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	Masters
1.6 Programme of studies	Electric Vehicle Propulsion and Control

2. Date despre disciplină

2.1 Course name (ro) (en)				Încărcătoare de baterii Battery Chargers			
2.2 Course Lecturer				Conf. Dr. George Ștefan ROȘU			
2.3 Instructor for practical activities				Conf. Dr. George Ștefan ROȘU			
2.4 Year of studies	2	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M3.O.24-21		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.					54
Tutoring					0
Examinations					4
Other activities (if any):					0

3.7 Total hours of individual study	58.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Completion of the following disciplines: • Power electronics

4.2 Results of learning	Knowledge about electrical DC-DC and DC-AC power conversion

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

5.1 Course	The course will take place in a room equipped with a video projector
5.2 Seminary/ Laboratory/Project	The laboratory will take place in a room with specific equipment, which must include PCs

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)*

The Battery Chargers discipline is studied within the field Electronic Engineering, Telecommunications and Information Technology and aims to familiarize students with the main approaches, models and explanatory theories of the field, used in solving practical applications and problems related to the battery chargers modules in electric cars.
The discipline has as an objective the study, analysis, design and simulation of battery chargers made of AC-DC, DC-DC electronic power converters, interface and control circuits with applications in electric cars
This discipline combines the fundamental aspects of the electronic power circuits used to charge auto batteries with aspects that can be encountered in practice. The activities in the discipline familiarize students with basic theoretical and applicative aspects that allow addressing and solving some problems requiring knowledge in the field of auto power electronics

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	Demonstrates advanced knowledge of automotive power electronics Correlates fundamental knowledge with automotive power electronics Elaborates engineering solutions in solving problems from the field of power electronics, renewable energy systems and automotive Apply knowledge in the field of battery chargers in practice It argues and analyzes coherently and correctly the context of application of the basic knowledge of the field, using key concepts of the discipline and the specific methodology. Oral and written communication in Romanian: uses the scientific vocabulary specific to the field, in order to communicate effectively, in writing and orally. Oral and written communication in a foreign language (English): demonstrates understanding of subject-related vocabulary in a foreign language.
Transversal (General) Competences	Autonomy and critical thinking: the ability to think in scientific terms, search and analyze data independently, and draw and present conclusions / identify solutions from the field of power electronics Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a process of systematic analysis. Respect the principles of academic ethics: correctly cite the bibliographic sources used in the documentation activity. Puts elements of emotional intelligence into practice in the appropriate social-emotional management of real-life/academic/professional situations, demonstrating self-control and objectivity in decision-making or stressful situations.

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.* Lists the most important topologies of converters used to charge batteries Defines notions specific to the field of automotive power electronics Describe the operation of power converters Highlights consequences and relationships between various types of car battery 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).* Selects and groups relevant automotive power electronics information in a given context. Reasonably uses specific principles in order to find optimal solutions for the realization of a car battery charger Check through simulations solutions identified from the initial technical requirements. Solve practical applications related to car battery chargers. Analyze and compare various car battery charger topologies. Identifies solutions and develops solution plans/projects specific to the field of automotive power electronics.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Select bibliographic sources specific to the field of automotive power electronics and analyze them. Respect the principles of academic ethics, correctly citing the bibliographic sources used. Demonstrates responsiveness to new learning contexts. Demonstrates autonomy in organizing the learning situation/context or the problem situation to be solved Demonstrates social responsibility through active involvement in student social life/involvement in academic community events Promotes/contributes through new solutions related to the specialized field to improve the quality of social life. Realizes the value of his contribution in the field of engineering to the identification of viable/sustainable solutions to solve problems in social and economic life (social responsibility).

