SYLLABUS

1. Information about the program

1.1 Higher education institution	Universitatea Politehnica Timișoara
1.2 Faculty[1] / Department[2]	ELECTRONICS, TELECOMMUNICATIONS AND INFORMATION TECHNOLOGIES / Applied Electronics
1.3 Field of study (name/code[3])	Electronics, Telecommunications and Information Technologies Engineering /20/20/10
1.4 Study cycle	Master
1.5 Study program (name/code/qualification)	AUTOMOTIVE ELECTRONIC SYSTEMS/ 20/20/10 / 2152

2. Information about discipline

2.1a Name of discipline/The educational classe[4]	Automotive Communication Protocols/DF						
2.1b Name of discipline in Romanian	Sisteme și protocoale de comunicație în automotive						
2.2 Coordinator (holder) of course activities	S.L. dr. ing. Maranescu Valentin						
2.3 Coordinator (holder) of applied activities[5]	S.L. dr. ing. Maranescu Valentin						
2.4 Year of study[6]	1	**2.5** Semester	2	**2.6** Type of evaluation	E	**2.7** Regime of discipline[7]	DOB

3. Total estimated time (direct activities (fully assisted), partially assisted activities and unassisted activities[8])

3.1 Number of hours fully assisted/week	4 ,of which:	course	2	seminar/laboratory/project			2
3.1* Total number of hours fully assisted/sem.	56 ,of which:	course	28	seminar/laboratory/project			28
3.2 Number of on-line hours fully assisted/sem	12 ,of which:	course	6	seminar/laboratory/project			6
3.3 Number of hours partially assisted/week	,of which:	project, research		training		hours designing M.A. dissertation	
3.3* Number of hours partially assisted/ semester	,of which:	project of research		training		hours designing M.A. dissertation	
3.4 Number of hours of unassisted activities/ week	4.93 ,of which:	Additional documentation in the library, on specialized electronic platforms, and on the field					1.43
		Study using a manual, course materials, bibliography and lecture notes					1.5
		Preparation of seminars/ laboratories, homework, assignments, portfolios, and essays					2
3.4* Total number of hours of unasssited asctivities/ semester	69 ,of which:	Additional documentation in the library, on specialized electronic platforms, and on the field					20
		Study using a manual, course materials, bibliography and lecture notes					21
		Preparation of seminars/ laboratories, homework, assignments, portfolios, and essays					28
3.5 Total hrs./week[9]	8.93						
3.5* Total hrs./semester	125						
3.6 No. of credits	5						

4. Prerequisites (where applicable)

4.1 Curriculum	• Electronic devices, Fundamental electronic circuits, Analog integrated circuits, Embedded systems, Software for Applied Electronics, Hardware and software design methods for ensuring operational safety in the automotive industry, Algorithms in the automotive industry
4.2 Learning outcomes	• Ability to work with embedded systems, understand basic communication protocols, and apply automotive electronics and networking concepts

5. Conditions (where applicable)

5.1 of the course	• Board, projector, notebook

5.2 to conduct practical activities	• microcontroller boards, protocol interface modules (CAN, LIN), diagnostic tools, oscilloscopes, development and simulation software

6. Learning outcomes acquired through this discipline

Knowledge	• **C1.** The student/graduate demonstrates advanced knowledge of the categories of electronics, the principles of electricity and engineering, and the physics and mathematics required for the design and analysis of complex electronic systems. • **C2.** The student/graduate explains concepts and methods of research and industrial development applicable to electronics, including applied mechanics, testing methods for electrical equipment, and procedures for testing electronic components and systems. • **C13.** The student/graduate demonstrates advanced knowledge of power electronics principles, conversion circuits, and their applications in industrial and energy systems. • **C16.** The student/graduate demonstrates advanced knowledge of the operating principles, typologies, and applications of sensors.
Skills	• **A3.** The student/graduate designs electronic systems, including circuits, equipment, and applications in fields such as automotive and instrumentation. • **A6.** The student/graduate applies testing and validation procedures for electronic products, systems, and components. • **A9.** The student/graduate designs control systems for the monitoring and optimization of industrial processes. • **A14.** The student/graduate integrates automation technologies into manufacturing and industrial monitoring processes. • **A18.** The student/graduate designs and develops microsystems using dedicated simulation and modeling tools.
Responsibility and autonomy	• **RA2.** The student/graduate demonstrates autonomy in leading scientific research and making complex engineering decisions, coordinating multidisciplinary technical teams. • **RA4.** The student/graduate promotes innovation and lifelong learning, integrating scientific and technological progress into research and development activities. • **RA6.** The student/graduate engages in lifelong learning, continuously updating competences in line with scientific and technological progress. • **RA14.** The student/graduate assumes responsibility for the quality of design and testing of power electronic systems, ensuring compliance with technical and safety standards.

7. Objectives of the discipline (based on the grid of learning outcomes acquired)

- Fundamental and applied knowledge required to understand, implement, and evaluate communication protocols used in automotive systems.
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8. Content

8.1 Course	Number of hours	Of which online	Teaching methods
Introduction to Automotive Communication Systems	2		
Automotive Network Architectures.Bus topologies and network layers. Overview of in-vehicle communication domains	4	2	
CAN Protocol (Controller Area Network) Frame structure, arbitration, and error handling Use cases in powertrain and body electronics	2		
CAN FD and Advanced CAN Features Differences from classical CAN Benefits in high-speed and high-data applications	2		
LIN Protocol (Local Interconnect Network) Master-slave communication model Applications in comfort and body control systems	2		
FlexRay Protocol Deterministic communication and time-triggered architecture	2		

Use in safety-critical systems (e.g., braking, steering			
MOST Protocol (Media Oriented Systems Transport) Multimedia data transmission Synchronization and bandwidth management	2		
Automotive Ethernet BroadR-Reach, 100BASE-T1, and IEEE 802.3 standards Applications in ADAS, infotainment, and backbone networks	4	2	
Security in Automotive Communication Threat models and vulnerabilities Encryption, authentication, and secure gateways	2		
UDS Protocol (Unified Diagnostic Services) ISO 14229 standard Diagnostic session control and service identifiers	2		
DoIP (Diagnostics over IP) Ethernet-based diagnostics Integration with service tools and remote access	2		
Protocol Integration and Gateway Design Inter-protocol communication Gateway ECUs and data routing strategies	2	2	

Bibliography[10]

1. Zimmermann, W. & Schmidgall, R.. *Automotive Networks: Bus Communication in Cars – Protocols, Standards, Software Architecture.* Springer Vieweg, 5th Edition, ISBN: 978-3-658-02419-2
2. Vale, M.J., *Vehicle Networking for Technicians: A Practical Guide to CAN, LIN, FlexRay, and Automotive Ethernet,* FuseBox Technical Media, 2025, Kindle Edition
3. Paret, D., *Multiplexed Networks for Embedded Systems: CAN, LIN, FlexRay, Safe-by-Wire* Wiley, ISBN: 978-0-470-51170-1
4. Pasumarthi, S. & Vankayala, S.M., *A Survey of Automotive Communication Protocols and System-Level Design Considerations* IJERT, 2025

8.2 Applied activities[11]	Number of hours	Of which online	Teaching methods
CAN Protocol Implementation and Analysis Configure and transmit CAN messages using microcontroller boards Use protocol analyzers to observe arbitration, error handling, and message prioritization	6	2	Interactive lectures: theoretical presentation of automotive communication protocols Case studies: real-world applications in the automotive field Dialogue and explanations
LIN and FlexRay Network Setup Set up a LIN master-slave network and monitor communication. Simulate FlexRay communication and analyze deterministic timing behavior using dedicated tools.	4		
Automotive Ethernet and BroadR-Reach Establish Ethernet communication using BroadR-Reach transceivers. Analyze packet flow, latency, and error rates using tools like Wireshark	4		
Diagnostic Protocols: UDS and DoIP Initiate UDS services using diagnostic tools and interpret ECU responses. Set up and test DoIP sessions over Ethernet for remote diagnostics.	4		

Security in Automotive Networks Simulate basic attack scenarios on CAN/Ethernet. Implement and test encryption/authentication mechanisms	4	2	
Gateway ECU Simulation Design and simulate a gateway ECU bridging CAN and Ethernet. Route and filter messages between domains using software tools.	6	2	
	Bibliography[12] 1. RapidSEA Blog – A Comprehensive Guide to Automotive Communication Protocols 2. Softing Automotive – Bus Systems Overview 3. Texas Instruments – Communication Protocols in Modern ADAS Architectures		

9. Evaluation

Type of activity	**9.1** Evaluation criteria[13]	**9.2** Evaluation methods	**9.3** Share of the final grade
9.4 Course	Theoretical knowledge of main automotive protocols (CAN, LIN, FlexRay, MOST, Ethernet, UDS)	Written exam	66%
9.5 Applied activities	**S:**		
	L: Ability to configure, monitor, and analyze communication between ECUs	Lab work and Practical assignments	34%
	P:		
	Pr:		
	Tc-R[14]:		
9.6 Minimum performance standard (minimum amount of knowledge necessary to pass the discipline and the way in which this knowledge is verified[15]			
• Basic understanding of key automotive protocols: CAN, LIN, FlexRay, MOST, Ethernet, and UDS. • Ability to interpret protocol structures: message formats, arbitration, error handling. • Hands-on familiarity with protocol tools (e.g., CANalyzer, CANoe) and microcontroller communication. • Basic diagnostic and troubleshooting skills for vehicle networks. • Awareness of safety and timing requirements in automotive communication systems.			

Date of completion 24.09.2025	**Course coordinator (signature)**	**Coordinator of applied activities (signature)**
Head of Department (signature)	**Date of approval in the Faculty Council** [16] 7.10.2025	**Dean (signature)**