Total No. of Questions – [04]

Total No. of Printed Pages 03

U218-143(TL)

G.R. No.	

OCTOBER 2018/IN-SEM (T1-Marking Schema)

S. Y. B. TECH. (Information Technology) (SEMESTER - I)

COURSE NAME: Fundamentals of Data Communication

COURSE CODE: ITUA21173

(PATTERN 2017)

Time: [**1Hour**] [Max. Marks: **30**]

(*) Instructions to candidates:

1) **Answer Q.1 OR Q.2 and Q.3 OR Q.4.**
2) **Figures to the right indicate full marks.**
3) **Use of scientific calculator is allowed**
4) **Use suitable data whereever required**

Q.1) a) Diagrammatically represent [6 marks]

i. Analog signal with Amplitude= 2v, Frequency= 2Hz in time domain.

ii.Analog signal with Amplitude= 2v, Frequency= 2Hz in frequency domain.

iii. Digital signal two transmit 2-bit data.

Draw Signals by pencil with proper labels Each 1+1+1 M

Proper Assumption and units Each 1+1+1M

b) Solve fallowing with appropriate assumptions. [6 marks]

i. If a periodic signal is decomposed into five sine waves with frequencies of 100, 300, 500, 700, and 900 KHz, what is its bandwidth? Draw the spectrum, assuming respective components have a amplitude of 10 V, 30V, 50V, 70V and 90V.

Calculate BW- 1M

Solution with diagram- 2M

ii. A sine wave is offset 1/6 cycle with respect to time 0. What is its phase in degrees and radians? Draw the signal having pahse=180°.

Phase in degree+ formula- 1M

Phase in radians+ formula- 1M

Draw signal- 1M

c) Define Fallowing terms with example. [4 marks]

i. Jitter ii. Periodic Signal

iii. Composite Signal iv. Discrete signal

Definition- each 1+1+1 M

Example each 1+1+1M

OR

Q.2) a) List out and label the basic features of analog signal using sine wave signal representation (time domain) and describe the features in brief (Any three). [6 marks]

Sate the truth of the sentence and justify your answer "Amplitude can be calculated from given value of frequency"

Draw appropriate signal with minimum three labels- [if not more 1M]

Define Identified features, explain in brief and mention their units each - 2+2+2 M

b) Explain how Transmission Impairment affects the original signal [6 marks]

List out three impairments- 1M

Understanding of three Impairment and its effect on signal quality Each 1+1+1 M

and calculate maximum bit rate, for a noiseless channel with Bandwidth of 3000 Hz transmitting a signal with two signal levels.

Formula- 1Mark

Solution along with unit- 1M

c) How many signal levels required for fallowing noiseless channel? [4 marks]

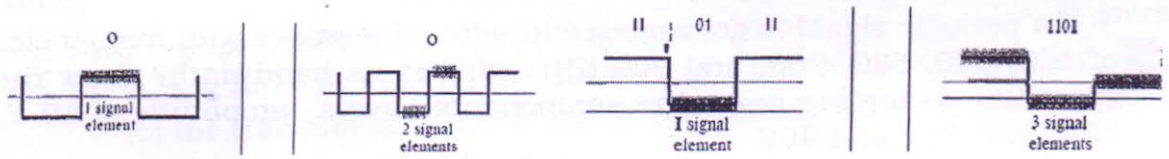
A.We need to send 300 kbps over a bandwidth of 20 kHz.

B.We need to send 200 Mbps over a bandwidth of 30 kHz.

Each solution- 2+2M

Q.3) a) Explain what is Signal rate and Data rate. [6 marks]

Calculate the value of the signal rate for each case in Figure if the data rate is 1 Mbps and c is between 0 and 1.



