EEE.7-1.6 **POWER ELECTRONICS II**

COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING			
LEVEL OF STUDIES	UNDERGRADUATE			
COURSE CODE	EEE.7-1.6	SEMESTER	7	
COURSE TITLE	POWER ELECTRONICS II			
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		3	4
			-	
	Total		3	
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/EEE318/			

(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*

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

1. Knowledge of the operating principles and the parts which dc-dc converters consist of
2. Knowledge of the basic dc-dc converter control techniques
3. Capability of Designing Switched-Mode Power Supplies
4. Ability to select the appropriate materials, adapted to the environment of application requirements, based on their characteristics
5. Knowledge of the operating principles of the resonant converters and their characteristics based on their categorization.
6. Knowledge of inverters and control techniques applied to applications of photovoltaic systems and wind turbines.
7. Knowledge of basic energy storage systems and power converters to manage this energy and their interconnection with the grid.
8. Knowledge of categories and basic design techniques for the selection and design of passive filters to limit harmonic components.
9. Knowledge of categories and basic design techniques for the selection of active filters to limit harmonic components.

More specifically, students should:

1. Be able to understand how dc-dc converters work.
2. Have the knowledge of designing a switched-mode power supply, both the power and control circuits.
3. Be able to understand how resonant converters work, their advantages and disadvantages.
4. Be able to choose energy storage media, its management and network interface converters.
5. Be able to design passive filters depending on the application and the specific features of the power system.
6. Be able to choose the appropriate type and category of active filter depending on the application and the specific features of the system in which it will be placed.
7. Be able to collaborate with their fellow students to conduct and present case studies.

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 subject of the course consists of the following modules:

Module 1: DC Converters: Basic DC-DC inverters without galvanic isolation (buck, boost, buck-boost) with galvanic isolation (forward converter, flyback).

Module 2: Control Techniques for DC Converters: Pulse Width Modulation (PWM) technique, direct voltage and / or current mode control voltage control method, current feedback and variable frequency control modes (hysteresis control, fixed-time control , fixed cut-off control), control methods with current feedback and constant operating frequency (peak current mode control, average current mode control).

Module 3: Resonant Converters: operating principle, inverter categories, basic resonant circuits, resonant load transducers, resonant switch converters.

Module 4: Power Electronics & RES-Energy Storage: Photovoltaic energy conversion systems (interconnected and autonomous PV systems, power curves, inverter topologies (single and three phase), control systems, maximum power point tracking techniques, detection and avoidance of the isolating phenomenon), energy conversion systems for wind turbines (turbine generators, inverters and control techniques, control and interconnection issues, harmonics and quality power systems), - Power electronics systems for charging and managing energy in storage systems (e.g. batteries, fuel cells, superconductors and flywheels) for on-grid and off-grid applications.

Module 5: Improvement of Network Stability with Power Electronics: Static Reaction Capacitor (SVC), TCSC, Stationary SPS, STCOM (SSSC) Controller, Consolidated Power Flow Controller (UPFC).

Module 6: Power Transmission with DC (HVDC): Comparison of energy transfer with AC and DC current versus distance, advantages and disadvantages (investment costs, losses, submarine cables, energy transfer and stabilization of asynchronous AC networks, reliability and availability, control and maintenance), HVDC converters: line-commutated converters, CSC-HVDC converters, voltage source converters (VSC-HVDC).

Module 7: Introduction to passive & active filters: passive filtering principle, passive filtering categories (single tuning, double tuning, high passes, low passes), principle of active filters, active filter classes (power source, voltage source, parallel, hybrid).

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Lectures, laboratories , face to face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Teaching using ICT, Laboratory Education using ICT, Communication and Electronic Submission</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>45</td></tr>
<tr><td>Personal study</td><td>45</td></tr>
<tr><td>Optional individual work- Self study - Preparation for examinations</td><td>30</td></tr>
<tr><td>Course total</td><td>120</td></tr>
</table>
</td></tr>
<tr><td>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.</td><td>Assessment Language: Greek

1. Written final exam including:
• questions of theoretical content and judgment questions
• Multiple choice questions
• solving computer problems
2. Optional individual project

The final grade of the course is as follows:

<u>Without the optional individual work</u>
Degree of written examination of theory

<u>With optional individual work</u>
0,8 x written test theory + 0,2 x degree of work (project)</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

1. Σ. Μανιάς (2014), “Ηλεκτρονικά Ισχύος”, Εκδόσεις Συμεών, 4η Έκδοση , Αθήνα
2. Π. Μαλατέστας, Η. Βυλλιώτης (2004), “Εργαστηριακές Ασκήσεις Ηλεκτρονικών Ισχύος”, Εκδόσεις Τζιόλα, Αθήνα.
3. Γ. Βόκας (2016), Εργαστήριο Ηλεκτρονικών Ισχύος, Σημειώσεις, Αθήνα.
4. Rashid Mohammad (2017), “Power Electronics: Devices, Circuits and Applications”, 4th edition, Pearson Education.
5. K. Billings, T. Morey (2010), “Switchmode Power Supply Handbook”, 3rd edition, McGraw-Hill Education.
6. Mohan N., Undeland T., Robbins W. (2007), “Power Electronics: Converters Applications and Design”, 3rd edition, John Wiley & Sons.
7. S. Maniktala (2004), “Switching Power Supply Design & Optimization”, McGraw-Hill
8. Kield Thordorg (2002),”Power Electronics”, Prentice – Hall.
9. E. Acha, V. Agelidis, O. Anaya, T. J. E. Miller (2002), “Power Electronic Control in Electrical Systems”, MPG Books Ltd Bodmin, Cornwall, UK.

10. A.I. Pressman, K. Billings, T. Morey (2009), “Switching Power Supply Design”, 3rd edition, McGraw-Hill Education.
11. K. Billings (1999), “Switchmode Power Supply Handbook”, McGraw-Hill Professional.
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.