Course Description

1. **Course title:** PROGRAMMING LEGO MINDSTORMS NXT ROBOTS
2. **Course code:** NXT

3. **Validity of course description:** 2016/2017
4. **Level of studies:** BA, BSc programme
5. **Mode of studies:** Intramural studies
6. **Field of study:** MACROFACULTY; RAU
7. **Profile of studies:** Comprehensive practical
8. **Programme:** all
9. **Semester:** 7
10. **Faculty teaching the course:** Faculty of Automatic Control, Electronics and Computer Science
11. **Course Instructor:** PhD Eng. Piotr Czekalski, PhD Eng. Grzegorz Baron
12. **Course classification:**
    - Common Courses
13. **Course status:** elective
14. **The language of instruction:** English
15. **Pre-requisite qualifications:** An elementary understanding of Newton physics, basic skills on C# and Java programming.
16. **Course objectives:** The main goal is to present audience a modern robot building platform and a wide range of construction and programming methods of LEGO Mindstorms NXT robots.
   
   The course contains a presentation on both constructing and programming universal robotics platform based on LEGO Mindstorms NXT. Programming in NXT-G visual language on LabVIEW-based Mindstorms EDU NXT Software environment will be presented (autonomous systems), programming in C# as well, as running programs on dedicated NXT Virtual Java Machine (NX.J) will be presented. Additionally, the course covers communication ideas on both inter-robotics and robots-to-PC models. As an extra part, this course presents embedded system construction of NXT Intelligent Brick considerations on popular sensors, to let the students design and implement their own interfaces, robot constructions.
17. Description of learning outcomes:

<table>
<thead>
<tr>
<th>No</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 on how to program a mobile robot in different environments and is able to use literature, online resources and tutorials to implement it. Can collaborate within the development group and prepare a report documenting their achievements.</td>
<td>LE</td>
<td>Lecture and laboratory</td>
<td>K1A_W3, K1A_W9, K1A_K3, K1A_K4</td>
</tr>
<tr>
<td>2</td>
<td>Knows data and programming structures and is able to choose appropriate of them to solve given problem.</td>
<td>LE</td>
<td>Lecture and laboratory</td>
<td>K1A_W12, K1A_W18, K1A_K3, K1A_K4</td>
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<tr>
<td>3</td>
<td>Has structured knowledge on the algorithms, methods of the software implementation of the numerical problems in engineering, programming in object-oriented models in C#, Java or Python and graphical languages in the mobile robotics control algorithms.</td>
<td>LE</td>
<td>Laboratory</td>
<td>K1A_W3</td>
</tr>
</tbody>
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18. Teaching modes and hours

W. Ćw. L. P. Sem. 15/03/00/0

19. Syllabus description:

Lecture:

# Why just NXT platform? From a game to the business and industry. Platform procedures.
# Overview of NXT Intelligent Brick construction and its communication interfaces. Platform specification and capabilities.
# Overview of available platform sensors and servo motors.
# Constructing NXT robots. Theory vs physics.
# Open hardware platform Mindstorms NXT -- Hardware Development Kit.
# The most popular NXT models overview.
# Mindstorms NXT application software models. Internal (non-autonomous) software and remote managed software. Serial and parallel programming. Calibrating sensors and servo motors. A starting point and border conditions. Uploading autonomous programs and communicating over Bluetooth protocol.
# Programming in NXT-G Visual Language on LabVIEW environment.
# Programming in Microsoft Visual Programming Language (VPL) and C# language on Microsoft Robotics Studio.
# Programming with means of Virtual Java Machine for NXT Intelligent Brick.

Laboratory:

The main target is to let the audience practice construction and programming of NXT base robots. All exercises are performed by students during laboratories. The laboratory is equipped with 9 complete Mindstorms NXT platforms (edu edition) each equipped with NXT Intelligent Brick, a set of genuine LEGO sensors and actuators and 3 EV3 platforms plus modern PC workstations. The laboratory also contains a set of third-party sensors, including object tracking cameras, tilt/accelerometer sensors, gyro sensors, compass sensors and color recognition sensors.

Lab exercises:
1. Programming in NXT-G on LabVIEW environment -- simple operations on Tribot, Spike, Roboarm popular models.
2. Programming in Java on dedicated JVM (JavOS) with particular respect for conceptual movement programming modal (including Pilots and Navigators) over a flat, Cartesian surface.
3. Programming in C# with Mindset or programming in C# with native Microsoft libraries for EV3. This also includes a sort of UI devices including Kinect or Leap Motion or MYO band to control the robot (as chosen by students).

20. Examination: none
21. Primary sources:


22. Secondary sources:

23. Total workload required to achieve learning outcomes:

<table>
<thead>
<tr>
<th>No.</th>
<th>Teaching mode</th>
<th>Contact hours / Studet workload hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lecture</td>
<td>15/0</td>
</tr>
<tr>
<td>2</td>
<td>Classes</td>
<td>0/0</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory</td>
<td>30/15</td>
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<tr>
<td>4</td>
<td>Project</td>
<td>0/0</td>
</tr>
<tr>
<td>5</td>
<td>BAMA 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>0/0</td>
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</tbody>
</table>

24. Total hours: 60

25. Number of ECTS credits: 2

26. Number of ECTS credits allocated for contact hours: 1.5
| 27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): | 0.5 |
| 28. Comments: | |

Approved:

[date, Instructor’s signature]  [date, the Director of the Faculty Unit signature]