Training Course on Wireless Sensor Networks (WSN) and IoT Communications

Professional Development Training Course Outline

Category	Engineering	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

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This intensive training course provides a comprehensive exploration of Wireless Sensor Networks (WSN) and Internet of Things (IoT) Communications, equipping participants with the foundational knowledge and practical skills to design, deploy, and manage distributed sensing and intelligent connectivity solutions. Training Course on Wireless Sensor Networks (WSN) and IoT Communications delves into the core concepts of sensor node architecture, low-power communication protocols, network topology design, and data aggregation techniques, preparing engineers and developers to build robust and efficient sensing infrastructures that collect, transmit, and process environmental and physical data for a multitude of applications across various industries.

In today's interconnected world, where pervasive sensing and data-driven decision-making are paramount, understanding the intricate interplay between WSNs and IoT is crucial for developing innovative solutions. This course covers trending topics such as LPWAN technologies (LoRaWAN, NB-IoT), edge computing for IoT, fog computing, security in WSN/IoT, machine learning at the edge, and the integration of WSNs with cloud platforms. Through a blend of theoretical foundations, hands-on programming exercises with popular IoT development boards, and real-world case studies, attendees will gain invaluable expertise in creating smart environments, optimizing industrial processes, and enabling pervasive monitoring for diverse applications, from smart cities and smart agriculture to industrial automation and healthcare.

Programme Curriculum

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Course Objectives

1. Understand the fundamental architecture and principles of Wireless Sensor Networks (WSN).
2. Comprehend the core concepts and ecosystem of the Internet of Things (IoT).
3. Analyze and select appropriate sensor technologies for various WSN/IoT applications.
4. Master low-power communication protocols including Zigbee, Bluetooth Low Energy (BLE), and LoRaWAN.
5. Design efficient network topologies and routing algorithms for WSN/IoT deployments.
6. Implement effective data aggregation and fusion techniques for sensor data.
7. Understand the role of edge computing and fog computing in IoT architectures.
8. Address security and privacy challenges in WSN and IoT communication systems.
9. Utilize popular IoT platforms and development boards for practical projects.
10. Explore data analytics and visualization techniques for WSN/IoT data.
11. Understand the integration of WSN/IoT with cloud services and mobile applications.
12. Investigate trending LPWAN technologies such as NB-IoT and LTE-M.
13. Contribute to the design and deployment of smart environments and pervasive sensing solutions.

Organizational Benefits

1. Enhanced Operational Efficiency: Real-time monitoring and data-driven optimization.
2. Improved Decision-Making: Actionable insights from pervasive sensor data.
3. Development of Smart Products and Services: Creating innovative IoT solutions.
4. Reduced Costs: Predictive maintenance, optimized resource usage, minimized waste.
5. Increased Safety and Security: Proactive monitoring and alert systems.
6. Better Asset Management: Tracking and optimizing utilization of physical assets.
7. Competitive Advantage: Early adoption and mastery of WSN/IoT technologies.
8. Scalable and Resilient Deployments: Designing robust and future-proof networks.
9. Skilled Workforce: Empowered employees proficient in WSN/IoT development.

10. Accelerated Digital Transformation: Enabling smart initiatives across the organization.

Target Participants

- Embedded Systems Engineers
- IoT Developers
- Network Engineers
- Automation Engineers
- Data Scientists working with sensor data
- Application Developers
- R&D Engineers in Smart Systems
- Computer Science and Electrical Engineering Graduates

Course Outline

Module 1: Introduction to Wireless Sensor Networks (WSN)

- **Definition and Characteristics of WSNs:** Distributed sensing, low power, self-organization.
- **WSN Architecture:** Sensor node components (sensors, microcontroller, radio, power).
- **Applications of WSNs:** Environmental monitoring, industrial automation, healthcare.
- **Design Challenges in WSNs:** Energy efficiency, scalability, reliability, security.
- **Case Study:** Designing a basic WSN for monitoring soil moisture in a smart agriculture setup.

Module 2: Fundamentals of Internet of Things (IoT)

- **Defining the IoT Ecosystem:** Devices, connectivity, platforms, applications.
- **IoT Architecture Layers:** Perception, Network, Application, (often, Processing/Service).
- **IoT Paradigms:** Industrial IoT (IIoT), Consumer IoT, Smart City IoT.
- **Enabling Technologies for IoT:** Sensors, actuators, cloud computing, big data.
- **Case Study:** Mapping the components of a smart home system to the IoT architectural layers.

Module 3: Sensor Node Hardware and Programming

- **Microcontrollers for WSN/IoT:** ESP32, Arduino, Raspberry Pi, STM32.
- **Common Sensors:** Temperature, humidity, light, motion, pressure, gas.
- **Actuators:** Relays, motors, LEDs.
- **Power Management in Sensor Nodes:** Battery life, energy harvesting.
- **Case Study:** Programming an ESP32 board to read temperature and humidity data from a sensor.

Module 4: Low-Power Wireless Communication Protocols (Short-Range)

- **Zigbee:** Mesh networking, low power, home automation, industrial control.
- **Bluetooth Low Energy (BLE):** Proximity sensing, personal devices, beacons.
- **NFC (Near Field Communication):** Short-range, passive applications.
- **Wi-Fi for IoT:** Higher data rates, power consumption considerations.
- **Case Study:** Developing a BLE-based asset tracking system for indoor environments.

