45 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCT	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Data Communication *(CT602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Define transmission Impairment. Compare analog communication system with digital communication system with appropriate block diagram for half-duplex mode. [4+6]
2. Explain the linearity and time invariance property of a system with example. Check whether the following system is linear, time invariant and causal or not. [5+3]

   $y(t) = x(t-2) + x(2-t)$
3. Find the output of LTI system having impulse response $h(t) = e^{-2t}; t > 0$ to the input. [8]

$$x(t) = \begin{cases} 0 \text{ for } t<0 \\ 1 \text{ for } 0 \le t \le 1 \\ 0 \text{ for } 1<t \end{cases}$$

4. a) What are the advantages of optical fibers over coaxial cable and twisted pair cable? [3]
   b) State Nyquist's and Shannon's channel capacity formula. Find the Capacity of a channel for a signal with a bandwidth of 3.1 KHz and Signal to Noise ratio of O dB and comment on it. [2+3+3]
5. Encode the bit stream 1010011001 using NRZ-L, NRZ-I, RZ, Manchester, Bipolar AMI encoding technique. [2×5]
6. a) Define multiplexing with example. Compare synchronous and asynchronous TDM. [3+3]
   b) Generate a CRC-3 transmission code and analyze its error detection performance with example.
7. Explain the rate of switching and compair circuit switching with packet switching. [2+5]
8. Consider a five symbol source with probability assignment as $P(X_1) = 0.2, P(X_2) = 0.35$ $P(X_3) = 0.1, P(X_4) = 0.2, P(X_5) = 0.15$. By using Huffman algorithm, find the source code for these symbols and determine efficiency of the code. [10]
9. Describe with short notes: (any two) [2×5]
   i) HD3S coding
   ii) Packet switching
   iii) Designing a codeword of a c(6,3) block code with any suitable generation matrix

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35 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCT	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Data Communication *(CT602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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1. Draw a generic block diagram of digital communication system for full duplex mode and briefly explain the function of each block. [8]
2. Derive an expression to find even and odd part of signal x(t). Find even and odd part of a signal $x(t) = 0.5(t+1)$ for $-1 \le t \le 1$. [4+4]
3. State the properties of continuous time Fourier series. [6]
4. Define LIT system. Determine the range of values of "a" and "b" for the stability of LTI system with impulse response. $h(t) = e^{at} u(t) + e^{-bt}u(t)$ [3+5]
5. A single tone FM is represented by the voltage equation as $v(t) = 12\cos(6\times10^{8}t+5\sin1250t)$. Determine following: [8]
   a) Carrier frequency
   b) Modulating frequency
   c) Modulation index
   d) Maximum frequency deviation
6. Applying a $\frac{1}{2}$ rate, 4-state convolutional code correct errors of two bits with the help of its trellis diagram. [8]
7. What is multiplexing and why we need it? Explain FDM hierarchy in telephone system. [3+5]
8. What is CRC? Explain 3 bit CRC generator and decoder with example of no error case. [2+6]
9. Write down the Huffman Algorithm clearly. Find an efficient code word and calculate efficiency that can be assign to the symbols using Huffman Algorithm using probabilities $p(x1) = 0.5$, $p(x2) = 0.25$, $p(x3) = 0.125$, $p(x4) = 0.125$. [4+4]
10. Write short notes on: (Any two) [2×5]
    a) Means of Band width utilization
    b) Data communication impairments
    c) B8ZS

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46 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCT	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Data Communication *(CT602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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1. Draw generic block diagram of digital communication duplex system and explain each block. Write down the advantages and disadvantages of digital communication over analog communication system. [5+3]
2. Define LTI system. Compute convolution between two signals $x(t) = e^{-at}.u(t)$ $(a > 0)$ and $h(t) = e^{at}.u(-t)(a > 0)$ and plot the resulting signal. [3+6+1]
3. Check linearity, causality, stability and time invariance characteristics of system $y(t) = 2x(t+1)$ [6]
4. Identify and discuss different data transmission channels. How synchronous transmission differs from asynchronous transmission? [4+4]
5. What is Frequency modulation (FM)? Explain with suitable equations and waveforms. [2+4]
6. Define multiplexing. Compare the merits and demerits of synchronous TDM and statistical TDM method. [2+6]
7. What is Data Switching? Clarify the differences between datagram switching and virtual packet switching. [2+6]
8. Where convolution codes are used? Describe a convolution codes with ½ rate. [2+6]
9. What do you mean by entropy? Describe linear block coding method with a suitable example for detection of an error. [2+6]
10. Explain the general working principle of Binary Huffman Coding Algorithm. Design a Binary Huffman code with a six symbol source with probability assignment as: $P(s_1)$=0.0 $P(s_2) = 0.1, P(s_3) = 0.1, P(s_4) = 0.4, P(s_5) = 0.06$ and $P(s_6) = 0.3$. [4+6]

