UNIVERSITY OF WESTERN MACEDONIA
SCHOOL OF ENGINEERING
INTERDEPARTMENTAL PROGRAM OF MASTER STUDIES
RENEWABLE ENERGY SOURCES & BUILDINGS ENERGY MANAGEMENT

Co-organization of the Department of Mechanical Engineering
(administrative support) the
Department of Electrical & Computer Engineering

STUDY GUIDE

ACADEMIC YEAR 2022-2023

KOZANI 2022
https://www.ape.uowm.gr/

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INTRODUCTION - WELCOME

I welcome you at the Inter-Departmental Program of Master Studies, Renewable Energy Sources & Buildings Energy Management which is organized by the Department of Mechanical Engineering (administrative support) in co-operation with the Department of Electrical & Computer Engineering.

Climate change is emerged as the dominant danger for humanity future. Renewable Energy Sources are the dominant way to confront it combining a series of advantages (from the dependence's reduction to the job creation) with the improvement of living standards.

Important is also, the effective energy use for the sustainable development attainment. Of paramount importance in this direction is the rational use of energy in buildings as they constitute the sector with large energy consumption, however a great energy saving potential.

Studying in the Inter-Departmental Program of Master Studies, Renewable Energy Sources & Buildings Energy Management, creates multitudes of perspectives and opportunities for any scientist, not only for his/her professional future, but also for the general life vision, the problems of any kind in connection with it and the way to tackle them.

We don't wish simply to transfer knowledge to the students but to create something new, necessary for our lives and the society, to be pioneer in the creation of a new world.

Master Program Director

Nikolaos Taousanidis Professor

1. BRIEF HISTORICAL OVERVIEW

The Inter-Departmental Program of Master Studies, Renewable Energy Sources & Buildings Energy Management (RES-EMB in brief) first established in 2015 (Governmental Gazette 1328/Β΄/2-7-2015) as Inter-Departmental Program of Postgraduate Studies of the two historical Departments of the Western Macedonia University of Applied Sciences, the Department of Mechanical Engineering & Industrial Design and the Department of Electrical Engineering, School of Engineering.

According to Law 4610/2019 (Governmental Gazette 70/Α'/7-5-2019), and the provisions of Ch. Ι', article 55, par. 10 and article16 of Ch. Δ', the Master Program is re-established with the Governmental Gazette 3716/Β΄/8-10-2019 as Inter-Departmental Program of Master Studies of the two flagship Departments of the University of Western Macedonia Engineering School.

In academic year 2015-2016 the Master Program welcomed the first 40 students (upper limit of first establishment decision) which continued throughout the next years. Since a few candidates were being excluded, an increase in the number of accepted students has been decided with the Governmental Gazette ΦΕΚ 3440/τ.Β'/17.08.2018. Throughout the next years the number of enrolled students was around 40 students per year as a considerable number of new Master Programs has been established in Engineering School. Still today this program is considered as one of the most successful Master Programs.

2. ADMINISTRATION OF MASTER PROGRAM

According to Law 4957/2022 (article 81) the supervisory bodies of an Inter-Departmental Master Program are:

α) the UOWM Senate

β) the Study Program Committee,

γ) the Coordination Committee and

δ) the Master Program Director

2.1. Master Program Director

Νικόλαος Ταουσανίδης, Καθηγητής

2.2. Study Program Committee

1	N. Taousanidis	*Professor*	Director
2.	D. Tsiamitros	*Assoc. Professor*	Member
3	S. Douvartzidis	*Assoc. Professor*	Member
4	D. Stimoniaris	*Assoc. Professor*	Member
5	G. Panaras	*Assist. Professor*	Member

2.3. Coordination Committee

1	N. Taousanidis	*Professor*	Director
2.	D. Tsiamitros	*Assoc. Professor*	Member
3	S. Douvartzidis	*Assoc. Professor*	Member
4	D. Stimoniaris	*Assoc. Professor*	Member
5	G. Panaras	*Assist. Professor*	Member

2.4. Administration Office

Mechanical Engineering Dpt:	Anna Tzika
Master Program:	Anna Tsianaka
Master Program Contact Details:	tel: +30 24610 68225 email: ape@uowm.gr
Address:	Kila University Campus, GR50 100, Kila Kozani

2.5. Academic Counsellors

1	N. Taousanidis	*Professor*
2.	D. Tsiamitros	*Assoc. Professor*
3	S. Douvartzidis	*Assoc. Professor*
4	D. Stimoniaris	*Assoc. Professor*
5	L. Karagiannakis	*Lecturer*

3. PROGRAM AIMS AND ORGANIZATION

The Inter-Departmental Program of Master Studies, Renewable Energy Sources & Buildings Energy Management aims at fostering and promoting knowledge and know-how in subjects relevant to Development, Design, Installation, Evaluation and Monitoring Energy Behavior of systems based on Renewable Energy Sources (RES) and the Rational Use of Energy (RUE).

