The Hong Kong University of Science and Technology

UG Course ELEC3500 Syllabus

Title: Integrated Circuit Devices

Code: ELEC3500

Credits: 4 units

Pre-requisites: ELEC2400

Name: Scottie MAN

Email: eescottie@ust.hk

Lecture Hours: TuTh 04:30PM – 05:50PM, RM6555, Lift 29-30

Course Description

This is an introductory course for semiconductor device operation principles and technology in common electronic products such as integrated circuit (IC), camcorder, solar cell, memory elements, smartcard, etc. Topics covered include semiconductor properties, IC fabrication technology, PN junctions, MOSFETs, CCD, memory devices, 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. MOS Capacitor
7. CCD camera and CMOS active pixel camera
8. Classical MOSFET characteristics
9. Subthreshold MOSFETs
10. Mobility degradation and velocity saturation
11. Short channel effects
12. Scaling Trends and technology direction
13. Memory devices
14. More than Moore

Intended Learning Outcomes (ILOs)

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

1. communicate with the language of semiconductor (diode, MOSFET, doping, Fermi-level, drift-diffusion, memory, etc.

2. describe the basic principles of some common circuit active elements plus photo active devices (solar cell, LED, CCD)

3. describe the effects of changing the key physical parameters of diode, MOSFET, and memory on the trend of their characteristics

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

5. understand basic lab operations (including cleanroom and device testing) in 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*	10%	Before class
Homework*	9%	Biweekly
In-course exercise problems*	10%	In class
Quizzes*	15%	Biweekly
Labs*	6%	Monthly
Class participation*	10%	After final exam week
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 ability to explain and apply semiconductor concepts, evaluate implications, analyze their role in technology, and synthesize solutions.
Homework	ILO1, ILO2, ILO3	Tests knowledge application of semiconductor principles and problem-solving skills.
In-course exercise problems	ILO1, ILO2, ILO3, ILO5	Evaluates understanding and practical application of device concepts, and 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 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

Assessed Task	A (Excellent Performance)	B (Good Performance)	C (Satisfactory Performance)	D (Marginal Pass)	F (Fail)
Pre-class questions	Demonstrates excellent understanding of semiconductor concepts and effectively applies them to real-world scenarios.	Shows good understanding of semiconductor concepts with mostly accurate applications.	Provides adequate understanding with some correct applications of semiconductor principles.	Displays minimal understanding with few correct applications of semiconductor concepts.	Lacks understanding and provides incorrect applications of semiconductor concepts.
Homework	Applies IC device concepts expertly, showing deep understanding of PN junctions, MOSFETs, and memory devices.	Applies concepts well, showing good understanding of key devices and technology trends.	Applies concepts adequately with some understanding of basic device principles.	Shows limited application and understanding of IC device concepts.	Fails to apply IC concepts, showing little understanding of devices.

In-course exercises	Demonstrates thorough understanding of device physics and innovative problem solving in scaling trends and technology direction.	Shows strong understanding and effective problem solving in device characteristics.	Demonstrates basic understanding and problem solving in classical MOSFET characteristics.	Displays minimal understanding and struggles with problem solving in device physics.	Lacks understanding and problem solving skills in device physics.
Quizzes	Exhibits excellent comprehension of semiconductor properties and critical thinking in assessing future technology trends.	Demonstrates Good comprehension and critical thinking in semiconductor properties.	Shows satisfactory comprehension and some critical thinking in semiconductor properties.	Displays minimal comprehension and limited critical thinking in semiconductor properties.	Fails to comprehend semiconductor properties and lacks critical thinking.
Labs	Demonstrates excellent practical skills in device fabrication techniques and theoretical application to cleanroom operations.	Shows good practical skills and theoretical application in device testing.	Exhibits satisfactory practical skills with basic theoretical application in IC fabrication.	Displays minimal practical skills and limited theoretical application in IC fabrication.	Lacks practical skills and theoretical application in IC fabrication.
Class participation	Engages actively and insightfully in discussions about semiconductor devices and their societal impact.	Participates well with meaningful contributions to discussions on device applications.	Participates adequately with occasional contributions to discussions on basic devices.	Shows minimal participation and contributions to discussions on devices.	Does not participate or contribute to discussions on devices.
Final examination	Demonstrates comprehensive understanding and analysis of all course topics, including advanced semiconductor and memory device concepts.	Shows strong understanding and analysis of most course topics, including key semiconductor concepts.	Exhibits satisfactory understanding and analysis of core course topics, such as PN junctions and MOSFETs.	Displays minimal understanding and analysis of course topics related to semiconductor devices.	Lacks understanding and analysis of course topics in integrated circuit devices.

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 analyze 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 judgments. 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 provided that the use is declared. Note that the assessment tasks will be evaluated by human beings.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include specific details and areas for improvement. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Resubmission Policy

No resubmission.

Required Texts and Materials

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

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.

Reference Resources

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