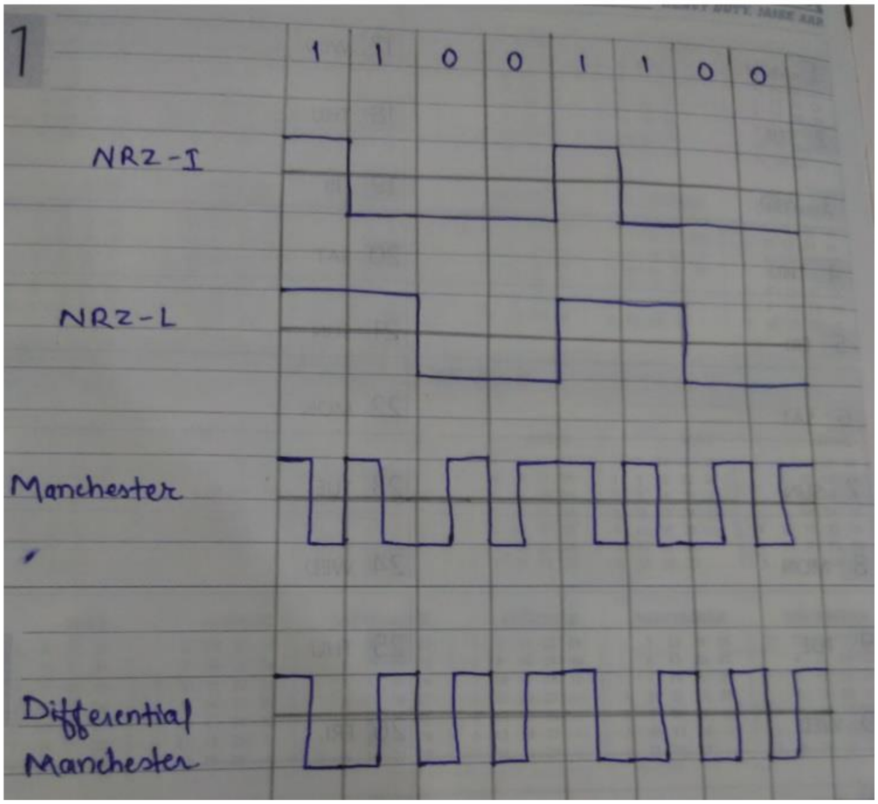
Part b :

Draw the graphs of the Manchester, differential Manchester, NRZ-I and NRZ-L schemes for each of the following data streams: (4 marks)

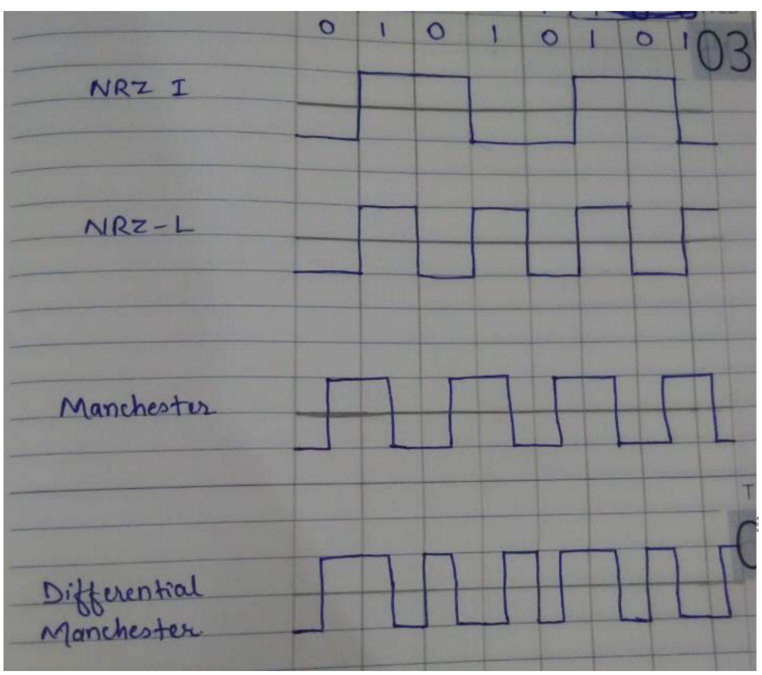
Answer:

a. 11001100

A.