Data rate- definition and Ex. 1M

Signal rate- definition and Ex. 1M

Solution for above cases each 1+1+11 M

b) Explain the process of Frequency Modulation in detail with appropriate labeled diagrams. [4 marks]

Process- 2 Marks.

labeled signals I/P and O/P- 2M

c) List out all the types of Multiplexing. Identify the best technique to share the channel among multiple digital information sources. Justify your answer. [4 marks]

List of all -1 M
Explain best technique in detail-2 M
Justification/Advantages-1M

OR

Q.4) a) Discuss the steps in Analog to Digital conversion in detail with appropriate example and explain the process to generate the binary codes as an output. [6 marks]
Sampling- 2M
Quantization- 2M
Code generation- 2M

b) In a digital transmission, the receiver clock is 0.1 percent faster than the sender clock. How many extra bits per second does the receiver receive if the data rate is 1 kbps? How many if the data rate is 1 Mbps? Discuss it's adverse effect. [4 marks]
Adverse effect -1 M
Adverse effect (i.e. loss of data)-1 M

c) Four 1-kbps connections are multiplexed together. A unit is 1 bit. Find (a) the duration of 1 bit before multiplexing, (b) the transmission rate of the link, (c) the duration of a time slot and (d) the duration of a frame. [4 marks]
Formula/logic for each- 1/2M
Final answaer for each- 1/2M

(*) Course coordinator can change instructions as per course requirement

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G.R. No.	

U218-143(T1)

OCTOBER 2018/IN-SEM (T1- Solution)

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Q.1) a) Diagrammatically represent [6 marks]

i. Analog signal with Amplitude= 2v, Frequency= 2Hz in time domain.

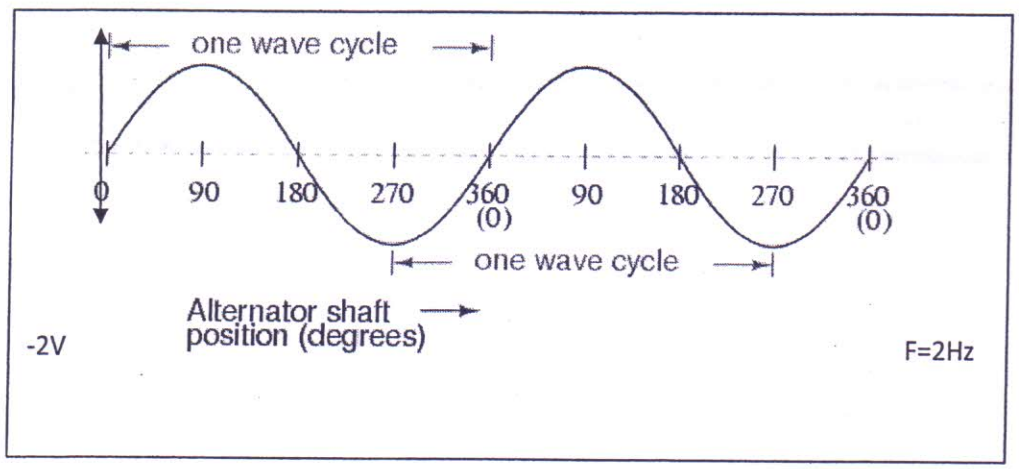
ii. Analog signal with Amplitude= 2v, Frequency= 2Hz in frequency domain.

iii. Digital signal two transmit 2-bit data.

Draw Signals by pencil with proper labels Each 1+1+1 M

Proper Assumption and units Each 1+1+1M

Ans: Ex. i)



.....2M

b) Solve fallowing with appropriate assumptions. [6 marks]

i. If a periodic signal is decomposed into five sine waves with frequencies of 100, 300, 500, 700, and 900 KHz, what is its bandwidth? Draw the

spectrum, assuming respective components have a amplitude of 10 V, 30V, 50V, 70V and 90V.

