e-Niyama Labs
Engineering the rules of learning

Embedded Systems for Automotive Applications2

Introduction to Connected Car & Telematics Systems

- Architecture of Connected Vehicle Ecosystems
- Communication Types: V2C (Vehicle-to-Cloud), V2V, V2I
- Telematics Control Unit (TCU): Software Stack, Data Flow, and Cloud Interface
- Connectivity Technologies: 4G/5G, MQTT, TCP/IP, GNSS, Wi-Fi, Bluetooth
- Cloud Data Flow: Data Logging → Edge Processing → Cloud Upload
- OTA (Over-the-Air) Update Frameworks (FOTA / SOTA)
- Use Case Discussion: Real-time Vehicle Monitoring and OTA Update Mechanisms
- Bootloader and Firmware Update Concepts (FOTA / SOTA)

Introduction to Infotainment, Digital Cluster & Digital Cockpit Systems

- Overview of In-Vehicle Infotainment (IVI) and Digital Cluster Architecture, including system layers and ECU communication flow
- Operating Systems used in cockpit domains: Android Automotive OS, Embedded Linux, FreeRTOS
- In-Vehicle Communication Protocols: SOME/IP, CAN, LIN, MOST, and Ethernet AVB
- Audio/Video Middleware and Media Frameworks for infotainment and cluster data management
- Connectivity Technologies: Bluetooth, Wi-Fi, Android Auto
- Graphics & HMI Frameworks: Qt/QML, OpenGL for real-time display rendering in cluster and infotainment systems
- Integration of vehicle data (Speed, RPM, Fuel, Warnings) into infotainment and cluster displays with safety / ASIL compliance
- Introduction to Digital Cockpit Solutions: Unified platform combining infotainment, cluster, and head-up display (HUD) on a single compute unit
- Cockpit Domain Controller (CDC): Architecture, virtualization, multi-OS integration, and data synchronization across multiple displays

Introduction to Software-Defined Vehicle (SDV) & Cloud Integration

- Introduction to Software-Defined Vehicle (SDV) concepts — Central Compute, Vehicle OS, OTA Updates, Cloud Integration
- SDV Architecture and Transition from ECU to Central Compute Platforms
- Vehicle OS and Middleware: AUTOSAR Adaptive, QNX, ROS2, AAOS
- Service-Oriented Communication: SOME/IP, DDS, MQTT
- Microservices & Containerization Concepts (Docker, Kubernetes)
- Cloud Platforms for Vehicle Connectivity: AWS IoT FleetWise, Azure IoT, Bosch IoT Suite
- Vehicle Data Analytics, Edge AI, and Predictive Maintenance Applications
- Mini Project: SDV Signal Flow and OTA Data Exchange Simulation

Introduction to Testing & Validation tools

- Automotive Software Testing Life Cycle and Test Levels
- SIL, PIL, HIL, and Cloud-based Test Automation
- Functional Testing with Vector CANoe / CANalyzer
- CAPL Scripting Basics for Test Automation
- UDS, DoIP, and Telematics Validation Techniques
- ASPICE-Compliant Test Case Design and Traceability