Department: CSE

Program: B.Sc. in CSE

Course No: CSE3211

Course Title: Data communication

Examination: Semester Final

Semester(session): Fall2020

Student No: 18.01.04.072

Signature and Date: Rakib, 9 November, 2021

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Ans to the que. No: 2

(a)

Yes, we can say if a signal is periodic or non-periodic by looking at its frequency domain plot.

A periodic signal completes a pattern within a measurable time frame, called a period and repeats that pattern over subsequent identical periods. The completion of one full pattern is called a cycle.

on the other hand, a non-periodic signal changes without exhibiting a pattern or cycle that repeats over time.

If a signal will be periodic then its frequency will be discrete else in case of a non-periodic its continuous. So for frequency domain plot, there will be a discrete value for a periodic signal. Thus, we can differentiate between periodic and non-periodic signal by looking at the discrete value on the frequency domain plot.

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(b)

We use the Nyquist theorem for noiseless channel. For a noiseless channel, the Nyquist bit rate formula defines the theoretical maximum bit rate,

$$\text{Bit Rate} = 2 \times \text{bandwidth} \times \log_2 L$$

Here, bandwidth is the bandwidth of the channel.
L is the number of signal levels used to represent data.
Bit Rate is the bit rate in bits per second.

On the other hand, we use the Shanon capacity for noisy channel. For a noisy channel, the Shanon capacity defines the theoretical highest data rate,

$$\text{capacity} = \text{bandwidth} \times \log_2 (1 + SNR)$$

Here, bandwidth is the bandwidth of the channel.
SNR is the signal to noise ratio.
capacity is the capacity of the channel in bits per second

Both Nyquist theorem and Shanon capacity are used to calculate the data rate. But they differ based on the noiseless or noisy property of a channel.

Given, the peak voltage value of a signal is 20 times the peak voltage value of the noise.

We know that,

$$SNR = \frac{\text{signal power}}{\text{noise power}}$$

However, power is proportional to the square of voltage. That means,

$$SNR = \frac{(\text{signal voltage})^2}{(\text{noise voltage})^2}$$

$$\Rightarrow SNR = \left(\frac{\text{signal voltage}}{\text{noise voltage}}\right)^2$$

$$\Rightarrow SNR = (20)^2$$

$$\therefore SNR = 400$$

Again we know that,

$$SNR_{dB} = 10 \log_{10} SNR$$

$$= 10 \log_{10} (400)$$

$$= 26.021$$

So, the value of signal to noise ratio (SNR) is 400 and the value of SNR_{dB} is 26.021.

