<table>
<tr><td>Course Title</td><td colspan="5">Robotics</td></tr>
<tr><td>Course Code</td><td colspan="5">ACOE414</td></tr>
<tr><td>Course Type</td><td colspan="5">Elective</td></tr>
<tr><td>Level</td><td colspan="5">BSc (Level 1)</td></tr>
<tr><td>Year / Semester</td><td colspan="5">4th (Fall)</td></tr>
<tr><td>Teacher’s Name</td><td colspan="5">Dr. Giorgos Demetriou</td></tr>
<tr><td>ECTS</td><td>6</td><td>Lectures / week</td><td>2</td><td>Laboratories/week</td><td>1</td></tr>
<tr><td>Course Purpose</td><td colspan="5">The design of any successful robot involves the integration of many different disciplines, among them kinematics, signal analysis, information theory, artificial intelligence, and probability theory. This course presents the techniques and technology that enable mobility in a series of interacting modules. Each chapter covers a different aspect of mobility, as the course moves from low-level to high-level details. The first two chapters examine the robots' locomotion and principles of kinematics. This is followed by an in-depth view of perception, including descriptions of many "off-the-shelf" sensors and an analysis of the interpretation of sensed data. The final two chapters consider the higher-level challenges of localization and cognition, localization strategies, autonomous mapping, and navigation competence.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="5">Upon successful completion of the course students will be able to:
1. Understand the various type of mobile robot locomotion (Legs and Wheels).
2. Understand the kinematics models and motion control of mobile robots.
3. Introduction to sensors, sensing and perception, and uncertainty representation, feature extraction.
4. Odometry, map representation, introduction to probabilistic map-based localization, Markov localization, Kalman filter localization, map building.
5. Path planning techniques, obstacle avoidance, techniques of decomposition.
6. Project development.</td></tr>
<tr><td>Prerequisites</td><td colspan="2">None</td><td colspan="2">Co-requisites</td><td>None</td></tr>
<tr><td>Course Content</td><td colspan="5">• Locomotion with legs and wheels: Locomotion Concepts: Principles Found in Nature, Locomotion Concepts: Biped Walking, Walking and rolling, Characterization of locomotion concept, Mobile Robots with legs, Humanoid Robots, Mobile Robots with Wheels: Wheels Types, Characteristics of Wheeled Robots and Vehicles, examples.
• Mobile Robot Kinematics: Kinematics Model, Representing Robot Position, Wheel Kinematic Constraints, Robot Kinematic Constraints, Mobile Robot Maneuverability, Five Basic Types of Three-Wheel Configurations, Mobile Robot Workspace: Degrees of Freedom, Motion Control (kinematic control)
• Perception: Sensors: case studies, classification, performance, technology overview, Vision, Uncertainties, Fusion, Features: Edges,</td></tr>
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	Histograms, Fingerprints, Lines, Planes • **Localization and Mapping:** Intro, odometry, map representations, Markov localization, Kalman filter and SLAM • **Path Planning and Navigation:** Configuration Space for a mobile robot, Road-Map Path Planning: Visibility Graph, Voronoi Diagram, Cell Decomposition, Path / Graph Search Strategies, Potential Field Path Planning, Obstacle Avoidance: Vector Field Histogram, The Bubble Band Concept, Basic Curvature Velocity Methods, Lane Curvature Velocity Methods, Dynamic Window Approach, The Schlegel Approach, ETH-ASL Approach, Localization: Position Estimation, Mapping: Environment Representation
Teaching Methodology	This is a project base course. Lectures will be given 3 times a week in a classroom where the concepts and technologies of mobile robotics will be covered. The lectures are available on the University Learning site and they will be presented using PowerPoint slide presentations. In addition to this, supplement papers related to the topic will be given to the students to study. Students will be advised to use the reference books for further reading and practice. For every subject that will be presented, homework will be assigned in order to reinforce the material. Students will use the textbook, reference textbooks and supplemental papers to solve the homework problems. Example problems will be solved during lectures in order to help the students understand the material better. Students are assessed continuously and their knowledge is checked through the midterm exam and homework. They are prepared for final exam, by revision on the matter taught, problem solving and concept testing and are also trained to be able to deal with time constraints and revision timetable. A final group project will be assigned after the midterm is completed. The groups will be between 3-4 students and they will be dived based on their expertise and interest. A number of lecture hours will be devoted to assigning and assisting in the development of the project. The students will show their weekly progress to the professor during class hours.
Bibliography	Textbooks: • Roland Siegwart, Illah Nourbakhsh and Davide Scaramuzza. *“Introduction to Autonomous Mobile Robots”,* 2nd Edition, MIT Press, ISBN 0-262-19502-X References: • John J. Craig. “Introduction to Robotics – Mechanics and Control”, 3rd Edition, ISBN: 0201-54361-3, Prentice Hall, 2005. • Saeed B. Niku. “*Introduction to Robotics: Analysis, Systems, Applications*”, ISBN: 0-13-061309-6, Prentice Hall, 2001. • James L. Fuller. “*Robotics: Introduction, Programming, and Projects*”, 2nd Edition, ISBN: 0-13-095543-4, Prentice Hall, 1999. • Sensors for Mobile Robots --- Theory and Application, H. R. Everett, A. K. Peters, Ltd, ISBN 1-56881-048-2. • Introduction to AI Robotics, Robin R. Murphy, The MIT Press, 2000, ISBN 0-262-13383-0. • Computational Principles of Mobile Robotics, Gregory Dudek, Michael Jenkin, Cambridge University Press, 2000, ISBN 0-521-56876-5. • Fundamentals of Robotics --- Analysis and Control, Robert J. Schilling, Prentice Hall, 1990, ISBN 0-13-344433-3.

	• Robotics --- Control, Sensing, Vision and Intelligence, K. S. Fu, R. C. Gonzalez, C. S. G. Lee, McGraw-Hill, 1987, ISBN 0-07-022625-3.
Assessment	Students are assessed on the theoretical aspects of the course through tests, and the final exam, while lab exercises cover the applied and hand-on aspects of the course. Coursework will comprise of one test, a set of lab exercises, and three-hour closed book exam. The weights for each assessment component are: • Assignments 10% • Tests: 10% • Group Project: 20% • Final Exam 60%
Language	English