Akashi College	Year	2022	Course Title	Micromachine

Course Information

Course Code	4041	Course Category	Specialized / Elective
Class Format	Lecture	Credits	Academic Credit: 2
Department	Mechanical and Electronic System Engineering	Student Grade	Adv. 2nd
Term	Second Semester	Classes per Week	2
Textbook and/or Teaching Materials			
Instructor	MATSUZUKA Naoki		

Course Objectives

(1) Understand the characteristics of anisotropic materials and can calculate the physical property values of crystal orientation. (H)
(2) Understand and can explain the principles of typical semiconductor micromachining techniques. (D)
(3) Can explain micromachines from their structure to the fabrication process. (F)
(4) Understand and can explain detection principles of sensors and driving principles of actuators. (D)
(5) Learn about sensor and actuator design techniques. (F) and (H)

Rubric

	Ideal Level	Standard Level	Unacceptable Level
Achievement 1	Fully understand the characteristics of anisotropic material and can accurately calculate the physical property values of crystal orientation.	Understand the characteristics of anisotropic materials and can calculate the physical property values of crystal orientation.	Do not understand the characteristics of anisotropic materials and cannot calculate the physical property values of crystal orientation.
Achievement 2	Fully understand and can accurately explain the principles of typical semiconductor micromachining techniques.	Understand and can explain the principles of typical semiconductor micromachining techniques.	Do not understand and cannot explain the principles of typical semiconductor micromachining techniques.
Achievement 3	Can explain micromachines in detail from their structure to the fabrication process.	Can explain micromachines from their structure to the fabrication process.	Cannot explain micromachines detail from their structure to the fabrication process.
	Fully understand and can accurately explain detection principles of sensors and driving principles of actuators.	Understand and can explain detection principles of sensors and driving principles of actuators.	Do not understand and cannot explain detection principles of sensors and driving principles of actuators.
	Can accurately apply sensor and actuator design techniques.	Can apply sensor and actuator design techniques.	Cannot apply sensor and actuator design techniques.

Assigned Department Objectives

Teaching Method

Outline	Micromachines or micro electro mechanical systems (MEMS) are devices that integrate micro structures, sensors, actuators, and electronic circuits using semiconductor micromachining technology. They are applied in a wide range of fields. The first half of this course will explain typical semiconductor micromachining techniques and micromachine fabrication methods. The second half will explain the principles of sensors used in micromachines, driving principles of actuators, typical sensors, and actuator design techniques.
Style	Classes will be held in a lecture-style format and will be taught with handouts.
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. It is recommended that students have a basic knowledge of engineering materials, strength of materials, and electronic circuits. However, this course is open to all students as the necessary knowledge will be explained in class. Students who miss 1/3 or more of classes will not be eligible for a passing grade.

Characteristics of Class / Division in Learning

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

Course Plan

			Theme	Goals
2nd Semester	3rd Quarter	1st	An overview of micromachines	Understand micromachine development history and scaling laws.
		2nd	Physical properties of single-crystal silicon (1)	Understand the crystal structure, manufacturing methods and anisotropic properties of single-crystal silicon.
		3rd	Physical properties of single-crystal silicon (2)	Understand the calculation method for the physical properties in arbitrary crystal orientation of single-crystal silicon.
		4th	Photolithography	Understand the principles of photolithography.
		5th	Film deposition (1)	Understand the sputter, vapor deposition, and chemical vapor deposition methods.
		6th	Film deposition (2)	Understand thermal oxidation and impurity diffusion.
		7th	Etching (1)	Understand liquid-based isotropic and anisotropic etching of single-crystal silicon.
		8th	Etching (2)	Understand gas-based dry-etching.
	4th Quarter	9th	Micromachine fabrication technology	Understand micromachine fabrication processes using semiconductor micromachining techniques.

		10th	Sensor design technology (1)	Understand typical micro-sensors and sensing principles.
		11th	Sensor design technology (2)	Understand how to design piezoresistive pressure sensors.
		12th	Sensor design technology (3)	Design a piezoresistive pressure sensor.
		13th	Actuator design technology (1)	Understand typical micro actuators and their driving principles.
		14th	Actuator design technology (2)	Understand how to design an electrostatic drive actuator.
		15th	Actuator design technology (3)	Design a electrostatic drive actuator.
		16th	Final exam	

Evaluation Method and Weight (%)

	Examination	Assignments	Mutual Evaluations between students	Behavior	Portfolio	Other	Total
Subtotal	60	40	0	0	0	0	100
Basic Proficiency	0	0	0	0	0	0	0
Specialized Proficiency	60	40	0	0	0	0	100
Cross Area Proficiency	0	0	0	0	0	0	0