1
1 1 0 0 1 1 0 0
NRZ-I
NRZ-L
Manchester
Differential Manchester

b. 01010101


0 1 0 1 0 1 0 1
NRZ I
NRZ-L
Manchester
Differential Manchester

Part c: What is the Nyquist sampling rate for the band-pass signal with bandwidth of 950 KHz if the lowest frequency is 450 KHz?

Answer:

Bandwidth = Highest frequency - Lowest frequency
950KHz = x - 450KHz
x = 950 + 450 = 1400KHz

Nyquist Sampling Rate => should be at least twice the maximum frequency
Hence,
Nyquist Sampling Rate = 2*1400 Khz = 2800 KHz

Question no 3

Part a: We have an available bandwidth of 300 kHz which spans from 500 to 800 kHz. What are the carrier frequency and the bit rate if we modulated our data by using ASK with d.

Answer:

The middle of the bandwidth is located at 650 kHz.
as, (500 + 800)/ 2 = 650 .

This means that our carrier frequency can be at f_c = 650 kHz.
We can use the formula for bandwidth to find the bit rate (with d = 1 and r = 1).

B = (1 + d) * S = 2 * N * (1 / r)
= 2 * N
=> 2 * N = 650 kHz.
=> N = 325 kbps.

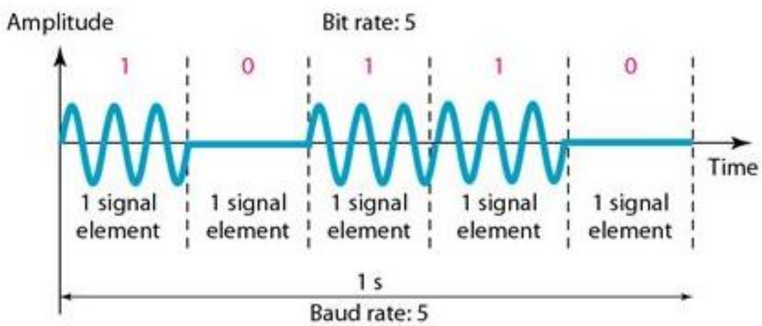
Part b: which shift keying technique is used in the following diagram? Briefly explain:

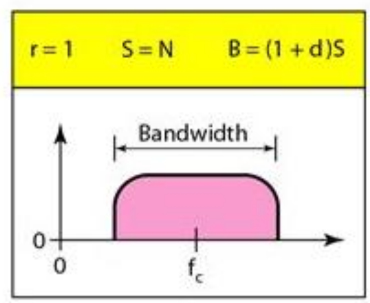
Amplitude shift keying technique used in the following figure.

In amplitude shift keying, the amplitude of the carrier signal is varied to create signal elements. Both frequency and phase remain constant while the amplitude changes.

Binary ASK (BASK)

ASK is normally implemented using only two levels. This is referred to as binary amplitude shift keying or on-off keying (OOK). The peak amplitude of one signal level is 0; the other is the same as the amplitude of the carrier frequency. The following figure gives a conceptual view of binary ASKS.





Question no 4

Part a: Briefly explain the FDM Multiplexing and De-Multiplexing Process with the help of diagram and also differentiate between TDM and FDM?

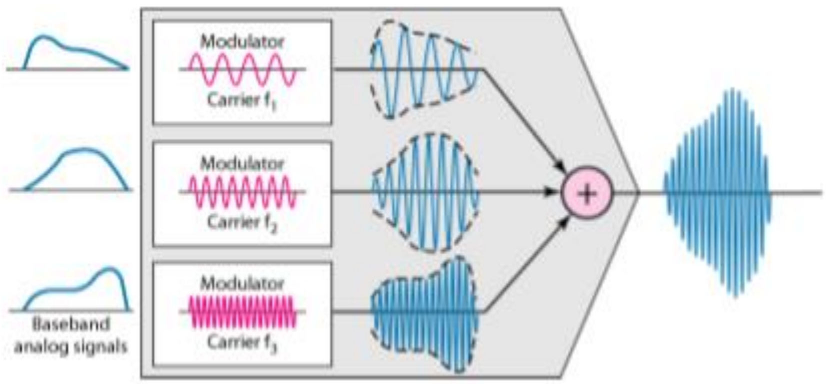
FREQUENCY DIVISION MULTIPLEXING - A number of signals can be combined into a composite signal suitable for transmission over a common channel.

