Solution by NTR

# CSE 320– Data Communications

**QUIZ 2 (set A)**
**Spring Semester – 2024**
[CO2]

**Grade**

**Full Name (in Block Letter):** _____

**ID:** _____ **Section:** _____ **Signature:** _____

**Marks: 15 points** **Time: 35 minutes**

**Question 1: (2+2points):** Consider a communication channel that requires to send 10MB. The link operates on signals with frequency range from 900 KHz to 14 MHz. If the link is perfect, i.e., no noise is introduced in the link,

a) • **Determine** the number of voltage levels needed to fulfill the requirement.

b) • In practical, there is no noise free channel. Suppose, the strength of the noise power is 20mW which is 60 times weaker than the signal power. **What** will be the channel capacity considering the noise?

**Answer:**

Here, Bitrate = 10MB
$= 10 \times 10^6 \times 8$

Bandwidth = $(14\,MHz - 900kHz)$
$= (14 \times 10^6) - (900 \times 10^3)$
$= 13100000$

SNR = 60.

a) Bitrate $= 2 \times B \times \log_2 L$

$\therefore \log_2 L = \frac{10 \times 10^6 \times 8}{2 \times 13100000}$

$\Rightarrow \log_2 L = 3.0534$

$\therefore L = 2^{3.0534} \simeq 2^4 \simeq 2^3$

$\therefore L = 8$ or 16 (Ans.)

b) Capacity $= B \times \log_2(1 + SNR)$
$= 13100000 \times \log_2 61$
$= 77692659.12$ bps
$= 77.69$ Mbps
$\simeq 78$ Mbps (Answer).

**Bandwidth**

(1) It is the maximum amount of data flow in a channel.

(2) We can get bandwidth by:

$B = f_h - f_l$.

**Throughput**

(1) It is the actual amount of data that flows in an unit of time.

(2) Throughput can be calculated as: Throughput = $\frac{\text{avg frame} \times \text{bit}}{\text{time in second}}$

**Question 2: (2+2 points): What** the difference between bandwidth and throughput.
An aperiodic composite signal has a bandwidth of 300 kHz, with a middle frequency of 210 kHz and peak amplitude of 25 V. The two extreme frequencies have an amplitude of zero. **Draw** the frequency domain of the signal.

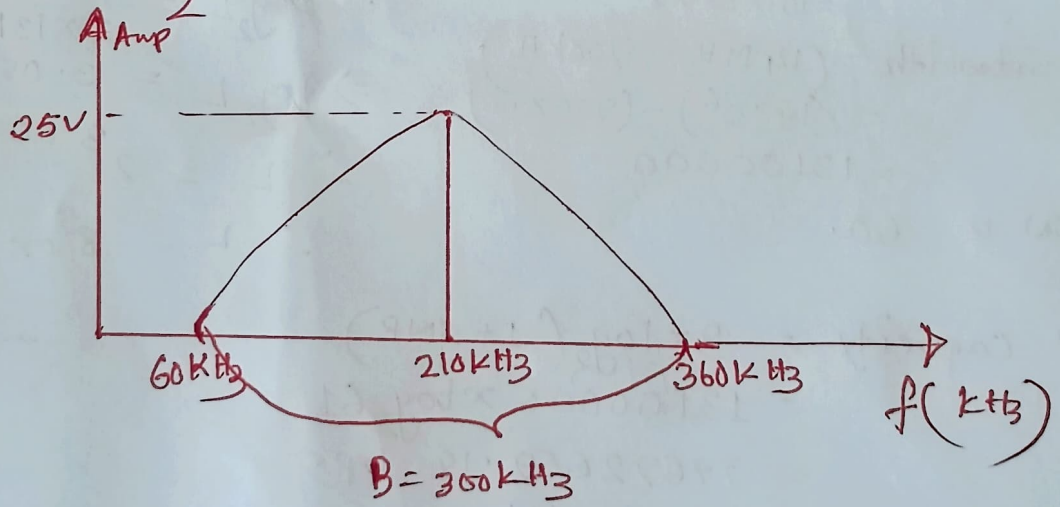
**Answer:**

$B = 300\ KHz$

$M.f. = 210\ kHz$

$H.f = 210 + \frac{300}{2} = 360\ kHz$

$L.f = 210 - \frac{300}{2} = 60\ KHz$



**Question 3: (3+2+2 points):**

a. Distinguish between periodic and non-periodic analog signals with respect to their time and frequency domain.
b. A signal travels from one point A to another point B. The signal power is 200watt at point A and 170watt at point B. What is the attenuation in decibels?
c. A signal with 300 mill watts power passes through 5 devices, each with an average noise of 2 microwatts. What is the SNR? What is the $SNR_{dB}$?

