



ΠΑΝΕΠΙΣΤΗΜΙΟ  
ΠΕΛΟΠΟΝΝΗΣΟΥ  
UNIVERSITY *of the* PELOPONNESE

**STUDY GUIDE FOR THE ACADEMIC YEAR 2025–2026 OF  
THE POSTGRADUATE STUDY PROGRAMME “MODERN  
APPLICATIONS OF ELECTRIC POWER SYSTEMS”**

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## CONTENTS

### CONTENTS

<b>1. INTRODUCTION</b> .....	3
<b>2. STUDIES</b> .....	4
<b>2.1 CALL FOR APPLICATIONS – SELECTION OF CANDIDATES</b> .....	4
<b>2.2 ACADEMIC CALENDAR</b> .....	4
<b>2.3 COURSES</b> .....	4
<b>2.4 THESIS</b> .....	6
<b>2.5 DEGREE AND DIPLOMA SUPPLEMENT</b> .....	6
<b>3. STUDENT SERVICES</b> .....	6

## 1. INTRODUCTION

The Postgraduate Study Programme “Modern Applications of Electric Power Systems” of the Department of Electrical and Computer Engineering was established in 2022 (Government Gazette 4901/16-10-2022, Series B’) by decision of the Senate of the University of the Peloponnese. The aim of the programme is to offer its graduates high-level postgraduate education and the cultivation of skills in cutting-edge fields and technologies relating to: (a) microgrids and their interconnection with strong power networks, (b) energy saving in buildings, and (c) electric and hybrid vehicles and the facilities serving them.

The duration of the Postgraduate Study Programme is three (3) academic semesters, of which the first two (2) include theoretical teaching and practical exercises, while the third (3rd) includes the preparation of a thesis. The total number of credits that the student must accumulate is 90 ECTS credits. The curriculum of the programme was designed considering the academic profile and orientation of the Department of Electrical and Computer Engineering and extends already existing fields while also covering new subject areas within the Energy Systems track.

Upon completion of their studies, graduates of the Postgraduate Study Programme:

- will possess specialized knowledge in the fields of microgrids, energy saving in buildings, and electric vehicle technology.
- will demonstrate a critical understanding of the theory and principles governing the fields of microgrids, energy saving in buildings, and electric vehicle technology.
- will be able to apply their knowledge creatively in research, analysis, and the development of innovative solutions to complex problems.
- will be able to interpret, evaluate, and promote modern scientific research and studies related to the subject areas of the programme.
- will be able to substantiate their positions with specialized information and arguments with clarity, adequacy, and precision.
- will have the ability to develop their knowledge and skills autonomously.
- will have the ability to apply effectively the specialized knowledge and skills they have acquired in order to address new, interdisciplinary, and complex problems.
- will be able to solve problems and make decisions based on inductive reasoning.

## 2. STUDIES

### 2.1 CALL FOR APPLICATIONS – SELECTION OF CANDIDATES

The Programme admits holders of a first-cycle degree from Higher Education Institutions (HEIs) in Greece or equivalent institutions abroad, and in particular graduates of:

(a) Polytechnics, Schools of Engineering, Schools of Science, of Greek universities or corresponding departments of foreign institutions,

(b) Departments of Technological Educational Institutes (TEIs) whose subject matter is related to Energy, Electronics, and Electrical/Mechanical Engineering of the technological sector.

The procedure for announcing places in the Programme, the required supporting documents to be submitted by the candidate, and the candidate selection procedure are described in detail in the Operating Regulations of the Programme, which are posted on the Programme website.

### 2.2 ACADEMIC CALENDAR

Each new cycle of the Programme begins in October on a date determined by the Department Assembly following a recommendation by the Director of the Programme and the Coordinating Committee. Courses last at least 13 weeks and are followed by the examination period. The start and end dates of classes each semester, as well as the dates of examinations, are announced in due time by the Secretariat on the Department website and on the Programme website. The weekly class timetable is announced in the same way. Courses are held on weekdays in the afternoon and on Saturdays in the morning.

### 2.3 COURSES

In each of the first two semesters of the programme, 5 compulsory courses are offered, while in the third semester, the postgraduate student must prepare a thesis. The total workload of each course corresponds to 6 ECTS credits. The thesis, which corresponds to an average completion time of one semester, is worth 30 ECTS credits. The award of the degree corresponds to 90 ECTS credits in accordance with international standards. Courses are taught by faculty members, mainly members of the Department or of other departments of the University of the Peloponnese, on the basis of their field of expertise, while it is also possible to assign teaching to faculty members of other universities in Greece or abroad, as well as to external collaborators who necessarily hold a doctoral degree and possess experience and expertise in the subject area of the course they are called upon to teach.

The courses of the 1st semester are intended to enrich the knowledge students

STUDY GUIDE OF THE M.Sc. PROGRAMME “MODERN APPLICATIONS OF ELECTRIC POWER SYSTEMS”

acquired at the undergraduate level, while the courses of the 2nd semester focus on students’ specialization in the subject areas of the programme. Lectures are delivered in classrooms equipped with audiovisual media, while the Department’s laboratory infrastructure is used wherever required.

Course table by semester:

<b>1st SEMESTER – Fundamental Knowledge</b>		
<b>Compulsory Courses</b>		
<b>Code</b>	<b>ECTS</b>	<b>Title</b>
ENE-APP-101	6	Energy Production – Energy Saving Using Renewable Energy Sources
ENE-APP -102	6	Advanced Topics in Electrical Machines
ENE-APP -103	6	Microcontrollers & Data Transfer
ENE-APP -104	6	Modelling and Control of Electromechanical Systems
ENE-APP -105	6	Modern Applications of Power Electronics
<b>Total</b>	<b>30</b>	

<b>2nd SEMESTER – Specializations</b>		
<b>Compulsory Courses</b>		
<b>Code</b>	<b>ECTS</b>	<b>Title</b>
ENE-APP -201	6	Energy Storage Systems
ENE-APP -202	6	Advanced Topics in Electrical Installations
ENE-APP -203	6	Energy Economics
ENE-APP -204	6	Energy Performance of Buildings
ENE-APP -205	6	Electric Vehicle Technology
<b>Total</b>	<b>30</b>	

<b>3rd SEMESTER</b>		
<b>Code</b>	<b>ECTS</b>	<b>Title</b>
ENE-APP -MDE	30	Thesis
<b>Total</b>	<b>30</b>	

## **2.4 THESIS**

Each student is required, to complete their studies, to prepare a thesis in the 3rd semester on a topic directly related to the subject area of the programme. Thesis topics are research and knowledge-application topics based on the use of bibliography and are announced during the 2nd semester of studies by the Secretariat. The preparation of the thesis provides an opportunity for the synthesis and use of the knowledge acquired during the studies in specific applications.

## **2.5 DEGREE AND DIPLOMA SUPPLEMENT**

Graduates of the Programme who have successfully fulfilled their obligations are awarded a Postgraduate Diploma (M.Sc.) entitled “Modern Applications of Electric Power Systems”. The Diploma is signed by the Rector of the Institution and the Director of the Programme. Holders of the postgraduate degree may continue their studies for the award of a Doctoral Diploma in accordance with the applicable provisions. Before the degree award ceremony, graduates of the Programme may be issued with a certificate stating that they have successfully completed the Programme. The Diploma is accompanied by a Diploma Supplement in Greek and English, in accordance with the model of the European Commission.

## **3. STUDENT SERVICES**

Upon admission to the Postgraduate Study Programme, postgraduate students are provided with an academic account and access to the Department’s electronic services (email, e-students, eClass). They are also entitled to all rights and benefits provided to undergraduate students, such as a student card, free meals, and medical/pharmaceutical care, except for the provision of free textbooks.

## COURSE DESCRIPTIONS

### **ENE-APP-101 ENERGY PRODUCTION – ENERGY SAVING USING RENEWABLE ENERGY SOURCES**

The aim of the course is to deepen postgraduate students’ knowledge of methods for utilizing Renewable Energy Sources both for energy production and for energy saving, so that they can assess the relevant processes from a technical, economic, and social point of view within the framework of their training. Specifically, the course focuses on the following topics.

