



# UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2022/2023
BACHELOR'S DEGREE (BSC)	ENERGY ENGINEERING AND RENEWABLE ENERGIES
SUBJECT	PRINCIPLES OF RENEWABLE ENERGIES
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50299-Ingegneria energetica
CODE	20468
SCIENTIFIC SECTOR(S)	ING-IND/11
HEAD PROFESSOR(S)	BECCALI MARCO      Professore Ordinario      Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	<b>BECCALI MARCO</b> Thursday 09:30 11:00 T 208, ed. 9

DOCENTE: Prof. MARCO BECCALI

<b>PREREQUISITES</b>	Knowledge of fundamentals of physics, thermodynamics, heat transfer, hydraulics, chemistry
<b>LEARNING OUTCOMES</b>	<p>Knowledge and understanding</p> <p>Knowledge of physical and environmental phenomena, as well as technologies, for renewable energy exploitation (RES).</p> <p>Understanding problems, opportunities and limits; find design solutions in particular dealing with energy uses.</p> <p>Learning of fundamentals of physics and their application in energy conversion.</p> <p>Applying knowledge and understanding</p> <p>Learning of methods and tools able to fulfil design objectives related to proper use of resources through a correct match between final uses and conversion processes and technologies.. Knowledge of laws and standards about RES.</p> <p>Making judgements</p> <p>To be able to assess "energy and environmental qualities" of proposed systems. To be able to understand how. Make own design choices not only considering standards guidelines and limitations.</p> <p>Communication skills</p> <p>Work in team with other professionals and stakeholders. Approach holistic design. Go ahead "greenpainting" of projects: be confident of analysis and calculations to support the quality of the project.</p> <p>The check of this goals will be done through the written and the possible oral tests.</p>
<b>ASSESSMENT METHODS</b>	<p>There will be two written tests each one related to the subject items discussed in different periods. There will be at least 10 questions per test. Questions need either closed and open answers. The tests may be organised on an electronic platform.</p> <p>The teacher will assess basic knowledge, mastery of language and the capacity to build relationships among theory and practical applications. Students that will fail one or both the written test can have access to the oral examination.</p> <p>The assessment is carried out of thirty.</p> <p>Rating votes: excellent 30/30 e lode: excellent knowledge of the topics, excellent mastery of language, good analytic capability; the student is able to apply his knowledge to solve the proposed problems.</p> <p>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.</p> <p>Good 24-25: basic knowledge of the main topics, basic command of the language, limited ability to independently apply the knowledge to the solution of the proposed problems</p> <p>satisfactory 21-23: the student does not have full capabilities but has the knowledge, satisfactory command of the language, poor ability to independently apply the knowledge</p> <p>sufficient 18-20: student has minimal knowledge of topics and minimal technical language, very little or no ability to independently apply the knowledge</p> <p>insufficient: the student does not have an acceptable knowledge of the topics</p>
<b>EDUCATIONAL OBJECTIVES</b>	The course aims at providing the basic scientific principles behind all major renewable energy resources, such as solar, wind, geothermal, hydro and biomass. Starting from this point, lectures and exercises are focused on knowledges of main technologies for renewable energy harvesting and conversion. Student will have the capability to understand how to assess resource availability and potential, pros and cons of exploitation hypotheses. He will be able to make a pre design of several plant typologies, also dealing with economics, and consider environmental advantages and drawbacks.
<b>TEACHING METHODS</b>	Lectures and exercises
<b>SUGGESTED BIBLIOGRAPHY</b>	<p>Bent Sorensen, Renewable Energy, Academic Press, 4th Edition, ISBN: 9780123750259</p> <p>Materiale didattico fornito dal docente (Slides, reports and other written texts provided by the teacher)</p>

## SYLLABUS

Hrs	Frontal teaching
6	Introduction, sustainability and climate change. General classification of Renewable Energy resources. Law in energy topics. Fundamentals of economics of energy.
15	Wind energy. Wind phenomena at macro, meso and microscale. Wind analysis, frequency (legge di Weibull) and vertical gradients. Maximum theoretical power of a wind turbine (Betz). Blade design: lift and drag. Power factor of a turbine. Construction and operation of a wind turbine. Applications for remote sites, wind fields and off shore. Assessment of annual electricity production. Economics
12	Fundamentals of Solar Energy. Solar radiation. Basics of thermal and PV conversion, solar cooling and solar thermodynamics. Heat balance and efficiency of a solar thermal collector (Bliss law). Assessment of productivity.

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Hrs	Frontal teaching
10	Hydropower. Water energy potential, resource assessment. Fundamentals of hydraulics. Basics and classification of hydropower plants. River and basin plants. Civil works and equipment. Water turbines: classification and properties. Economics. Assessment of annual production. Environmental impact.
10	Geothermal systems. Earth structure. Classification and assessment of geothermal resources. Electricity production. Direct uses of geothermal heat, heat pumps.
10	Biomass. Classification, availability and use of different biomasses. Technologies for energy conversion. Production biofuels (biogas, pellet, biodiesel, ethanol, etc) and related technologies (anaerobic digestion, pyrolysis, gasification, chemical treatments, etc..). Power production and direct combustion. Economics and environmental impacts.
4	Production and uses of hydrogen for energy storage. Electrolysis, fuel cells, combustion. Energy and environmental balances.
Hrs	Practice
8	Wind energy
6	Solar Energy