**Answer:**

b) $dB = 10\log_{10}\frac{P2}{P1}$

$\Rightarrow dB = 10\log_{10}\frac{170}{200}$

$= 10\log_{10} 0.85$

$= -0.705810\ dB.\ (Ans)$

c) $SNR = \frac{S.P}{N.P} = \frac{300\,mW}{5 \times 2\,\mu W}$

$= \frac{300 \times 10^{-3}}{5 \times 2 \times 10^{-6}}$

$= 30000\ Ans$

and $SNR_{dB} = 10\log_{10} 30000$

$= 44.7712\ Ans.$

a) A signal is said to be periodic signal if it has a definite pattern and repeats itself at a regular interval of time. In frequency domain shows a single spike.

* Where as the signal which does not at the regular interval of time is known as an uperiodic signal. In frequency domain shows continious signal within a range.

# Solution of Assignment 2,

1. $SNR = \frac{S.P}{N.P} = \frac{30 \times 10^{-3}}{3 \times 10^{-3}} W = 10$

Bandwidth = (220 − 204) MHz

= 16 MHz

= $16 \times 10^6$ bps.

a) Capacity = $B \times \log_2(1 + SNR)$

= $16 \times 10^6 \times \log_2(1 + 10)$

= 55350905.9 bps

= 55.35 Mbps

≃ 56 Mbps

b) $\frac{1}{2} \times$ Datarate = $2 \times B \times \log_2 L$

$\Rightarrow \log_2 L = \frac{\text{Datarate} \times 2}{2 \times B \times 2}$

$= \frac{56 \times 10^6}{16 \times 10^6} = \frac{56 \times 10^6}{4 \times 16 \times 10^6} = \frac{56}{64} = 0.875$

$\Rightarrow \log_2 L = 0.875$

$\Rightarrow L = 2^{0.875} \simeq 2^{\frac{4}{2}} = 1.82$ Levels. Answer.

c) Here, Bandwidth = 10 MHz = $10 \times 10^6$ Hz.

$\therefore \log_2 L = \frac{\text{Datarate}}{2 \times B} = \frac{56 \times 10^6}{2 \times 10 \times 10^6} = 2.8$

$\therefore L \simeq 2^3 = 8$ Levels.

If we maintain the same data rate is this case the signal level will be change to 8. (Ans.)

d) Adv: Decrese the complexity of implementation

Disad: for using minimum signal level or reduce signal level we could fail to send maximum data element.

Q.2 Answer: Propagation time = $\frac{\text{Distance}}{\text{Propagation speed}}$

$= \frac{48000 \times 10^3}{2 \times 10^8}$

$= 0.024$ second

Transmission time = $\frac{\text{Frame size}}{\text{Bandwidth}}$

$= \frac{5 \times 10^6}{18 \times 10^9}$

$= 2.778 \times 10^{-4}$ s.

total queueing time = $5\mu s + 2ps + 3ns + 5ps + 4ps + 3ps + 3ns$

$= 5 \times 10^{-6} + (6 \times 10^{-9}) + (14 \times 10^{-12})$

$= 5.006 \times 10^{-6}$ second

total processing time = $2ps + 3ps + 3ns + 2\mu s + 4ps + 6\mu s + 5\mu s$

$= 13\mu s + 3ns + 9ps$

$= 1.3003 \times 10^{-5}$ second

∴ Total delay (Latency) = $0.024 + (2.778 \times 10^{-4}) + (5.006 \times 10^{-6}) + (1.3003 \times 10^{-5})$

$= 0.024296$ s

$= 24.296$ ms (Ans.)

Solution of 6

At point A = 6MW = 6000000W

At point B = (3 × 100) = 300 kW

$= 300 \times 10^3$ W

$= 300000$

∴ Signal power at point B = (6000000 − 300000)

= 5700000W

= 5.7 MW

∴ From A → B $dB = 10 \log_{10} \frac{5.7}{6} = -0.2228$ dB

From B → C $dB = 10 \log_{10}\left(\frac{2}{1}\right) = 3.0103$ dB.

From C → d dB = (0.04 dB/km × 200 km)

= 8 dB [Since it is attenuated]

= − 8 dB

From D → E $dB = 10 \log_{10}\left(\frac{5}{1}\right)$

= 6.9897 dB.

∴ Total change in power = (− 0.2228 + 3.0103 − 8 + 6.9897)

= 1.7772 dB

(∵ Signal gained)

or.

= 1.8 dB

Ans.

Answer: 3 Bandwidth calculation:

We know, $B = f_h - f_l$

$= (60 - 25)$ KHz

$= 36$ KHz

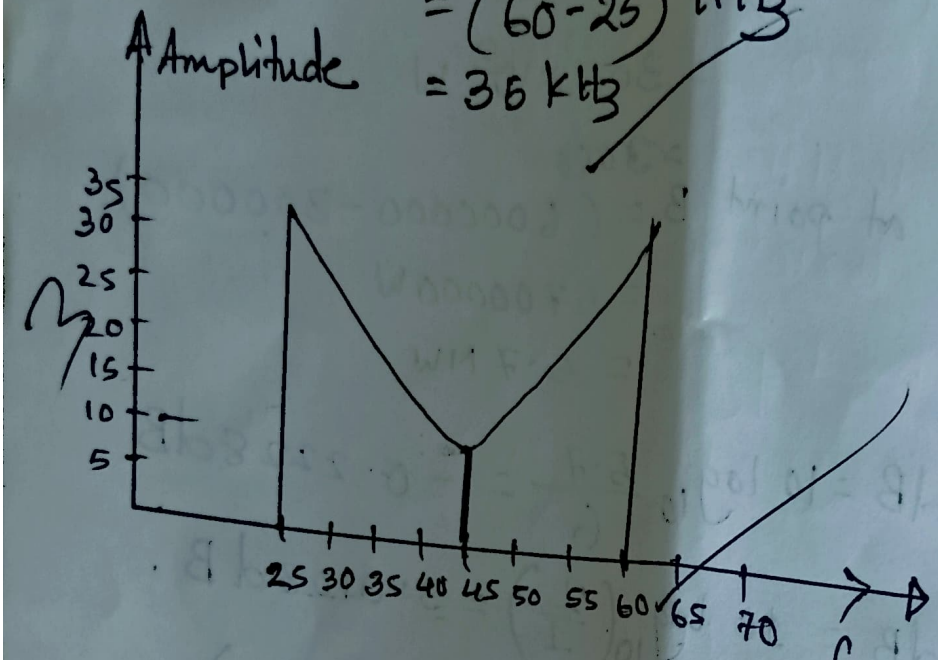



Figure: frequency spectrum

—x—

A4. SNR depends on 2 factors:

a) signal power b) noise power

Distortion: Distortion refers to change in the shape of a signal. In this case receiver receives different shape of the signal than what is was sent by the receiver. It occur for uneven delay in transmission for different signals which is actually a main composite signal.

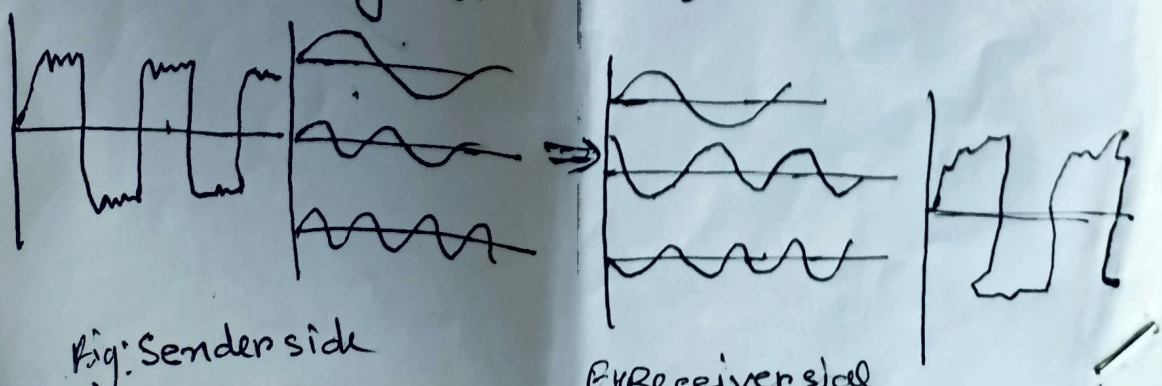


Fig: Sender side

Fig: Receiver side