NIRMA UNIVERSITY

Institute:	**Institute of Technology**
Name of Programme:	**M. Tech. in Electrical Engineering (Electric Vehicular Technology)**
Semester:	**II**
Course Code:	**3EE32D13**
Course Title:	**Automotive Embedded Systems and Communication Protocols**
Course Type:	(□ Core/ □ Value Added Course / √ **Department Elective** / □ Institute Elective/ □ University Elective/ □ Open Elective / □ Any other)
Year of Introduction:	**2022 – 23**

L	T	Practical component				C
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Course Learning Outcomes (CLOs):

At the end of the course, the students will be able to-

1. appraise the components and architecture of Embedded system **(BL2)**
2. explain the design process of an embedded system **(BL2)**
3. illustrate building blocks of Embedded system and its characteristics **(BL4)**
4. compare and contrast communication protocols of EVs **(BL3)**

Syllabus: **Teaching Hours: 30**

Unit-1: Introduction to Embedded system **05**

Overview of Embedded system, Characteristics of an Embedded System, Basic Structure of an Embedded System, Processors for Embedded System, CISC vs RISC Processors, Types of Embedded Systems, Requirement and types of communication system, Communication Protocols.

05

Unit-2: ARM Controller for Embedded system

An overview of ARM-Cortex- M Architecture, CISC versus RISC, The RISC and ARM design philosophy, ARM addressing modes, assembly language instructions and programming.

Unit-3: Sensor Interfacing and Communication using ARM Controller **07**

Input/output programming, timer/counter programming, I/O peripheral interfacing, hardware and software synchronization, multithreading, Nested Vectored Interrupt Controller (NVIC), external hardware interrupts, I/O interrupts, SysTick interrupts, Temperature sensing, Voltage Sensing, Torque Sensing, Implement architectural design for IoT using ARM Controller.

08

Unit-4: Communication Protocols

On-board communication interfaces-I2C, SPI, overview of CAN –fundamentals, parallel interface; External communication interfaces-RS232 and RS485, USB, infrared, Bluetooth, Wi-Fi, ZigBee, GPRS, GSM. Overview of general-purpose networks and protocols -Ethernet, TCP, UDP, IP, ARP, RARP - LIN standard overview –workflow concept-applications –LIN protocol specification, vehicle telematics

Unit-5: Security and Safety Standards of Embedded System **05**

Functional Safety in Automotive Embedded System, System Security in the Automotive Industry, failure modes and effects analysis (FMEA); and failure modes, effects and diagnostic analysis (FMEDA), safety standards ISO 26262, automotive hacking and the ISO 21434 standard (Road vehicles -Cybersecurity engineering).

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Laboratory Experiments:

This shall consist of at least 10 experiments / simulations based on the above syllabus.

Suggested Readings:

1. Shibu K V, Introduction to Embedded Systems, McGraw Hill Education.
2. Lyla B Das, Embedded Systems- An integrated approach, Pearson Education.
3. Zach Shelby, Carsten Bormann, LoWPAN: The Wireless Embedded Internet, Wiley
4. Dominique Paret, Multiplexed Networks for Embedded Systems: CAN, LIN, FlexRay, Safe-by-Wire, Wiley.
5. Popescu-Zeletin R, Radusch I and Rigani M.A, Vehicular-2-X Communication, Springer.
6. Olaf Pfeiffer, Andrew Ayre, Christian Keydel, Embedded Networking with CAN and CANopen, Annabooks/Rtc Books

Suggested List of Experiments (not restricted to the following):
(Only for Information)

1. Introduction and familiarization with ARM microcontroller.
2. Programming of arithmetic and logical operations using ARM microcontroller.
3. Executing branching operation in ARM microcontroller.
4. To perform timer operation of ARM microcontroller.
5. To implement interfacing of a LCD/LED using ARM microcontroller.
6. To perform ADC Channel configuration of ARM microcontrollers.
7. Configuration and generation of PWM pulses using ARM microcontrollers.
8. Perform an experiment for sensing analog signal using ADC channels of ARM microcontrollers (04 hours).
9. Perform an experiment to interface keypad and display with ARM microcontrollers.
10. Interfacing of stepper motor driver using ARM microcontrollers.
11. To implement IOT based interfacing using controller (04 hours)
12. To perform an experiment for familiarizing with various communication protocols in vehicles
13. To perform an experiment to interface sensors and actuators using various protocols (04 hours).

L = Lecture, T = Tutorial, P = Practical, C = Credit