**Birla Institute of Technology & Science, Pilani**

**Work Integrated Learning Programmes Division**

## **M.Tech. Automotive Engineering**

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| **Course Title** | Automotive Communications |
| **Course No(s)** | AE ZG513 |
| **Credit Units** | 5 |
| **Credit Model** | 1-1-2 |
| **Content Authors** |  |
| **Version Number** | 1.0 |
| **Date** | 25-07-2020 |

**Course Objectives:**

To introduce the students to automotive communication systems, vehicle system networking, in-vehicle networks, physical layer, communication layer and application layer, protocols for automotive networking, hardware implementation, Diagnostic services.

**Text Book(s):**

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| **T1** | Multiplexed Networks for embedded systems, Dominique Paret, John Wiley and sons, 2007, ISBN 978-0-470-03416-3 |

**Reference Book(s) & other resources:**

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| --- | --- |
| **R1** | Bosch Automotive Electrics and Automotive Electronics, 5th edition, Springer-Vieweg, 2007, ISBN 978-3-658-01783-5 |
| **R2** | Understanding Automotive Electronics-An Engineering Perspective William B. Ribbens, Butterworth-Heinemann- Elsevier Imprint 2017, 8th edition ISBN: 978-0-12-810434-7 |
| **R3** | Vehicular Networking-Automotive Applications and Beyond, Marc Emmelmann, Bernd Buchow, Christopher Kellum, Wiley publications, 2010 ISBN 9780470741542 |
| **R4** | Inter and Intra Vehicle communications, Gilbert Held, Auerbach Publications-Taylor and Francis 2008, ISBN 13: 978-1-4200-5221-3 |
| **R5** | Vehicular Networking, Christoph Somner and Falko Dressler, Cambridge University Press, 2014, ISBN 13: 9781107046719 |
| **R6** | Flexray and its Applications, Dominique Paret, John Wiley and sons, 2012, ISBN 978-1-119-97956-2 |
| **R7** | Reference Manuals/ Published Papers   1. Vehicular Networking: A survey and Tutorial on Requirements, Architectures, Challenges and Solutions, IEEE Communications Surveys and Tutorials, 2011 2. dsPIC CAN-LIN Starter Kit Users Guide 3. Automotive Ethernet-The Definitive Guide, Intrepredics 4. NXP TJA 1100-100Base T1-PHY for Automotive Ethernet   Note : Required manual and reference papers will be uploaded on course website . |

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| **LEARNING OUTCOMES** | |
| **LO1** | Introduce Hardware and Software Components of automotive communication networks |
| **LO2** | Introduce the protocols for various communication networks |
| **LO3** | Develop basic testing and programming skills required for automotive communications |
| **LO4** | Introduce advanced topics of research in the field of automotive communications |

**Experiential Learning Components:**

1. **Lab**: On-site/Remote lab
2. Case study: None
3. Work integrated Learning Exercise: None
4. Design work/Field work: None

**Content Structure:**

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| --- | --- | --- | --- |
| **Contact Hour** | **List of Topic Title** | **Sub-Topics** | **Reference** |
| 1-4 | Introduction to Automotive Networking | * Principles of networking * Basics, Current and Future vehicular networks * Open systems Interconnection model * Bus systems * In-vehicle networks * Layered communication * Topologies, Medium and Data transmission * Protocols * ECU Architecture * Intra-vehicle networks * Information dissemination * Beaconing and Intelligent Transport Systems |  |
| 5-8 | CAN and CAN-FD Protocol | * Fundamentals of CAN communication * Protocol Layers * Content Based Addressing * Bus Access- Arbitration * Priority Assignments * Message Format-Data, Remote, Error and Overload frames * Hardware Implementation * Data Transfer Sequence |  |
| 9-10 | LIN Protocol | * Introduction to LIN Bus * Protocol-Frame, Header and Synchronization * Identifier and Data field * Description file * Message Scheduling-Examples |  |
| 10-14 | MOST Protocol | * Introduction to MOST * Requirements * Data Transmission Channels * Topology * Network Interface Controller * Controllers * Transmission Agent * Data Transfer * Control command transfer, multimedia and packet data transfer * Configuration Status * Network model |  |
| 15-16 | Review session | | |
| 17-20 | Bluetooth Protocol | * Transmission method * Frequency bands * Piconet, Scatternet * Data channel- Timing, physical connection, packets * Hardware side protocols * Applications |  |
| 21-24 | Flexray Protocol | * Network Topology * Hardware –Transmission agents * Host processor, Communication controller * Bus Driver, Bus guardian * Protocol layers * Coding on physical layer * Bit stream * Communication cycle-Static segment, Dynamic Segment * Frame format-Payload and Trailer segment |  |
| 25-26 | Time Triggered Protocol | * TTP-A potocol * TTP-C protocol * Design Principles, Operating Modes, Applications |  |
| 26-30 | Inelligent vehicles | * Performance Analysis and Optimization * Fault Tolerance and Reliability * RT Ethernet Modifications for In vehicle networks |  |
| 31-32 | Review Session | | |

**Project Activity/ Experiential Lab:**

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| **Sr No** | **Lab Details/ Project Details** | **Access** |
| 01 | Remote lab: Physical experiments at Integrated Automotive Engineering lab | At Integrated Automotive Engineering lab, Hyderabad campus. |

**Evaluation Scheme:**

**Legend:** EC = Evaluation Component; AN = After Noon Session; FN = Fore Noon Session

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| --- | --- | --- | --- | --- | --- |
| Evaluation Component | Name  (Quiz, Lab, Project, Mid-term exam, End semester exam, etc.) | Type (Open book, Closed book, Online, etc.) | Weight | Duration | Day, Date, Session, Time |
| EC - 1 | Theory- Quiz/Assignment | Online | 10% |  |  |
| Lab Assignment | Online | 20% |  |  |
| EC - 2 | Mid-Semester Test | Closed Book | 30% | 2 hours |  |
| EC - 3 | Comprehensive Exam | Open Book | 40% | 3 hours |  |

Syllabus for Mid-Semester Test (Closed Book): Topics in Contact Hours: 1 to 16

Syllabus for Comprehensive Exam (Open Book): All topics

Important links and information:

Elearn portal: https://elearn.bits-pilani.ac.in

Students are expected to visit the Elearn portal on a regular basis and stay up to date with the latest announcements and deadlines.

Contact sessions: Students should attend the online lectures as per the schedule provided on the Elearn portal.

Evaluation Guidelines:

1. EC-1 consists a Quiz/Assignment/ Project along with Onramp course, Virtual lab and On-site lab. Performing the physical experiments available only in the on-site lab at Hyderabad campus is mandatory. Announcements will be made on the portal, in a timely manner.
2. For Closed Book tests: No books or reference material of any kind will be permitted.
3. For Open Book exams: Use of books and any printed / written reference material (filed or bound) is permitted. However, loose sheets of paper will not be allowed. Use of calculators is permitted in all exams. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
4. If a student is unable to appear for the Regular Test/Exam due to genuine exigencies, the student should follow the procedure to apply for the Make-Up Test/Exam which will be made available on the Elearn portal. The Make-Up Test/Exam will be conducted only at selected exam centres on the dates to be announced later.

It shall be the responsibility of the individual student to be regular in maintaining the self-study schedule as given in the course handout, attend the online lectures, and take all the prescribed evaluation components such as Assignment, Mid-Semester Test and Comprehensive Exam according to the evaluation scheme provided in the handout.

**Instructor-in-charge**

**(AEL ZG513)**