

# Mobile & Wireless Communication (4351104) - Winter 2023 Solution

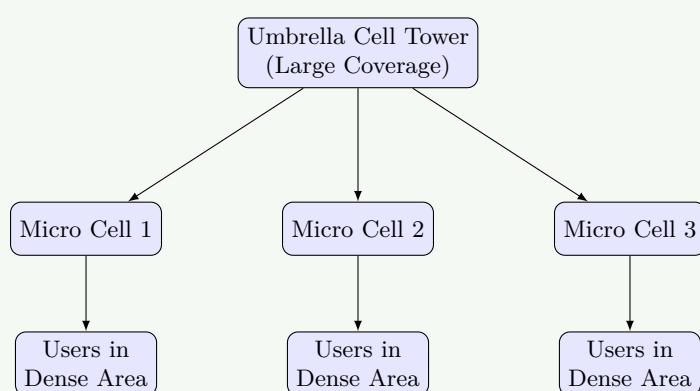
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December 12, 2023

## Question 1(a) [3 marks]

Draw & Explain umbrella cell.

### Solution



- **Umbrella Cell:** Large coverage cell overlaying smaller cells.
- **Purpose:** Handles overflow traffic from micro/pico cells.
- **Coverage:** Provides backup coverage for high-traffic areas.

### Mnemonic

“Under My Big Umbrella”

## Question 1(b) [4 marks]

Define full forms: (i) CCH (ii) TCH (iii) SCH (iv) BCCH

### Solution

Acronym	Full Form	Function
CCH	Control Channel	Carries control information
TCH	Traffic Channel	Carries voice/data traffic
SCH	Synchronization Channel	Provides timing sync
BCCH	Broadcast Control Channel	Broadcasts system info

### Mnemonic

“Control Traffic Sync Broadcast”

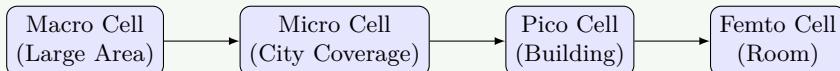
## Question 1(c) [7 marks]

What is cell? Explain different types of cells.

### Solution

Cell is the basic coverage area served by one base station in cellular communication.

Cell Type	Coverage	Power	Usage
Macro Cell	1-30 km	High	Rural areas
Micro Cell	100m-2km	Medium	Urban areas
Pico Cell	10-100m	Low	Indoor coverage
Femto Cell	10-30m	Very Low	Home/office



- **Function:** Each cell provides wireless service to mobile users.
- **Frequency Reuse:** Same frequencies used in non-adjacent cells.
- **Handoff:** Users move between cells seamlessly.

### Mnemonic

“Many Mobile People Find coverage”

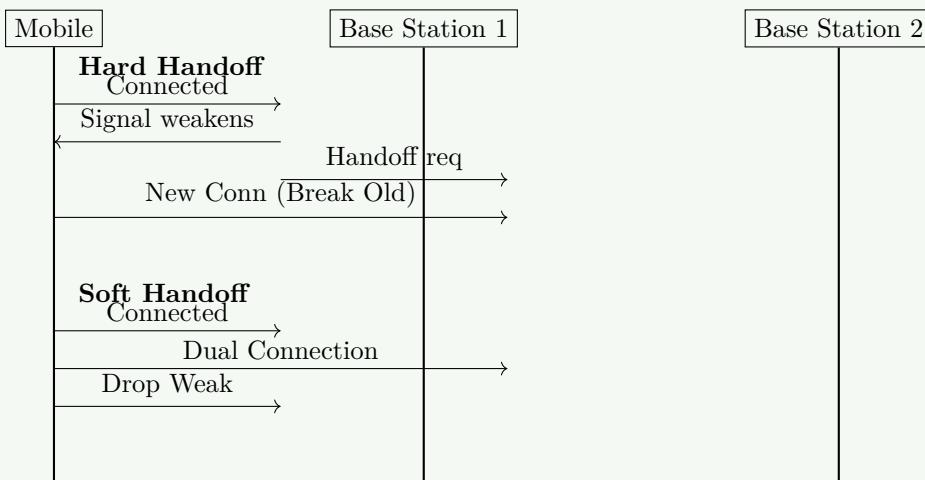
## Question 1(c) OR [7 marks]

What is handoff? Explain soft and hard handoffs.