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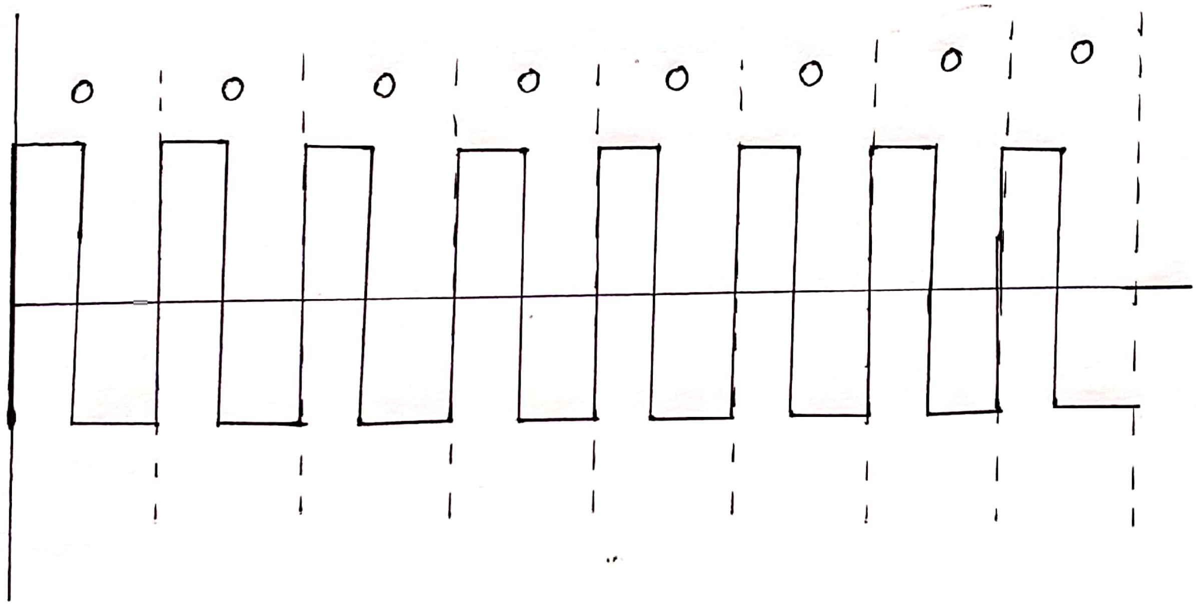
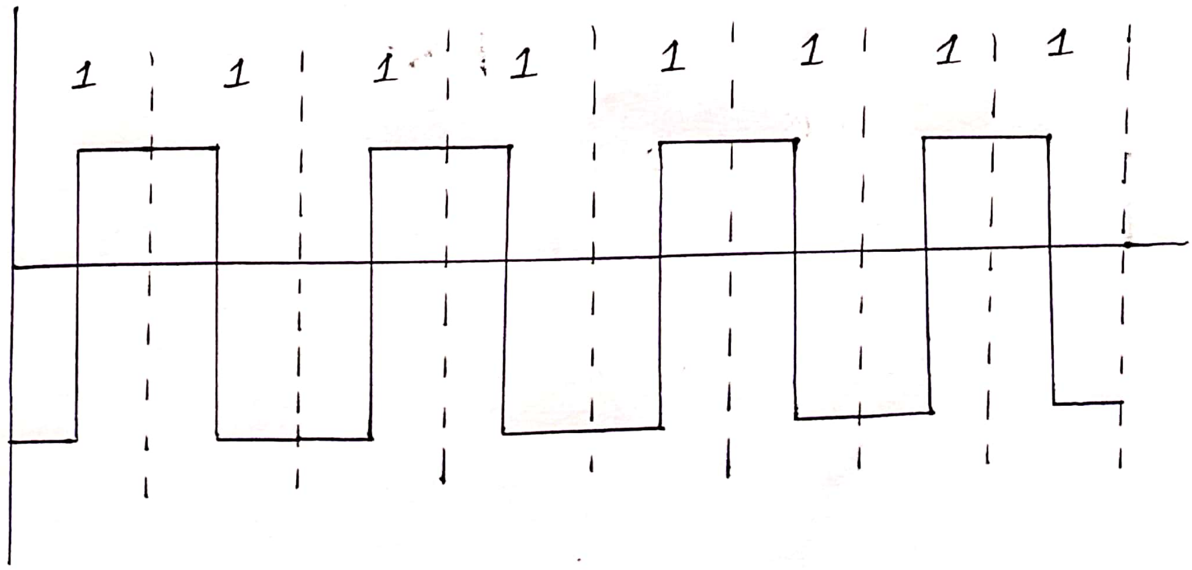
(c)

Assuming that the last signal level has been negative. Following are the graph of the Differential Manchester scheme using each of the given data streams:

