UNIVERSITÀ DEGLI STUDI DI PALERMO

DIPARTIMENTO	Ingegneria
ANNO ACCADEMICO OFFERTA	2015/2016
ANNO ACCADEMICO EROGAZIONE	2016/2017
CORSO DILAUREA MAGISTRALE	INGEGNERIA ELETTRICA
INSEGNAMENTO	SMART-GRID AND DEDICATED MEASUREMENT SYSTEMS C.I.
CODICE INSEGNAMENTO	18058
MODULI	Si
NUMERO DI MODULI	2
SETTORI SCIENTIFICO-DISCIPLINARI	ING-INF/07, ING-IND/33
DOCENTE RESPONSABILE	CATALIOTTI ANTONIO Professore Ordinario Univ. di PALERMO
ALTRI DOCENTI	RIVA SANSEVERINO ELEONORA Professore Ordinario Univ. di PALERMO CATALIOTTI ANTONIO Professore Ordinario Univ. di PALERMO
CFU	12
PROPEDEUTICITA'	
MUTUAZIONI	
ANNO DI CORSO	2
PERIODO DELLE LEZIONI	1° semestre
MODALITA' DI FREQUENZA	Facoltativa
TIPO DI VALUTAZIONE	Voto in trentesimi
ORARIO DI RICEVIMENTO DEGLI STUDENTI	**CATALIOTTI ANTONIO** Lunedì 11:00 13:00 Laboratorio di misure Mercoledì 11:00 13:00 Laboratorio di misure **RIVA SANSEVERINO ELEONORA** Lunedì 12:00 13:00 DEIM, Ed 9 - Viale delle scienze - II piano Giovedì 12:30 13:30 Polo didattico Caltanissetta

DOCENTE: Prof. ANTONIO CATALIOTTI

PREREQUISITI	
RISULTATI DI APPRENDIMENTO ATTESI	LEARNING OUTCOMES KNOWLEDGE AND UNDERSTANDING At the end of the course, students will have acquired knowledge and understanding basis for developing or applying original ideas concerning: the main technical and market issues in smart grids and modern power systems when high penetration of energy generated from non programmable renewable energy sources; the main measurement and communication systems, techniques and devices for smart grids monitoring, control and diagnosis. They will be able to: model the different components injecting or absorbing energy from the grid; formulate optimization problems for smart grids; identify the basic networking and sensing technologies involved with the smart grid, understand where and how measurement, monitoring and communication systems are implemented in the power grids. To reach these results, the course program includes lectures and exercises. The outcomes achievement is verified during both ongoing and final exams. APPLYING KNOWLEDGE AND UNDERSTANDING Students will be able to apply their knowledge and understanding skills in analysis and problem solving of smart grid and related measurement systems architectures, needs and challenges. They will be able to face new situations for optimal management of smart grids, knowing the behaviour of the different smart grids components and being aware on the impact of measurements and communications issues and features on control and automation properties of the electric power network. To reach these results, the course program includes lectures and guided exercises and projects/case studies analysis. To verify the outcomes achievement both ongoing and final exams include problem solving issues related to the course topics. MAKING JUDGMENTS Students will be able to integrate their knowledge and critical faculties concerning the choice of the basic components of an automatic measurement system and the development of dedicated software for signals acquisition and analysis. Such skills will provide students with the ability to make judgments concerning the smart grids and measurements needs and opportunities from a system perspective, even in the case of limited or incomplete information on the specifications and requirements of the application being studied. To reach these results, the course program includes exercises and projects/ case studies development and analysis (undertaken individually and/or in groups). To verify the outcomes achievement, both ongoing and final exams entail making judgments issues related to the course topics. COMMUNICATION SKILLS Students will acquire the ability to communicate their knowledge, analysis and conclusions concerning the problems and solution techniques for modern power systems, particular operational architectures (microgrids and virtual power plants), as well as dedicated measurement and communication systems, techniques and devices for smart grids monitoring, control and diagnosis. In doing this, students will be able to address both specialist and non-specialist audiences, communicating in a suitably clear and unambiguous manner and with correct use of language. To reach these results, the course program includes classroom discussion of exercises/projects/case studies. The outcomes achievement is verified during the oral exams (both ongoing and final). LEARNING SKILLS At the end of the course, students will be able to keep themselves abreast of developments and new findings in the field of smart electrical networks and dedicated measurement systems. They will be able to autonomously update and deepen their knowledge through the consultation of scientific materials, journal papers and participation to scientific seminars. To reach these outcomes, the course program includes lectures, exercises and classroom analysis and discussion of projects/case studies. The outcomes achievement is verified during the final exam.
VALUTAZIONE DELL'APPRENDIMENTO	Oral end-of-module tests (ongoing and final).
ORGANIZZAZIONE DELLA DIDATTICA	Lectures; classroom and lab exercises; projects/case studies analysis.

