

The Hong Kong University of Science and Technology

UG Course ELEC3500 Syllabus

Title:	Integrated Circuit Devices
Code:	ELEC3500
Credits:	4 units
Pre-requisites:	ELEC2400
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Lecture Hours:	TuTh 10:30AM - 11:50AM, 5583, Lift 27-28
Office Hours:	on Canvas or by appointment

Course Description

This is an introductory course for semiconductor device operation principles and technology in common electronic products such as integrated circuit (IC), digital camera, solar cell, memory elements, smartcard, etc. Topics covered include semiconductor properties, IC fabrication technology, PN junctions, Bipolar Junction Transistors (BJT), MOSFETs, CCD and the future technology trend in the electronic industry. [BLD] Blended learning [SPO] Self-paced online delivery.

List of Topics

1. Properties of semiconductor
2. Device fabrication techniques
3. PN Junction physics and diode design
4. Optical property of PN Junction: solar cell and LED
5. Metal Semiconductor contact
6. Bipolar junction transistor (BJT) basics and characteristics
7. BJT switching and design model
8. MOS Capacitor
9. CCD camera and CMOS active pixel camera
10. Classical MOSFET characteristics
11. Subthreshold MOSFETs
12. Mobility degradation and velocity saturation
13. Short channel effects
14. Scaling Trends and technology direction

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

ILO1: communicate with the language of semiconductors (diode, MOSFET, doping, Fermi-level, drift-diffusion, memory, etc.).

ILO2: describe the basic principles of common circuit active elements and photo-active devices, including solar cells, LEDs, and CCDs.

ILO3: describe how changes in key physical parameters of diodes, MOSFETs, and memory devices affect their characteristics.

ILO4: match a given model to measurement data by selecting relevant parameters.

ILO5: understand basic laboratory operations, including cleanroom and device testing, in the integrated circuits industry.

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
Pre-class questions*	12%	Before each class
In-class exercise problems*	12%	In each class
Quizzes*	18%	Biweekly
Labs*	8%	Week 3, 6, 8, 11
Participation*	10%	Continuously
Final examination*	40%	Final exam week period

* Assessment marks for individual assessed tasks will be released within two weeks of the due date.

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Pre-class questions	ILO1, ILO2, ILO3, ILO5	Assesses students' ability to explain and apply semiconductor concepts, evaluate implications, analyse their role in technology, and synthesize solutions.
In-class exercise problems	ILO1, ILO2, ILO3, ILO5	Evaluates understanding and practical application of device concepts, and the ability to propose improvements.
Quizzes	ILO1, ILO2, ILO3, ILO5	Measures comprehension of key topics and critical thinking in semiconductor technology.
Labs	ILO1, ILO2, ILO3, ILO4	Assesses hands-on skills in device fabrication and testing, and the ability to relate theory to practice.
Class participation	ILO1, ILO2, ILO3, ILO5	Encourages engagement with course material and peers, fostering collaborative learning and discussion.
Final examination	ILO1, ILO2, ILO3	Tests comprehensive understanding and analytical skills across all course topics.

Grading Rubrics

The rubrics below describe the expected performance levels for each assessed task.

Assessed Task	A (Excellent Performance)	B (Good Performance)	C (Satisfactory Performance)	D (Marginal Pass)	F (Fail)
Pre-class questions	Complete 95% of the post-video questions correctly	Complete 90% of the post-video questions correctly	Complete 85% of the post-video question correctly	Complete 80% of the post-video questions correctly	Complete less than 80% of the post-video question correctly
In-class exercise problems	Submit and answer 90% of the in-class questions correctly.	Submit and answer 80% of the in-class questions correctly.	Submit and answer 70% of the in-class questions correctly.	Submit and answer 60% of the in-class questions correctly.	Submit and answer less than 60% of the in-class questions correctly.
Quizzes	Answer 70% of the in-class quiz questions correctly.	Answer 60% of the in-class quiz questions correctly.	Answer 50% of the in-class quiz questions correctly.	Answer 40% of the in-class quiz questions correctly.	Answer below 40% of the in-class quiz questions correctly.
Labs	Complete the lab reports with 90% accuracy	Complete the lab reports with 80% accuracy	Complete the lab reports with 70% accuracy	Complete the lab reports with 60% accuracy	Complete the lab reports less than 60% accuracy
Class participation	Complete 95% of the assigned work, regardless of correctness	Complete 90% of the assigned work, regardless of correctness	Complete 85% of the assigned work, regardless of correctness	Complete 80% of the assigned work, regardless of correctness	Complete less than 80% of the assigned work
Final examination	Answer 70% of the exam questions correctly	Answer 60% of the exam questions correctly	Answer 50% of the exam questions correctly	Answer 40% of the exam questions correctly	Answer less than 40% of the exam questions correctly

Final Grade Descriptors

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive grasp of subject matter, expertise in problem-solving, and significant creativity in thinking. Exhibits a high capacity for scholarship and collaboration, going beyond core requirements to achieve learning goals.
B	Good Performance	Shows good knowledge and understanding of the main subject matter, competence in problem-solving, and the ability to analyse and evaluate issues. Displays high motivation to learn and the ability to work effectively with others.
C	Satisfactory Performance	Possesses adequate knowledge of core subject matter, competence in dealing with familiar problems, and some capacity for analysis and critical thinking. Shows persistence and effort to achieve broadly defined learning goals.
D	Marginal Pass	Has threshold knowledge of core subject matter, potential to achieve key professional skills, and the ability to make basic judgements. Benefits from the course and has the potential to develop in the discipline.
F	Fail	Demonstrates insufficient understanding of the subject matter and lacks the necessary problem-solving skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline.

Course AI Policy

Use of generative artificial intelligence tools is allowed in all activities except for in-class quizzes and final exam.

Communication and Feedback

Assessment of pre-class questions and in-class questions will be given immediately after submission. Other assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments and class content will include specific details and areas for improvement will be communicated in classes and through discussion in canvas. Students who have further questions about the feedback, including marks, can bring the problem to the instructor for discussion.

Resubmission Policy

No resubmission.

Required Texts and Materials

Lecture notes and pre-recorded videos distributed through the Canvas course website.

Reference Resources

Chenming Calvin Hu, Modern Semiconductor Devices for Integrated Circuits, Pearson, 2010.

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.