

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	<p>"General, by specialty, : General</p> <p>field of study: general: pysics</p> <p>Required, compulsory, elective or elective: Must complete subjects</p> <p>Foundational adademic disciplines: engineering/basics of engineering</p> <p>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.</p> <p>Relationship with JABEE programs : A-1</p> <p>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.</p>							
Style	<p>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%).</p> <p>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.</p>							
Notice	<p>"Course Note: This course is required to complete the course.</p> <p>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.</p> <p>Basic subjects: Electronic Circuits I (3rd year), Physics I, II (1, 2), Chemistry I, II (2, 3)</p> <p>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)</p> <p>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."</p>							
Characteristics of Class / Division in Learning								
<input type="checkbox"/> Active Learning		<input type="checkbox"/> Aided by ICT			<input type="checkbox"/> Applicable to Remote Class		<input type="checkbox"/> 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