# SYLLABUS

## 1. Data about the program of study

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| 1.1 Institution | Technical University of Cluj-Napoca |
| 1.2 Faculty | Electronics, Telecommunications and Information Technology |
| 1.3 Department | Applied Electronics |
| 1.4 Field of study | Electronics Engineering, Telecommunications and Information Technology |
| 1.5 Cycle of study | Bachelor of Science |
| 1.6 Program of study/Qualification | Applied Electronics |
| 1.7 Form of education | IF-Full time |
| 1.8 Subject code | 36.00 |

## 2. Data about the subject

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|---|---|---|---|---|---|---|---|
| 2.1 Subject name | Power Electronics | | | | | | |
| 2.2 Subject area | Theoretical area<br>Methodological area<br>Analysis area | | | | | | |
| 2.3 Course responsible/lecturer | S.L. Dr. Ing. Pătărău Toma – toma.patarau@ael.utcluj.ro | | | | | | |
| 2.4 Teachers in charge of applications | S.L. Dr. Ing. Pătărău Toma – toma.patarau@ael.utcluj.ro | | | | | | |
| 2.5 Year of study | III | 2.6 Semester | 2 | 2.7 Assessment | E | 2.8 Subject category | DD DI |

## 3. Estimated total time

| | | | | | |
|---|---|---|---|---|---|
| 3.1 Number of hours per week | 4 | of which, 3.2 course | 2 | 3.3 applications | 2 |
| 3.4 Total hours in the curriculum | 56 | of which, 3.5 course | 28 | 3.6 applications | 28 |
| Individual study | | | | | Hours |
| Manual, lecture material and notes, bibliography | | | | | 8 |
| Supplementary study in the library, online and in the field | | | | | 4 |
| Preparation for seminars/laboratory works, homework, reports, portfolios, essays | | | | | 4 |
| Tutoring | | | | | 2 |
| Exams and tests | | | | | 1 |
| Other activities…….. | | | | | |

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| 3.7 Total hours of individual study | 19 |
| 3.8 Total hours per semester | 75 |
| 3.9 Number of credit points | 3 |

## 4. Pre-requisites (where appropriate)

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| 4.1 Curriculum | |
| 4.2 Competence | Knowledge of electronics, system control and magnetic theory |

## 5. Requirements (where appropriate)

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| 5.1. For the course | Amphitheatre, Cluj-Napoca |

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| 5.2. For the applications | Laboratory, Cluj-Napoca |

**6. Specific competences**

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| Professional skills | **C5 Application of the basic knowledge, concepts and methods from: power electronics, automatic systems, electricity management, electromagnetic compatibility**<br>C5.1 Defining the specific elements that individualize the electronic devices and circuits in the fields of: power electronics, automated systems, electricity management, medical electronics, automotive electronics, consumer goods<br>C5.2 Qualitative and quantitative interpretation of the functioning of circuits in the fields of: power electronics, automatic systems, electricity management, medical electronics, automotive electronics, consumer goods; operation regarding electromagnetic compatibility<br>C5.5 Designing, using established principles and methods of subsystems of reduced complexity, from the fields of applied electronics: power electronics, automated systems, electricity management, medical electronics, auto electronics, consumer goods |
| Cross competences | |

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

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| 7.1 General objectives | Development of professional skills in the field of design, simulation and testing of electronic power circuits. |
| 7.2 Specific objectives | 1. The assimilation of theoretical knowledge regarding design and simulation of electronic circuits using advanced simulation programs;<br>2. Obtaining the skills and abilities necessary for implementation and testing of the performance of power electronic circuits. |

**8. Contents**

| 8.1 Lecture (syllabus) | Teaching methods | Notes |
|---|---|---|
| 1. Introduction to power electronics. The use of power electronics inside an automatic control system. Converters classifications. Performances of power electronic devices on switching mode. | Presentation, heuristic conversation, exemplification, problem presentation, teaching exercise, case study, formative evaluation | Use of .ppt presentation, projector, blackboard |
| 2. Power semiconductor diode (Structure. Symbol. Turn on and turn off the diode. Reverse recovery current. Power diode used in switching inductive loads). | | |
| 3. Bipolar junction transistor (Structure. Operating principle. Base drive principle. Darlington connection. Emitter drive principle). | | |

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| 4. Power MOSFET transistor (Structure. Operating principle. Gate drive principle). | | |
| 5. Thyristor (Triggering the SCR using phase control). TRIAC (Structure. Operating principle. Features). | | |
| 6. Insulated gate bipolar transistor (Structure. Electrical equivalent schematics. Gate drive principle. Over-current and short-circuit current protection). | | |
| 7. Bidirectional switch. Inverter leg configuration. Bootstrap drive principle and gate isolated control) | | |
| 8. Inverter's leg protection against short-circuit (Introducing a dead time interval in the drive signals. The use of the snubbers on the supply DC link). | | |
| 9. Half-bridge and full-bridge single phase inverters with full-wave operation mode (Operation principle. Calculus of the frequency's spectrum harmonics. Analysis of the active energy transfer and energy recovering modes). | | |
| 10. Full-bridge single phase inverters with phase displacement control. Freewheeling mode. Three-phase full-bridge inverters in six step operation. Vector model of a three-phase full-wave inverter. Transitions diagram. | | |
| 11. Selected harmonics elimination Pulse Width Modulation (PWM). Sinusoidal PWM. Overmodulation. | | |
| 12. Space vector PWM. Linear SV-PWM modulation. | | |
| 13. Frequency converters. Voltage, current and oscillating DC link converters. | | |
| 14. AC choppers. Exam revision and preparing. | | |

