### COURSE DESCRIPTION

1. **Course title**: CONCURRENT PROGRAMMING  
2. **Course code**: CCP

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

4. **Level of studies**: 2nd cycle of higher education

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

6. **Field of study**: MACROFACULTY

7. **Profile of studies**: general academic

8. **Programme**: COMPUTER SCIENCE (INFORMATICS)

9. **Semester**: 1

10. **Faculty teaching the course**: Institute of Informatics

11. **Course instructor**: dr inż. Jacek Widuch

12. **Course classification**: common courses

13. **Course status**: compulsory

14. **Language of instruction**: English

15. **Pre-requisite qualifications**: It is assumed that the student has the basic knowledge of computer programming in the C/C++ language and problems presented in subjects of 1st cycle of higher education: Computer Programming, Algorithms and Data Structures.

16. **Course objectives**: The course introduces students into the basic subjects of parallel computing and concurrent programming. The fundamental concepts of parallel computing, models of parallel computations and architectures of parallel computers, designing of parallel algorithms are discussed. Some libraries and programming languages supporting parallel computing are discussed. The lecture provides basic information that is then used in practice in laboratory and classes.

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 possesses advanced knowledge of models of parallel computations, basic parallel algorithms and designing of parallel algorithms.</td>
<td>Written exam, test on classes, laboratory exercises</td>
<td>Lectures, Classes, Laboratory exercises</td>
<td>K2A_W23, K2A_W29</td>
</tr>
<tr>
<td>2</td>
<td>Student possesses detailed knowledge of OpenMP standard.</td>
<td>Written exam, laboratory exercises</td>
<td>Lectures, Laboratory exercises</td>
<td>K2A_W23, K2A_W29</td>
</tr>
<tr>
<td>3</td>
<td>Student is able to use the library for thread management.</td>
<td>Written exam, laboratory exercises</td>
<td>Lectures, Laboratory exercises</td>
<td>K2A_U18</td>
</tr>
<tr>
<td>4</td>
<td>Student is able to use the methods for solving synchronization of parallel processes in the model with shared memory.</td>
<td>Written exam, test on classes, laboratory exercises</td>
<td>Lectures, Classes, Laboratory exercises</td>
<td>K2A_U08</td>
</tr>
</tbody>
</table>
Student is able to run parallel processes and designing of parallel algorithms and analyzing them.

<table>
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<tr>
<th>Written exam, test on classes, laboratory exercises</th>
<th>Lectures, Classes, Laboratory exercises</th>
<th>K2A_U02, K2A_U10, K2A_U17</th>
</tr>
</thead>
</table>

18. **Teaching modes and hours**

  *Lecture:* 30 h., *Class:* 30 h., *Laboratory:* 30 h.

19. **Syllabus description:**

**Lectures:**

1. Definitions of parallel algorithm and concurrent process. Parameters of parallel algorithm (time complexity, speed-up, cost of the algorithm, efficiency).
3. Expressing concurrency: fork-join-quit statements, cobegin-coend block, parfor statement.
6. Communication and synchronization of parallel processes in the model with distributed memory: sending and receiving messages, synchronous and asynchronous communication, buffered communication, selective communication (guarded statements).
7. Fundamental problems of concurrent programming: the producer-consumer problem, the dinning philosophers problem, the readers-writers problem, the barrier synchronization.
9. The OpenMP standard.
10. The MPI standard.

**Class:**

During classes tasks with the following topics are solved:

1. Expressing the concurrency.
2. Correctness of parallel algorithms: deadlock, starvation, critical section, mutual exclusion.
3. The communication of parallel processes in the model with shared memory, the synchronization using mutexes and semaphores.
4. The communication of parallel processes in the model with shared memory, the synchronization using monitors.
5. The communication and the synchronization of parallel processes in the model with distributed memory.

**Laboratory:**

Laboratory exercises presents the practical related to communication and synchronization of parallel processes and threads. The following standards supporting parallel programming are presented:

2. The OpenMP standard.
3. The MPI standard.

20. **Examination:** yes
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 / 15</td>
</tr>
<tr>
<td>2</td>
<td>Classes</td>
<td>30 / 30</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory</td>
<td>30 / 30</td>
</tr>
<tr>
<td>4</td>
<td>Project</td>
<td></td>
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<tr>
<td>5</td>
<td>BA/ MA Seminar</td>
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<tr>
<td>6</td>
<td>Other</td>
<td>0 / 15</td>
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<tr>
<td></td>
<td>Total number of hours</td>
<td>90 / 90</td>
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</table>

24. Total hours: 180

25. Number of ECTS credits: 6

26. Number of ECTS credits allocated for contact hours: 1

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 2

26. Comments:

Approved:

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