

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2081 Bhadra

Exam.	Regular	
Level	BE	Full Marks 80
Programme	BCT	Pass Marks 32
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.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

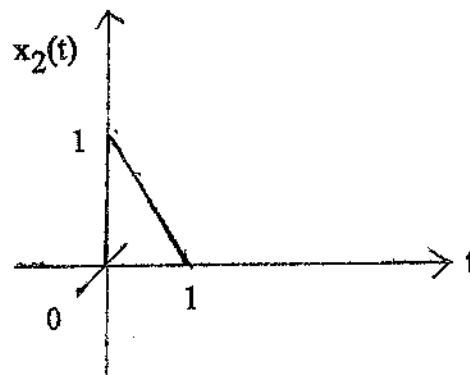
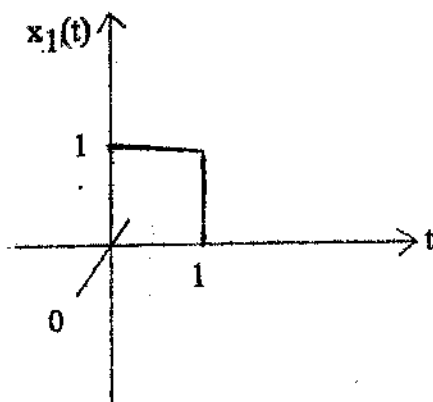
1. a) Prepare a generic block diagram of a digital communication system representing communications between an air traffic controller and an in flight pilot in a cockpit. [5]
b) Explain the basic causes of transmission impairments in communication system. [3]
2. Define a linear system and a time invariant system. Evaluate the odd and even component of a signal defined as: $x(t) = e^{-2t}u(t)$. [2+6]
3. Considering the combinations of at least seven mathematical operations in an equation, prepare a signal flow diagram of any system. [8]
4. Compare and contrast Fourier series and Fourier transform. Mention the conditions and properties of Fourier transformation. [2+2+4]
5. a) Explain the different modes of data transmission in optical fiber. List out and mention the protocols of different categories of twisted pair cables. [3+3]
b) A bandlimited signal with maximum frequency 4 KHz is sampled at the rate of Nyquist frequency. It is quantized into 128 levels and encoded. Calculate: Bandwidth of the channel required to transmit the data through a channel with SNR of 0 dB. [2]
6. Encode the given bit sequence 110000000000101 using any suitable two of polar and two of bipolar encoders. [2+2+2+2]
7. Prepare Code Tree, State Space and Trellis diagrams of 1/2 rate convolutional channel coding for a message bit of 1101; and demonstrate how Viterbi Decoding corrects a single bit error. [2+2+2+4]
8. Encode "SaReGaMaPaDhaNiSa" using Huffmann Encoding and calculate its transmission efficiency. What would be the code sequence if the recipient has wrongly received the message like "SaReSaRePaDhaNiSa"? [4+2+4]
9. Write short notes on: (Any Three) [3×4]
 - a) CDMA
 - b) Packet switching
 - c) CRC-4
 - d) 16-QAM
 - e) E1 Hierarchy

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1. Define transmission performance parameters in data communication system. Explain digital communication system with appropriate generic block diagram. [4+4]
2. Define a causal system and a stable system with example. Evaluate power and energy of a signal given as $x(t) = e^{-2|t|}$. Justify whether it is energy signal or power signal. [4+6]
3. Define LTI system. Convolve the following signals graphically. [2+6]



4. a) Explain different types of pulse modulation techniques with necessary diagrams. [6]
b) Explain briefly about 8-QAM with constellation diagram. [4]
5. a) Determine the CDMA encoded transmitting message for four users using Walsh Hadamard codes, where user A, B, C and D are transmitting 1,0, silent, 1 respectively. [5]
b) What is multiplexing? Why statistical TDM is preferred than synchronous TDM? [2+3]
6. Define Hamming distance and Minimum hamming distance with an example. What are the error detection and error correction capabilities of block codes? Explain. [2+4]
7. Obtain all code words for a (6, 3) block code from the systematic generator matrix given below. [8]