### Solution

**Handoff** is the process of transferring an ongoing call from one cell to another as mobile moves.

Feature	Hard Handoff	Soft Handoff
<b>Connection</b>	Break-before-make	Make-before-break
<b>Channels</b>	One at a time	Multiple simultaneously
<b>Technology</b>	GSM, TDMA	CDMA
<b>Quality</b>	Brief interruption	Seamless transition



- **Initiation:** Based on signal strength measurements.

- **MAHO:** Mobile Assisted Handoff improves decision accuracy.

### Mnemonic

“Hard Hurts, Soft Smooth”

## Question 2(a) [3 marks]

Define full forms: (i) SIM (ii) LTE (iii) WCDMA

### Solution

Acronym	Full Form	Purpose
SIM	Subscriber Identity Module	User authentication
LTE	Long Term Evolution	4G technology
WCDMA	Wideband Code Division Multiple Access	3G standard

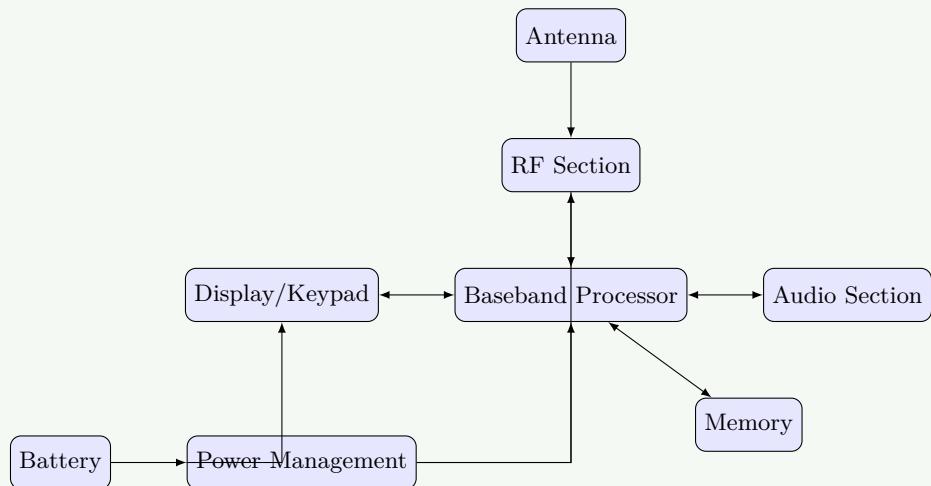
### Mnemonic

“Subscriber’s Long Wideband connection”

## Question 2(b) [4 marks]

Draw mobile handset block diagram.

### Solution



- **RF Section:** Transmits/receives radio signals.
- **Baseband:** Processes digital signals and protocols.
- **Audio:** Handles voice input/output.
- **Power Management:** Controls battery usage efficiently.

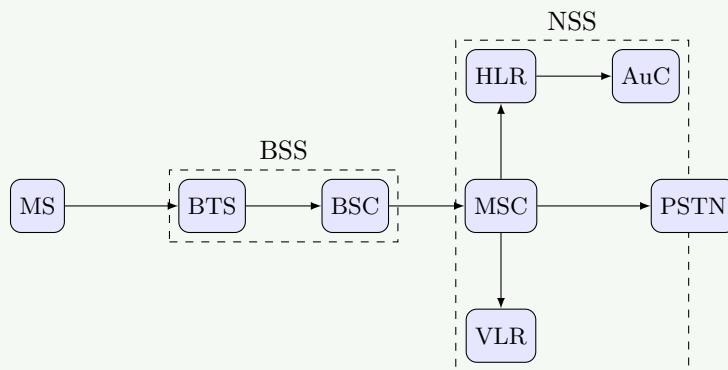
### Mnemonic

“Radio Baseband Audio Power”

## Question 2(c) [7 marks]

Explain GSM architecture with diagram.

### Solution



Component	Function
<b>MS</b>	Mobile Station (handset)
<b>BTS</b>	Base Transceiver Station
<b>BSC</b>	Base Station Controller
<b>MSC</b>	Mobile Switching Center
<b>HLR</b>	Home Location Register
<b>VLR</b>	Visitor Location Register

- **BSS:** Base Station Subsystem handles radio interface.
- **NSS:** Network Switching Subsystem manages calls.
- **Authentication:** AuC verifies subscriber identity.

