课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	**课程名称 Course Title**	量子计算硅基工艺器件入门 Introduction to Si-Based Quantum Computing (QC) Devices
2.	**授课院系** **Originating Department**	深港微电子学院 / School of Microelectronics
3.	**课程编号** **Course Code**	SME325
4.	**课程学分 Credit Value**	1 学分 / 1 credit
5.	**课程类别** **Course Type**	专业选修课 Major Elective Courses
6.	**授课学期** **Semester**	秋季 Fall
7.	**授课语言** **Teaching Language**	中英双语 English & Chinese
8.	**授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师）** **Instructor(s), Affiliation& Contact** **（For team teaching, please list all instructors）**	陈凯、深港微电子学院、手机 18917520665，邮件: chenk6@sustech.edu.cn Kai Chen, School of Microelectronics, mobile 18917520665, email: chenk6@sustech.edu.cn
9.	**实验员/助教、所属学系、联系方式** **Tutor/TA(s), Contact**	无 NA **（请保留相应选项 Please only keep the relevant information）**
10.	**选课人数限额(可不填)** **Maximum Enrolment（Optional）**	

11.	授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other（Please specify）	总学时 Total
	学时数 Credit Hours	14	2			16

12.	先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	PHY206-15 量子力学 I 或 EE205 半导体器件导论或 SME204 微电子基础 II
13.	后续课程、其它学习规划 Courses for which this course is a pre-requisite	N/A
14.	其它要求修读本课程的学系 Cross-listing Dept.	

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

量子计算经过近 20 年的发展，有望在未来 15 年取得进一步突破。其中硅基工艺器件最具产业化潜力，既是国际微电子巨头 Intel 等日益聚焦的方向，也是国内在量子信息科学（QIS）领域相对薄弱的短板，由于国内微电子产业基础较国际先进水平薄弱，故此前积累也相对较弱，亟需尽快培养具有产业化视野的量子计算优秀人才。 本课程旨在聚焦量子计算硅基工艺器件的入门基础知识，为后续学习和研究打下基础。

After nearly 20 years' development, Quantum Computing (QC) is expected to further breakthrough in next 15 years or so. Among the promising niche area, Si-based process and device approach is focused more and more by international microelectronics leaders such as Intel. It is also a shorthand for China due to its relatively weak Si-based microelectronics infrastructure relative to the international leaders. The build up in this niche field is relatively weeker than other niche areas of Quantume Information Sciences (QIS) in China. This course aims to focus on the introduction of basic knowledge of Si-based QC so that students can be exposed to the niche field as early as possible in their education or training.

16. 预达学习成果 Learning Outcomes

了解量子计算基本原理、硅基工艺器件的基本概念与优势、当前前沿研究热点和未来发展趋势，并建立 CMOS 主流技术发展历程与量子计算的对比参照，和前者对后者研发突破的赋能作用的视野，为未来在此新兴领域的进一步学习和研究打下初步基础。

Educate students to understand the basic concepts of fundamental principles of quantum computing (QC), advantages of Silicon based device and process approach, current research focus and future trend, the parallelism of CMOS technology development and QC roadmap, as well as the empowering of the former to the later in order to establish insight for future study and research in QC area.

17. **课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）**
Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

本课程除介绍量子计算基本原理、器件实现、不同器件与工艺的基本选项、硅基器件的优势，相关工艺集成与超低温建模（4.2K 以下）等基础概念外，还包括当前前沿研究热点和未来发展趋势，并建立 CMOS 主流技术发展历程与量子计算的对比参照，和前者对后者研发突破的赋能作用的视野，为未来在此新兴领域的进一步学习和研究打下初步基础。

Educate students to understand the basic concepts of fundamental principles of quantum computing (QC), device realization, device/process options, advantages of Silicon based device and process approach, associated challenges of process integration and device modelling (below 4.2K). In addition, current research focus and future trend in the niche area will be discussed. Furthermore, the parallelism of CMOS technology development and QC roadmap, as well as the empowering of the former to the later will be introduced to establish insight for future study and research in QC area.

第 1-2 周：量子计算基本概念介绍；

第 3-4 周：量子计算的器件实现与不同选择的特点和优劣势；

第 5-6 周：硅基量子计算器件的特点及其优势；

第 7-8 周：硅基量子计算相关的工艺集成与超低温 CMOS 器件建模等相关领域；

第 9-10 周：超低温 CMOS 器件建模；

第 11-12 周：CMOS 主流技术与量子计算的参照比较与赋能作用；

第 13-14 周：硅基量子计算当前研究方向与趋势；

第 15-16 周：选题讨论+学期论文+口头报告；

第 17-18 周：期末考试。

1st-2nd week: Introduction to basic concepts of Quantum Computing (QC);

3rd-4th week: Device realization of QC, QC device options and their associated characteristics, respectively;

5th-6th week: Silicon based QC devices and its pros and cons;

7th-8th week: related topics to Silicon based QC devices such as CMOS process integration;

9th-10th week: Cryogenic CMOS device modelling;

11th-12th week: CMOS mainstream technology vs. QC， their parallelism and empowering of the former to the later;

13th-14th week: Silicon based QC device current research results and future trend;

15th - 16th week: Term paper and oral presentations;

17th-18th week: Final exam.

18. **教材及其它参考资料 Textbook and Supplementary Readings**

自编，适当选用专业会议和期刊的最新论文以及公开的各国政府关于量子信息科学（QIS）特别是量子计算的政策文件，以介绍当前动态及发展趋势。

Compile by lecturer, partially select from published conference and journal papers and government documents, including most recent materials to reflect dynamics and progresses.

课程评估 ASSESSMENT

19.

评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance		60%		
课堂表现 Class Performance				
小测验 Quiz				
课程项目 Projects				
平时作业 Assignments				
期中考试 Mid-Term Test				
期末考试 Final Exam		15%		
期末报告 Final Presentation	含 presentation	25%		
其它（可根据需要改写以上评估方式） Others (The above may be modified as necessary)				

20. 记分方式 **GRADING SYSTEM**

☐ A. 十三级等级制 **Letter Grading**
☑ B. 二级记分制（通过/不通过） **Pass/Fail Grading**

课程审批 REVIEW AND APPROVAL

21. **本课程设置已经过以下责任人/委员会审议通过**
This Course has been approved by the following person or committee of authority