Syllabus

1. Data about the program of study

1.1 Institution	Technical University of Cluj-Napoca
1.2 Faculty	Automation and Computer Science
1.3 Departament	Automation
1.4 Field of study	Systems Engineering
1.5 Cycle of study	Bachelor of Science
1.6 Program of study/Qualification	Automation and Applied Informatics (English)
1.7 Form of education	Full time
1.8 Codul disciplinei	35

2. Data about the subject

2.1 Subject name	***Power Electronics***				
2.2 Course responsible/lecturer	Prof.dr.ing Festila Clement – clement.festila@aut.utcluj.ro				
2.3 Teachers in charge of applications	Conf.dr.ing. Rusu-Both Roxana – roxana.both@aut.utcluj.ro				
2.4 Year of study	3	2.5 Semester	1	2.6 Assessment *(E/C/V)*	E
2.7 Type of subject	*DF – fundamental, DD – in the field, DS – specialty, DC – complementary*				DS
	DI – compulsory, DO – elective, Dfac – optional				DI

3. Estimated total time

3.1 Number of hours per week	4	of which:	Course	2	Seminar	0	Laboratory	1	Project	1
3.2 Number of hours per semester	56	of which:	course	28	Seminar	0	Laboratory	14	Project	14
3.3 Individual study										
(a) Manual, lecture material and notes, bibliography										28
(b) Supplementary study in the library, online and in the field										10
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										28
(d) Tutoring										
(e) Exams and tests										3
(f) Other activities:										

3.4 Total hours of individual study (sum of (3.3(a)…3.3(f)))	69
3.5 Total hours per semester (3.2+3.4)	125
3.6 Number of credit points	5

4. Pre-requisites (where appropriate)

4.1 Curriculum	Basisc of the Electronic Circuits, System Theory
4.2 Competence	• actual semiconductor devices (diodes, transistors, thyristors) in fundamental electronic circuits (amplifiers, oscillators) •Analog integrated circuits, common applications

5. Requirements (where appropriate)

5.1. For the course	N/A
5.2. For the applications	Attendance is mandatory

6. Specific competences

6.1 Professional competences	C4.1 Defining the requirements of applicable standards and of the methods of implementation, testing, operation and maintenance for the equipments used in the applications of automatic control and applied informatics based on the operation and design principles. C4.5 Development and implementation of technical projects for automatic systems and information systems, that include general purpose and dedicated equipments (digital and analogue), including computer networks
6.2 Cross competences	Issues and need for electronic converters in industry, energy, etc.

7. Course objectives

7.1 General objective	Integration of the electronic equipment in a complex control loop ((position, speed, robotics, automotivs)
7.2 Specific objectives	• Knowledge of the design, operation and control of current power converters (DC, AC) •Power electronic converter modelling: frequency domain models, state space models

8. Contents

8.1 Lecture	No.hours	Teaching methods	Notes
Emergence, evolution, specifics of power electronics, separation with "small signal linear electronics"	2	Teaching using laptop and projector, interactive course, debate	
Switching mode of operation, essential role in the power electronic converters	2		
Switching of common power semiconductor devices: bipolar transistors, MOSFETs, IGBTs, thyristors, GTO and MCT thyristors	4		
DC voltage converters: transformerless version	2		
DC voltage converters: with transformer	2		
Controlled rectifiers: single-phase, three-phase, correction circuits (PFC), rectifiers for charging power accumulators for electric vehicles	2		
Single-phase and three-phase inverters: knowledge of design, operation and control strategies	4		
Modelling of power electronic converters, in frequency domain and in state space	2		
Control of power electronic converters using analogue controllers	2		
Control of power electronic converters using digital controllers, PLC systems and DSP systems	4		
Case studies	2		

Bibliography
1 Festila, Cl. ş.a. – Power Electronics in Automation Control, Editura Mediamira, Cluj-Napoca, 2000.
2. Frede Blaabjerg, Control of Power Electronic Converters and Systems, Academic Press, Elsevier, 2018
3. Trzynadlowski Andrzej M., Power Electronic Converters and Systems, New York, 2020
4. Seddik Bacha et al., Power Electronic Converters Modeling and Control, Springer, 2022
5. Buso Simone, Mattaveli Paolo, Digital Control in Power Electronics, 2nd Edition, Morgan and Claypool publishers, 2006
6. Corradini Luca et al., Digital Control of High-Frequency Switched-mode Power Converters, Wiley, 2015

