(*faculty stamp*)

COURSE DESCRIPTION

1. Course title: SENSORS AND ACTUATORS	**2. Course code**
3. Validity of course description: 2012/2013	
4. Level of studies: MSc programme	
5. Mode of studies: intramural studies	
6. Field of study:	(FACULTY SYMBOL)
7. Profile of studies:	
8. Programme:	
9. Semester: 2	
10. Faculty teaching the course:	
11. Course instructor: Dariusz Buchczik Ph.D.	
12. Course classification:	
13. Course status: compulsory	
14. Language of instruction: English	

15. Pre-requisite qualifications:

Physics, Introduction to electronics, Introduction to system dynamics, Measurement systems. It is assumed that students have a basic knowledge on concepts of measurements, construction of transducers and measurement systems for measurement of the selected quantities.

16. Course objectives:

The main objective of the course is to show technology, construction, theory of operation and applications of modern integrated solid–state sensors and actuators. There are also presented new trends in sensor technology and integration into the network-enabled smart transducers.

17. Description of learning outcomes:

Nr	Learning outcomes description	Method of assessment	Teaching methods	Learning outcomes reference code
W1	Knows construction, principle of operation, manufacturing technology and measurement characteristics of sensors and actuators	Written test	Classical lecture, Multimedia presentation	K_W05/3
W2	Knows the most important fields of application of sensors and actuators	Written test	Classical lecture, Multimedia presentation, Laboratory exercise	K_W02/1; W20/2
U1	Can build and operate a simple measurement system for measurement of the selected physical and chemical quantities	Laboratory exercise, Report presentation	Laboratory exercise	K_U05/1; U11/3; U25/1
U1	Can determine measurement characteristics of the selected sensors and measurement systems	Laboratory exercise, Report presentation	Laboratory exercise	K_U12/2
K1	Can work in the group taking the measurements	Laboratory exercise	Laboratory exercise	K_K03/2
K2	Can present and discuss the results of measurements	Laboratory exercise, Report presentation	Laboratory exercise	K_K03/2; K05/1

18. Teaching modes and hours

Lecture: 30 / Laboratory: 45

19. Syllabus description:

Semester : 2

Lecture:

Introduction: scope of lectures, literature. Examples of integrated sensors and actuators (micro-pumps, microvalves, micromachines).

Microelectromechanical systems (MEMS, MEOMS, μTAS, VSM). Integrated sensors technology, application areas.

Silicon and its properties. MEMS technologies: bulk micromachining, surface micromachining, LIGA, wafer bonding, laser micromachining, 3-D stereo lithography.

Actuators. Principles of actuation: electrostatic, electromagnetic, piezoelectric, thermal, electrodynamic. Examples of actuators.

Temperature sensors and its electronic circuits. Thermoresistive sensors (resistance temperature detectors, silicon resistive sensors, thermistors), semiconductor pn-junction sensors, thermoelectric contact sensors (thermocouples).

Pressure sensors: basic definitions, units of pressure and conversion. Sensing elements: diaphragms, bellows, tubes. Detection methods: capacitive, piezoresistive, resonant, piezoelectric.

Acceleration sensors: dynamic model of accelerometer, damping and frequency response, cross-axis sensitivity, self testing, force feedback, multiaxial accelerometers. Principles of operation – piezoelectric, piezoresistive and capacitive.

Force sensors: strain gauges and elastic elements. Basic types of sensors: piezoresistive, capacitive, resonant, piezoelectric.

Humidity sensors: basic concepts and definitions, impedance sensors (resistive and capacitive), chilled mirror sensors – methods of condensation detection.

Fibre optics sensors: basic concepts, optical fibres. Multimode sensors with internal and external amplitude modulation, sensors utilizing selective wavelength modulation. Monomode sensors: interferometers and their fibre optics realisation, polarometric sensors.

Laboratory:

List of laboratory exercises:

1. Dynamic Properties of Sensors
2. Acceleration Measurement
3. Ultrasound Measurement
4. pH Measurement
5. Radiation Measurement
6. Gas Sensors
7. Dissolved Oxygen Sensors
8. Humidity Sensors
9. Temperature Sensors
10. Barometric Pressure Sensor
11. Virtual Instruments
12. Semiconductor Pressure Sensors

20. Examination: none

21. Primary sources:

Göpel W. (editor)., Sensors. A Comprehensive Survey, Weinheim, VCH, (Eight volumes) 1989 -1995
Fraden J., Handbook of modern sensors : physics, designs, and applications, 5th ed., Springer-Verlag, New York, 2016
Webster J., Eren H. (editors): Measurement, instrumentation, and sensors handbook, 2nd ed., CRC Press, 2017
Laboratory of Integrated Solid-State Sensors, Wydawnictwo Politechniki Śląskiej, Gliwice, 1997

22. Secondary sources:

Beeby S., Ensell G., Kraft M., White N.: MEMS mechanical sensors, Artech House, Norwood, 2004
Maluf N., Williams K.: An introduction to microelectromechanical systems engineering, Artech House, Norwood, 2004
Lobontiu N., Garcia E.: Mechanics of microelectromechanical systems, Kluwer Academic Publishers, Boston, 2006
Sensors and Actuators, A: Physical, B: Chemical Combined, Jurnal – available in the library of Silesian University of Technology

23. Total workload required to achieve learning outcomes

Lp.	Teaching mode :	Contact hours / Student workload hours
1	Lecture	30/15
2	Classes	/
3	Laboratory	45/30
4	Project	/
5	BA/ MA Seminar	/
6	Other	5/5
	Total number of hours	80/50

24. Total hours:130

25. Number of ECTS credits: 5

26. Number of ECTS credits allocated for contact hours: 3

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 3

26. Comments:

Approved:

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(date, Instructor's signature)

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(*date , the Director of the Faculty Unit signature)*