Question 1(a) [3 marks]

Explain selective cell.

Answer:

Table: Selective Cell Characteristics

Feature	Description
Purpose	Provides coverage for specific areas
Size	Small coverage area
Application	Indoor locations, tunnels, buildings
Antenna	Directional antenna system

- **Selective coverage**: Targets specific geographical areas needing signal
- **Indoor solution**: Primarily used for building coverage enhancement
- **Directional transmission**: Uses focused beam patterns for efficiency

Mnemonic: "Select Special Spots"

Question 1(b) [4 marks]

Draw and explain umbrella cell.

Answer:

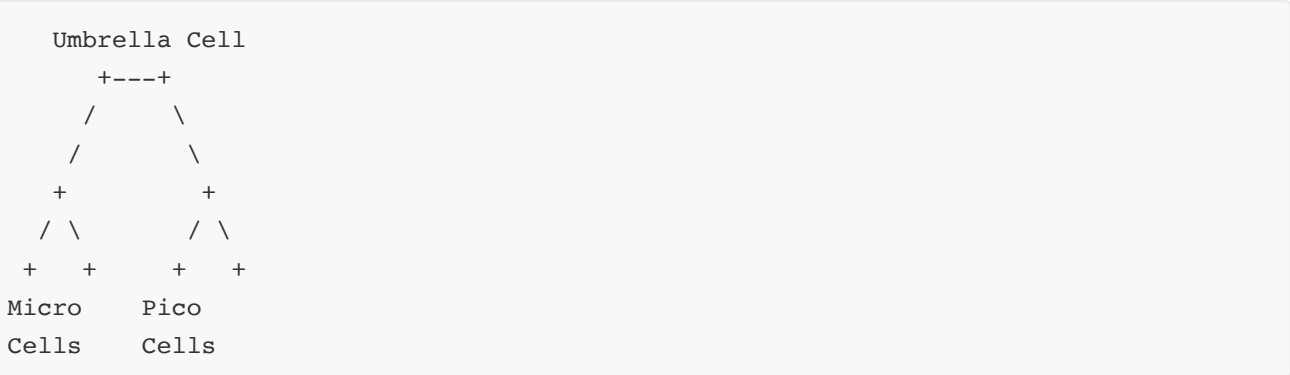


Table: Umbrella Cell Features

Parameter	Description
Coverage	Large area coverage
Purpose	Overlays smaller cells
Handoff	Manages inter-cell transitions
Capacity	Handles overflow traffic

- **Large coverage**: Provides wide area signal coverage over smaller cells
- **Traffic management**: Handles overflow from micro and pico cells
- **Seamless handoff**: Ensures continuous communication during movement

Mnemonic: "Umbrella Covers All"

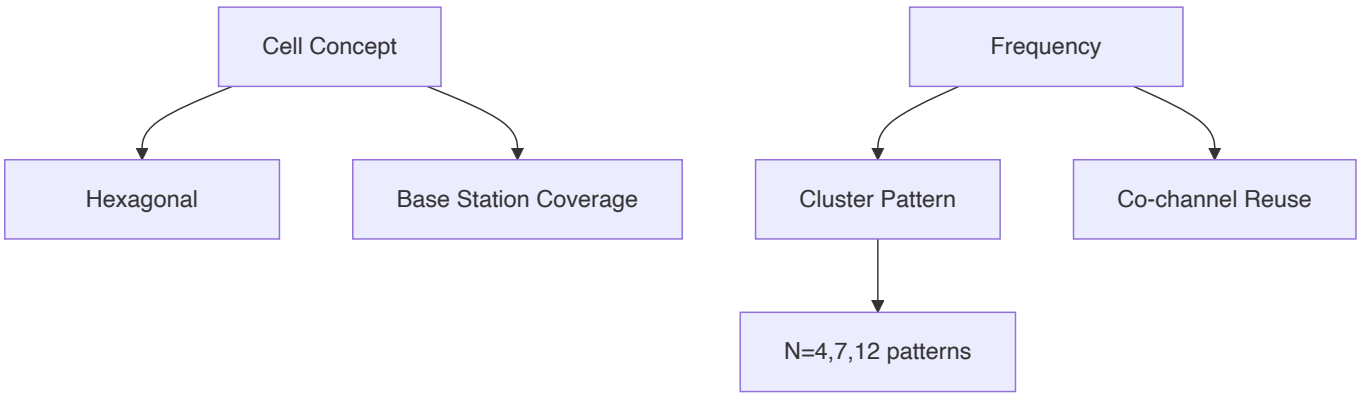
Question 1(c) [7 marks]

What is the cell? Explain frequency reuse.