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45 TRIBHUVAN UNIVERSITY
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Examination Control Division
2073 Chaitra

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Subject: - Data Communication *(CT602)*

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1. Define analog and digital signal with example. Explain digital communication system with general block diagram for full-duplex mode. [2+6]
2. Explain deterministic and random signal with example. Justify whether unit step signal is energy signal or power signal. [4+4]
3. Define LTI system. Find convolution between x(t) = u(t) and h(t) = u(t) and comment on the result. [2+5+1]
4. Why we need Fourier transform even we have Fourier series? State and explain briefly about the properties of Fourier transform. [2+6]
5. Generate a codeword of a c(6,3) block code with any suitable generation matrix. [6]
6. An audio signal of $10\sin 1000\pi t$ is used for AM with a carrier of $50\sin 200000\pi t$. [2+2+2+2]

   Calculate:

   i) Modulation index
   ii) Required bandwidth
   iii) Total power using load resistance of 800 ohm
   iv) Efficiency of AM
7. For a binary data sequence 1111000111 sketch (a) NRZ-I waveform, (b) AMI waveform, (c) RZ waveform and (d) Manchester waveform. [2+2+2+2]
8. What is spread spectrum? Explain Frequency Hopping Spread Spectrum and Direct Sequence Spread Spectrum with its block diagram. [2+6]
9. A message source generates 8 symbols with the following probabilities $P(x1) = 1/2$,

   $P(x2) = 1/4, P(x3) = 1/8, P(x4) = 1/16, P(x5) = 1/32, P(x6) = 1/64, P(x7) = 1/128, P(x8) = 1/128.$

   Encode the message with variable length binary codes using Shannon-Fano procedure. Find the transmission efficiency. [8]
10. Write short notes on: (any two) [5×2]

    i) UTP versus STP
    ii) E-Hierarchy versus T-Hierarchy
    iii) Convolutional codes.

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45 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Kartik

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Year / Part	III / I	Time	3 hrs.

Subject: - Data Communication *(CT602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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1. Differentiate between causal and anticausal signals with examples. Determine the power and energy for a continuous time signal of $x(t) = e^{-2t}u(t)(t \geq 0)$ [6+4]
2. Define periodic and non-periodic signals. Determine if the following systems are linear, time-invariant, stable and memoryless. [2+3+3]
   a) $y(t) = [1 - e^{-4t}][U(t)]$ where U(t) is the continuous-time unit step function
   b) $y[k] = \sin(x[k-4])$
3. Define LTI system and impulse response. For the given signal $x(t) = e^{-at}u(t)(a > 0)$, find and plot the magnitude and phase spectra. [2+2+6]
4. Briefly discuss about the measures used to characterize the performance of a channel. State Nyquist's and Shannon's channel capacity formula. [2+2]
5. Define Throughput and Latency. Explain about different types of propagation. [3+5]
6. Design (a) RZ (b) NRZ-L (c) NRZ-I (d) AMI waveforms for the data sequences of 111100011100110. [10]
7. Define multiplexing and list out its applications. Draw block diagram of Frequency Hopping Spread Spectrum transmitter and receiver and explain briefly. [4+6]
8. Differentiate between datagram switching and virtual circuit switching technique. Discuss packet switching taking example of X.25 protocol in detail. [5+5]
9. Show the application of hamming distance with suitable example. [4]
10. Write short notes on: [3×2]
    i) Linear block coding
    ii) Huffman loading

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45 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Chaitra

