Akashi College	Year	2023	Course Title	Robotics

Course Information

Course Code	5525		Course Category	Specialized / Elective
Class Format	Lecture		Credits	Academic Credit: 2
Department	Mechanical Engineering		Student Grade	5th
Term	First Semester		Classes per Week	2
Textbook and/or Teaching Materials				
Instructor	SEKIMORI Daisuke			

Course Objectives

(1) Understand how to describe the position and posture of a robot, and can convert it to other coordinate systems.
(2) Can analyze the relation between the position of a robot arm and the angle of the joint, and the speed of the arm and the joint velocity.
(3) Can analyze the relationship between the hands of a robot arm and the forces acting on the joints.
(4) Understand and learn the structure and operating principle of stepping motors, which are typical actuators of robot arms, and the driving method.
(5) Learn how to control a robot arm with two degrees of freedom using a computer.

Rubric

	Ideal Level	Standard Level	Unacceptable Level
Achievement 1	Understand how the position and posture of the robot are described, and can accurately convert them to other coordinate systems.	Understand how to describe the position and posture of the robot and can convert them to other coordinate systems.	Do not understand how to describe the position and posture of the robot. Also, cannot covert them to other coordinate systems.
Achievement 2	Can accurately analyze the relation between the position of the robot arm and the angle of the joint, and the speed of the arm and the joint velocity.	Can analyze the relation between the position of the robot arm and the angle of the joint, and the speed of the arm and the joint velocity.	Cannot analyze the relation between the robot arm's head position and joint angle, and the target speed and joint velocity.
Achievement 3	Can accurately analyze the relationship between the hands of the robot arm and the forces acting on the joints.	Can analyze the relationship between the hands of the robot arm and the forces acting on the joints.	Cannot analyze the relationship between the hands of the robot arm and the forces acting on the joints.
	Understand the structure and operating principles of stepping motors and can learn how to drive them sufficiently.	Understand the structure and operating principles of stepping motors and can learn how to drive them.	Do not understand the structure and operating principles of the stepping motor. Also, cannot learn how to drive.
	Learn well how to control the two-degree robot arm using a computer.	Learn how to control the two-degree robot arm using a computer.	Do not learn how to control the two-degree robot arm using a computer.

Assigned Department Objectives

Teaching Method

Outline	Robots are composed of mechanisms, sensors, actuators, computers, etc. Robotics is related with a wide range of fields, including machinery, materials, control, electrical and electronic, and information engineering. The purpose of this class is to use a jointed-arm robot as an example and acquire necessary skills to achieve its main function, manipulation.
Style	Lectures will be given in accordance with textbooks and handouts. The course also includes exercises using robot as materials.
Notice	This course's content will amount to 90 hours of study in total. These hours include the learning time guaranteed in classes and the standard self-study time required for pre-study / review, and completing assignment reports. Always pre-study and review the material to ensure better understanding of the content of the lecture. Make sure to understand the physical meaning of formulas, not just memorize them. Students who miss 1/3 or more of classes will not be eligible for evaluation.

Characteristics of Class / Division in Learning

☐ Active Learning	☐ Aided by ICT	☐ Applicable to Remote Class	☐ Instructor Professionally Experienced

Course Plan

			Theme	Goals
1st Semester	1st Quarter	1st	Basic concept of a robot	Understand the basic concepts of how the robot arm is operated and controlled. In addition, understand the latest robot technologies and research.
		2nd	Coordinate conversion (1)	Learn how to describe the position and posture of the robot using the reference coordinate system. Also understand the relationship between the Euler's angle and the rotation matrix, which is the way in which the posture is described.
		3rd	Coordinate conversion (2)	Understand the concept of the homogeneous conversion matrix, which describes the position and posture of the robot together, and to learn how to convert coordinates using the same order transformation matrix.

		4th	Robot arm kinematics (1)	Learn how to set the base, link, and target coordinate systems necessary for analyzing arm kinematics. Moreover, understand the relation between the joint angles of the arms and the position and posture of the hands.
		5th	Robot arm kinematics (2)	For a 3-degree-of-freedom scalar-type robot arm, can analyze the problem of forward kinematics that requires the position and posture of the hand from the joint angle of the arm.
		6th	Robot arm kinematics (3)	For a 3-degree-of-freedom scalar-type robot arm, can analyze the inverse kinematics of the arm to determine the joint angle from the position and posture of the arm's hands.
		7th	Robot arm kinematics (4)	Understand the relation between the angular joint velocity of the arm and the target speed of the two-degree-of-freedom planar robot arm. Moreover, can determine the Jacobian matrix from the relationship between the two, and analyze the specific posture of the arm.
		8th	Midterm exam	
	2nd Quarter	9th	The static dynamics of the robot arm	Understand the static relationship between the joint driving force of the arm and the force of the hand for a two-degree flat robot arm.
		10th	Robotic arm dynamics	Can analyze the relation between arm motion and joint drive force using Lagrange's equation for a planar robot arm with two degrees of freedom.
		11th	Robot arm control (1)	Understand the structure, operating principle and driving method of stepping motors, which are typical actuators of robot arms.
		12th	Robot arm control (2)	Learn how to drive a stepping motor using a computer.
		13th	Robot arm control (3)	Same as above
		14th	Robot arm control (4)	Learn how to control the robot arm with two degrees of freedom using a computer.
		15th	Robot arm control (5)	Same as above
		16th	Final exam	

Evaluation Method and Weight (%)

	Examination	Exercises	Total
Subtotal	90	10	100
Basic Proficiency	0	0	0
Specialized Proficiency	90	10	100
Cross Area Proficiency	0	0	0