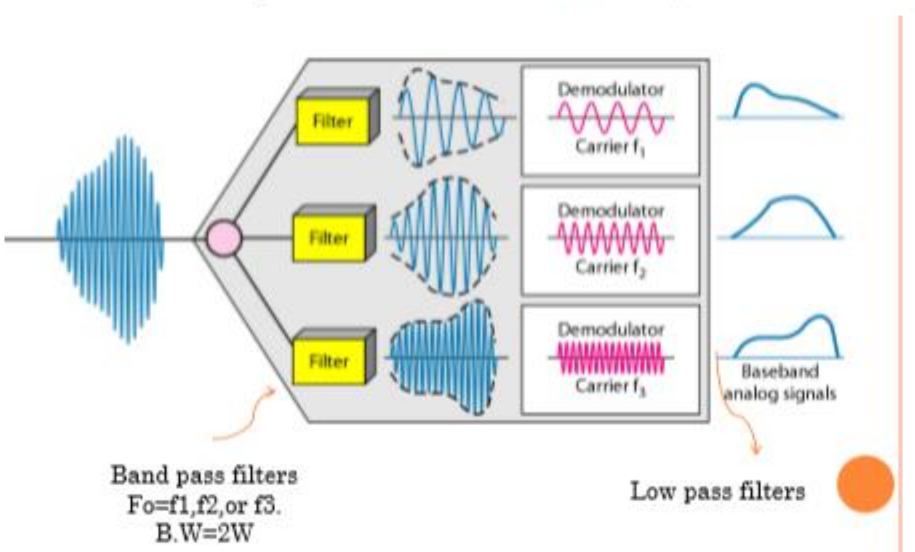
- Each signal is modulated using different carrier frequency.

- The signals must be kept apart so that they don't interfere with each other, and thus, they can be separated at the receiving end.

Frequency division **multiplexing** (**FDM**) is a technique of **multiplexing** which means combining more than one signal over a shared medium. In **FDM**, signals of different frequencies are combined for concurrent transmission

BLOCK DIAGRAM OF FDM MULTIPLEXING



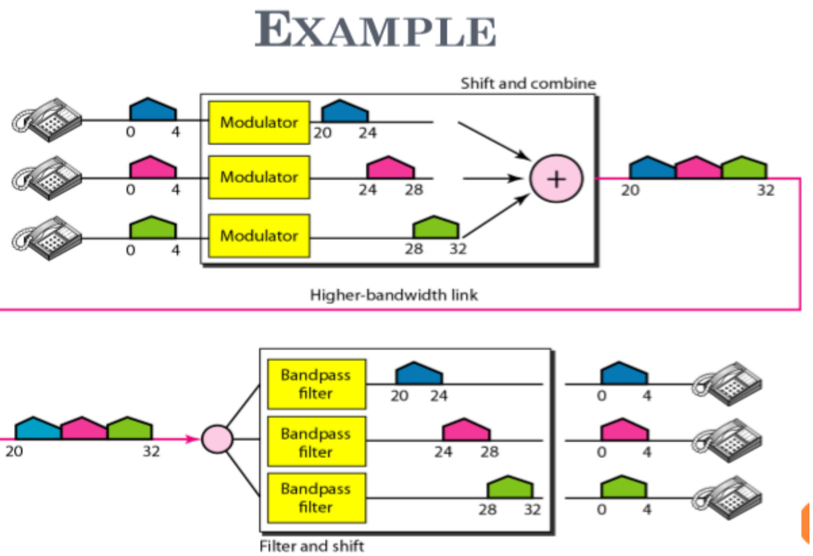


BLOCK DIAGRAM OF FDM DEMULTIPLEXING

FDM VS TDM

In FDM, the total channel bandwidth is divided into smaller portions and all messages are sent at the same time using different frequencies. Thus, the data can reach its destination more rapidly.