i) 0 0 0 0 0 0 0 0



ii) 1 1 1 1 1 1 1 1



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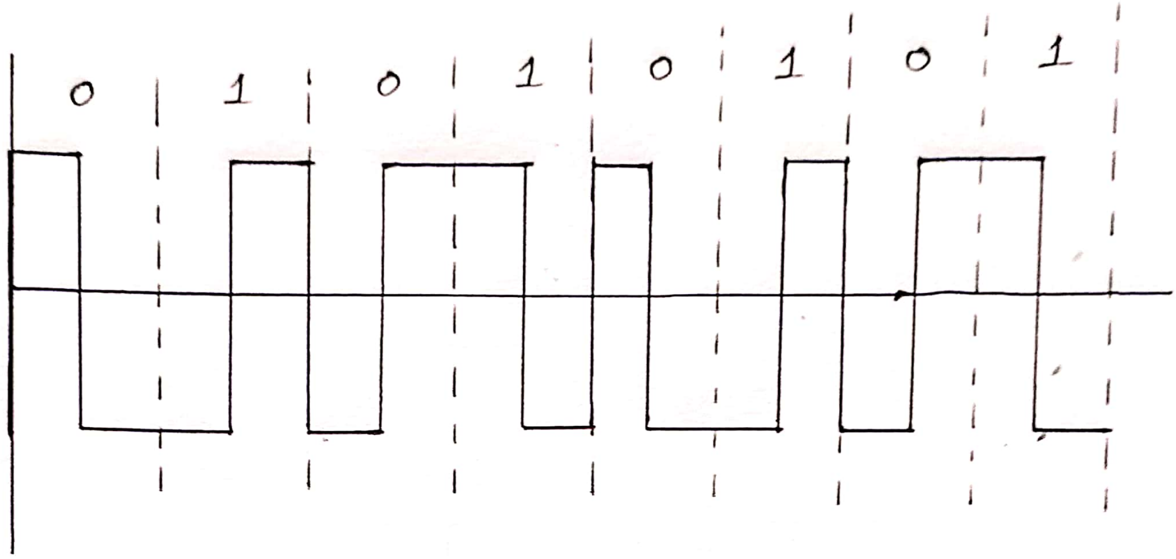
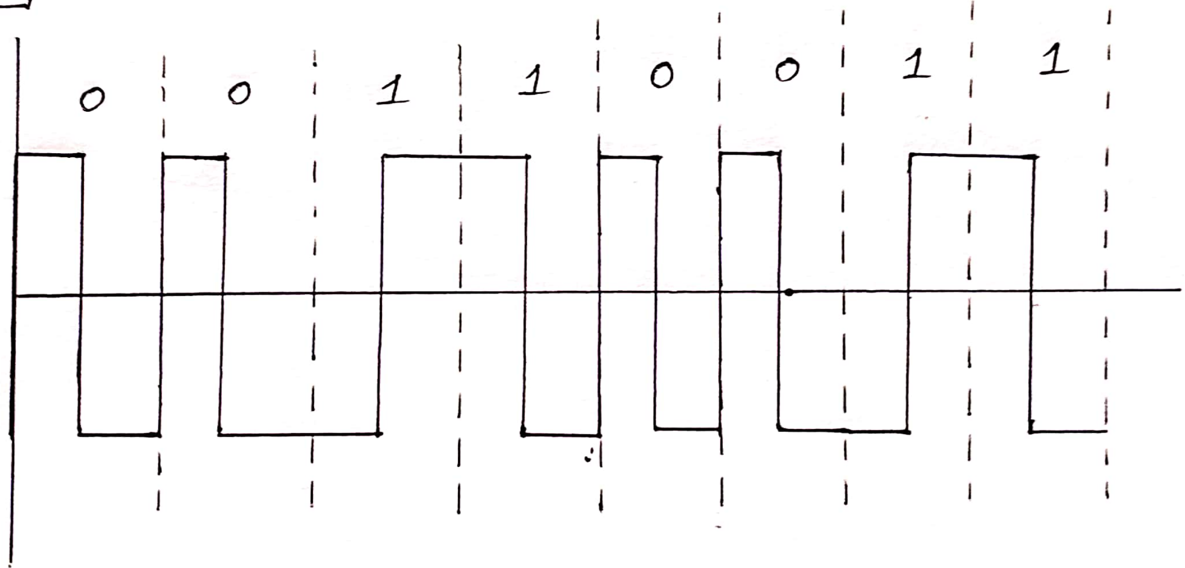
iii) 0 1 0 1 0 1 0 1



iv) 0 0 1 1 0 0 1 1



Ans. to the que. No: 6

(a)

Given,

channel Bandwidth = 4 KHz

Guard Band = 500 Hz

= 0.5 KHz

For multiplexing 10 voice channels with guard bands using FDM, we will require 9 guard bands.

∴ Required Bandwidth = $(4 \times 10 + 0.5 \times 9)$ KHz

= 44.50 KHz

So, we will ~~be able to send~~ need 44.50 KHz bandwidth for multiplexing 10 voice channels with guard bands using FDM.

(b)

My student ID is 180104072. The 3rd last digit is 0, which is an even number.

So $\$ = 0$.

i) Dataword 0 1 0 0

a_3	a_2	a_1	a_0
0	1	0	0

So, $r_0 = a_2 + a_1 + a_0 = 1+0+0 = 1$

$r_1 = a_3 + a_2 + a_1 = 0+1+0 = 1$

$r_2 = a_1 + a_0 + a_3 = 0+0+0 = 0$

$\therefore$ Codeword = 0 1 0 0 0 1 1

Corrupted codeword = 1 1 0 0 0 1 1

b_3	b_2	b_1	b_0	q_2	q_1	q_0
1	1	0	0	0	1	1

Now, Syndrome,

$S_0 = b_2 + b_1 + b_0 + q_0$
$= 1+0+0+1 = 0$

$S_1 = b_3 + b_2 + b_1 + q_1$
$= 1+1+0+1 = 1$

$S_2 = b_1 + b_0 + b_3 + q_2$
$= 0+0+1+0 = 1$

$\therefore$ Syndrome = 1 1 0 ; error detected

As syndrome is 110, there is an error in b_3. We have detected the error easily as there is only one bit error.