Ans- Calculate BW- 1M

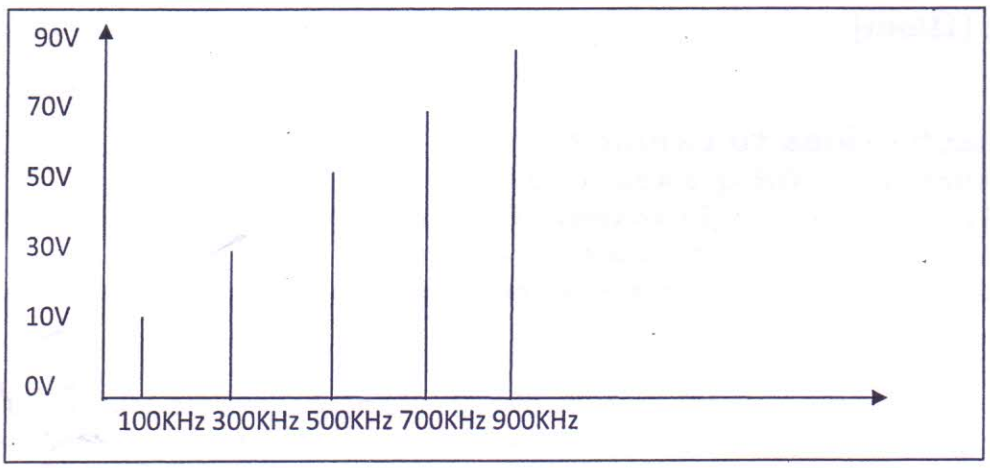
Let fh be the highest frequency, fl the lowest frequency, and B the bandwidth. Then

$$B = f_h - f_l = 900 - 100 = 800 \text{ Hz}$$

.....*1M*

Answer is 800KHz

Solution with diagram- 2M



.....2M

ii. A sine wave is offset 1/6 cycle with respect to time 0. What is its phase in degrees and radians? Draw the same signal.

Phase in degree+ formula- 1M

Phase in radians+ formula- 1M

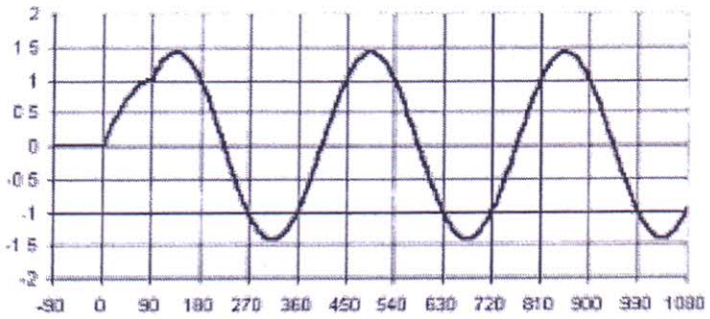
We know that 1 complete cycle is 360°. Therefore, 1/6 cycle is

$$\frac{1}{6} \times 360 = 60° = 60 \times \frac{2\pi}{360} \text{ rad} = \frac{\pi}{3} \text{ rad} = 1.046 \text{ rad}$$

....*2 M*

Draw signal- 1M

Fig 6 - Sine Waves in Fig 5 Added



.....1 M

c) Define Fallowing terms with example. [4 marks]

i. Jitter ii. Periodic Signal

iii. Composite Signal iv. Discrete signal

Definition- each 1/2M

Example each 1/2 M

Ans-

Jitter : Jitter is defined as a variation in the delay of received packets.

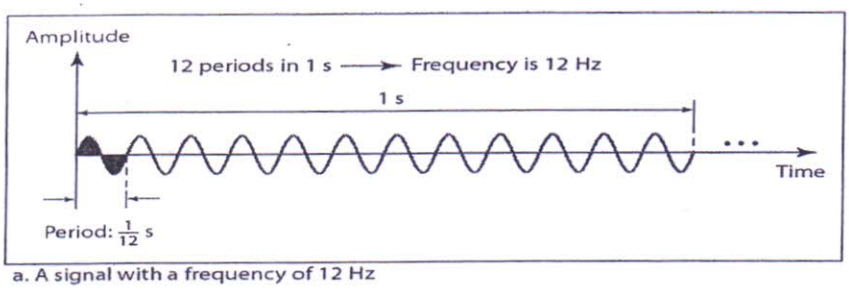
Ex. packet from sender side takes transmission duration d.

Assume Packet p1 sent at time t1 and received at t1+d+1sec.

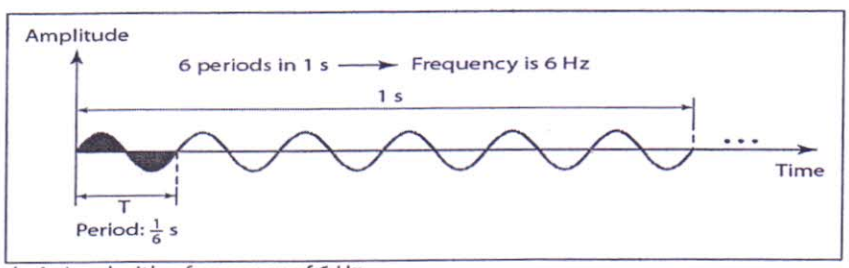
Packet p2 sent at time t2 and received at t2+d+3sec

This variation of p1 and p2 of 2 sec delay though they are transmitted using same channel

ii. Periodic Signal: A information signal where Pattern get repeated over a fixed interval of time.Ex..... 1/2 M



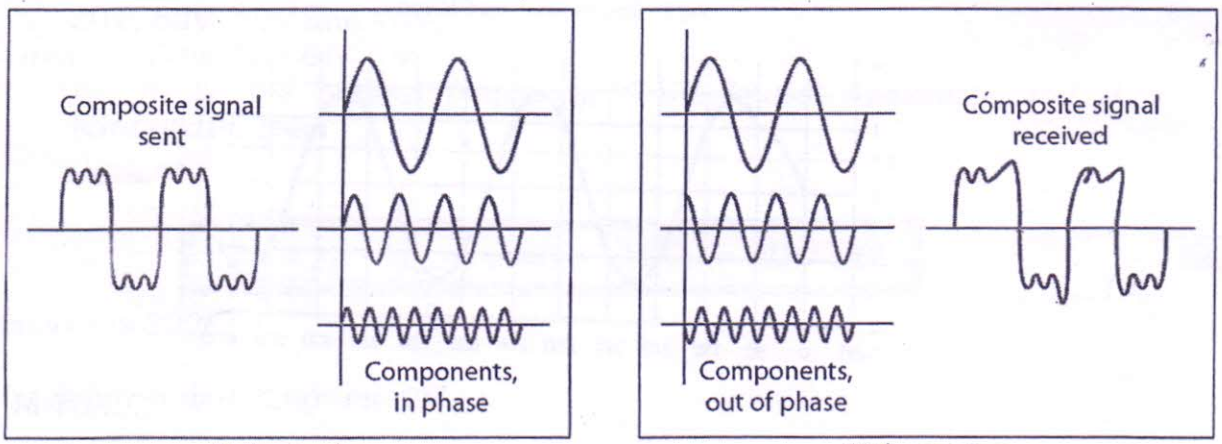
a. A signal with a frequency of 12 Hz



b. A signal with a frequency of 6 Hz ..... 1/2 M

iii. Composite Signal: a signal made of many simple sine waves.

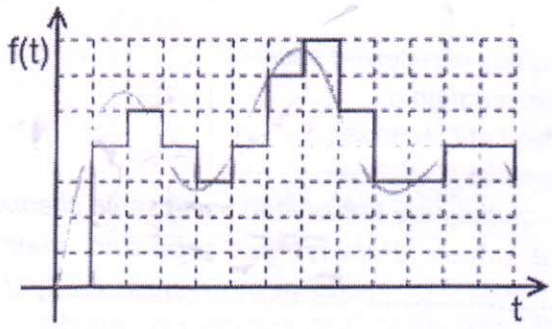
Ex.



.....*1M*

iv. Discrete signal: A signal that have finite number of points at any given time; maintains a constant level then changes to another constant level.

Ex.



