Soham - 180771

1 Saathi

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1) 1. Network Access layer is a logical interface to actual network hardware. It is concerned with the delivery of packets across one single link. It involves transmission of data over the link to which the device is attached. [Flow Control, Error Control, Might have reliability control]

~~Transfer~~ Transport layer deals with end-to-end data transmission. Contrary to network access layer, it involves the delivery of packets from one end point, via multiple hops to another endpoint.

TL might provide reliable delivery, error control & flow control. (host-to-host layer) ↳ {TCP is reliable, UDP is non reliable}

2. $s(t) = 4\sin(2\pi t) + 2\sin(6\pi t) + \frac{8}{\pi}\sin(7\pi t)$

$f = 1\,Hz$ $\quad f = 3\,Hz$ $\quad f = \frac{7}{2}\,Hz$

[comparing with $A\sin(2\pi f t)$]

$f_{min} = 1\,Hz,\ f_{max} = 3.5\,Hz \rightarrow \text{Bandwidth} = 2.5\,Hz$ ($f_{max} - f_{min}$)

3. $P_t = 20\,mW,\ P_r = 5\,mW$

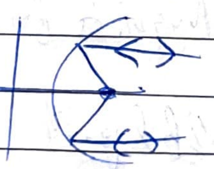
$G_{dB} = 10\log_{10}\frac{P_r}{P_t} = 10\log_{10}\frac{5}{20} = -10\log_{10}4 = -6.02\,dB$ ($P_r \to P_{out}$, $P_t \to P_{in}$)

$\therefore$ Loss in dB $= -G_{dB} = +6.02\,dB$

4. Advantages of parabolic reflective Antenna are:—

→ High Gain: Antenna gain in case of parabolic reflective antenna is very high.

→ High directivity: Parabola property. [Parabola is locus of points equidistant from a point and a line]



Rays parallel to axis converge at focus.

→ Smaller size and low cost → Can be used both as a transmitting and receiving antenna. [Principle of reciprocity]

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5. According to Nyquist Sampling Theorem, the sampling rate must be atleast twice the highest frequency contained in the signal.

$$\boxed{\text{Sampling Rate} \geq 2f_{max}}$$

In case the sampling rate is lower, the receiver will get a distorted signal, which it will not be able to reconstruct well.
This sampling theorem comes in handy during Analog to Digital Encoding.

Sampling above the nyquist rate creates a good approximation of the input signal.

Section-2

$f_{min} = 3MHz$, $f_{max} = 4 MHz$ ∴ Bandwidth = 1 MHz
$SNR_{dB} = 24 dB$.

(Noisy Env) Shannon → $C = B\log_2(1+SNR)$

$10\log_{10}\left(\frac{S}{N}\right) = 24$ $\quad = 10^6 \log_2(1+10^{2.4})$

$\Rightarrow \frac{S}{N} = 10^{2.4}$ $\quad = 10^6 \log_2(252.188)$

$C = 7.978 \times 10^6$ bps (bits/second)

Here C is the maximum capacity of the channel

(Noise free) From Nyquist's formula;

$C = 2B\log_2 M \Rightarrow \log_2 M = \frac{C}{2B} = \frac{7.978 \times 10^6}{2 \times 10^6}$

∴ $M = 2^{3.989} = 15.878 \simeq 16$ levels

Since no. of levels is an integer, we have rounded it up.

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Section-3

a) $P_t/P_r = \frac{(4\pi d)^2}{\lambda^2}$ Also, $\lambda = \frac{c}{f}$

$\therefore \frac{P_t}{P_r} = \frac{(4\pi d f)^2}{c^2}$ Given $f = 4 \times 10^{9}$ Hz
$d = 35863$ km $= 35863000$ m

Taking $c = 3 \times 10^8$ m/sec,

$\frac{P_t}{P_r} = \underline{3.61 \times 10^{19}}$ ≡ Isotropic free space loss @ 4GHz.
$= \underline{195.575 \text{ dB}}$ $\left[P_t/P_r|_{dB} = 10\log_{10}(P_t/P_r) \right]$

b) $\frac{P_t}{P_r} = \frac{1}{G_t G_r}\left(\frac{4\pi f d}{c}\right)^2$ ⇒ Here, given $G_t = 44$ dB
$G_r = 48$ dB