### Mnemonic

“Mobile Base Network calls Home”

## Question 2(a) OR [3 marks]

Define full forms: (i) RSSI (ii) MAHO (iii) NCHO

### Solution

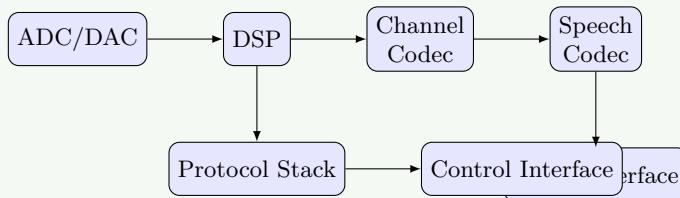
Acronym	Full Form	Function
RSSI	Received Signal Strength Indicator	Signal quality measurement
MAHO	Mobile Assisted Handoff	Mobile helps handoff decision
NCHO	Network Controlled Handoff	Network decides handoff

### Mnemonic

“Received Mobile Network signals”

## Question 2(b) OR [4 marks]

Draw baseband section block diagram.

**Solution**

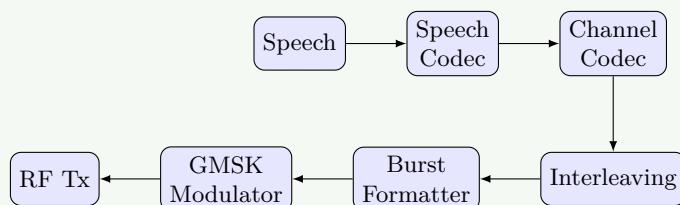
- **ADC/DAC:** Analog to Digital conversion.
- **DSP:** Digital Signal Processor.
- **Channel Codec:** Error correction coding.
- **Speech Codec:** Voice compression/decompression.

**Mnemonic**

“Analog Digital Speech Protocol”

**Question 2(c) OR [7 marks]**

Explain GSM signal processing with diagram.

**Solution**

Stage	Function	Purpose
Speech Codec	Compress voice to 13 kbps	Bandwidth efficiency
Channel Codec	Add error correction	Signal reliability
Interleaving	Distribute burst errors	Error protection
GMSK	Gaussian MSK modulation	Spectral efficiency

- **Processing Rate:** 270.833 kbps gross bit rate.
- **Frame Structure:** 8 time slots per TDMA frame.
- **Frequency Hopping:** 217 hops per second.

**Mnemonic**

“Speech Channel Interleaves Modulated Radio”

**Question 3(a) [3 marks]**

Explain cell splitting.

**Solution**

Cell splitting divides congested cells into smaller cells to increase capacity.

- **Process:** Replace high-power cell with multiple low-power cells.
- **Benefit:** Increases system capacity by frequency reuse.

- Implementation:** Reduce antenna height and transmit power.

**Mnemonic**

“Split Small Cells”

**Question 3(b) [4 marks]**

Explain Li-Ion type batteries used in mobile handset with its advantages and disadvantages.

**Solution**

Advantages	Disadvantages
High energy density	Safety concerns
No memory effect	Degradation over time
Low self-discharge	Temperature sensitive
Lightweight	Expensive

- Chemistry:** Lithium ions move between electrodes.
- Voltage:** 3.7V nominal per cell.
- Capacity:** Measured in mAh (milliampere-hours).

**Mnemonic**

“Light Ion Energy Safety”

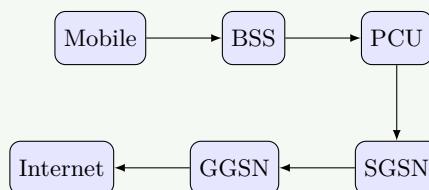
**Question 3(c) [7 marks]**

Explain GPRS.

**Solution**

**GPRS** (General Packet Radio Service) provides packet-switched data service over GSM.

Feature	Specification
Data Rate	Up to 171.2 kbps
Technology	Packet switching
Channels	Uses multiple time slots
Billing	Based on data volume



- PCU:** Packet Control Unit manages packet data.
- SGSN:** Serving GPRS Support Node.
- GGSN:** Gateway GPRS Support Node.
- Classes:** Class 1-12 with different speed/slot combinations.

**Mnemonic**

“General Packet Radio Service”

**Question 3(a) OR [3 marks]**

Explain cell sectoring.

**Solution**

Cell sectoring divides omnidirectional cell into sectors using directional antennas.

- **Common:** 3-sector ( $120^\circ$ ) or 6-sector ( $60^\circ$ ) configurations.
- **Benefit:** Reduces co-channel interference.
- **Implementation:** Directional antennas at same site.

