Alberto Prudenzi

Programme of "Sistemi Elettrici per l'Energia" "Electrical Energy Systems"		
• Code: **I2L** • type of course unit: **compulsory** • level of course unit: **second cycle in Electrical Engineering** • year of study: **1st**; semester: **1st**		
Number of ECTS credits: **9** (workload is **225** hours; 1 credit = 25 hours)		
Teacher: **Alberto Prudenzi**		
1	**Course objectives**	Delivery of sustainable, reliable and competitive energy is one of the largest and most important global challenges of our time. Our dependency of fossil fuels and the global climate challenge requires an urgent technological transformation of all parts of the electrical energy system. Novel electric plants and components have to be developed, and power systems have to be redesigned and transformed into smart user-interactive grids enable integration of a variety of sources. This course aims to develop the expertise on all aspects concerning a modern electrical energy chain from energy generation, both from conventional and renewable sources (RES), up to electrical energy end-use and the various possible energy applications at customers'. On successful completion of this module, the student should be able to deeply analyse every competing electrical energy system in terms of its technical characteristics and design, its economic performances and its environmental impact. The student should also be able to design main strategies for energy efficiency improvement of electricity applications in different segments of end use.
2	**Course content and Learning outcomes (Dublin descriptors)**	Topics of the module include: **Electrical energy fundamentals** Main concepts, definitions, metric units, energy conversion, energy sources, electrical energy chain, the Italian electrical system **Environmental impact of electrical energy systems** Number and types of impact, different emissions, climate change and global warming, Kioto protocol, 20-20-20 Directive, LCC, LCA, VIA, VAS **Renewable Energy Sources (RES)** Introduction to RES, types of RES, RES market trends in Italy, Europe and World. Economics of RES. **Thermal power plants** Energy generation from conventional sources, modern technologies, typical layouts, costs, applications and case studies, environmental impact **Hydroelectric plants** Hydroelectric generation systems, theory, technology, large conventional systems, typical layouts, costs, applications and case studies, mini and micro hydro, new systems: wave energy, tidal energy **Wind energy** Theory, technology, typical layouts, costs, off-shore plants, design, applications and case studies **Solar energy** PV systems: theory, technology, typical layouts, costs, design, applications and case studies; solar heating systems: theory, technology, typical layouts, costs, applications and case studies; solar-thermal systems, technology, applications and case studies **Dispersed generation** Dispersed generation, combined heat and power, tri-generation, smart grids **Open access electricity market** Theory and models, Italian market, organization and structure, main actors **Energy efficiency and energy management** theory and main strategies, energy codes, appliance labelling, energy efficiency in buildings, ESCO and TPF, benchmarking, commissioning, guidelines and case studies **Power quality** Definitions and standard, disturbances classification, origins, mitigation techniques, PQ indices, custom power, PQ costs

		On successful completion of this module, the student should: - have knowledge and understanding of energy basics; - have knowledge of mechanisms and technologies of conventional electric energy production; - have knowledge of renewable electrical energy systems with their characteristics and design - have knowledge of the fundamental concepts and evaluation procedures of environmental impact of energy processes; - have knowledge of economic analysis of competing energy alternatives; - have knowledge of the impact of dispersed generation on existing grids, and design for new grid development; - have knowledge of the principles of energy efficiency and energy management; - have knowledge of power quality problems and solutions.
3	**Prerequisites and learning activities**	You should have completed a programming course and several mathematical courses. You should be able to analyse electrical energy circuits, and conduct mathematical analyses. It is assumed that you have a broad scientific and engineering background, and can for example perform energy balance analysis of renewable energy systems. The student must have notions of electrical engineering and lectric power systems taught in the exams of Electrical Engineering, Power Systems offered in the 1st Cycle of Industrial Engineering.
4	**Teaching methods and language**	**Teaching method:** Lectures, classroom exercises, team work. **Language:** Italian / English **Ref. Text books :** Didactic material available by the teacher.
5	**Assessment methods and criteria**	Oral examination and homeworks/project.