City University of Hong Kong
Course Syllabus

offered by Department of Physics
with effect from Semester B 2017/18

Part I Course Overview

Course Title:	**Microelectronic Materials and Processing**
Course Code:	**AP6120**
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)*	**AP8120 Microelectronic Materials and Processing**

Part II Course Details

1. Abstract

To provide fundamental understanding of the various processes used in integrated circuit fabrication, with emphasis on the front-end technologies.

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 structure of basic integrated circuits and the processes used to fabricate them			√	
2.	Apply fundamental principles to microelectronics fabrication			√	
3.	Relate technological limitations of integrated circuits to fundamental principles or engineering limitations			√	
4.	Be aware of possible future trends in the processing and structure of integrated circuits		√		
5.	Identify state-of-the-art developments in the relevant area and to form innovative opinions on specific issues.				√
		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 self-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. Teaching and Learning Activities (TLAs)

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

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4	5		
Lectures and Tutorials	Explain the relevant concepts and applications	√	√	√	√*	√*		3 hrs/wk
Mini Project	Perform computer simulation to study ion ranges and implantation parameters	√*	√	√	√	√		3 hrs/wk for 3 weeks
Exercises	Applies knowledge to solve various types of problems including numerical questions	√*	√	√	√	√		3 hrs/wk for 3 weeks

*indirectly

1. In tutorial classes, students will be required to present and discuss on assigned topics, including creative activity in the design of fibre-reinforced composites. In helping students to solve numerical assignment problems, one hour of office hour will be assigned so that a Teaching Assistant will be available to answer questions.
2. Students may be asked to study and submit written reviews on assigned journal articles. In addition, students understanding on the assigned journal articles will be tested in the final examination paper.
3. On top of the hours listed in the TLA Table, students are expected to spend additional hours on the lecture notes, textbooks, etc.

Scheduled activities: 2 hrs lecture + 1 hr tutorial

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: 40%								
Homework	√	√	√		√		10%	
Mini-project		√	√	√	√		15%	
Mid-term quiz	√	√	√	√	√		15%	
Examination: 60% (duration: 2 hours)								
							100%	

5. Assessment Rubrics

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

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Continuous assessment	Ability to understand and explain the relevant materials	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Final Examination	Ability to understand and explain the relevant materials	High	Significant	Moderate	Basic	Not even reaching marginal levels

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

1. Keyword Syllabus

- Semiconductor physics (2 hours)
  Crystal structure, energy states, carrier concentration, energy bands, donors and acceptors, Fermi-Dirac relationship, mobility, resistivity, p-n junctions, recombination, metal-oxide-silicon field effect transistors, CMOS.

- Crystal growth and wafer preparation (2 hours)
  Dislocations, electronic grade silicon, Czochralski crystal growth, impurity segregation, float-zone process, characterization, wafer preparation.

- Epitaxy (2 hours)
  Dynamic read-only memory (DRAM), chemical vapor deposition (CVD), doping, autodoping, defects, molecular beam epitaxy (MBE), rapid thermal processing, silicon-on-insulator (SOI).

- Oxidation (2 hours)
  Deal-Grove model, experimental fits, influencing factors, plasma oxidation, oxide properties.

- Lithography (2 hours)
  Cleanroom, optical lithography, equipment, masks, photoresists, pattern transfer, electron beam lithography, x-ray lithorgraphy, ion beam lithography.

- Etching (2 hours)
  Wet chemical etching, dry etching, plasma etching, reactors, ion-assisted reactions, lift-off.

- Polysilicon and dielectric film deposition (2 hours)
  Reactor design, reactions, polysilicon deposition, silicon dioxide deposition, silicon nitride and oxynitride deposition.

- Diffusion (3 hours)
  Diffusion theory, constant-surface-concentration diffusion, constant-total-dopant diffusion, dual diffusion, extrinsic diffusion, diffusion in silicon, measurement techniques, oxide masking, lateral diffusion, diffusion in polysilicon.

- Ion implantation (3 hours)
  Ion stopping, range distributions, damage, channeling, recoils, ion instrumentation, implant uniformity and contamination, furnace annealing, rapid thermal annealing, shallow junction formation, silicide and polysilicon, high energy implantation, buried insulator.

- Metallization (2 hours)
  Flat-band voltage, metallization materials, physical vapor deposition (PVD), chemical vapor deposition (CVD), self-aligned silicide, metal plugs, damascene, dual damascene, chemical mechanical polishing, electromigration, metal corrosion.

- Testing, assembly, and packaging (2 hours)
  Testing, wafer preparation, die and wire bonding, flip-chip technique, hermetic and plastic packages, through-hole and surface-mount packages, tape carrier packages.

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.	Semiconductor Devices: Physics and Technology, SM Sze, Wiley 1985.
2.	VLSI Technology (2nd Edition), SM Sze (Editor), McGraw Hill 1988.

2.2 Additional Readings

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

1.	Solid State Electronic Devices (3rd Edition), B. G. Streetman, Prentice Hall 1990.
2.	ULSI Technology, CY Chang and SM Sze (Editors), McGraw Hill 1996.
3.	Journals: IEEE Electron Device Letters IEEE Transactions on Electron Devices Semiconductor International Solid State Technology Applied Physics Letters Journal of Applied Physics