Answer:

Table: Cell and Frequency Reuse Concepts

Concept	Definition	Purpose
Cell	Geographic coverage area	Service provision
Frequency Reuse	Same frequency in different cells	Spectrum efficiency
Cluster	Group of cells with unique frequencies	Interference control
Reuse Distance	Minimum distance between same frequencies	Signal quality



- **Cell definition**: Geographical area covered by one base station antenna
- **Hexagonal pattern**: Most efficient shape for coverage without gaps
- **Frequency reuse**: Same frequencies used in non-adjacent cells for capacity
- **Cluster size**: Determines frequency reuse pattern (N=4,7,12)

- **Co-channel interference**: Controlled by minimum reuse distance

Mnemonic: "Cells Reuse Frequencies Efficiently"

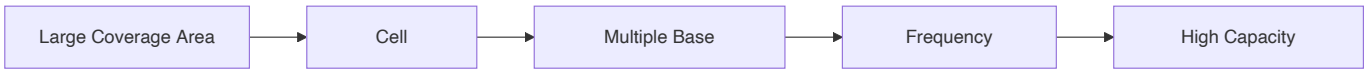
Question 1(c) OR [7 marks]

Explain cellular concept in detail.

Answer:

Table: Cellular System Components

Component	Function	Benefit
Cell Division	Area split into cells	Coverage optimization
Base Stations	Serve individual cells	Signal transmission
Mobile Switching	Call routing	Network connectivity
Frequency Planning	Spectrum allocation	Interference control



- **Area division**: Large service area divided into smaller hexagonal cells
- **Power control**: Low power transmitters reduce interference
- **Frequency efficiency**: Same frequencies reused in distant cells
- **Capacity increase**: More simultaneous users served
- **Seamless coverage**: Continuous service across all cells

Mnemonic: "Divide Area For Better Service"

Question 2(a) [3 marks]

Define full forms: (i) IMEI (ii) LTE (iii) GSM

Answer:

Table: Full Forms

Abbreviation	Full Form	Purpose
IMEI	International Mobile Equipment Identity	Device identification
LTE	Long Term Evolution	4G technology standard
GSM	Global System for Mobile Communication	2G cellular standard

Mnemonic: "Identity, Long-term, Global"

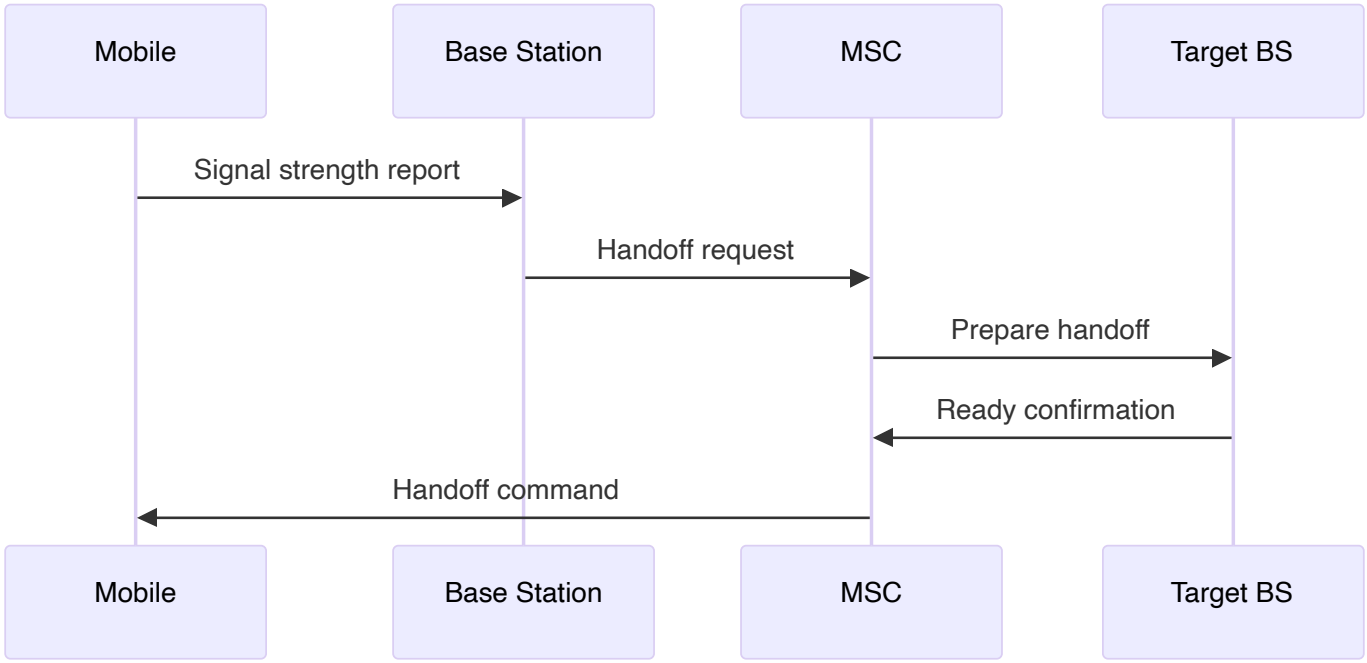
Question 2(b) [4 marks]

Explain MAHO in detail.