Aims to specialize scientists who will contribute to the development of innovations in the Sector of RES Applications and of Energy Saving Technologies and respond to the undertaking and design of relevant systems, assuring simultaneously a considerable competitive advantage in their professional development and evolution in the most powerful Energy fields.

The aims of the Program are:

(a) Knowledge advancement and research development in scientific areas, dealing with the promotion and optimization of systems and devices dealing with the production and exploitation of energy coming from sources environmentally friendly, targeting to its protection and the maximum possible security of energy supply.

(b) Provision of necessary, high-level knowledge for the energy design of sustainable buildings integrating “smart energy saving techniques” and innovative bioclimatic solutions.

(c) Production of scientific resource, serving fundamental human values, as sustainability, natural and cultural environment protection using analytical, interpretive and synthetic tools in the broader energy sector.

3.1. Learning outcomes

The studies in the Inter-Departmental Program of Master Studies, Renewable Energy Sources & Buildings Energy Management, create a multitude of perspectives and possibilities for any scientist, not only for his professional advancement, but also as far as his/her general perspective for life and all accompanying problems and the way they tackle them is concerned. The relevant learning outcomes could be summarized as follows:

- The graduates know and understand energy issues relevant to the modern society challenges, that is the Climate Change, the energy supply security and the improvement of society's living standards. According elements they acquired in their first level studies, but also the contribution of specialized knowledge of cutting-edge technologies which they have been taught in their second level studies, the will have the capability to develop and apply innovative ideas and scientific activity in RES technology and energy design of sustainable buildings issues, incorporating "smart energy techniques" and innovative bioclimatic solutions.
- Use knowledge and critical capability they developed during their studies, for the solution of complex problems in the rapidly evolving field of RES and Energy Management in Buildings of any kind but also in fields connected with them, as Energy Policy, Energy Markets and Energy Economy in general.
- Raise judgements in energy issues closely interlinked with social and ethical problems, serving fundamental human rights, as the sustainability, the protection of natural and cultural environment and to deal with crises demanding integrated knowledge and to transfer their judgements effectively to experts an non-experts.

- Take immediate decisions in complex and continuously changing working environments and social frames, which may demand diverse strategies using analytical, interpretative and synthetic tools in energy sector
- Can continue to third level studies serving research and innovation in scientific areas, related to the development and optimization of systems and devices for the production and use of energy coming from environmentally friendly sources, targeting to environment protection and the maximum possible energy supply security

4. ACADEMIC CALENDAR

4.1. Courses and Exams

Applications for participation in new round (Dates are defined in the Call)	
Enrollment applications	2nd half of September
Winter Semester courses	14/10/2022 - 18/12/2022
	and 13/01/2023 - 28/01/2023
Winter semester exams	03/02/2023 - 10/02/2023
Spring semester coursed	17/02/2023 - 08/04/2023
	and 28/04/2023 - 10/06/2023
Spring semester exams	16/06/2023 - 24/06/2023

4.2. National & Local Holidays and Student Vacations of Winter Semester

October, the 11th	*(Liberation of Kozani City)*
October, the 28th	*(National Holiday)*
November, the 17th	*(Polytechnio Anniversary)*
December, the 6th	*(St.Nichola Day – Kozani Patron Saint)*
December, the 24th – January the 6th	*(Christmas Holidays)*
January, the 30th	*(Three Ierarches-Education-Holiday)*

4.3. National & Local Holidays and Student Vacations of Spring Semester

February, the 27th	*(Ash Monday)*
March, the 25th	*(National Holiday)*
April, the 10th – April, the 21st	*(Easter Holidays)*
May, the 1st	*(International Worker's Day)*
June, the 5th	*(Whit Monday)*

5. INFORMATION ABOUT THE ORGANIZATION OF STUDY

5.1. Duration of Studies

The **minimum possible duration** of studies is **3 semesters**.

Every semester consists of 13 full teaching weeks.

The working load for the completion of study program and graduation corresponds to 90 ECTS including diploma thesis, which corresponds to 30 ECTS.

5.2. Studies interruption

Students have the right to interrupt, upon written request to the Administration Office of the Master Program and approval of the Study Program Committee, their studies for as many semesters, consecutive or not, as they wish, however not more than the minimum number of semesters required to receive diploma according to the curriculum. **These semesters are not calculated in the maximum studies duration**. Students who interrupt as aforesaid their studies, do not maintain their student membership throughout the whole period of their studies interruption. After the end of the studies interruption, students return automatically to the Master Program. The application for interruption of studies, is submitted twice a year and exclusively during the submission time of courses statement. (winter and spring semester).

5.3. Cycles and Directions of Studies- Specialization of Studies

The studies in the Inter-Departmental Program of Master Studies, Renewable Energy Sources & Buildings Energy Management, of the School of Engineering, University of Western Macedonia consist of three semester Cycles of Studies.

- The **First Cycle of Studies** include **three (5)** mandatory courses, which are common to all specialization of studies.
- The **Second Cycle of Studies** include **eight (8)** Elective Specialization courses (ES). In the second cycle students are given the opportunity, based on their interests, to choose one of the following Specialization of Studies.

1. Specialization of Renewable Energy Sources
2. Specialization of Buildings' Energy Management

Also in this cycle it is possible the Diploma thesis subject to be selected.

- The **Third Cycle of Studies** include the Diploma thesis

5.4. Participation supporting documents-Selection Procedure

- Application for the admission to Master Program, on a special form, including photo ID type (link from the Call to http://ape.uowm.gr/).
- Analytical CV.
- Degree Copy (including Hellenic NARIC recognition if necessary) with analytical marks of all years.
- Two (2) referee letters. (link from the Call to http://ape.uowm.gr/).
- Publications copies (if exist).
- Certificate of English language proficiency.
- Other certificates (eg. Professional experience) for the qualifications referred in the CV, as it is in the application – formal declaration.
- Copy of ID or Passport.
- Two (2) ID photos.

The aforesaid supporting documents are included in Master webpage announcement (**ape.uowm.gr)** for each round Call.

For candidates' selection the evaluation criteria and the relevant points are as follows:

1. Final Degree/Diploma Grade (35%)
2. Research activity (excluding final thesis) of canditate, shown with publications and/or certificates for participation in research programs (10%).
3. English Language Knowledge (as ASEP proposes) with 5 grades for level B2, 7,5 for level C1 and 10 for level C2: (10%)
4. Evaluation of referee letters (10%).
5. Candidate professional activity of proper level, relevant to Master program scientific areas. (15%).
6. Evaluation of Interview Committee (20%). It can be omitted with Study Program Committee decision

The evaluation of candidates, having submitted in time all the supporting documents is carried out in three phases:

A' Preliminary Phase

The Study Program Committee checks all the supporting documents having the right to ask for clarifications relevant to the submitted documents. Then calls the candidates for interview.

B' Phase:

The Study Program Committee decides the candidate's classification establishing the relevant list. The list is sent to the Master Administration Office. Candidates can submit their objections in the next 5 working days.

C' Phase:

After the objections examination the Study Program Committee establishes the final classification list. The successful candidates are invited to answer in

written, in five (5) working days if they accept or not their inclusion the Master Program. If they do not answer in time, it is equivalent to acceptance denial. In such case the Administration Office informs the immediate next candidates from the list

5.5. Students evaluation - Exams

The students` performance evaluation in each course takes place during the whole academic year. Examination mode is different for each course, it is determined by the staff, and it is communicated during the first week of the course's teaching.

There are **two (2) examination periods** for the courses taught in each semester. The first period is set immediately after the end of that semester, winter, or spring. The second is set in September, before the beginning of the next winter semester.

5.6. Education material

The educational procedure is complemented with the use of textbooks and other educational aids which are provided to students for free, as well as by ensuring their information and access to the relevant Greek and foreign bibliography (article 285, Law 4957/2022).

5.7. Diploma Thesis

The studies in the Master Program are completed with the Diploma Thesis. This thesis is an extended study in a scientific area of the Master Program and corresponds to 30 ECTS. The Diploma Thesis aims to demonstrate the

student`s ability to work and deepen scientifically in a narrow academic field.

Every student may choose the scientific area in which he/she wants to work out his/her Diploma Thesis.

5.8. Diploma

All Master Program graduates are awarded with the Master Program Diploma entitled "Renewable Energy Sources & Buildings Energy Management" in the following specializations:

a) Renewable Energy Sources

b) Buildings' Energy Management.

6. STUDY PROGRAM

The Study Program includes course titles, their syllabus and the relevant credit units (ECTS).

6.1. Semester Programme

1st Semester

s/n	Code	Course	Instructor	Course Designation	Hours*	ECTS
1	MN0161	Energy Economics and Energy Markets	*K.Kaldellis-E.Kondili*	Mandatory	36	7
2	MN0121	Heat Transfer	*S. Douvartzidis*	Mandatory	39	7
3	MN0171	Electrical Energy Systems	*G. Christoforidis*	Mandatory	26	5
4	MN0181	Mechanical Energy Systems	*S. Douvartzidis*	Mandatory	26	5
5	MN0191	Renewable Energy Technologies	*N. Taousanidis-D.Stimoniaris*	Mandatory	36	6
		TOTAL				30