II] Dataword 0111

a_3	a_2	a_1	a_0
0	1	1	1

$\therefore r_0 = a_2 + a_1 + a_0$
$= 1+1+1 = 1$

$r_1 = a_3 + a_2 + a_1$
$= 0+1+1 = 0$

$r_2 = a_1 + a_0 + a_3$
$= 1+1+0 = 0$

$\therefore$ codeword $= 0111001$

$\therefore$ corrupted codeword $= 0011001$

b_3	b_2	b_1	b_0	q_2	q_1	q_0
0	0	1	1	0	0	1

Now, Syndrome,

$$S_0 = b_2 + b_1 + b_0 + q_0$$
$$= 0+1+1+1$$
$$= 1$$
$$S_1 = b_3 + b_2 + b_1 + q_1$$
$$= 0+0+1+0 = 1$$
$$S_2 = b_1 + b_0 + b_3 + q_2$$
$$= 1+1+0+0 = 0$$

$\therefore$ Syndrome $= 011$; Error detected

As syndrome is 011, there is an error in b_2. We have detected the error easily as there is only one-bit error.

iii) Dataword 0000 ;(As $f = 0$)

a_3	a_2	a_1	a_0
0	0	0	0

$$r_0 = a_2 + a_1 + a_0 = 0+0+0 = 0$$
$$r_1 = a_3 + a_2 + a_1 = 0+0+0 = 0$$
$$r_2 = a_1 + a_0 + a_3 = 0+0+0 = 0$$

$\therefore$ Codeword = 0000000

$\therefore$ Corrupted codeword = 0000001

b_3	b_2	b_1	b_0	q_2	q_1	q_0
0	0	0	0	0	0	1

Now, Syndrome,

$S_0 = b_2 + b_1 + b_0 + q_0$
$= 0+0+0+1 = 1$

$S_1 = b_3 + b_2 + b_1 + q_1$
$= 0+0+0+0 = 0$

$S_2 = b_1 + b_0 + b_3 + q_2$
$= 0+0+0+0 = 0$

$\therefore$ Syndrome = 001 ; error detected

As syndrome is 001, there is an error in q_0. We have detected this error easily as there is only one-bit error.

iv) Dataword 0110 ; (As $\$ = 0$)

a_3	a_2	a_1	a_0
0	1	1	0

$r_0 = a_2 + a_1 + a_0$
$= 1+1+0 = 0$

$r_1 = a_3 + a_2 + a_1$
$= 0+1+1 = 0$

$r_2 = a_1 + a_0 + a_3$
$= 1+0+0 = 1$

$\therefore$ Codeword $= 0110100$

$\therefore$ corrupted codeword $= 0110001$

b_3	b_2	b_1	b_0	q_2	q_1	q_0
0	1	1	0	0	0	1

Now, syndrome,

$$s_0 = b_2 + b_1 + b_0 + q_0$$
$$= 1 + 1 + 0 + 1 = 1$$
$$s_1 = b_3 + b_2 + b_1 + q_1$$
$$= 0 + 1 + 1 + 0 = 0$$
$$s_2 = b_1 + b_0 + b_3 + q_2$$
$$= 1 + 0 + 0 + 0 = 1$$

$\therefore$ Syndrome $= 101$; error detected

As the syndrome is 101, there is an error in b_0. But we see, the codeword has been corrupted by 2 bits. we have detected error only in one bit, but we could not find error in another bit.

So, we can say that the Hamming code for $C(7,4)$ can detect one-bit error but not necessarily two-bit errors by testing the code in the given cases.

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Ans. to the ques. No.-5

(a)

Error correction has 2 main methods. Such as:

1) Forward Error correction
2) Error correction by Retransmission.

Forward Error correction is the process in which the receiver tries to guess the message by using redundant bits. This error correction is possible only if the number of error bit is small.

On the contrary, Error correction by Retransmission is a method in which the receiver detects the occurrence of error and asks the sender to resend the message. Here, resending is repeated until a message arrives that the receiver got the error-free message. But in this technique some errors might not be detected i.e., remain undetected.

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(b)

checksum is an error detection method which is used in the Internet by several protocols although not at the data link layer. It is based on the concept of redundancy. Several protocols still use the checksum for error detection.