Answer:

Table: MAHO Characteristics

Feature	Description
Full Form	Mobile Assisted Handoff
Function	Mobile helps in handoff decision
Measurement	Signal strength monitoring
Reporting	Mobile reports to network



- **Mobile assistance**: Mobile unit measures neighboring cell signals
- **Signal reporting**: Continuous measurement reports sent to network
- **Decision support**: Network uses mobile data for handoff decisions
- **Quality improvement**: Better handoff decisions with mobile input

Mnemonic: "Mobile Assists Network Decisions"

Question 2(c) [7 marks]

Explain GSM architecture with diagram

Answer:

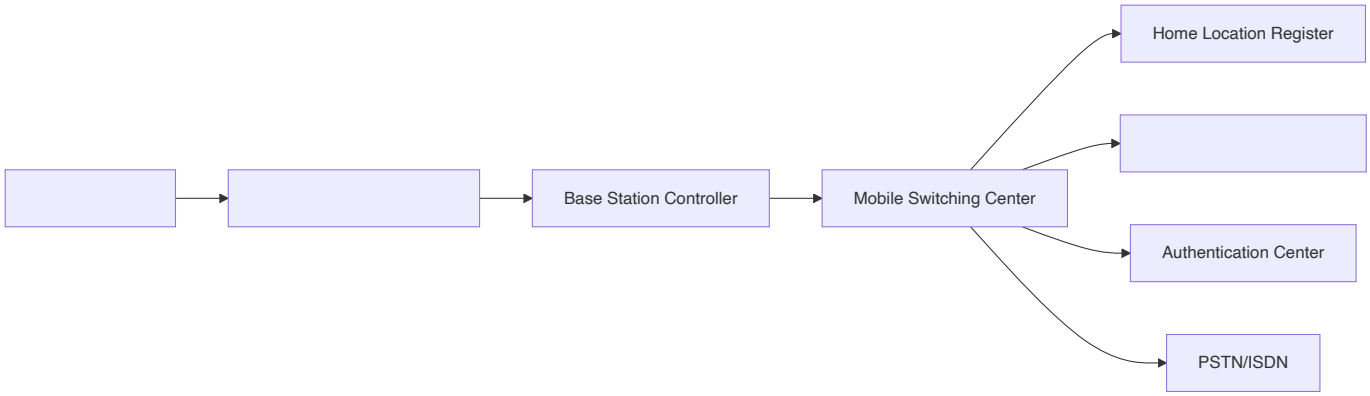


Table: GSM Architecture Components

Component	Function	Purpose
MS	Mobile Station	User equipment
BTS	Base Transceiver	Radio interface
BSC	Base Station Controller	Radio resource management
MSC	Mobile Switching Center	Call switching
HLR	Home Location Register	Subscriber database
VLR	Visitor Location Register	Temporary subscriber data

- **Radio subsystem**: BTS and BSC handle radio communications
- **Network subsystem**: MSC, HLR, VLR manage calls and mobility
- **Database management**: HLR stores permanent, VLR stores temporary data
- **Authentication**: AuC provides security functions

Mnemonic: "Mobile Base Network Database"

Question 2(a) OR [3 marks]

Explain cell splitting.

Answer:

Table: Cell Splitting Process

Step	Action	Result
1	Reduce transmit power	Smaller coverage
2	Add new base stations	Fill coverage gaps
3	Frequency planning	Maintain interference control
4	Capacity increase	More users served

- **Power reduction**: Original cell power decreased to shrink coverage
- **New cells**: Additional base stations installed in coverage gaps
- **Capacity gain**: More cells mean higher user capacity in same area

Mnemonic: "Split Cells Double Capacity"

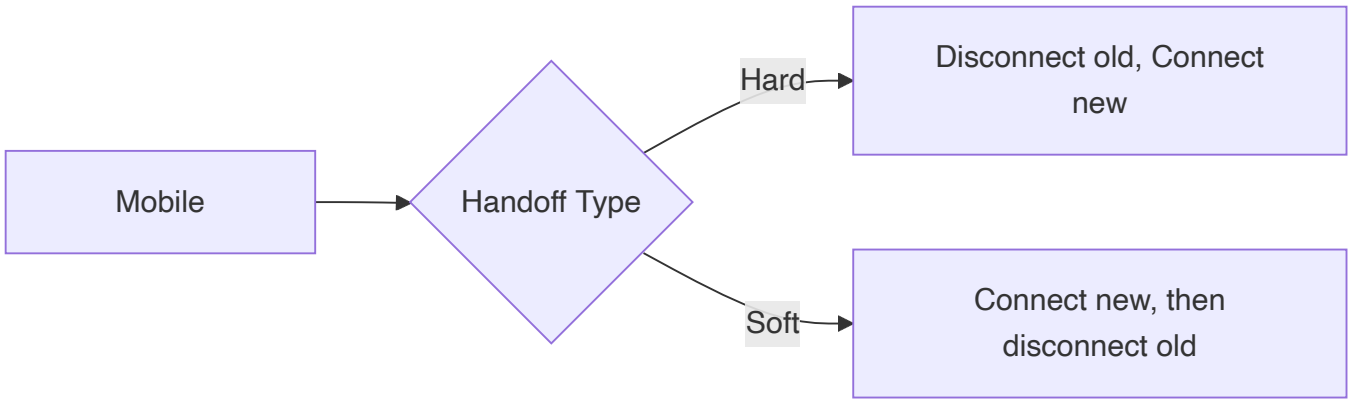
Question 2(b) OR [4 marks]

What is handoff? Explain soft and hard handoffs.

