Computer Networks

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Ans 1. Original message polynomial is x^7+x^5+1 which is encoded as 10100001.

Generator poly. is x^3+1 which is encoded as 1001.

Performing binary division,

```
1001 ) 10100001000 [ 10110111 (thrown away)
       1001
       ~~0110~~
       ~~0000~~
        1100
        1001
        1010
        1001
        ~~0111~~
         0000
         1110
         1001
         1110
         1001
         1111  <- remainder (CRC)
```

Thus, remainder polynomial is x^2+x+1.

Ans 2. A: 01000111

B: 11100011

Flag: 01111110

ESC: 11100000

Frame: A B ESC Flag

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Date.....

Byte Count:

00000101 01000111 11100011 11100000 01111110

Flag Bytes:

Flag Header A B Esc Esc Esc Flag Trailer Flag

01111110 Header 01000111111100011111000001110000110000001111110 Trailer 01111110

Starting and Ending Flag Byte:

Flag Header A B Esc Flag Trailer Flag

01111110 Header 01000111 11010011 11110000 00011111010 Trailer 01111110

Ans 3. Given A B Esc C Esc Flag Flag D

Output after stuffing:

A B Esc Esc C Esc Esc Esc Flag Esc Flag D

Ans 4. Maximum overhead in a byte-stuffing algorithm is 2n, where n is the number of bytes in the payload. If all the data in the transmitted frame is either ESC byte sequence or Flag-byte sequence then for each byte the algorithm would add an ESC byte sequence.

Spiral

Date.....

Ans 5. No, in this method, start and end of frame are recognized with the help of flag bytes. Each frame starts with and ends with a flag byte. Two consecutive flag bytes indicate the end of one frame and start of the next one.

If there is a long interval between the 1st frame and 2nd frame receiver won't be able to determine if the first frame has finished or not.

Ans 6.

Given string: 01111011111 01111110

Separating whenever we encounter 5 consicutive ones.
Data set after bit stuffing : 011110111110011111010

Ans 7. Given generator polynomial is x^3+1 which is encoded as 1001.

```
1001 ) 100 11101 000 ( 1000110
       1001
       ------
        0001
        0000
        ------
         0011
         0000
         ------
          0110
          0000
          ------
           1101
           1001
           ------
            1000
            1001
            ------
             0010
             0000
             ------
              0100
              0000
              ------
               100
```

Spiral CRC

Date.....

Transmitted codeword, therefore : 1001110111000 - 100
= 10011101100

The third bit from left is inverted and the frame received as 10111101100. Hence, by dividing this by polynomial generator, we get a reminder 100 which shows that an error has occurred. We should receive reminder zero, if the frame received is error free.

Ans 8. The message is of 16 bits i.e. $m=16$.
For the requirement of Hamming code,

$$(m+r+1) \leq 2^r$$

$$\therefore \quad 16+r+1 \leq 2^r$$

$$\Rightarrow \quad r = 5 \quad \left[\begin{array}{l} \text{as } 22 \leq 32 \\ \text{But } 21 \geq 16 \end{array}\right]$$

Substituting $m=16$ & $r=5$,
total number of bits in this codeword $n = m+r = 16+5 = 21$
As there are 5 check bits, these must be at the following positions,

$P_1 = 2^0 = 1$
$P_2 = 2^1 = 2$
$P_3 = 2^2 = 4$
$P_4 = 2^3 = 8$
$P_5 = 2^4 = 16$

All the other bit positions are occupied by original message bits.
The codeword is like :

P_1	P_2	1	P_3	1	0	1	P_4	0	0	1	1	0	0	1	P_5	1	0	1	1	0	1

The message bit positions can be expressed in terms of power of 2 as follows :

Spiral

Date.....

3 = 1+2
5 = 1+4
6 = 2+4
7 = 1+2+4
9 = 1+8
10 = 2+8
11 = 1+2+8
12 = 4+8
13 = 1+8+4
14 = 2+4+8
15 = 1+2+4+8
17 = 1+16
18 = 2+16
19 = 1+2+16
20 = ~~1+2+16~~ 4+16
21 = 4+16+1

Now, we have to compute check bits.