In TDM, the time is divided into slots and each signal uses all of the bandwidth at a time. Thus, TDM provides greater flexibility and efficiency than FDM , as the width of the allocated frequency cannot be dynamically changed using FDM. In FDM de-multiplexing ,band-pass filters are needed. These filters are relatively expensive and complicated to construct and design. Thus, using TDM is relatively more simple and less costly.



Question no 4

PART b: Briefly explain Analog to Analog conversion techniques with the help of diagrams?

Analog To Analog Conversion Techniques

Analog-to-analog conversion, or analog modulation, is the representation of analog information by an analog signal. Modulation is needed if the medium is bandpass in nature or if only a bandpass channel is available to us.

An example is radio. The government assigns a narrow bandwidth to each radio station. The analog signal produced by each station is a low-pass signal, all in the same range. To be able to listen to different stations, the low-pass signals need to be shifted, each to a different range.

Analog-to-analog conversion can be accomplished in three ways:

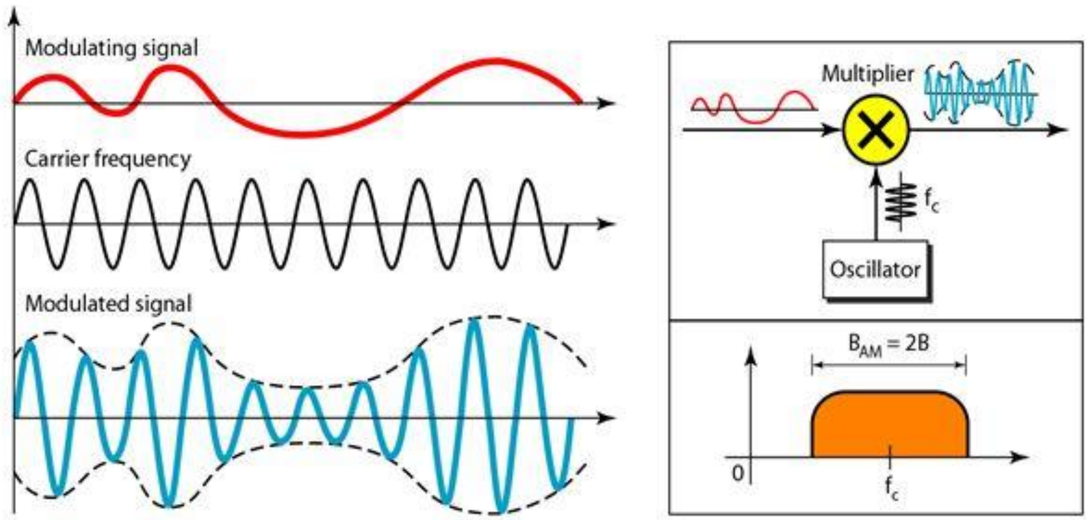
Amplitude Modulation (AM)

Frequency Modulation (FM)

Phase Modulation (PM)

1. Amplitude Modulation:

In AM transmission, the carrier signal is modulated so that its amplitude varies with the changing amplitudes of the modulating signal. The frequency and phase of the carrier remain the same. Only the amplitude changes to follow variations in the information. The following figure shows how this concept works. The modulating signal is the envelope of the carrier.



AM is normally implemented by using a simple multiplier because the amplitude of the carrier signal needs to be changed according to the amplitude of the modulating signal.

AM Bandwidth:

The modulation creates a bandwidth that is twice the bandwidth of the modulating signal and covers a range centered on the carrier frequency. However, the signal components above and below the carrier frequency carry exactly the same information. For this reason, some implementations discard one-half of the signals and cut the bandwidth in half.