Non isotropic Antenna

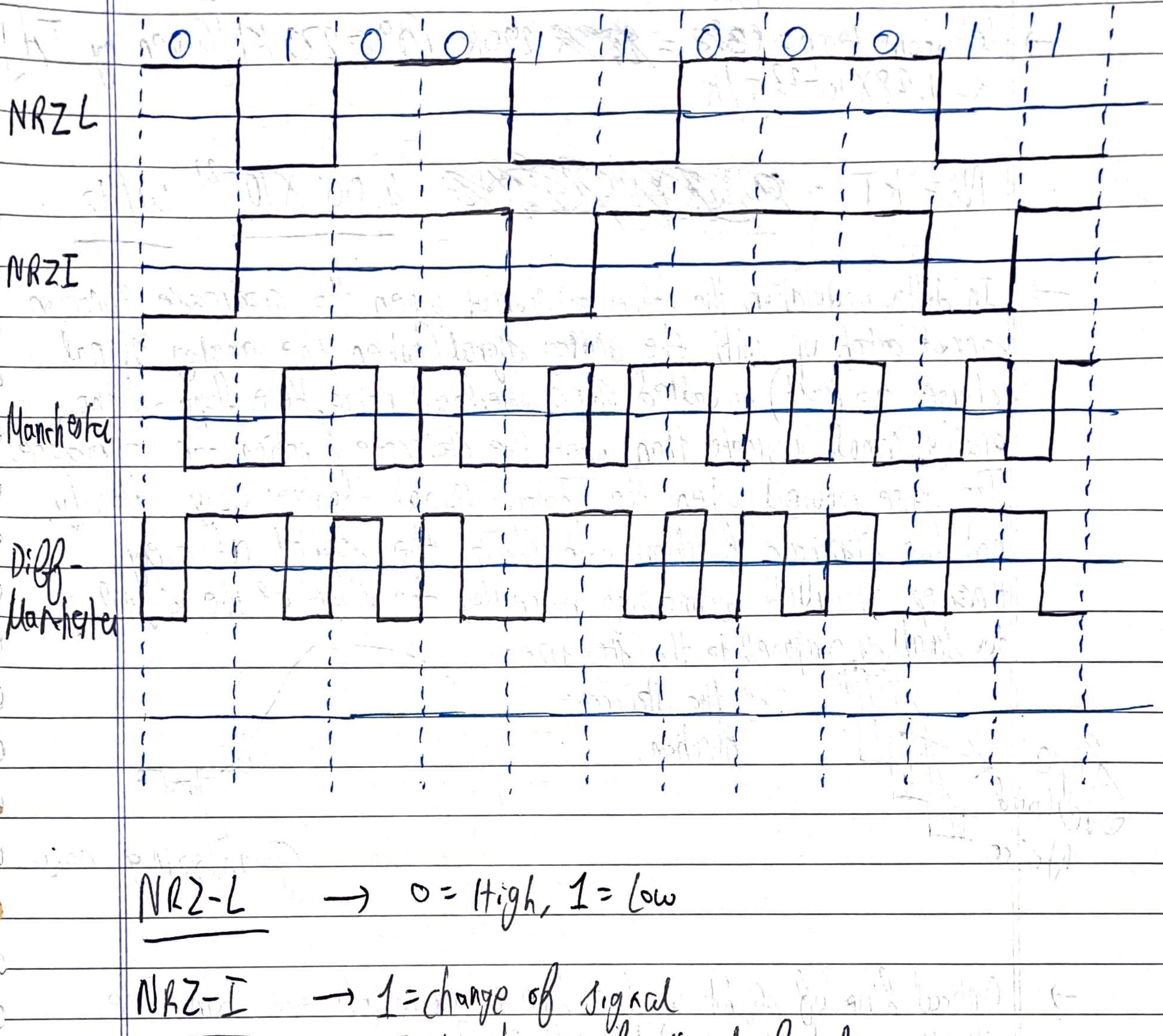
⇒ $10\log_{10} G_t = 44$ ⇒ $G_t = 10^{4.4} = 25118.864$
$10\log_{10} G_r = 48$ ⇒ $G_r = 10^{4.8} = 63095.73445$

⇒ $\frac{P_t}{P_r} = \underline{2.278 \times 10^{10}} = \underline{103.575 \text{ dB}}$ $\left[\frac{P_t}{P_r}\Big|_{dB} = 10\log_{10}\left(\frac{P_t}{P_r}\right) \right]$

c) $P_t = 250$W. $P_r = \frac{P_t}{2.278 \times 10^{10}} = \underline{1.097 \times 10^{-8} \text{ W}}$