Answer:

Table: Handoff Types Comparison

Type	Process	Technology	Quality
Hard Handoff	Break-then-make	GSM, TDMA	Brief interruption
Soft Handoff	Make-then-break	CDMA	Seamless transition



- **Handoff definition**: Process of transferring call from one cell to another
- **Hard handoff**: Connection broken before establishing new connection
- **Soft handoff**: New connection established before breaking old one
- **Quality difference**: Soft handoff provides better call quality

Mnemonic: "Hard Breaks, Soft Connects"

Question 2(c) OR [7 marks]

Explain GSM signal processing with diagram

Answer:

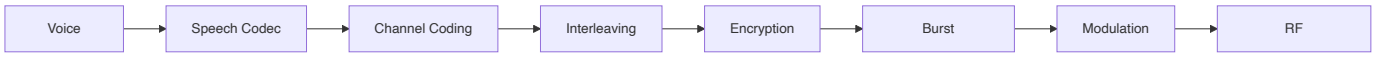


Table: GSM Signal Processing Stages

Stage	Function	Purpose
Speech Codec	Voice compression	Bandwidth efficiency
Channel Coding	Error correction	Transmission reliability
Interleaving	Burst error protection	Data integrity
Encryption	Security	Privacy protection
Modulation	RF conversion	Air interface

- **Speech processing**: Voice compressed using RPE-LTP codec
- **Error protection**: Convolutional coding adds redundancy
- **Security layer**: A5 algorithm encrypts data
- **Burst structure**: Data organized in time slots
- **Modulation**: GMSK modulation for RF transmission

Mnemonic: "Voice Coded Interleaved Encrypted Modulated"

Question 3(a) [3 marks]

Explain cell sectoring.

Answer:

Table: Cell Sectoring Benefits

Feature	Description
Antenna Pattern	Directional instead of omnidirectional
Sectors	3 or 6 sectors per cell
Capacity	3x or 6x capacity increase
Interference	Reduced co-channel interference

- **Directional antennas**: Replace omnidirectional with sector antennas

- **Capacity multiplication**: Each sector treated as separate cell
- **Interference reduction**: Directional pattern reduces interference

Mnemonic: "Sector Antennas Triple Capacity"

Question 3(b) [4 marks]

Explain GSM call procedure.

Answer:

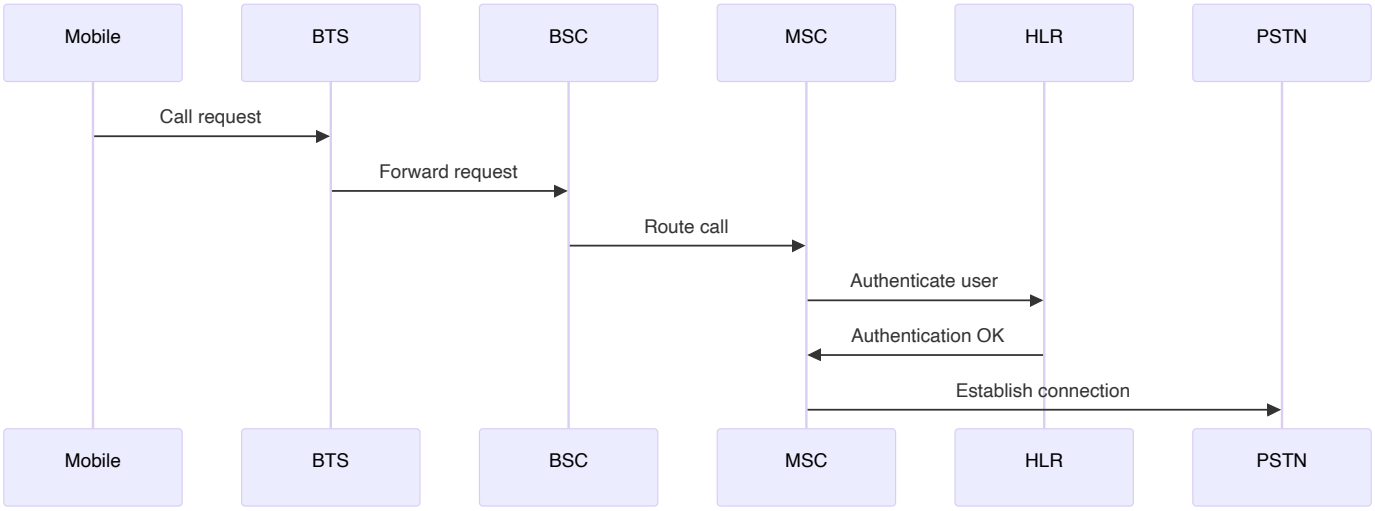


Table: Call Setup Steps

Step	Process	Purpose
1	Authentication	User verification
2	Channel allocation	Resource assignment
3	Call routing	Path establishment
4	Connection setup	Communication link

- **Authentication**: Network verifies subscriber identity
- **Resource allocation**: Traffic channel assigned to call
- **Routing**: Call path determined through network
- **Connection**: End-to-end communication established

Mnemonic: "Authenticate Allocate Route Connect"

