1. Course title: SENSORS AND ACTUATORS

2. Course code


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:

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

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.


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


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.


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:


Laboratory of Integrated Solid-State Sensors, Wydawnictwo Politechniki Śląskiej, Gliwice, 1997

22. Secondary sources:


Maluf N., Williams K.: An introduction to microelectromechanical systems engineering, Artech House, Norwood, 2004


Sensors and Actuators. A: Physical, B: Chemical Combined, Jurnal – available in the library of Silesian University of Technology
### Total Workload Required to Achieve Learning Outcomes

<table>
<thead>
<tr>
<th>Lp.</th>
<th>Teaching mode</th>
<th>Contact hours / Student workload hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lecture</td>
<td>30/15</td>
</tr>
<tr>
<td>2</td>
<td>Classes</td>
<td>/</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory</td>
<td>45/30</td>
</tr>
<tr>
<td>4</td>
<td>Project</td>
<td>/</td>
</tr>
<tr>
<td>5</td>
<td>BA/MA Seminar</td>
<td>/</td>
</tr>
<tr>
<td>6</td>
<td>Other</td>
<td>5/6</td>
</tr>
<tr>
<td></td>
<td>Total number of hours</td>
<td>80/50</td>
</tr>
</tbody>
</table>

### Total Hours: 130

### Number of ECTS Credits: 5

### Number of ECTS Credits allocated for contact hours: 3

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

### Comments:

Approved:

(date, Instructor's signature)   (date, the Director of the Faculty Unit signature)