NEPAL COLLEGE OF INFORMATION TECHNOLOGY

Balkumari, Lalitpur

Affiliated to Pokhara University

ASSIGNMENT FOR DATA COMMUNICATION

UNIT TEST TUTORIAL

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BE-CE (3rd SEM)

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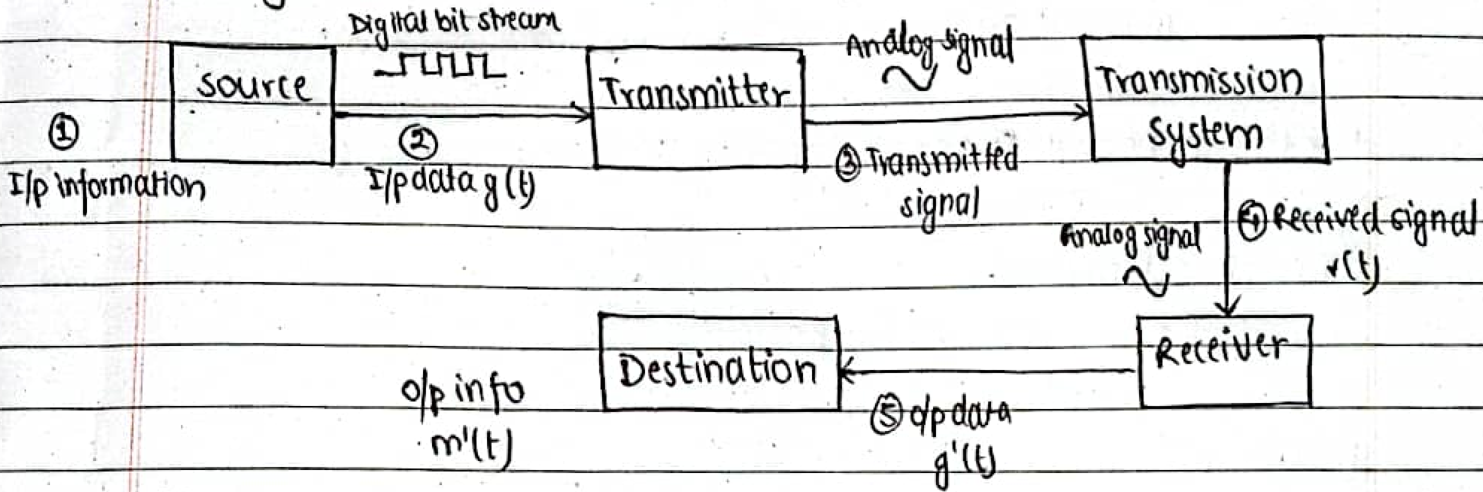
Data communication
UT set

1. a) Draw and explain a generic data communication model. Explain in brief the basic signal processing operations at each block.

→

~~Th~~ A generic data communication block is,



- I/p data are transferred to binary i/p bit (g(t)).
- The incoming i/p stream g(t) are transferred into a transmitted analog signal s(t) suitable for transmission.
- The transmitted signal s(t) presented to the medium is subject to a number of imperfection i.e. white noise, formal noise and interference before it reaches the receiver.
- The received signal r(t) may differ from s(t).
- The receiver will attempt to estimate the original s(t) based on r(t) and its knowledge of the medium producing a sequence of bits.
- The message m'(t) as viewed by the user will usually be an exact copy of original message m(t).

1.b) → Channel capacity refers to the maximum rate of data that a channel can transmit across its medium of transmission.

For Noiseless channel, Nyquist Bit Rate theorem,

$$R = 2B\log_2 L$$

where, B = Bandwidth of channel

L = No. of levels in which the information transmit across channel.

For Noisy channel, Shannon Capacity Theorem:

$$C = B\log_2(1+SNR)$$

where, B = Bandwidth

SNR = Signal to Noise Ratio

Numerical:

Bandwidth (B) = 6MHz $= 6\times10^6$ Hz

Noise Power (N_P) = 1.2mW $= 1.2\times10^{-3}$ W

Signal Power (S_P) = 2W

Here, $SNR = \frac{S_P}{N_P} = \frac{2}{1.2\times10^{-3}} = 1666.67$

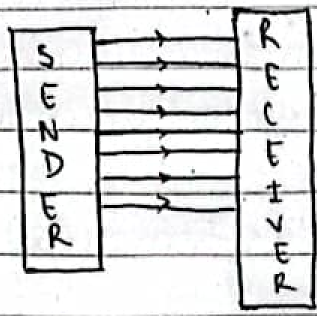
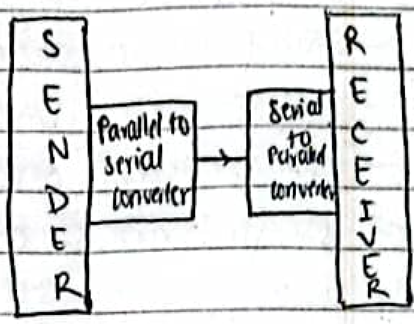
Now, capacity $= B\log_2(1+SNR)$

$= 6\times10^6 \log_2(1+1666.67)$

$= 6\times10^6 \times 10.70$

$= 64221691.42$ bps Ans

Q2a) Differentiate parallel and serial transmission. Explain different modes of serial transmission.

