Question 1(a) [3 marks]

Define: (1) Bit rate, (2) Baud rate, and (3) Bandwidth

Solution

Answer:

Table 1. Definitions

Term	Definition
Bit Rate	Number of bits transmitted per second (bps)
Baud Rate	Number of signal elements or symbols transmitted per second
Bandwidth	Range of frequencies required to transmit a signal, measured in Hertz (Hz)

Mnemonic

"BBB - Bits move By Bands"

Question 1(b) [4 marks]

A signal has a bit rate of 8000bps and baud rate of 1000 baud. How many data element is carry by each signal? How many signals element do we need?

Solution

Answer:

Table 2. Signal Calculation

Parameter	Value	Calculation
Bit rate	8000 bps	Given
Baud rate	1000 baud	Given
Data elements per signal	8 bits	Bit rate $\div$ Baud rate $= 8000 \div 1000 = 8$
Signal elements needed	$2^8 = 256$	$2^{\text{bits per signal}}$

Diagram:

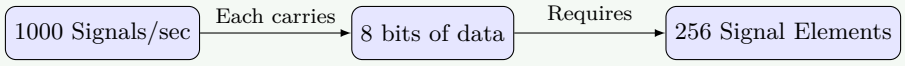


Figure 1. Signal Element Representation

Mnemonic

"Divide to Decide - Divide bit rate by baud rate to decide how many bits per signal."

Question 1(c) [7 marks]

Describe Elements of digital communication system with its block diagram

Solution

Block Diagram:

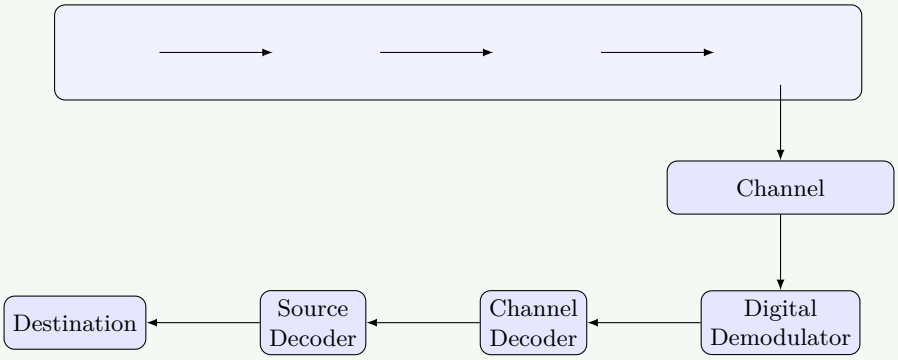


Figure 2. Digital Communication System

Key Elements:

Table 3. System Components

Element	Function
Source	Generates message to be transmitted
Source Encoder	Converts message to digital format, removes redundancy
Channel Encoder	Adds redundancy for error detection/correction
Digital Modulator	Converts digital data to signals suitable for channel
Channel	Physical medium that carries the signal
Digital Demodulator	Extracts digital information from received signals
Channel Decoder	Detects/corrects errors using added redundancy
Source Decoder	Reconstructs original message from digital data
Destination	Receives the final message

Mnemonic

"Send Messages Carefully; Destination Must Comprehend Signals Deeply"

Question 1(c) OR [7 marks]

What is fundamental limitation of digital communication system? What are the advantages and disadvantages of digital communication system?

Solution

Fundamental Limitations:

Table 4. Limitations

Limitation	Description
Bandwidth	Digital signals require more bandwidth than analog
Noise	Limits maximum achievable data rate
Equipment	Digital systems need complex hardware and processing

Advantages vs Disadvantages:

Table 5. Pros and Cons

Advantages	Disadvantages
Noise Immunity	Higher bandwidth requirements
Easy Multiplexing	Complex equipment
Error Detection & Correction	Quantization errors
Enhanced Security	Synchronization problems
Signal Regeneration	Higher initial cost
Integration with Computers	Sampling rate limitations

Mnemonic

"NEEDS - Noise, Equipment, and Environment Determine Success"

Question 2(a) [3 marks]

Describe QPSK Modulator with block diagram

Solution

Block Diagram:

