a) General			
School	ENGINEERING		
Academic unit	MECHANICAL ENGINEERING		
Level of studies	Undergraduate		
Course code	MM109Y02	*Semester*	9
Course title	**Hybrid systems of energy generation**		

Independent teaching activities	*Weekly teaching hours*	*ECTS*
Lectures	3	7.0
Laboratory exercises	2	

Course type	Knowledge deepening/consolidation
Course category	Compulsory for Direction 1
Prerequisite courses	-
Language of instruction and examinations	Greek
Is the course offered to Erasmus students	No
Course website (url)	https://moodle.puas.gr/course/view.php?id=386

b) Learning outcomes and general competences

b1. Learning outcomes

Upon successful completion of this course, the student will be able to:

- Comprehend all parameters that should be taken into account with regards to the installation and operation of hybrid systems
- Analyze the energy needs of a final consumer
- Apply established methodologies for the design of hybrid systems
- Determine the optimum dimensions of a hybrid power generation installation
- Apply methods of thermal energy management by means of combining solar thermal systems and systems for the exploitation of geothermal energy
- Determines the economic viability of hybrid installations

b2. General competences

- 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 the natural environment
- Production of free, creative and inductive thinking

c) Syllabus

Theory: Energy systems and remote consumers, main components of energy consumption, operation principles of hybrid systems, study of the operation of autonomous electrical hybrid systems, problems on the cooperation between thermal power stations and wind turbines, advantages and disadvantages of the cooperation between thermal engines and wind turbines, hybrid system sizing on the basis of thermal engines and wind turbines, hybrid thermal-wind-hydro systems, photovoltaic-thermal hybrid systems, photovoltaic-wind-thermal hybrid systems,

hybrid installations for space and domestic water heating, hybrid systems for the coverage of heating loads (solar energy, biomass, geothermal energy), environmental-social benefits of hybrid energy installations, new technologies for hybrid systems.

Lab: Sizing of thermal and wind hybrid systems, investigation of cooperation issues between thermal power engines and wind turbines, photovoltaic-thermal hybrid systems, photovoltaic-wind-thermal hybrid systems, techno-economic evaluation of hybrid energy systems.

d) Teaching and learning methods - Evaluation

Delivery	Face - to - face (classroom lectures, working groups, lab)
Use of information and communications technology	- Commercial/free/open source software - Multimedia applications - MS Teams/Moodle - Site visits - Open courses

Teaching methods

Activity	*Semester workload*
Lectures	26
Tutorials	15
Laboratory exercises	26
Computational exercises	13
Individual work	76
Course total	156

Student performance evaluation	For the theoretical part of the module: Individual and/or group assignments and presentation of the assignments (10%) and written final exam (60%), that include short-answer questions and solving of numerical problems. For the lab part of the module: Individual and/or group assignments and presentation of the assignments and written exam or presentation for each assignment and case study (30%). The theoretical part of the module holds 70% of the final grade weight and the lab part holds 30%.

e) Suggested bibliography

1. Kaldellis J. K. (Ed). (2010). *Stand-alone and hybrid wind energy systems. Technology, energy storage and applications*. Woodhead Publishing, ISBN 978-1-84569-527-9.
2. Zohuri, B. (2018). *Hybrid Renewable Energy Systems*. In: Hybrid Energy Systems (pp. 1–38). Springer, Cham. https://doi.org/10.1007/978-3-319-70721-1_1.
3. Καλδέλλης, Ι. Κ., Καββαδίας, Κ. Α. (2005). *Υπολογιστικές Εφαρμογές Ήπιων Μορφών Ενέργειας (Αιολική Ενέργεια – Μικρά Υδροηλεκτρικά)*. Εκδ. Αθ. Σταμούλης, ISBN: 960-351-631-7.
4. Καλδέλλης, Ι. Κ., Σπυρόπουλος, Γ. Χ., Καββαδίας, Κ. Α. (2007). *Υπολογιστικές Εφαρμογές Ήπιων Μορφών Ενέργειας (Ηλιακή Ακτινοβολία–Φωτοβολταϊκές Εγκαταστάσεις–Ηλιακά Θερμικά Συστήματα)*. Εκδ. Αθ. Σταμούλης, ISBN: 978-960-351-686-6.