Tsuyama College	Year	2021	Course Title	Condensed Matter Physics

Course Information

Course Code	0098	Course Category	General / Compulsory
Class Format	Lecture	Credits	School Credit: 1
Department	Department of Integrated Science and Technology Communication and Informations System Program	Student Grade	4th
Term	Second Semester	Classes per Week	2
Textbook and/or Teaching Materials	Textbook: Basic Electronics by Akira Fujimoto, Morikita PublishingReference book: Semiconductor starting from high school chemistry by Masaya Ichimura, Ohm-sha Schrodinger's equation in high school mathematics by Jun Takeuchi Blue Books, Kodansha Jun Takeuchi, Principles of Semiconductors in High School Mathematics by Atsushi Takeuchi, Blue Backs, Kodansha Furukawa, Ogino, and Asano) Electronic Device Engineering, Morikita Publishing		
Instructor	KATORI Shigetaka,HARADA Kanji,NAKAMURA Shigeyuki,YAMAMOTO Tsunayuki		

Course Objectives

Learning purposes : The objective of this lecture is to understand the basics of the operating principles of semiconductor devices, such as diodes and transistors, with an emphasis on energy.

Course Objectives :
1. Simple quantum mechanics. (Bohr's hypothesis, de Broglie waves and quantum numbers)
2. Energy band structure of semiconductors. (conduction band, valence band, and forbidden band)
3. Carriers of semiconductors. (Free electron, hole, n-type, p-type, donor, acceptor, density of states, distribution function, Fermi level)
4. pn junctions and diodes. (pn junction, potential barrier, bias, I-V characteristics)
5. MOS field-effect transistors (MOS-FETs), the smallest unit in a processor.(MOS structure, inversion layer, pinch off)
6. Structure and operation mechanism of memory IC. (Address bus, data bus, read, write, DRAM, EEPROM)
7. Quantum computers. (qubit, device, algorithm)

Rubric

	Excellent	Good	Acceptable	Not acceptable
Achievement 1	From the Bohr condition, the orbital radius and total energy of the electrons of the hydrogen atom are found. Explain principal quantum numbers, subquantum numbers, and magnetic quantum numbers, and explain the difference in orbital shapes.	Can explain particle-wave duality, Bohr's hypothesis, de Broglie waves, quantum numbers, and Pauli's exclusion principle.	Can explain particle-wave duality, Bohr's hypothesis, de Broglie's wave, quantum numbers, and Pauli's exclusion principle using the reference book	Can't explain particle-wave duality, Bohr's hypothesis, de Broglie's wave, quantum numbers, and Pauli's exclusion principle even using the reference book
Achievement 2	Can explain the mechanism of the formation of the energy band structure of semiconductors.	Can draw conduction, forbidden and valence band structures in semiconductors. Explain the differences in the energy band structures of metals, semiconductors, and insulators.	Can explain the differences between the energy band structures of metals, semiconductors and insulators using the drawings of the energy band structure of semiconductors in the reference book.	Can't explain the differences between the energy band structures of metals, semiconductors and insulators even using the drawings of the energy band structure of semiconductors in the reference book.
Achievement 3	Equations for state density, distribution function and carrier density can be derived. The temperature characteristics of carrier density can be drawn and the true region, the exodus region, and the impurity region can be explained.	Can explain the meaning of expressions for state density, distribution function and carrier density. I can explain the Fermi level. Explain free electrons and holes. We can explain the difference between a genuine semiconductor and an impurity semiconductor. Explain the impurity levels.	Can explain density of states and distribution function, carrier density, Fermi levels, and the difference between intrinsic and impurity semiconductors. Explain impurity levels using the electron state diagrams in the reference book,	Can't explain density of states and distribution function, carrier density, Fermi levels, and the difference between intrinsic and impurity semiconductors. Explain impurity levels even using the electron state diagrams in the reference book,
Achievement 4	Can explain quantitatively the rectifying action of a diode using an equation.	Can draw the energy level diagram of a pn junction. Explain the rectifying action of diodes qualitatively using the energy level diagram	Explain the rectifying action of diodes qualitatively using the energy level diagram of pn junctions in the reference book.	Cannot draw an energy level diagram of a pn junction. The rectification action of the diode cannot be explained qualitatively using the energy level diagram.
Achievement 5	The operation of MOS-FETs can be explained and the operating points can be calculated.	Can explain the operation of MOS-FETs.	MOS-FET operation can be explained using the reference book	MOS-FET operation is not explained using the reference book
Achievement 6	Explain the operation of memory IC (DRAM, EEPROM). Explain the operation of memory IC (DRAM).	Explain memory IC (DRAM) operation	Explain memory IC (DRAM) operation using reference books.	The operation of memory IC (DRAM) cannot be explained by using reference books.
Achievement 7	Can write the symbol for a quantum bit and explain one of the quantum algorithms using a reference book.	can write the symbols for qubits and explain one of the quantum algorithms with the help of a reference book.	Can write symbols for qubits using a reference book.	can't write symbols for qubits using a reference book.

Assigned Department Objectives

Teaching Method

Outline	"General, by specialty, : General field of study: general: pysics Required, compulsory, elective or elective: Must complete subjects Foundational adademic disciplines: engineering/basics of engineering Relevance to the educational objectives: This course is designed to meet the learning objectives of the Department of Integrated Science and Engineering (2) Acquire solid knowledge of basic science. Relationship with JABEE programs : A-1 Outline: This class covers the theory of physical properties in relation to the behavior of electrons in semiconductors. The behavior of electrons and holes in semiconductors will be explained with a focus on energy, and students will develop the basic knowledge necessary to understand the principles of operation of semiconductor devices, such as diodes and transistors.
Style	Grading system: The results of the two regular exams will be evaluated equally (60%). Grades are based on the results of quizzes, reports, and exercises (40%). Students with poor grades may be required to retake the examination. If a retest is given, the results of the retest will be included in the regular exam results with a maximum of 60 points.
Notice	"Course Note: This course is required to complete the course. Advice: this is an important course that provides a foundation for understanding the principles of operation of semiconductor devices such as transistors, LEDs, and solar cells. There may be many new ideas that are unfamiliar to you, but you should ask questions if you do not understand them. Basic subjects: Electronic Circuits I (3rd year), Physics I, II (1, 2), Chemistry I, II (2, 3) Related subjects: Electronic Engineering (4 years), Electrical and Electronic Materials (5), Electronic Circuits II (4), Electronic Devices (2), Applied Physics I, II (4, 5), Quantum Science (5) Advice: There are many words and concepts that are new to you. It is also necessary to acquire the basic knowledge necessary to understand electronic engineering in the electrical and electronic systems. Do enough reviewing. Reports must be handed in. Attendance will be taken at the beginning of each credit period, and students who have not responded to the call will be considered tardy. For every 3 tardies, the student will be charged with one absence. A student who is more than 25 minutes late will be considered to have missed one class."

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		
		2nd		
		3rd		
		4th		
		5th		
		6th		
		7th		
		8th		
	4th Quarter	9th		
		10th		
		11th		
		12th		
		13th		
		14th		
		15th		
		16th		

Evaluation Method and Weight (%)

	Examination	Presentation	Mutual Evaluations between students	Behavior	Portfolio	Mini test	Report	Total
Subtotal	60	0	0	0	0	0	40	100
Basic Proficiency	0	0	0	0	0	0	0	0
Specialized Proficiency	60	0	0	0	0	0	40	100
Cross Area Proficiency	0	0	0	0	0	0	0	0