$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 \end{bmatrix}$$

8. Using a suitable example, explain state, tree and trellis diagrams for $\frac{1}{2}$ code rate and 4 states. [10]
9. Write short notes on : (Any Two) [2×5]
 - a) Datagram packet switching vs Virtual circuit packet switching
 - b) E1 and T1 Hierarchies
 - c) Modes of operation of optical fiber

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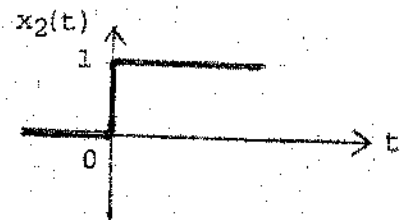
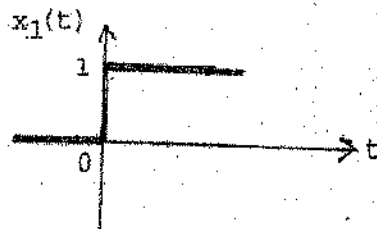
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1. Explain the digital data communication system working in full duplex mode using a block diagram. Define the transmission performance parameters in a data communication system. [4+4]
2. Define energy and power signal with examples. Check whether the following system is linear, causal and time invariant or not. [4+6]

$$y(t) = \log x(t)$$
3. State the properties of Fourier Transform. Convolve the following signals graphically. [2+6]



4. a) Explain the importance of Scrambling in the digital data encoding process. Encode the binary pattern 101000011101 using polar RZ, NRZ-I, AMI and Manchester line coding techniques. [2+4]
- b) Explain 16-QAM with constellation diagram. [4]
5. Compress "Ghumne Mech Mathi Andho Manche" using Huffman coding to determine efficiency redundancy and compare it with entropy. [10]
6. Write down the applications of multiplexing. Describe FHSS and DSSS with necessary diagrams. [2+4+4]
7. Explain CRC-4 generator and decoder with example for both no-error and with-error cases. [8]
8. With suitable example demonstrate how convolutional code corrects errors. [6]
9. Write short notes on: (Any Two) [2×5]
 - a) Difference between circuit switching and packet switching
 - b) Code division Multiple Access (CDMA)
 - c) Shannon's channel capacity theorem.

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1. Define data and signal. Elaborate the advantages of digital communication system as compared to analog communications system. Explain the basic causes of transmission impairments in communication system. [2+2+4]
2. a) Determine whether or not the following CT signal is periodic. If the signal is periodic, determine its fundamental period. $x(t) = 3\cos(4t + \pi/3)$. [2]
 b) Test the linearity of the systems, $y(t) = x^2(t)$ and $y(t) = 3x(t) + 5$ [4]
 c) Test the systems static or dynamic, $y(t) = 2x(t)$ and $y(t) = 2x(t) - 3x(t-3)$ [4]
3. a) Find the output response of an LTI system when input $x(t) = e^{-t} u(t)$ and impulse response $h(t) = e^{-2t} u(t)$. [4]
 b) Find magnitude and phase spectrum of $x(t) = 4 + 2\cos\frac{2\pi}{3}t + 4\sin\frac{5\pi}{3}t$. [4]
 c) Discuss any four properties of Fourier Transform. [2]
4. Compare coaxial cable with optical fibre. Evaluate the maximum capacity of a channel through which a signal with power of 10 dBW is transmitted. (Assume that the noise power spectral density is given as 5 m W/Hz). [4+4]
5. a) Consider AM signal as $m(t) = 5[1 + 2\cos(2\pi + 1000t)] \cos(2\pi \cdot 10^8 t)$. Determine modulation index, total power delivered. [4]
 b) Define PCM technique used to convert analog signal into digital data. In a PCM system, a bandlimited signal with maximum frequency 4 kHz is sampled at the rate of Nyquist frequency. It is quantized into 256 levels and encoded. Calculate: [2+4]
 (i) Minimum data rate available at the output of the encoder.
 (ii) Bandwidth of the channel required to transmit the data through a channel of 15 dB SNR.
 c) What are the basic factors to be considered while line coding? Encode the binary pattern 100000000100001 using B8ZS and HDB3 encoding. [2+4]
6. Explain the major bandwidth utilization techniques used in data communication. Explain Frequency Hopped Multiple Access (FHMA) technique using its transmitter and receiver blocks. [4+6]
7. Differentiate between circuit switching and Packet switching used in computer networks with an example. [6]
8. a) Explain error detection and correction mechanism with trellis diagram. [10]
 b) Differentiate convolutional code and block code. [2]

