Program of "**Misure Elettriche**" (**Electrical Measurements**)		
• Code: I0635 • Compulsory • 1st cycle in Industrial Engineering, 3rd year, 1st semester, Curriculum in Electrical Engineering.		
Number of ECTS credits: 9 (Lecture activity is around 90 hours, workload 225 hours; 1 credit = 25 hours). Course Structure Lecture: 7 hour per week, including laboratory activities.		
Teacher: Giovanni BUCCI		
1	**Course objectives**	The goal of this course is to provide the measurement and working principles of various instruments and devices used to measure electrical parameters. On successful completion of this module, the student should understand the fundamental concepts of measurement theory and should be aware of potential applications of basic electronic instrumentation in different engineering fields.
2	**Course content and Learning outcomes**	Topics of the module include: Fundamentals of measurement theory. Measurement of electrical resistance and impedance. Principle of moving coil instruments. Electronic analog and digital voltmeters. Electronic counters. Basic sensors and transducers. Data Acquisition Systems. Digital oscilloscopes. Spectrum analyzers. Electronic wattmeters. On successful completion of this module, the student should: - have profound knowledge of basic concepts and definitions in measurement; - have profound knowledge of basic measurement theory; - have knowledge and understanding of working principle of basic electronic instrumentation, such as voltmeters, ammeters, counters, digital scopes, spectrum analyzers, wattmeters; - demonstrate skill in main instruments and ability to measure voltage and current signals and their associated quantities, such as power, energy, frequency, time and impedance; - understand and explain the validity and the reliability of measures taken from a given system attached to a signals source; - demonstrate capacity for defining and selecting appropriate strategies to solve problems using electrical measurements as the subject; - demonstrate capacity to communicate the results of technical works in a clear and coherent way, with the generation of systematic and meaningful documentation for any designed and assembled system.
3	**Prerequisites and learning activities**	The student must know the basic notions of basic electric circuits, circuit analysis, and analog electronics.
4	**Teaching methods and language**	Lectures, laboratory team work. Language: Italian. Ref. Text books: Lesson notes in Italian or English. For better improvements: Fundamentals of measurement theory. Gerhard Bohm, Günter Zech, "Introduction to Statistics and Data Analysis for Physicists", Verlag Deutsches Elektronen-Synchrotron. Keith Birch, "Estimating Uncertainties in Testing", Measurement Good Practice Guide No. 36, British Measurement and Testing Association. The International System of Units (SI) Barry N. Taylor and Ambler Thompson, Editors "The International System of Units (SI)", NIST Special Publication 330, 2008 Edition. Sensors and transducers Robert A. Peura and John G. Webster, "Basic Sensors and Principles", Medical Instrumentation Application and Design, John G. Webster. 2009. Sensor Technology Handbook, Volume 1, Cap.4 Sensor signal conditioning. Elsevier. Linear Circuit Design Handbook, Cap.10 Passive components, Analog Devices. Harry N. Norton, Handbook of transducers, Prentice Hall PTR, 1989. M. J. Usher, Sensors and transducers, Macmillan, 1985.

		John G. Webster, Measurement, Instrumentation, and sensors, CRC Press, IEEE Press, 1999. "Isolated Current and Voltage Transducers". Characteristics - Applications Calculations. LEM Publication CH 96101 E. Measurement of electrical resistance "High Resistance Measurements", Application Note Series, Number 312, Keithley Instruments, Inc., 2005. Dale Cigoy, "Accurate Low-Resistance Measurements Start with Identifying Sources of Error", Keithley Instruments, Inc. 2010. A/D converters, DAS, The Data Conversion Handbook, edited by Walt Kester (2005). Data Converter Applications. Chap. 8.2 Multichannel Data Acquisition Systems. Analog devices. Electronic Instrument Handbook, Chap.6, John J. Corcoran, "Analog-to-Digital Converters", Agilent technologies. 2004. "AC Voltage Measurement Errors in Digital Multimeters", Digital Multimeter Measurement Errors Series, AN 1389-3, Agilent Technologies, Inc. 2002. "Understanding SAR ADCs: Their Architecture and Comparison with Other ADCs", Maxim integrated, TUTORIAL 1080, 2001. Digital oscilloscopes, counters. "Oscilloscope Fundamentals", Tektronix. 2009. Peter J. Pupalaikis, "Random Interleaved Sampling (RIS)", LeCroy Corporation. "Enhanced Resolution in LeCroy Digital Oscilloscopes", AN 006, LeCroy Corporation. "What is the difference between an equivalent time sampling oscilloscope and a real-time oscilloscope?", AN 1608. Agilent Technologies. 2008. "Fundamentals of the Electronic Counters", AN 200, Electronic Counter Series, Hewlett-Packard Company, 1997. Spectrum analyzers Robert A. Witte, Spectrum and network measurements, Prentice Hall 1991. Morris Engelson, Modern spectrum analyzer theory and applications, Artech House, 1984. "Agilent Spectrum Analysis Basics", AN 150. Agilent Technologies. 2006. Electronic wattmeters. G. Bucci, C. De Capua, C. Landi, Wiley Survey of Instrumentation and Measurement: Power and Energy: Power Measurement, Stephen A. Dyer Ed., John Wiley & Sons, 2001, pp.809-826.
5	**Assessment methods and criteria**	Oral exam: discussion on any three topics from the course, proposed by the teacher during the examination.