COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF ELECTRONICS ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	2605003	**SEMESTER**	5
COURSE TITLE	Power Electronics		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS (ECTS)**
Lectures	4	7
Laboratory	2	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialisation Course
PREREQUISITE COURSES:	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES (in English)
COURSE WEBSITE (URL)	www.powerelectronics.teipir.gr/

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

This course provides to the students their first contact on the field of Power Electronics; therefore, the curriculum to introduce basic concepts and familiarize the students with the wide object of Power & Energy Management.

During the recent years there is increasing need for improvement of the competitiveness of the productive companies, especially of those of the industrial sector. This is mainly consisted in steps towards energy saving and optimization of the production procedures. Recent technology in electronics has offered many tools for this purpose. Power Electronics is the tool, through which the energy is much better controlled and offered in an optimal way in order to better serve the load and save energy at the same time. These power converters are also used in order to convert and adjust the energy produced by Renewable Energy Sources (photovoltaics, wind turbines, etc) in a usable and suitable form for the consumers.

Power Electronics course aims in the familiarization with the main controllable switches, the converter types, their operational characteristics, and their main design principles. The students

that follow this course (theoretical and laboratory) will be in place to understand the advantages that Power Electronics are offering and use this knowledge further on.
In the theoretical part (lectures), for the analysis and the description of the various converter topologies and parameters mathematical expressions are used, a deeper mathematical analysis is avoided on purpose, so as to help the students focus on the basic concepts.
In order to deeply and fully understand this course, knowledge of other subjects is necessary such as: Electronics, Energy management, Automatic Control Systems, Materials Technology, Mathematics, Measurements techniques, etc.
Furthermore, in order to provide the students with combined knowledge and experimental procedures, the theoretical module is connected to the laboratory exercises, which are performed in complete coordination with the theoretical knowledge obtained so far.

Upon successful completion of this course module students possess advanced knowledge, skills and competences in the subject of Power Electronics that enable them to:

- Understand and possess the basic concepts and operating principles of power electronic controllable semiconductors
- Define the type of the various converter topologies.
- Explain the main operation principles of the power electronic semiconductors as controllable switches in various converter topologies.
- Describe theoretically and draw in block diagram the control strategy and pulses production methodology for the power control of the supplied power to the load.
- Describe and analyze the operation of various converter sub-systems when supplying different loads (R, R-L, motors, etc).
- Study experimentally the basic characteristics of various converter circuits and record performance parameters using measuring instruments (oscilloscope).
- Collaborate in a team to study and design a medium difficulty power electronic topology for Renewable Energy Sources or industrial purpose and synthesize a solution.
- Carry out maintenance and trouble-shooting procedures for power electronic devices in a given setup, in cooperation with the supplier company.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*
	…….

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Working independently
- Team work
- Production of free, creative and inductive thinking

(3) COURSE CONTENT

Lectures

1. Introduction - Types and characteristics of controlled switches and power diodes
2. Analysis of simple circuits with dc or ac input, with diodes or thyristors and under various loads (R, R-L, motors, etc)
3. Rectifiers (AC-DC):
   - Single phase half bridge rectification (ac-dc) with diodes and thyristors
   - Single phase full bridge rectification (ac-dc) with diodes and thyristors
   - Three phase full bridge rectification (ac-dc) with diodes and thyristors
   - Firing power electronic semiconductors – Electronic Pulse Production level

   In all different topologies studied, a full presentation of input and output waveforms as well as the corresponding mathematical analysis takes place.
4. AC-AC converters. Complete analysis of the operational principles and presentation of input & output waveforms supported by corresponding mathematical analysis.
5. DC-DC converters:
   - Step-up (Boost converters)
   - Step-down (Buck converters)
   - Buck-Boost converter topologies
   - Pulse Width Modulation technique

   Full presentation of input and output waveforms as well as the corresponding mathematical analysis takes place.
6. DC-AC inverters:
   - Main topologies and operation principles
   - Pulse Width Modulation technique for voltage regulation
   - Sinusoidal PWM for harmonics reduction

   Full presentation of input and output waveforms as well as the corresponding mathematical analysis takes place.
7. Applications of Power Electronics in Industry, Renewable Energy Sources projects, etc. Search project for recent power semiconductor products. Presentation of future trends.

Laboratory Experiments:

1. Introduction, Laboratory rules and Safety issues.
2. Familiarization with lab equipment and basic measurements. Power measurements with oscilloscope.
3. Three-phase alternator – 1st part / Energy production.
4. Three-phase alternator – 2nd part / Power supply.
5. Electronic switches – Smooth connection of large loads to the power system through power electronic devices.
6. Half bridge ac/dc rectifier – 1 Thyristor with a UJT pulse production device.
7. Full bridge ac/dc rectifier – 4 Thyristors with a pulse production device - Part I.
8. Full bridge ac/dc rectifier – 4 Thyristors with a pulse production device - Part II.
9. AC/AC converter – A TRIAC power part with a UJT pulse production device.
10. DC/DC step-up converter.
11. Photovoltaic system simulation for technical characteristics and efficiency experiment.
12. Student's time.

13. Lab examinations.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of electronic presentation with multimedia content in class, • Student support through the course webpage and the departmental e-learning platform, • Electronic communication of instructors and students, through the course webpage and by e-mail.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	Lectures, Laboratory experiments, case study / project assignment and study. ***Activity*** / ***Semester workload (hours)*** Lectures: 52 Study for lectures: 52 Laboratory experiments: 26 Report on lab experiments: 26 Case study / project and report: 26 Study and preparation for exams: 28 **Course Total**: ***210***
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Final course grade = Lectures part grade x 60% + Laboratory part grade x 40% *Lectures part grade:* Final written exam on all taught material (100%) Exam includes multiple choice questions, design questions and relative assessment questions. *Lab part grade:* Assessment of lab reports and student presence Participation in all lab experiments and oral evaluation – (20%) Mid-term evaluation test (40%) End-term evaluation test (40%)

(5) ATTACHED BIBLIOGRAPHY

Recommended Books

1. MANIAS ST., Power Electronics, Papasotiriou, Athens 2014.
2. RASHID M., Power Electronics Handbook, Academic Press, USA, 2001.
3. MOHAN et al., Power Electronics, Tziolas Publ. Thessaloniki.

4. POLITIS G. and TSIALAS C., Power Electronics, Self Publishing, 2011.
5. Laboratory handbook by the instructor.

Scientific Journals:

1. IEEE Transactions in Power Electronics
2. IEEE Transactions in Power Delivery
3. IEEE Transactions in Industry Applications
4. IJAREEIE - International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering