COURSE OUTLINE

1. GENERAL

SCHOOL	ENVIRONMENT AND AGRICULTURAL ENGINEERING		
ACADEMIC UNIT	NATURAL RESOURCE DEVELOPMENT & AGRICULTURAL ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**2975**	**SEMESTER**	5^{TH}
COURSE TITLE	ELECTROTECHNICS-ELECTRICAL MACHINES		

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	4
LABORATORY EXERCISES	1	1
TOTAL	5	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*	GENERAL BACKGROUND
PREREQUISITE COURSES:	• MATHEMATICS I • MATHEMATICS II • MATHEMATICS III • PHYSICS
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE WEBSITE (URL)	To be constructed

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, the student(s) will be able to:

- Understand the basic laws of the electromagnetic field and the relationships between the physical quantities involved.
- Understand the basic laws and principles of DC and AC electrical circuits, as well as methods of analysis.
- Understand the basic electrical power relationships and perform power factor correction on single-phase electrical loads.
- Understand and analyse three-phase circuits and perform transformations between connections and power compensation in three-phase power circuits.
- Understand and analyse electrically tuned circuits.
- Understand and analyse magnetically coupled circuits.
- Understand the operating principle of DC motors and transformers.
- Identify the parts that make up these two types of machines.
- Know the types of generators, DC motors and transformers.
- Know the ways of controlling the rotational speed and braking of DC motors.
- Know the equivalent circuits of DC motors, three-phase power transformers, short-circuit and open-circuit controls and solves related issues.
- Know the types of three-phase transformer wiring diagrams.
- Know the orders of magnitude of the electrical parameters that prevail in these two types of machines.
- Understand the operating principle of synchronous and asynchronous machines.
- Identify the parts that make up these two types of machines.
- Know the types of synchronous generators and asynchronous machines.
- Know their equivalent circuits.
- Know the power and torque relationships.
- Know the starting modes.
- Know the orders of magnitude of the electrical parameters prevailing in these two types of machines.
- Understand the operation and use of various types of electric machines as one of the basic methods of providing power in the field of agriculture.
- Handle electrical machine breakdown and maintenance problems.
- Use criteria for rational selection of electric machines, depending on the type of application being considered.

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…*
	…….

Research, analysis and synthesis of data and information, using the necessary theoretical knowledge

and established technologies.

Application of theoretical knowledge in practice.

Ability to work both independently and in teams.

Working in an interdisciplinary environment.

Decision-making.

Promotion of free, creative and deductive thinking.

3. SYLLABUS

Elements of electromagnetic field theory. DC circuits. Basic elements of electrical circuits. Fundamental laws and theorems of electrical circuits. Methods of analysis of electrical circuits. Transient phenomena in DC circuits. Single phase AC circuits. Generation of single-phase AC voltage. RMS values of voltage and current. Rotating vectors. Complex functions and representation of sinusoidal phenomena. Active resistance and impedance. Steady-state analysis of R-L-C series circuits. Power in AC. Power factor. Power as a complex quantity. Improvement of the power factor. Susceptibility and composite conductivity in AC parallel circuits. Analysis of composite AC circuits. Tuning in series and parallel circuits.

Magnetic Circuits. Ampere's circuit law. Proportions of magnetic circuits in relation to electrical circuits. Solution of series, parallel and composite magnetic circuits. Iron losses, hysteresis & bipolar currents. Stored energy in a magnetic field and attractive force between poles.

Three-phase AC circuits. Generation of symmetrical three-phase sinusoidal voltage. "Star" and "Triangle" interconnections. Polar and Phase Quantities. Solving three-phase star/triangle circuits with symmetrical supply voltages and symmetrical loads. Conversion ratios. Rotating vector diagrams for three-phase circuits. Three phase systems of four and three conductors. Three phase circuits with asymmetrical loads. Conversion relations. Faults of three-phase circuits. Three phase electrical power, measurement of three phase power, determination of power factor from watt metering. Improvement of power factor in three phase circuits. Conversion ratios.

Transformers. The single-phase transformer: Principle of operation, constructional characteristics, EMF equation, transformer losses, the transformer under load conditions, magnetic and ohmic leakages, equivalent circuit of single phase transformer, control of transformer, regulation of transformer, transformer efficiency, the effect of variation in power factor on transformer efficiency. The autotransformer and its comparison with the two-winding transformer. The three-phase transformer: Connections of three phase transformer, Types of three phase transformers, Power supply of three phase transformer, Various types of three

phase transformer connections, Parallel operation of three phase transformers, Current transformers, Potential transformers, Instrument transformers.

Principles of electromechanical energy conversion - Rotating Electric Machines. Forces and torques in magnetic field systems, single and multiple excitation field systems. Fundamental principles of rotating electric machines: General constructional characteristics, conditions for producing permanent electromagnetic torque, multi-pole machines, mechanical and electrical angle and their relationship, losses and efficiency, leakage and harmonic currents, ventilation and cooling, categorization and evaluation of rotating machines.

Direct Current Electrical Machines. The basic DC motor. Construction characteristics of DC electric machines. Methods of excitation of DC electric machines. The equivalent circuit of a DC motor. The action of the collector and the armature reaction. Interpole windings and compensating windings. The magnetisation characteristics of a dc machine. Classification of DC generators. The characteristics of the excited dc generator, external excitation. Self-excitation. The characteristics of parallel excitation, series excitation, and complex excitation dc generator. Classification of dc motors. The characteristics of dc motors. Starting of parallel excitation dc motor. Control of DC motors. Speed control of motor with parallel and series excitation. Testing and performance of DC motors. Applications of DC motors.

Asynchronous Induction Electric Machines. Construction characteristics of multiphase induction electric machines. The stator and its rotating magnetic field. Torque generation. Slip. Equivalent circuit of a polyphase induction electric motor. Calculation of equivalent circuit characteristics from test data. The behaviour of three-phase induction electric machines. The torque-speed characteristic. Circular diagrams. Speed control of multi-phase induction electric motors. Starting methods of multi-phase induction electric motors. Induction generators. Transmission systems. Single-phase induction electric motors. No load and stationary rotor tests. Starting methods for single-phase induction motors. Applications of multi-phase induction electric motors.

Modern Electric Machines. Construction characteristics of modern electric motors. The basic modern electric machine. Equivalent circuit of a modern electric machine. Voltage regulation in modern electric machines. Power-angle characteristics and other performance characteristics of modern electric machines under load. V curves. Determination of right and transverse axis reactions. Starting of the modern electric motor. Use of the modern electric motor to improve the power factor. Areas of safe operation. Paralleling of interconnected synchronous electric generators.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	✓ Use of ICT in teaching and communication with students ✓ Laboratory education
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*	
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.*	1. Written Progress Testing (mid-course): 30% 2. Written Examination (Conclusion on Theory): 70% 3. Technical laboratory reports: 40%. 4. Oral Examination in laboratory environment: 60%.

Activity	***Semester workload***
Lectures	120
Laboratory practice	30
Course total	***150***

5. ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Additional suggested bibliography:

1. Electrical Machines, Pantelis Malatestas, TZIOLA PUBLICATIONS, THESSALONIKI 2013.
2. Electrical Machines, Charles I. Hubert, ION PUBLICATIONS, ATHENS 2008

3. Electrical Machines AC-DC, Stephen J. Chapman, TZIOLA PUBLICATIONS, THESSALONIKI 2010.
4. Laboratory Exercises Brochure.