..... 1M

OR

Q.2) a) List out and label the basic features of analog signal using sine wave signal representation (time domain) and describe the features in brief (Any three). [6 marks]

Sate the truth of the sentence and justify your answer "Amplitude can be calculated from given value of frequency"

Ans- Draw appropriate signal with minimum three labels- [or only diagram 1M] Define Identified features, explain in brief and mention their units each - 2+2+2 M

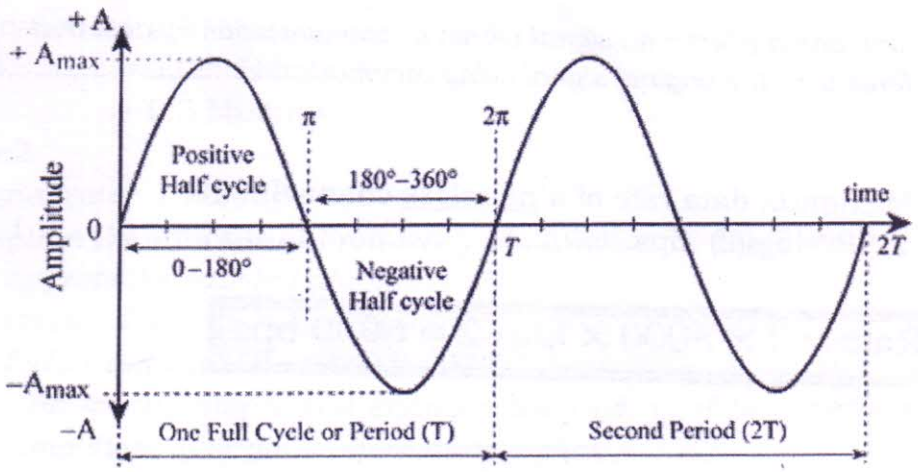


Figure 1 .....2.5M

Amplitude: peak voltage level attained by continuous analog signal at =+Ve or -Ve side of equilibrium is called as amplitude.
Measured in Volts.....1/2M
Frequency: the rate at which something occurs over a particular period of time or in a given sample.
Measured in Hz.....1/2M
Phase: phase is the position of a point in time (an instant) on a waveform cycle
Measured in degree or radian.....1/2M

Statement given is False.... 1M
Amplitude is not dependent on frequency.... 1 M

b) Explain how Transmission Impairment affects the original signal [6 marks]
Understanding of three Impairment and its effect on signal quality Each
List and def of impairment- 1M, Each Impairment-1+1+1 M
and calculate maximum bit rate, for a noiseless channel with
Bandwidth of 3000 Hz transmitting a signal with two signal levels.
Formula- 1Mark
Solution along with unit- 1M

Ans:

- *The imperfection causes signal impairment. This means that the signal at the beginning of the medium is not the same as the signal at the end of the medium.*
- *Three causes of impairment are attenuation, distortion, and noise.....1 M*
- *Attenuation: the reduction of the amplitude of a signal, electric current, or other oscillation.*

attenuation is a general term that refers to any reduction in the strength of a signal through amplitude.

- *Distortion: distortion refers to any kind of deformation of an output waveform compared to its input, usually clipping, harmonic distortion*
- *Noise: unwanted (and, in general, unknown) modifications that a signal may suffer during capture, storage, transmission, processing, or conversion.*

any unwanted (electrical) signal within a communication system that interferes with the original signal being communicated. 3M

- Maximum data rate of a noiseless channel = $2 * F * \log_2(L)$ bps.....1 *M*

$$\text{BitRate} = 2 \times 3000 \times \log_2 2 = 6000 \text{ bps}$$ .....1 *M*

c) How many signal levels required for fallowing noiseless channel? [4 marks]
A. We need to send 300 kbps over a bandwidth of 20 kHz.
B. We need to send 200 Mbps over a bandwidth of 30 kHz.
Each solution- 2+2M

