

**WIRELESS SENSOR NETWORKS
(CSE5143)**

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) Which component of a sensor node is primarily responsible for data acquisition?
(a) Microcontroller (b) Transceiver
(c) Sensor (d) Battery.
- (ii) A query-driven sensing scenario typically occurs when
(a) the network continuously samples data
(b) the sink requests specific information on demand
(c) events trigger the sensing nodes
(d) sensors remain idle until reprogrammed.
- (iii) The hidden-terminal problem occurs when
(a) two nodes cannot sense each other's transmissions
(b) the base station goes offline
(c) all nodes use TDMA
(d) the routing table becomes full
- (iv) Which protocol uses synchronization and sleep scheduling to reduce idle listening?
(a) S-MAC (b) CSMA
(c) ALOHA (d) BTMA.
- (v) Contention-free MAC protocols are most suitable for
(a) sparse deployments
(b) high traffic and delay-sensitive applications
(c) random event detection
(d) energy-harvesting nodes only.
- (vi) In Geographic routing, forwarding decisions depend mainly on
(a) source node ID (b) hop count
(c) physical location of nodes (d) routing table size.

- (vii) In WSN routing, data aggregation is used to
 - (a) increase redundancy
 - (b) minimize energy usage by combining data
 - (c) delay packet transmission
 - (d) enhance congestion.
- (viii) A Sybil attack in WSN occurs when
 - (a) a node replicates itself with multiple identities
 - (b) two nodes share the same encryption key
 - (c) the base station malfunctions
 - (d) packets are dropped due to buffer overflow.
- (ix) In RBS synchronization, time reference is distributed by
 - (a) GPS signals
 - (b) reference broadcast messages
 - (c) timestamp piggybacking
 - (d) MAC beacons only.
- (x) Underwater WSNs differ from terrestrial WSNs because
 - (a) they use acoustic signals and face higher propagation delay
 - (b) they use infrared sensors
 - (c) they operate with optical wireless communication
 - (d) they do not require synchronization.

Fill in the blanks with the correct word

- (xi) The four main components of a sensor node are sensing unit, _____, transceiver unit, and power unit.
- (xii) In a duty-cycled MAC protocol, nodes periodically switch between _____ and _____ states to conserve energy.
- (xiii) A TDMA-based MAC protocol allocates separate _____ to each node for collision-free transmission.
- (xiv) In geographic routing, nodes use their _____ information to make forwarding decisions without global topology knowledge.
- (xv) The OGDC algorithm in WSNs addresses the _____ problem by controlling node density and sensing coverage.

Group - B

2. (a) Draw and explain the architecture of a typical sensor node. Describe the functions of sensing, processing, communication, and power units. [[CO2](Understand/LOCQ)]
 (b) Predict how edge computing and 6G technologies may shape the next generation of WSNs. [[CO4](Create/HOCQ)]
8 + 4 = 12

3. (a) A city wants to deploy a WSN for real-time traffic monitoring. Identify the major design parameters that must be considered. Explain how node architecture and communication protocols influence performance in such a deployment. [[CO2, CO4](Apply/IOCQ)]
 (b) Suggest one optimization strategy to improve network lifetime under high data load conditions. [[CO5](Evaluate/HOCQ)]
6 + 6 = 12

Group - C

4. (a) Identify any three performance issues of WSN MAC protocols and describe their causes. *[[CO5](Remember/LOCQ)]*
(b) Explain how hidden and exposed terminal problems degrade MAC layer efficiency. *[[CO3](Understand/IOCQ)]*
(c) Suggest a design-level optimization to overcome both issues while maintaining low overhead. *[[CO4](Apply/HOCQ)]*
4 + 4 + 4 = 12
5. (a) Explain the basic operation of a TDMA-based MAC protocol with a neat time-slot diagram. *[[CO3](Understand/LOCQ)]*
(b) Discuss how slot assignment and synchronization affect throughput. *[[CO5](Analyze/IOCQ)]*
(c) Suggest how TDMA can be adapted for event-driven emergency WSNs. *[[CO4](Apply/HOCQ)]*
4 + 4 + 4 = 12

Group - D

6. (a) Design a cluster-based routing architecture that supports macro-level task distribution through macroprogramming. *[[CO4](Create/IOCQ)]*
(b) Analyze how dynamic reprogramming can adapt routing decisions in real time during a disaster monitoring operation. *[[CO6](Analyze/HOCQ)]*
6 + 6 = 12
7. (a) Explain the concept of geographic routing with an example protocol (GEAR or GPSR). *[[CO3](Understand/LOCQ)]*
(b) Describe how location information is used for forwarding and path selection. *[[CO4](Apply/IOCQ)]*
(c) Discuss the limitations of GPS-based position estimation in indoor WSN applications. *[[CO5](Evaluate/HOCQ)]*
4 + 8 = 12

Group - E

8. (a) Define the coverage problem in WSNs and classify it as area, point, or barrier coverage. *[[CO3](Understand/IOCQ)]*
(b) Explain the working principle of the OGDC (Optimal Geographical Density Control) algorithm for coverage optimization. *[[CO4](Apply/IOCQ)]*
(c) Derive how sensor placement and sensing radius jointly affect coverage probability. *[[CO5](Analyze/HOCQ)]*
5 + 3 + 4 = 12
9. (a) Define opportunistic routing and describe how it differs from deterministic routing. *[[CO3](Understand/LOCQ)]*

- (b) Model the node transmission process as a Markov chain, defining states, transition probabilities, and steady-state behaviour. *[(CO5)(Analyze/HOCQ)]*
- (c) Derive a performance metric (e.g., expected number of successful transmissions) using the Markov model. *[(CO5)(Evaluate/IOCQ)]*
- 4 + 4 + 4 = 12**
-

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	23.96	37.5	38.54