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Ans. to the Ques. No. 5

(a) forward error correction is the process in which the receiver tries to guess the message by using redundant bits. This is possible if the number of errors is small.

Whereas, Error Correction by retransmission is a technique in which the receiver detects the occurrence of an error and asks the sender to resend the message. Resending is repeated until a message arrives that the receiver believes is error-free.

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(b) The traditional Checksum uses a small number of bits (16) to detect errors in a message of any size.

There are at least 3 types of errors which are undetectable by the Checksum error detection method:

* If the data items/bits are swapped during transmission then the sum and the Checksum values will be the same and thus the error cannot be detected.

* If one or more data items/bits are changed. ~~then~~ in such a way that the change is a multiple of 216-1, The sum or the checksum cannot detect any changes.

⊗ If the value of one data item is increased and the value of another one is decreased the same amount, then the sum and the checksum cannot detect these changes.

Replacing the checksum with a CRC may increase error detection rate.

(c) The parity bit for each of the following data units will be :

(i) 1001011

There are 4 number of occurrences of '1'. Since 4 is an even number, thus to maintain an even parity, The parity bit must be set to 0.

Result : 10010110

(ii) 0001100

There are 2 number of occurrences of '1'. 2 is also an even number, So, the parity bit must be 0.

Result : 00011000

(iii) 1000000

There is only a single occurrence of '1'. Since 1 is an odd number, the parity bit must be 1 in order to maintain an even parity.

Result : 10000001.

(iv) 1110111

There are 6 number of occurrences of '1'. 6 is an even number which means the parity bit should be 0.

Result : 1110111$\underline{0}$

Ans. to the Quest No. 4

(a) Differences between the Synchronous TDM and Statistical TDM is given below:

Synchronous TDM	Statistical TDM
(1) The number of slots in each frame is equal to number of input lines.	(1) Number of slots in each frame are less than the number of input lines.
(2) Data flow of each input connection is divided into units and each input controls one output time slot.	(2) The slots are alloted dynamically. Input line is given but the slots goes to output frame only if it has any data to send.

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(3) Addressing is not needed, slots carry data only.	(3) Slots contain both data and address of the destination.
(4) Uses synchronization bits at the beginning of each frame.	(4) No use of synchronization bits.
(5) No buffering occurs, frames are ~~sed~~ sent after a specific interval of time whether it has any data to send or not.	(5) Buffering is done and only ~~these~~ the inputs are given in output frame which has a buffer containing any data to send.
(6) When all inputs have data to send, the maximum utilization is done.	(6) Sum of the volumes of each channels is greater than the link vol.

(b) To maximize the efficiency of infrastructure, telephone companies have traditionally multispreaded 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.

One of such hierarchical system is made up of groups, super-groups, mastergroups and jumbo group.

Groups contain 48 kHz of ~~bandw~~ bandwidth and supports 12 voice channels.

Super-groups contain 240 kHz of

bandwidth and supports up to 60 voice channels.

Master-group has 2.40 MHz of ~~badn~~ bandwidth and supports up to 600 voice channels.

Jumbo-groups has 15.12 MHz of bandwidth and supports 3600 voice channels.

~~For the~~ From the given figure-1:

Overhead (Guard bands) of Group level:

$= 48\ KHz - (12 \times 4) KHz$

$= 0\ Hz$

So, there is no guard bands between the channel.

Overhead of Super-group level:

$= 240\ KHz - (5 \times 48\ KHz)$

$= 0\ Hz.$

Therefore, no guard band between these channels.

Overhead of Master-group:

$$= 2520 KHz - (10 \times 240 KHz)$$

$$= 120 KHz$$

$\therefore$ 120 KHz of guard band is found between the ~~ ~~ groups in master-group.

Overhead of Jumbo-group:

$$= 16.984 \ MHz - (6 \times 2.52 MHz)$$

$$= 1.864 \ MHz$$

so, 1.864 MHz is found between the channels of the Jumbo-group.

We can observe from the figure-1 that, there are guardbands ~~in~~ between channels in Master-group level and Jumbo-group level. Since, in each group level, number of voice channels ~~is~~ gets increased. and in Master-group and Jumbo-group, voice channels gets massively increase. These ~~chan~~ massive number of voice channels has a risk of getting interfered among themselves. This is why guard bands are applied to thoes group levels. Basically guard band is a narrow frequency range that seperates two ranges of wider frequency. This ensures that simultaneously used voice communication ~~can~~ channels do not experience interference, which would result in decreased quality for both transmissions. This is why the master-group has 120 KHz of guard band and the jumbo-group has 1.864 MHz of guard band between channels.

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'9' is odd.

∴ No. of Sources = 20.

Here, 6 sources has a bit rate of 200 kbps and (20-6) or 14 sources has a bit rate of 400 kbps.

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

∴ Total Number of sources

$= 6 + (14 \times 2)$ of 200 kbps

$= 34$ of 200 kbps.

(i) The size of the frame = 34 bits.

(ii) The frame rate = 200 000 frames per second.

(iii) The frame duration

$$= \frac{1}{\text{frame rate}}$$

$$= \frac{1}{200000}$$

$$= 5 \times 10^{-6} \text{ seconds}$$

(iv) The data rate

$$= \text{frame rate} \times \text{size of frame}$$

$$= 200000 \times 34$$

$$= 6800000 \text{ bps}$$

$$= 6.8 \text{ Mbps.}$$

Ans. to the Ques. No. 6

(a) Given that,

10 voice channels each occupying bandwidths of 4KHz ~~is~~ needed to multiplexed with guard bands of 500 Hz using FDM.

So, the required bandwidth

$= (10 \times 4\,KHz) + (500\,Hz \times 9)$

$= 40\,KHz + 4.5\,KHz$ [9 guard bands ~~betw~~ between 10 channels]

$= 44.5\,KHz.$

(Ans).

(b) Student-ID : 180104129

~~Q is odd~~ Third last digit is "1" (odd)

(i) Dataword : 0100
$a_1\ a_2\ a_3\ a_4$

We know, for $C(7,4)$ there will be $(7-4)$ or 3 redundant bits.

$r_0 = a_2 + a_1 + a_0$

$r_1 = a_3 + a_2 + a_1$

$r_2 = a_1 + a_0 + a_3$

a_3	a_2	a_1	a_0	r_2	r_1	r_0

$\therefore r_0 = 1$, ~~r_2~~ $r_1 = 1$, $r_2 = 0$.

$\therefore$ Codeword = 0100011
$b_3\ b_2\ b_1\ b_0\ q_2\ q_1\ q_0$

Checking syndrome

$s_0 = b_2 + b_1 + b_0 + q_0$

$s_1 = b_3 + b_2 + b_1 + q_1$

$S_2 = b_1 + b_0 + b_3 + q_2$

as, E V V V V V V. So b_3 has error.

b_3

So, if we flip it, we will get,

~~1 1 0 0 1 1~~ $\boxed{1}$ 1 0 0 0 1 1 [Corrupted Codeword]

~~$b_3\ b_2\ b_1\ b_0$~~ $b_3\ b_2\ b_1\ b_0\ q_2\ q_1\ q_0$

Here, $S_0 = 0$, $S_1 = 1$, $S_2 = 1$ } 1 1 0 ($S_2\ S_1\ S_0$) ∴ Syndrome = 110.

from the syndrome table,

Syndrome $S_2\ S_1\ S_0$	Error
0 0 0	No error
0 0 1	q_0
0 1 0	q_1
0 1 1	b_2
1 0 0	q_2
1 0 1	b_0
1 1 0	b_3 ✓
1 1 1	b_1

So, for 110, the error is in b_3.

So, it can detect 1 bit error.

(ii) Dataword: 0 1 1 1
a_3 a_2 a_1 a_0

$\therefore r_0 = 1, r_1 = 0, r_2 = 0.$

$\therefore$ Codeword = 0 1 1 1 0 0 1
b_3 b_2 b_1 b_0 q_2 q_1 q_0

Now, V E V V V V V
b_2

Here, error is in b_2, so we flip b_2 $(1 \to 0)$ we get.

