EEE.6.3 **POWER ELECTRONICS I**

COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	EEE.6.3	SEMESTER	6	
COURSE TITLE	POWER ELECTRONICS I			
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
Lectures			4	5
Laboratory Exercises			2	
Total			6	
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*	Specialization Course			
PREREQUISITE COURSES:				
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek (official)			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	https://eclass.uniwa.gr/courses/EEE211/			

(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*

The Power Electronics I course aims to give the students the necessary knowledge on the operation of the various semiconductor switches (transistors, MOSFETs, thyristors, GTOs, IGBTs, MCTs, Triacs) and the main techniques for converting electrical power from one form to another using suitable circuits known as power converters, such as: DC-DC Converters, DC-AC Inverters, AC-DC Rectifiers, Cycloconverters.

The course intends to cover theoretical and practical issues related to the way various power converters are built and interconnected to meet the load needs. Extensive reference and familiarity with all kinds of converters, their operation, their specificities and their construction principles.

The course requires good knowledge and in-depth understanding of other subjects such as material technology, mathematics, measurement, basic electronics, automated control systems, energy management, computer programs, etc.

Upon successful completion of the course, students should have acquired:

1. Knowledge of the operating principles of the various controlled semiconductor elements and the individual blocks from which the power electronics circuits are comprised.
2. Ability to recognize power converters, understand their operation and applications within productive industrial plants and elsewhere.
3. Capability of understanding the way of controlling and firing semiconductor power switches, in order to control the supplied electrical power to the load.
4. Knowledge of analysis and calculation of the basic operating characteristics of a converter supplying a load (R, R-L, motor, etc.).
5. Knowledge of the safety and operation requirements of semiconductor electrical systems.
6. Knowledge of the operation of semiconductor power elements (diodes, bipolar transistors, MOSFETs, GTOs, IGBTs, MCTs, Triacs), both theoretically and experimentally.
7. Ability to design basic control devices using power electronics.
8. Ability to select materials suitable to the environment of application, according to their own characteristics.
9. Knowledge of new devices and technologies to achieve the best techno-economic solution for the operation of power electronic devices.

More specifically, students will be able to:

1. understand the operation and detect errors and faults on devices that include power electronic circuits.
2. possess the knowledge to check the safety and operation of the relevant devices.
3. design electronic power circuits according to the application's specific operating requirements.
4. calculate and choose the appropriate materials that correspond to the characteristics of the loads to be fed.
5. understand how power semiconductors are controlled to achieve high-performance devices.

6. work with their fellow students to create and present both a personalized and a group case study from its initial stages to its final evaluation and proposal for solutions.
7. work with their fellow students or engineers in designing, installing and maintaining systems using power electronics (industry, Renewable Energy Systems, etc.).
8. undertake basic steps to correct, maintain or optimize their operation in cooperation with suppliers.

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…*
	…….

The course aims at fostering the following capabilities:

1. Search for, analysis and synthesis of data and information, with the use of the necessary technology
2. Decision making
3. Independent work
4. Teamwork
5. Project planning and management
6. Respect for the natural environment
7. Production of free, creative and inductive thinking

(3) SYLLABUS

A. THEORY

The theory part of the course consists of the following modules:

Module 1: Introduction: Power Electronics Applications, Power Electronics Semiconductor Overview, Technology Trends.

Module 2: Power Semiconductor Switches: Bipolar Junction Transistor, Power MOSFET, IGBT, GTO, Silicon (Si) and Silicon Carbide (SiC).

Module 3: Circuit with Switches and Diodes: Circuits with DC and AC sources and R-C, R-L and R-L-C loads.

Module 4: Harmonic components: harmonic definition and origin, Fourier analysis, harmonic current characteristics, inter-harmonics, subharmonicscomponents, active current value, apparent, real and reactive power, distortion power, power factor, ripple factor, voltage and current total harmonic distortion factors, effects of harmonic components.

Module 5: Uncontrolled Power Rectifications: Power Diode, R-C, R-L, R-L-C Load Circuits, Full Point Recovery, Single Phase Full Bridge Rectification, Multipoint Common Point Corrections.

Module 6: Controlled Power Rectifications: Thyristor, controlled semi-rectification with R, L and R-L loads, fully controlled single-phase rectifier, three-phase fully controlled rectifying bridge.

Module 7: Inverters: Inverter applications, half bridge single phase inverter, full bridge single phase inverter, three phase inverter, PWM technique, harmonics reduction with SPWM, Patel & Hoft techniques.

Module 8: AC-AC regulators: AC Regulator Applications, Single-Phase Regulator using R and R-L loads, Three-Phase AC Regulators.

B. LABORATORY

The subject of the Laboratory consists of the following independent modules:

Module 1: Information and familiarization with the laboratory and its equipment - Laboratory regulation

Module 2: Study of electrical characteristics (V-I) of power semiconductors: diode and thyristor.

Module 3: Single Phase Uncontrolled Half Wave Rectifier with R and R-L loads

Module 4: Single-Phase Uncontrolled Bridge with Loads R and R-L

Module 5: One-Phase Semiconductor with UJT + thyristor

Module 6: Fully Controlled Single-Phase Bridge with R and R-L loads

Module 7: Three-Phase Fully Controlled Bridge

Module 8: Single Phase AC/AC. (TRIAC)

Module 9: Driving Circuit for Single-Phase ac / ac Converter with UJT + Triac

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures, laboratories , face to face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Teaching using ICT, Laboratory Education using ICT, Communication and Electronic Submission
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*	(see table below)
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.*	Assessment Language: Greek Theory Written final exam (70% of the final grade) comprising: • questions of theoretical content and judgment questions • Multiple choice questions • solving computational problems

Activity	*Semester workload*
Lectures	52
Laboratories Exercises	26
Preparation for writing laboratory reports - homework	26
Personal study	76
Course total	**180**

	Laboratory I. Individual or group technical report (40% of the final grade of the laboratory) for each laboratory exercise including: • Description of the laboratory exercise and how it is conducted • Presentation of measurements • Presentation of the results (calculations, diagrams, etc.); and • Comment on the results with conclusions. Written final laboratory examination (60% of the laboratory final grade) The final grade of the laboratory part of the course results from the following relationship: 0.6 x written laboratory examination + 0.4 x final grade of laboratory technical reports (average of grades in technical reports) The final grade of the course is based on the following relationship: 0.7 x written exam theory + 0.3 x final laboratory grade

(5) ATTACHED BIBLIOGRAPHY

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4. Rashid Mohammad (2017), "Power Electronics: Devices, Circuits and Applications", 4th edition, Pearson Education.
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12. W. Shepherd, L. N. Hulley, D. T. W. Liang (1996), "Power Electronics and Motor Control", Cambridge University Press.

13. J. Hindmarsh (1985), “Electrical Machines and Drives, Worked Examples”, 2nd edition, Pergamon Press.