- General elements of electric energy conversion devices using renewable sources and basic operating principles.
- Advanced knowledge of semiconductor theory and low-dimensional semiconductors. Energy bands, metal-semiconductor contacts, and semiconductor-semiconductor contacts.
- New photovoltaic system technologies for integration into buildings (first- and second-generation PVs). Operating principles and applications.
- Third-generation photovoltaic systems (transparent photovoltaics). Development of PV technology based on dye-sensitized solar cells (DSSC) and perovskite solar cells (PSC). Operating principles and applications.
- Development of PV technology based on quantum-structured semiconductors (QSSC) and organic photovoltaics (OPV). Operating principles and applications.
- Energy-saving technologies in buildings based on new types of glazing (low-e, smart windows, liquid crystals). Operating principles of these devices.
- Thermal conversion of solar energy. Solar water heaters and hybrid systems. Heat exchangers.
- Thermal / solar collector technology.
- Energy balance and solar collector efficiency.
- Hybrid solar and thermal systems.
- Characteristics of the wind potential of an area. Maps and calculations of wind characteristics. Statistical analysis of wind potential.
- Wind turbines and their main types. Wind turbine siting. Calculation of wind turbine power and energy yield.
- Siting and calculation of the power and energy yield of wind farms. Hybrid electric power generation systems.

### **ENE-APP-102 ADVANCED TOPICS IN ELECTRICAL MACHINES**

Within the framework of the course, the required theory is presented for the study of the operation of specific machines and related concepts such as magnetomotive force, rotating magnetic field, voltage and torque development, and equivalent circuits. AC machines are analysed on the basis of the generalized theory of electrical machines, and an introduction is given to the dynamic analysis of AC electrical machines and to the transformation of stator and rotor windings into the (d, q,  $\gamma$ ) axis system.

### **ENE-APP-103 MICROCONTROLLERS & DATA TRANSFER**

The objective of the course is to understand the process of designing systems comprising networked microcontrollers for the development of integrated monitoring and control applications, both locally and via the Internet (IoT). The course covers the architecture of advanced 32-bit microcontrollers (ESP32-C3, STM32) based on RISC architecture, methods of interfacing with analog/digital inputs/outputs using appropriate integrated circuits and widely used protocols (RS232, I2C, SPI, CAN), as well as their interconnection via the MQTT protocol with IoT platforms (HiveMQ MQTT broker, ThingSpeak, ThingsBoard, etc.) for the development of Internet-based monitoring and control applications. Emphasis is placed on developing applications in C/C++ and MicroPython for dynamic load management and demand response within the framework of dynamic energy pricing in the smart grid.

### **ENE-APP-104 MODELLING AND CONTROL OF ELECTROMECHANICAL SYSTEMS**

The aim of the course “Modelling and Control of Electromechanical Systems” is to deepen postgraduate students’ knowledge of electromechanical systems such as the electric power grid and microgrids and their applications. Emphasis is placed on learning modern simulation tools for such systems, with a view to improved control for their uninterrupted and smooth operation regardless of the problems that may arise. The models developed for simulation concern dynamic non-linear systems that, in essence, are never in complete equilibrium. Loads and power demands change continuously, and there is a problem in storing large amounts of energy that could smooth out any operational issues that may arise. These problems are multiplied by the integration of modern renewable energy sources, which require faster responses for their proper control. Proper control presupposes a proper model. Grid and microgrid components are modelled appropriately with whatever simplifications are required for correct networking in specific applications. The main simulation software tool is MATLAB with the Simulink, Simscape, and Control Toolboxes, which allows the implementation of classical as well as new innovative automated control methods. Other software tools are described as appropriate.

### **ENE-APP-105 MODERN APPLICATIONS OF POWER ELECTRONICS**

The aim of the course “Modern Applications of Power Electronics” is to deepen postgraduate students’ knowledge of modern power electronic converters together with the corresponding pulse modulation techniques. The interaction of converters with the full set of power-system parameters is also examined.

Within the framework of the course, the basic topologies of power electronic converters (AC-AC, AC-DC, DC-DC, and DC-AC) in modern applications are examined. The most widely used of these are analyzed, with emphasis placed on advanced pulse modulation techniques aimed at improving power quality and increasing system efficiency. In addition, topologies are presented for: (a) the connection of RES to the grid and (b) the charging of electric batteries.