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1. Define Data and Signal with examples. Sketch a generic block diagram of digital data communication system for full duplex mode. [2+6]
2. Define a causal system and a stable system. Check whether a system $y(t) = x(t) + x(t - 1)$ is (i) linear (ii) time-invariant (iii) causal (iv) memoryless system [2+6]
3. State properties of continuous time Fourier Transform. [4]
4. Find convolution between two signals $x_1(t) = u(t) - u(t-3)$ and $x_2(t) = u(t+4) - u(t)$. [4]
5. State and explain theorem for noisy and noiseless channel. Briefly discuss about the measures that are used to characterize the performance of channel. [4+4]
6. a) Why we need modulation? A modulating signal, $m(t) = 10 \cos(2\pi \times 10^3 t)$ is amplitude modulated with carrier signal, $c(t) = 50 \cos(2\pi \times 10^5 t)$. Find the modulation index, the carrier power and the power required for transmitting AM wave. [2+6]
 b) Encode the bit stream 101110001010 using NRZ-L, NRZ-I, Manchester, Bipolar AMI. [4×2]
7. a) Discuss briefly on Spread Spectrum communication with neat block diagram. [4]
 b) What are the two basic approaches commonly used to packet switching? [4]
 c) Compare all three types of multiplying technique with the application case of each. [8]
8. a) Apply the Huffman coding procedure to determine Entropy, Average Code length, code efficiency and Redundancy for the following message ensemble
 $[x] = [x_1, x_2, x_3, x_4, x_5, x_6]$ and $[p] = [0.30, 0.25, 0.15, 0.12, 0.08, 0.10]$, Take $M = 2$ [8]
 b) For a (6, 3) code, the generator matrix is

$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$$

 Find (i) All corresponding code vectors (ii) Minimum Hamming distance (iii) Verify that this code is a single error correcting code (iv) Parity check matrix (v) Determine transmitted codeword if received code is 100011. [8]

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- What are the different types of data transmission technology? Mention advantage and disadvantage of analog and digital communication system. [4+6]
- a) A system's output is given as:
 $y(t) = 2x(t) + 3$, where $x(t)$ is its input. Determine whether the system is LTI or not. [5]
 b) Obtain the Fourier transform of a DC signal whose amplitude is unity at all time instants, and hence, plot its magnitude and phase spectrum. [5]
 c) Mention any two applications of Fourier series. [2]
- The equation of amplitude modulated wave is given by $s(t) = 40 [1 + 0.8\cos(2\pi \times 10^3 t)] \cos(4\pi \times 10^5 t)$. Find the carrier power, the total sideband power and bandwidth of the signal. The value of resistor given is 30 ohm. [4+4+2]
- What are the needs of line coding in data communication? Given the binary data sequence 1101110111 represent it in unipolar NRZ, polar RZ, Manchester and AMI waveform. [2+2+2+2]
- Define multiplexing and write its application system. Explain the operation of TDM and FDM clearly with diagram. [2+4+4]
- What is Spread Spectrum? Explain frequency hopping spread spectrum and direct sequence spread spectrum with its block diagram. [4+6]
- Define block codes. The systematic generator matrix for a (6,3) block code is given below. Obtain all code words, Hamming weights and minimum hamming distance from this matrix. [2+4+2+2]

$$G = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$$

- Calculate coding efficiency of "Khoji Rahechha Desh Le Yek Yug Nayak" using Huffman coding technique. [10]

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1. a) Differentiate data and signal with two examples of each. [5]
b) Explain the procedure of converting an analog signal to digital. Also, briefly explain each steps involved. [5]
2. Define periodic and non-periodic signals with examples. [2+4+4]
a) Test the stability of the system $h(t) = e^{4t}.u(t)$
b) Test the given function $y(t) = t.x(t)$ for causality, non causality and anti causality.
3. How Nyquist theorem applied for a noiseless channel? Calculate number of discrete signal content in the channel if a channel has a spectrum of 3 to 4 MHz with signal to noise ratio of 24 dB. [5+5]
4. Explain the operation of CRC-4 with example of error detection. [10]
5. Define line coding. Explain polar RZ and bipolar AMI line coding scheme with example and compare them. [4+3+3]
6. a) How is source coding different from channel coding? [2]
b) Under what conditions does a linear code become a cyclic code? Explain with the help of an example. [3]
c) Explain the concept of convolutional code with the help of a state-transition diagram. [5]
7. Write down the Huffman Algorithm clearly and find an efficient code word and efficiency that can be assign to the symbols using Huffman Algorithm for "Kun Mandir Ma Janchhau Yattri". [10]
8. a) Explain the mechanism of frequency Hopping spread spectrum (FHSS). Also, compare FDM and FHSS using suitable time-frequency graph. [4+3]
b) Explain the "near-far problem" in CDMA. How can it be solved? [2+1]

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1. Differentiate between energy and power signals with examples. Determine if the following system is stable LTI.
 $Y(t) = x(t^2)$ [5+5]
2. List and describe all data communication parameters that describe the performance of the system. [8]
3. Explain how we plot line spectrums of a continuous time signal and illustrate an example. [8]
4. Encode 111000000000000011 using B8ZS and HDB3 encoders. [10]
5. Demonstrate how checksum is used to detect errors while sending a data word of 12, 15, 10, 5, 2. [8]
6. a) Explain the working principle of FHSS technique. [5]
b) Explain how CDMA works with example. [5]
7. What are linear block codes? Design a code word of a C(8, 4) block code with any suitable generation matrix. [8]
8. Encode "Jasta lai tastai dhido lai nistai" using weighted Huffman encoder. Also demonstrate how it is decoded. [10]
9. Describe with short notes on: (Any Two) [2×4]
 - a) Double-tone AM
 - b) Hamming codes
 - c) Packet switching versus message switching
 - d) X.25 protocol

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1. Draw a generic block diagram of a digital communication system used in mobile telephony and explain each block. Compare analog and digital communication system with examples. [6+2]
2. Explain the properties of causal, non-causal and anticausal systems with example. [10]
3. Explain why we need Fourier Transform. Plot the line spectrums of $X(t) = 12 + 6\sin(140\pi t + 30^\circ) - 9\cos(80\pi t - 70^\circ)$. [5+5]
4. Why we need Modulation? Illustrate an example of a 4-bit PCM with AMI encodes. [2+6]
5. Demonstrate how CRC-5 works to detect errors in data communication. [8]
6. What is multiplexing? Compare synchronous and statistical TDM. Describe Frequency hopping spread spectrum and direct sequence spread spectrum with its block diagram. [2+4+4]
7. Construct a (7, 4) Hamming code using a 4×4 generation matrix for any arbitrary message. [8]
8. Encode "Phool ko aankhama phoolai sansara" using Huffman encoder and find the transmission efficiency. [10]
9. Write short notes on: (Any two) [4×2]
 - a) STP versus UTP
 - b) Frame relay
 - c) 16-Quadrature amplitude modulation
 - d) Multi mode optical fiber

