



GUJARAT TECHNOLOGICAL UNIVERSITY

BE – Semester 6
 Minor Degree : Electric Vehicles
 Subject Code : 116AL01

Subject Name : Data Communication and Embedded Systems in Electric Vehicles

Prerequisite : Knowledge of microprocessor/microcontroller hardware, programming concept in assembly and C and basic knowledge of communication system are desirable.

Objective :

On successful completion of this course, student will have an understanding of the underlying concepts and technologies of Embedded System as it relates to a vehicle perspective. This will also develop skills for students interested working in the automotive industry on current and future autonomous vehicles through in-depth study of automotive architectures and embedded communication through application.

Teaching and Examination Scheme :

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	00	30	00	100

Sr. No.	Content	Total Hrs.
1	VEHICULAR NETWORKS : Overview of Data communication and networking, Vehicular Networks: Cross-System Functions, Requirements for Bus Systems, Classification of Bus Systems, Application in The Vehicle, Coupling of Networks, Examples of Networked Vehicles.	04
2	EMBEDDED NETWORK : Fundamental of Embedded network, Importance of communication in automation, Introduction to Automotive Embedded Systems & Systems Design, Basic network layout, Communication requirement for Embedded System, Bus Configuration.	06
3	BUS SYSTEM : Bus Systems: CAN Bus, CAN-FD, LIN Bus, MOST Bus Bluetooth, Flex Ray, Diagnostic Interfaces: Implementation of Body Electronics Functionalities Using Controllers.	06
4	VEHICULAR COMMUNICATION : Vehicular Communications: Intelligent Transportation Systems: IEEE 802.11p-ITS-IVC: Inter-Vehicle Communications- Mobile Wireless Communications and Networks- Architecture Layers, Communication Regime. V2V, V2I-VANET-WAVE, DSRC. Information In the Vehicle Network, Routing-Physical Layer Technologies-Medium Access for Vehicular Communications- Security.	06



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5	NETWORKS AND PROTOCOLS : Overview of general-purpose networks and protocols -Ethernet, TCP, UDP, IP, ARP, RARP - LIN standard overview –workflow concept-applications –LIN protocol specification –signals - Frame transfer –Frame types –Schedule tables – Task behavior model –Network management –status management - overview of CAN –fundamentals –Message transfer – frame types-Error handling –fault confinement-Bit time requirements.	06
6	HIGHER LAYER PROTOCOL : Introduction to CAN open –TTCAN –Device net -SAE J1939 - overview of data channels –Control channel-synchronous channel – asynchronous channel – Logical device model – functions-methods properties-protocol basics- Network section-data transport –Blocks – frames –Preamble-boundary descriptor.	05
7	FLEXRAY PROTOCOL : Introduction – network topology – ECUs and bus interfaces – controller host interface and protocol operation controls – media access control and frame and symbol processing – coding/decoding unit – FlexRay scheduling.	05
8	LATEST TRENDS : Car networking protocols – Networking future trends –Roadmaps –Competitive advantage.	04

Suggested Specification table with Marks (Theory) :

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	25	25	15	10	5

Legends : R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from the above table.

Reference Books :

- 1) Dominique Paret, “Multiplexed Networks for Embedded Systems: CAN, LIN, FlexRay, Safe-by-Wire”, Wiley,2007.
- 2) Dominique Paret, “FlexRay and its Applications: Real Time Multiplexed Networks”, Second Edition, Wiley,2012.



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- 3) Popescu-Zeletin R, Radusch I and Rigani M.A, “Vehicular-2-X Communication”, Springer,2010.
- 4) J.Gabrielleen,”Automotive In-Vehicle Networks”, John Wiley & Sons, Limited, 2008.
- 5) Robert Bosch,” Bosch Automotive Networking”, Bentley publishers, 2007.
- 6) Society of Automotive Engineers, ”In-Vehicle Networks”, 2002.
- 7) Ronald K Jurgen, “Automotive Electronics Handbook”, McGraw-Hill Inc. 1999.
- 8) Xiang W, “Wireless Access in Vehicular Environments Technology”, Springer, 2015.
- 9) Indra Widjaja, Alberto Leon-Garcia, “Communication Networks: Fundamental. Concepts and Key Architectures”, McGraw-Hill College; 1st edition, 2000.
- 10) Olaf Pfeiffer, Andrew Ayre, Christian Keydel, “Embedded Networking with CAN and CANopen”, Annabooks/Rtc Books, 2003.

Course Outcomes :

Sr. No.	CO STATEMENT	Bloom’s taxonomy level	Marks % weightage
CO1	Understand the architecture and implementation of vehicle embedded systems applications.	Remember L1 , Understand L2	25 %
CO2	Understanding about Network and Bus system in vehicular communication with protocols.	Remember L1 , Understand L2	25 %
CO3	To know about Intelligent Transportation Systems and vehicle networking.	Remember L1 , Understand L2, Evaluate L5,	25 %
CO4	Explain the different network and communication protocol.	Remember L1 , Understand L2, Evaluate L5,	25 %

Suggestive List of Experiments :

- 1) To understand the microcontroller kits with its sensors.
- 2) To study and perform basic timer, interfacing and measurement with on-board microcontroller.
- 3) To understand the temperature sensor and measurement.
- 4) To understand the proximity sensor and its interfacing
- 5) Implementation of a wireless link with standards.
- 6) Implementation of the low power Bluetooth ad hoc network.
- 7) To understand the IEEE 802.11 Wireless Router - Setting IP addresses on Router and PC.
- 8) Examine operation of various available ADAS systems – Driver attention, lane change, etc.

List of Software/learning website :