



विज्ञान एवं प्रौद्योगिकी विभाग  
DEPARTMENT OF  
SCIENCE & TECHNOLOGY



**AWaDH**  
IIT Ropar - TIF

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# Ropar - TIF

Summer Training Program on IoT & CPS

**Transform Skills into Practical Innovation**

15 Days | Hands-on | Industry-Focused



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 [iitrpr.ac.in](http://iitrpr.ac.in)

 **Program Details:** [bit.ly/AWaDH\\_Internship26](https://bit.ly/AWaDH_Internship26)

# Detailed Curriculum - Summer Training Program on IoT & CPS

## Module 1: Embedded Systems & CPS Foundations (nRF52 Ecosystem)

Theory	Lab
Program Introduction: CPS architecture, role in Agriculture & Water systems, edge-to-cloud pipeline	Development environment setup: nRF Connect SDK, toolchains, VS Code
nRF52832 Architecture: CPU, memory, peripherals, BLE stack overview	Hardware familiarization: nRF52 DK, GPIO mapping, onboard peripherals
Embedded Systems Fundamentals: firmware, interrupts, real-time constraints	First firmware build: Blinky & button interrupt-based application
Introduction to Zephyr RTOS: kernel concepts, threads, scheduling	Creating and running Zephyr-based applications
Build & Flashing Process: toolchain, binaries, debugging fundamentals	Flashing firmware and UART-based logging/debugging
CPS Use Case Context: environmental sensing systems	Mini use-case: event-driven embedded control system

## Module 2: Sensor Systems & Communication Protocols

Theory	Lab
Sensor Fundamentals: environmental (temperature, humidity), soil, motion, light sensors	Interfacing digital sensors with GPIO
Analog vs Digital Sensing, signal conditioning basics	ADC-based analog sensor interfacing
Communication Protocols: I2C, SPI, UART (architecture, timing, trade-offs)	I2C sensor integration (e.g., environmental sensor)
Data acquisition, sampling strategies, noise & calibration concepts	SPI-based high-speed sensor interfacing
Data structuring and transmission formats	UART communication with external modules
CPS Applications: soil monitoring, water sensing systems	Mini use-case: multi-sensor data acquisition system

## Module 3: BLE Communication & Mobile Data Systems

Theory	Lab
BLE Fundamentals: BLE stack, GAP vs GATT, device roles	BLE device configuration and advertising
GATT Profile Design: services, characteristics, descriptors	Creating custom BLE services for sensor data

BLE Communication Flow: connection, data exchange, notifications	Sending real-time sensor data via BLE
BLE Scanning & Filtering: RSSI, device discovery	Implementing a BLE scanner and data parsing
Mobile Integration Concepts: BLE apps, dashboards, UX basics	Visualization of sensor data using mobile apps
CPS Data Flow: edge device to user interface	Mini use-case: live environmental monitoring system

#### Module 4: IoT Gateway, Edge Processing & Cloud Integration

Theory	Lab
IoT Architecture: edge, gateway, cloud layers in CPS	Setting up the BLE gateway node
BLE Gateway Design: multi-node communication & aggregation	Data collection from multiple BLE devices
Data Transmission Protocols: MQTT, HTTP fundamentals	Sending data to cloud platforms
Cloud Integration: dashboards, storage, remote monitoring	Creating real-time monitoring dashboards
Edge Processing: filtering, thresholding, local decision-making	Implementing alert-based automation
CPS Use Cases: irrigation automation, water distribution systems	Mini use-case: multi-node smart monitoring system

#### Module 5: System Integration, Prototyping & Deployment

Theory	Lab
End-to-End System Design: integrating sensing, communication, and cloud	Designing a complete CPS solution architecture
Product Development Lifecycle for IoT systems	Full system integration (sensor + BLE + gateway + cloud)
Power Optimization: low-power modes, duty cycling, battery systems	Implementing low-power configurations
Rapid Prototyping: 3D printing, enclosure design basics	Designing and fabricating a device enclosure
Data-driven Decision Systems: rule-based automation, intro to AI at the edge	Implementing threshold-based decision logic
Deployment Challenges: scalability, reliability, and field conditions	Final prototype testing, debugging, and validation

## Tools & Technologies

Category	Tools / Technologies	Application in Program
Embedded Systems	nRF Connect SDK, Zephyr RTOS	Firmware & RTOS-based development
Programming	Embedded C, Python (intro)	System & analytics development
Communication	BLE, UART, I2C, SPI	Device-level communication
IoT Protocols	MQTT, HTTP	Data transmission
Cloud Platforms	AWS IoT	Monitoring & storage
Mobile Interface	nRF Connect App / Custom Apps	BLE visualization
Hardware	nRF52832 DK, sensor modules	Prototyping
Design Tools	Fusion 360 / TinkerCAD	Enclosure design
AI/Analytics	Python, basic ML frameworks	Decision support
Chatbots	Dialogflow / Rasa / API-based LLMs	Advisory systems

### Capstone Project (Agri & Water Focus)

Develop an integrated CPS-based solution combining smart irrigation (soil moisture + automated control), water quality monitoring (pH, turbidity, temperature), autonomous weather sensing, and smart water tank/distribution systems, with advanced features like precision agriculture (multi-sensor data fusion), greenhouse automation, flood monitoring, livestock tracking, pest detection, and AI-driven fertilizer recommendations.

The system will include AI-enabled chatbot interfaces for farm advisory, irrigation scheduling, water management decision support, and crop health alerts, enabling real-time monitoring, automation, and intelligent decision-making through a unified IoT architecture (sensors + BLE + gateway + cloud).

### Evaluation Criteria

Participants who successfully fulfil all requirements will receive a **Certificate of Completion** from **IIT Ropar-TIF( iHub-AWADH)**. The evaluation criteria are based on the following:

- **Final Online Examination (30%)**: Evaluation of conceptual understanding of AI/ML techniques and their application in agriculture (Offline)
- **Capstone Project (70%)**: Demonstration of applied learning through real-world problem-solving and implementation
- **Minimum Attendance**: 80% attendance in both theory and lab sessions
- **Capstone Project or Hackathon**: Submission and demonstration of a final project and presentation

### Project Website and UI/UX Support

<https://cpslabhub.com/>