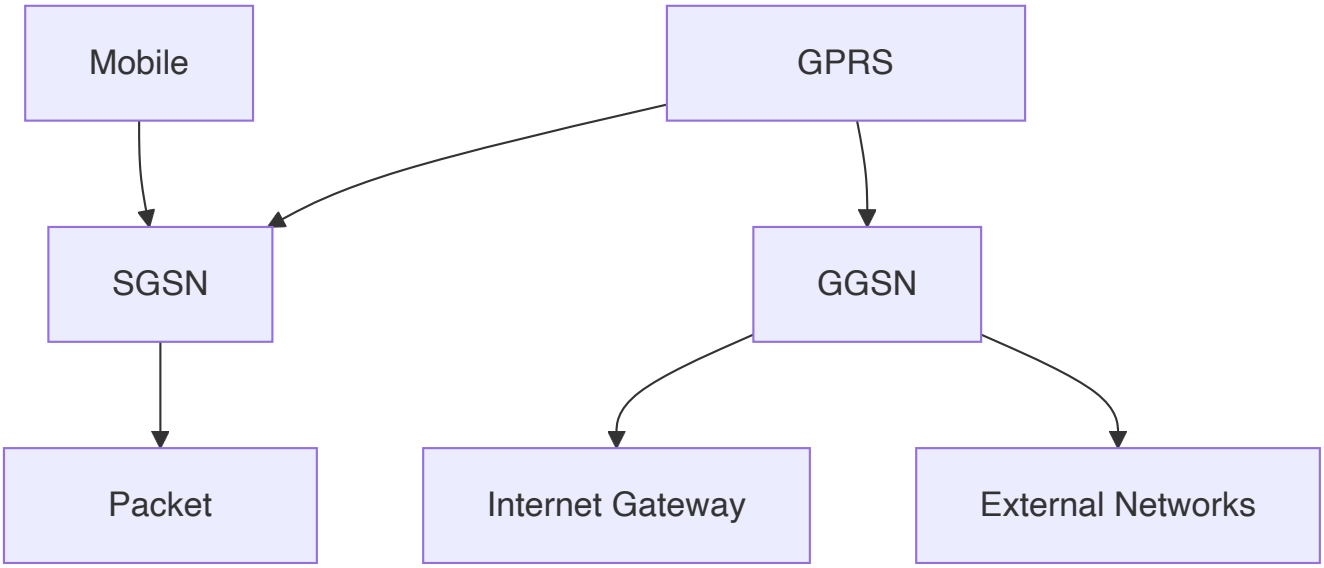
Question 3(c) [7 marks]

Explain GPRS.

Answer:

Table: GPRS Features

Feature	Description	Benefit
Technology	General Packet Radio Service	Data service
Data Rate	Up to 114 kbps	High speed
Connection	Packet switched	Always on
Applications	Internet, email	Data services



- **Packet switching**: Data transmitted in packets, not circuits
- **Always-on connection**: No dial-up required for data access
- **Higher speeds**: Significant improvement over circuit-switched data
- **New nodes**: SGSN and GGSN added to GSM architecture
- **Internet access**: Direct connection to IP networks

Mnemonic: "General Packet Radio Service"

Question 3(a) OR [3 marks]

Explain advantage of CDMA

Answer:

Table: CDMA Advantages

Advantage	Description
Capacity	Higher user capacity
Security	Built-in encryption
Quality	Better voice quality
Power	Efficient power control

- **Increased capacity**: More users per frequency band
- **Enhanced security**: Spread spectrum provides natural encryption
- **Soft handoff**: Better call quality during handoffs

Mnemonic: "Capacity Security Quality"

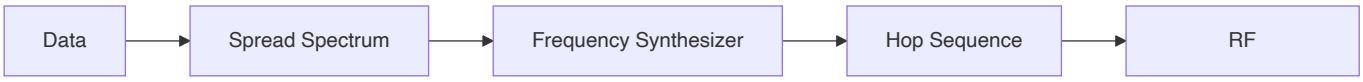
Question 3(b) OR [4 marks]

Explain frequency hopping techniques.

Answer:

Table: Frequency Hopping Types

Type	Hopping Rate	Application
Slow FH	Less than symbol rate	GSM
Fast FH	Greater than symbol rate	Military



- **Frequency hopping**: Carrier frequency changes according to pattern
- **Interference resistance**: Reduces effect of narrowband interference
- **Security enhancement**: Difficult to intercept hopping signals
- **GSM implementation**: Slow frequency hopping used for quality

Mnemonic: "Frequency Hops For Security"