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1. Describe the Transmission Impairments of Data Communication system with suitable examples. [6]
2. Define stable and unstable systems. Test the stability of the LTI systems whose impulse responses are given as (i) $h(t) = e^{\Psi t}u(t)$ (ii) $h(t) = e^{-\Psi t}u(t)$ [2+3+3]
3. Distinguish between energy and power signal with an example. Justify whether a signal $x(t) = e^{-a|t|}.u(t)(a > 0)$ is energy or power signal. [4+4]
4. State and explain Shannon-Hartley channel capacity theorem. Briefly discuss about the measures that are used to characterize the performance of a channel. [4+4]
5. Encode the Bit Stream 10110001110 using the following scheme. [10]
   a) RZ
   b) NRZ-I
   c) NRZ-L
   d) AMI
   e) Manchester
6. What do you mean by multiplexing? Explain about working mechanism of FDM and TDM. [2+3+3]
7. Differentiate between circuit switching and packet switching with suitable diagram. [6]
8. What are block codes? The generator matrix for a (6,3) block code is shown below. Obtain all code words. [2+8]

$$G = \left[\begin{array}{ccc:ccc} 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 & 0 & 1 \end{array}\right]$$

9. What are Hamming codes? Write the properties of Hamming codes. Visualize a 3-bit code words as code vector. [2+4+4]
10. A message source generates 8 symbols with the following probabilities: [6]

$P(X_1) = 1/2$, $P(X_2) = 1/4$, $P(X_3) = 1/8$, $P(X_4) = 1/16$, $P(X_5) = 1/32$, $P(X_6) = 1/64$

$P(X_7) = 1/128$ and $P(X_8) = 1/128$

Encode the message using Huffman code.

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46 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Shawan

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Subject: - Data Communication *(CT602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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1. Explain digital communication system with general block diagram. Explain the advantages of digital communication system over analog communication system. [6+2]
2. Explain the basic properties of systems with examples. [8]
3. Define unit impulse and unit step function. Obtain the Fourier transform of a single sided exponential function e^{-at}. u(t). Also draw the spectrum. [2+5+3]
4. Compare guided and unguided transmission media. Calculate the channel capacity having bandwidth and SNR of 6 kHz and 6 db respectively. [5+3]
5. Define modulation. Why is it necessary? Encode the bitstream 10101111000011 using, NRZ, RZ, AMI and Manchester coding. [4+4]
6. Explain Quadrature Amplitude Modulation (QAM) with transmitter and receiver block diagram. [8]
7. What are the differences between multiplexing and multiple access? Define Time Division multiplexing (TDM) and explain it briefly. [3+5]
8. Define switching. Compare circuit and pocket switching. Draw the X.25 layers and data formats. [7]
9. Define Information, Entropy and Minimum Hamming Distance with examples. [2+2+2]
10. Define cyclic code. Explain the procedure for determining code vector for linear block code. [3+6]

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45 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Chaitra

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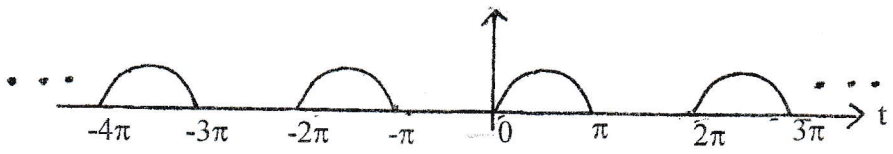
1. Define noise. Briefly discuss the types of noise. Define thermal noise power density; calculate the thermal noise power density in Watts/Hz at a temperature of 17°C, the Boltzmann's constant is 1.38×10^{-23} J/K. What is delay distortion and how can it be corrected? Why is digital transmission preferred over analog transmission? [4+2+2]
2. Define energy and power signal. Check the signal $x(t) = u(t)$ and $x(t) = \delta(t)$ is Energy or Power type. [1+4]
3. Define Linear, Stable, Time Invariant and Causal system with suitable examples. [4]
4. Find the Fourier series representation of the half-wave rectified Sine wave. [4]