For example, if we take three 4-bit numbers which we want to send to a destination, we have to send the sum of these numbers with the main numbers. If we want to send (9, 5, 4), then we have to send (9, 5, 4, 18) where 18 is the sum. The receiver adds those three numbers again and compares the result with the sum. If two sum matches, receiver assumes there is no error. otherwise there is an error and the data is not accepted.

This procedure has a major drawback as the numbers and the sum bit may vary in size. To resolve this drawback, one's complement arithmetic is used.

If two number in the sent sequence exchange their positions, the sum will remain same. The receiver will accept the date as there is no error, i.e., the error sum matched. In this case, the error is undetected by the checksum.

If the value of one word is incremented and the value of another word is decremented by the same amount, the two errors can't be detected because the sum and checksum remain the same.

If the values of several words are incremented but the total change is a multiple of 65535, the sum and the checksum does not change, which means the errors are not detected.

We can eliminate the 2nd problem by using weighted checksum, in which each word is multiplied by a number (its weight) that is related to its position in the text.

(c)

If the number of 1's is even, the parity bit is 0, otherwise 1. We can calculate parity bit by the following formula:

$$r_0 = a_6 + a_5 + a_4 + a_3 + a_2 + a_1 + a_0$$

i) 1001011

$\therefore$ Parity bit, $r_0 = 1+0+0+1+0+1+1$
$= 0$

As the number of 1's is even, the parity bit is 0.

ii) 0001100

$\therefore$ Parity bit, $r_0 = 0+0+0+1+1+0+0$
$= 0$

As the number of 1's is even, the parity bit is 0.

iii) 1000000

$\therefore$ parity bit, $r_0 = 1+0+0+0+0+0+0$
$= 1$

As the number of 1's is odd, the parity bit is 1.

iv) 1110111

∴ Parity bit, r_0 = 1+1+1+0+1+1+1
= 0

As the number of 1's is even, the parity bit is 0.

Ans. to the que. No: 4

(a)

Following are the differences between synchronous TDM and statistical TDM:

Synchronous TDM	Statistical TDM
i) Data flow of each input connection is divided into units and each input control one output time slot.	i) The slots are allotted dynamically. Input line is given. slots in output frame only if it has data to send.
ii) Number of slots in each frame are equal to number of input lines.	ii) Number of slots in each frame are less than the number of input lines.
iii) uses synchronization bits at the begining of each frame.	iii) Don't use synchronization bits.

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Synchronous TDM	Statistical TDM
iv) No need of addressing, slots carry data only.	iv) Slots contain both data and address of destination.
v) Maximum bandwidth utilization is done when all inputs have data to send.	v) volume of link is normally less than the sum of the volume of each channel.

(b)

To maximize the efficiency of infrastructure, telephone companies have traditionally multiplexed analog signals from lower bandwidth lines into higher bandwidth lines. In this way, many switched or leased lines can be combined into fewer but bigger channels. For analog lines FDM is used.

For the given figure 1:

Group level overhead = $48kHz - (12 \times 4) kHz$
$= 0$

So, no guard bands between the channels is required,

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Subgroup level overhead $= 240\,kHz - (5\times48)\,kHz$
$= 0$

No guard band is necessary between the groups.

master group overhead $= 2520\,kHz - (10\times240)\,kHz$
$= 120\,kHz$

$\therefore$ 120 kHz of guard band is necessary between the subgroups to get the necessary bandwidth of 2.52 MHz.

$\therefore$ Jumbo group overhead $= 16.984\,MHz - (6\times2.52)\,MHz$
$= 1.864\,MHz$.

$\therefore$ 1.864 MHz of guard band is required between the master groups to get the necessary bandwidth of 16.984 MHz

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(c)

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$\therefore$ No of sources = 10 [as 2 is even]

Here, 6 sources has a bit rate at = 200 kbps.
and (10-6) = 4 sources has a bitrate
at = 400 kbps.

As it is a multiple slot TDM multiplexing.
then the 400 kbps sources will be splitted
into 200 kbps sources.

$\therefore$ Total number of sources = 6 + (4 × 2)
= 14 of 200 kbps

I) The size of frame = 14 bits

II) The frame rate = 200,000 frames/second

III) The frame duration = $\frac{1}{\text{frame rate}}$

$= \frac{1}{2,00,000}$

$= 5 \times 10^{-6}$ s.

= 5 μs.

IV) data rate = frame rate × size of frame
= 200,000 × 14
= 2800000 bps