Module 5: Network Topologies and Routing in WSN

- **Common WSN Topologies:** Star, Mesh, Cluster-Tree.

- **Routing Protocols for WSNs:** Flooding, Gossiping, LEACH (Low-Energy Adaptive Clustering Hierarchy).
- **Data Aggregation and Fusion:** Reducing redundant transmissions.
- **Geolocation and Localization in WSNs:** Estimating sensor node positions.
- **Case Study:** Designing a cluster-based routing scheme for a large-scale environmental monitoring WSN.

Module 6: LPWAN Technologies (Low-Power Wide-Area Networks)

- **LoRaWAN:** Architecture, classes (A, B, C), duty cycle, gateways.
- **NB-IoT (Narrowband IoT):** Cellular-based LPWAN, deep indoor coverage.
- **LTE-M (LTE-Machine-to-Machine):** Higher data rates, voice support.
- **Sigfox and Weightless:** Other LPWAN contenders.
- **Case Study:** Selecting between LoRaWAN and NB-IoT for a smart parking application in a city.

Module 7: IoT Protocols for Application and Cloud Connectivity

- **MQTT (Message Queuing Telemetry Transport):** Lightweight messaging protocol for IoT.
- **CoAP (Constrained Application Protocol):** RESTful protocol for constrained devices.
- **HTTP/HTTPS for IoT:** Web-based communication.
- **AMQP (Advanced Message Queuing Protocol):** Enterprise messaging for IoT.
- **Case Study:** Designing a data flow from an IoT sensor to a cloud platform using MQTT.

Module 8: IoT Platforms and Cloud Integration

- **Major IoT Cloud Platforms:** AWS IoT, Azure IoT Hub, Google Cloud IoT Core.
- **Device Management and Provisioning:** Onboarding and lifecycle management.
- **Data Ingestion and Storage:** Handling large volumes of sensor data.
- **IoT Analytics and Visualization Tools:** Deriving insights from data.
- **Case Study:** Connecting an ESP32-based temperature sensor to AWS IoT Core and visualizing data in a dashboard.

Module 9: Edge Computing and Fog Computing for IoT

- **Edge Computing Concepts:** Processing data closer to the source.
- **Fog Computing Architecture:** Distributed computing from edge to cloud.
- **Benefits:** Reduced latency, bandwidth savings, improved security.
- **Edge AI/Machine Learning:** Running inference models on IoT devices.
- **Case Study:** Implementing an edge computing solution for real-time anomaly detection in industrial machinery.

Module 10: Security and Privacy in WSN and IoT

- **Threat Models for WSN/IoT:** Node compromise, data tampering, denial of service.
- **Security Mechanisms:** Encryption, authentication, access control.
- **Secure Boot and Firmware Updates:** Protecting device integrity.
- **Privacy-Preserving Techniques:** Anonymization, differential privacy for sensor data.
- **Case Study:** Analyzing the security vulnerabilities of a smart home IoT device and recommending countermeasures.

Module 11: Data Analytics and Machine Learning for WSN/IoT

- **Exploratory Data Analysis (EDA) of Sensor Data:** Identifying patterns and anomalies.
- **Time Series Analysis:** Forecasting sensor readings, trend detection.

- **Machine Learning for Anomaly Detection:** Identifying faulty sensors or unusual events.
- **Predictive Maintenance with IoT Data:** Forecasting equipment failures.
- **Case Study:** Using historical sensor data to train a machine learning model for predicting equipment failure in a factory.

Module 12: IoT Application Development

- **Mobile App Development for IoT:** Interacting with IoT devices and platforms.
- **Web Dashboard Development:** Visualizing sensor data, controlling devices.
- **API Integration:** Connecting IoT platforms with other enterprise systems.
- **User Experience (UX) Design for IoT Applications:** Intuitive interfaces.
- **Case Study:** Developing a simple web-based dashboard to monitor and control smart lighting in a building.

Module 13: Industrial IoT (IIoT) and Smart Manufacturing

- **IIoT Reference Architecture:** Sensors, gateways, platforms, analytics.
- **Key IIoT Technologies:** OPC UA, MQTT, TSN (Time-Sensitive Networking).
- **Applications:** Predictive maintenance, asset tracking, quality control, process optimization.
- **Digital Twins in IIoT:** Virtual replicas for real-time monitoring and simulation.
- **Case Study:** Implementing an IIoT solution for real-time monitoring of a production line to improve efficiency and reduce downtime.

Module 14: Smart City and Smart Agriculture Applications

- **Smart City Applications:** Smart lighting, traffic management, waste management, environmental monitoring.
- **Smart Agriculture Applications:** Precision farming, crop monitoring, livestock tracking.
- **Infrastructure for Smart Cities:** LPWANs, 5G, public safety communication.
- **Challenges and Opportunities:** Data privacy, scalability, funding.
- **Case Study:** Designing an IoT-based system for urban air quality monitoring with LPWAN connectivity.

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Physical	$12,000

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