UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2017/2018
MASTER'S DEGREE (MSC)	ENERGETIC AND NUCLEAR ENGINEERING
SUBJECT	SOLAR ENERGY SYSTEMS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50367-Ingegneria energetica e nucleare
CODE	18022
SCIENTIFIC SECTOR(S)	ING-IND/11
HEAD PROFESSOR(S)	LO BRANO VALERIO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**LO BRANO VALERIO** Thursday 12:00 13:30 edificio 9

DOCENTE: Prof. VALERIO LO BRANO

PREREQUISITES	none
LEARNING OUTCOMES	1. Knowledge and understanding. The student will be able to know and to understand basics of solar energy conversion through the technologies presented in the course; it will be able to estimate the energy availability of a site choosing the most appropriate technology to exploit it. Among the possible technical solutions, the student will make an analysis of economic feasibility. 2. Applying knowledge and understanding. The student will produce technical reports relating to different topics with the application of technical knowledge, choosing among different solutions on the basis of economic optimization. 3. Making judgements. The course provides students with basic technical knowledge but also the cultural elements to understand the policy implications of the social and environmental choices in the energy sector by providing a global overview useful for an independent understanding of the student. The student will find autonomously the information about the different types of solar systems, to detail proposed solutions and technologies and to make a consistent economic analysis. Moreover, often the student will propose assumptions to show the degree of maturity achieved in analyzing the issues proposed. 4. Communication. This ability is stimulated during the drafting of the technical reports, during the design and the drafting of the plan, and during the analysis of technical and economic feasibility of renewable energy plants. 5. Lifelong learning skills. The technical and cultural knowledge provided by the course allows the students who want to continue their education or to begin his job in the company, to do it easily.
ASSESSMENT METHODS	Combination of oral and written exams Oral examination Student must meet at least three questions posed orally, on all parties covered by the program, with reference to the recommended texts. Final assessment aims to evaluate whether the student has knowledge and understanding of the topics, has acquired capability of interpretation and independent judgment of concrete cases. The sufficiency is reached when the student shows knowledge and understanding at least of general issues and has minimal application skills in solar energy systems. In order to solve concrete cases; student must expose capabilities in exhibition and argumentation and must demostrate the possibility to transmit his knowledge to the examiner. Below this threshold, the examination result insufficient. The assessment is carried out of thirty. Rating votes excellent 30 30 e lode: excellent knowledge of the topics, excellent properties of language, good canaliti capability students is able to apply knowledge to solve the proposed problems very good 26-29: good knowledge of the subjects, full mastery of language, the student is able to apply knowledge to solve the proposed problems good 24-25: basic knowledge of the main topics, basic command of language, limited ability to independently apply the knowledge to the solution of the proposed problems satisfactory 21-23: student does not have full capabilities but has the knowledge, satisfactory command of language, poor ability to independently apply the knowledge sufficient 18-20: student has minimal knowledge of topics and minimal technical language, very little or no ability to independently apply the knowledge insufficient: student does not have an acceptable knowledge of the topics Written test The written tests tend to verify the skills and knowledge relating to the field of solar energy systems, consist of a series of closed questions accompanied by two or more possible answers. The skills and knowledge of the student are not tested through an independent processing of answers, but by the choice of the exact answers among those offered to every question. The score given for each correct, missing or wrong answer is before illustrated.
EDUCATIONAL OBJECTIVES	The course aims to provide the basics and a methodology for the analysis of the main technologies of solar thermal and photovoltaic plants. At the end of the course students will be able to describe the various technologies, to size plants, to plan maintainance and to assess a pre-analysis of economic feasibility of the proposed solutions
TEACHING METHODS	Lessons and numerical exercises

SUGGESTED BIBLIOGRAPHY	Kalogirou, S. A. . Solar energy engineering: processes and systems. Academic Press. Sørensen, B. . Renewable Energy: Its physics, engineering, environmental impacts, economics & planning. Academic Press, Incorporated. Duffie, J. A., & Beckman, W. A. . Solar engineering of thermal processes (Vol. 3). New York etc.: Wiley.

SYLLABUS

Hrs	Frontal teaching
4	Introductory concepts. Energy sources and energy production. Correlation between Energy, Environment and Development. Classification of technologies of renewable sources. The legislation in the energy and environmental, Electricity Market. Sustainability of energy sources.
4	Heat transfer due to radiation, convection and conduction. The electromagnetic spectrum; body black and gray bodies. Heat transfer coefficients. Radiation characteristics of opaque materials.
5	Solar Power. Measures, experimental data and evaluations; measurement systems of direct and diffuse solar radiation. Simulation models of the solar radiation
5	The energy balance of the Earth. Evaluation of the global radiation to the ground. Greenhouse effect.
12	Solar thermal collectors: general description, energy balance, temperature distributions, performance. Thermal storage. Simulation models of the solar thermal collector.
12	Photovoltaic systems: general description, energy balance, effect of temperature, performance. Photovoltaic effect - Photovoltaic cells - Materials - Features. Daily / annual incident solar energy - Installation of photovoltaic modules - Captured energy. Type of use: (isolated systems - systems connected to the network). Design and sizing of a photovoltaic system. Simulation models

Hrs	Practice
1	Introductory concepts. Energy sources and energy production. Correlation between Energy, Environment and Development. Classification of technologies of renewable sources. The legislation in the energy and environmental, Electricity Market. Sustainability of energy sources.
2	Solar Power. Measures, experimental data and evaluations; measurement systems of direct and diffuse solar radiation. Simulation models of the solar radiation.
1	The energy balance of the Earth. Evaluation of the global radiation to the ground. Greenhouse effect.
1	Heat transfer due to radiation, convection and conduction. The electromagnetic spectrum; body black and gray bodies. Heat transfer coefficients. Radiation characteristics of opaque materials
5	Solar thermal collectors: general description, energy balance, temperature distributions, performance. Thermal storage. Simulation models of the solar thermal collectors. Daily / annual incident solar energy - Installation of solar collectors - Captured energy
2	Photovoltaic systems: general description, energy balance, effect of temperature, performance. Photovoltaic effect - Photovoltaic cells - Materials - Features. Type of use: (isolated systems - systems connected to the network). Design and sizing of a photovoltaic system. Simulation models,