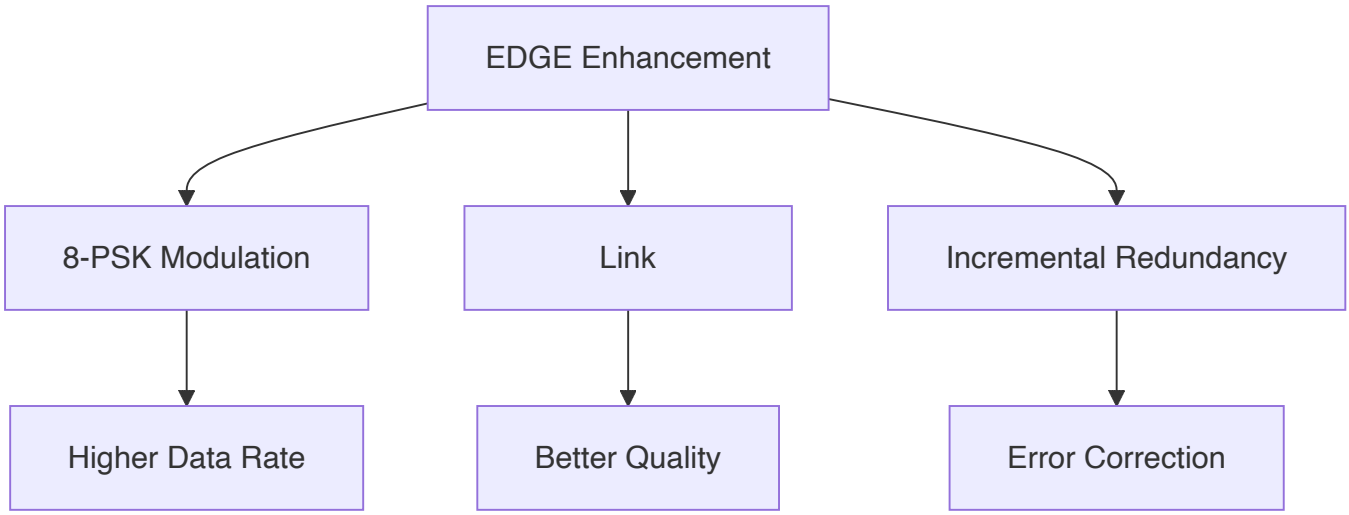
Question 3(c) OR [7 marks]

Explain EDGE.

Answer:

Table: EDGE Specifications

Parameter	Value	Improvement
Full Form	Enhanced Data rate for GSM Evolution	-
Data Rate	Up to 384 kbps	3x GPRS
Modulation	8-PSK	Higher order
Compatibility	GSM/GPRS	Backward compatible



- **Enhanced modulation**: 8-PSK instead of GMSK increases data rate
- **Link adaptation**: Modulation scheme adapts to channel conditions
- **Incremental redundancy**: Improved error correction mechanism
- **Backward compatibility**: Works with existing GSM/GPRS infrastructure
- **3G stepping stone**: Bridge between 2G and 3G technologies

Mnemonic: "Enhanced Data Gets Excellence"

Question 4(a) [3 marks]

Draw FHSS transmitter block diagram

Answer:

```
Data --> Modulator --> Frequency --> RF Amp --> Antenna
Input                Synthesizer
                          ^
                     PN Sequence
                     Generator
```

Table: FHSS Components

Component	Function
PN Generator	Produces hopping sequence
Frequency Synthesizer	Changes carrier frequency
Modulator	Modulates data

Mnemonic: "Data Modulated Frequency Hops"

Question 4(b) [4 marks]

Explain call processing in CDMA

Answer:

Table: CDMA Call Processing

Phase	Process	Purpose
Access	System access	Initial connection
Authentication	Identity verification	Security
Traffic	Communication	Data transfer
Release	Call termination	Resource cleanup

- **System access**: Mobile acquires pilot channel and synchronizes
- **Authentication**: Network verifies subscriber credentials
- **Traffic state**: Active communication with power control
- **Call release**: Resources freed when call ends

Mnemonic: "Access Authenticate Transfer Release"

Question 4(c) [7 marks]

Draw OFDM receiver and explain its working

Answer:

```
RF      --> Down    --> ADC --> Remove  --> FFT --> Parallel --> Channel --> Data
Input       Converter           Cyclic            to Serial    Decoder     Output
                                Prefix            Converter
```

Table: OFDM Receiver Functions

Component	Function	Purpose
Down Converter	RF to baseband	Frequency conversion
ADC	Analog to digital	Signal digitization
Remove CP	Cyclic prefix removal	ISI elimination
FFT	Fast Fourier Transform	Subcarrier separation
Channel Decoder	Error correction	Data recovery

- **RF processing**: Converts received RF signal to baseband
- **Digital conversion**: ADC samples the analog signal
- **Prefix removal**: Cyclic prefix removed to eliminate ISI
- **FFT processing**: Separates orthogonal subcarriers
- **Data recovery**: Channel decoding recovers original data

Mnemonic: "Receive Convert Remove Transform Decode"

Question 4(a) OR [3 marks]

Explain radiation hazard due to mobile.

Answer:

Table: Mobile Radiation Effects

Parameter	Value	Effect
SAR	Specific Absorption Rate	Tissue heating
Frequency	900/1800 MHz	Penetration depth
Power	Transmit power	Exposure level

- **SAR measurement**: Specific Absorption Rate measures energy absorption
- **Thermal effects**: High SAR can cause tissue heating
- **Safety limits**: International standards limit SAR values

Mnemonic: "SAR Safety Absorption Rate"

Question 4(b) OR [4 marks]

Explain Li-Po type batteries used in mobile handset.

Answer:

Table: Li-Po Battery Characteristics

Feature	Description	Advantage
Chemistry	Lithium Polymer	High energy density
Shape	Flexible form factor	Design freedom
Weight	Lightweight	Portability
Charging	Fast charging	User convenience

- **Polymer electrolyte**: Uses polymer instead of liquid electrolyte
- **Flexible packaging**: Can be shaped to fit device design
- **High energy density**: More capacity in smaller size
- **Fast charging**: Supports rapid charging protocols

Mnemonic: "Lithium Polymer Power"

Question 4(c) OR [7 marks]

Explain mobile handset block diagram.