5. Find the Fourier transform of the signal $x(t) = e^{-a|t|}$, where $(0 < a < \infty)$ is real-valued and $|t|$ denotes the absolute value of (t). Define the terms linear time-invariant (LTI) systems and impulse response. [4+2]
6. Compare the transmission characteristics and performance (frequency range, bandwidth, security, flexibility, interference, connectivity) of Optical fiber cable and Satellite transmission. [6]
7. Given a channel with an intended capacity of 40 Mbps. The bandwidth of the channel is 6 MHz. What signal-to-noise ratio is required in order to achieve this capacity? Also find number of bits/sample if channel becomes noiseless. [3+2]
8. Explain the working of Pulse Code Modulation (PCM). Draw AMI and Manchester encoding for the sequence [0 1 1 0 1 0 0 0 1]. [4+3+3]
9. Define multiplexing. Explain the working mechanism of WDM. Differentiate between synchronous and statistical TDM. How is spread spectrum utilized in CDMA? What are the advantages and disadvantages of CDMA? [2+2+2+2+2]
10. How does ATM differ from frame relay? What are the advantages and disadvantages of ATM compared to frame relay? [2+3]
11. Why is source coding necessary? Differentiate between fixed length codes and variable length codes. What is the purpose of Huffman's coding algorithm? Explain the general working principle of the Huffman coding algorithm. [1+1+1+3]
12. Define Dataword and Codeword with suitable example. List the error detection and correction coding techniques with their application case. [2+4]
13. Discuss the concept of redundancy in error detection and correction. Define Hamming distance? Differentiate between linear block codes and cyclic codes. [1+1+3]

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46 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Ashad

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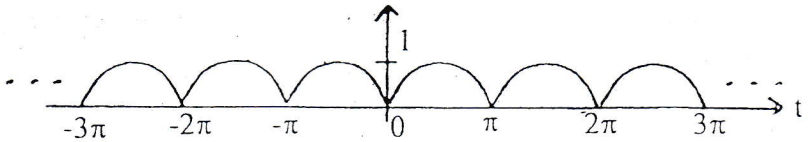
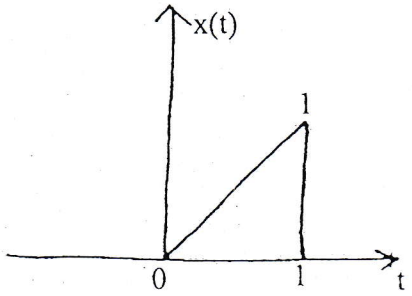
1. Define data representation. How can data be represented? Compare and contrast analog communication system with digital communication system with appropriate block diagram. [2+6]

2. Define deterministic and random signal with example. Check whether the given system is linear and time invariant or not. [2+6]
   i) $y(t) = \log\ (x\ (t))$
   ii) $y(t) = t.x(t)$

3. a) Find the Fourier series representation of the full-wave rectified Sine wave given below. [5]



   b) Determine the Fourier transform of the following signal, x(t). [5]



4. a) Briefly describe about transmission characteristics (frequency range, attenuation, delay and repeater spacing) of twisted pair cable, coaxial cable and optical fiber. [4]
   b) Describe about the factors that determine the performance of a channel? [4]

5. a) What is line coding? What are the desired properties of a line code? Encode the bit stream 01001100011 using the following encoding schemes: Unipolar NRZ-L, Unipolar NRZ-I, Unipolar RZ, Polar NRZ-L, polar NRZ-I, polar RZ, Manchester, and Alternate Mark Inversion (AMI) [3+8]
   b) Differentiate between PAM and PWM. [5]

6. a) Define multiplexing with example. Compare synchronous and asynchronous TDM. [2+4]
   b) Explain how DSSS (Direct Sequence Spread Spectrum) achieves bandwidth spreading. [4]

7. Differentiate between circuit switching and packet switching? Elaborate X.25 switching. [2+3]

8. a) What is the physical meaning of entropy and mention its equation. What is the condition for maximum and minimum entropy? Suppose there are 9 balls in a bin. Out of the 9 balls, 4 balls are red, 2 balls are yellow and 3 balls are green. Calculate the entropy of the system each time a ball is picked from the bin. [2+2]
   b) What is the minimum Hamming distance? Differentiate between dataword and codeword. We need a dataword of at least 11 bits. Find the values of (k) and (n) in the Hamming code C(n,k) with $d_{min} = 3$. [2+4]

45 TRIBHUVAN UNIVERSITY
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2070 Chaitra

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1. Differentiate between digital and analog data communication systems with the help of functional block diagrams. Define transmission impairments. [5+3]
2. Define casuality and stability properties of systems. What are energy and power signals. Explain with example. [3+5]
3. Define LTI system. Find the convolution between $x(t) = e^{-at}u(t), (a > 0)$ and $h(t) = u(t)$ [3+5]
4. Define bandwidth, throughput, latency, jitter and bit error rate. Differentiate between coascial cable and optical fiber. [5+3]
5. Differentiate AM and FM based on modulation index and bandwidth. An audio frequency signal $20\sin 2\pi.500t$ is used for AM with a carrier of $60\sin 2\pi.10^6 t$. Calculate: (a) modulation index (b) Sideband frequencies, (c) Bandwidth requirements, (d) Total power delivered with a load of 75 Ohm. [4+4]
6. Explain polar, unipolar, bipolar and Manchester coding with example. Encode the bit stream 101000111011 using all coding mentioned above. [6+4]
7. What is block code? Design the code word of a (6,3) block code with any suitable generation matrix. [2+6]
8. Describe FDMA with example. Explain the digital hierarchy of T-carriers. [5+2]
9. Write short notes on: [3×5]
   a) Spread spectrum
   b) Packet switching
   c) Cyclic codes

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46 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Ashad

Exam.	New Back (2066 & Later Batch)		
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Year / Part	III / I	Time	3 hrs.

Subject: - Data Communication *(CT 602)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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1. Explain transmission impairments in detail. If the signal at the beginning of a cable with –0.3dB/km has a power of 2mW, what is the power of the signal at 5km? [8]
2. Define energy and power of a signal with appropriate example. Determine whether or not the given system is linear, time invariant, causal and with or without memory. $y(t)=t^2x(t-1)$. [4+4]
3. Find the unit step response of a Linear time invariant system having impulse response $h(t)=\exp(-at)$, for $a>0$. [5]
4. Differentiate between Fourier series and Fourier transform with suitable examples. [5]
5. Briefly describe the physical description of each guided transmission media. Why do we twist two wires in twisted pair cable? Mention the advantages of optical fiber over copper cable. [3+2+3]
6. Differentiate between PAM and QAM. [4]
7. Why is it necessary to limit the band of a signal before performing sampling? Between AM and FM, which one has better noise immunity? Explain. [2+4]
8. Compare the three possible digital to analog modulation techniques (ASK, FSK and PSK). Encode the following bit stream using polar NRZ, Bipolar AMI and Manchester encoding techniques 1101001. [3+3]
9. List three main multiplexing techniques and briefly explain anyone of the analog multiplexing technique. Compare synchronous and asynchronous methods of TDM implementation. Explain how FHSS (Frequency Hopping Spread Spectrum) achieves bandwidth spreading. [3+3+4]
10. Distinguish betwgen frame relay and x.25. [5]
11. Explain the following terms with reference to information theory (i) Entropy (ii) Information rate (iii) Channel capacity. [5]
12. Explain forward error correction techniques with example of Hamming code. [5]
13. What is cyclic redundancy check code (CRC)? Explain with example. [5]

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46 TRIBHUVAN UNIVERSITY

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1. What are the advantages of digital communication system over analog communication system? Explain digital communication system with the help of block diagram. [2+6]

2. Define energy and power signals with appropriate mathematical expressions. Determine whether the following discrete-time (DT) signal is an energy or power signal. Also find its corresponding energy or power. $x[k] = \begin{cases} \cos\left(\frac{3\pi k}{16}\right), & -10 \le k \le 0 \\ 0, & \text{otherwise} \end{cases}$ [2+6]

3. a) Sketch output of Linear Time invariant system having impulse response $h(t) = e^{-at}\,u(t)$, for $a > 0$ and input signal $x(t) = u(t) - u(t-2)$. [5]

   b) Find the Fourier Transform of continuous time signal $x(t) = e^{-a|t|}$, for $a > 0$ [5]

4. a) What is guided transmission media? What are the advantages of optical fibers over coaxial cables and twisted pair cables? [1+3]

   b) State Nyquist's and Shannon's channel capacity formula. The spectrum of a channel is in between 3 MHz and 4 MHz. The SNR = 24 dB. Calculate the bandwidth, the maximum channel capacity using Shannon's formula. Then based on Nyquist's formula, find the number of signal levels required to reach the maximum channel capacity. [2+2]

