# Electron Theory in Solids (固態電子理論)

Course level: Graduate students
Course goals: Understanding the fundamental theory of electron in solids, including metal and semiconductors, as well as the electronic properties in bulk and low dimensional scales. Lab practicing and selected topic presentation are designed to enhance the efficacy of student's learning.
Keywords: Scattering model, Wave mechanics, Quantum mechanics, Density of States, Distribution function, Bloch Theorem, Semiconductors carrier concentration, Hall effects, Excess carries, PN junction
Text Book :

"Solid State Physics for Engineering & Materials Science," by John McKelvey, Krieger Publishing, ISBN 0-89464-436-X

"Principles of Electronic Materials and Devices," by S. O. Kasop, McGraw Publishing, 3rd edition, ISBN 007-124458-1

Handouts will be provided

Course Outline

1. Classical Free electron in metals (9/14)
2. Classical Physics: Wave properties and behaviors/History of Quantum Mechanics (9/21)
3. Quantum Mechanics: Wave Mechanics/Uncertainty principles/1D infinite/finite potential wells (10/05)
4. Quantum Mechanics: Tunneling of particles/Density of states (10/12)
5. Statistical Mechanics: Distribution function (10/19)
6. Designated topic presentation 1 (10/26)
7. Exam 1 (11/02)
8. Quantum Mechanics for crystals: Bloch Theorem/Semiconductor properties: Carrier concentration and conductivity (11/9)
9. Semiconductor Materials Properties: Hall Effects and excess carriers (11/16)
10. Lab practice: Electrical Measurement: Ohmic contacts/sheet resistance (11/23)
11. PN junction (11/30, 12/07)
12. Lab practice: Electrical measurement: PN diodes (12/14)
13. Designated topic presentation 2 (12/21)
14. Designated topic presentation 3 (12/28)

15. Exam 2 (1/4)
16. Final Presentation (1/11) Research Topics must be selected as “Novel 2D-semiconductor materials” published in Nature/Science series journals.

Grading: Exam 1- 25%, Exam 2- 25%, Designated topic presentation 15%, Final presentation 15%, Lab practicing with reports 15%, attendance & contribution to the class 5%.

1. For the Exam 1and Exam 2: Closed book exams.
2. For the designated topic presentation: students will present a designated topic as in the lecture materials and will be asked questions by the instructor and the class.
3. For the Lab practicing: Electrical measurements with written reports including the principle, measurement setup and steps, results and discussion, and conclusion.
4. For the Final presentation: Each student is allowed to give a talk in 15 mins and the Q & A in 5 mins. The grade for the presentation will be assessed by the whole class. English is required for the presentation. Language fluency may be considered in grading. Students need to present one major paper and include a few references in the presentation. Research topics should be the “Novel 2D semiconductor materials” published in Nature/Science series journals”. Students are required to present the topic by utilizing the knowledge they have learned in this class. The significance, organization, depth/scientific sound, speaking fluency, and Q&A will be evaluated for the presentation.