Course Title	Smart Sensors & Actuators				
Course Code	WSS532				
Course Type	Specialization (Elective)				
Level	Master (2nd Cycle)				
Semester	2 or 3				
Teacher's Name	Konstantinos Tatas, PhD, Prof. Costas Kyriacou, PhD				
ECTS	10	Lectures/week	3	Laboratories/week	0
Course Purpose	The objective of the course is to give an overview of sensor and actuator technology and its applications on smart systems. To that purpose, it examines sensors, actuators and interface systems as separate components, without losing sight of the fact that they have to function as parts of an integrated smart system. This module aims to provide you with the knowledge of the essential tools and techniques to extend the concepts to components not covered in the material, since it is not possible to cover every single sensor and actuator used.				
Learning Outcomes	By the end of the course, students should be able to: • Illustrate the role of sensors and actuators in embedded and smart systems • Model sensors using transfer functions • Select and use appropriate sensors and actuators in their systems • Compensate for systematic and random sensor errors • Appropriately connect sensors and actuators to a digital system • Write programs for reading sensors and controlling actuators • Describe sensor and actuator technologies and their limitations. • Identify current and future trends in sensors and actuators • Augment basic sensors and actuators with intelligent behavior				
Prerequisites	None		Required	None	

Course Content	1. **Transducers, sensors and actuators:** Role of sensors and actuators in smart systems. Application scenarios. The instrumentation process. Classification of sensors based on the measurand and based on sensor technology. 2. **Sensor Characteristics:** Transfer functions, accuracy, precision, sensitivity, hysteresis, systematic and random errors, range and repeatability 3. **Sensor and Actuator Design and Modelling:** Physical principles of sensing: Charge, Capacitance, Induction, Resistance, Piezoelectric effect, hall effect. 4. **Analog and Digital Sensors:** Motion transducers, potentiometers, variable capacitance transducers, Piezoelectric sensors, accelerometers, image sensors 5. **Interfacing with Sensors:** Signal conditioning, Amplifiers, Analog to Digital conversion, filters, ADC characteristics 6. **Stepper motors:** Principle of operation, stepper motor classification, driver and controller. Static position error. 7. **Continuous-Drive Actuators:** DC motor principle of operation, brushless DC motors, AC torque motors. Control of DC motors and servo motors. DC motor selection considerations. Linear and hydraulic actuators. 8. **Sensor and Actuator applications:** Sensor and actuator applications such as wireless sensor networks. 9. **Adaptive and hierarchical sensing and fault tolerance:** Adaptive and hierarchical sensing systems and trade-offs, fault tolerance and diagnostics
Teaching Methodology	The course is structured in lectures of 3 hours per week in classrooms using traditional means. The primary resources are presentations that introduce the course material together with practical examples and exercises to enhance the material learning process based on the textbook(s). The material is available online on the course e-learning page and students are advised to use the bibliography for further study. Student questions are addressed, besides face-to-face in class or during office hours, through online interaction both synchronous and asynchronous (chat sessions and forum discussions in the course e-learning page). A number of case study readings are considered to demonstrate the applications of sensors and actuators in smart systems, such as wireless sensor networks and IoT. Other resources include research papers and online tutorials in presentation or video format.
Bibliography	• **Textbook:**

	• Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs and Applications", Springer, 2010 • **References:** • Clarence W. de Silva, Sensors and Actuators: Engineering System Instrumentation, Second Edition, CRC Press, 2016 • Dharma Prakash Agrawal, “Embedded Sensor Systems”, Springer 2017
Assessment	Students are continuously assessed throughout the semester, through class participation, and two individual assignments. The first is a survey paper which must also be presented in class. The second assignment is a programming/design assignment including writing requirements for a system with sensors and actuators. Online short post-lecture quizzes are used to assess the level of student understanding and provide feedback. • Survey assignment: 10% • Presentation: 10% • Design assignment: 20% • Participation activities: 10% • Quizzes: 10% • Final exam: 40%
Language	English