Answer:

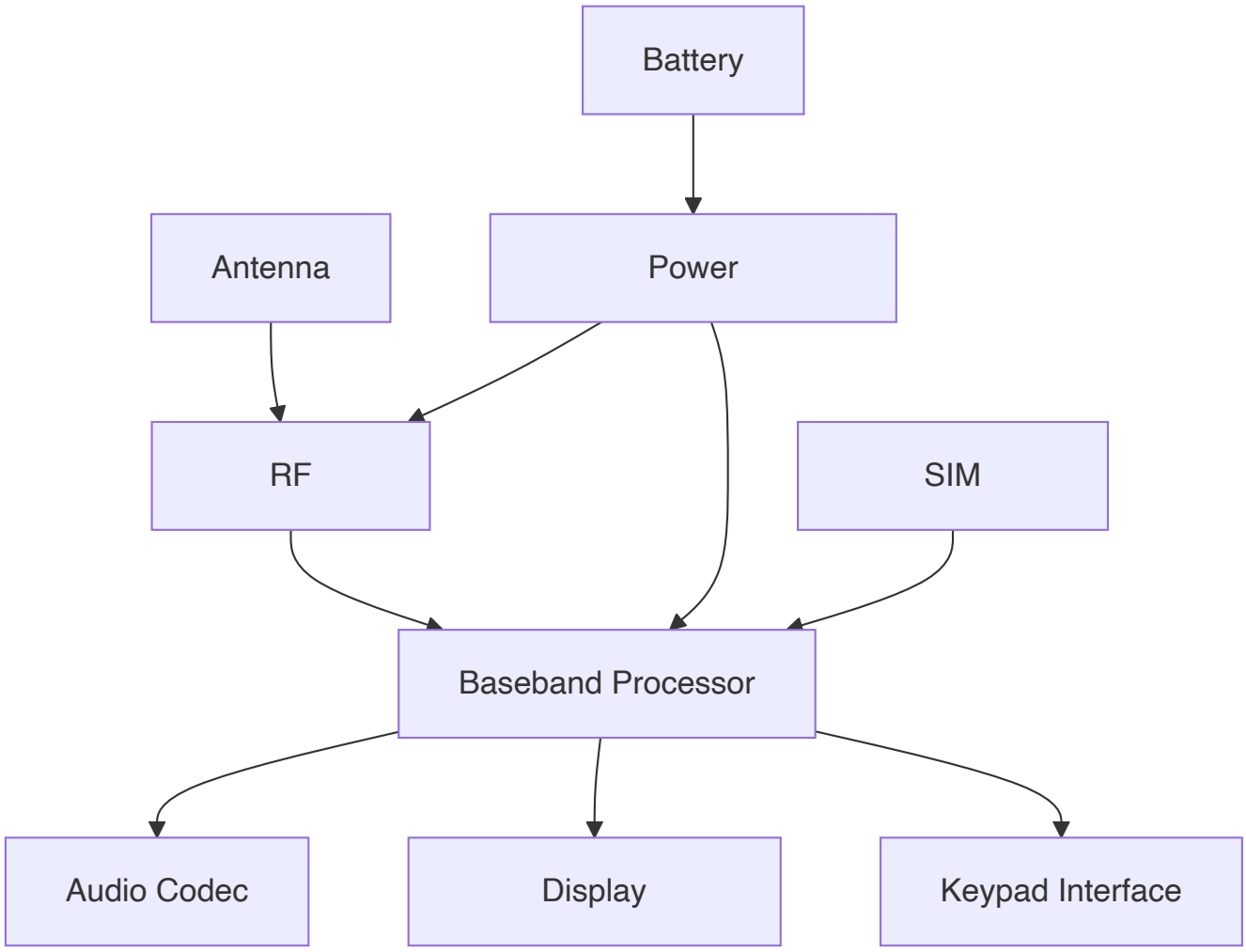


Table: Mobile Handset Components

Section	Function	Purpose
RF Section	Radio frequency processing	Air interface
Baseband	Digital signal processing	Protocol handling
Audio Codec	Voice processing	Sound conversion
Power Management	Battery control	Power efficiency
SIM Interface	Subscriber identity	User authentication

- **RF section**: Handles transmission and reception of radio signals
- **Baseband processor**: Implements communication protocols
- **Audio subsystem**: Processes voice and audio signals
- **Power management**: Controls battery usage and charging
- **User interface**: Display, keypad, and user interaction

Mnemonic: "Radio Baseband Audio Power Interface"

Question 5(a) [3 marks]

Compare CDMA and GSM

Answer:

Table: CDMA vs GSM Comparison

Feature	CDMA	GSM
Access Method	Code Division	Time Division
Capacity	Higher	Lower
Handoff	Soft	Hard
SIM Card	Not required	Required

Mnemonic: "Code vs Time Division"

Question 5(b) [4 marks]

Explain HSDPA.

