Module name: Soft computing in modeling and control

Academic year: 2019/2020  Code: RIMM-1-713-s  ECTS credits: 3

Faculty of: Mechanical Engineering and Robotics

Field of study: Mechanical and Materials Engineering  Specialty: —

Study level: First-cycle studies  Form and type of study: Full-time studies

Lecture language: English  Profile of education: Academic (A)  Semester: 7

Course homepage: —

Responsible teacher: dr hab. inż. Smoczek Jarosław (smoczek@agh.edu.pl)

Module summary
The course is intended to provide the students with the knowledge and understanding of computational intelligence and soft computing concepts and their applicability to solve the real-world decision-making, modeling and control problems. The selected soft computing concepts and techniques, including fuzzy logic, artificial neural network, evolutionary computing, swarm intelligent and their hybrids are introduced and discussed with application examples.

Description of learning outcomes for module

<table>
<thead>
<tr>
<th>MLO code</th>
<th>Student after module completion has the knowledge/ knows how to/is able to</th>
<th>Connections with FLO</th>
<th>Method of learning outcomes verification (form of completion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social competence: is able to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M_K001</td>
<td>Student knows that computational intelligence and soft computing methodologies can be effectively applied to solve real-world decision-making, modeling and control problems.</td>
<td>IMM1A_K01</td>
<td>Activity during classes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skills: he can</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M_U001</td>
<td>Student is able to apply the software tools in Matlab program to implement the soft computing methods for modeling and control system design.</td>
<td>IMM1A_U10</td>
<td>Execution of exercises</td>
</tr>
<tr>
<td>M_U002</td>
<td>Student is able to select and apply the supervised or unsupervised techniques for fuzzy model/controller identification/design.</td>
<td>IMM1A_U10</td>
<td>Activity during classes</td>
</tr>
<tr>
<td>M_U003</td>
<td>Student is able to identify, select and implement a suitable soft computing method to solve the problem.</td>
<td>IMM1A_U10</td>
<td>Execution of exercises</td>
</tr>
<tr>
<td>Knowledge: he knows and understands</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### M_W001
Student has knowledge in modeling of dynamic systems and control system design using soft computing methods: knowledge engineering, fuzzy logic, artificial neural networks, evolutionary algorithms, and their hybrids.

<table>
<thead>
<tr>
<th>Form of classes</th>
<th>Lectures</th>
<th>Auditorium classes</th>
<th>Laboratory classes</th>
<th>Project classes</th>
<th>Conversation seminar</th>
<th>Seminar classes</th>
<th>Practical classes</th>
<th>Fieldwork classes</th>
<th>Workshops</th>
<th>Prace kontrolne i przejściowe</th>
<th>Lektorat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suma</td>
<td>30</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### M_W002
Student has knowledge about the soft computing techniques and their applicability to solve the real word problems.

### Number of hours for each form of classes

### FLO matrix in relation to forms of classes

**MLO code**

**Student after module completion has the knowledge/ knows how to/is able to**

<table>
<thead>
<tr>
<th>Form of classes</th>
<th>Lectures</th>
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<th>Lektorat</th>
</tr>
</thead>
</table>
| Social competence: is able to

**M_K001**
Student knows that computational intelligence and soft computing methodologies can be effectively applied to solve real-world decision-making, modeling and control problems.

**Skills: he can**

**M_U001**
Student is able to apply the software tools in Matlab program to implement the soft computing methods for modeling and control system design.

**M_U002**
Student is able to select and apply the supervised or unsupervised techniques for fuzzy model/controller identification/design.

**M_U003**
Student is able to identify, select and implement a suitable soft computing method to solve the problem.
Knowledge: he knows and understands

| M_W001   | Student has knowledge in modeling of dynamic systems and control system design using soft computing methods: knowledge engineering, fuzzy logic, artificial neural networks, evolutionary algorithms, and their hybrids. | + - - - - + - - - - |
| M_W002   | Student has knowledge about the soft computing techniques and their applicability to solve the real word problems. | + - - - - - - - - |

**Student workload (ECTS credits balance)**

<table>
<thead>
<tr>
<th>Student activity form</th>
<th>Student workload</th>
</tr>
</thead>
<tbody>
<tr>
<td>Udział w zajęciach dydaktycznych/praktyka</td>
<td>30 h</td>
</tr>
<tr>
<td>Preparation for classes</td>
<td>15 h</td>
</tr>
<tr>
<td>przygotowanie projektu, prezentacji, pracy pisemnej, sprawozdania</td>
<td>20 h</td>
</tr>
<tr>
<td>Realization of independently performed tasks</td>
<td>15 h</td>
</tr>
<tr>
<td>Examination or Final test</td>
<td>2 h</td>
</tr>
<tr>
<td>Summary student workload</td>
<td>82 h</td>
</tr>
<tr>
<td>Module ECTS credits</td>
<td>3 ECTS</td>
</tr>
</tbody>
</table>

**Additional information**

**Module content**

**Lectures**
The general program of lectures:

1. Introduction to artificial intelligence, computational intelligence and soft computing. Review of the main soft computing components and their hybrids. Examples of artificial applications to real world problems.
2. Introduction to fuzzy logic, fuzzy set theory.
5. Type-2 fuzzy logic. Interval type-2 fuzzy sets and logic.
7. Data-based fuzzy modeling (machine learning, fuzzy clustering).
10. Swarm intelligence.

Seminar classes
During seminar classes students present seminar presentations reporting artificial intelligence applications and take active part in a discussion.

Individual/team presentation:
- presentation topics will be assigned, discussed and scheduled at the beginning of the course,
- students are expected to prepare a presentation and send it via e-mail to the instructor for evaluation before a seminar meeting,
- during seminar classes students present their presentations and take active part in a discussion.

Teaching methods and techniques:
Lectures: The lectures are in the form of multimedia presentations.
Seminar classes: multimedia presentation presented by students; active participation in a discussion.

Warunki i sposób zaliczenia poszczególnych form zajęć, w tym zasady zaliczeń poprawkowych, a także warunki dopuszczenia do egzaminu:
Condition of gaining credit: attendance to the classes, presentation given during a seminar meeting, participation in a discussion.

Individual/team presentation:
- presentation topics will be assigned, discussed and scheduled at the beginning of the course,
- students are expected to prepare a presentation and send it via e-mail to the instructor for evaluation before a seminar meeting,
- during seminar classes students present their presentations and take active part in a discussion.

Zasady udziału w poszczególnych zajęciach, ze wskazaniem, czy obecność studenta na zajęciach jest obowiązkowa:
Lectures:
- Attendance is mandatory: No
- Participation rules in classes: Attendance to the lecture is not obligatory but recommended, and rewarded with the student’s final grade being raised.
Seminar classes:
- Attendance is mandatory: Yes
- Participation rules in classes: Students are expected to prepare a presentation and send it via e-mail to the instructor for evaluation before the seminar meeting in which the student is scheduled to present his/her work.

Method of calculating the final grade
Final grade: presentation, active participation in a seminar discussion (bonus/penalty for attendance to the classes).

Sposób i tryb wyrównywania zaległości powstałych wskutek nieobecności studenta na zajęciach:
Students who have missed class should contact with the instructor during his consultation hours to make up missed work.

Prerequisites and additional requirements
Prerequisites and additional requirements not specified
Recommended literature and teaching resources

Scientific publications of module course instructors related to the topic of the module

Additional information
None