COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	ELECTRICAL AND COMPUTER ENGINEERING DEPT.		
LEVEL OF STUDIES	MASTER LEVEL		
COURSE CODE	**ENE-APP-202**	**SEMESTER**	**2**
COURSE TITLE	ADVANCED TOPICS IN ELECTRICAL INSTALLATIONS		

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	
Tutorial/Seminars	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, Specialised
PREREQUISITE COURSES:	No
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No
COURSE WEBSITE (URL)	https://eclass.uop.gr/courses/3538/

(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 course "Advanced Topics in Electrical Installations" aims to introduce graduate students to the emerging opportunities and challenges of modern power grids, characterised by an increased penetration of renewable energy sources.

The course presents the theory required to understand the problems arising from transitioning traditional power systems to intelligent and flexible cyber-physical power systems. The concepts of distributed generation, flexibility, active distribution networks and microgrids as building blocks of the Smart Grid are introduced. Issues related to the connection of (Renewable Energy Sources) RES to the grid are also presented, as well as current trends in the provision of ancillary services through active demand management methods and distributed generation control algorithms.

Emphasis is placed on installations of renewable energy sources in buildings combined with energy storage under net-metering or net-billing programs for energy cost reduction, increase of self-consumption, load shifting and peak shaving.

Also, the principle of smart electric vehicle charging is introduced in different scales. Smart charging strategies are studied in charging stations combining renewable energy sources and battery energy storage systems.

Interactive workshops introduce modern open-source programming tools for modelling load flows and conducting RES grid connection studies.

Learning Outcomes

Upon successful completion of the course, the student will be able to demonstrate the following learning outcomes:

At the knowledge level:

1. Understand fundamental concepts of Smart Grids such as flexibility, distributed generation, microgrids and demand response.
2. Understand the different levels of control in modern power systems and the potential to improve the efficiency of their operation using active resource management methods.
3. Know fundamental methodologies for the analysis of the connection of RES to the grid.
4. Know algorithms for modelling and solving load flows.
5. Know the differences between net-metering and net-billing and the impact to the prosumers and the grid.
6. Know the principles of smart charging and the use of multi-objective optimization to charging stations with RES and battery energy storage systems (BESS).

At the skill level:

1. Conduct analyses for estimating the generation of wind and photovoltaic power plants.
2. Solve the problem of load flow in transmission and distribution networks.
3. Understand the requirements of renewable power plant installations in buildings with energy storage and evaluate the proposed solutions regarding net-energy/net-billing programs.
4. Solve the problem of optimization of charging stations with RES and BESS.

At the level of abilities:

1. Propose solutions to improve the efficiency of modern power systems using active demand management and distributed generation methods.
2. Generalize the acquired knowledge and use it to solve problems in the context of Smart Grids that are not familiar to them.
3. To propose solutions for installations of RES and BESS in buildings based on the specific requirements.
4. To propose solutions for installations of charging stations incorporating RES and/or BESS.

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
Adapting to new situations
Decision-making
Working independently
Team work
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas

Project planning and management
Respect for difference and multiculturalism
Respect for the natural environment
Showing social, professional and ethical responsibility and sensitivity to gender issues
Criticism and self-criticism
Production of free, creative and inductive thinking
……
Others…
…….

- Working autonomously
- Team work
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Production of new research ideas

(3) SYLLABUS

1. Introduction to the challenges of modern power systems, distributed generation, smart grids and microgrids.

2. Autonomous/interconnected operation and control of microgrids, primary and secondary control.

3. Energy Management Systems (EMS), examples of real microgrids.

4. Ancillary services and large-scale electricity storage systems.

5. Connection of RES to the power system.

6. Demand side management, energy cost reduction, load shifting, peak shaving.

7. Photovoltaics with battery energy storage systems, net-metering, net-billing, dynamic electricity pricing.

8. charging management, smart charging, dynamic load management, multi-objective optimization, charging stations with RES and battery energy systems, electric vehicle aggregators.

9. Preparation for programming assignment related to RES connection (wind and PV generation calculation).

10. Preparation for programming assignment on modelling and solving load flows in electricity transmission and distribution networks.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	In lecture
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Teaching using ICT for supporting the learning process through the e-class electronic platform, and use of Open-Source Software for the seminars and assignments.
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.*	**Evaluation language**: **Greek**. **Evaluation Method:** Written examination (short answer questions, multiple choice questions, problem-solving): 50%. Assignments on a) the analysis of the connection of new RES and load flows using open source software and b) optimal energy management: 50%.

Activity	***Semester workload***
Lectures	26
Laboratory Exercises (in Lab)	14
Assignments	30
Course Project	30
Lecture & bibliography study	50
Course Total	***150***

(5) ATTACHED BIBLIOGRAPHY

Momoh, James A. Smart grid: fundamentals of design and analysis. Vol. 63. John Wiley & Sons, 2012.

Hatziargyriou, Nikos, et al. Microgrids. IEEE power and energy magazine 5.4 (2007): 78-94.

Narejo, Ghous Bakhsh, et al., eds. Microgrids: design, challenges, and prospects. (2021).

Du, Pengwei, Ning Lu, and Haiwang Zhong. Demand response in smart grids. Vol. 262. Cham: Springer International Publishing, 2019.

Guerrero-Lemus, Ricardo, et al. Electricity storage. Renewable Energies and CO2: Cost Analysis, Environmental Impacts and Technological Trends-2012 Edition (2013): 307-333.

Manwell, James F., Jon G. McGowan, and Anthony L. Rogers. Wind energy explained: theory, design and application. John Wiley & Sons, 2010.

Murty, P. S. R. Power systems analysis. butterworth-heinemann, 2017.

Garcés, Alejandro. Mathematical Programming for Power Systems Operation: From Theory to Applications in Python. United Kingdom, Wiley, 2021.

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