Feature	Parallel Transmission	Serial Transmission
1. Block Diagram		
2. Data Transmission	Multiple bits transmitted simultaneously over multiple channels	one bit transmitted at a time over a single channel
3. Speed	Faster for short distances due to simultaneous transmission.	slower, but can achieve high speeds with modern technology
4. complexity	More complex due to multiple wires & channels.	simpler, requires fewer wires and less complex hardware.
5. Distance	Suitable for short distance	suitable for long distance
6. Cost	More expensive	Less expensive
7. Interference	Prone to interference and crosstalk over long distances.	Less prone to interference and cross talk
8. Example Usage	Internal computer connections	Communication ~~b~~on between devices.

Diffrent modes:

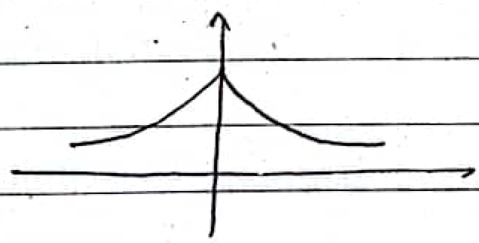
1. simplemode
- Data flows in only one direction from sender to receiver.
- E.g.: Television broadcasting, Keyboard to computer
- Unidirectional communication
- No feedback or acknowledgement from receiver.

2. Half-Duplex Mode
- Data can flow in both directions, but not at the same time.
- E.g.: walkie-talkies, CB radios.
- Bidirectional communication
- Requires switching between sending and receiving.

3. Full-Duplex
- Data flows simultaneously in both directions between the sender and receiver.
- E.g.: Telephone systems, modern internet communication
- Bidirectional communication with simultaneous transmission.
- Both devices can send and receive data at same time.

Q2b) Differentiate between energy and power signal with example. Justify whether $x(t) = e^{-a|t|}$, $a > 0$ is energy power signal.

Sol. →



At $t \geq 0$,

$x(t) = e^{-at}$

At $t < 0$, $x(t) = e^{at}$

$$E = \int_{-\infty}^{\infty} x^2(t)\,dt$$

$$= \int_{-\infty}^{0} e^{2at}\,dt + \int_{0}^{\infty} e^{-2at}\,dt$$

$$= \left[\frac{e^{2at}}{2a}\right]_{-\infty}^{0} + \left[\frac{e^{-2at}}{-2a}\right]_{0}^{\infty}$$

$$= \frac{e^{0}}{2a} - \frac{e^{-\infty}}{2a} + \frac{e^{-\infty}}{2a} + \frac{e^{0}}{2a} \qquad = \frac{1}{a},$$

$$P = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} x^2(t)\,dt$$

$$= \lim_{T\to\infty} \frac{1}{2T} \left[\int_{-T}^{T} e^{2at}\,dt \right]$$

$$= \lim_{T\to\infty} \frac{1}{2T} \left[\frac{e^{2at}}{2a}\right]_{-T}^{T}$$

$$= 0$$

So, it is energy signal. Ans

Parameter	Energy signal	Power signal
1. Definition	A signal with finite energy but zero average power.	A signal with finite average power but infinite energy.
2. Energy	Finite ($E<\infty$)	Infinite ($E=\infty$)
3. Power (P)	Zero ($P=0$)	Finite ($P<\infty$)
4. Duration	Exists for a limited time (non-continuous signal).	Exists indefinitely (continuous or periodic signal)
5. Application	~~Used~~ Used in non-periodic systems like data transmission	Used in periodic systems like AC power supply & communications.

Q3 a) What is pure ALOHA and how slotted ALOHA address its limitations?

→

Pure ALOHA is a random access protocol where users transmit data at any time without coordination.

- collisions occur when two or more users ~~&~~ send data simultaneosly.
- After a collision, users must wait a random time before retransmitting.

slotted ALOHA improves upon pure ALOHA by synchronizing transmissions to fixed time slots, reducing collisions and improving overall efficiency.

It can be more classified in table as:

Aspect	Pure ALOHA	slotted ALOHA
Time synchronization	No synchronization, users transmit anytime.	Users transmit only at slot boundaries.
collision Rate	High	Reduced due to time slots
channel Efficiency	18.4%	36.8%

3b) Explain the electromagnetic spectrum and its application in wireless transmission media with their modes of propagation.

→

The electromagnetic spectrum is the range of all electromagnetic waves, classified by frequency and wavelength.

Applications:

1. Radio waves
Used in AM/FM radio, TV, and mobile communications.

2. Microwaves:
Used in satellite communication & Wi-Fi.

3. Infrared
Used in remote controls & short-range communication

Modes:
When it comes to data transmission in computer networks, we define modes by the direction of data flow, the number of simultaneous bits being sent, and the synchronicity of devices.
- simplex, Half-duplex, Full duplex
- Serial or Parallel
- Synchronous, Asynchronous, Isochronous

Q4a)
→

step 1:
In Binary Huffman coding, the input data bits are first arranged in descending or ascending order, for uniformity.

~~Then~~
step 2:
After arranging, we ~~operate~~ start the operation from the bottom two elements. The operation may be addition.

step 3:
After operation between two last elements, the result is replaced ~~for the~~ in place of two elements. Now, the result is treated as a data and arranged again in the order, used in step 1.

step 4:
Step 1 - Step 3 is repeated until we get the last two datas.

step 5:
Now, we assign the codes to the data, either in ~~to~~ order 0-1 or 1-0.

$n-k+1=4$

Step 6:

Now, we backtrace the ~~result~~ ~~to~~ merge we have done by operation of two elements.

For e.g. If result's bit is 0, the starting bit of data where operation is performed is 0 and we assign bits again.

so, the bit of child are 01 and 00.

Step 7:

Step 6 is repeated until we obtain code for all data.

These are the steps of applying Binary Huffman Coding Algorithm.

4.b) → CRC is an error-detection technique used to ensure data integrity in data transmission. It adds a redundant check value to the data, helping detect errors during transmission.

<u>4-bit CRC Generator and Decoder:</u>

~~1. Given Data : D (data bits)~~

<u>Generator:</u>

E.g. General polynomial $= x^4 + x + 1$

$= x^4 + 0x^3 + 0x^2 + x + x^0$

$= 10011$

Lets add 4 zeros at the end of bitstream.

Bitstream = 11010 so, k = 5

No. of generator = 5 (1001)

or, $n - k + 1 = 5$

Or, $n - 5 + 1 = 5$

$\therefore n = 9$ (no. of transmitted bit is 9)

```
        11000
10011 ) 110100000
        10011
        -----
         10010
         10011
         -----
          00010
          00000
          -----
           00100
           00000
           -----
            01000
            00000
            -----
             1000
```

Transmitted word: 110101000

Receiver :

```
              10001
    10011 ) 100101000
            10011↓
             00011
             00000↓
              00110
              00000↓
               01100
               00000↓
                11000
                10011
                 1011        (error)
```

5) <u>Short notes</u>:

a) <u>USAT (Very small Aperture Terminal)</u>

USAT is a satellite communication system that uses small dish antennas for two-way data transmission in remote areas.

Features:

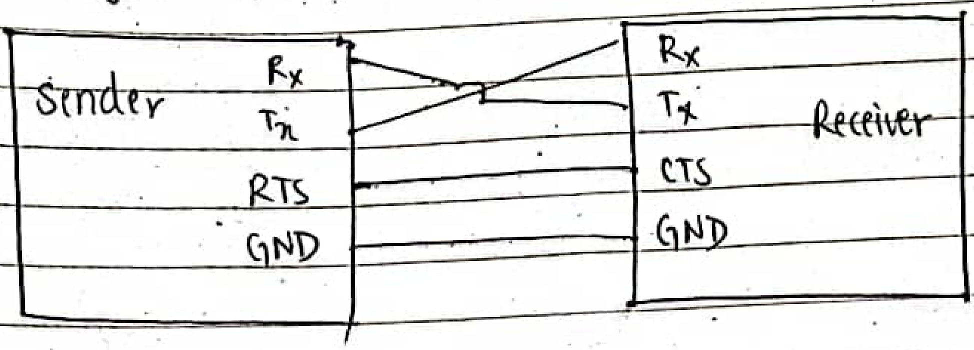
- Antenna size : 0.75 to 3 meters
- Provides internet, voice, video and data services.

Applications:

- Banking (ATMs)
- Remote Education
- Disaster communication
- Maritime & Aviation connectivity

5. b) RS232C standard

1. It supports full duplex mode.
2. It is used for asynchronous data communication.
3. Block diagram:



The two pins Ready to send (RTS) and clear to send (CTS) synchronize the communication between two blocks.

4. Voltage Level:
   Voltage 0 = High voltage (+3V to +15V)
   Voltage 1 = Low voltage (-3V to -15V)