8.2 Aplications (laboratory)	No.hours	Teaching methods	Notes
L1. Security rules on Power Electronic Laboratory. Analysis of the bipolar transistor switching	2	Presentation of examples, demonstrations, discussions, practical applications	Mandatory attendance
L2. Analysis of power amplifiers in switching mode of operation	2		
L3. Dedicated integrated circuits for thyristors and triacs control	2		
L4. Controller rectifiers, Power Factor Correction (PFC) circuits, Battery charging strategies	2		
L5. DC/DC voltage controllers, applications	2		
L6. Three phase inverter, Field Oriented Control (FOC), J-15 Hittachi	2		
L7. Laboratory exam	2		

Bibliography
1. Festila, Cl. ş.a. – Power Electronics in Automation Control, Editura Mediamira, Cluj-Napoca, 2000.
2. WILLIAMS B.W., Power electronics : devices, drivers, applications and passive components, London, 1992
3. Mohan, N. ş..a. – Power Electronics, John Wiley, 1995
4. BOSE Bimal K., Modern power electronics and AC Drives, Upper Saddle River, New Jersey, 2001
5. TRZYNADLOWSKI Andrzej M., Introduction to modern power electronics, New York, 1998

8.3 Aplications (project)	No.hours	Teaching methods	Notes

Variant A: Electronic power converter for battery charging control of electric vehicles		Presentation of examples, demonstrations, discussions, practical applications	Mandatory attendance
PA1. Choice of specific main transformers, connections	2		
PA2. Design of controlled rectifier circuits (thyristor, transistor)	2		
PA3. Analysis of Power Factor Correction Circuit (PFC): selection, use, connection schemes	2		
PA4. Modeling of power electronic converter for battery charging	2		
PA5. Design of controllers for the required charging regime (analogue versions, digital versions)	2		
PA6. Simulation of converter operation in automatic charging mode	2		
PA7. Project presentation and Conclusions	2		
Variant B. Switched mode power supply design			
PB1. Choice and analysis of a line transformer	2		
PB2. Design and analysis of rectifier circuits	2		
PB3. Design of the smoothing filter	2		
PB4. Design of step-down power supply	2		
PB5. Design of bipolar thyristor rectifier	2		
PB6. Design of step-up power supply	2		
PB7. Project presentation and Conclusions	2		

Bibliography

1. Festila, Cl. ş.a. – Power Electronics in Automation Control, Editura Mediamira, Cluj-Napoca, 2000.
2. WILLIAMS B.W., Power electronics : devices, drivers, applications and passive components, London, 1992
3. Mohan, N. ş..a. – Power Electronics, John Wiley, 1995
4. BOSE Bimal K., Modern power electronics and AC Drives, Upper Saddle River, New Jersey, 2001
5. TRZYNADLOWSKI Andrzej M., Introduction to modern power electronics, New York, 1998
6. Festila. Cl - Design of a battery charging station for electric vehicle - Project guide

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

Course content was discussed with representatives of prestigious companies in the field in Romania , Europe and USA and rated several times by government agencies in Romania
(CNEAA , ARACIS)

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Assessment of knowledge through a test based on the knowledge gained following participation in the course	Written exam	60%
Seminar			
Laboratory	Examination of the skills and knowledge acquired through the participation in the laboratory.	Practical assessment	20%
Project	Project presentation	Practical presentation	20%

Minimum standard of performance: Written exam grade > 5 and practical assessment grade > 5 and practical presentation grade > 5
N=0.6E+0.2*L+0.2P, N>5, E>5, L>5, P>5

Date of filling in:		Title Firstname NAME	Signature
1.06.2024	Course	Prof. Eng. Clement FESTILA, PhD	
	Applications	Assoc. Prof. eng. Roxana BOTH, PhD	

Date of approval by the Department Board ……. _____	Head of Departament ..... Prof.dr.ing. Honoriu VĂLEAN
Date of approval by the Faculty Council …… _____	Dean Prof.dr.ing. Mihaela DINȘOREANU