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DeCAIR Course Syllabus Form

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Organization Name(s)	The University of Jordan		
WP Number & Title	Work Package 2: Development of new MSc and BSc programs in AIR		
Activity Number & Title	Activity 2.2: Designing and developing syllabi and content for the agreed upon courses in the new programs		
WP Leader	Francesco Masulli, University of Genoa		
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Revision History

Version	Date	Author	Description	Action *	Page(s)
1	8/11/2021	Musa Al-Yaman	Original (base) document	C	1-6
2	Dec, 9 2021	Mohammad Mashagbeh	Update Original Document	U	1-6
3					
4					

(*) Action: C = Creation, I = Insert, U = Update, R = Replace, D = Delete

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Course title	Autonomous Mobile Robots
Course number	0908723
Credit hours (lecture and lab)	3 (3 + 0)
ECTS (weekly contact and self-study load)	6 (3 + 3)
Prerequisites/co-requisites	0908721 (Introductory Robotics: Sensing, Controlling and Actuating)
Prerequisites by topic	Students are assumed to have good background in mathematical modeling, sensor types and control systems. Additionally, the students should have good programming skills, preferably, using Python and Matlab.
Level and type (compulsory, elective)	Masters' mandatory course
Year of study and semester	First year, second semester
Description	This course presents the fundamentals of Autonomous systems, including both perception and planning for autonomous operation. Topics include sensor modeling, vehicle state estimation using Kalman Filters, and Extended Kalman Filters. Topics in Planning include vehicle motion modeling and control. Finally, examples from recent research in Autonomous systems.
Objectives	1. Describe different types of autonomous systems. 2. Solve the kinematics problem of different types of autonomous systems. 3. Develop motion and measurement models for autonomous systems. 4. Control of autonomous systems. 5. Plan and design collision free paths in working environments based on maps. 6. Introduce students to the programming techniques and toolboxes used in robotic manipulator simulation.
Intended learning outcomes	Upon successful completion of this course, students will be able to:

No	Intended learning Outcome (ILO)	Program learning outcome (PLO)*
1	Identify different types of autonomous systems.	1
2	Develop motion and measurement models for autonomous systems	2
3	Design and implement estimation algorithms for state estimation	3
4	Plan collision free paths through environments based on maps	4

(*) The PLOs are listed in the appendix

Teaching and learning methods	Development of ILOs is promoted through the following teaching and learning methods: • Lectures will be delivered face to face and through Microsoft Teams and will be recorded for later access.

<table>
<tr><td></td><td>

The robotics lab is open for the students to practice the practical aspects and solve the homework assignments.
The student attends the class presentations and participates in the discussions.
The student joins the related online team/group and participates in its discussions.
The student studies the reference material, including books and videos.
The student solves the assignments in robotics field.
Student will carry out a term project in groups. Deliverables includes a professional report and a presentation for the project in class towards end of the semester.

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<tr><td>Learning material</td><td>Textbook, class handouts, some instructor keynotes, selected YouTube videos, and access to a personal computer and the internet.</td></tr>
<tr><td>Resources and references</td><td>A- Required book(s), assigned reading and audio-visuals:

Siegwart, Nourbakhsh and Scaramuzza, Introduction to Autonomous Mobile Robots,2nd edition, MIT press, 2011.
Alonzo, Mobile Robotics: Mathematics Models and Methods, Cambridge press, 2014.

B- Recommended book(s), material, and media:

Corke P., Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.
Guowei Cai, Ben M. Chen, Tong Heng Lee, Unmanned Rotorcraft Systems, Springer Tracts in Advanced Robotics, 2011.
Sebastian T., Wolfram B., Dieter F., Probabilistic Robotics, MIT press, 2005.
Bruno Siciliano, Robotics: modelling, planning and control, springer, 2009.
S. G. Tzafestas, Introduction to mobile robot control, Elsevier, 2013.

