COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING SCHOOL		
DEPARTMENT	DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING		
LEVEL OF STUDIES	UNDER GRADUATE		
COURSE CODE	EEE.7-1.3	SEMESTER	7
COURSE TITLE	HIGH VOLTAGE ENGINEERING		

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	5
Laboratory	2	
Total	5	
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
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English for ERASMUS students)
COURSE WEBSITE (URL)	http://moodle.teipir.gr/user/view.php?id=9424&course=230

(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 completion of the course, students will have acquired:

1. Knowledge of the high voltage applications and general knowledge of high voltage engineering.
2. Knowledge of the basic gaseous dielectrics, their properties and behavior under high voltage stresses, physicochemical phenomena during breakdown and mechanisms during ionization.
3. Knowledge of the basic liquid dielectrics, their properties and behavior under high voltage stresses, physicochemical phenomena during breakdown and mechanisms and aging effects.
4. Knowledge of the basic solid dielectrics, their properties and behavior under high

voltage stresses, physicochemical phenomena during breakdown and mechanisms and aging effects, non-linear conductivity phenomena, macroscopic and microscopic analysis of the aging and breakdown effects.

5. Knowledge of the high voltage testing equipment and methods, requirements for high voltage testing procedures, testing procedures.
6. Ability to use the above mentioned knowledge to inspect high voltage equipment, check electrotechnical materials and devices. They will be able to analyze and understand the electrical insulation condition in several types of applications, detect potential risks from malfunctions related to dielectric materials, and propose and implement technical solutions towards reducing risk and failure.

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. Teamwork
4. Work in a multidisciplinary environment
5. Project planning and management
6. Production of free, creative and inductive thinking

(3) COURSE CONTENT

A. THEORY

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

1st Module: Introduction to high voltage engineering: Basic concepts and definitions, high voltage applications, high electric fields, different forms of electric fields, electrodes' geometries and basic knowledge.

2nd Module: Air gaps breakdown theory: Basic gaseous dielectrics. Properties of air gaps, the physics and the phenomena which appear during their use in high voltage equipment and structures. Ionization and breakdown phenomena in air gaps under uniform and non-uniform high electric fields. Townsend's breakdown theory. Corona effect in electric networks and Corona losses. Streamers and ladders theory on gaseous dielectrics.

3rd Module: SF6 and gaseous mixtures breakdown theory: SF6 physicochemical properties and its behavior under uniform and non-uniform electric fields. Ionization and breakdown phenomena in SF6 gaps under uniform and non-uniform high electric fields. Other gaseous mixtures in high voltage engineering. Phenomena during their use in high voltage equipment and structures.

4rd Module: Liquid dielectric materials: Basic liquid dielectric materials, mineral and natural dielectric oils and their physicochemical properties. Aging and breakdown mechanisms in dielectric oils under uniform and non-uniform

electric field stress. Effects during their use in high voltage equipment and structures.

5th Module: Generation and measurement of in high voltage testing: Typical waveforms of high voltages used for equipment testing. AC high voltage testing equipment. DC high voltage circuits (rectifiers, Cocroft, Villard, Greinacher topologies) and testing equipment. Impulse voltage and current testing equipment. Single and multiple stages generators. High voltage measuring equipment selection and design. High Voltage dividers. Schering bridge and dielectric losses measurement. High voltage testing and measuring procedures.

6th Module: Solid dielectric materials: Basic concepts and definitions, basic solid dielectric materials and their properties. Loss Factor (tgδ). Specific Electrical Conductivity. Surface Conductivity. Coefficient of Thermal Conductivity. Mechanical strength. Partial Discharges, starting field / voltage, calculation of charge transportation and its waveform during PDs . Experimental Determination of PD. Measuring capacitor Cm. Macroscopic and Quantum Mechanics related theories during aging and breakdown of solid dielectrics. **N**ew theories for the analysis of phenomena, occurring during the operation of high voltage equipment, innovative new materials that will be used in high voltage equipment, etc.

B. LABORATORY

The Laboratory part of the course consists of the following separate modules:

1st Module: Laboratory configuration, equipment and operation. Rules of operation and protective measures.

2nd Module: Air gaps breakdown mechanisms under uniform and non-uniform stress.

3rd Module: Breakdown mechanisms in the combination of insulator-air.

4th Module: Corona discharges and losses in high voltage power lines.

5th Module: Voltage distribution along catenary type, high voltage insulators

6th Module: Dielectric strength and breakdown voltage of dielectric oils

7th Module: Measurement of the capacitance and power loss factor (tgδ) in dielectrics using Schering bridge

8th Module: Theoretical and experimental study of the lightning impulse voltages' generators

9th Module: Partial discharge measurements during the stress of insulators using different high voltage forms

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures and laboratory exercise, 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.*	

Activity	*Semester workload*
Lectures	52
Study of course material	52
Laboratory Exercises	26
Team work reports	26
Personal Study	24
Course total	***180***

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	
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.*	Evaluation Language : Greek English for Erasmus students **Theory** Final Written Exams: 100% **Laboratory** Final Written Exams:: 70% Team laboratory exercise report : 30% The grade of the course is 60% x Theory + 40% x Laboratory grades

(5) ATTACHED BIBLIOGRAPHY

1. Nikolopoulos P.N., (1993), High Voltage – Vol. A΄,Athens (In Greek).
2. Stathopoulos J., (1988), High Voltage I, Pub Simeon, Athens (In Greek)
3. Stathopoulos J., (1989), Protection of technical installations against overvoltages) Pub Simeon, Athens, (In Greek)
4. Oikonokou L., Fotis G., (2008), Introduction to high voltages, Tziolas Publ., Athens (In Greek)
5. Kind D., (1978), An Introduction to High Voltage Experimental Technique, Vieweg.
6. Kuffel E., Abdullah M. , (1970), High-Voltage Engineering, Pergamon Press, Oxford.
7. Schwab A.J.., (1972), High-Voltage Measurement Techniques, MIT Press Cambridge, Massachusetts.
8. Kuffel E., W.S. Zaengl, (1984), High Voltage Engineering Fundamentals, Pergamon Press, Oxford.