The Hong Kong University of Science and Technology

UG Course Syllabus

Semiconductor Physics for Solid-State Electronics

ELEC4510

3 credits

Prerequisite: ELEC 3500

Exclusion: ELEC 4010Q (if taken in Spring 2024-2025)

Name: Man Hoi WONG

Email: eemhwong@ust.hk

Office Hours: By email appointment

Course Description

This course covers fundamental semiconductor physics relevant to modern electronics and provides a physical understanding of advanced solid-state devices. Topics include quantum mechanics of electrons in solids, crystalline structures, band theory of semiconductors, electron statistics and dynamics in energy bands, carrier transport, and semiconductor heterostructures. Background in basic calculus, linear algebra, and probability is assumed.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:
1. Understand basic quantum-mechanical descriptions of electronic solids.
2. Interpret and construct the electronic bandstructures of semiconductor crystals.
3. Extract the properties of semiconductor materials and devices from electronic bandstructures.
4. Analyze semiclassical carrier transport and dynamics in semiconductors.

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

Assessments:

Assessment Task	Contribution to Overall Course grade (%)	Due date
Homework assignments	25% (5×5%)	Weeks 1 to 13
Midterm 1	25%	After Homework #2
Midterm 2	25%	After Homework #4
Final examination	25%	Exam Period

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Homework assignments	ILO1, ILO2, ILO3, ILO4	This task assesses students' ability to apply theoretical knowledge discussed in the lectures to synthesize well-argued solutions for complex practical problems.
Midterms	ILO1, ILO2, ILO3	This task assesses the students' understanding of the lecture materials, including their ability to explain fundamental concepts.
Final examination	ILO1, ILO2, ILO3, ILO4	This task provides a comprehensive assessment of the students' mastery of the core subject materials discussed throughout the course.

Grading Rubrics

Detailed solutions and marking schemes for all assessment tasks will be outlined. Students can refer to these rubrics to understand the criteria used for grading.

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates mastery of the subject matter and exceptional creativity or critical thinking in developing solutions to unfamiliar problems.
B	Good Performance	Demonstrates solid understanding of the subject matter and competency in problem solving.
C	Satisfactory Performance	Demonstrates adequate understanding of the subject matter and satisfactory problem-solving skills.
D	Marginal Pass	Shows limited understanding of the subject matter and basic ability to analyze problems.
F	Fail	Shows insufficient understanding of the subject matter and a lack of the necessary problem-solving capability.

Course AI Policy

The use of generative AI in completing the assessment tasks is permitted with proper acknowledgement.

Communication and Feedback

Assessment marks of the assessed tasks will be communicated via Canvas within two weeks of submission.

Late Submission Policy

Late submissions will not be accepted without prior consent of the instructor.

Required Texts and Materials

Debdeep Jena, *Quantum Physics of Semiconductor Materials and Devices*, Oxford University Press.

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.

Additional Resources

The following reference texts are on reserve in the university library:

1. E. F. Schubert, *Doping in III-V Semiconductors* (1st Edition), Cambridge University Press.
2. David J. Griffiths and Darrell F. Schroeter, *Introduction to Quantum Mechanics* (3rd Edition), Cambridge University Press.
3. Herbert Kroemer, *Quantum Mechanics for Engineering: Materials Science and Applied Physics* (1st Edition), Pearson.
4. Charles Kittel, *Introduction to Solid State Physics* (8th Edition), John Wiley & Sons.
5. Neil W. Ashcroft and N. David Mermin, *Solid State Physics* (1st Edition), Cengage Learning.