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| Enroll No |
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K.E.Society's  
**Rajarambapu Institute of Technology, Rajaramnagar**  
 (An Empowered Autonomous Institute, Affiliated to SUK)  
 End Semester Examination (Nov./Dec. 2025)  
 T.Y.B.Tech. Robotics & Automation V

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| Q.P.Code |
| E 1224   |

**Course Code:** RA311

**Course Name:** PE-I Wireless Sensors Networks for Robotics

Day & Date: Monday 10/11/2025

Time : 10:30 To 1:30

Max Marks: 100

- Instructions:**
- 1) All questions are compulsory.
  - 2) Figures in rounded( ) brackets within the question, indicate the scheme of marking for respective part of the question, whereas, figures in the first right column indicate total marks for that whole question.
  - 3) CO is the index number of the Course Outcome statement.
  - 4) The Bloom's taxonomy level (BL) for 1,2,3,4,5 and 6 is remember, understand, apply, analyze, evaluate and create respectively.
  - 5) Assume suitable data if necessary.
  - 6) Use of non-programmable calculators is allowed

| Q.1 |  | Marks | COs | BT Level |
|-----|--|-------|-----|----------|
| (a) | Explain the major constraints (2) and challenges (3) encountered in Wireless Sensor Networks.                                      | 5     | 1   | 2        |
| (b) | Explain the architecture (3) and major components (2) of a typical sensor node in WSNs.  | 5     | 1   | 2        |
| (c) | Apply the concept of clustering (3) to enhance energy efficiency and data management in WSNs (2).                                  | 5     | 1   | 3        |
| (d) | Analyze the basic concepts (3) and architecture (2) of Wireless Sensor Networks (WSNs).  | 5     | 1   | 4        |
| OR  |  |       |     |          |
| (d) | Analyze the hardware features of MICA 2 (2.5) and Telos B (2.5) sensor nodes in WSNs   | 5     | 1   | 4        |
| Q.2 |  |       |     |          |
| (a) | Explain the major security challenges (2) in robotic wireless networks and methods (3) to ensure secure communication.             | 5     | 2   | 2        |
| (b) | Explain how Edge and Fog Computing support low-latency and real-time decision-making in wireless sensor networks. (2.5*2)          | 5     | 2   | 2        |
| (c) | Apply transceiver design considerations (3) to optimize performance and reliability in wireless robotic communication systems. (3) | 5     | 2   | 3        |
| (d) | Analyze how Low Duty Cycle Protocols enhance energy efficiency and network lifetime in robotic sensor networks. (Dia 2)            | 5     | 2   | 4        |
| OR  |  |       |     |          |
| (d) | Analyze the working of MACA Protocols and explain how they minimize data collision in real-time wireless communication. (Dia 2)    | 5     | 2   | 4        |

Q.3



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|-----|---|---|---|---|
| (a) | Explain how threat modeling and risk assessment improve the security of robotic WSNs. (2.5 *2)              | 5 | 3 | 2 |
| (b) | Explain the role of encryption techniques in securing communication within robotic sensor networks. (Dia 2) | 5 | 3 | 2 |
| (c) | Analyze the role of Zero-Trust and Post-Quantum Security principles in robotic WSNs. (2.5 *2)               | 5 | 3 | 4 |

OR

- |     |   |   |   |   |
|-----|---|---|---|---|
| (c) | Analyze cybersecurity requirements in industrial robotic and cyber-physical systems. (2.5 *2) | 5 | 3 | 4 |
|-----|---|---|---|---|

Q.4

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|-----|--|---|---|---|
| (a) | Explain how network resilience and self-healing techniques support robust robotic WSNs. (2.5 *2) | 5 | 3 | 2 |
| (b) | Explain fault tolerance (3) methods that enhance reliability in robotic sensor networks.         | 5 | 3 | 2 |
| (c) | Apply cybersecurity measures to secure industrial robotic and cyber-physical systems. (2.5 *2)   | 5 | 3 | 3 |

OR

- |     |   |   |   |   |
|-----|---|---|---|---|
| (c) | Apply cybersecurity strategies to overcome challenges in Wireless Sensor Networks (WSNs) for robotic systems. (Dia 2) | 5 | 3 | 3 |
|-----|---|---|---|---|

Q.5

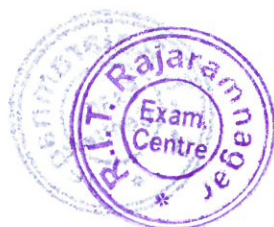
- |     |  |   |   |   |
|-----|--|---|---|---|
| (a) | Explain how Digital Twin technology (2) supported by WSN enhances robotic operations and system optimization in smart manufacturing. | 5 | 4 | 2 |
| (b) | Explain the role of WSN-based sensor integration (3) in improving safety and adaptability in collaborative robotic systems.          | 5 | 4 | 2 |
| (c) | Analyze the role of WSN in enhancing navigation, localization, and coordination (3) of AMRs and AGVs (2) in industrial environments. | 5 | 4 | 4 |

OR

- |     |   |   |   |   |
|-----|---|---|---|---|
| (c) | Analyze how WSN connectivity enables cloud-based monitoring and control in Robotics-as-a-Service (RaaS) applications. (2.5*2) | 5 | 4 | 4 |
|-----|---|---|---|---|

Q.6

- |     |   |   |   |   |
|-----|---|---|---|---|
| (a) | Explain how WSN integration with IORT (3) enables real-time communication and smart decision-making in industrial robotics.       | 5 | 4 | 2 |
| (b) | Explain how Siemens uses WSN and Digital Twin technologies (3) for predictive maintenance and efficiency in robotic manufacturing | 5 | 4 | 2 |
| (c) | Apply WSN-enabled robotic solutions implemented (1) by Bosch and ABB to improve automation, quality control, and                  | 5 | 4 | 3 |



interoperability in Industry 4.0. (4\*1)

OR

- |     |   |   |   |   |
|-----|---|---|---|---|
| (c) | Apply emerging technologies such as 6G, AIOT, and bio-inspired                      | 5 | 4 | 3 |
|     | (3) WSNs to develop intelligent and adaptive robotic systems for future industries. |   |   |   |



