City University of Hong Kong
Course Syllabus

offered by Department of Electrical Engineering
with effect from Semester B in 2024/2025

Part I Course Overview

Course Title:	Advanced CMOS Technology
Course Code:	EE5430
Course Duration:	One Semester (13 weeks)
Credit Units:	3
Level:	P5
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

This course aims to provide the students with advanced CMOS technology knowledge required for VLSI circuits and system designs. Emphasis is placed on understanding the characteristics and limitations of nanoscale CMOS devices and the fabrication processes. The students will also be provided with hands-on experience in device designs and process simulations using the state-of-the-art CAD tools.

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 the processes and techniques used in both Analog and Digital CMOS device and circuit fabrication.		✓		
2.	Discuss the limitations and their solutions of CMOS devices for different types of integration.		✓		
3.	Derive the model equations for characterizing the short-channel effects, and figures of merit of CMOS transistors, in analog or digital domain.		✓		
		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				
Lecture	The students will be introduced to CMOS technology, in both digital and analog circuit designs, with more in the analog domains.	✓	✓	✓				3 hrs/wk (*Some of the lectures will be conducted in the laboratory)*
Tutorial	The students will be shown how key concepts are derived based on questions and problem solving	✓	✓					
Laboratory	The students will gain hands-on experience for the latest circuit design technology and device and circuit simulation techniques	✓	✓	✓				
Case study	The students will practice presentation and group discussion skills and gain knowledge on various technology options.	✓	✓	✓				

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					
Continuous Assessment: 50%								
At least 1 assignments (assignments, case studies, laboratory experiments etc.)	✓						25%	1 course project will be conducted
Test	✓						25%	1 test will be carried out
Examination: 50% (duration: 2hrs , if applicable)								
							100%	

Remark:

To pass the course, students are required to achieve at least 30% in course work and 30% in the examination. Also, 75% laboratory attendance rate must be obtained.

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. Examination	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level

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. Examination	Achievements in CILOs	High	Medium	Low	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Medium	Low	Not even reaching marginal level

6. Constructive Alignment with Programme Outcomes

PILO	How the course contribute to the specific PILO(s)
1, 2, 3, 4	This course aims to provide students with knowledge in advanced CMOS technology. Upon completion of this course, students will be able to describe current and anticipated trends in the CMOS technology, to evaluate and analyze the new technological options for advanced CMOS integrated circuit fabrication, and basic circuit techniques in both analog and digital domains.
5,6	A mini project is allocated to allow students to practice this type of work which is directly linked to the methodologies learnt in the lectures. Students will be grouped into 2 to 4 a group, and given a chance to practice the use of engineering tools in microelectronics and their communication skills in report writing and demonstrations.

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

1. Keyword Syllabus

Syllabus Outline

Objective: Provide a comprehensive understanding of modern semiconductor devices, focusing on:

- CMOS technology
- MOSFET behavior
- Challenges in circuit integration
- Integration: Combines theoretical knowledge with practical applications.

Syllabus Overview (teaching order may vary)

CMOS Technology and Fabrication Processes:

- Evolution and advancements in silicon electronics
- Moore's Law and the International Technology Roadmap for Semiconductors (ITRS)
- Latest advancements in CMOS technology
- Fundamentals of Fabrication Processes:
- photolithography
- layer deposition techniques
- Plasma etching

Device Modeling and Circuit Design

- Basic Device Modeling:
- Modes of operation for MOS transistors
- Large and small-signal analyses

Analog Circuits:

- Single-transistor amplifiers
- Differential pairs
- Multi-transistor amplifiers
- Various types of current mirrors
- High-frequency transistor circuits
- Basic Operational Amplifiers
- High-frequency operational amplifiers transistor-level design (optional)

- On and off current
- VI metric

Integration Issues:
- Reliability and yield
- Power dissipation and thermal issues
- Economic considerations
- Practical Application

Case Study:
- Analysis of a practical circuit to apply learned theoretical concepts
- Enhancement of real-world technology understanding

Teaching Approach:
- Logical sequence of topics
- Adaptation to class pace and interests
- Building knowledge from basic concepts to complex applications

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.)

1.	Textbooks aren't necessary. Your attendance + notes should be adequate for examination. Below is a list of commonly used references, I have only flipped through a few, though.

2.2 Additional Readings

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

1.	Analysis and Design of Elementary MOS Amplifier Stages (https://github.com/bmurmann/Book-on-MOS-stages), Copyright (c) 2013-2022 National Technology and Science Press, Copyright (c) 2022 Boris Murmann
2.	B. Razavi, "Design of Analog CMOS Integrated Circuits", New York: McGraw Hill.