

## COURSE OUTLINE

### (1) GENERAL

<b>SCHOOL</b>	School of Engineering		
<b>ACADEMIC UNIT</b>	Department of Mechanical Engineering		
<b>LEVEL OF STUDIES</b>	Undergraduate		
<b>COURSE CODE</b>	EM0902	<b>SEMESTER</b>	9 <sup>th</sup>
<b>COURSE TITLE</b>	Robotics		
<b>INDEPENDENT TEACHING ACTIVITIES</b> <i>if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits</i>		<b>WEEKLY TEACHING HOURS</b>	<b>CREDITS</b>
Lectures		5	6
<i>Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).</i>			
<b>COURSE TYPE</b> <i>general background, special background, specialized general knowledge, skills development</i>	Special background		
<b>PREREQUISITE COURSES:</b>	-		
<b>LANGUAGE OF INSTRUCTION and EXAMINATIONS:</b>	Greek or English		
<b>IS THE COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (lecturing)		
<b>COURSE WEBSITE (URL)</b>	<a href="https://www.mie.uth.gr/?page_id=18493&amp;lang=en">https://www.mie.uth.gr/?page_id=18493&amp;lang=en</a>		

### (2) LEARNING OUTCOMES

<p><b>Learning outcomes</b></p> <p><i>The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.</i></p> <p><i>Consult Appendix A</i></p> <ul style="list-style-type: none"> <li>• <i>Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area</i></li> <li>• <i>Descriptors for Levels 6, 7 &amp; 8 of the European Qualifications Framework for Lifelong Learning and Appendix B</i></li> <li>• <i>Guidelines for writing Learning Outcomes</i></li> </ul>
<p>This course is an introduction to the field of robotics. It covers the fundamentals of kinematics, dynamics, trajectory planning, control of robot manipulators, and sensing. The course deals with homogeneous transformations, forward and inverse kinematics of robotic manipulators, differential kinematic equations, the manipulator Jacobian, and force relations. It also presents the fundamental principles on motion planning, proximity, tactile, and force sensing. Students are expected to have a background in linear algebra, calculus, and physics.</p> <p>By the end of this course, the students will understand the basic concepts and theory governing the modelling of robots that perform autonomous tasks such as navigation and manipulation. Student should be able to:</p> <ul style="list-style-type: none"> <li>• Describe the different forms of robot architectures.</li> <li>• Kinematically model simple manipulators and mobile robots.</li> <li>• Analyze manipulation and navigation problems using knowledge of coordinate frames, kinematics, optimisation, and control.</li> <li>• Compute forward and inverse kinematics of robotic manipulators.</li> <li>• Consider trade-offs among position control, velocity control, and force control when solving a robot control problem.</li> <li>• Describe the problems of motion planning, proximity, tactile, and force sensing.</li> <li>• Describe how sensors and actuators used in robotics applications work.</li> </ul>

<b>General Competences</b>	
<i>Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?</i>	
<i>Search for, analysis and synthesis of data and information, with the use of the necessary technology</i>	<i>Project planning and management</i>
<i>Adapting to new situations</i>	<i>Respect for difference and multiculturalism</i>
<i>Decision-making</i>	<i>Respect for the natural environment</i>
<i>Working independently</i>	<i>Showing social, professional and ethical responsibility and sensitivity to gender issues</i>
<i>Team work</i>	<i>Criticism and self-criticism</i>
<i>Working in an international environment</i>	<i>Production of free, creative and inductive</i>
<i>thinking Working in an interdisciplinary environment</i>	<i>.....</i>
<i>Production of new research ideas</i>	<i>Others...</i>

  

<ul style="list-style-type: none"> <li>• Search for, analysis and synthesis of data and information with the use of the necessary technology</li> <li>• Decision making</li> <li>• Working independently</li> <li>• Team work</li> <li>• Application of theory to practice</li> <li>• Production of new research ideas</li> <li>• Project planning and management</li> </ul>
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### (3) SYLLABUS

The Robotics course covers the following modules:
<ul style="list-style-type: none"> <li>• Robot kinematics (forward and inverse Kinematics).</li> <li>• Velocity kinematics and statics (differential kinematics, Jacobians, singularity analysis, holonomic and nonholonomic manipulators).</li> <li>• Denavit-Hartenberg algorithm and the Product of Exponentials (PoE) formula.</li> <li>• Dynamics.</li> <li>• Robot motion planning.</li> <li>• Swarm coordination.</li> <li>• Control of robotic manipulators.</li> <li>• Automated ground vehicles (AGVs).</li> <li>• Sensors and actuators.</li> <li>• Simulation of robotic manipulators using «CoppeliaSim» and «Robotic Operating System (ROS)».</li> </ul>

### (4) TEACHING and LEARNING METHODS - EVALUATION

<b>DELIVERY</b> <i>Face-to-face, Distance learning, etc.</i>	Face-to-face	
<b>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</b> <i>Use of ICT in teaching, laboratory education, communication with students</i>	<ul style="list-style-type: none"> <li>• Use of “CoppeliaSim” and “Robotic Operating System (ROS)” for the simulation of robotic manipulators.</li> <li>• Use of internet for notes and additional material on robotic systems</li> <li>• Communication with students via the eclass platform</li> </ul>	
<b>TEACHING METHODS</b> <i>The manner and methods of teaching are described in detail.</i> <i>Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop,</i>	<i>Activity</i>	<i>Semester workload</i>
	Lectures	40
	Tutorials	12
	Laboratory work	6
	Coursework/Project work (at home)	42
	Private study	50

<p><i>interactive teaching, educational visits, project, essay writing, artistic creativity, etc.</i></p> <p><i>The student's study hours for each learning activity are given as well as the hours of non- directed study according to the principles of the ECTS</i></p>		
	Course total	150
<p><b>STUDENT PERFORMANCE EVALUATION</b></p> <p><b>Description of the evaluation procedure</b></p> <p><i>Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open- ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other</i></p> <p><i>Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</i></p>	<p><b>Language of evaluation:</b> Greek (or English)</p> <p><b>Assessment:</b></p> <ul style="list-style-type: none"> <li>• Examination (70%)</li> <li>• Coursework and/or laboratory work (30%)</li> </ul> <p><b>Description of Coursework and/or laboratory work</b></p> <ul style="list-style-type: none"> <li>• Coursework: 6 sets of exercises and/or</li> <li>• 1-2 laboratory assignments or small project on the application of robotic manipulators to real life problems (students can work in teams)</li> </ul>	

## (5) ATTACHED BIBLIOGRAPHY

<p><b>Books</b></p> <ul style="list-style-type: none"> <li>• J. Craig. Introduction to Robotics: Mechanics and Control, 3<sup>rd</sup> Ed. Prentice-Hall, NJ, 2004.</li> <li>• K. M. Lynch and F. C. Park. Modern Robotics: Mechanics, Planning, and Control. Cambridge University Press, 2017. Online: <a href="http://modernrobotics.org">http://modernrobotics.org</a>.</li> <li>• M. W. Spong, S. Hutchinson, and M. Vidyasagar. Robot Modeling and Control. Wiley, 2005.</li> <li>• H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun. Principles of Robot Motion: Theory, Algorithms, and Implementations. MIT Press, Cambridge, MA, 2005.</li> <li>• J.-C. Latombe. Robot Motion Planning. Kluwer Academic Publishers, 1991.</li> <li>• S. M. LaValle. Planning Algorithms. Cambridge University Press, 2006.</li> <li>• M. T. Mason. Mechanics of Robotic Manipulation. MIT Press, 2001.</li> <li>• B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo. Robotics: Modelling, Planning and Control. Springer, 2009.</li> <li>• B. Siciliano, O. Khatib. Handbook of Robotics, 2<sup>nd</sup> Ed. Springer, 2016. Online: <a href="http://handbookofrobotics.org">http://handbookofrobotics.org</a>.</li> </ul> <p><b>Journals</b></p> <ul style="list-style-type: none"> <li>• IEEE Transactions on Robotics</li> <li>• IEEE Transactions on Automation Science &amp; Engineering</li> <li>• IEEE Transactions on Haptics</li> <li>• IEEE Transactions on Medical Robotics &amp; Bionics</li> <li>• IEEE Robotics and Automation Letters</li> <li>• IEEE Robotics &amp; Automation Magazine</li> <li>• IEEE/ASME Transactions on Mechatronics</li> <li>• Science Robotics</li> </ul> <p><b>Conferences</b></p>
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- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
- IEEE International Conference on Robotics and Automation (ICRA)
- IEEE International Conference on Automation Science and Engineering (CASE)
- IEEE Haptics Symposium (HAPTICS)
- International Conference on Unmanned Aircraft Systems (ICUAS)
- ACM/IEEE International Conference on Human-Robot Interaction (HRI)