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1. Enlist the advantages and disadvantages of digital communication system over analog communication system. Discuss the transmission impairments of data communication system with suitable diagrams and suggest the methods in overcoming attenuation. [3+5]
2. What are properties Fourier transform? Plot the magnitude and phase spectra of $X(t) = 5 + \sin(12t + 20^\circ) - \cos(16t - 60^\circ) + \cos(20t + 40^\circ)$. [4+4]
3. Sketch the output of LTI system having impulse response $h(t) = e^{-at}u(t)$ ($a > 0$) and $h(t) = e^{at}u(-t)$ ($a > 0$). [10]
4. List different types of digital-to-analog line encoding techniques. Give an example of QAM-32 in its constellation diagram. [2+6]
5. Explain with example how CRC-5 work to detect 3 burst errors. [10]
6. Define Frequency division Multiplexing. Explain the FDM Multiplexing and demultiplexing process with neat diagrams. [8]
7. Design a suitable generation matrix for a convolution code using $c(3,1,3)$ architecture and encode input data stream of (00110). [10]
8. Design a Binary Shannon-Fano code with a six symbol source with probability assignment as $P(s_1)=0.04$, $P(s_2)=0.1$, $P(s_3)=0.1$, $P(s_4)=0.4$, $P(s_5)=0.06$, $P(s_6)=0.3$. Test its transmission efficiency. [7+3]
9. Write short notes on: (Any Two) [4×2]
 - a) Analog versus digital mux hierarchy
 - b) DSSSH versus FSSH
 - c) Optical fiber versus STP

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1. Sketch a generic block diagram of digital data communication system for full duplex mode. [8]
2. Distinguish between power and energy signals with examples. [8]
3. State the condition for the stability of LTI system. Test the stability of the system whose impulse response is $h(t) = te^{-3t}u(t)$ [8]
4. List digital- to-digital line encoding techniques and explain in detail Bipolar 8-zero substitution and High Density 3-zero substitution techniques. [2+4+4]
5. With suitable mathematical expression, explain double-tone AM technique. [8]
6. Demonstrate how CRC-4 works to trace two burst errors. [10]
7. Differentiate between digital and analog spread spectrum techniques using examples. [8]
8. Define entropy in information theory. Find the efficient code word and efficiency using Hoffman algorithm using probabilities $p(x_1)=0.6$, $p(x_2)=0.2$, $p(x_3)=0.1$, $p(x_4)=0.05$, $p(x_5)=0.05$. [8]
9. Explain why channel coding is required in data communication. Generate a convolution code for a input bit streams of (111011) using a c(3,1,3) architecture. [2+10]

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1. Describe the transmission impairments of data communication system with suitable example. [6]
2. Define periodic and non-periodic signals with examples. Determine whether the following signals are periodic or not. [2+3+3]
 - a) $X(t) = \sin 15\pi t$ b) $x(t) = \sin \sqrt{2}\pi t$
3. What are Recursive and Nonrecursive system? Test the stability of the CTI system whose impulse response is given as: $h(t) = e^{-t} \sin(t) u(t)$ [3+5]
4. State and explain Shannon-Hartley channel capacity theorem with example. Briefly discuss about the measures that are used to characterize the performance of a channel. [4+4]
5. a) An audio frequency signal $10 \sin 1000\pi t$ is used for a single tone amplitude modulation with a carrier of $50 \sin 2\pi \times 10^5 t$. Calculate :
 - (i) Modulation index
 - (ii) Bandwidth requirement
 - (iii) Total power delivered if load = 60Ω [2×3]
- b) Encode the bit stream 10010110001 using the following encoding schemes:
 - (i) Polar NRZ-L
 - (ii) Polar NRZ-I
 - (iii) Differential Manchester [2×3]
6. a) Explain, how spread spectrum techniques like FHSS and DSSS work? [6]
- b) Explain the operation of packet switching system. [4]
7. Considering a $\frac{1}{2}$ rate, 4-state convolutional code, correct 3 bits errors using the help of its trellis diagram. [10]
8. Explain QAM with its transmitter circuit and draw any one constellation diagram for 32-QAM. [6+2]
9. The source of information symbols {A0, A1, A2, A3 and A4} have corresponding probabilities {0.4, 0.3, 0.15, 0.1 and 0.5}. Encode the source symbols using most efficient coding scheme and calculate the corresponding efficiency. [10]