Answer:

Table: HSDPA Features

Feature	Description
Full Form	High Speed Downlink Packet Access
Data Rate	Up to 14.4 Mbps
Technology	3.5G enhancement
Direction	Downlink optimization

- **3.5G technology**: Enhancement to 3G UMTS system
- **High speed downlink**: Optimized for download applications
- **Adaptive modulation**: QPSK to 16-QAM based on channel
- **Fast scheduling**: 2ms scheduling intervals

Mnemonic: "High Speed Download Access"

Question 5(c) [7 marks]

Explain architecture, features and advantage of Bluetooth.

Answer:

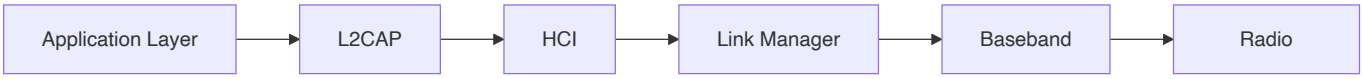


Table: Bluetooth Features

Feature	Description	Advantage
Range	10 meters	Personal area network
Frequency	2.4 GHz ISM	Unlicensed band
Topology	Star/Scatternet	Flexible connections
Power	Low power	Battery efficiency

Table: Bluetooth Applications

Application	Use Case
Audio	Wireless headphones
Data	File transfer
Input	Wireless keyboard/mouse
Networking	Internet sharing

- **Short range**: Designed for personal area networks
- **Low power**: Optimized for battery-powered devices
- **Frequency hopping**: 79 channels for interference resistance
- **Master-slave**: One master can connect to 7 slaves
- **Applications**: Audio, data transfer, input devices

Mnemonic: "Blue Personal Area Network"

Question 5(a) OR [3 marks]

Explain basic concept of RFID.

Answer:

Table: RFID Components

Component	Function
RFID Tag	Stores identification data
RFID Reader	Reads tag information
Antenna	RF communication
Backend System	Data processing

- **Radio frequency identification**: Uses RF waves for identification
- **Contactless operation**: No physical contact required
- **Automatic identification**: Reads tags automatically in range

Mnemonic: "Radio Frequency Identifies"

Question 5(b) OR [4 marks]

Explain architecture of 5G system.

Answer:

Table: 5G Architecture Components

Component	Function
gNodeB	5G base station
AMF	Access and Mobility Function
SMF	Session Management Function
UPF	User Plane Function

- **Service-based architecture**: Modular network functions
- **Network slicing**: Virtual networks for different services
- **Edge computing**: Processing closer to users
- **Massive MIMO**: Multiple antenna technology

Mnemonic: "Service Based Network Slicing"

Question 5(c) OR [7 marks]

Explain MANET in detail.

Answer:

Table: MANET Characteristics

Feature	Description	Benefit
Infrastructure	Infrastructure-less	No base stations needed
Mobility	Mobile nodes	Dynamic topology
Routing	Multi-hop routing	Extended coverage
Self-organizing	Automatic configuration	Easy deployment

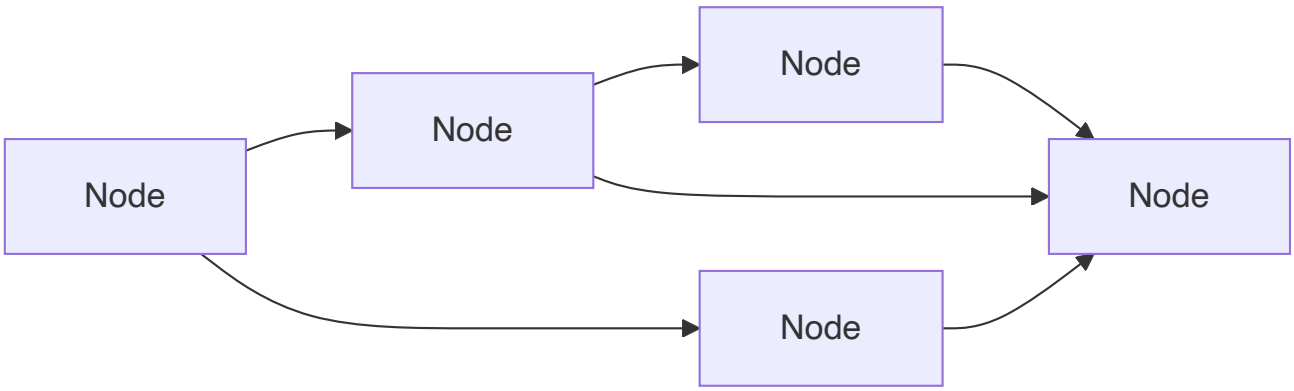


Table: MANET vs Cellular Network

Parameter	MANET	Cellular
Infrastructure	None	Base stations required
Topology	Dynamic	Fixed
Range	Multi-hop	Single hop
Cost	Low	High infrastructure cost

- **Mobile Ad-hoc Network**: Self-configuring network of mobile devices

- **No infrastructure**: Nodes communicate directly without base stations
- **Dynamic routing**: Routes change as nodes move
- **Multi-hop communication**: Messages relay through intermediate nodes
- **Applications**: Military, disaster recovery, sensor networks

Mnemonic: "Mobile Adhoc Network"