P_1 = 1, 3, 5, 9, 11, 13, 15, 17, 19, 26 ⇒ 0 1 1 1 0 1 0 1 1 1 1 ∴ $P_1 = 0$
P_2 = 2, 3, 6, 7, 10, 11, 14, 15, 18, 19 ⇒ 1 1 0 1 0 1 0 1 0 1 ∴ $P_2 = 1$
P_3 = 4, 5, 6, 7, 12, 13, 14, 15, 20, 21 ⇒ 1 1 0 1 1 0 0 1 0 1 ∴ $P_3 = 1$
P_4 = 8, 9, 10, 11, 12, 13, 14, 15 ⇒ 1 0 0 1 1 0 0 1 ∴ $P_4 = 1$
P_5 = 16, 17, 18, 19, 20, 21 ⇒ 1 1 0 1 0 1

The final bit pattern : 0 1 1 1 1 0 1 1 0 0 1 1 0 0 1 1 1 0 1 0 1

Ans 9: 12 bit Hamming Code whose hexadecimal value is
0 x E4F is (1)(1)(1)0 0 1 (0) 0 1 1 1 1
P_1 P_2 P_3 P_4

P_1 = 1, 3, 5, 7, 9, 11 = 1 1 0 0 ∴ $P_1 = 1$ (correct)
P_2 = 2, 3, 6, 7, 10, 11 = 1 1 1 0 1 1 ∴ $P_2 = 0$ (But $P_2 = 1$)
P_3 = 4, 5, 6, 7, 12 = 0 0 1 0 1 ∴ $P_3 = 0$ (correct)
P_4 = 8, 9, 10, 11, 12 = 0 1 1 1 1 ∴ $P_4 = 0$ (correct)

Therefore, P_2 is flipped due to error, on correction, the corrected bit stream is,
1 0 1 0 0 1 0 0 1 1 1 1

Ans 10. Message : 1 0 0 1 1 1 0 0 1 0 1 0 0 0 1 1

Date.....

Adding the 4 word yields : 1001
1100
1010
0011
10010

Wrap : 0010
10
0100

1's complement ⇒ 1011 ← check sum

Now, adding the data & checksum,

10010 1101
1011 ⇒ 10
10110 1111

1's complement → 0000
(negation)

It means that the checksum value is correct.
Value of checksum : 1011

Ans 11. Given, 1mps satellite link connects 2 ground station.
Distance = 36,504 km
speed = 3×10^8 m/s
QB = 127
channel utilization = 25%
Ack size ≈0.

Tp : Time to reach satellite = $\frac{36504000}{300000000}$ = 0.12168 s

2 × Tp : Total time taken = 2 × 0.12168 = 0.24336 sec

Spiral

Date.....

Now, η = Actual window size / Max. window size $(1+2a)$

$$\eta = \frac{127}{1+2a}$$

now,

$$a = TP / T_T$$

$$a = 243360 / T_T$$

T_T = Packet Size / Bandwith

$$T_T = \frac{\text{Packet size}}{10^6 \text{ bits/sec}}$$

Packet Size = $T_T \times 10^6$ bits sec

let $T_T = x$ u/sec

$\therefore$ Packet size = $x \times 10^{-6}$ sec $\times 10^6$ bits/sec

$\therefore$ Packet size = x bits

$$\eta = \frac{127}{1+2a}$$

$$0.25 = \frac{127}{1 + 2 \times \frac{243360}{x}}$$

$$x = 960 \text{ bits}$$

$\therefore$ $x = 120$ Bytes

Ans 12. size = 50 bytes

Bandwith = 10 mbps

Header size = 100 byte

No. of packets = 5

Packet Size = 500 + 100 = 600 bytes

Spiral

Date.....

Transmission Delay = $\frac{600}{10 \times 10^6}$ = 600×10^{-7}

= 60×10^{-6}

= 60 μsec

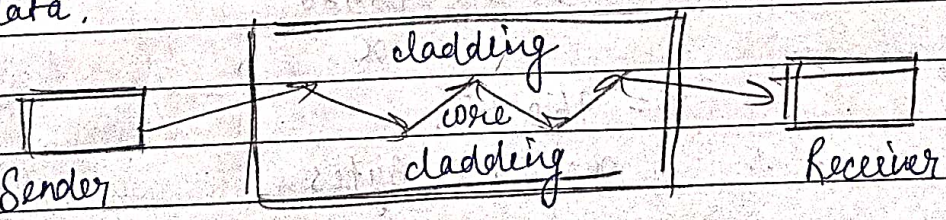
= 0.06 ms

∴ Total time = 0.06 ms × 5

= 0.3 ms.

Ans 13. Ask technique is not suitable for high bit rate data transmission and has poor Bandwith efficiency. Hence, it is highly suspectible to noise and other external factors as compared to (Ask, Fsk, Psk, QAm) other analog modulation techniques.

