

## Syllabus

### Course description

<b>Course title</b>	Mobile Robotics
<b>Course code</b>	47536
<b>Scientific sector</b>	ING-INF/04
<b>Degree</b>	Master in Industrial Mechanical Engineering
<b>Semester</b>	II
<b>Year</b>	I
<b>Academic Year</b>	2019-2020
<b>Credits</b>	5
<b>Modular</b>	No

<b>Total lecturing hours</b>	28 hrs
<b>Total exercise hours</b>	18 hrs
<b>Attendance</b>	Attendance at lectures and exercise sessions is strongly recommended.
<b>Prerequisites</b>	none
<b>Course page</b>	<a href="http://www.unibz.it/en/sciencetechnology/progs/master/industrial-and-mechanical-engineering/default.html">http://www.unibz.it/en/sciencetechnology/progs/master/industrial-and-mechanical-engineering/default.html</a>

<b>Specific educational objectives</b>	<p>A mobile robot is an unmanned system that operates in unstructured and dynamic environments, with or without the oversight of a human. Applications of mobile robots include: environmental monitoring; manufacturing logistics and production; search &amp; rescue; construction; forestry management, agricultural monitoring and production; mining; marine measurement and monitoring; and aerospace operations. This course covers the fundamental principles of mobile robotics at an introductory level. The topics covered include: functional architecture of unmanned systems (electrical, mechanical and software); vehicle dynamics and modeling; common navigation sensors, state &amp; disturbance estimation; low-level control; and trajectory generation. Laboratory exercises that use Matlab, Simulink and Ardupilot software to control unmanned vehicles will be given.</p>
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<b>Lecturer</b>	<p>Prof. Karl von Ellenrieder Facoltà di Scienze e Tecnologie          Building K, Room 2.08          Tel.: +39 0471 017172          E-mail: karl.vonellenrieder@unibz.it          Web :  <a href="https://next.unibz.it/en/faculties/sciencetechnology/academic-staff/person/37038-karl-dietrich-von-ellenrieder">https://next.unibz.it/en/faculties/sciencetechnology/academic-staff/person/37038-karl-dietrich-von-ellenrieder</a></p>
<b>Scientific sector of the lecturer</b>	ING-INF/04 - Automatica
<b>Teaching language</b>	English

<b>Office hours</b>	As listed on Cockpit or by appointment
<b>Teaching assistant (if any )</b>	NN
<b>Office hours</b>	As listed on Cockpit or by appointment
<b>List of topics covered</b>	<p>The course covers the following topics:</p> <ol style="list-style-type: none"> <li>1. Functional architecture of unmanned systems.</li> <li>2. Vehicle dynamics and modeling. <ol style="list-style-type: none"> <li>a. Inertial and body-fixed coordinate systems</li> <li>b. Dynamic equations of motion</li> </ol> </li> <li>3. Common navigation sensors. <ol style="list-style-type: none"> <li>a. Compass</li> <li>b. Inertial Measurement Units (IMUs)</li> <li>c. Global Positioning System (GPS) Sensors</li> </ol> </li> <li>4. Low-level, control. <ol style="list-style-type: none"> <li>a. Fundamentals of state space control</li> <li>b. Fundamentals of backstepping control</li> <li>c. Techniques for mitigating actuator saturation</li> </ol> </li> <li>5. State &amp; disturbance estimation. <ol style="list-style-type: none"> <li>a. State estimation</li> <li>b. Kalman filtering</li> <li>c. Disturbance observers</li> </ol> </li> <li>6. Path generation &amp; waypoint navigation.</li> </ol>
<b>Teaching format</b>	Classroom lectures and laboratory exercises

<b>Learning outcomes (ILOs)</b>	<p><u>Knowledge and understanding</u></p> <ol style="list-style-type: none"> <li>1. Applying basic principles to a broad range of dynamic system models (such as those typically learned in the 1<sup>st</sup> cycle).</li> <li>2. Defining sensing and controller requirements for unmanned vehicles that operate in different conditions.</li> <li>3. Understanding factors that affect system performance and stability.</li> <li>4. Use of state space techniques for designing controllers and observers.</li> </ol> <p><u>Applying knowledge and understanding</u></p> <ol style="list-style-type: none"> <li>5. Analyzing, developing and presenting control &amp; navigation systems for applications that span multiple disciplines through laboratory exercises, which complement the lectures.</li> </ol> <p><u>Making judgements</u></p> <ol style="list-style-type: none"> <li>6. On the choice of analytical and numerical tools to use in the lab exercises. This may require you to integrate knowledge, handle complexity, and formulate judgements with incomplete data.</li> </ol>
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	<p><u>Communication skills</u></p> <p>7. Laboratory reports will require you justify your solutions/conclusions concisely (in clear and simple language).</p> <p><u>Learning Skills</u></p> <p>8. Students will be required to develop a proficiency in Matlab, Simulink and Ardupilot with a few in-class examples, but mostly on their own. This is intended to help students develop the ability to study in a manner that is largely self-directed or autonomous.</p>
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<b>Assessment</b>	<b>Formative assessment</b>			
	<b>Form</b>	<b>Length /duration</b>	<b>ILOs assessed</b>	
	Exercises	18 hours total	1-8	
	<b>Summative assessment</b>			
	<b>Form</b>	<b>%</b>	<b>Length /duration</b>	<b>ILOs assessed</b>
	Exercises	40		1-8
	Final Exam	60	4 hours	1-6

<b>Assessment language</b>	English
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<b>Evaluation criteria and criteria for awarding marks</b>	<p>Laboratory Exercises: Completeness and correctness of answers; level of understanding</p> <p>Written Final Exam: Completeness and correctness of answers.</p> <p>Students are required to receive an overall grade of greater than 60/100 points in order to pass the course.</p>
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<b>Required readings</b>	Lecture notes and exercises will be available on the UniBZ Open Learning Environment (OLE)
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<b>Supplementary readings</b>	Additional books and articles may be recommended by the instructor during the course.
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