2nd Semester – RES specialization

s/n	Code	Course	Instructor	Course Designation	Hours*	ECTS
1	MN0211	Solar Energy Systems	*N. Taousanidis*	Elective Mandatory	39	7,5
2	MN0221	Wind Energy Systems	*K. Kaldellis - K.Kavvadias- N. Taousanidis*	Elective Mandatory	39	7,5
3	MN0241	Smart Grids	*D. Tsiamitros*	Elective Mandatory	39	7,5
4	MN0231	Emerging RES & Energy Storage	*S. Douvartzidis*	Elective Mandatory	39	7,5

s/n	Code	Course	Instructor	Course Designation	Hours*	ECTS
		TOTAL				30

2nd Semester – EBM specialization

s/n	Code	Course	Instructor	Course Designation	Hours*	ECTS
1	MN0251	Building Energy Systems	*N.Taousanidis-L.Karagiannakis*	Elective Mandatory	39	7,5
2	MN0261	Passive & Bioclimatic Systems Use	*N.Taousanidis-N.Ndinas*	Elective Mandatory	39	7,5
3	MN0271	Energy Conservation Systems Automation	*K.Gavros*	Elective Mandatory	39	7,5
4	MN0281	Smart Buildings Design	*D.Stimoniaris*	Elective Mandatory	39	7,5
		TOTAL				30

* Teaching hours are for the 13 weeks program

3rd Semester

s/n	Code	Course	Instructor	Course Designation	Hours*	ECTS
1		Diploma Thesis	*Supervisor*	Mandatory		30

6.2. Diploma Grade Calculation

The degree is calculated using the following algorithm:

α) all courses, necessary for obtaining diploma, carry a weight factor W_i= Course ECTS.

β) Diploma Thesis carry a weight factorW_d=30.

Diploma Grade (D.G.) is then given by:

$$\text{D.G.} = \frac{W_d B_d + \sum_{i=1}^{M} W_i B_i}{W_d + \sum_{i=1}^{M} W_i}$$

where M is the number of courses passed successfully in exams, Bi is the successful examination grade of course i and B_d is the Diploma Thesis grade.

7. COURSE CONTENTS

HEAT TRANSFER	
Course Code	MN0121
URL	https://eclass.uowm.gr/courses/RES104/
Course Content	• Introduction to the heat transfer mechanisms. • Differential equations of heat conduction. • Steady heat conduction. • Transient heat conduction. • Numerical methods in steady heat conduction. • Numerical methods in transient heat conduction. • Forced convection. • Natural convection. • Thermal and solar radiation. • Radiation heat transfer. • Design and analysis of heat exchangers. • Heat transfer in building design.
Expected learning outcomes and competences to be acquired	Upon successful completion of the course, the student will: • Describe heat transfer fundamentals and laws. • Distinguish and analyze in depth heat transfer mechanisms (conduction, convection, radiation) in steady and transient conditions, for one- and multi-dimension problems. • Resolve steady and transient heat transfer problems in simple and complex geometries assuming a single heat transfer mechanism (e.g. convection) or combined heat transfer mechanisms (e.g convection with radiation). • Understand in depth numerical methods of analysis and problem solution (finite differences, energy balance method) in steady and transient conditions, for one- and multi- dimension problems. • Apply technical heat transfer calculations in practical applications (e.g. heat exchangers, insulation, solar collectors, buildings).

	• Evaluate practical applications operation and propose optimal solutions.
Teaching methods	Lectures, Tutorials
Evaluation	Written final examination

ENERGY ECONOMY AND ENERGY MARKETS	
Course Code	MN0161
URL	https://eclass.uowm.gr/courses/RES107/
Course Content	1st Section: Global Energy Balance and the National Energy system ○ Global Energy Balance across different periods in time ○ Primary and final energy consumption ○ Installed Power and energy production in our planet ○ Global energy mix ○ Relationship between the energy consumption and the economic growth ○ Energy production and demand in Greece - National Energy Balance ○ Basic energy sources and contribution in the national energy balance ○ The energy autonomy great issue 2nd Section: Main power generation technologies - Renewable and conventional energy sources ○ Basic categories of power generation plants ○ Basic principles and characteristics of power generation systems (thermal, Hydro, RES) ○ Thermal and electric energy cogeneration plants ○ Power and Energy Loads Demand analysis ○ Load Demand curves and base - peak load plants (Ramp Rate) ○ Energy storage systems 3rd Section: Basic Engineering Economics for Energy Projects

- The most important current energy projects in the country
- Funding of energy projects
- Feasibility studies: scope and objectives
- Basic economic characteristics of energy Projects. Capital and Operating Costs.
- Break-Even Point Analysis.
- Cash flows. Time value of money.
- Energy Investments evaluation. Simple and Complex Evaluation Criteria.
- Examples and Case Studies
- ESCOs (basic characteristics - regulatory framework in Greece)

4th Section: Electricity Markets in Greece

- The structure of the Greek electricity system
- Electricity market in Greece, Regulatory framework, stakeholders, control organisations, role and intervention rights
- Electrical networks and Renewable Energy Sources
- Central and Distributed Power Generation - and smart networks
- Reliability of power networks and consumers
- Demand management
- Participation in electricity markets (consumers and producers)
- Power and energy electricity supply tariffs in Greece
- Competitive and control premiums
- The target model
- Natural Gas and its Applications
- Natural Gas Transportation Networks

5th Section: Environmental Economics - Externalities - ESCOs

- Externalities in energy projects
- Environmental impacts in the production and use of energy
- Environmental Impact Assessments
- The impacts of the most widely applied energy projects

	○ Environmental Economics. The economic pollution problem in regional and local range. The socially optimum pollution level. ○ The economic problem of climate change. Economic incentives and penalties - pollution rights. ○ The most important environmental valuation methods. Revealed preference and stated preference methods. The replacement cost and the contingent valuation method. <u>6th Section: Energy Markets and Energy Policy</u> ○ Basic principles and basic characteristics of electric energy markets ○ Energy market liberisation ○ Energy as a public or merit good ○ Energy Costs ○ Environmental and Macroeconomic energy cost ○ Energy taxation ○ Long term planning of the energy system ○ The Energy Choice - The Energy Trilemma ○ Marginal System Pricing ○ Daily energy planning ○ Utilities needs, markets, pricing. ○ Introduction in the competition economy in the energy markets ○ Energy pricing mechanisms ○ Net metering, Energy Communities ○ The limitation of energy resources and its impact in the energy prices ○ Social impacts of energy projects ○ EU energy policy and contemporary energy issues ○ The Greek energy policy and its prospects ○ Electromobility: Prospects and challenges
Expected learning outcomes and competences to be acquired	Upon the successful course completion, students would be able to show a complete knowledge of energy economics as well as their interconnection with energy markets, externalities and environmental / social impacts.
Teaching	Lectures and homework

methods	
Evaluation	Individual Projects (30%)-Final written examination (70%)

ELECTRICAL ENERGY SYSTEMS	
Course Code	MN0171
URL	https://eclass.uowm.gr/courses/RES109/

Course Content	The course consists of the following sections:
	• The building as a system - interaction with the grid
	  ○ Nearly-zero energy buildings (NZEBs)
	  ○ Net-zero energy buildings
	  ○ Electrical power generation in buildings
	  ○ The building as a nanogrid
	• Effect of increased RES penetration into the grid
	  ○ Need to provide flexibility
	  ○ Power quality issues (overvoltages, reverse flow, etc.)
	  ○ Demand side management and demand response
	• Interconnection of RES units with the grid
	  ○ Power electronics for grid integration of RES
	  ○ Types and characteristics of modern power inverters
	  ○ Selection, dimensioning, settings and calculations
	  ○ Electrical characteristic and parameters of photovoltaic (PV) panels
	  ○ Detailed design of PV systems with inverters
	  ○ Special software
	• Electricity Storage using batteries
	  ○ Use storage for self-consumption and reduce demand
	  ○ Cooperation of different storage systems with different power / speed

	characteristics ○ Energy modeling, load and generation profiles ○ Design and configuration of typical PV installations with storage ○ Detailed examples • Financial evaluation of RES investments in electricity grids ○ The importance of the electricity market ○ Key support schemes for RES and important parameters ○ Available tools and examples of financial evaluation
Expected learning outcomes and competences to be acquired	Upon successful completion of the course the student will: 1. Understand and realize a building as a "system" and recognize its specific features when it interacts with energy networks. 2. Categorizes buildings according to how Renewable Energy Systems (RES) are integrated and operated. 3. Know and explain the effects of increased RES penetration on electricity networks and propose ways to address them. 4. Determine the available ways of interconnecting RES units with the grid and analyze the specific characteristics of the different types of power inverters. 5. Has state-of-the-art knowledge on integrating energy storage into RES systems in buildings, as well as evaluating the possibilities of installing such systems in parallel with RES units. 6. Be able to study in-depth and design RES systems in buildings, considering their specific characteristics. 1. 7. Incorporate appropriate economic parameters when evaluating different technical solutions in the study of RES systems in buildings.
Teaching methods	Lectures and homework
Evaluation	Group Project

MECHANICAL ENERGY SYSTEMS	
Course Code	MN0181
URL	https://eclass.uowm.gr/courses/RES108/
Course Content	1. Introduction to energy systems. 2. Properties of pure substances, gases and liquids. 3. Thermodynamic Analysis of Energy Systems 4. Internal combustion engines. 5. Gas turbines technologies 6. Steam generators 7. Steam turbine technologies. 8. Steam power units. 9. Combined power cycles and Cogeneration cycles. 10. Refrigeration and Air-Conditioning Units 11. Thermal Design and Optimization of energy systems.
Expected learning outcomes and competences to be acquired	Upon successful completion of the course the student will: 1. Know the characteristics and operation of all existing power production technologies 2. Carry out complete calculations of analysis, design and evaluation for energy installations and units 3. Implement complete studies for energy units optimization.
Teaching methods	Lectures, Tutorials
Evaluation	Written final examination

RENEWABLE ENERGY TECHNOLOGIES	
Course Code	MN0181
URL	https://eclass.uowm.gr/courses/RES101/
Course Content	1. Climate change and sustainability. 2. Depletion of energy sources and necessity for renewable power. 3. Thermal solar technologies. 4. Photovoltaic solar technologies.

