City University of Hong Kong
Course Syllabus

offered by College/School/Department of Materials Science and Engineering
with effect from Semester A 2025 /26

Part I Course Overview

Course Title:	**Semiconductor Materials and Devices**
Course Code:	**MSE 6266**
Course Duration:	**One Semester**
Credit Units:	**3**
Level:	**P6**
Medium of Instruction:	**English**
Medium of Assessment:	**English**
Prerequisites: *(Course Code and Title)*	**Nil**
Precursors: *(Course Code and Title)*	**Nil**
Equivalent Courses: *(Course Code and Title)*	**Nil**
Exclusive Courses: *(Course Code and Title)*	**Nil**

Part II Course Details

1. Abstract

(A 150-word description about the course)

This course provides both fundamental and practical knowledge on the properties, design, and applications of semiconductor materials and devices. Designed for students in Materials Science and Engineering, this course addresses the essential areas of semiconductor physics, material properties, device fabrication, and system applications. Emphasis will be placed on understanding the semiconducting properties of both traditional materials such as silicon (Si) and gallium nitride (GaN), as well as emerging materials including zero-dimensional (0D), one-dimensional (1D), two-dimensional (2D) materials, and organic/polymeric materials. In an era where integrated circuits power the economy, drive the development of AI, and are integral to national security, this course also dedicates substantial coverage to the important area of electronic chips.

The course is structured to cover firstly the fundamental theories of semiconductors, such as junction theory, carrier transport, and recombination mechanisms. Then, students will delve into the design and fabrication of various semiconductor devices, including diodes, field-effect transistors (FETs), photodetectors, photovoltaics. Practical aspects of device fabrication, including lithography, doping, and etching techniques, will be thoroughly explored.

Upon completion of the course, students will have acquired a good command of both the theoretical and practical aspects of semiconductor materials and devices. The knowledge gained will be especially applicable to industries such as integrated circuits, optoelectronics, and nanotechnology.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Describe and explain the concepts, preparation, and characterization of semiconductor materials, devices, and circuits used in modern chips.	20%	✓		
2.	Describe the working principles and applications of various types of semiconductor materials and devices.	20%	✓		
3.	Apply the relevant methodologies to evaluate and demonstrate the semiconducting properties of currently used or researched semiconductor materials, devices, and circuits used in modern chips.	20%		✓	
4.	Innovatively apply knowledge of materials science and engineering to design or propose new semiconductor materials, devices, and circuits used in modern chips.	20%			✓
5.	Discuss state-of-the-art development in the relevant areas and to form opinions on specific issues.	20%	✓		
** If weighting is assigned to CILOs, they should add up to 100%.*		100%			

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Learning and Teaching Activities (LTAs)

(LTAs designed to facilitate students' achievement of the CILOs.)

LTA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4	5		
1.	Lectures	✓	✓	✓	✓	✓		2 hrs
2.	Tutorial	✓	✓	✓	✓	✓		1 hrs

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting*	Remarks
	1	2	3	4	5			
Continuous Assessment: 50%								
Assignments		✓	✓	✓	✓		20%	
Midterm Tests	✓	✓	✓				30%	
Examination: 50%								
Examination (Duration: 2h)	✓	✓	✓	✓			50%	
** The weightings should add up to 100%.*							100%	

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Assignment(s)	UNDERSTANDING concepts of semiconductor materials and devices, their working principles, characterization techniques, and applications.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Midterm	CAPACITY to solve an engineering problem related to semiconductor materials and device design.	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Examination	ABILITY to ANALYSE problems and EXPLAIN engineering concepts related to semiconductor materials and devices.	High	Significant	Moderate	Basic	Not even reaching marginal levels

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Assignment(s)	UNDERSTANDING concepts of semiconductor materials and devices, their working principles, characterization techniques, and applications.	High	Moderate	Basic	Not even reaching marginal levels
2. Midterm	CAPACITY to solve an engineering problem related to semiconductor materials and device design.	High	Moderate	Basic	Not even reaching marginal levels
3. Examination	ABILITY to ANALYSE problems and EXPLAIN engineering concepts related to semiconductor materials and devices.	High	Moderate	Basic	Not even reaching marginal levels

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

(An indication of the key topics of the course.)

Part A: Semiconductor Materials

1. Introduction to Semiconductor Materials
2. Fundamental Theories
3. Carrier Transport in P/N Junctions
4. Traditional Semiconductor Materials
5. Emerging Semiconductor Materials

Part B: Semiconductor Devices

6. Diodes
7. Field-Effect Transistors (FETs)
8. Advanced Semiconductor Devices
9. Integrated Circuits Fabrication Techniques
10. Device Characterization Techniques

Part C: Systems Applications of Semiconductor Devices

11. Device and System Applications
12. Emerging Trends and Future Directions

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	Sze, Simon M., and Kwok K. Ng. *Physics of Semiconductor Devices*. 3rd ed., Wiley-Interscience, 2006. ISBN: 978-0471143239.
2.	Neamen, Donald A. *Semiconductor Physics and Devices*. 4th ed., McGraw-Hill Education, 2011. ISBN: 978-0073529585.
3.	Streetman, Ben G., and Sanjay Banerjee. *Solid State Electronic Devices*. 7th ed., Pearson, 2015. ISBN: 978-0133356038.
4.	Pierret, Robert F. Advanced Semiconductor Fundamentals. 2nd ed., Pearson, 2002. ISBN: 978-0130617927.
5.	Pierret, Robert F. Semiconductor Device Fundamentals. 2nd ed., Pearson, 1996. ISBN: 978-0201543933.
6.	Pierret, Robert F. Advanced Semiconductor Fundamentals. 2nd ed., Pearson, 2002. ISBN: 978-0130617927.
7.	Taur, Yuan, and Tak H. Ning. Fundamentals of Modern VLSI Devices. 2nd ed., Cambridge University Press, 2009. ISBN: 978-0521832946.