**Mnemonic**

“Sector Reduces Interference”

**Question 3(b) OR [4 marks]**

Explain Li-Po type batteries used in mobile handset with its advantages and disadvantages.

**Solution**

Advantages	Disadvantages
Flexible shape	Lower energy density
Ultra-thin design	Shorter lifespan
Lightweight	Safety risks
No memory effect	Higher cost

- **Technology:** Lithium Polymer electrolyte.
- **Form Factor:** Can be molded into various shapes.
- **Voltage:** 3.7V nominal per cell.

**Mnemonic**

“Polymer Flexible Thin Light”

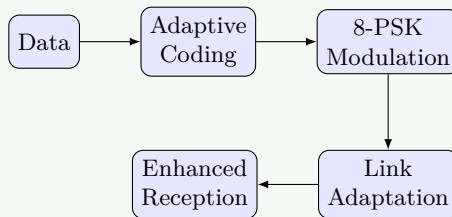
**Question 3(c) OR [7 marks]**

Explain EDGE.

**Solution**

EDGE (Enhanced Data rates for GSM Evolution) improves GSM data rates.

Parameter	GSM	EDGE
Modulation	GMSK	8-PSK
Data Rate	9.6 kbps	Up to 384 kbps
Error Correction	Basic	Advanced
Spectrum	Same as GSM	Same as GSM



- **8-PSK:** 8-Phase Shift Keying provides 3 bits per symbol.
- **Link Adaptation:** Adjusts coding scheme based on channel quality.
- **Incremental Redundancy:** Improves error correction efficiency.

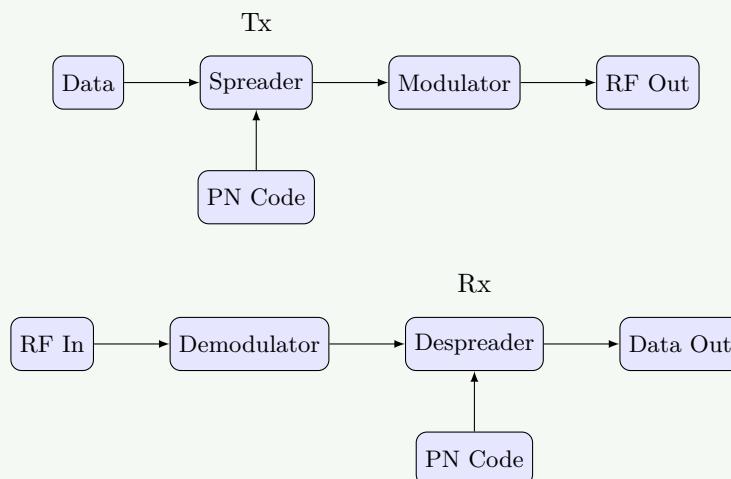
#### Mnemonic

“Enhanced Data GSM Evolution”

### Question 4(a) [3 marks]

Draw DSSS transmitter and receiver block diagram.

#### Solution



- **Spreader:** Multiplies data with PN sequence.
- **Despread:** Correlates received signal with same PN code.
- **Processing Gain:** Ratio of spread to original bandwidth.

#### Mnemonic

“Direct Sequence Spread Spectrum”

### Question 4(b) [4 marks]

Compare CDMA and GSM.

**Solution**

Parameter	CDMA	GSM
Multiple Access	Code Division	Time Division
Capacity	Higher (soft capacity)	Fixed capacity
Handoff	Soft handoff	Hard handoff
Power Control	Critical	Less critical
Frequency Planning	Not required	Required
Voice Quality	Better	Good

**Mnemonic**

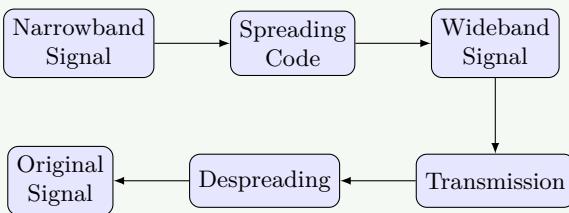
“Code Division vs Time Division”

**Question 4(c) [7 marks]**

Explain concept of spread spectrum with applications.

**Solution**

**Spread Spectrum** spreads signal bandwidth much wider than required for data transmission.



Type	Method	Application
<b>DSSS</b>	PN sequence multiplication	CDMA, WiFi
<b>FHSS</b>	Frequency hopping	Bluetooth
<b>THSS</b>	Time hopping	UWB systems

Benefits:

- **Anti-jamming:** Resistant to interference.
- **Low Power Density:** Difficult to detect.
- **Multiple Access:** Many users share spectrum.
- **Multipath Resistance:** Resolves delayed signals.

