1. **Course title:** RELIABILITY AND INTRINSIC SAFETY
2. **Course code**

3. **Validity of course description:** 2016/2017

4. **Level of studies:** BSc programme / MSc programme

5. **Mode of studies:** intramural studies

6. **Field of study:** MACRO COURSE (FACULTY SYMBOL) AEII

7. **Profile of studies:** general

8. **Programme:** Automatic

9. **Semester:** 6

10. **Faculty teaching the course:** Institute of Automatic Control, Rau1

11. **Course instructor:** dr inż. Andrzej Kozyra

12. **Course classification:** programme courses

13. **Course status:** compulsory / elective

14. **Language of instruction:** English

15. **Pre-requisite qualifications:** It is assumed that prior to learning this course, students have a background in probability and statistics, solving linear differential equations using Laplace transform.

16. **Course objectives:** Objectives of the lectures is to acquaint the students with: 1). A necessity of reliability assessment of technical objects and systems. 2.) Reliability analysis methods in which reliability structures, maintenance and a human role are taken into account. 3). Constructions of explosion-proof apparatus and designing of measurement and automatic control systems with intelligent transducers, as an intrinsically safe systems, in which the reliability plays the most important role. Laboratory exercises aim is: 1). To acquire ability to evaluate reliability of electronics circuits, equipment and systems by using computer programs 2) To familiarize with building an intrinsically safe control and measurement systems in which reliability plays an important role.

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>1.</td>
<td>Student knows the methods of reliability analysis of technical objects and systems.</td>
<td>Written test, Laboratory exercise, Preparation of reports</td>
<td>Classical lecture, Laboratory exercise</td>
<td>K_W17 K_U02 K_U07 K_W21</td>
</tr>
<tr>
<td>2.</td>
<td>Student knows the meaning of basic concepts: reliability, unreliability, failure rate, MTTF, MTBF, MTTFF. Methods of determination reliability factors.</td>
<td>Written test, Laboratory exercise, Preparation of reports</td>
<td>Classical lecture, Laboratory exercise</td>
<td>K_W17 K_W22 K_U07 K_W21</td>
</tr>
<tr>
<td>3.</td>
<td>Student is understood that work in some areas can cause risk of explosion. He knows conditions in which explosive atmosphere can occur and he knows what could be a source of ignition.</td>
<td>Written test, Laboratory exercise</td>
<td>Multimedia presentation, Laboratory exercise</td>
<td>K_W22 K_U26 K_K02 K_K05 K_U26</td>
</tr>
<tr>
<td>4.</td>
<td>Student is able to estimate the reliability of electronics circuit.</td>
<td>Laboratory exercise, Preparation of reports</td>
<td>Classical lecture, Laboratory exercise</td>
<td>K_W04 K_U03</td>
</tr>
<tr>
<td>5.</td>
<td>Student is able to assess the reliability of the system and the technical object by using proper methods: modular decomposition, fault tree analysis, Markov graphs.</td>
<td>Written test, Laboratory exercise, Preparation of reports</td>
<td>Classical lecture, Laboratory exercise</td>
<td>K_W21 K_U07</td>
</tr>
</tbody>
</table>
6. Student is able to estimate the probability of human error.

7. He is aware of what the consequences may cause neglect in terms of reliability, safety, improper operation of equipment in hazardous areas.

8. Can present, he knows when to use, what limitations have methods for estimating reliability.

18. Teaching modes and hours

**Lecture / BA / MA Seminar / Class / Project / Laboratory**

Sem 5 - 30 h, Sem 6 - 30 h

19. Syllabus description:

**Semester 5:**

**Lectures**

Reliability:

1. Introduction to the subject. Basic terms: component, system, damage to objects, forcing factors, reliability R(t), frequency of failures f(t), intensity of failures λ(t). Mean time to first failure (MTTFF). Mean time between failures (MTBF).


5. Reliability model of non-repairable system: assumptions, graph, matrix of states, system of equations, examples of calculation of measures of reliability: R(t), λ, MTBF, MTTFF.

6. Reliability of repairable system: assumptions, graph, matrix of states, system of equations, examples of calculation of measures of reliability: availability function A(t), availability A, MTBF, MTTFF.

7. Human error assessment; Human Error Assessment and Reduction Technique (HEART).


**Intrinsic Safety:**

9. Characteristics of gases, vapours and dust in terms of explosiveness. Classifications of gases, dust, equipment and areas. Basic terms: the probability of ignition, minimum ignition energy, minimum current of the ignition.


11. Standardization in the field of explosion protection. Institutions and national and international standards. Attesting institutions, the recognition of foreign certificates.

**Laboratory**

1. NUE - Assessment of the reliability of electronic circuits. The purpose of this exercise is to solve the problem for estimating reliability of electronic systems. Students use reliability analysis methods described in international standards MIL-HDBK-217 and IEC 62380.

2. NSZ - Evaluation of reliability of complex systems. The purpose of this exercise is to acquire the skills reliability analysis of complex systems with static reliability structure by using specialized computer programs. Method of teaching: a case study - solve the problem reliability assessment of the system with static reliability structure.
3. STR - The basic reliability structures of the systems. The purpose of this exercise is to acquire the skills of reliability analysis by using Markov analysis. Creating: a graph, equations of states and the determination of basic indicators of reliability of the system. Method of teaching: a case study - solution to the problem of reliability evaluation of selected electronic system.

4. STD - Estimating the reliability of systems with dynamic reliability structure. Students solve the problem of estimating the reliability of systems using graph states and specialized software.

5. FUZ - Using fuzzy sets in the evaluation of reliability. The purpose of this exercise is to acquire the skills to use fuzzy set theory in reliability issues. Students create fuzzy logic reliability models of selected systems in LabView.

6. PDP - Intrinsically safe, modular system with PROFIBUS-DP. The purpose of exercises to acquaint the modern, industrial measurement system which enables measurements in hazardous areas. Students learn how to select the components of system in order to apply it in a specific application.

7-8. AN1, AN2 – Reliability analysis of a complex system with increased reliability. Students have the opportunity to use all the knowledge gained during lectures and previous laboratory exercises to determine various reliability parameters of the chosen system.

20. Examination: NO. The test after the lectures, completion laboratory exercises.

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>15/10</td>
</tr>
<tr>
<td>2</td>
<td>Classes</td>
<td>0/0</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory</td>
<td>15/15</td>
</tr>
<tr>
<td>4</td>
<td>Project</td>
<td>0/0</td>
</tr>
<tr>
<td>5</td>
<td>BA/MA Seminar</td>
<td>0/0</td>
</tr>
<tr>
<td>6</td>
<td>Other</td>
<td>0/0</td>
</tr>
<tr>
<td></td>
<td>Total number of hours</td>
<td>30/25</td>
</tr>
</tbody>
</table>

24. Total hours: 55

25. Number of ECTS credits: 2

26. Number of ECTS credits allocated for contact hours: 2

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 1

28. Comments:

Approved: