

## SYLLABUS

### 1. Data about the program of study

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

2.1 Subject name	Power Electronics						
2.2 Subject area	Theoretical area						
	Methodological area						
	Analysis area						
2.3 Course responsible/lecturer	Assist. Prof. Pătărașu Toma, PhD Eng. – toma.patarau@ael.utcluj.ro						
2.4 Teachers in charge of applications	Assist. Prof. Pătărașu Toma, PhD Eng.– 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.....					
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)

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

### 5. Requirements (where appropriate)

5.1. For the course	Amphitheatre, Cluj-Napoca
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5.2. For the applications	Laboratory, Cluj-Napoca
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## 6. Specific competences

Professional skills	<p>C4 - To design and use low complexity hardware and software applications, specific to applied electronics</p> <ul style="list-style-type: none"> <li>• C4.3 Identification and optimization of hardware and software solutions of problems related to: industrial electronics, medical electronics, automotive electronics, automation, robotics, production of consumer goods</li> <li>• C4.4 Use of appropriate performance criteria for the evaluation, including by simulation, of hardware and software of dedicated systems or service activities in which microcontrollers or computing systems of reduced or medium complexity are used</li> </ul> <p>C5 - Application of the basic knowledge, concepts and methods from: power electronics, automatic systems, electricity management, electromagnetic compatibility</p> <ul style="list-style-type: none"> <li>• 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</li> <li>• 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</li> <li>• 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</li> </ul> <p>C6 - To solve technological problems, specific to applied electronics</p> <ul style="list-style-type: none"> <li>• C6.1 Defining the principles and methods underlying the manufacture, adjustment, testing and troubleshooting of the appliances and equipment in the fields of applied electronics</li> <li>• C6.5 Designing the manufacturing and maintenance technology (specifying the necessary components and operations) of low and medium complexity products from the fields of applied electronics</li> </ul>
Cross competences	N.A.

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

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; 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).		
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.		
<b>References</b> <ul style="list-style-type: none"> <li>- Palaghiță N., "Electronică de Putere – partea I – Dispozitive semiconductoare de putere", Editura Mediamira, Cluj-Napoca, 2002., 202 pag.</li> <li>- Palaghiță 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.</li> <li>- Bimal K. Bose, Modern Power Electronics and AC Drives, Prentice Hall; 1 Edition, October 2001, 736 pag., ISBN-13: 007-6092010555</li> <li>- Mohan N., Undeland T., M., Robbins W., P., Power Electronics – Converters, Applications and Design, (New York: Wiley), 1995.</li> <li>- Rashid M., Power Electronics: Circuits, devices and Applications, Second Edition, Prentice Hall, USA, 1993.</li> </ul>		

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.		
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.		
<b>References</b> <ul style="list-style-type: none"> <li>- Palaghiță N., "Electronică de Putere – partea I – Dispozitive semiconductoare de putere", Editura Mediamira, Cluj-Napoca, 2002., 202 pag.</li> <li>- Palaghiță N., Petreus D., Fărcaș C., Electronică de putere partea a II-a, Circuite electronice de putere, Editura Mediamira, Cluj-Napoca, 2004, 310 pag., ISBN 973-713-039-1.</li> <li>- Bimal K. Bose, Modern Power Electronics and AC Drives, Prentice Hall; 1 Edition, October 2001, 736 pag., ISBN-13: 007-6092010555</li> <li>- Mohan N., Undeland T., M., Robbins W., P., Power Electronics – Converters, Applications and Design, (New York: Wiley), 1995.</li> <li>- Rashid M., Power Electronics: Circuits, devices and Applications, Second Edition, Prentice Hall, USA, 1993.</li> </ul>		

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

The discipline content and the acquired skills are in agreement with the expectations of the professional organizations and the employers in the field, where the students carry out the internship stages and/or occupy a job (in the field of applied electronics), and the expectations of the national organization for quality assurance (ARACIS).

### 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			
<b>Quality level:</b>			
Minimum knowledge:			

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

Minimum 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:  $0.6 * \text{Exam grade} + 0.4 * \text{laboratory grade}$

Date of filling in	Responsible	Title, Name Surname	Signature
23.06.2023	Course	Assist. Prof. Pătăraș Toma, PhD Eng.	
	Applications	Assist. Prof. Pătăraș Toma, PhD Eng.	

Date of approval in the Department of Applied Electronics	Head of department
30.06.2023	Prof. Dorin PETREUȘ, PhD Eng.
Date of approval in the Council of Faculty of Electronics, Telecommunications and Information Technology	Dean
12.07.2023	Prof. Ovidiu Aurel POP, PhD Eng.