UNIVERSITÀ DI PAVIA

Anno Accademico 2018/2019

SOLAR AND BIOMASS ENERGY SYSTEMS

Enrollment year	2018/2019
Academic year	2018/2019
Regulations	DM270
Academic discipline	ING-IND/32 (POWER ELECTRONIC CONVERTERS, ELECTRICAL MACHINES AND DRIVES)
Department	DEPARTMENT OF ELECTRICAL,COMPUTER AND BIOMEDICAL ENGINEERING
Course	ELECTRICAL ENGINEERING
Curriculum	Energetica
Year of study	1°
Period	1st semester (01/10/2018 - 18/01/2019)
ECTS	6
Lesson hours	45 lesson hours
Language	
Activity type	WRITTEN AND ORAL TEST
Teacher	PEDRAZZINI SERGIO GABRIELE (titolare) - 6 ECTS
Prerequisites	=
Learning outcomes	The aim of the course is to give an overview, as complete as possible, about energy production from renewable sources. The course is composed of three modules, worth 3 CFUs each, that are: biomass energy systems, wind energy systems and photovoltaic energy systems. Each module will introduce the working principle of the corresponding system and will give the theoretical and practical knowledged required to design te plant. Norms and regulations will be also presented. Finally, the economy of building and running the plants is studied.
Course contents	Biomass energy systems Biomass: definition and classification. Italian rules to reduce emissions

of greenhouse gases. Availability biomass at global, European and Italian. Regional availability of biomass. Chain of woody biomass, and herbaceous seeds and fruits. Dies possible in Italy. Properties of biomass. Types. Lignocellulose. Starchy. Sugar. Oilseed crops. Municipal solid waste (MSW). Manure. Liquid biofuels. Gaseous biofuels. Processes for biomass conversion. Types and global analyzes of conversion systems. Reactor parameters and process analysis. Types of reactors. Process parameters. Analysis of the process. Biochemical conversion. Anaerobic digestion. Fermentation. Oil extraction, refining and esterification.Entry systems. Mixing Systems. Harmful substances. Conditioning cold. Conditioning hot. Monitoring systems. Heat generation. Fireplaces. Boilers. Thermal power stations. Electricity generation. Turbomachines. Fuel cells. Description and analysis of systems of generation from biomass. Anaerobic digestion plants. Gasification plant. The cogeneration. Analysis of costs and revenues. Exercise in parallel to the electrical systems in biomass. Incentive systems and withdrawal commercial electricity delivered to the grid. Description and symbols of P&ID scheme (Process and Instrument Diagram).Projects of biomass plants.

Wind Energy

Introduction: history of wind energy, modern wind turbines, anatomy of a wind turbine, HAWT and VAHW, power coefficient
Airfoils and general concept of aerodynamic: general overview, aerodynamic forces and coefficients, Buckingham's theorem, Reynolds and Mach numbers, airfoils, lift and drag.
Aerodynamic of wind turbines: one-dimensional momentum theory, Betz limit, wake rotation, blade element momentum theory, blade shape for ideal rotor, aerodynamic of VAWT.
Wind characteristics and resources.
Wind turbine control: introduction and motivation, overview of wind turbine control systems, active and passive control system, yaw control.
Wind turbine design and testing: sources of loading, ultimate and fatigue loads, design loads, international standards, modern wind turbine design procedure.

Solar Energy Plants

What is solar energy and how to take advantage of it: the source and the available power, air mass, istruments to measure irradiation, fotoelectric effect, physical structure of the photovoltaic cell, various types of cells.
Photovoltaic cells and modules.
Production of electric energy.
Photovoltaic plant design.
Econonomy: payback for solar energy plant.
Concentration plants.
New technologies for the exploitation of solar energy.
Hybrid plants for the exploitation of solar energy.

Teaching methods

Lectures (hours/year in lecture theatre): 68
Practical class (hours/year in lecture theatre): 0

	Practicals / Workshops (hours/year in lecture theatre): 0
Reccomended or required readings	Slides or lecture notes will be made available for each modules. Biomass Plants: suggested books "Wastewater engineering - Treatment and Reuse" Metcalf & Eddy - Mc Graw Hill "Depurazione Biologica" - Vismara - Hoepli "Biofuels Engineering Process Technology" - Caye M. Drapcho, Nghiem Phu Nhuan, Terry H. Walker - Mc Graw Hill Solar energy Plants: suggested books "Guida Blu n. 15" - Vito Carrescia - Edizioni TNE
Assessment methods	An oral test, during which a project produced by the student will be discussed, is foreseen for each module.
Further information	An oral test, during which a project produced by the student will be discussed, is foreseen for each module.
Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile