e-Niyama Labs
Engineering the rules of learning

Embedded Systems for Robotics & Automation

Introduction to Robotics and Automation
- Overview of Modern Robotics and Industrial Automation Ecosystems
- Role of Embedded Systems in Robotics and Mechatronics
- Types of Robots: Industrial, Service, Mobile, and Collaborative (Cobots)
- Emerging Trends: Autonomous Systems, Edge AI, and Human–Robot Collaboration

Embedded Hardware for Robotics
- Microcontrollers and SoCs for Robotics: STM32, ESP32, Raspberry Pi, NVIDIA Jetson
- Power Electronics and Motor Drivers for Robotic Systems
- Sensor Interfacing and Real-Time Data Acquisition
- Actuators: DC/BLDC Motors, Servo Motors, Stepper Motors, Pneumatic & Hydraulic Systems

Perception Systems and Sensors
- Core Sensors: Ultrasonic, IR, LIDAR, Encoder, IMU, Proximity, and Vision Sensors
- Sensor Fusion Techniques for Accurate Motion and Localization
- Camera Interfacing and Image Capture using Embedded Platforms
- Real-Time Signal Processing for Sensor Data

Embedded Control Systems
- Fundamentals of Control Theory and PID Implementation in Embedded Systems
- Real-Time Control using Timers, Interrupts, and RTOS
- Motor Speed and Direction Control (PWM, H-Bridge, ESC)
- Safety Mechanisms and Fail-Safe System Design

Motion Planning and Navigation
- Motion Control Algorithms for Mobile and Manipulator Robots
- Path Planning and Obstacle Avoidance Techniques
- Localization and Mapping Concepts (SLAM Overview)
- Integration with IMU and GPS for Navigation

Communication and Networking
- Embedded Communication Protocols: UART, SPI, I2C, CAN
- Wireless Connectivity: Wi-Fi, Bluetooth, Zigbee, and LoRa
- Networked Robotics and Multi-Agent Communication
- IoT-Enabled Robots: Cloud and Edge Integration

Robotics Software and Programming
- Embedded C / C++ Programming for Robot Control
- Python for Automation and Control Logic
- Introduction to ROS (Robot Operating System): Architecture, Nodes, Topics, and Packages
- Using Simulation Tools: Gazebo, Tinkercad, or Webots for Robot Design and Testing

Machine Vision and AI in Robotics
- Introduction to Computer Vision in Robotics
- Image Processing using OpenCV and Embedded Cameras
- Object Detection, Tracking, and Recognition Concepts
- Integrating Edge AI and Machine Learning Models into Embedded Robotics
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Industrial Automation and Control
- Fundamentals of Industrial Automation and Mechatronic Systems
- PLC and Embedded Controller Integration
- SCADA and HMI Concepts for Real-Time Monitoring
- Smart Manufacturing (Industry 4.0) and IIoT Applications
- Predictive Maintenance and Data-Driven Automation