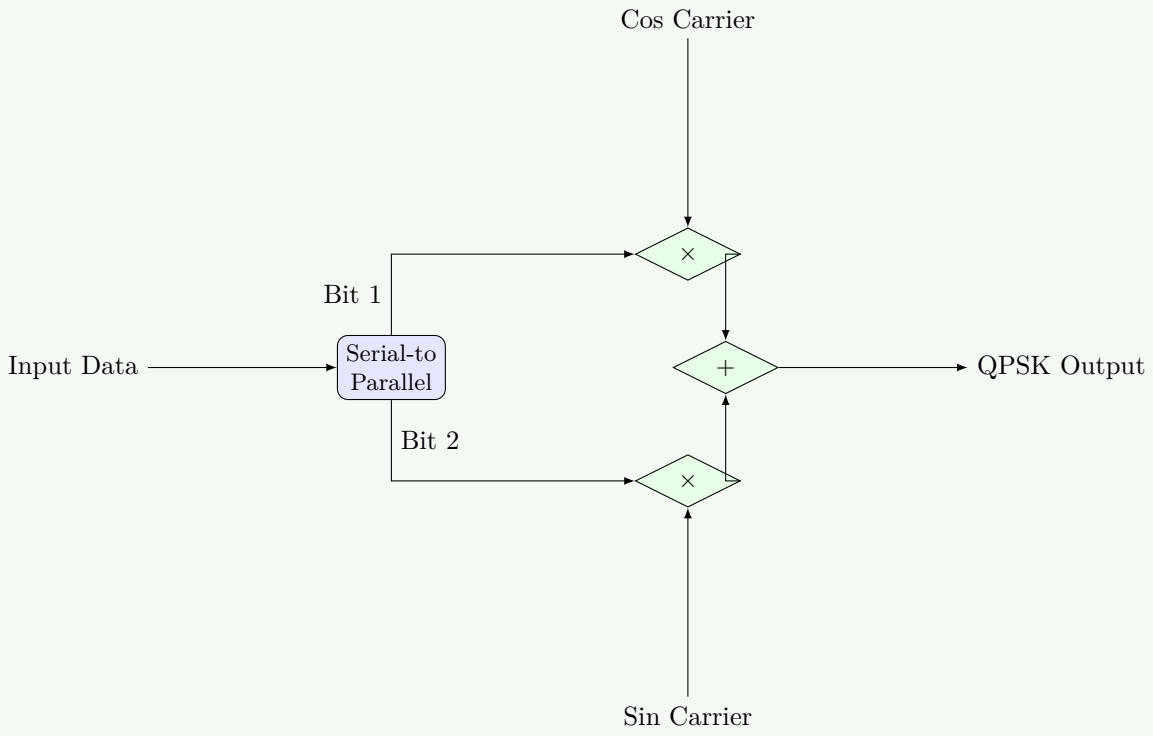


Figure 3. QPSK Modulator

Key Components:

- **Serial-to-Parallel Converter**: Splits data into 2-bit groups
- **Cosine Carrier**: Modulates first bit (I-channel)
- **Sine Carrier**: Modulates second bit (Q-channel)

Mnemonic

"Split Pair, Carrier Square - data split into pairs, carried by squared signals"

Question 2(b) [4 marks]

Describe ASK Modulator with block diagram

Mnemonic

"Amplify Signal when Keen - carrier amplitude changes when signal is high"

Question 2(c) [7 marks]

Compare ASK, FSK and PSK and Draw the wave form of ASK, FSK and PSK for the input digital signal 100101000101

Solution

Comparison:

Table 7. Modulation Comparison

Parameter	ASK	FSK	PSK
Modulation	Amplitude	Frequency	Phase
Noise Immunity	Poor	Moderate	Good
Bandwidth	Narrow	Wide	Moderate
Power Eff.	Poor	Moderate	Good
Complexity	Simple	Moderate	Complex
BER	Poor	Moderate	Good

Waveforms (Input: 1 0 0 1 0 1 0 0 0 1 0 1):