	5. Hydroelectric power technologies. 6. Wind power technologies. 7. Biomass power technologies. 8. Waste power technologies. 9. Geothermal power technologies. 10. Ocean power technologies. 11. Renewable energy systems life-cycle analysis.
Expected learning outcomes and competences to be acquired	The course aims to introduce students in the modern renewable energy technologies, and issues arising from climate change. Upon the successful course completion, students would be able to present a thorough and complete view on subjects of solar energy, wind energy, biomass, geothermal energy, hydraulic energy and ocean energy.
Teaching methods	Lectures and homework
Evaluation	Individual Projects

SOLAR ENERGY SHYSTEMS	
Course Code	MN0211
URL	https://eclass.uowm.gr/courses/RES106/
Course Content	The course is outlined in 13 units covering the following: 1. Solar energy & Solar geometry 2. Thermal conversion of solar energy 3. Conversion units – flat solar collector 4. Energy balance – solar collector's efficiency 5. Storage of solar thermal energy 6. Calculation of thermal loads 7. f-chart method 8. Φ-f chart method 9. Photovoltaic conversion of solar energy 10. Photovoltaic systems 11. Design of stand-alone photovoltaic systems 12. Grid connected photovoltaics systems
Expected learning outcomes and	The aim of this course is the development of deep knowledge and capability to analyze and design solar thermal systems to cover thermal loads and of

competences to be acquired	photovoltaic systems to cover electrical loads. Upon the accomplishment of the subject students would design systems which can support fully or partially to monthly estimated loads, succeeding fossil fuels conservation and environmental impacts minimization.
Teaching methods	Lectures, Tutorials
Evaluation	Final written examination

WIND ENERGY SYSTEMS	
Course Code	MN0221
URL	https://eclass.uowm.gr/courses/RES105/
Course Content	The course is outlined in 13 units covering the following: 1. Energy Balance of Our Planet 2. Renewable Energy Sources (RES) Contribution 3. Comparison between Fossil Fuels & RES (Wind mainly) 4. Introduction to Wind Energy Technology 5. Wind Power Industry and Markets 6. Fundamental Principles of Wind Energy Exploitation 7. Technology of Modern Wind Turbines 8. Wind Potential Evaluation-Wind Parks 9. Wind Potential-Resource Analysis 10. Wind Energy Prediction Analysis 11. Technical Availability of Wind Parks 12. Financial Evaluation of Wind Energy Projects 13. Environmental Assessment of Wind Parks 14. Social Approval of Wind Energy Applications 15. Wind Farm Development 16. Design and Optimization of Wind Power Stations 17. Wind Power Project Development-Construction-Commissioning 18. Wind Park Operation and Maintenance 19. Wind Energy Integration in Electrical Grids

	20. Offshore Wind 21. Special Wind Energy Applications (Hybrid Systems, Stand-alone, Desalination, etc.) 22. Future Development of Wind Energy
Expected learning outcomes and competences to be acquired	The aim of this course is the development of deep knowledge and understanding of the operation of contemporary wind turbines. Furthermore, special emphasis is put on investigating the optimum exploitation of the available wind potential, on wind park design and on the implementation of a wind power project. Moreover, the environmental and financial performance of wind power installations is also investigated along with special topics like the offshore wind power activity, the wind power integration etc
Teaching methods	Lectures and homework
Evaluation	Individual Projects (30%)-Written final examination (70%)

EMERGING RENEWABLE ENERGY TECHNOLOGIES AND ENERGY STORAGE	
Course Code	MN0231
URL	https://eclass.uowm.gr/courses/RES113/
Course Content	1. Introduction to Energy Storage (ES). 2. Economic benefits and policies of ES. 3. Mechanical ES: Pumped hydroelectric, Compressed Air ES, Flywheels. 4. Thermal ES: Sensible heat ES, Latent heat ES, Thermochemical ES, Seasonal ES. 5. Chemical ES: Biomass and biofuels, Nonrenewable hydrogen, Renewable hydrogen, Hydrogen storage, Hydrogen economy. 6. Electrochemistry, Catalysis, Electrocatalysis, Chemical Kinetics. 7. Electrochemical ES: Batteries, Flow batteries, Fuel Cells. 8. Electrical ES: Capacitors, Supercapacitors,

	Superconducting Magnet ES. 9. Design and modeling of energy storage systems. 10. Design and modeling of electrochemical power generation. 11. New materials and innovative processes.
Expected learning outcomes and competences to be acquired	This course provides participants a detailed investigation of energy storage systems and an up-to-date presentation and analysis of emerging renewable technologies such as hydrogen power and fuel cells.
Teaching methods	Lectures, Tutorials
Evaluation	Written final Examination

SMART GRIDS	
Course Code	MN0231
URL	https://eclass.uowm.gr/courses/RES110/
Course Content	The course consists of the following sections: Distributed Electrical Power Generation • Necessity for connection in electricity network. • Types and characteristics of distributed generation units. • Impediments on the Penetration of Distributed Generation Units into the Network. The Role of Existent Electrical Grid. • Protection of the supply network and problems due to distributed production units. • Meters and smart meters. • Internal and external transmission substations. Limitations due to distributed production units. • Simulation of the distribution network of an urban area. • Smart Grids and Possible Ways for Smart Grid Implementations for the Increase of Penetration of Distributed Generation Units into Electricity Network. • The microgrid as a necessary construction unit

	of the smart electrical grid, Definition and characteristics, topologies, smart meters. • Implementation of topology - Microgrid control • Primary control (voltage regulation and frequency of weak or islanded microgrid) without software use. • Primary control (voltage regulation and frequency of weak or islanded microgrid) with software use. • Secondary microgrid control with software use. Application of policies for energy management, demand and distributed productions. • Tertiary microgrid control for low cost operation. • Microgrid control with forecast models . Artificial intelligence • Interactivity with protocols of energy management and demand in buildings. Simulation of microgrids and weak networks in PSCAD • Experimental data based simulation of the microgrid units. Models of photovoltaics, wind turbines, batteries and loads. • Behavior of the simulation model and comparison with experimental data. • Expansion of the simulation model in IEEE networks. • The role of smart cars on the smart grid. European Guidelines for Smart Grids • Architectures, Protocols, Interfunctionality, The role of smart meters. • The situation in EU member states relative to smart grid and smart meter implementation
Expected learning outcomes and competences to be acquired	The aim of this module is to deliver an introduction to Smart Grids and further analysis of the smart grids components and principles. The basic components and principles of the electricity grid are analyzed together with the interaction of the grid to the Renewable Energy Sources. On completion, the students will be able to: o Realize the necessity of the smart grids. o Realize the operation principles of a microgrid

	with increased RES penetration. ○ Define the technologies that constitute a grid smart.
Teaching methods	Lectures and Homework
Evaluation	Group Project (30%)- Individual Examination (70%)

BUILDING ENERGY SYSTEMS	
Course Code	MN0251
URL	https://eclass.uowm.gr/courses/RES103/
Course Content	1. Introduction to Energy: Energy, Fuels, Energy management, Statistics, Evaluation and measurement of energy parameters. 2. Aim and design of an energy study - investigation. 3. Energy in buildings: Building shell, Insulation adequacy. 4. Energy in buildings: Electrical and mechanical equipment, Passive solar systems. 5. Heat pumps. 6. Geothermal energy. 7. Cogeneration of electricity and heat. 8. Methods of energy management in buildings (Degree days method, Method of consecutive summations, Base temperature method). 9. Methods of energy management in buildings: Temperature frequency method. 10. Comparison of energy systems and economic analysis. 11. Motors and illumination. 12. Control systems: Systems for energy saving and efficiency improvements. 13. Application examples.
Expected learning outcomes and competences to be acquired	The aim of this module is to deliver an introduction to the Building Energy Efficiency Regulation and of knowledge in heat pumps technology, geothermal energy, and heat-electricity cogeneration. Also, knowledge in energy analysis and energy saving systems evaluation. Upon its completion students will have the

	capability to present a complete view in buildings energy saving technologies.
Teaching methods	Lectures, Tutorials
Evaluation	Written final examination

PASSIVE AND BIOCLIMATIC SYSTEMS USE	
Course Code	MN0261
URL	https://eclass.uowm.gr/courses/RES102/
Course Content	The course is outlined in 13 units covering the following: 1.Climate & Environment 2.Built environment – urban climate 3.Climate factors and buildings energy behavior 4.Building envelope & thermal behavior 5.Solar exposure and solar protection 6.Inner climate– thermal comfort 7.Pasive heating systems 8.Natural buildings cooling 9.Natural buildings lighting 10. Building surroundings– microclimate 11. Optimal cost methodology
Expected learning outcomes and competences to be acquired	The aim of this module is to deliver knowledge upon building design adapted to local climate conditions aiming to maximize users' comfort and to minimize energy consumption. Upon course's completion students will have the capability to design bioclimatic buildings with nearly zero energy consumption and environmental impact
Teaching methods	Lectures and Homework
Evaluation	Individual Projects

