SYLLABUS

1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Electronics, Telecommunications and Information Technology
1.3	Department	Applied Electronics
1.4	Field of study	Electronics and Telecommunications Engineering
1.5	Cycle of study	Bachelor of Science
1.6	Program of study/Qualification	Telecommunications Technologies and Systems/ Engineer
1.7	Form of education	Full time
1.8	Subject code	TST-E106.00

2. Data about the subject

2.1	Subject name					Power Electronics					
2.2	Subject area					Power electronic devices and circuits					
2.3	Course responsible/lecturer					Assoc. Prof. Niculaie Palaghita, PhD eng.					
2.4	Teachers in charge of applications					Assoc. Prof. Cristian Farcas, PhD eng., Assistant Ionut Ciocan, PhD eng.					
2.5	Year of study	III	2.6	Semester	2	2.7	Assessment	Exam	2.8	Subject category	DS/FAC

3. Estimated total time

Year/ Sem.	Subject name	No. of weeks	Course	Applications			Course	Applications			Indiv. study	TOTAL	Credits
			[hours/week]				[hours/sem.]						
				S	L	P		S	L	P			
III / 2	Power Electronics	14	2	-	2	1	28	-	28	14	60	130	5

3.1	Number of hours per week	5	3.2	of which, course	2	3.3	applications	3
3.4	Total hours in the curriculum	70	3.5	of which, course	28	3.6	applications	42

Individual study	hours
Manual, lecture material and notes, bibliography	28
Supplementary study in the library, online and in the field	-
Preparation for seminars/laboratory works, homework, reports, portfolios, essays	28
Tutoring	2
Exams and tests	2
Other activities	-

3.7	Total hours of individual study	60
3.8	Total hours per semester	130
3.9	Number of credit points	5

4. Pre-requisites (where appropriate)

4.1	Curriculum	N / A
4.2	Competence	Knowledges about the electronic devices and their use in electronic circuits;

5. Requirements (where appropriate)

5.1	For the course	Amphitheatre, Cluj-Napoca
5.2	For the applications	Laboratory, Cluj-Napoca

6. Specific competences

Professional competences	Theoretical knowledge: (what the student must know):	After completing the discipline, the student will know: - operating principles of the power electronic devices and their use in the specific applications; - techniques for analysis and design of a power electronic circuit; - appropriate software for simulation and modeling of power electronic circuits and their classification according to their benefits and limitations; - methods for evaluation and interpretation of data obtained from the design, simulation and testing of the power electronic circuits;
	Acquired skills: (what the student is able to do):	After completing the discipline, the students will be able to: - use power electronic devices in both, ON and OFF, operating regimes; - design and implement the specific drivers for the studied power electronic devices; - analyze and experimentally determine the performances of the power electronic circuits; - use the appropriate methods for monitoring and testing the power electronic circuits; - describe the techniques for linear PWM modulation, sinusoidal PWM and space vector PWM; - use dedicated integrated circuits for various drivers;
	Acquired abilities: (what type of equipment the student is able to handle)	After completing the discipline, the students will be able to: - use the experimental laboratory boards and simulation tools used to identify the operating principles of power devices and circuits studied - use the lab instrumentation (power supplies, power analyzers, high voltage power supplies, electronic loads, digital oscilloscopes, multimeters) for the experimental study and testing of the power electronic circuits - store and analyze the numerical data obtained by the explorations equipments, and to determine the characteristics of a power circuit from testing;
	In accordance with Grila1 and Grila2 RNCIS	N.A.
Cross competences (Grila1, 2 RNCIS)	N.A.	

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

7.1	General objectives	Developing the competences regarding the design, simulating and testing of the power electronic circuits.

7.2	Specific objectives	1. Assimilation of theoretical knowledge for the design and simulation of electronic circuits using advanced simulation tools 2. Obtaining the needed skills and abilities to implement and test the performance of power electronic circuits.

8. Contents

8.1. Lecture (syllabus)		Teaching methods	Notes
1	Introduction in 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 MOS-FET transistor (Structure. Operating principle. Gate drive principle). Silicon controlled rectifier thyristor (Structure. Electrical equivalent schematics. Turning on using gate current pulses and parasitical turning on).		
5	Thyristor (Triggering the SCR using phase control). The Gate Turn-Off (GTO) thyristor (Gate drive principles. Cathode drive principles). 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. Boostrap 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. Free wheeling 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.		
8.2. Applications (lab)		Teaching methods	Notes
1	Laboratory description. Labour protection measures.	Didactic and experimental proof, didactic exercise, team work.	Use of laboratory instrumentation, advanced simulating tools, 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.		

Bibliography

1. Palaghiţă N., “Electronică de Putere – partea I – Dispozitive semiconductoare de putere”, Editura Mediamira, Cluj-Napoca, 2002., 202 pag.
2. 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.
3. Bimal K. Bose, Modern Power Electronics and AC Drives, Prentice Hall; 1 Edition, October 2001, 736 pag., ISBN-13: 007-6092010555
4. Alexa D., Gâtlan L., Ionescu F., Lazăr A., Convertoare de putere cu circuite rezonante, Editura Tehnică, Bucureşti, ISBN 973-31-1245-3, 1998.
5. Alexa D., Hrubaru O., Aplicaţii ale convertoarelor statice de putere, Editura Tehnică, Bucureşti, 1989.
6. Mohan N., Undeland T., M., Robbins W., P., Power Electronics – Converters, Applications and Design, (New York: Wiley), 1995.
7. Rashid M., Power Electronics: Circuits, devices and Applications, Second Edition, Prentice Hall, USA, 1993.

Teaching materials in digital format

1. Palaghiţă N., Power Electronics, PowerPoint Presentations

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

Competences acquired will be used in the following COR occupations (Electronics Engineer; Telecommunications Engineer; Electronics Design Engineer; System and Computer Design Engineer; Communications Design Engineer) or in the new occupations proposed to be included in COR (Sale Support Engineer; Multimedia Applications Developer; Network Engineer; Communications Systems Test Engineer; Project Manager; Traffic Engineer; Communications Systems Consultant).

10. Evaluations

Activity type	10.1	Assessment criteria	10.2	Assessment methods	10.3	Weight in the final grade
Course		Two issues of theory from the first and, respectively, the second part of the subjects taught		Oral examination		60%
Applications		Solving a problem specific to the power electronic circuits		Oral examination		20%
		Two written and one oral tests for evaluating the knowledge and practical skills and abilities acquired		Ongoing evaluation		20%
10.4 Minimum standard of performance						
Answer correctly at least one subject of theory, exposing issues of theory and applications in a technical appropriate speech and obtain a minimum of 5 at the laboratory evaluation.						

Date of filling in
09.02.2015

Course responsible
Assoc. Prof. Niculaie Palaghita, PhD

Teachers in charge of applications
Assoc. Prof. Cristian Farcas, PhD
Assistant Ionut Ciocan, PhD

Date of approval in the department
09.02.2015

Head of department
Prof. Dorin Petreus, PhD