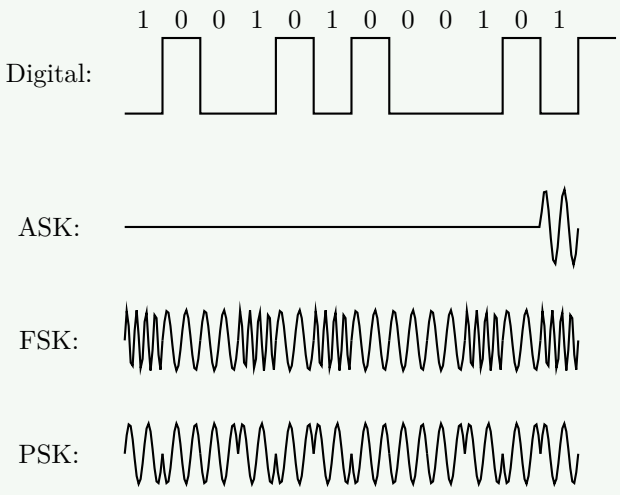


Figure 5. Modulation Waveforms

Mnemonic

"AFP - Alter Frequencies or Phases"

Question 2(a) OR [3 marks]

Describe QPSK Demodulator with block diagram

Solution

Block Diagram:

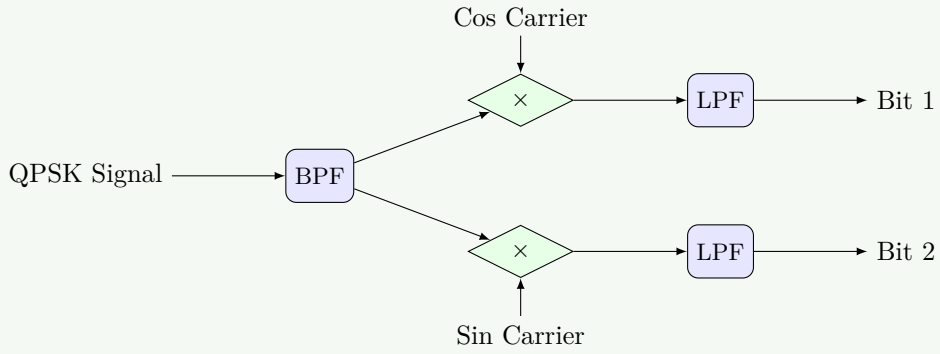


Figure 6. QPSK Demodulator

Key Components:

- **BPF**: Bandpass Filter ensures only signal passes
- **Product Detectors**: Multipliers using Cos/Sin matching carriers
- **LPF**: Lowpass Filters retrieve original data bits

Mnemonic

"Filtered Pairs Deliver Data"

Question 2(b) OR [4 marks]

Draw the Constellation diagram of ASK, BPSK and QPSK

Solution

Constellation Diagrams:

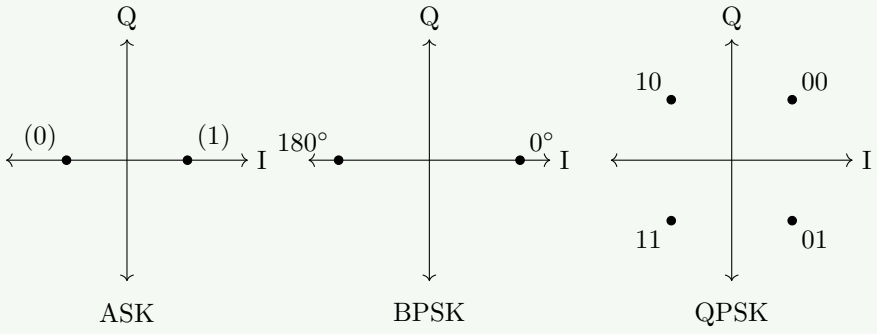


Figure 7. Constellation Plots

Characteristics:

Table 8. Constellation Features

Modulation	Points	Phases
ASK	2	1 (0°)
BPSK	2	2 (0°, 180°)
QPSK	4	4 (45°, 135°, 225°, 315°)

Mnemonic

"Points Double When Phases Double"

Question 2(c) OR [7 marks]

Describe FSK Modulator and demodulator with block diagram and output wave form

Solution

FSK Modulator:

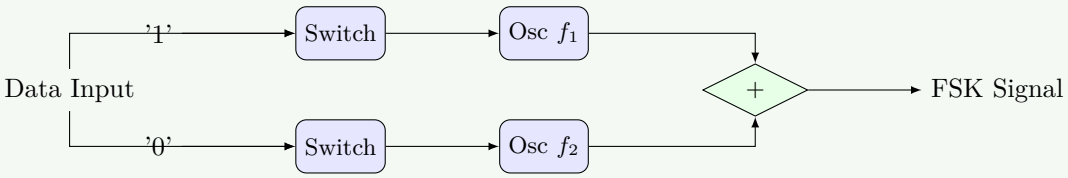


Figure 8. FSK Modulator

FSK Demodulator:

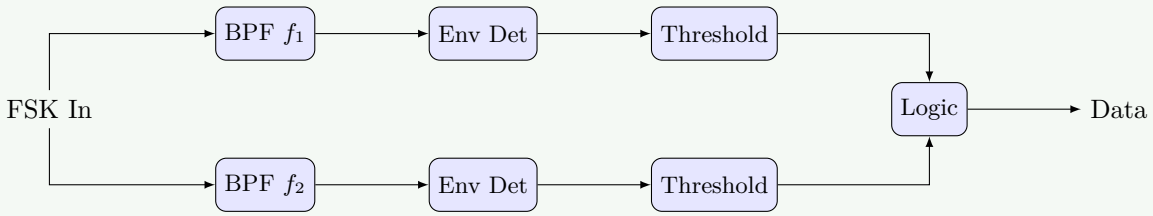


Figure 9. FSK Demodulator

Waveform: See Q2(c) above for FSK waveform example.

Mnemonic

"Frequency Shift Key - Two Tones Tell Truth"

Question 3(a) [3 marks]

State the significance of probability in communication

Solution

Answer:

Table 9. Significance of Probability

Significance	Description
Information Measurement	Quantifies uncertainty/surprise in messages
Channel Capacity	Determines maximum possible data rate
Error Analysis	Predicts and minimizes communication errors

Mnemonic

"ICE - Information, Capacity, Errors - need probability"

Question 3(b) [4 marks]

State channel capacity in terms of SNR and explain its importance

Solution

Shannon's Channel Capacity Formula:

$$C = B \times \log_2(1 + \text{SNR})$$

Where:
- C = Channel capacity (bits/second)
- B = Bandwidth (Hz)
- SNR = Signal-to-Noise Ratio

Importance:

Table 10. Importance

Aspect	Importance
Theoretical Limit	Defines maximum possible error-free data rate
System Design	Guides bandwidth and power requirements
Performance Evaluation	Benchmark for actual system performance
Coding Efficiency	Indicates how close a system is to optimal performance

Mnemonic

"BEST - Bandwidth and Error-free Signal Transmission"

Question 3(c) [7 marks]

Discuss classification of line codes with suitable example

Solution

Line Code Classification:

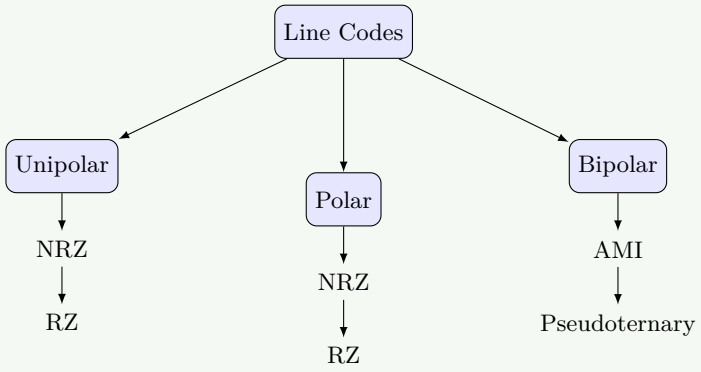


Figure 10. Line Code Classification

Waveform Visualization (Data: 1 0 1 1 0 1 0 0):