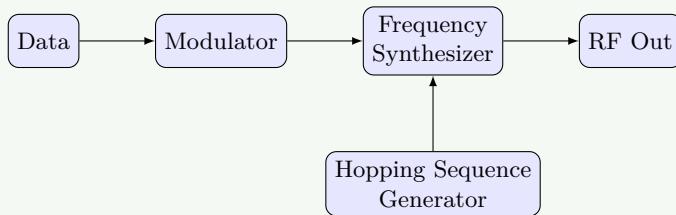
Applications: GPS, WiFi, Bluetooth, Military communications.

**Mnemonic**

“Spread Signal Spectrum Security”

**Question 4(a) OR [3 marks]**

Draw FHSS transmitter block diagram.

**Solution**

- **Frequency Synthesizer:** Changes carrier frequency rapidly.
- **Hopping Sequence:** Pseudo-random frequency pattern.
- **Dwell Time:** Time spent on each frequency.

**Mnemonic**

“Frequency Hopping Spread Spectrum”

**Question 4(b) OR [4 marks]**

Explain call processing in CDMA.

**Solution**

Phase	Process	Description
<b>System Access</b>	Power control	Mobile adjusts power
<b>Call Setup</b>	Channel assignment	Assign Walsh code
<b>Traffic</b>	Soft handoff	Multiple base stations
<b>Call Release</b>	Power down	Gradual power reduction

- **Rake Receiver:** Combines multipath signals.
- **Power Control:** 800 times per second.
- **Soft Capacity:** Degrades gracefully with load.

**Mnemonic**

“Code Division Multiple Access”

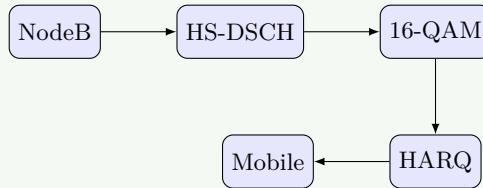
**Question 4(c) OR [7 marks]**

Explain HSDPA.

**Solution**

**HSDPA** (High Speed Downlink Packet Access) enhances WCDMA downlink data rates.

Feature	Enhancement
<b>Data Rate</b>	Up to 14.4 Mbps
<b>Modulation</b>	16-QAM
<b>HARQ</b>	Hybrid ARQ
<b>Fast Scheduling</b>	2ms TTI



- **HS-DSCH:** High Speed Downlink Shared Channel.
- **AMC:** Adaptive Modulation and Coding.
- **Fast Cell Selection:** Improves cell edge performance.
- **MIMO:** Multiple antenna configurations possible.

#### Mnemonic

“High Speed Downlink Packet Access”

## Question 5(a) [3 marks]

List LTE specifications.

#### Solution

Parameter	Specification
<b>Peak Data Rate</b>	300 Mbps DL, 75 Mbps UL
<b>Bandwidth</b>	1.4 to 20 MHz
<b>Latency</b>	<10ms user plane
<b>Mobility</b>	Up to 350 km/h
<b>Spectrum Efficiency</b>	3-4x better than 3G

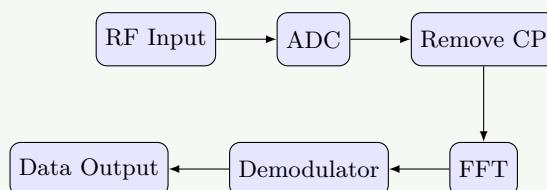
#### Mnemonic

“Long Term Evolution specifications”

## Question 5(b) [4 marks]

Draw OFDM receiver and explain its working.

#### Solution



- **FFT:** Fast Fourier Transform converts time to frequency domain.
- **Cyclic Prefix:** Guards against inter-symbol interference.
- **Subcarriers:** Parallel transmission on multiple frequencies.
- **Demodulation:** QPSK/16QAM/64QAM per subcarrier.