ENERGY CONSERVATION SYSTEMS AUTOMATION	
Course Code	MN0271
URL	https://eclass.uowm.gr/courses/RES112/
Course Content	The course consists of 6 sections: 1. Definition and Development of Buildings Installations Automation 2. Digital Controllers, Sensors and Actuators 3. Technologies of local networks and the Internet in the management building installations 4. Communication Standards for management building installations 5. Process Control, PID controllers and adaptive control 6. Climate Control systems, cooling, lighting and building security
Expected learning outcomes and competences to be acquired	The course aims to introduce the student to the concepts related to the topic of automation of building facilities in order to save energy and generally of intelligent management of buildings. The students are required to implement a selection of laboratory experiments that cover all the main types of building automation, providing relative laboratory reports. Furthermore, students are required to complete various assignments, dealing with simulating of building automation systems using specialized software, solving of problems and practical applications. On successful completion of this module the student will be able to: • Recognize and describe the system devices • Explain the principles of building automation systems • Explain in detail the basic functions of building automation system devices • Implement experiments in the laboratory and analyze their operation • Design simple automation systems and Simulate

	them using special software and Lab equipment • Collaborates with fellow students in project development
Teaching methods	Lectures, Tutorials & Laboratory exercises
Exercises	Theory (50%): Written examination (35%). Exercises (15%) Laboratory (50%): Group Project (20%) – Individual Project (30%)

SMART BUILDINGS DESIGN	
Course Code	MN0281
URL	https://eclass.uowm.gr/courses/RES111/
Course Content	This course is divided into eight sections: 1. Introduction to Smart Electrical Installation 2. Topology of Smart Electrical Installations / Smart Grid topology 3. Communication in Smart Electrical Installations 4. Basic/Main Materials for Smart Electrical Installations 5. Types and Structure of BUS devices 6. Programming of Smart Electrical Installations (e.g. ETS software) 7. Practical Applications 8. Constructing Smart Electrical Installations
Expected learning outcomes and competences to be acquired	The objective of this course is to provide an in-depth understanding of the fact that the consumed-energy's smart management is a prerequisite for the design of smart buildings. This can be achieved through the use of the so-called BUS systems. During this course, the basic rules for the smart electrical installations are analyzed, while particular emphasis is given to the KNX open technique, which is the worldwide standard for home and building control/smart electrical installations. This technique is the most widespread one both in Europe and in Greece.

Teaching methods	Lectures, Tutorials & Laboratory exercises
Evaluation	Individual Project (50%) - Group Project (50%)

DIPLOMA THESIS	
Course Code	-
URL	https://ape.uowm.gr/index.php?option=com_content&view=article&id=57&Itemid=218&lang=el
Course Content	Every student may choose the scientific area in which he/she wants to work out his/her Diploma Thesis. The only limitation in this selection is that the thesis must be relevant to (at least) one of his/her specialization, which he/she has attended.
Expected learning outcomes and competences to be acquired	The diploma thesis is an extended study in a scientific area of the Master Program. Its main aim is to assist student to acquire deep knowledge in a specialized scientific area of the Master Program and to present an autonomous scientific work. The assignment of the thesis is during the 2nd semester and the preparation throughout the 3rd semester of studies.
Teaching methods	-

8. OTHER USEFUL INFORMATION

8.1. DIPLOMA SUPPLEMENT

The Master Program ΔΠΜΣ grants a Diploma Supplement to all graduates according to the provisions of Law 3374/2005 and the M.D. F.5/72535/B3/10.08.2006.

8.2. HEALTH CARE

All students (undergraduate, postgraduate, expatriates and foreign) are entitled to health, medical and nursing care for a period equal to the years of studies which 140

are considered having a minimum duration of the undergraduate studies incremented by two years.

For this purpose the University provides students with a healthcare booklet that can be used in the region of the university concerned and only in exceptional cases outside it.

In case that the student is entitled directly or indirectly to additional health coverage by another healthcare insurer, and still wants the student healthcare plan, he should waive the insurance from the other carrier and choose the student insurance instead by a solemn statement (Law 1599/86), stating that "he is not insured under any other insurance carrier."

Additional information on healthcare is provided in the Healthcare booklet

For obtaining the Healthcare booklet, the students should address to the Administration Office.

8.3. ACADEMIC IDENTITY CARD – STUDENT TICKET

Every student is granted an Academic Identity Card. The relevant acquisition process is described on the website http://academicid.minedu.gov.gr/. The Academic ID Card is valid for as many years as the student membership lasts and covers multiple uses, including the Student Ticket (Pass). The duration of the Student Ticket is valid for n + 4 semesters. The discounts provided to Means of Transportation, are those laid down by the legislation concerned.

The Academic Identity Card is deposited at the Administration Office of the Master Program with the swearing-in ceremony of the student or when for any reason the student membership ceases to exist (e.g. interruption of studies).

UNIVERSITY OF
WESTERN MACEDONIA

IN TER-DEPARTMENTAL PROGRAM OF MASTER STUDIES

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