### **ENE-APP-201 ENERGY STORAGE SYSTEMS**

The aim of the course “ENERGY STORAGE SYSTEMS” is to deepen postgraduate students’ knowledge of energy storage systems so that they are able to assess the relevant processes from a technical, economic, and social perspective within the framework of their training. More specifically, students are expected to develop personal skills such as critical thinking, the ability to design research studies, oral presentation skills, and the ability to write scientific articles on the review, investigation, and evaluation of modern energy storage technologies (electrical and thermal), since this scientific field constitutes a critical parameter for optimizing the corresponding power flows and an essential factor for the further penetration of RES in the energy balance. These skills, in combination with students’ know-how and specialization, will make them highly attractive and competitive scientific personnel, capable of meeting the modern demands of the global labour market.

### **ENE-APP-202 ADVANCED TOPICS IN ELECTRICAL INSTALLATIONS**

Within the course, the required theory is presented to understand the problems arising from the transition of traditional Electric Power Systems to intelligent, flexible, cyber-physical electrical systems. The concepts of distributed generation, flexibility, the active distribution network, and the microgrid as a cell of the smart grid are introduced. Issues related to the connection of RES stations to the grid are also presented, along with modern trends in the provision of ancillary services through active demand management methods and distributed generation control algorithms. Emphasis is placed on renewable energy installations in buildings combined with electrical energy storage under net-metering or virtual net-billing schemes to achieve goals such as reducing energy costs, increasing self-consumption, load shifting, and reducing peak loads.

In addition, the principles of smart charging of electric vehicles at various scales are

introduced. Smart charging techniques at charging stations are studied in combination with the utilization of renewable energy sources and electrical energy storage. Through interactive laboratories, students are introduced to the use of modern open-source programming tools for modelling load flows and conducting studies on the connection of RES to the grid.

#### **ENE-APP-203 ENERGY ECONOMICS**

The aim of the course “Energy Economics” is to understand concepts related to the operation of modern electricity markets within the framework of the Electric Power System. Initially, the fundamental problem of economic dispatch is solved analytically, and an introduction to linear programming is then provided as a tool for modelling problems such as scheduling and unit commitment of thermal and hydroelectric units. Market operation and wind generation operation are modelled and simulated in the laboratory using open-source software tools. Finally, methodologies for forecasting electricity demand are presented, as well as issues related to the operation of energy exchanges and energy communities.

#### **ENE-APP-204 ENERGY PERFORMANCE OF BUILDINGS**

The determination of the energy performance of buildings incorporates complex design and installation principles and applications, as it aims at satisfying thermal comfort in combination with energy saving and the improvement of their environmental footprint. A key parameter for the sustainable energy management of buildings is the integration of passive and active design systems through the implementation of effective and “smart” energy management systems that adapt their operation according to building use. Accordingly, energy design and air-conditioning of buildings require that the engineer master issues relating to heat transfer, psychrometrics, and air-conditioning, as well as the integration of RES into their energy balance.

#### **ENE-APP-205 ELECTRIC VEHICLE TECHNOLOGY**

The aim of the course “Electric Vehicle Technology” is to deepen postgraduate students’ knowledge of the technology and analysis of electric vehicle systems. An electric vehicle consists of: (a) the electric drive system, (b) energy storage, (c) the mechanical part (transmission system, steering system, etc.), and (d) the supervision and control system of the vehicle subsystems, as well as the communication system between the electric vehicle, the charging infrastructure, and the smart grid. Some of the topics have been analysed in previous postgraduate courses. Those systems that have not yet been analysed, as well as the synthesis of all subsystems into a single system, constitute the basic structure of this course. Thus, the mechanical

subsystems of an electric vehicle, the electric motor control, and finally the vehicle automation system, as well as the communication system, will be presented.

#### **ENE-APP-MDE Thesis**

- 1) The student should be able to search for, select, analyse, and synthesize bibliographic data in a specific scientific field and topic.
- 2) The student should be able to organize the theoretical/bibliographic material and become familiar with a specific way of writing scientific text.
- 3) The student should become familiar with the concept of plagiarism and its avoidance through proper reproduction of bibliographic data.
- 4) The student should become familiar with the use and citation of bibliographic references.
- 5) The student should be able to organize and present their data to a broad audience.