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

# COURSE DESCRIPTION

## 1. Program identification information

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|---|---|
| 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

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|---|---|---|---|---|---|---|---|
| 2.1 Course name (ro)<br>(en) | | | | Convertoare electronice de putere<br>Power Electronic Converters | | | |
| 2.2 Course Lecturer | | | | Prof. Dr. Adriana FLORESCU | | | |
| 2.3 Instructor for practical activities | | | | Prof. Dr. Adriana FLORESCU | | | |
| 2.4 Year of studies | 1 | 2.5 Semester | II | 2.6. Evaluation type | V | 2.7 Course regime | Ob |
| 2.8 Course type | | DA | 2.9 Course code | UPB.04.M1.O.24-07 | | 2.10 Tipul de notare | Nota |

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

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|---|---|---|---|---|---|
| 3.1 Number of hours per week | 3 | Out of which: 3.2 course | 1.00 | 3.3 seminary/laboratory | 2 |
| 3.4 Total hours in the curricula | 42.00 | Out of which: 3.5 course | 14 | 3.6 seminary/laboratory | 28 |
| Distribution of time: | | | | | hours |
| Study according to the manual, course support, bibliography and hand notes<br>Supplemental documentation (library, electronic access resources, in the field, etc)<br>Preparation for practical activities, homework, essays, portfolios, etc. | | | | | 25 |
| Tutoring | | | | | 0 |
| Examinations | | | | | 8 |
| Other activities (if any): | | | | | 0 |

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| 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)

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| 4.1 Curriculum | To pass of the following disciplines:<br>• Basics of electrical engineering<br>• Signals and systems<br>• Electronics devices<br>• Fundamental electronics circuits |
| 4.2 Results of learning | Accumulation of the following knowledge:<br>• power electronics devices<br>• power electronics converters |

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

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| 5.1 Course | The course will take place in a properly equipped room, which will allow the teaching staff to alternate the classic blackboard presentation with multimedia presentations. Students have access to the course notes on the Internet. During the lectures, as far as is appropriate, interactive debates are encouraged. |
| 5.2 Seminary/ Laboratory/Project | The laboratory will take place in room B235 in the LEU Complex of the ETTI faculty in UPB, with specific hardware and software equipment. The platform sheets for the laboratory are available to the students both on paper and in electronic form on the Moodle website. Attendance is mandatory at the laboratories (according to the Master's University Study Regulations in UPB). |

**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)*

This discipline is studied within the Electronic Engineering, Telecommunications and Information Technologies field of study within the Electric Vehicle Propulsion and Control (EPIC) advanced master's and aims to familiarize students with the main approaches, models and explanatory theories of the field, used in solving practical applications, with relevance for stimulating the learning process in students.
The general objective of the discipline is the initiation of the students of the Faculty of Electronics, Telecommunications and Information Technology from the first year, the second semester of the EPIC master's degree in the very interesting, useful and dynamic reality of devices and especially of power electronics converters that have also a potential applicability in the field of electric vehicles studied in this master. All these contributing to the transmission/formation towards/to the students of an overview of methodological and procedural benchmarks related to the field.

**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.)*

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| **Specific Competences** | Demonstrates basic knowledge of power electronics devices, circuits, systems, technology and software packages<br>Correlates knowledge<br>Applies knowledge in practice<br>Applies standardized methods and tools, specific to the field, to carry out the evaluation and diagnosis process in a situation, depending on the identified/reported problems, and identifies solutions.<br>Coherently and correctly argues and analyzes the context of application of the basic knowledge of the field, using key concepts of the discipline and the specific methodology.<br>Coomunicates orally and in written in a foreign language (English): demonstrates understanding of the vocabulary related to the field. |
| **Transversal (General) Competences** | Methodically analyzes the problems encountered in the activity, identifying the elements for which there are established solutions, thus ensuring the fulfillment of the professional tasks<br>Works in a team and communicates effectively, coordinating its efforts with the others in order to solve problem situations of medium complexity.<br>Demonstrates autonomy and critical thinking: the ability to think in scientific terms, to search and analyze independent data, as well as to extract and present conclusions / identify solutions.<br>Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a systematic process of analysis.<br>Respects the principles of academic ethics: correctly cite the bibliographic sources used in the documentation activity. |

