### 1. Course title: MEASUREMENT SYSTEMS

### 2. Course code


### 4. Level of studies: BSc programme

### 5. Mode of studies: intramural studies

### 6. Field of study: CONTROL ELECTRONIC AND INFORMATION ENGINEERING (FACULTY SYMBOL) RAU

### 7. Profile of studies:

### 8. Programme:

### 9. Semester: 4 (S1)

### 10. Faculty teaching the course: Institute of Automatic Control, Faculty Of Automatic Control, Electronics And Computer Science

### 11. Course instructor: Roman Wyżgolik, PhD

### 12. Course classification: common courses

### 13. Course status: compulsory

### 14. Language of instruction: English

### 15. Pre-requisite qualifications: completed or partially completed courses on Physics, Introduction to electronics, Probability and statistics.

### 16. Course objectives: To acquaint students with measurement systems and their role in Automatic Control and Robotics, Electronics and Telecommunication, Computer Science.

### 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>Has knowledge about metrology, selected sensors, measuring transducers and measurement systems, about measurement techniques for different physical and electrical quantities. Has basic knowledge about software design for DAQ (Data AcQuisition) systems.</td>
<td>EP/EU</td>
<td>WM, WT</td>
<td>K1A_W11</td>
</tr>
<tr>
<td>U1</td>
<td>Can design a simple measurement system and create the application for this system.</td>
<td>CL, PS, OS</td>
<td>L</td>
<td>K1A_U18</td>
</tr>
<tr>
<td>U2</td>
<td>Can acquire and analyze signals with the use of DAQ devices.</td>
<td>CL, PS, OS</td>
<td>L</td>
<td>K1A_U20</td>
</tr>
<tr>
<td>K1</td>
<td>Can work together in a team in different roles</td>
<td>CL, PS, OS</td>
<td>L</td>
<td>K1A_K3</td>
</tr>
</tbody>
</table>

### 18. Teaching modes and hours

- Lecture: 30, Laboratory: 30

### 19. Syllabus description:

#### Semester : 4

Lecture

Introduction to measurement systems in industry, research & development and science. Elements of measurement systems.

Integration of intrinsically safe field instrumentation into industrial communication networks.

Vocabulary of Basic and General Terms in Metrology: sensor, measuring instrument, measuring chain, measuring system, static characteristics - range, span, zero, zero drift, sensitivity, resolution, response, linearity, hysteresis, calibration, accuracy…; dynamic characteristics.

From sensor to acquisition device. Review of sensors: conventional, thick, thin and semiconductor technologies. Smart transducer, standarized signals and most popular industrial protocols – HART, Profibus PA (and Profibus DP), Foundation Fieldbus. Analog to digital converters for sensors and data acquisition.

Sensors properties: range, sensitivity, characteristic, intrinsic and additional errors.

Examples of Production Line Testers, End-Of-Line testers.

Laboratory
1. Temperature sensors calibration
2. Strain gauges.
3. Digital to analog and analog to digital converters.
4. AC voltage measurement.
5. Signal generation and acquisition in DAQ based systems.
6. Dual slope AD converter.
7. LabVIEW 1 – Introduction to LabVIEW programming
8. LabVIEW 2 – State Machine design pattern
9. LabVIEW 3 – Producer Consumer design pattern.
10. Multifunction DAQ device in measurement systems.

20. Examination: yes, semester 4

21. Primary sources:

22. Secondary sources:

23. 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>30/10</td>
</tr>
<tr>
<td>2</td>
<td>Classes</td>
<td>/</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory</td>
<td>30/45</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>10/25</td>
</tr>
<tr>
<td></td>
<td>Total number of hours</td>
<td>70/80</td>
</tr>
</tbody>
</table>

24. Total hours:150

25. Number of ECTS credits: 6

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:

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