Course title	**Computational Aspects of Robotics**
Course number	COMP 624
Credit hours (lecture and lab)	3 (3 + 0)
ECTS (weekly contact and self-study load)	6 (3 + 3)
Prerequisites/co-requisites by course number and name	None
Prerequisites by topic (other than the formal prerequisites above)	None
Level and type (compulsory, elective)	Masters' elective course
Year of study and semester	Any
Catalogue description	Introduction to robotics from a computational perspective covering AI foundations. Sensing and perception: state estimation challenges, such as robot localization, simultaneous localization and mapping (SLAM), Bayesian solutions, Kalman and particle filters, etc. Planning and decision making: basic planning and re-planning methods, A* and D*-like algorithms, configuration space abstraction, sampling-based planners, etc. Multi-robot systems: online planning and handling uncertainty. Control: introductory coverage of robot kinematics and dynamics.
Objectives	This course introduces the concepts, principles, methods, implementation techniques, and applications of computational robotics. The course puts emphasis on motion planning, state estimation, localization and mapping, kinematics, and robot learning. The students are introduced to the use of modern robotics tools.
Intended learning outcomes	Upon successful completion of this course, students will be able to:

No	Intended learning Outcome (ILO)	PLO*
1	Demonstrate understanding of the classical computational tools employed in robotics research and applications that relate to perception, decision making and control.	1, 2, 3, 6
2	Identify proper models for robot localization tasks and put together implementations that realize these models.	1, 2, 3
3	Build geometric models of simple motion planning problems for mobile robots and apply deterministic and sampling-based search algorithms to solve them.	1, 2, 3
4	Use tools relating to simulation of mobile robots and middleware for interactive with robots.	2, 3, 4
5	Demonstrate understanding of how algorithms can lead to solutions of more complex problems involving flying machines, human-robot interaction, mobile manipulators, and multi-robot	2, 3, 4, 5, 6

	systems.
	(*) The Program learning outcome (PLOs) are listed in the appendix
Teaching and learning methods	Development of ILOs is promoted through the following teaching and learning methods: • The Digital Systems Lab. is open for the students to practice the practical aspects and solve the programming 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 programming assignments in robotics. • The student carries out a term project for solving a problem using robotics techniques. • The student develops a professional report for the term report. • The student presents the term project in class.
Learning material type	Textbook, class handouts, some instructor keynotes, selected YouTube videos, and access to a personal computer and the internet.
Resources and references	A- Required book(s), assigned reading and audio-visuals: 1. Choset, Howie M., Kevin M. Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, Sebastian Thrun, and Ronald C. Arkin. Principles of robot motion: theory, algorithms, and implementation. MIT press, 2005. 2. Siegwart, Roland, Illah Reza Nourbakhsh, and Davide Scaramuzza. Introduction to autonomous mobile robots. MIT press, 2011. B- Recommended book(s), material and media: 3. Russell, Stuart J., and Peter Norvig. "Artificial intelligence: a modern approach."Pearson Education Limited, 2016.
Topic outline and schedule	

Week	Topic	ILO	Resources
1-2	Introduction to Computational Robotics	1, 2	1, 2, 3
3-7	Planning	3, 4	1, 3
8	Sensing	1, 2	2
9-10	Probability and Bayesian Reasoning	2, 4	1, 3
11-13	Simultaneous Localization and Mapping	2, 3, 4	1
14	Machine learning	1, 3, 4, 5	1, 3
15	Project Presentations	All	

<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>Theoretical aspects</td><td>W1-W7</td></tr>
<tr><td>Midterm exam</td><td>30%</td><td>Applications</td><td>W8-W14</td></tr>
<tr><td>Term project report and presentation</td><td>20%</td><td>Practical and presentation aspects</td><td>W8-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>
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<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 not 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:
• Moodle course page
• AI Lab for practicing the practical aspects and solving the programming assignments.
• Program announcements Facebook group</td></tr>
<tr><td>Additional information</td><td>None</td></tr>
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