The total bandwidth required for AM can be determined from the bandwidth of the audio signal:

BAM =2B

Standard Bandwidth allocation for AM Radio:

The bandwidth of an audio signal (speech and music) is usually 5 kHz. Therefore, an AM radio station needs a bandwidth of 10kHz. In fact, the Federal Communications Commission (FCC) allows 10 kHz for each AM station.
AM stations are allowed carrier frequencies anywhere between 530 and 1700 kHz (1.7 MHz). However, each station's carrier frequency must be separated from those on either side of it by at least 10 kHz (one AM bandwidth) to avoid interference. If one station uses a carrier frequency of 1100 kHz, the next station's carrier frequency cannot be lower than 1110 kHz.

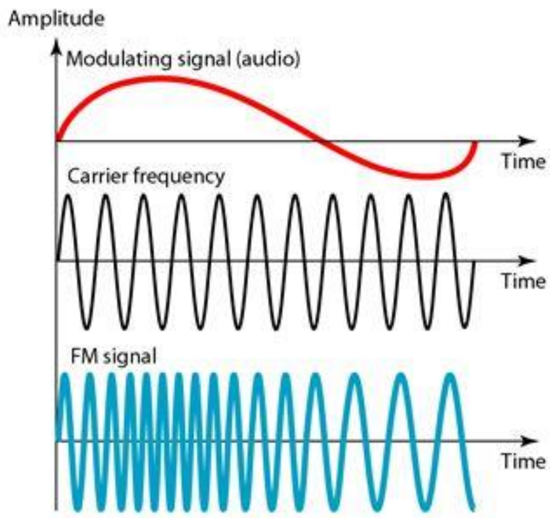
2. Frequency Modulation

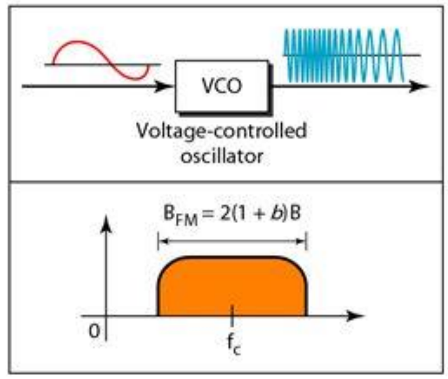
In FM transmission, the frequency of the carrier signal is modulated to follow the changing voltage level (amplitude) of the modulating signal. The peak amplitude and phase of the carrier signal remain constant, but as the amplitude of the information signal changes, the frequency of the carrier changes correspondingly.

The following figure shows the relationships of the modulating signal, the carrier signal, and the resultant FM signal. FM is normally implemented by using a voltage-controlled oscillator as with FSK. The frequency of the oscillator changes according to the input voltage which is the amplitude of the modulating signal.

FM Bandwidth

The actual bandwidth is difficult to determine exactly, but it can be shown empirically that it is several times that of the analog signal or $2(1 + \beta)B$ where β is a factor depends on modulation technique with a common value of 4.





Standard Bandwidth allocation for FM Radio:

The bandwidth of an audio signal (speech and music) broadcast in stereo is almost 15 kHz. The FCC allows 200 kHz (0.2 MHz) for each station. This mean β = 4 with some extra guard band. FM stations are allowed carrier frequencies anywhere between 88 and 108 MHz. Stations must be separated by at least 200 kHz to keep their bandwidths from overlapping.

To create even more privacy, the FCC requires that in a given area, only alternate bandwidth allocations may be used. The others remain unused to prevent any possibility of two stations interfering with each other. Given 88 to 108 MHz as a range, there are 100 potential PM

bandwidths in an area, of which 50 can operate at any one time.

3. Phase Modulation:

In PM transmission, the phase of the carrier signal is modulated to follow the changing voltage level (amplitude) of the modulating signal. The peak amplitude and frequency of the carrier signal remain constant, but as the amplitude of the information signal changes, the phase of the carrier changes correspondingly. It is proved mathematically that PM is the same as FM with one difference.

In FM, the instantaneous change in the carrier frequency is proportional to the amplitude of the modulating signal; in PM the instantaneous change in the carrier frequency is proportional to the derivative of the amplitude of the modulating signal. The following figure shows the relationships of the modulating signal, the carrier signal, and the resultant PM signal.