ATILIM UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF MECHATRONICS ENGINEERING

Course Name	Code
Industrial Automation and Robotics Technology	MECE 574

Term	Credits	ECTS
Spring	3	5

Pre-requisite Courses	-
Language of the Course	English
Course Type	Elective
Course Coordinator	N/A
Instructors	Dr. Muhammad Umer KHAN
Assistants	N/A
Course Objective	The main objective of this course is to familiarize students with the interdisciplinary field of robotics. The student must learn the Kinematics and Dynamics model of Serial manipulator, their correspondence with the real world. The course is designed with the objective of introducing students to the position and velocity-based control of robots. At the end of the course, the students should have gained aptitude in understanding, designing and implementation of the robot's control to perform certain task.
Learning Outcomes of the Course	CLO1: The students should be able to classify robots based upon their movement, and evaluate the performance based upon their specifications. In addition, basic elements of the robot will be explored and their movement in different coordinates and in view from different reference frames. CLO2: The students must be able to transform the 3D position of the robot to its equivalent joint angles or contrarily transform the joint angles to the corresponding 3D position of the robot. In simple, the objective is to control both the position and orientation of the tool in 3D space. CLO3: The students should be able to learn about differential motions of frames relative to a fixed frame, differential motions of robot joints relative to a fixed frame, Jacobians, and robot velocity relationships. CLO4: The students should achieve the understanding of Lagrangian mechanics with the objective of utilizing robot motion. CLO5: The students should be capable of specifying the movement of end-effectors precisely by planning its trajectory and ensuring its actual movement by means of some controller.
Contents of the Course	Introduction to robotics and automation, history, components, forward kinematics, inverse kinematics, differential motion and velocities, dynamic analysis and forces, trajectory planning, robot control

WEEKLY SCHEDULE AND PRE-STUDY PAGES		
Week	**Topics**	**CLOs**
1	Fundamentals: What is a Robot? Classification, History	CLO1
2	Components, Degrees of Freedom Joints, Coordinates, Reference Frames, Characteristics, Workspace, Applications	CLO1
3	Robot Kinematics: Coordinate Frames, Matrix Representation, Homogeneous Transformation Matrices, Denavit-Hartenberg Representation of Forward Kinematic Equations of Robots, Inverse Kinematic Solution of Robots. Types of Planar and Spatial mechanism. Degeneracy and Dexterity. The Fundamental Problem with the Denavit-Hartenberg Representation.	CLO2
4		
5		
6	Differential Motions and Velocities. Differential Relationships. Jacobian. Differential Motions of a Frame. Interpretation of Differential Change. Differential Changes Between Frames. Differential Motions of a Robot and Its Hand Frame. Calculation of the Jacobian. How to Relate the Jacobian and the Differential Operator. Inverse Jacobian.	CLO3
7		
8	**Mid Term Examination**	
9	Dynamic Analysis and Forces: Lagrangian Mechanics, Dynamic Equations for Multiple-Degree-of-Freedom Robots. Static Force Analysis of Robots, Transformation of Forces and Moments Between Coordinate Frames	CLO4
10		
11	Trajectory Planning: Path vs. Trajectory. Joint Space vs. Cartesian-Space. Basics of Trajectory Planning. Joint space trajectory planning, Cartesian space trajectories	CLO5
12		
13		
14	Robot Control, Linear Feedback Systems, PD-Gravity Control, Computed Torque Control	

SOURCES	
Reference Books	Peter Corke, "Robotics, Vision and Control", Springer, 2011 Saeed B. Niku, "Introduction to Robotics: Analysis, Systems, Applications", Pearson Education, 2003 Robert J. Schilling, "Fundamentals of Robotics", Prentice Hall, 2005 J. J. Craig, Introduction to Robotics, Mechanics and Control, Pearson, Prentice Hall, 3rd Ed., 2005 M.W. Spong, S. Hutchinson, M. Vidyasagar, Robot Modeling and Control, Wiley, 2006.

EVALUATION SYSTEM		
Term Studies	**Quantity**	**Percentage**
Mid-terms (Classroom and take home examinatons, intermediate reports and presentations)	1	30
Quizzes	2	10
Assignments	2	10
Final reports and presentations of Design/Research Projects, Laboratory Works, Term assignments etc.	1	30
Final Examination		20
	TOTAL	**100 %**

CORRELATION BETWEEN COURSE LEARNING OUTCOMES AND PROGRAM COMPETENCIES

No	**Program Competencies**	**Percentage**				
		1	**2**	**3**	**4**	**5**
1	An ability to apply theoretical and applied knowledge of mathematics, science and mechatronics engineering; to model and analyze mechatronics engineering problems.					X
2	An ability to identify, formulate, and solve engineering problems; an ability to select and apply proper analysis, modeling and implementation techniques for the identified engineering problems.					X
3	An ability to design a complex system, component, or process to meet desired needs under realistic constraints and conditions; an ability to apply contemporary design methodologies; an ability to implement effective engineering creativity techniques.					
4	An ability to develop, select and use modern techniques, skills and tools for mechatronics engineering and robot technologies and their applications.				X	
5	An ability to design experiments, experimentation, data accumulation, data analysis and reporting.					
6	An ability to function effectively on single disciplinary and multi-disciplinary teams; an ability for individual work; ability to communicate and collaborate/cooperate effectively with other disciplines, ability to work with other discilines.					
7	An ability to communicate effectively in Turkish and English language, oral and written.			X		
8	Recognition of the need for, and an ability to access and report knowledge, to engage in life-long learning.					
9	An understanding of professional and ethical responsibility.					
10	A knowledge of business oriented project organization and management; awareness of enterpreneurship, innovation and sustainable development.					
11	The broad education necessary to understand the impact of engineering solutions in a global, societal and individual context, human health, environmental, security and other modern age problems; recognition of engineering philosophy on the related; understanding legal issues of engineering					

	problems and their solutions.					

TABLE OF ECTS / WORKLOAD			
Activities	**Quantity**	**Duration (Hours)**	**Total Workload**
Lectures	14	3	42
Study Hours Out of Class (Preliminary work, reinforcement, etc.)	14	1	14
Project	1	16	16
Assignments (Computer based)	2	5	10
Quizzes	2	2.5	5
Mid-term examinations; Classroom and take-Home examinations, intermediate presentations, demonstrations and reports.	1	20	20
Final examinations; Classroom and take-Home examinations, term presentations, final reports.	1	20	20
Total Work Load			127
Total Work Load / 25			5.08
ECTS Credit of the Course			5