Corrupted Codeword = 0 0 1 1 0 0 1.
b_3 b_2 b_1 b_0 q_2 q_1 q_0

Now, $s_0 = 1$
$s_1 = 1$
$s_2 = 0$

0 1 1
s_2 s_1 s_0

$\therefore$ Syndrome = ~~0~~011

from the syndrome table, we know if syndrome is 011 then error is in b_2 so it can detect 1 bit error.

(iii) Dataword = 0 1 1 0
a_3 a_2 a_1 a_0

$\therefore$ $r_0 = 0$, $r_1 = 0$, $r_2 = 1$

$\therefore$ Codeword = 0110 001

for, V V V V V V $\frac{E}{q_0}$

$\therefore$ Corrupted codeword

= 0110 000
b_3 b_2 b_1 b_0 q_2 q_1 q_0

Now,

$$\left.\begin{array}{l} s_0 = 1 \\ s_1 = 0 \\ s_2 = 0 \end{array}\right\} \text{Syndrome} = 001.$$

if syndrome is 001 then error in q_0. So it successfully detected 1 bit error.

(iv) Dataword = 1 1 1 1
$a_3\ a_2\ a_1\ a_0$

$\therefore r_0 = 1,\ r_1 = 1,\ r_2 = 1$

$\therefore$ Codeword = 1 1 1 1 1 1 1
$b_3\ b_2\ b_1\ b_0\ q_2\ q_1\ q_0$

for, V V V V E V E
$\overline{q_2}\quad \overline{q_0}$

$\therefore$ Corrupted Codeword
= 1 1 1 1 0 1 0
$b_3\ b_2\ b_1\ b_0\ q_2\ q_1\ q_0$

Now, $\left.\begin{array}{l} s_0 = 1 \\ s_1 = 0 \\ s_2 = 1 \end{array}\right\}$ Syndrome = 101
$s_2\ s_1\ s_0$

from synchrome table, if syndrome is 101 then error is in b_0 but here we have errors in $q_2 - q_0$. So, it could not detect 2 bit error.

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Ans. to the Ques. No. 3

(a)

(b) Bit rate is the inverse of bit duration.

(i) ~~Bit~~ Bit duration = 0.001 s

$\therefore$ Bit rate = $\frac{1}{0.001}$ = 1000 bps

= 1 kbps

(ii) ~~Bit~~ Bit duration = 2 ms

= 0.002 s

$\therefore$ Bit rate = $\frac{1}{0.002}$ = 500 bps

(iii) Bit duration = $\frac{20\ \mu s}{10}$

= $1\ \mu s$

= 10^{-6} s

$\therefore$ Bit rate = $\frac{1}{10^{-6}}$ = 10^{6} bps

= 1 Mbps

(c)

(i)
Send voice signal from microphone to recorder : Baseband is a single channel digital system that is used to communicate with devices on a network. In this scenario, it is ~~b~~ using baseband transmission. Baseband uses the entire bandwidth for a single signal transmission. It ~~Ro~~ is suitable for short distance transmission. Since baseband sends a digital signal over ~~a~~ channel without ~~covering~~ converting ~~a~~ it to analog.

it can be transfer ~~that~~ ~~that~~ data directly from microphone to recorder.

(ii) Send a digital signal from one station ~~to a~~ on A LAN to another station: This is an example of baseband transmission. Since it is used in a LAN, so this scenario is a baseband transmission.

(iii) Modulate several voice signals and send them through the air: Broadband transmission uses analog signalling that travels through a long distance. Simultaneous transmission of multiple signal is possible on broadband. So, several voice signals can be given different frequency range to transmit simultaneously on the air.

(a) In AM transmissions, the carrier signal is modulated in amplitude. In FM, frequency of the carrier signal is modulated. In PM, phase is modulated.

FM / PM are the most susceptible to noise.