MODULO
DEDICATED MEASUREMENT SYSTEMS

Prof. ANTONIO CATALIOTTI

TESTI CONSIGLIATI

Course teaching material (provided by the professors)
J.A. Momoh, “Smart Grid. Fundamentals of Design and Analysis”, John Wiley & Sons Inc., 2012.
B. M. Buchholz, Z. Styczynski, “Smart Grids – Fundamentals and Technologies in Electricity Networks”, Springer, 2014
J. Ekanayake et al, “Smart Grid. Technology And Applications”, John Wiley & Sons Inc., 2012.

TIPO DI ATTIVITA'	B
AMBITO	50363-Ingegneria elettrica
NUMERO DI ORE RISERVATE ALLO STUDIO PERSONALE	96
NUMERO DI ORE RISERVATE ALLE ATTIVITA' DIDATTICHE ASSISTITE	54

OBIETTIVI FORMATIVI DEL MODULO

MODULE LEARNING OBJECTIVES
The module is aimed at providing the fundamentals of the main measurement and communication systems, techniques and devices for smart grids monitoring, control and diagnosis. The learning objectives concern the following topics: power grid sensors and instrumentation, energy and power quality monitoring, smart metering, measurement systems and communication architectures for smart grids.

PROGRAMMA

ORE	Lezioni
8	Energy and power quality measurements. Power quality fundamentals and related measurement issues. Power quality disturbances classification. Power quality and harmonics. Standards on energy, power quality and harmonics measurements. Power and energy measurements in nonsinusoidal conditions.
8	Power grid sensors and instrumentation. Voltage and current transducers. Metrological characterization and transducers behavior in nonsinusoidal conditions. Voltage and current measurement transformers (VTs and CTS). Current shunts and voltage dividers. Isolation amplifiers. Hall effect transducers. air core transducers, Rogowski coils. Optical current and voltage transducers. Power analyzers. Phasor Measurement Units (PMU). Smart meters. Interface devices. Intelligent electronic devices (IED). Smart protection systems.
8	Measurement systems for smart grids. Measurement systems based on microprocessors and data acquisition boards. Modular measurement systems (PXI, VXI, LXI). Workbench and rack measuring systems. Measurement instruments remote control. Distributed measurement systems. Serial and parallel communication and interfaces. IEEE 488, USB, Firewire, Field bus.
8	Measurement and communication architectures for smart grids. Substations network architectures. SCADA systems, Extended substation model. Communication protocols. Monitoring systems for the smart grid (smart metering). Measurement systems with functions of Automated Meter Reading (AMR). Functionality and architecture of smart meters (AMI – Advanced Metering Infrastructure) for the development of demand response functionalities. Building management systems (BMS).
8	Measurement networks. Smart metering tecnologies. Home area network. Wireless sensors and actuators networks. Wireless and power line communication technologies for metering applications.

ORE	Esercitazioni
14	Measurement applications examples for smart grids. Case studies and projects analyses.

MODULO
SMART-GRID

Prof.ssa ELEONORA RIVA SANSEVERINO

TESTI CONSIGLIATI	
Lectures slides and teaching materials form the professor	
TIPO DI ATTIVITA'	B
AMBITO	50363-Ingegneria elettrica
NUMERO DI ORE RISERVATE ALLO STUDIO PERSONALE	96
NUMERO DI ORE RISERVATE ALLE ATTIVITA' DIDATTICHE ASSISTITE	54
OBIETTIVI FORMATIVI DEL MODULO	
The main educational objectives are the acquisition of advanced notions about technologies for modern power systems and techniques for the analysis of their relevant architectures. More in details, the student will have acquired knowledge about the main technical and market issues in smart grids and modern power systems when high penetration of energy generated from non programmable renewable energy sources. The student will be able to model the different components injecting or absorbing energy from the grid. The student will be able to formulate optimization problems for smart grids.	

PROGRAMMA

ORE	Lezioni
6	Power systems components and modelling: Loads, storage systems, generation systems
10	Main technical issues in power systems: voltage and frequency regulation for high penetration of non programmable generation from renewable sources
4	Electrical energy market in Italy and new actors of the energy market
6	Relevant architectures for smart grids: virtual power plants e microgrids
4	Optimization and optimization problems for smart grids.
6	Formulation and solution of optimal management problems for smart grids: Energy Management Systems
4	Smart Cities and smart communities

ORE	Esercitazioni
14	Applications for Energy Management Systems