Akashi College	Year	2023	Course Title	Introduction to Nano Materials Design

Course Information

Course Code	5004	Course Category	General / Elective
Class Format	Lecture	Credits	Academic Credit: 2
Department	Mechanical and Electronic System Engineering	Student Grade	Adv. 1st
Term	First Semester	Classes per Week	2
Textbook and/or Teaching Materials	Handouts		
Instructor	NAKANISHI Hiroshi		

Course Objectives

Objectives are to:
Evaluation 1: Understand the various laws that govern the natural world and learn the methods in applying the laws to nanomaterials design through the lectures.
Evaluation 2: Deepen one's understanding of quantum mechanics and develop presentation skills in expressing one's opinions and ideas to others plainly through exercises and a presentation.
Evaluation 3: Develop the basic skills in applying and expanding nanomaterials design to researches in one's major field. (D, E, H)

Rubric

	Ideal Level of Achievement	Standard Level of Achievement	Unacceptable Level of Achievement)
Evaluation 1	The student clearly understands and explains the nanomaterials design methods.	The student describes that material properties come from the quantum mechanics.	The student did not describe that material properties come from the quantum mechanics and did not explain the nanomaterials design methods.
Evaluation 2	The student clearly understands and explains how to utilize the quantum mechanic algebra.	The student utilizes the quantum mechanics algebra.	The student did not utilize the quantum mechanics algebra.
Evaluation 3	The student applies the nanomaterials design for developing her/his field.	The student proposes the application of the nanomaterials design in her/his field.	The student did not propose the application of the nanomaterials design in her/his field.

Assigned Department Objectives

Teaching Method

Outline	Nanomaterials design is a method of designing various materials that support the present and future science and technologies. An objective of this course is to develop a scientific way of thinking by learning nanomaterial design. First, students are going to learn the outline of quantum mechanics, which explains the motions of nuclei and electrons that make up a material. Second, the students are going to learn how quantum mechanics clarifies the composition and characteristics (physical properties) of materials. Lastly, the students are going to learn the state-of-the-art nanomaterials design method to design highly-functional materials, which will be required in various engineering fields in the future.
Style	Outline and necessary subjects will be illustrated through theory lectures, followed by practice lectures. The student is expected to solve the practice problems with her/his own hands, and to explain her/his solutions to other students easy to understand.
Notice	In this course, the learning time guaranteed in the class and the total of the standard self-study time necessary for the preparation / review are 90 hours of study content. Students who miss 1/5 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	Outline of Quantum Mechanics (First Half) Learn the outline of quantum mechanics and differences between quantum mechanics and Newtonian mechanics by comparing the two mechanics.	The student explains the differences between quantum mechanics and Newtonian mechanics
		2nd	Outline of Quantum Mechanics (Second Half) Learn the method of expressing motions quantum mechanically.	The student explains the description of the particle motion in quantum mechanics.
		3rd	Basics of Quantum Mechanics 1 (Operator Algebra) Learn operator algebra, which is necessary to learn quantum mechanics	The student handles the basic algebra necessary in quantum mechanics.
		4th	Basics of Quantum Mechanics 2 (Schrödinger Equation) Schrodinger wave equation is the basic equation in quantum mechanics. Learn Schrödinger wave equation.	The students explains the relation between wave packet and particle motion.
		5th	Basics of Quantum Mechanics 3 (Commutation Relations I: Coordinates and Momentum) Learn the commutation relation between coordinates and momentum.	The students operates the commutator brackets to coordinates and momentum.
		6th	Basics of Quantum Mechanics 4 (Commutation Relations II: Angular Momentum) Learn the commutation relation regarding an angular momentum.	The students operates the commutator brackets to coordinates and momentum.

		7th	Basics of Quantum Mechanics 5 (Hermitian Operators) Learn about Hermitian operators.	The student explains the Hermitian, and calculates the time evolution of expectation value of physical quantity.
		8th	Basics of Quantum Mechanics 6 (Square well Potential) Learn the quantum states of a particle bound by a square-well potential.	The student derives the quantum states of a particle bound by a square-well potential.
	2nd Quarter	9th	Basics of Quantum Mechanics 7 (One-Dimensional Scattering Problem and Tunnel Effect) Learn about scattering problems and understand the tunnel effects.	The student derives the transmission probability through the square-well potential energy barrier.
		10th	Basics of Quantum Mechanics 8 (Harmonic Oscillators) Learn about the quantum states of harmonic oscillators.	The student derives the quantum states of Harmonic Oscillator.
		11th	Basics of Quantum Mechanics 9 (Lattice Specific Heat) Learn about Einstein solid.	The student derives the heat capacity of Einstein solid.
		12th	Electron Configuration of Atom 1 Learn about the quantum states of an electron bounded by the Coulomb force.	The student explains the quantum states of an electron in an atom.
		13th	Electron Configuration of Atom 2 (Spin and Quantum Statistics) Learn about the existence of spin, the outline of the quantum statistics, and the periodic laws of elements.	The student explains the electron configuration in an atom.
		14th	Cohesion Mechanism of atoms in materials (Ionic Bond, Covalent Bond and Metallic Bond) Learn the cohesion mechanisms of atoms in materials.	The student explains the ionic bond, covalent bond and metallic bonds) Learn the cohesion mechanisms of atoms in materials.
		15th	Density Functional Theory and Computational Material Design Learn the density functional theory, the first principle calculation based on the density functional theory, and nanomaterials design using the first-principle calculations.	The student explains the nanomaterials design methods.
		16th	Term-end examination	

Evaluation Method and Weight (%)

	Examination	Practice & Presentation	Mutual Evaluations between students	Behavior	Portfolio	Other	Total
Subtotal	80	20	0	0	0	0	100
Basic Ability	20	5	0	0	0	0	25
Technical Ability	50	5	0	0	0	0	55
Interdisciplinary Ability	10	10	0	0	0	0	20