**SYLLABUS**

## 1. Data about the program of study

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|---|---|---|
| 1.1 | Institution | The Technical University of Cluj-Napoca |
| 1.2 | Faculty | Automotive Engineering, Mechatronics and Mechanics |
| 1.3 | Department | Automotive Engineering and Transportation |
| 1.4 | Field of study | Automotive Engineering |
| 1.5 | Cycle of study | Master's in Science |
| 1.6 | Program of study/Qualification | Tehnici Avansate în Ingineria Autovehiculelor (Advanced Techniques in Automotive Engineering) - în limba engleză |
| 1.7 | Form of education | Full time |
| 1.8 | Subject code | 13.00 |

## 2. Data about the subject

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|---|---|---|---|---|---|---|---|
| 2.1 | Subject name | | | Hardware and Software in the Loop | | | |
| 2.2 | Subject area | | | Automotive Engineering | | | |
| 2.3 | Course responsible/lecturer | | | Associate Professor PhD Iclodean Călin<br>calin.iclodean@auto.utcluj.ro | | | |
| 2.4 | Teachers in charge of seminars | | | Associate Professor PhD Iclodean Călin<br>calin.iclodean@auto.utcluj.ro | | | |
| 2.5 Year of study | II | 2.6 Semester | 3 | 2.7 Assessment | E | 2.8 Subject category | DA/DI |

## 3. Estimated total time

| | | | | | |
|---|---|---|---|---|---|
| 3.1 Number of hours per week | 4 | 3.2 of which, course: | 2 | 3.3 applications: | 2 |
| 3.4 Total hours in the curriculum | 100 | 3.5 of which, course: | 28 | 3.6 applications: | 28 |
| Individual study | | | | | hours |
| Manual, lecture material and notes, bibliography | | | | | 16 |
| Supplementary study in the library, online and in the field | | | | | 16 |
| Preparation for seminars/laboratory works, homework, reports, portfolios, essays | | | | | 10 |
| Tutoring | | | | | - |
| Exams and tests | | | | | 2 |
| Other activities | | | | | - |

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|---|---|---|
| 3.7 | Total hours of individual study | 44 |
| 3.8 | Total hours per semester | 100 |
| 3.9 | Number of credit points | 4 |

## 4. Pre-requisites (where appropriate)

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| 4.1 | Curriculum | - |
| 4.2 | Competence | General knowledge in the fields of automotive, electronics and computer science. |

## 5. Requirements (where appropriate)

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| 5.1 | For the course | - |
| 5.2 | For the applications | Attending (100% attendance) and performing (promoting) the activities from the laboratory applications condition the admission to the final form of evaluation of the discipline. |

**6. Specific competences**

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|---|---|
| Professional competences | Ability to describe, explain and demonstrate the operation of the main command and control systems and equipment in the field of automobile construction.<br>Knowledge of the functional role of the main command and control systems and equipment in the field of car construction.<br>Knowledge of some typologies of architectures for the communication networks used in the construction of vehicles and the deepening of the main physical and virtual models used in the development and validation of these communication networks.<br>Knowledge of possible faults and the way, respectively of the repair procedures.<br>Knowledge of the advantages of using command and control systems in the construction of vehicles developed in physical and virtual environments. |
| Cross competences | Oral and written communication skills in the mother tongue / foreign language.<br>Use of information and communication technology.<br>Execution of professional tasks according to the specified requirements following a pre-established work plan under qualified guidance.<br>Completion of homework and projects imposed on time and at a high-quality standard.<br>Integration within a working group, assuming specific roles and achieving good communication within the team.<br>Achieving personal and professional development, efficiently using own resources and modern study tools. |

**7. Discipline objectives (as results from the *key competences gained*)**

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|---|---|---|
| 7.1 | General objective | Development of specific skills in the field of command-and-control systems and equipment in the field of automobile construction in support of professional training. |
| 7.2 | Specific objectives | Assessment and analysis of requirements for new technologies integrated in vehicles in order to implement advanced command and control systems. |

**8. Contents**

| 8.1. Lecture (Syllabus) | Methods | Notes |
|---|---|---|
| 1. In-Vehicles ECU (Electronic Control Unit). | Exposure, conversation, exemplification, orientation, etc. Use of technical and visual means. | 2 hours |
| 2. Virtual ECU for Powertrain Domain. | | 2 hours |
| 3. Virtual ECU for Chassis and Safety Domain. | | 2 hours |
| 4. Virtual ECU for Body and Confort Domain. | | 2 hours |
| 5. Virtual ECU for Infotainment Domain. | | 2 hours |
| 6. Virtual ECU for Telematic Domain. | | 2 hours |
| 7. Embedded System development based on the "V" Model. | | 2 hours |
| 8. Model-in-the-Loop (MiL) model development methodology. | | 2 hours |
| 9. Software-in-the-Loop (SiL) model development methodology. | | 2 hours |
| 10. Processor-in-the-Loop (PiL) model development methodology. | | 2 hours |
| 11. Hardware-in-the-Loop (HiL) model development methodology. | | 2 hours |
| 12. AUTOSAR Classic Architecture. | | 2 hours |
| 13. AUTOSAR Adaptive Architecture. | | 2 hours |
| 14. AUTOSAR Application Interface. | | 2 hours |
| 8.2. Applications/Seminars | Methods | Notes |
| 1. XiL development methods in simulation applications (1). | Exercices, conversations, description, modeling, etc. Use of technical | 2 hours |
| 2. XiL development methods in simulation applications (2). | | 2 hours |
| 3. Defining a virtual model based on a real model (1). | | 2 hours |
| 4. Defining a virtual model based on a real model (2). | | 2 hours |
| 5. Defining a virtual model based on a real model (3). | | 2 hours |
| 6. Defining a virtual model based on a real model (4). | | 2 hours |

| | | |
|---|---|---|
| 7. XiL development: Virtual ECU modeling (1). | and visual means. | 2 hours |
| 8. XiL development: Virtual ECU modeling (2). | | 2 hours |
| 9. XiL development: Virtual ECU modeling (3). | | 2 hours |
| 10. Testing and optimizing Virtual ECU parameters (1). | | 2 hours |
| 11. Testing and optimizing Virtual ECU parameters (2). | | 2 hours |
| 12. Testing and optimizing Virtual ECU parameters (3). | | 2 hours |
| 13. Testing and optimizing Virtual ECU parameters. | | 2 hours |
| 14. Analysis and interpretation of simulation results. | | 2 hours |

Bibliography


1. Bosch Automotive Electrics and Automotive Electronics Systems and Components (link).
2. Bosch Automotive Mechatronics, Automotive Networking, Electronics (link).
3. Bosch Diesel Engine Management, Systems and Components (link).
4. Bosch Gasoline Engine Management Systems and Components (link).
5. Bosch Fundamentals of Automotive and Engine Technology, Standard Drives (link).
6. Bosch CAN Specification version 2.0 (download link).
7. Bosch CAN FD Specification version 1.0 (download link).
8. Grzemba MOST The Automotive Multimedia Network (download link).
9. Iclodean Metode de Simulare a Sistemelor de Propulsie prin Aplicații Numerice (download link).
10. Iclodean Rețele de Comunicație pentru Autovehicule (download link).
11. Iclodean Interconectarea sistemelor virtuale de ... control pentru autovehicule (download link).
12. Kozierok Automotive Ethernet: The Definitive Guide (download sample).
13. Mariașiu Aplicații Numerice în Simularea Proceselor Motoarelor cu Ardere Internă (download link).
14. Mariașiu Managementul Motoarelor cu Ardere Internă (download link).
15. Burnete Motoare cu Ardere Internă Procese și Management Motor (download link).
16. Paret FlexRay and its Applications: Real Time Multiplexed Network (link).
17. Varga Electric and Plug-In Hybrid Vehicles Advanced Simulation Methodologies (link).
18. Varga Electric and Hybrid Buses for Urban Transport Energy Efficiency Strategies (link).
19. Iclodean Autonomous Vehicles for Public Transportation (link).
20. Varga Simulation in the Loop of Electric Vehicles (download link).
21. FlexRay Communications System Protocol Specification version 3.0.1 (download link).
22. Freescale Automotive Solutions Setting the Pace for Innovation (download link).
23. Paret Multiplexed Networks for Embedded Systems: CAN, LIN, FlexRay, Safe-by-Wire... (link).
24. LIN Specification Package revision 2.2A (download link).
25. MatLab & Simulink Vehicle Network Toolbox version R2021a (download link).
26. AUTOSAR Standard Classic Platform (download link).
27. AUTOSAR Standard Adaptive Platform (download link).
28. AUTOSAR Application Interface (download link).


## 9. Bridging course contents with the expectations of the representatives of the community, professional associations, and employers in the field

In the training of skills, the options of employers recommended to higher education institutions for the training of graduates are taken into account (ability to use time efficiently, ability to work in a team, ability to learn quickly, ability to coordinate teams, new opportunities in the interest company, the ability to use the computer and the Internet, the ability to adapt to new situations, etc.) and the priorities recommended by employers in training graduates (creativity and ability to innovate, the ability to negotiate, the ability to critically analyze, the ability to learn quickly , knowledge from other fields). The content of the discipline is in accordance with the study materials and methods that are used by Bosch Romania Company. The content of the discipline is in accordance with the study materials and methods that are used at other universities in the country and abroad.

**10. Evaluation**

| Activity type | 10.1 Assessment criteria | 10.2 Assessment methods | 10.3 Weight in the final grade |
|---|---|---|---|
| 10.4 Course | The degree of assimilation of the notions presented during the course. Correctness of acquired knowledge. | Written evaluation. | 60% |
| 10.5 Applications | Ability to operate with assimilated knowledge. | Checking applications. | 40% |
| 10.6 Minimum standard of performance: final grade 5. | | | |
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| **Date of filling in:** | | **Title Surname Name** | **Signature** |
|---|---|---|---|
| 10.06.2024 | Lecturer | Associate Professor PhD Iclodean Călin | |
| | Teachers in charge of application | Associate Professor PhD Iclodean Călin | |
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Date of approval in the department ART
26.06.2024
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Head of department
Prof.dr.ing. Barabás István

Date of approval in the faculty ARMM

___28.06.2024_____

Dean
Prof.dr.ing. Filip Nicolae