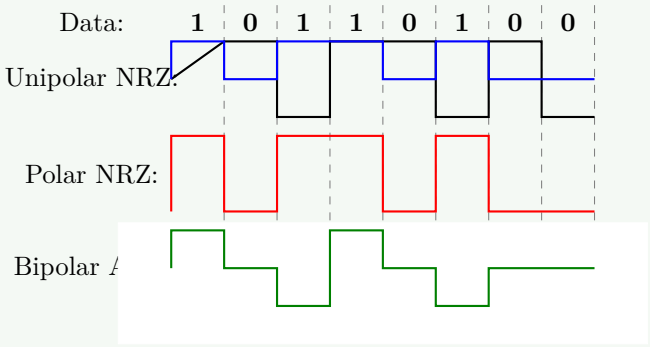


Figure 11. Line Code Waveforms

Mnemonic

"UPB - Use Proper Bits"

Question 3(a) OR [3 marks]

Discuss conditional probability

Solution

Definition:

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

In Communication:

Table 11. Applications

Application	Description
Channel Modeling	Probability of receiving Y given X was sent
Error Detection	Probability of error given specific patterns
Decision Making	Optimizing receiver decisions based on observations

Mnemonic

"CEaD - Calculate Events after Data"

Question 3(b) OR [4 marks]

Define Entropy and Information. Discuss its physical significance

Solution

Definitions:

Table 12. Definitions

Term	Definition	Formula
Entropy	Average information content of a source	$H(X) = -\sum P(x) \log_2 P(x)$
Information	Measure of uncertainty reduction	$I(x) = \log_2(1/P(x))$

Physical Significance:

- **Unpredictability**: Higher entropy means less predictable source
- **Compression Limit**: Minimum bits needed to represent a source
- **Optimal Coding**: Guides efficient source coding design
- **Resource Allocation**: Determines bandwidth/power requirements

Mnemonic

"UCOR - Uncertainty Correlates with Optimal Resources"

Question 3(c) OR [7 marks]

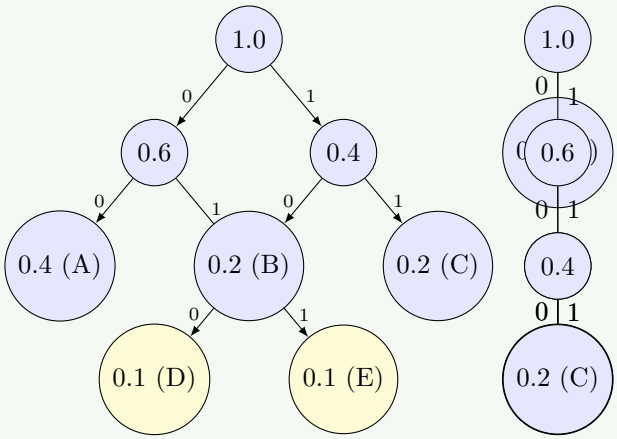
Describe Huffman code with suitable example

Solution

Huffman Coding: Variable-length prefix code for lossless data compression.
Example:

Symbol	Probability	Code
A	0.4	0
B	0.2	10
C	0.2	11
D	0.1	100
E	0.1	101

Huffman Tree:



Codes:

- A: 0
- D: 100
- E: 101
- B: 110
- C: 111

Mnemonic

"HIGH PROB, LOW BITS"

Question 4(a) [3 marks]

List Data transmission techniques

Solution

Data Transmission Techniques:

Technique	Description
Serial	Bits sent one after another over single channel
Parallel	Multiple bits sent simultaneously over multiple channels
Synchronous	Data sent in blocks with timing controlled by clock
Asynchronous	Data sent with start/stop bits, no common clock
Half-Duplex	Data flows in both directions but not simultaneously
Full-Duplex	Data flows in both directions simultaneously

Mnemonic

"SPASH-F - Serial, Parallel, Asynchronous, Synchronous, Half/Full"

Question 4(b) [4 marks]

Explain needs of multimedia processing for communication

Solution

Needs:
- **Compression**: Reduces bandwidth for large files
- **Format Standardization**: Ensures compatibility
- **Quality Control**: Maintains AV quality
- **Synchronization**: Coordinates audio/video
- **Error Resilience**: Protects against data loss

Multimedia Flow:

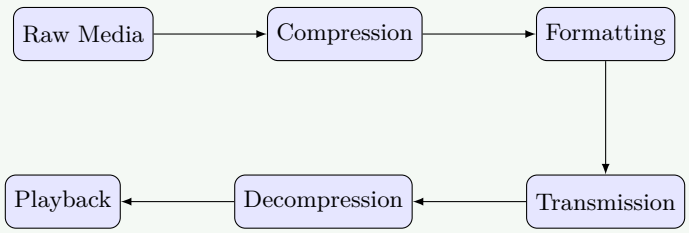


Figure 12. Multimedia Processing Flow

Mnemonic

"CQSEF - Compress Quality, Standardize and Ensure Fidelity"

Question 4(c) [7 marks]

Explain data transmission mode

Solution

Modes:

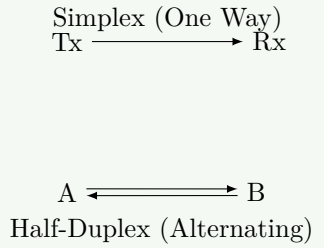


Figure 13. Transmission Modes

Comparison:

Parameter	Simplex	Half-Duplex	Full-Duplex
Direction	One-way	Two-way (Alt)	Two-way (Simul)
Efficiency	Low	Medium	High
Cost	Low	Medium	High
Example	Radio	Walkie-talkie	Telephone

Mnemonic

"SHF - Speed and Handling Factors"

Question 4(a) OR [3 marks]

List Important characteristics of data communication

Solution

Characteristics:

- **Delivery**: Correct destination
- **Accuracy**: No alteration
- **Timeliness**: Within timeframe
- **Jitter**: Variation in packet arrival
- **Security**: Unauthorized access protection
- **Reliability**: Resilience

Mnemonic

"DATJSR"

Question 4(b) OR [4 marks]

Discuss the standards for data communication

Solution

Standards:

Standard	Org	Purpose
IEEE 802.x	IEEE	LAN/MAN
TCP/IP	IETF	Internet
X.25	ITU-T	Packet Switching
RS-232	EIA	Physical Interface
USB	USB-IF	Device Connection

Mnemonic

"PITS - Protocols, Interfaces, Transmission and Standards"

Question 4(c) OR [7 marks]

Explain model of Multimedia communications and elements of Multimedia system

Solution

Multimedia Communication Model:

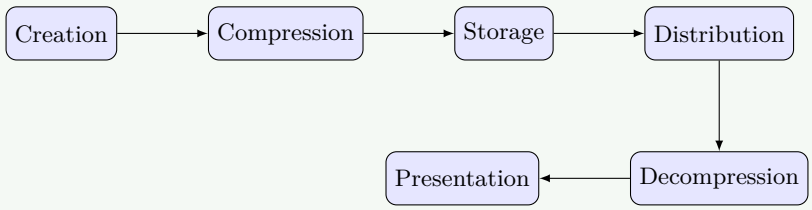


Figure 14. Multimedia Communication Model

Elements:

- **Input Devices**: Camera, Mic
- **Processing**: CPU, GPU
- **Storage**: HDD, Cloud
- **Network**: Transmission medium
- **Output**: Display, Speakers
- **Software**: Codecs, Players

Mnemonic

"CNIS-OS - Capture, Network, Input-output, Storage, Output, Software"

Question 5(a) [3 marks]

Explain important elements of 5G technology

Solution

Key 5G Elements:

Element	Description
Millimeter Waves	Higher frequency (24-100 GHz) for more bandwidth
Massive MIMO	Multiple-input multiple-output antennas for capacity
Beamforming	Focused signal transmission for efficiency
Network Slicing	Virtual networks on shared infrastructure
Edge Computing	Processing closer to data source for latency

Mnemonic

"MMBN-E - Millimeter, MIMO, Beamforming, Network, Edge"

Question 5(b) [4 marks]

Describe Spread spectrum communication

Solution

Definition: Technique where signal is spread over a wide frequency band, much wider than minimum bandwidth.
Types:

- **DSSS**: XOR data with higher-rate pseudorandom code
- **FHSS**: Rapidly switches carrier frequency
- **THSS**: Transmits in short bursts at different times

DSSS Process Visualization:

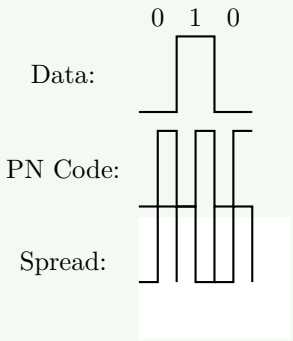


Figure 15. DSSS Spread Signal

Mnemonic

"DFT - Difficult For Trackers - Direct, Frequency, Time Hopping"

