Subject (English)	Introductory Quantum Mechanics		Semester	Fall	Day/Slot	Fri. / 3rd 13:00-14:30
科目名(日本語)	量子力学					
Course Code	VJ253F73	Course Numbering	TEI-QTME301		Period	Oct. 4, 2019 – Jan. 31, 2020
Instructor (Post)	Simon J. Greaves (Assoc. Prof.)				Campus	Aobayama
					Building	Electrical, Information and Physics Building No.1
Faculty	School of Engineering		Credits	2	Class Room	Lecture Room 2B

Class subject: Introductory Quantum Mechanics

Object and summary of class

Beginning with a review of some early 20th century experiments, this course aims to develop an understanding of the basic concepts of quantum mechanics and how they differ from classical mechanics.

Keywords: quantum mechanics

Goal of study

Use the Schrödinger equation to solve one-dimensional problems and show that quantum mechanics can be used to predict the existence of physical phenomena such as quantum mechanical tunneling, discrete energy levels and energy band-gaps in solids.

Contents and progress schedule of class

1. Introduction: What is quantum mechanics and how does it differ from classical mechanics? Double slit experiments are used to illustrate the differences.
2. Blackbody radiation and the photoelectric effect: How can we explain the distribution of light emitted by black bodies, such as the sun?
3. Compton scattering, Franck and Hertz experiment: When a photon interacts with an electron we can treat the problem using relativistic mechanics. Electron energy levels in gases can be determined using the Franck and Hertz experiment.
4. Bohr's model of the hydrogen atom, de Broglie theory: A simple model is used to calculate the energy levels of the electron in a hydrogen atom. The de Broglie theory states that all matter has a wavelength. The Davisson-Germer experiment is used to demonstrate the validity of de Broglie's theory.
5. Schrödinger equation: the Schrödinger equation is introduced in its time dependent and time independent forms with wavefunctions as solutions.
6. Operators and eigenvalue equations: The Schrödinger equation is an eigenvalue equation for energy. Using appropriate operators we can derive similar eigenvalue equations for momentum and other physical observables.
7. The infinite potential well: A simple one-dimensional problem of a particle trapped in an infinitely deep well is solved using the Schrödinger equation.
8. Pauli exclusion principle, particle in a box, Heisenberg uncertainty principle: The Pauli exclusion principle requires that all particles have different wavefunctions. The Heisenberg uncertainty principle tells us that the more accurately we try to measure the position of an object, the less we know about its momentum, and vice-versa.
9. Delta-function potential, scattering and tunneling: Quantum mechanical tunneling is used in many devices but cannot be explained by classical mechanics. Using a delta-function potential the Schrödinger equation is solved to show that quantum mechanics can predict this effect. Some applications of quantum mechanical tunneling are reviewed.
10. One dimensional barrier problems: The Schrödinger equation is solved for various one dimensional problems, e.g. finite barrier, finite well, step potential.
11. Solids, band gaps, angular momentum: The Schrödinger equation is applied to a 1D periodic potential, which can represent atomic nuclei in a solid. The solution demonstrates that the periodic potential leads to the creation of energy bands and band gaps in solids.
12. The harmonic oscillator: The harmonic oscillator is used to represent the vibration of atomic nuclei in solids. The solution shows that the atoms can only take certain energies and that their energy is not zero, even at a temperature of absolute zero.
13. Free particles and wave packets: Solving the Schrödinger equation for a Gaussian wave packet shows that the width of the packet will increase and the amplitude decrease as it propagates.

Schedule

No.	1	2	3	4	5	6	7	8
Date	10/4	10/11	10/25	11/1	11/15	11/22	11/29	12/6
No.	9	10	11	12	13	14		
Date	12/13	12/20	1/10	1/17	1/24	1/31		

Preparation	None
Record and evaluation method	25% homework, 75% exams
Textbook and references	Many quantum mechanics textbooks cover the content of the class.
Self study	Review lecture notes before class.
In addition	-