Ans-

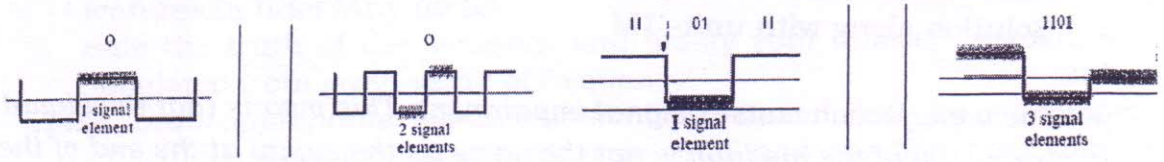
We can use the Nyquist formula as shown:.....1 M

$$265{,}000 = 2 \times 20{,}000 \times \log_2 L$$
$$\log_2 L = 6.625 \qquad L = 2^{6.625} = 98.7 \text{ levels}$$

Ans is 99..... 1 M

[Ideally, Since this result is not a power of 2, we need to either increase the number of levels or reduce the bit rate. If we have 128 levels, the bit rate is 280 kbps. If we have 64 levels, the bit rate is 240 kbps.]

Q.3) a) Explain what is Signal rate and Data rate. [6 marks]
Calculate the value of the signal rate for each case in Figure if the data rate is 1 Mbps and c is between 0 and 1.



Ans- Data rate- definition and Ex. 1M
Signal rate- definition and Ex. 1M
Solution for above cases each 1+1+11 M

Ex. case1 .
c= 1/2
Data rate= 1 Mbps
r= data element/signal element
=1/1=1

Signal rate= c*N*1/r

= 1/2* 1Mbps*1

= 0.5 Mbauds.

Case2

Signal rate= 1 Mbauds

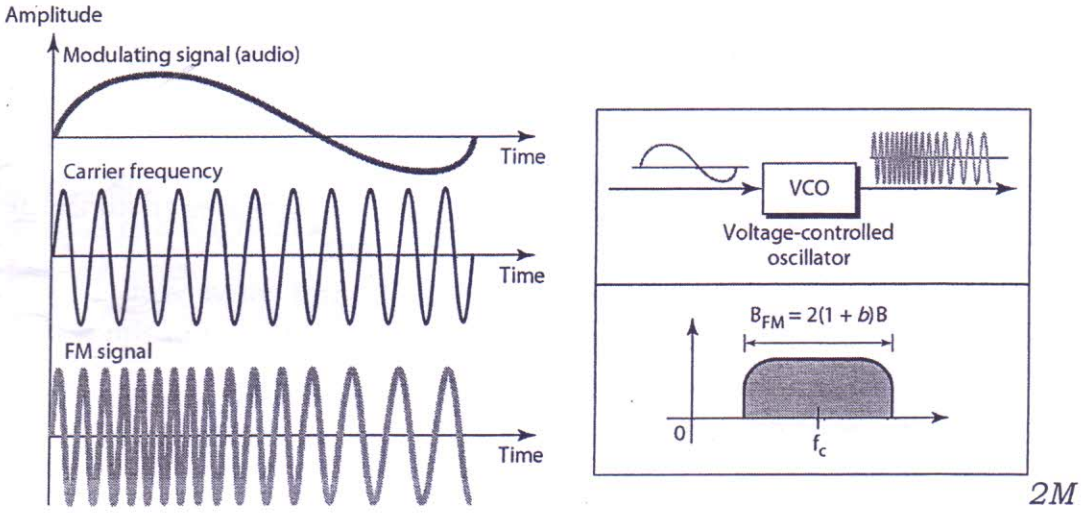
b) Explain the process of Frequency Modulation in detail with appropriate labeled diagrams. [4 marks]

Ans- appropriate labeled diagrams.2M

Process- 2 Marks.

labeled signals I/P and O/P- 2M

- *The modulating signal changes the freq. f_c of the carrier signal according to amplitude of original information signal.*
- *The bandwidth for FM is high*
- *It is approx. 10x the signal frequency*
- *Brief about components used like Information source, Carrier oscillator, modulator and Process of modulation 2M*



2M

c) List out all the types of Multiplexing. Discuss the best technique to share the channel among multiple digital information sources. Justify your answer. [4 marks]