Power received at the satellite antenna is 1.097×10^{-8} W

SECTION-4



NRZ-L → 0 = High, 1 = Low

NRZ-I → 1 = change of signal
0 = No change of signal level

Manchester → 0 = high to low transition
1 = low to high transition

Diff Manchester → 0 = transition @ beginning of bit period
1 = No transition @ beginning of bit period

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5) ⑤ ~~⑥~~ Saathi

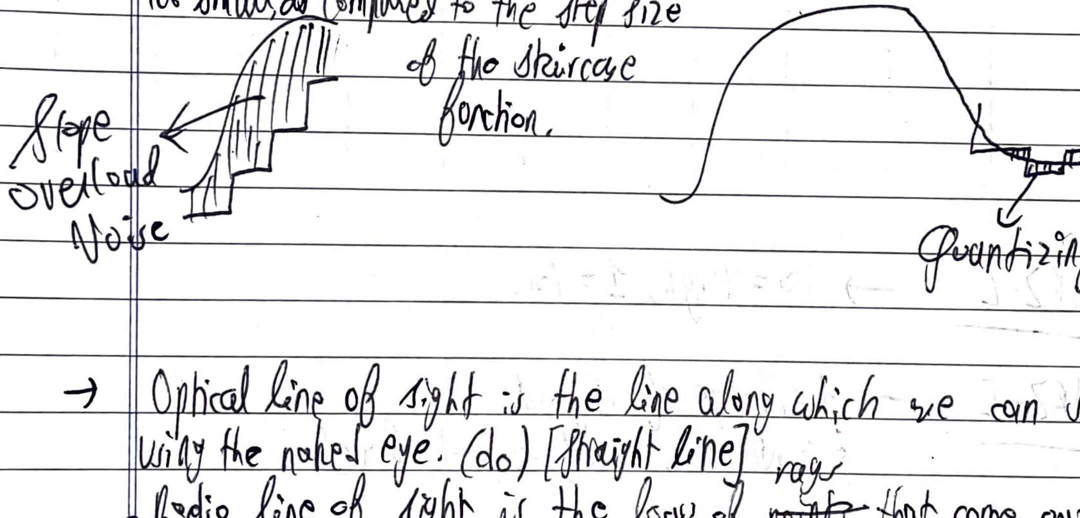
Section 5

→ Let room temp = 17°C = 290K (0°C = 273 K) [Given by TA]

$K = 1.38 \times 10^{-23}$ J/K

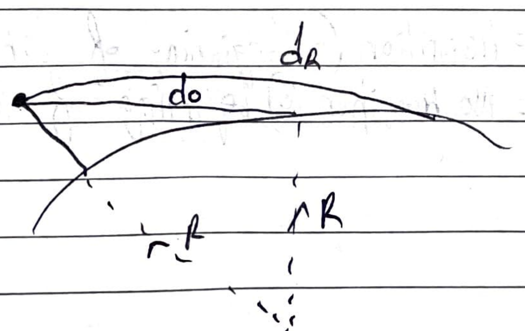
$N_0 = KT = 4.002 \times 10^{-21}$ W/Hz

→ In delta modulation, the noise incurred when the staircase function cannot catch up with the analog signal (when the analog signal change too fast) is called slope overload noise. Here, slope of the analog signal is greater than what the staircase function can reproduce. The noise incurred when the analog signal changes very slowly, and the staircase function overshoots the signal at every timestep is called quantizing noise. Here, the slope of the signal is too small, as compared to the step size of the staircase function.



→ Optical line of sight is the line along which we can see using the naked eye. (do) [straight line]

Radio line of sight is the locus of ~~points~~ rays that come out from an antenna and are tangential to the surface of the earth. (dR) [bends according to the curvature of the earth.]



$\boxed{d_o < d_R}$

d_o = Optical horizon

d_R = Radio horizon

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~~In optical LOS, waves will~~

Optical LOS can only send and receive data packets iff the transmission and receiver antenna are in direct view of each other without any obstacle in between.

→ Radio waves of frequency more than 30 MHz, requires LOS propagation

Radio LOS bends according to the curvature of earth. This fact can be attributed to gravity.