UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2017/2018
MASTER'S DEGREE (MSC)	ELECTRICAL ENGINEERING
INTEGRATED COURSE	SMART-GRID AND DEDICATED MEASUREMENT SYSTEMS - INTEGRATED COURSE
CODE	18058
MODULES	Yes
NUMBER OF MODULES	2
SCIENTIFIC SECTOR(S)	ING-INF/07, ING-IND/33
HEAD PROFESSOR(S)	CATALIOTTI ANTONIO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	RIVA SANSEVERINO ELEONORA Professore Ordinario Univ. di PALERMO CATALIOTTI ANTONIO Professore Ordinario Univ. di PALERMO
CREDITS	12
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	Annual
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**CATALIOTTI ANTONIO** Monday 11:00 13:00 Laboratorio di misure Wednesday 11:00 13:00 Laboratorio di misure **RIVA SANSEVERINO ELEONORA** Monday 12:00 13:00 DEIM, Ed 9 - Viale delle scienze - II piano Thursday 12:30 13:30 Polo didattico Caltanissetta

DOCENTE: Prof. ANTONIO CATALIOTTI

PREREQUISITES	Power plant systems and electrical measurement knowledge
LEARNING OUTCOMES	D.1: 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. D.2: 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. D.3: MAKING JUDGMENTS Students will be able 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. D.4: 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. D.5: 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.
ASSESSMENT METHODS	Oral end-of-module tests (ongoing and final). EXAMS OUTLINE Oral exam for each module The oral exam is a discussion with essay questions on the whole course programme. Oral exam looks at: - knowledge and understanding of the course programme; applying such skills for problem solving within the course or related contexts; - correct use of language, clearness, fluency; concepts reinterpretation, critical faculties, and connection skills in disciplinary or interdisciplinary contexts. Marks are out of 30 for both tests. Minimum mark for passing each test: 18/30. Final mark: mean of practical test and oral exam marks. ASSESSMENT CRITERIA For each test, marks are awarded considering to what extent the student has achieved the learning outcomes. The following scheme can be assumed for reference (see learning outcomes section, descriptors D.1-D.5). Best fit applies when learning outcomes are met at different levels. 28-30 / 30 with distinction D.1/D.2: full contents mastery; no errors; self-corrections/integrations of inaccuracies/omissions; correct and rigorous approach to problems; correct, complete and effective solutions; some originality evidence D.3/D.4/D.5: effective concepts reworking, coherent and autonomous approaches and judgments, disciplinary/interdisciplinary connections; very clear presentation, structured arguments, correct use of language. 24-27 D.1/D.2: good knowledge and understanding of course contents; few minor

	errors, partially fostered self-corrections or integrations; good approach to problems, essentially correct solutions; D.3/D.4/D.5: good coherence in linking concepts and approaching disciplinary or related subjects; good presentation, adequate use of language. 18-23 D.1/D.2: sufficient knowledge of contents; feasible approach to problems although with limited autonomy, acceptable solutions; errors or omissions not serious; D.3/D.4/D.5: sufficient concepts links within disciplinary contexts, although tentative and guided; basic presentation and use of language. below 18 (mark not awarded) D.1-D.5: learning outcomes are not sufficiently met. The final mark will be the mean value between the marks of the two modules.
TEACHING METHODS	Lectures; classroom and lab exercises; projects/case studies analysis.The module on smart grid will be held in the first semester while the module on dedicated measurements systems on smart grid will be carried out in the second semester.

MODULE
DEDICATED MEASUREMENT SYSTEMS

Prof. ANTONIO CATALIOTTI

SUGGESTED BIBLIOGRAPHY

Course teaching material provided by the professor
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.
J.A. Momoh, “Smart Grid. Fundamentals of Design and Analysis”, John Wiley & Sons Inc., 2012.

AMBIT	50363-Ingegneria elettrica
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54

EDUCATIONAL OBJECTIVES OF THE MODULE

Knowing the main features and types of instrumentations and measurement methods for power system and smart grid applications and the basic principles for their implementation and management, with particular respect to automatic distributed measurement systems, power quality and energy measurements

SYLLABUS

Hrs	Frontal teaching
14	Measurement systems for smart grids. Measurement systems based on microprocessors and data acquisition boards. Modular measurement systems (PXI, VXI, LXI). Measurement instruments remote control. Distributed measurement systems. Serial and parallel communication and interfaces (IEEE 488, USB, Field bus, etc)
14	Measurement and communication architectures for smart grids. SCADA systems, Communication protocols. Smart metering. Smart metering tecnologies. 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).
2	Measurement networks. Wireless and power line communication technologies for metering and monitoring applications.
6	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.
6	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. Hall effect transducers. Rogowski coils. Power analyzers. Phasor Measurement Units (PMU). Smart meters. Interface devices. Intelligent electronic devices (IED). Smart protection systems.

Hrs	Practice
12	Measurement applications examples for smart grids. Case studies and projects analyses.

MODULE
SMART-GRID

Prof.ssa ELEONORA RIVA SANSEVERINO

SUGGESTED BIBLIOGRAPHY

Materiale didattico elaborato dalla docente
Smart grid technology and applications Ed. Wiley - 2012 - J. Ekanayake, K. Lyanage, J Wu, A Yokoyama, N. Jenkins
Smart rules for smart cities Ed. Springer - 2015 - E. Riva Sanseverino, R. Riva Sanseverino, V. Vaccaro, G. Zizzo (integrativo)
Atlante delle smart city, Terza edizione - 2015 - Ed. Francoangeli (integrativo)

AMBIT	50363-Ingegneria elettrica
INDIVIDUAL STUDY (Hrs)	102
COURSE ACTIVITY (Hrs)	48

EDUCATIONAL OBJECTIVES OF THE MODULE

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 and will have acquired knowledge of the most relevant optimization techniques.

SYLLABUS

Hrs	Frontal teaching
2	Introduction to smart grids. Motivations. Enabling technologies. Environmental objectives.
4	Main components of modern power systems: generators, loads, storage units
10	Functions implemented by smart grids: technical functions (control, protection, predictive diagnostics, optimization) and "guided by the market" functions (Virtual Power Plants, Real Time Pricing, demand response, load aggregation, ...)
2	technical standards for smart grids
12	Optimization. Basic definitions. Linear and non linear optimization. Heuristic optimization. Multi-objective optimization.
4	Relevant architectures of smart grids: Microgrids and Virtual Power Plants
10	Formulation of a problem of optimal operation and identification of adequate optimization algorithms.
4	Intelligent communities. The integrated management of urban services and the availability of renewable resources in the urban districts. Multi-carrier energy hubs and urban districts.