Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Telecommunications**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Applied Electronics

2. Date despre disciplină

2.1 Course name (ro) (en)				Electronică auto Automotive Electronics			
2.2 Course Lecturer				Prof. Dr. Alexandru VASILE			
2.3 Instructor for practical activities				Prof. Dr. Alexandru VASILE			
2.4 Year of studies	4	2.5 Semester	I	2.6. Evaluation type	V	2.7 Course regime	F
2.8 Course type		S	2.9 Course code	04.S.07.L.117		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	3	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	14
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					20
Tutoring					14
Examinations					4
Other activities (if any):					10

3.7 Total hours of individual study	33.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Physics, Electrotechnics Basics, Electrical machines, Elementary Electrical Devices and Circuits, Analog and Digital Integrated Circuits, Micro-controllers, Power Electronics.

4.2 Results of learning	Assimilation of knowledge related to the special conditions of vehicles, the special electronic circuits destined to this field: circuits for the engine command and monitoring (spark-ignited engines, Diesel engines, and electric engines), circuits for the supervision and control of the running and environmental systems, the methodology of approaching and designing an electronic system destined to the automotive field

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	The lectures will be taken in a classroom with video projector and computer.
5.2 Seminary/ Laboratory/Project	Practical activities will be taken in a specialized laboratory, which will contain:testing platform for electric vehicles, electronic control units for vehicles, vehicles with internal combustion engine, charging stations for electric vehicles, dedicated test and measurement equipments, interfaces and software for automotive diagnosis.

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

Assimilation of knowledge related to the special conditions for design and development of the special electronic circuits in the automotive field, for powertrain (monitoring and control of spark-ignition engines, Diesel engines, and electric engines), body and chassis systems. Electric Vehicles (EVs) have become an essential part in the transition to or incorporation of electric mobility (e-mobility), which will imply significant changes for vehicle manufacturers, governments, companies and individuals. This course covers the most important aspects of the next generation of vehicles, presenting both, the fundamentals and cutting-edge technologies, theory and design of EVs (electric motors, batteries, power converters, and chargers), the integration of EVs in the smart grid infrastructure, world-wide and local business models, and policies for governmental bodies.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	- To apply fundamental and specialized knowledge to solve complex technological problems which are specific to Automotive Electronics and Applied Electronics;- To develop engineering solutions for solving technological problems in the fields of automotive electronics, power electronics, and renewable energy systems;- To solve problems regarding the automated processes control encountered in automotive systems and to use electronic controllers;- To apply the knowledge from the field of Applied Electronics in order to perform case studies in the field of dedicated systems for Automotive Electronics.

Transversal (General) Competences	- To define the advanced notions of information technology, electronic circuits and automation for performing quality management;- Responsibly working in a multidisciplinary team with abilities to assume roles specific to different hierarchical levels;- Capacity to identify the need for continuous education and efficient use of information sources, communication resources and training assistance (Internet portals, specialized software, databases, online courses) both in Romanian and a foreign language. - Autonomy and critical thinking: the ability to think in scientific terms, to search and analyze data independently, and to draw and present conclusions / identify solutions. - Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a systematic analysis process. - Respects the principles of academic ethics in the documentation activity, correctly cites the bibliographic sources used.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* - understanding the role of EVs in the transition to e-mobility; - understanding and applying fundamental concepts of automotive electronics ;- understanding basic technologies for electric propulsion, electric motors and power converters; - understanding battery technologies, management systems and chargers
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* - installation and configuration of after-market components and systems for conversion of EVs ;- creation of business models and developing new strategies in the field of EVs ;- assessing policy plans and regulations for e-mobility
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Selection and analyzing of appropriate bibliographic sources. - Respect the principles of academic ethics, correctly citing the bibliographic sources used. - Demonstrates collaboration with other colleagues and teaching staff - Promotes/contributes through new solutions related to the specialized field to improve the quality of social life. - Identifies sustainable solutions to solve problems in social and economic life . - Apply principles of professional ethics/deontology in the analysis of the impact of electric vehicle technologies on the environment . - Analyze and capitalize on business opportunities in the field of electric vehicles.

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

Teaching is carried out through the presentation and questioning methods. Modern teaching methods (video

projector) are used for presentation of the course notes, applications notes, videos and demonstrative software applications. The lectures notes and presentations are available to students in pdf format. Teaching is based on the experimentation method, using dedicated hardware equipments and software applications. Students perform experimental measurements, analyzing and interpreting the data.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	A short introduction in Automotive Electronics: past, present, and future	2
2	Internal Combustion Engine (ICE) vehicles. Main components of powertrain system: starting system, injection system, and ignition system, sensors and actuators. Engine Control Module (ECM).	4
3	Hybrid Electric Vehicles (HEV). Hybrid topologies for powertrain system. Mild hybrid vehicles. Hydraulic hybrid vehicles. Fuel Cell electric vehicles. Gas hybrid vehicles.	2
4	Electric Vehicles (EV). The need of EVs. General architecture of EVs. EV main components: electric motor, motor controller, high voltage battery pack, battery management system, on-board charger, auxiliary systems. Solar EVs	6
5	Vehicle Communication Networks. General architecture of Controller Area Networks (CAN): topology, CAN nodes, CAN frames, frames arbitration. Local Interconnect Network (LIN). FlexRay networks. Automotive Ethernet. Telematic Systems.	2
6	Instruments Clusters (ICs). Analog clusters. Mixed ICs. Fully digital ICs. Basic circuits and sensors for gauges. Indicators and Warning Lights. Multimedia Infotainment Units.	2
7	On Board Diagnosis (OBD) of vehicles. Main principles. Diagnostic Trouble Codes (DTC). OBD Communication protocol. OBD Services. OBD portable tools, interfaces and software applications	2
8	Chassis and Body Systems. Steering system, Braking system, Lighting system, Heating and ventilation system.	2
9	Advanced Driver Assistance Systems (ADAS). Main components for Driving Control Assistance, Collision Warning, Collision Intervention, Parking Assistance, and other systems.	2
10	Modeling and simulation of automotive systems. V cycle. Examples in Matlab/Simulink.	2
11	Hardware in the Loop (HIL) simulation and testing	2
	Total:	28

Bibliography:
1. A. Vasile, I. B. Bacîș, "Bazele Electronicii Auto", Editia III, Editura Cavallioti, 2018.
2. I. B. Bacîș, A. Vasile, "Electrician Electronist Auto", Editura PIM, 2016.
3. I. B. Bacîș, L. A. Perișoară, "Electronică auto. Îndrumar de laborator", Editura Cavallioti, București, Editura PIM, Iași, 2019.
4. A. Vasile, Industrial electronics, Cavallioti, ISBN 973-9463-75-4, Bucharest, 2004.
5. Manea C, Manea A, Mecatronics of the modern vehicles, vol. I, vol. II, Matrix-Rom, Bucharest 2000.
6. M. P. Brown, S. Prange, "Convert it: a step-by-step manual for converting an internal combustion vehicle to electric power", Future Books, 1993.
7. S. Dhameja, "Electric Vehicle Battery Systems", Butterworth–Heinemann, 2001.
8. J. Larminie, J. Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.
9. Ali Emadi, Handbook Automotive Power Electronics and Motor Drivers, Taylor & Francis, USA 2005.
10. M. Ehsani, Y. Gao, S. E. Gay, A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles - Fundamentals, Theory, and Design", CRC Press, 2005.
11. V. Pop, H. J. Bergveld, D. Danilov, P. P. L. Regtien, P. H.L. Notten, "Battery Management Systems - Accurate State-of-Charge Indication for Battery-Powered Applications", Springer, 2008.
12. S. Leitman, B. Brant, "Build Your Own Electric Vehicle", 2nd Edition, McGraw-Hill, 2009.
13. D. Andrea, "Battery management systems for large lithium-ion battery packs", Artech House, 2010.
14. I. Husain, "Electric and Hybrid Vehicles: Design Fundamentals", 2nd Edition, CRC Press, 2010.
15. T. Muneer, M. Kolhe, A. Doyle, "Electric Vehicles: Prospects and Challenges", Elsevier, 2017

LABORATORY

Crt. no.	Content	No. hours
1	Motor Controllers for Electric Vehicles. Case study for Curtis 1238-7601 controller.	2
2	Virtual Instruments for monitoring of Electric Vehicles through the CAN bus	4
3	Virtual instruments for vehicles monitoring and diagnosis	4
4	Charging stations for Electric Vehicles	2
5	Evaluation	2
	Total:	14

Bibliography:
Motor Controllers for Electric Vehicles. Case study for Curtis 1238-7601 controller.

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade

11.4 Course	- knowledge and understanding of fundamental theoretical notions; - comparative analysis of testing techniques and methods; - capacity to apply the theoretical notions to solve practical problems	Final examination at the end of the semester. The quiz test covers all lectures and contains 30 questions	60%
11.5 Seminary/laboratory/project	- acquiring and understanding of taught knowledge; - practical application of testing methods using laboratory equipments; - ability to analyze the testing results.	At the end of each lab session, students answer a quiz with questions from platforms. The total score is obtained by summing all scores obtained in each laboratory	40%
11.6 Passing conditions			
Supporting a test for determining the architecture of an electric vehicle and describing the electronic equipments. Accumulating at least 50 points out of 100 points.			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

This course prepares graduates for product design, development, manufacturing and testing in different engineering areas: automotive electronics, electrical engineering, power electronics, sustainable transport areas, energy policy, and integration of electric vehicles in smart grids. Students learn how electrical and mechanical engineers must work together in order to meet today's needs of clean, efficient, and sustainable vehicles. The lectures present a systematic and comprehensive description on the fundamentals of theory and design of electric vehicle technologies and systems. The practical activities provide a hands-on look at the research and development involved in the use and integration of electric vehicle technologies, which are reinforced with real-world case studies for conversion of classical vehicles to electric ones that were implemented in Romania. The master program provides to graduate students appropriate skills and training for the actual needs and scientific and technological qualifications, of high quality and competitively, allowing them rapid employment after graduation. This fact is consistent with the university policies, both in terms of content and structure, but also in terms of skills and international openness offered to students

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Date	Course lecturer	Instructor(s) for practical activities
10.10.2024	Prof. Dr. Ing. Alexandru VASILE	Prof. Dr.. Ing. Alexandru VASILE

Date of department approval	Head of department
	Conf. Dr. Ing. Bogdan Cristian FLOREA

Date of approval in the Faculty Council	Dean
25.10.2024	Prof. Dr. Mihnea Udrea