明石工業高等専門学校	開講年度	平成31年度 (2019年度)	授業科目	ナノマテリアルデザイン入門

科目基礎情報

科目番号	0007	科目区分	一般 / 選択
授業形態	講義	単位の種別と単位数	学修単位: 2
開設学科	建築・都市システム工学専攻	対象学年	専1
開設期	前期	週時間数	2
教科書/教材	Handouts		
担当教員	中西 寛		

到達目標

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 (D)
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. (D, E)
Evaluation 3: Develop the basic skills in applying and expanding nanomaterials design to researches in one's major field. (D, E, H)

ルーブリック

	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.

学科の到達目標項目との関係

学習・教育目標 (D) 学習・教育目標 (E)

教育方法等

概要	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.
授業の進め方・方法	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.
注意点	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. More than two-thirds of the attendance is required.

授業計画

		週	授業内容	週ごとの到達目標
前期	1stQ	1週	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
		2週	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.
		3週	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.
		4週	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.
		5週	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.
		6週	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.
		7週	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.
		8週	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.

	2ndQ	9週	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.
		10週	Basics of Quantum Mechanics 8 (Harmonic Oscillators) Learn about the quantum states of harmonic oscillators.	The student derives the quantum states of Harmonic Oscillator.
		11週	Basics of Quantum Mechanics 9 (Lattice Specific Heat) Learn about Einstein solid.	The student derives the heat capacity of Einstein solid.
		12週	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.
		13週	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.
		14週	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.
		15週	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.
		16週	Term-end examination	

モデルコアカリキュラムの学習内容と到達目標

分類	分野	学習内容	学習内容の到達目標	到達レベル	授業週

評価割合

	Examination	Practice & Presentation	Mutual Evaluations between students	Behavior	Portfolio	Other	合計
総合評価割合	60	40	0	0	0	0	100
Basic Ability	0	0	0	0	0	0	0
Technical Ability	50	30	0	0	0	0	80
Interdisciplinary Ability	10	10	0	0	0	0	20