5. What are the benefits of modulation? Explain ASK, FSK and PSK with mathematical expression, example and generation circuit. Encode the bit stream 1001101110 using unipolar, polar (NRZ-I, NRZ-L, RZ, Manchester), bipolar (AMI) encoding techniques. [3+7+6]

6. a) How can the use of spread spectrum technique provide security against jamming and interception? List the advantages and disadvantages of spread spectrum. [3+2]

   b) What is FDM? Assume a voice channel occupies a bandwidth of 4 kHz. We need to multiplex 10 voice channels with guard bands of 500 Hz using FDM. Calculate the required bandwidth. [2+3]

7. What is switching? Differentiate between datagram switching and virtual circuit switching. [2+3]

8. a) What do you mean by entropy? The five symbols from a source and their probabilities are shown in table below. By using the Huffman algorithm, find the source code for these symbols and determine the average code-word length and the entropy of the source. [1+8]

Symbol	Probabilities
A	0.4
B	0.3
C	0.15
D	0.1
E	0.05

   b) Where are the convolution codes used? Describe different types of convolution codes. [2+4]

45 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Chaitra

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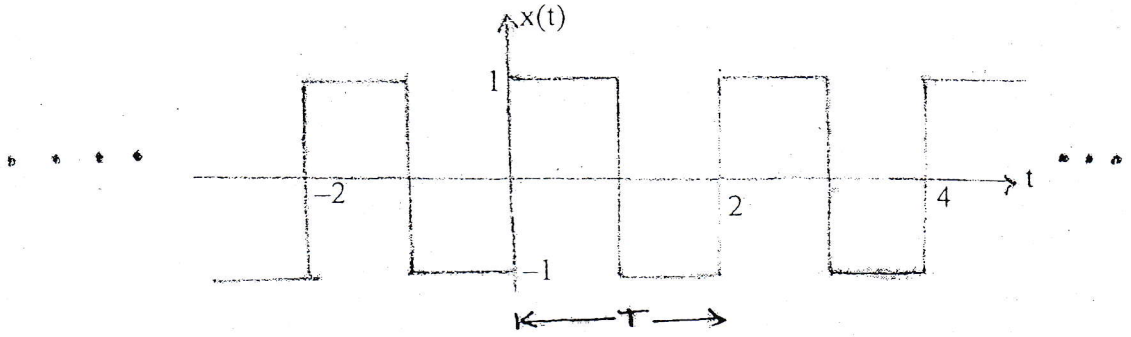
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. Compare digital communication with analog communication system and explain digital communication system with the help of functional block diagram. [8]
2. Distinguish between energy and power signals. Define invertibility of a system. Which properties (Linearity, Causality, Time invariance, Stability and Memory) processes by the following system(i) $y[n] = 3x[n]-4x[n-1]$ (ii) $y(t) = \sin(2\pi x(t))$. [2+6]
3. Define unit impulse function. What is its significance in signal analysis? Compute the Fourier series coefficients for the signal given below. [2+2+6]



4. Describe the characteristics and performance of UTP cables over other guided transmission media. [4]
5. State and explain Shannon's channel capacity theorem. [4]
6. What is a modulation? Why is it required? Briefly explain the steps involved in encoding analog data as digital signal. Encode the following bit stream using unipolar (NRZ), polar (NRZ-L, NRZ-I, RZ, Manchester), bipolar(AMI) 10110001110. [4+6+6]
7. What is multiplexing? Explain its application. [4]
8. Compare FDM, WDM and TDM. What are the advantages and disadvantages of CDMA technique? [4+2]
9. What is switching? Differentiate between circuit and packet switching. [5]
10. Define information and Entropy. The probability of the five possible outcomes of an experiment are given as: $P(x_1) = ½$, $P(x_2)=1/4$, $P(x_3)=1/8$, $P(x_4)=P(x_5)=1/16$. Determine the entropy and information rate if there are 16 outcomes per second. [4+6]
11. Define Hamming Distance and minimum Hamming distance. Suppose a code has a Hamming distance $d_{min}=4$. What is the error detection and correction capability of this scheme? [2+3]

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