Ans-List of all -1 M

Explain best technique for digital sources-2 M

Justification/Advantages-1M

List-

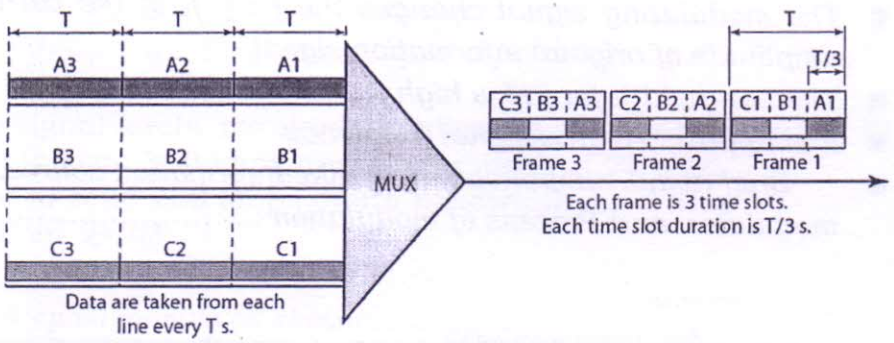
- *Frequency-Division Multiplexing*
- *Wavelength-Division Multiplexing*
- *Synchronous Time-Division Multiplexing*
- *Statistical Time-Division Multiplexing .....1 M*

Any one in detail...2M

Its advantages.....1

Ex. Synchronus TDM-

- *TDM is a digital multiplexing technique for combining several low-rate digital channels into one high-rate one..*
- *In synchronous TDM, the data rate of the link is n times faster, and the unit duration is n times shorter.*
- *The process of taking a group of bits from each input line for multiplexing is called interleaving, it is possible in TDM.*



.....2 M

- *So the output signal is better fort recovery of original as signal as synchronization is maintained*
- Also interleaving gives uniform priorities to all inputs .... 1 M

OR

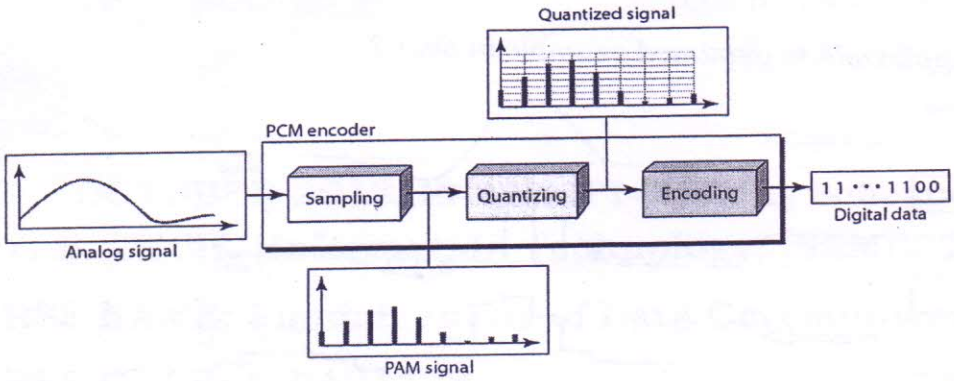
Q.4) a) Discuss the steps in Analog to Digital conversion in detail with appropriate example and explain the process to generate the binary codes as an output. [6 marks]

Ans-Sampling- 2M

Quantization- 2M

Code generation- 2M

- *PCM consists of three steps to digitize an analog signal:*
  1. *Sampling*
  2. *Quantization*
  3. *Binary encoding*
- *Before we sample, we have to filter the signal to limit the maximum frequency of the signal as it affects the sampling rate.*
- *Filtering should ensure that we do not distort the signal, ie remove high frequency components that affect the signal shape*



.....(only this 1.5M)

1. Sampling:
   - Analog signal is sampled every T_s secs.
   - T_s is referred to as the sampling interval.
   - $f_s = 1/T_s$ is called the sampling rate or sampling frequency.
   - There are 3 sampling methods:
   - Ideal - an impulse at each sampling instant
   - Natural - a pulse of short width with varying amplitude
   - Flattop - sample and hold, like natural but with single amplitude value
   - According to the Nyquist theorem, the sampling rate must be at least 2 times the highest frequency contained in the signal..... 1.5
2. Quantization
   - process of assigning the analog signal samples to a pre-determined discrete level.
   - Sampling results in a series of pulses of varying amplitude values ranging between two limits: a min and a max.
   - The amplitude values are infinite between the two limits.
   - We need to map the infinite amplitude values onto a finite set of known values.
   - This is achieved by dividing the distance between min and max into L zones, each of height Δ.

