

## DOMAIN 3: IoT, VLSI & Embedded Systems

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### PS-3.1: Edge-AI Wearable Health Monitoring Ecosystem

#### Problem Description

Continuous physiological monitoring generates sensitive, high-frequency data. Cloud-only analytics introduce latency, bandwidth, and privacy risks. There is a need for on-device intelligence to enable timely and secure health insights.

#### Objectives

- Perform real-time health anomaly detection
- Enable privacy-preserving federated learning
- Minimize false alarms
- Support automated emergency alerts

#### Constraints

- Ultra-low-power hardware
- Intermittent network connectivity
- Strict response-time requirements
- Data privacy regulations

#### Expected Deliverables

- Edge-AI anomaly detection model
  - Federated learning framework
  - Emergency alert workflow
  - System architecture documentation
  - Demo prototype
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### PS-3.2: AI-Assisted Rural Telemedicine Platform

#### Problem Description

Rural healthcare suffers from limited access to doctors, poor connectivity, and language barriers. AI-assisted telemedicine can support frontline health workers in diagnosis and triage.

#### Objectives

- Enable AI-assisted clinical decision support
- Support vernacular languages and voice interaction
- Operate in low-bandwidth environments
- Improve rural healthcare accessibility

### **Constraints**

- Noisy audio inputs
- Limited or unreliable internet access
- Trust and usability challenges
- Need for explainable recommendations

### **Expected Deliverables**

- Voice-based clinical AI module
  - Vernacular NLP system
  - Offline-first system architecture
  - Usability evaluation report
  - Working prototype
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## **PS-3.3: AI-Calibrated Biosensor for Lifestyle Diseases**

### **Problem Description**

Low-cost biosensors suffer from noise, drift, and calibration issues, limiting their clinical usefulness. AI-driven calibration can improve accuracy and reliability.

### **Objectives**

- Improve accuracy of low-cost biosensors
- Detect early indicators of lifestyle diseases
- Enable mobile health integration
- Ensure affordability and usability

### **Constraints**

- Noisy biomedical signals
- Sensor drift and aging
- Hardware and cost limitations
- Clinical interpretability requirements

### **Expected Deliverables**

- Signal processing and AI calibration models
  - Mobile health integration module
  - Accuracy and drift evaluation
  - Prototype or simulation
  - Technical documentation
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## **PS-3.4: AI-Optimized Electric Vehicle Charging Infrastructure**

### **Problem Description**

Uncoordinated EV charging stresses power grids and increases peak demand. Intelligent charging systems are required for grid stability and user convenience.

### **Objectives**

- Optimize EV charging schedules
- Enable dynamic pricing and incentives
- Balance grid load and peak demand
- Support vehicle-to-grid (V2G) integration

### **Constraints**

- Grid capacity and transformer limits
- Uncertain user charging behavior
- Real-time decision requirements
- Interoperability with grid systems

### **Expected Deliverables**

- Charging optimization and scheduling model
  - Dynamic pricing mechanism
  - Grid impact visualization dashboard
  - User and operator interfaces
  - Simulation and deployment documentation
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## **PS-3.5: Smart Energy Management System for Buildings**

### **Problem Description**

Buildings consume significant energy due to inefficient monitoring and control. IoT and AI can optimize consumption without compromising occupant comfort.

### **Objectives**

- Monitor real-time energy usage
- Predict and reduce energy wastage
- Optimize HVAC and lighting systems
- Improve energy efficiency

### **Constraints**

- Heterogeneous sensors and devices
- Occupant comfort requirements
- Legacy building infrastructure
- Data reliability issues

### **Expected Deliverables**

- IoT-based energy monitoring system
- AI-driven optimization algorithms
- Energy analytics dashboard
- Performance evaluation report

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## **PS-3.6: Intelligent Traffic Signal Controller using Embedded AI**

### **Problem Description**

Fixed-time traffic signals fail to adapt to dynamic traffic conditions, causing congestion and delays.

### **Objectives**

- Adapt traffic signals based on real-time traffic
- Reduce congestion and waiting time
- Prioritize emergency vehicles
- Improve road safety

### **Constraints**

- Limited edge-compute capability
- Sensor failures and noisy data

- Real-time decision latency
- Safety-critical operation

### **Expected Deliverables**

- Embedded AI traffic control algorithm
  - Traffic simulation and performance metrics
  - Signal controller prototype
  - Visualization dashboard
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## **PS-3.7: Low-Power IoT-Based Air Quality Monitoring System**

### **Problem Description**

Urban and industrial air pollution requires continuous, fine-grained monitoring using affordable and scalable systems.

### **Objectives**

- Monitor key air quality parameters
- Enable city-scale sensor deployment
- Provide real-time alerts
- Support data-driven policy decisions

### **Constraints**

- Sensor calibration and drift
- Low-power operation
- Environmental interference
- Data reliability

### **Expected Deliverables**

- IoT air quality sensor node
  - Data aggregation and analytics platform
  - Alert and visualization dashboard
  - Deployment report
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## **PS-3.8: Secure Embedded System for Industrial IoT Devices**

## **Problem Description**

Industrial IoT devices are vulnerable to firmware attacks, data tampering, and unauthorized access.

## **Objectives**

- Secure device boot and firmware updates
- Protect data integrity and confidentiality
- Detect device-level anomalies
- Ensure reliable operation

## **Constraints**

- Limited processing and memory
- Real-time performance requirements
- Long device lifecycle
- Industrial safety standards

## **Expected Deliverables**

- Secure embedded firmware design
  - Device authentication mechanism
  - Anomaly detection module
  - Security evaluation report
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# **PS-3.9: Autonomous Smart Irrigation System using IoT and AI**

## **Problem Description**

Traditional irrigation methods waste water and fail to adapt to crop and soil conditions.

## **Objectives**

- Monitor soil moisture and weather conditions
- Optimize irrigation schedules
- Reduce water consumption
- Improve crop yield

## **Constraints**

- Outdoor environmental conditions
- Sensor failures
- Limited rural connectivity
- Cost constraints

### **Expected Deliverables**

- IoT-based irrigation controller
  - AI-driven scheduling algorithm
  - Farmer dashboard or mobile app
  - Field-test or simulation results
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## **PS-3.10: Embedded Vision System for Industrial Quality Inspection**

### **Problem Description**

Manual quality inspection is slow and error-prone. Embedded vision systems can enable real-time defect detection on production lines.

### **Objectives**

- Detect surface and structural defects
- Perform real-time inspection
- Reduce production defects
- Improve manufacturing efficiency

### **Constraints**

- Limited embedded processing power
- Variable lighting and noise
- High-speed production lines
- Accuracy requirements

### **Expected Deliverables**

- Embedded vision inspection model
- Defect classification system
- Performance evaluation metrics
- Prototype or simulation demo