## 1. Course title: CAD OF CONTROL SYSTEMS

## 2. Course code

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

## 4. Level of studies: BSc programme

## 5. Mode of studies: intramural studies

## 6. Field of study: (FACULTY SYMBOL)

## 7. Profile of studies:

## 8. Programme:

## 9. Semester:

## 10. Faculty teaching the course: Marian Błachuta

## 11. Course instructor: Roman Czyba

## 12. Course classification:

## 13. Course status: compulsory

## 14. Language of instruction: English

## 15. Pre-requisite qualifications: Algebra and Analytic Geometry, Introduction to System Dynamics, Control Fundamentals, Microprosessor Systems

## 16. Course objectives: The objective of the lectures is to give fundamentals of numerical procedures and programs used for Computer Aided Design in Control Systems, while laboratory aims at fast prototyping tools used to design embedded controllers for selected laboratory plants. The theory is complemented with practical aspects of embedded control system.

## 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>Has knowledge of chosen areas of linear algebra used in numerical procedures and sources of errors in numerical programs</td>
<td>SP</td>
<td>WT,WM</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Knows and understands basic linear algebra algorithms implemented in MATLAB</td>
<td>SP</td>
<td>WT,WM</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Knows the basic algorithms of computer-aided design of control systems and algorithms for rapid prototyping of embedded systems</td>
<td>SP</td>
<td>WT,WM</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Can carry out the process of analysis and synthesis of control algorithm using the CADCS tools</td>
<td>RP</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Is able to implement the control algorithm to an embedded system using tools for rapid prototyping</td>
<td>RP</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Is able to make their own decisions about the best design solutions</td>
<td>RP</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Is able to present and defend the proposed design solution</td>
<td>OP</td>
<td>P</td>
<td></td>
</tr>
</tbody>
</table>

## 18. Teaching modes and hours

Lecture 30 Laboratory 30
19. Syllabus description:

Semester: 7

Lecture:

I. Introduction: History of CADCS, stages of design process, evolution of design tools, MATLAB approaches to the design process.
II. Selected Problems of Linear Algebra: norms of vectors and matrices, typical norms, relationships between norms of vectors and matrices, typical induced norms. Particular types of matrices and their properties, orthogonal matrices and their properties, complex matrices, normal matrix, Hermitian matrix, unitary matrices and their properties, Schur matrix and eigenvalues of a matrix, unitary similarity transformation to a Schur matrix.
V. Numerical procedures for control: algorithms for conversion from state-space to transfer function form, Markov parameters, canonical representations of state-space models and their relationship with transfer function, transformations between continuous-time and discrete-time systems, \( \delta \) operator models, computation of frequency plots, van Dooren algorithm for investigation of the structure of controllability and observability, controllability and observability Gramians, balanced realizations, model approximation, Lyapunov equations and associated numerical algorithms.

Laboratory:

III. Data transmission in CAN network.
IV. PWM control method. Reading analog values.
V. Modeling of the DC motor dynamics.
VI. PID discrete regulation.
VII. Prototyping of control system.

20. Examination:

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>30/0</td>
</tr>
<tr>
<td>2</td>
<td>Classes</td>
<td>/</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory</td>
<td>30/30</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>/</td>
</tr>
<tr>
<td></td>
<td>Total number of hours</td>
<td>60/30</td>
</tr>
</tbody>
</table>

24. Total hours: 90

25. Number of ECTS credits: 3

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

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

26. Comments:

Approved:

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