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.)*

The teaching process will explore both expository (lecture, exposition) and conversational-interactive teaching methods, based on discovery learning models facilitated by direct and indirect exploration of reality (experiment, demonstration, modeling), but also on methods based on action, such as exercise, practical activities and problem solving.
In the teaching activity, the video projector will be used to present the materials that will be made available to the students (covering the communication and demonstration function), and the oral communication method used is the problematization method, used frontally. Each course will start with a recap of the chapters already covered, with an emphasis on the concepts covered in the last course.
Students implement, test and evaluate independently the same problems through analytical methods and through the continuous use of laboratory platforms, the use of tools specific to the field of automotive electronics. Teaching materials are laboratory platforms and tools, simulation programs, used for their study.
Communication with students will be taken into account during the activities to identify possible lagging behind and, if necessary, the teaching process will be adapted for complete understanding of the subject.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Automotive electronics for battery chargers • automotive charger structures • classifications, • Distribution grid interface.	2
2	Single-phase AC-DC converters with power factor correction • operation, specific parameters, control methods, PWM modulation	6
3	Three-phase AC-DC converters with power factor correction • two-, multi-level or modular topologies, PWM modulation	6
4	DC-DC converters with unidirectional and bidirectional power flow • non-isolated conversion topologies - buck, boost • high frequency transformer isolated conversion topologies - LLC, DAB	4
5	Wireless power transfer (WPT) battery chargers • static and dynamic WPT battery chargers • transmitter and receiver coils and converters • command and control methods	4
6	Practical realization of battery chargers • control circuits with real time microcontrollers • interface and protection circuits • new generation semiconductor devices - GaN, SiC	4
7	Comparative analysis of battery chargers according to the maximum power and degree of implementation in the automotive market	2
	Total:	28

Bibliography:
1. Roşu Ştefan-George, Battery Chargers, electronic lecture notes, https://curs.upb.ro
2. C. Mi and M. A. Masrur, and D. W. Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, 2nd ed., Wiley, 2017.
3. C.T. Rim and C. Mi, Wireless Power Transfer for Electric Vehicles and Mobile Devices, Wiley, 2017.
4. S. Buso and P. Mattavelli, Digital Control in Power Electronics, 2nd Ed., Morgan & Claypool, 2015.
5. R. W. Erickson and D. Maksimovic, Fundamentals of power electronics, Springer US, 2001

LABORATORY

Crt. no.	Content	No. hours
1	PWM modulation methods for AC-DC converters	2
2	Single-phase AC-DC converters	2
3	Three-phase AC-DC converters	2
4	DC-DC converters with transformer isolation	2
5	DC-DC converters without transformer isolation	2
6	Wireless power transfer systems	2
7	Laboratory evaluation	2
	Total:	14

Bibliography:
6. Roşu Ştefan-George, Încărcătoare de baterii, suport de curs electronic https://curs.upb.ro
7. C. Mi and M. A. Masrur, and D. W. Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, 2nd ed., Wiley, 2017.
8. C.T. Rim and C. Mi, Wireless Power Transfer for Electric Vehicles and Mobile Devices, Wiley, 2017.
9. S. Buso and P. Mattavelli, Digital Control in Power Electronics, 2nd Ed., Morgan & Claypool, 2015.
10. R. W. Erickson and D. Maksimovic, Fundamentals of power electronics, Springer US, 2001.

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	knowledge of theoretical notions; the study of a specific application; synthesis and presentation of information	written work and oral presentation	25%
	- knowledge of the application of the theory to solve specific problems; - analysis techniques and theoretical methods specific to battery chargers	Exam	50%
11.5 Seminary/laboratory/project	Written test to evaluate the simulation and implementation skills acquired for the battery chargers circuits	Laboratory evaluation	25%
11.6 Passing conditions			
obtaining the minimum score of 50%			

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)

Through the activities carried out, students develop skills to offer solutions to problems and propose ideas to improve the existing situation in the field of automotive power electronics
In the development of the content of the discipline, knowledge described by the specialized literature was taken into account
This discipline combines the fundamental aspects of the electronic power circuits used to charge auto batteries with aspects that can be encountered in practice

Date	Course lecturer	Instructor(s) for practical activities
17.10.2024	Conf. Dr. George Ștefan ROȘU	Conf. Dr. George Ștefan ROȘU

Date of department approval	Head of department
27.10.2024	Conf. Dr. Serban Georgica Obreja

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