Course unit title:	Instrumentation and Measurements for Renewable Energy Systems				
Course unit code:	AEEE461				
Type of course unit:	Compulsory				
Level of course unit:	Bachelor (1st Cycle)				
Year of study:	4				
Semester when the unit is delivered:	7 (Fall)				
Number of ECTS credits allocated:	6	Lectures:	1	Labs:	2
Name of lecturer(s):	Dr Nicholas Christofides				
Learning outcomes of the course unit:	• Describe the basic mechanical and electrical measurement and instrumentation concepts • Apply independent judgment in performing instrument measurements, calibration and linearization • Analyze the working principles, operation and applications of various sensors and transducers in relation to renewable energy systems • Identify the components and operational parameters of a solar module • Identify the components and operational parameters of a wind turbine • Experiment with basic concepts of power measurements, calculations and transmission practices • Use of diagnosing and testing equipment for performance assessment				
Mode of delivery:	Face-to-face				
Prerequisites:	AEEE360, AEEE362		Co-requisites:	AEE460	
Course contents:	1. Introduction to Instrumentation and Measurements: Principles of Instrumentation and Measurements, Errors in Measurements, Measurement Standards, Uncertainties. 2. Measuring Devices (Sensors and Transducers): Introduction to Sensors and Transducers used in for renewable energy parameter measurements such as solar radiation, wind , Basic Electrical Sensing Elements, Strain Measurement, Introduction to Calibration, Calibration Techniques. 3. Energy Fundamentals and Trainer Familiarization: identify sources of energy. Review definitions of power and work, measurement methods and units. Identify Trainer components. Highlight safety practices. Perform Lockout-Tagout procedure for proper shut down of machinery. 4. Investigation of solar module: Carry out experiments on a solar module and measure its efficiency and long-term performance. Design different configurations of solar collector systems and record their characteristics for variations on temperature, irradiance and angle of incidence. Effect of shading on solar panel operation. 5. Analysis of solar module parameters: determination of cell distribution on a solar panel. Produce experimentally the V-I and P-V curve. Investigate PV array ratings. Setup of an off-grid power system with rechargeable solar cells. Perform and compare series and parallel configurations of circuits for solar cells. 6. Investigation of wind module: calculate and measure the performance of the wind turbine electrical systems. Operate the generator at varying wind force levels. Compare the efficiency for constant-speed and variable-speed configurations. 7. Power management: Perform power measurements and calculate power consumption, Calculate power efficiency and identify power losses. Configure power transmission and distribution systems. 8. DC to AC inverter: Study the main parameters that are involved during the DC-AC conversion, Operate and integrate the inverter in stand-alone systems.				

	Investigate inverter's efficiency. Utilize inverter electrical ratings and specifications. 9. On/Off Grid Operation: learn how to configure stand-alone off-grid systems, battery-based grid-tied systems and grid-tied systems without battery. Perform net metering and dual metering practices. 10. Fault finding and troubleshooting: Follow Systematic troubleshooting steps, perform visual inspections, test mechanical and electrical components. Diagnose common malfunctions with solar panels, wind turbines and inverters. Identify and repair defective parts 11. Field trip to solar park: field trip to an advanced solar park to view the application of large scale solar collectors. The field trip is followed by a written report. 12. Field trip to wind turbine park: field trip to an advanced wind energy park to view the application of large scale wind turbines. The field trip is followed by a written report. 13. Observe a real time installation: Monitor the installation of either a solar or a wind energy system. Write a report on the process and practical aspects to be taken in consideration in an actual application.
Recommended and/or required reading:	
Textbooks:	• Lab manual
References:	• Roger A. Messenger, Jerry Ventre, "Photovoltaic Systems Engineering", Taylor & Francis Group, 2017, 4 ed, 2017. • Fang Lin Luo, Ye Hong, "Renewable Energy Systems: Advanced Conversion Technologies and Applications" CRC Press, ISBN 9781439891094.
Planned learning activities and teaching methods:	Teaching is based on lectures and laboratory sessions. During these sessions, students perform individual or small group experiments. The laboratory is equipped with workstations that include renewable energy training hardware, a desktop computer that communicates and controls the board, a digital oscilloscope, multi-meter and other equipment for measurements. The course delivery will be based on experiment5al work and documentation. Each lab consists of a pre lab, the lab procedure and the post lab. Each lab requires an individual report from each student. The students will receive guidance and supervision during the experimental work and additional tutorial time at the beginning of each lab will be provided. Students are expected to demonstrate the necessary effort to become confident with the different concepts and topics of the course.
Assessment methods and criteria:	• Assignments 10% • Tests: 20% • Labs: 30% • Final Exam 40%
Language of instruction:	English
Work placement(s):	No