**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.)*

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| **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.*<br>Exemplu:<br>**Lists the most important stages that marked the development of the field.**<br>**Defines domain-specific notions.**<br>**Describes/classifies notions/processes/phenomena/structures.**<br>**Highlights consequences and relationships.**<br>**Knows the operation of AC** and DC power converters. specific to the studied PEC field. |

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| **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).*<br>Exemplu:<br>**Solve**s practical applications.<br>**Adequately interpret**s causal relationships.<br>**Analyzes** and compares methods.<br>**Identifies solutions and develops solution/project plans.**<br>**Formulates conclusions to the experiments carried out.**<br>**Argue**s the identified solutions/methods.<br>**Selects and groups relevant information in a given context.**<br>**Uses and argues specific principles**.<br>**Work**s productively within a team.<br>**Elaborate**s a scientific text.<br>Experimentally verifies the identified solutions. |
| **Responsability and autonomy** | *The student's capacity to autonomously and responsably apply their knowledge and skills.*<br>Exemplu:<br>**Select**s appropriate bibliographic sources and analyzes them.<br>**Respect**s the principles of academic ethics, correctly citing the bibliographic used sources.<br>**Demonstrates receptivity** to new learning contexts.<br>**Demonstrates collaboration with other colleagues and** with teaching staff in carrying out technical and scientific activities<br>**D**emonstrates autonomy in organizing the learning situation/context or the problem situation to be solved<br>**Demonstrates social responsibility through** an active involvement in student social life/involvement in academic community events related to the subject of the studied domain<br>**Promotes/contributes through new solutions related to the specialized field to improve the quality of** the social life.<br>**Realizes the value of its** contribution in the field of engineering to the identification of viable/sustainable solutions capable 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 methods are based on the use of the blackboard and the video projector, both in the course and in the laboratory. The oral communication methods used are the expository method and the problematization method, used head-on. The course materials are: course notes and presentations, collections of proposed problems (theoretical and solved on the computer). In the laboratory, students independently simulate, implement, test and evaluate problems through the continuous use of platforms and software environments. The didactic materials are the laboratory platforms included in the laboratory guide. All course and lab materials are available electronically on the Power Electronic Converters course Moodle site: https://curs.upb.ro/2021/course/view.php?id=9868.
Starting from the analysis of students' learning characteristics and their specific needs, the teaching process explores both expository (lecture, exposition) and conversational-interactive teaching methods, based on discovery learning models facilitated by direct and indirect exploration of reality (experiment, demonstration, modelling), but also on action-based methods, such as exercise, practical activities and problem solving. In the teaching activity, lectures are used, based on presentations that use images and

diagrams, so that the information presented is easy to understand and to assimilate by the students.
It is considered the practice of active listening and assertive communication skills, as well as feedback construction mechanisms, as ways of behavioral regulation in various situations of adapting the pedagogical approach to the students' learning needs. Students' teamwork skills are also practiced to solve different learning tasks.

**10. Contents**

| **COURSE** | | |
|---|---|---|
| **Chapter** | **Content** | **No. hours** |
| 1 | Introduction in power electronics devices and converters | 2 |
| 2 | Methods of analysis for power electronics circuits | 2 |
| 3 | Uncontrolled ingle-phase and poly-phase AC to DC converters | 2 |
| 4 | Controlled and half-controlled single-phase and three-phase AC to DC converters | 2 |
| 5 | Controlled and half-controlled single-phase and three-phase AC to DC converters | 2 |
| 6 | Elementary DC to DC converters | 2 |
| 7 | Single-phase and three-phase AC variators | 2 |
| 8 | Single-phase and three-phase AC variators | 0 |
| 9 | Applications od DC to AC and DC to DC converters in electric vehicles | 0 |
| | **Total:** | 14 |
| **Bibliography:** | | |

| **LABORATORY** | | |
|---|---|---|
| **Crt. no.** | **Content** | **No. hours** |
| 1 | Stabilized half-controlled bridge rectifier with thyristors | 4 |
| 2 | Inverter with voltage synthesis controlled with IBM-PC computer | 4 |
| 3 | Chopper with thyristors operating in one-quadrant | 4 |
| 4 | Laboratory colloquium | 2 |
| | **Total:** | 14 |
| **SEMINARY** | | |
| **Crt. no.** | **Content** | **No. hours** |
| 1 | Illustration of operation for power devices with DC and AC supply sources | 2 |
| 2 | Application of the state variable method for a DC to DC classical type of converter | 2 |
| 3 | Parameter calculation of single-phase and three-phase uncontrolled rectifiers | 2 |
| 4 | Parameter calculation of single-phase and three-phase controlled rectifiers and half-controlled rectifiers | 2 |
| 5 | Parameter calculation of single-phase and three-phase controlled rectifiers and half-controlled rectifiers | 2 |
| 6 | Analysis of DC to DC fundamental converters | 2 |
| 7 | Parameter calculation of the single-phase inverters | 2 |
| 8 | Operation and control illustration of controlled three-phase inverter | 0 |

| | | |
|---|---|---|
| 9 | Operation and control illustration of controlled three-phase inverter | 0 |
| | **Total:** | 14 |
| **Bibliography:** | | |

**11. Evaluation**

| Activity type | 11.1 Evaluation criteria | 11.2 Evaluation methods | 11.3 Percentage of final grade |
|---|---|---|---|
| 11.4 Course | Knowing about fundamental theoretical notions; | Verification test during the semester | 25% |
| | Knowing how to apply the theory to specific problems; | Partial exam during the semester, with the possibility to be repeated in the session | 25% |
| | Analysis of techniques and theoretical methods specific to the field of power electronics converters. | Final test in the session | 25% |
| 11.5 Seminary/laboratory/project | Knowing the operation mode of a given problem | Final laboratory colloquium type grid test, which contains theoretical questions presented in the laboratory works. | 5% |
| | Knowledge about the operation of the proposed power circuits. | Final laboratory colloquium type grid test, which contains questions from the simulations performed or given as homework in the laboratory works. | 10% |
| | Demonstration of the operation through simulation of an implemented system. | Final laboratory colloquium type grid test, which contains questions about the operating of the power circuits presented in the laboratory works. | 10% |
| 11.6 Passing conditions | | | |
| Obtaining 50% of the total score awarded to the laboratory, according to the ETTI Undergraduate Studies Regulations in force.<br>Obtaining 50% of the exam score (partial plus final exam). | | | |

**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)**

The Power Electronics Converters discipline encompasses the switching, control, regulation and conversion of electrical energy, using electronics devices together with their measurement and control circuits. Rectifiers (a.c.-d.c. converters), inverters (d.c.-a.c. converters), a.c.-a.c. converters and d.c.-d.c converters represent the fundamental building blocks of modern electronics applications used in telecommunications and mobile telephony, multimedia equipment, medical technology, etc.
The course curriculum and the content of the seminar and laboratory meet the requirements of this modern and current field of electrical energy processing, which gathers and promotes the information available in electrical power conversion electronics, so that the future electronics engineer can have immediate access to the knowledge, concepts and methodologies basic of the field. In this way, graduates of the Polytechnic University of Bucharest, the Faculty of Electronics, Telecommunications and Information Technology, the field of Electronics Engineering, Telecommunications and Information Technologies, the EPIC master's degree are ensured the appropriate skills correlated with the needs of current qualifications and a modern scientific and technical training, of quality and competitive, allowing them to be employed quickly after graduation, being perfectly aligned with the policy of the Polytechnic University of Bucharest, both from the point of view of content and structure, as well as from the point of view of the skills and international openness offered to students willing to work in the field of electronics applied.
European universities studying the field addressed: Uppsala University, Sweden; Aalborg University, Denmark; University of Greenwich and University of Nottingham, England etc

| Date | Course lecturer | Instructor(s) for practical activities |
|---|---|---|
| 09.10.2024 | Prof. Dr. Adriana FLORESCU | Prof. Dr. Adriana FLORESCU |

| 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 |