COURSE OUTLINE

1. GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	ELECTRICAL AND COMPUTER ENGINEERING DEPT.		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**ENE_APP-104**	**SEMESTER**	**1**
COURSE TITLE	MODELING AND CONTROL OF ELECROMECHANICAL SYSTEMS		

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	2	
Seminars / Practice exercises	1	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (4).	3	6

COURSE TYPE ***general background, special background, specialised, general knowledge, skills development***	Special Background. Specialization.
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No
COURSE WEBSITE (URL)	https://eclass.uop.gr/courses/3474/

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*

Course goal of"Modeling and Control of Electromechanical Systems" is for postgraduate students to deepen their knowledge of electromechanical systems such as electrical grids and microgrids and their applications. Emphasis is placed on learning modern tools for simulating such systems in order to better control their reliable, sustainable and resilient operation regardless of problems that may appear.

Models developed for simulation purposes are for dynamic nonlinear systems that are in fact never in full equilibrium. Loads and power requirements change all the time and there is a problem in storing large amounts of energy that can smooth out operational problems that do occur. Problems multiply with the entry of modern renewable energy sources that need faster reactions to properly control their operation.

Correct control requires correct model. Network and microgrid elements are modeled appropriately with whatever simplifications are required for proper networking in specific applications.

The main simulation software tool used is matlab with simulink, simscape and control toolboxes that allow application of traditional and new innovative automated control methods. Other software will be described as required on a case-by-case basis.

Learning outcomes

On course completion students are able to:

In terms of Knowledge:

1. Understand fundamental concepts of network components: generators, motors, transmission lines, transformers and loads as they apply to the network.
2. To understand basic structure and construction characteristics of above elements with whatever simplifications are common in modeling for specific operations.
3. Different operations often require different models. Students should know the appropriate model for the application they are dealing with.
4. To know the basic techniques for dynamic simulation and solution methodology in network and microgrid applications.

In terms of Skills:

1. Calculate various electrical and mechanical quantities such as voltage, current, power, torque and frequency in the ideal steady state of operation.
2. Apply appropriate simplifications to the generic models of network elements to suit specific applications.
3. Be able to use the simulink/simscape environment for grid/microgrid modeling.

In terms of Abilities:

1. Understand and solve complex problems related to operation and control in grids and microgrids.
2. To generalize the knowledge they acquired and use it to solve problems they are not familiar with.

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…*
	…….

- Work independently
- Team work
- Search for, analyse and synthesize data and information, with the use of appropriate technology.
- Production of free, creative and inductive thinking

3. SYLLABUS

1. Grid overview. Microgrids. Developments incorporating renewable energy sources. Developments in control systems.
2. Grid infrastructure. One-line diagrams. Per unit measurements. IEEE benchmark systems.
3. Simscape. Basic introduction and onramps.
4. Load/power flow. Example with Simscape.
5. Matpower. IEEE 5 and 9 bus examples with matpower and simscape.

6. Modeling energy systems as complex dynamic systems.
7. Modeling of generators, machines. Simplifications commonly utilized in power industry.
8. Modeling of lines and loads.
9. Principles of primary control of synchronous machine (frequency and voltage).
10. Primary power flow control and grid voltage support.
11. From individual components to interconnected components. Modeling and control.
12. Primary dynamical analysis for fast systems. Extension to secondary and tertiary analysis.
13. Developments in future power systems.

4. TEACHING and LEARNING METHODS-EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face in classroom and lab</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, Use of Matlab/Simulink/Simscape software. Learning process support through the e-class electronic platform.</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>Activities</th><th>Semester course load</th></tr>
<tr><td>Theory lectures</td><td>26</td></tr>
<tr><td>Problem solving</td><td>13</td></tr>
<tr><td>Report writing</td><td>40</td></tr>
<tr><td>Project</td><td>20</td></tr>
<tr><td>Independent study of lectures and bibliography</td><td>51</td></tr>
<tr><td>Total
(25 hours course load per credit)</td><td>150</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>Evaluation language: Greek

Evaluation method:
Written reports and final project that deals with grid and microgrid simulation with Matlab/Simulink/Simscape, 100%</td></tr>
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5. RECOMMENDED BIBLIOGRAPHY

M. Ilic, J. Zaborszky, *Dynamics and Control of Large Electric Power Systems,* J. Wiley, 2000

J.D. Glover, T.J. Overbye, M.S. Sarma, *Power System Analysis & Design, 6th ed.,* Cengage

Learning, 2017

A. E. Fitzgerald, C. Kingsley, S. Umans, *Electric machinery*, 7th ed., McGraw-Hill, 2013.

H. Saadat, *Power System Analysis,* McGraw-Hill, 1999.

P.M. Anderson, A.A. Fouad, *Power Control and Stability, 2nd ed.*, IEEE Press, 2003

P.W. Sauer, M.A. Pai, J.H. Chow, *Power System Dynamics and Stability. 2nd ed.*, IEEE Press, 2018

M. Ilic, L. Xie, Q. Liu, *Engineering IT-Enabled Sustainable Electricity Services*, Springer, 2013.

S. Krishna, *An Introduction to Modelling of Power System Components*, Springer, 2014

F. Andrade, M. Castilla, B.D. Bonatto, *Basic Tutorial on Simulation of Microgrids Control Using MATLAB & Simulink Software*, Springer, 2020

V. Perelmuter, *Renewable Energy Systems*, CRC Press, 2017

P. Schavemaker, L. Sluis, *Electrical Power System Essentials*, J. Wiley, 2017