Ans 16. The purpose of cladding is to avoid the cross talk during transmission. The outer layer of optical fiber is called cladding. Crosstalk is a signal interference occurs because of unwanted noise signal occurs doing communication. The function of cladding is to provide a lower refractive index at the core interface in order to cause reflections within the core ~~add~~ and to prevent any refraction while passing data.



Ans 17. Given,

Signal Power = 200 milliwatt = $\frac{200}{1000}$ = 0.2 watt

No. of devices = 10

Avg. noise = 2 microwatt

= 2×10-6 watt

Spiral

Date.....

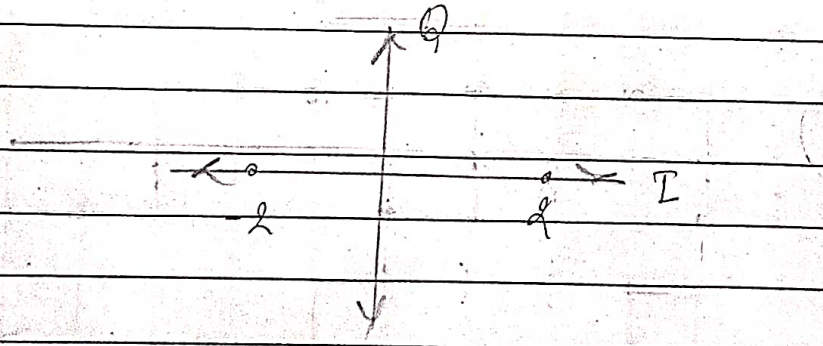
SNR = Avg. signal power / Avg. noise power = 0.2 / 2×10^{-5} = 10000

SNR dB = 10 log 10 (SNR)

So, in this case 10 log 10 (104) = 40.

Ans 18. Sky propagation is when higher frequency radio waves radiate upward into the ionosphere where they are then reflected back to earth. This allows for greater distances with lower output powers. Line of sight propagation is when very high frequency signals are transmitted in straight lines directly from antenna to antenna, not affected by the curvature of earth.

Ans 19. We have two signal elements with the same peak amplitude of 2. However, there must be 180 degree difference between the two phases. We assume one phase to be 0 and the other 180 degrees.



Ans 20 1. The duration of 1-bit before multiplexing is 1/1 kbps or 0.001s (ms).

2. The rate of the link is 4 times the rate of a connection.

Date.....

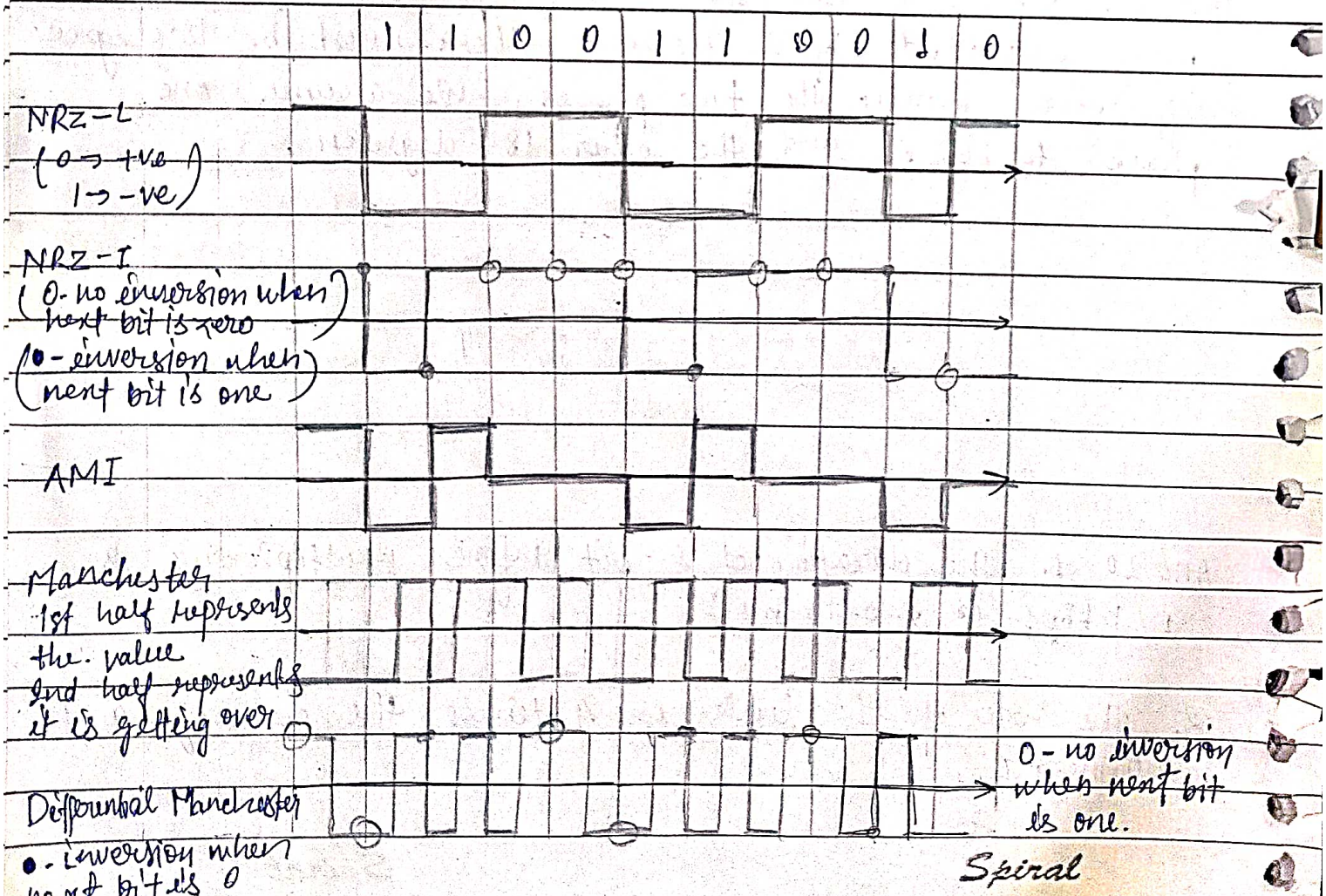
3. The duration of each time slot is one-fourth of the duration of each bit before multiplexing or 1ms or 250 μs, also the bit duration is inverse of the data rate or $\frac{1}{4}$ kbps or 250 μs.

4. The duration of a frame is always the same as the duration of a unit before multiplexing.

Ans 21.

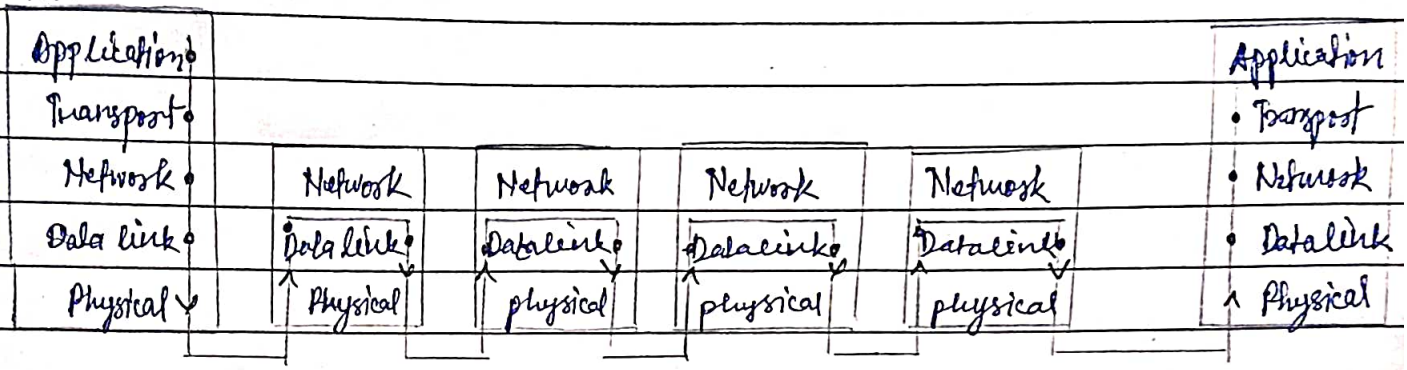
The most susceptible technique is AM because the amplitude is more affected by noise than the phase or frequency.

Ans 22. Bit stream : 1100110010



Date.....

Ans 23.



At intermediate routers, the packet will not go beyond the network layer. Hence network layer will be visited only once but the data link and physical layer will be visited twice. Hence, network layer will be visited only once but data link and physical layer will be 6 times and the data link layer and physical layer will be visited 10 times (1 + 2(R1) + 2(R2) + 2(R3) + 2(R4) + 1 = 10).

Spiral