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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 $-1 \leq t \leq 1$. [4+4]
3. State the properties of continuous time Fourier series. [6]
4. Define LTI 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 $v(t) = 12\cos(6 \times 10^8 t + 5\sin 1250t)$. 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 $p(x_1) = 0.5$, $p(x_2) = 0.25$, $p(x_3) = 0.125$, $p(x_4) = 0.125$. [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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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]

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

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 0 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 compare 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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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.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

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 $P(x_1) = 1/2$, $P(x_2) = 1/4$, $P(x_3) = 1/8$, $P(x_4) = 1/16$, $P(x_5) = 1/32$, $P(x_6) = 1/64$, $P(x_7) = 1/128$, $P(x_8) = 1/128$. 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.

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)

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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 $x(t) = e^{-at} \cdot u(t)$ ($a > 0$) and $h(t) = e^{at} \cdot u(-t)$ ($a > 0$) 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 $\frac{1}{2}$ 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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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) $h(t) = e^{at}u(t)$ (ii) $h(t) = e^{-at}u(t)$ [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]

$$G = \begin{bmatrix} 1 & 0 & 0 & : & 1 & 1 & 1 \\ 0 & 1 & 0 & : & 1 & 1 & 0 \\ 0 & 0 & 1 & : & 1 & 0 & 1 \end{bmatrix}$$
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]

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

$$P(X_7) = 1/128 \text{ and } P(X_8) = 1/128$$
 Encode the message using Huffman code.

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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 coding

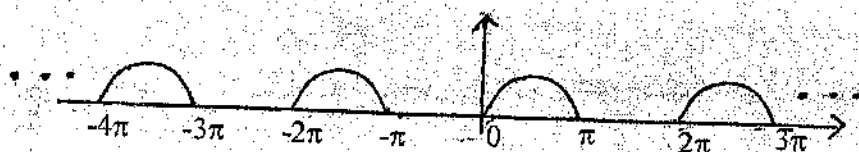
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCT	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Data Communication (CT602)

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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 $1.38 \times 10^{-23} \text{ J/K}$. 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 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 Datword 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]

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
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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.
- ✓ Attempt All questions.
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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 packet 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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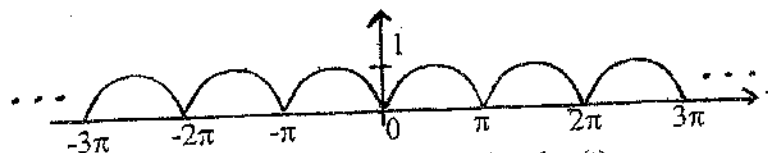
1. Differentiate between digital and analog data communication systems with the help of functional block diagrams. Define transmission impairments. [5+3]
2. Define causality and stability properties of systems. What are energy and power signals. Explain with example. [3+5]
3. Define LTI system. Find 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 coaxial cable and optical fiber. [5+3]
5. Differentiate AM and FM based on modulation index and bandwidth. An audio frequency signal $20\sin 2\pi \cdot 500t$ is used for AM with a carrier of $60\sin 2\pi \cdot 10^6t$. 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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Level	BE	Full Marks	80
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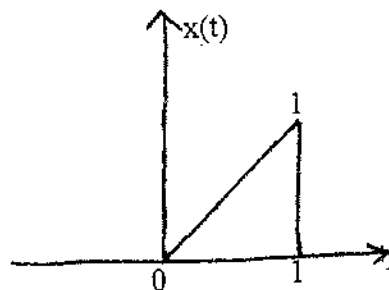
Subject: - Data Communication (CT602)

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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]
- c) What are cyclic codes? Differentiate between linear block codes and convolutional codes. [2+3]

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Subject: - Data Communication (CT602)

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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. $x[k] = \begin{cases} \cos\left(\frac{3\pi k}{16}\right), & -10 \leq k \leq 0 \\ 0, & \text{otherwise} \end{cases}$ [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 $x(t) = e^{-at} u(t)$, 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]