**Mnemonic**

“Orthogonal Frequency Division Multiplexing”

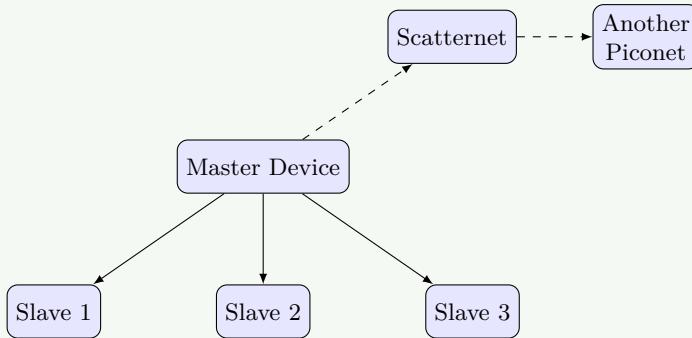
**Question 5(c) [7 marks]**

Explain Bluetooth Technology & list its applications.

**Solution**

**Bluetooth** is short-range wireless communication technology for personal area networks.

Parameter	Specification
<b>Range</b>	10m (Class 2)
<b>Frequency</b>	2.4 GHz ISM band
<b>Data Rate</b>	Up to 3 Mbps
<b>Topology</b>	Piconet (8 devices)

**Protocol Stack:**

- **RF Layer:** Physical radio interface.
- **Baseband:** Medium access control.
- **L2CAP:** Logical Link Control.
- **Applications:** Various profiles (A2DP, HID, etc.).

**Applications:**

- Audio devices (headphones, speakers)
- File transfer between devices
- Input devices (keyboard, mouse)
- Health monitoring devices
- Smart home automation

**Mnemonic**

“Blue Tooth Personal Area Network”

**Question 5(a) OR [3 marks]**

List advantages of 5G Technology.

**Solution**

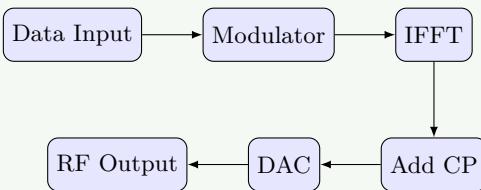
Advantage	Benefit
Ultra-low latency	<1ms response time
High data rates	Up to 10 Gbps
Massive connectivity	1M devices/km <sup>2</sup>
Network slicing	Customized services
Energy efficiency	90% more efficient

**Mnemonic**

“Fifth Generation advantages”

**Question 5(b) OR [4 marks]**

Draw OFDM transmitter and explain its working.

**Solution**

- **Modulation:** Maps bits to symbols (QPSK/QAM).
- **IFFT:** Inverse FFT converts frequency to time domain.
- **Cyclic Prefix:** Copies end samples to beginning.
- **DAC:** Digital to Analog Converter for transmission.

**Mnemonic**

“Orthogonal Frequency Division Multiplexing Transmitter”

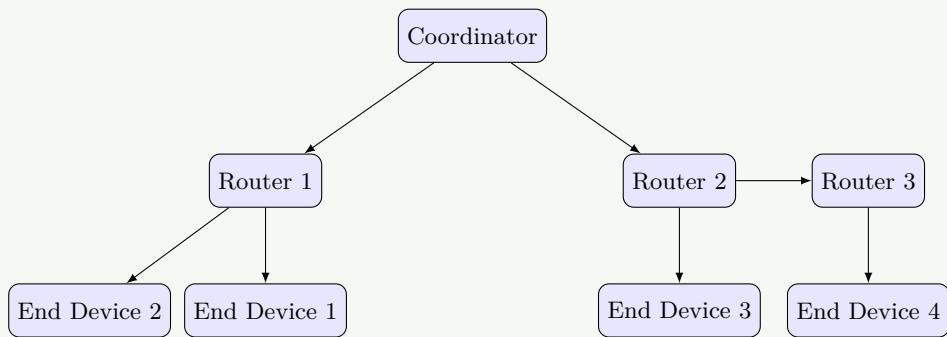
**Question 5(c) OR [7 marks]**

Explain Zigbee Technology & list its applications.

**Solution**

Zigbee is low-power wireless mesh networking standard based on IEEE 802.15.4.

Parameter	Specification
Range	10-100m
Data Rate	250 kbps
Power	Very low (battery years)
Topology	Mesh network
Frequency	2.4 GHz globally

**Network Roles:**

- **Coordinator:** Network manager.
- **Router:** Forwards messages.
- **End Device:** Simple sensors/actuators.

**Applications:**

- Home automation (lights, thermostats)
- Industrial monitoring
- Smart grid systems
- Healthcare monitoring
- Agricultural sensors
- Building management systems

**Features:**

- **Self-healing:** Automatic route discovery.
- **Low cost:** Simple implementation.
- **Secure:** AES encryption.
- **Reliable:** Mesh redundancy.

**Mnemonic**

“Zigbee Mesh Network Applications”