</td></tr>
<tr><td>Topic outline and schedule</td><td>
<table>
<tr><th>Week</th><th>Topic</th><th>ILO</th><th>Resources</th></tr>
<tr><td>1,2</td><td>Introduction to autonomous systems.</td><td>1</td><td>A1, B1</td></tr>
<tr><td>3</td><td>Mathematical modeling of autonomous systems</td><td>1, 2</td><td>A1, B2,B5</td></tr>
<tr><td>4, 5</td><td>Kinematics and dynamic.</td><td>2</td><td>A1, A2</td></tr>
<tr><td>6,7</td><td>Estimation: Extended Kalman Filter</td><td>3</td><td>A1, B4</td></tr>
<tr><td>8, 9</td><td>Mapping and SLAM</td><td>3,4</td><td>A1, B3</td></tr>
<tr><td>10,11</td><td>Autonomous systems Control</td><td>4</td><td>A1, B1</td></tr>
<tr><td>12,13</td><td>Motion Planning</td><td>4</td><td>A1, B1</td></tr>
<tr><td>14,15</td><td>Case study</td><td>1 to 4</td><td></td></tr>
<tr><td>16</td><td>Review and Evaluation (Final Exam)</td><td></td><td>A1</td></tr>
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<table>
<tr><td>Evaluation tools</td><td>Opportunities to demonstrate achievement of the ILOs are provided through the following assessment tools:
<table>
<tr><th>Assessment tool</th><th>Mark</th><th>Topic(s)</th><th>Time</th></tr>
<tr><td>Homework assignments</td><td>10%</td><td>Programming aspects</td><td>W2-W14</td></tr>
<tr><td>Midterm exam</td><td>30%</td><td>Introduction through Mapping</td><td>W8</td></tr>
<tr><td>Term project report and presentation</td><td>20%</td><td>Practical and presentation aspects</td><td>W15</td></tr>
<tr><td>Final exam</td><td>40%</td><td>All material</td><td>W16</td></tr>
<tr><td>Total</td><td>100%</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Student requirements</td><td>The student should have a computer and internet connection.</td></tr>
<tr><td>Course policies</td><td>A- Attendance policies:
Attendance is required. Class attendance will be taken every class and the university polices will be enforced in this regard.
B- Absences from exams and submitting assignments on time:
A makeup exam can be arranged for students with acceptable absence causes.
Assignments submitted late, but before announcing or discussing the solution can be accepted with 25% penalty.
The project report must be handed in in time.
C- Health and safety procedures:
All health and safety procedures of the university and the school should be followed.
D- Honesty policy regarding cheating, plagiarism, misbehavior:
Open-book exams
All submitted work must be of the submitting student.
Other text or code must be properly quoted with clear source specification.
Cheating will not be tolerated.
E- Available university services that support achievement in the course:
Microsoft Teams team and Moodle course page
Robotics Lab for practicing the practical aspects and solving the assignments.
Program announcements Facebook group</td></tr>
<tr><td>Additional information</td><td>None</td></tr>
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Appendix
Learning Outcomes for the MSc in Artificial Intelligence and Robotics

Students who successfully complete the MSc in Artificial Intelligence and Robotics (AIR) will be able to:

1. Demonstrate a sound understanding of the main areas of AIR including artificial neural networks, machine learning, data science, industrial and service robots, and intelligent and autonomous robots.

2. Apply a critical understanding of essential concepts, principles and practices of AIR, and critically evaluate tools, techniques and results using structured arguments based on subject knowledge.

3. Apply the methods and techniques of the AIR fields in the design, analysis and deployment of AIR solutions and solving practical problems.

4. Demonstrate the ability to produce a substantial piece of research work from problem inception to implementation, documentation and presentation.

5. Demonstrate life-long learning, independent self-learning and continuous professional development skills in the AIR fields.

6. Demonstrate a sound understanding of the ethical, safety and social impact issues of AIR solutions and products.