References
- Palaghiţă N., "Electronică de Putere – partea I – Dispozitive semiconductoare de putere", Editura Mediamira, Cluj-Napoca, 2002., 202 pag.
- Palaghiţă N., Petreuş D., Fărcaş C., Electronică de putere partea a II-a, Circuite electronice de putere, Editura Mediamira, Cluj-Napoca, 2004, 310 pag., ISBN 973-713-039-1.
- Bimal K. Bose, Modern Power Electronics and AC Drives, Prentice Hall; 1 Edition, October 2001, 736 pag., ISBN-13: 007-6092010555
- Mohan N., Undeland T., M., Robbins W., P., Power Electronics – Converters, Applications and Design, (New York: Wiley), 1995.
- Rashid M., Power Electronics: Circuits, devices and Applications, Second Edition, Prentice Hall, USA, 1993.

| 8.2 Applications | Teaching methods | Notes |
|---|---|---|
| 1. Laboratory description. Laboratory protection measures. | Didactic and experimental proof, didactic exercise, team work | Use of laboratory instrumentation, experimental boards, computers, white/magnetic board |
| 2. BJT base drive circuits. | | |
| 3. BJT parallel driving. | | |
| 4. Power MOS-FET gate drive circuits with galvanic insulation | | |
| 5. Snubber protection circuits | | |
| 6. Thyristor. Operating principles. Static characteristics | | |
| 7. Simulation of the power MOS-FET gate drives circuits. | | |
| 8. Thyristor gate drive principle using phase control of the firing angle. | | |
| 9. TRIAC switching using TCA785 IC. | | |

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| 10. Single-phase full-bridge inverter control using Bootstrap technique | | |
| 11. Overcurrent and short-circuit protection for IGBT | | |
| 12. Gate drive circuits for GTO thyristor. | | |
| 13. Simulating the single-phase AC Choppers | | |
| 14. Final assessment. Recovering the missing labs. | | |

References

- Palaghiţă N., "Electronică de Putere – partea I – Dispozitive semiconductoare de putere", Editura Mediamira, Cluj-Napoca, 2002., 202 pag.
- Palaghiţă N., Petreuş D., Fărcaş C., Electronică de putere partea a II-a, Circuite electronice de putere, Editura Mediamira, Cluj-Napoca, 2004, 310 pag., ISBN 973-713-039-1.
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- Rashid M., Power Electronics: Circuits, devices and Applications, Second Edition, Prentice Hall, USA, 1993.

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

The skills acquired will be required for employees in the following possible occupations according to the COR: engineer electronics, designer engineer, research engineer in applied electronics, engineer of research in microelectronics, engineers in electrotechnology, manager of information technology and communications, systems and computer systems engineer, communications engineer, specialists in information technology.

**10. Evaluations**

| Activity type | 10.1 Assessment criteria | 10.2 Assessment methods | 10.3 Weight in the final grade |
|---|---|---|---|
| 10.4 Course | Solving a problem and answering a set of theoretical questions | Written exam | 60% |
| 10.5 Applications | Verification of skills and abilities acquired as a result of laboratory activities | Oral examination during the semester | 40% |
| 10.6 Minimum standard of performance | | | |

***Qualitative level:***

*Minimal knowledge:*

- ✓ Knowledge of the basic operation of studied power devices
- ✓ Knowledge of the basic operation of the driver circuits studied

*Minimal competences:*

- ✓ To be able to describe the functionality of the main power devices
- ✓ To be able to choose the proper power device in specific applications

***Quantitative level:***

- ✓ Participation to all applications and laboratories
- ✓ The final exam and laboratory grades to be higher than 5
- ✓ The final grade is calculated as follows: 0.6*Exam grade+0.4*laboratory grade

| Date of filling in | Responsible | Title, Name Surname | Signature |
|---|---|---|---|
| 24.06.2024 | Course | S.L. Dr. Ing. Pătărău Toma | |
| | Applications | S.L. Dr. Ing. Pătărău Toma | |
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| Date of approval in the Department of Applied Electronics<br><br>28.06.2024 | Head of Department<br>Prof. Dorin PETREUS, PhD Eng. |
| Date of approval in the Council of Faculty of Electronics, Telecommunications and Information Technology<br><br>11.07.2024 | Dean<br>Prof. Ovidiu Aurel POP, PhD Eng. |