Question 5(c) [7 marks]

Explain block diagram of satellite communication

Solution

Block Diagram:

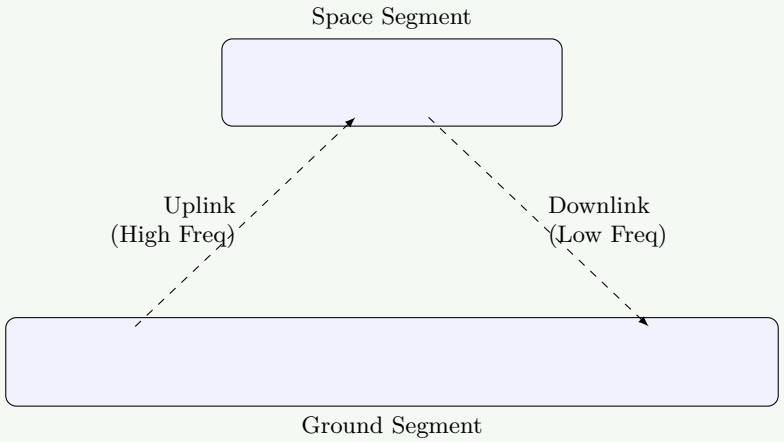


Figure 16. Satellite Communication

Components:

Component	Function
Earth Station (Tx)	Source of signals, uplink transmission
Uplink	Transmission from earth to satellite
Transponder	Receives, amplifies, frequency shifts, retransmits
Downlink	Transmission from satellite to earth
Earth Station (Rx)	Receives downlink signals

Frequency Bands: C-band (4/6 GHz), Ku-band (12/14 GHz), Ka-band (20/30 GHz).

Mnemonic

"STUDER - Station Transmits Uplink, Downlink to Earth Receiver"

Question 5(a) OR [3 marks]

Explain features and advantages of 5G technology

Solution

Advantages:

Feature	Advantage
High Speed	Up to 10 Gbps data rates
Ultra-Low Latency	<1ms response time
Massive Connectivity	1 million devices/sq km
Network Slicing	Customized virtual networks
Reliability	99.999% availability
Energy Efficiency	Lower power per bit

Mnemonic

"HUMNER - High-speed, Ultra-low, Massive, Network, Enhanced Reliability"

Question 5(b) OR [4 marks]

Describe Edge Computing

Solution

Definition: Computing paradigm bringing data processing closer to the source.
Architecture:

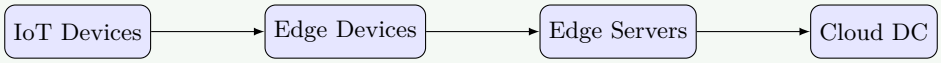


Figure 17. Edge Computing

Characteristics: Proximity, Distributed, Real-time, Bandwidth Optimization, Privacy.

Mnemonic

"PDRBD - Process Data Rapidly By Distributing"

Question 5(c) OR [7 marks]

Explain importance of block chain in Communication Security

Solution

Process:

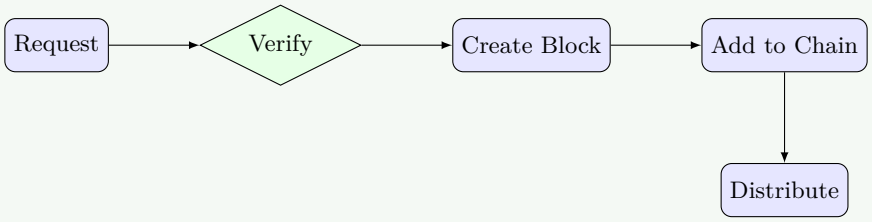


Figure 18. Blockchain Process

Security Benefits:

- **Immutability**: Data cannot be altered
- **Decentralization**: No single failure point
- **Transparency**: Visible transactions
- **Cryptography**: Strong integrity protection
- **Smart Contracts**: Automated security

Applications: Secure Messaging, Identity Management, IoT Security.

Mnemonic

"DTCSCI"