     $\Delta = (max - min)/L$..... 1.5
3. Binary encoding

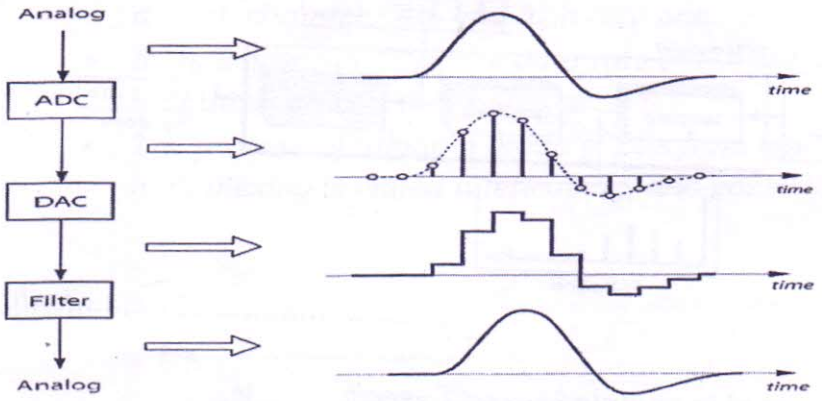
Three-Bit PCM Code

Sign	Magnitude		Decimal value	Quantization range
1	1	1	+3	+2.5 V to +3.5 V
1	1	0	+2	+1.5 V to +2.5 V
1	0	1	+1	+0.5 V to +1.5 V
1	0	0	+0	0 V to +0.5 V
0	0	0	−0	0 V to −0.5 V
0	0	1	−1	−0.5 V to −1.5 V
0	1	0	−2	−1.5 V to −2.5 V
0	1	1	−3	−2.5 V to −3.5 V

8 Sub ranges

..... 1.5M

Ex. Applicable to assumed example in step 3



.....*1.5 M*

b) In a digital transmission, the receiver clock is 0.1 percent faster than the sender clock. How many extra bits per second does the receiver receive if the data rate is 1 kbps? How many if the data rate is 1 Mbps? Discuss it's adverse effect. [4 marks]

Ans- Calculate no of extra bits each-1.5+1.5 M

Adverse effect -1 M

At 1 kbps, the receiver receives 1001 bps instead of 1000 bps.

1000 bits sent	1001 bits received	1 extra bps

.1.5

At 1 Mbps, the receiver receives 1,001,000 bps instead of 1,000,000 bps.

1,000,000 bits sent	1,001,000 bits received	1000 extra bps

...1.5

Adverse effect: loss of data packets is possible..... 1 M

c) Four 1-kbps connections are multiplexed together. A unit is 1 bit. Find (a) the duration of 1 bit before multiplexing, (b) the transmission rate of the link, (c) the duration of a time slot and (d) the duration of a frame. [4 marks]

Ans. Formula/logic for each- 1/2M

Final answaer for each- 1/2M

a. The duration of 1 bit before multiplexing is 1 / 1 kbps, or 0.001 s (1 ms).

b. The rate of the link is 4 times the rate of a connection, or 4 kbps.

c. The duration of each time slot is one-fourth of the duration of each bit before multiplexing, or 1/4 ms or 250 μs. Note that we can also calculate this from the data rate of the link, 4 kbps. The bit duration is the inverse of the data rate, or 1/4 kbps or 250 μs.

d. The duration of a frame is always the same as the duration of a unit before multiplexing, or 1 ms. We can also calculate this in another way. Each frame in this case has four time slots. So the duration of a frame is 4 times 250 μs, or 1 ms.