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**	模拟集成电路 Fundamentals of Integrated Circuit I- Analog Integrated Circuit
2.	**授课院系 Originating Department**	深港微电子学院 School of Microelectronics
3.	**课程编号 Course Code**	SME211
4.	**课程学分 Credit Value**	4
5.	**课程类别 Course Type**	专业基础课 Major Foundational Courses
6.	**授课学期 Semester**	春季 Spring /秋季 Fall
7.	**授课语言 Teaching Language**	英文 English / 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）**	高源，助理教授，深港微电子学院 Yuan GAO, Assistant Professor, School of Microelectronics, Email：gaoy@sustech.edu.cn; 方小虎，助理教授，深港微电子学院 Xiaohu FANG，Assistant Professor, School of Microelectronics, Email：fangxh@sustechedu.cn
9.	**实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact**	刘欢，实验员，深港微电子学院，13923875673 Huan LIU, laboratory technician, School of Microelectronics, contact phone number: 13923875673
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	48		32		80

12.	先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	SME103（或 EE104）电路基础 SME103（Or EE104）Fundamental of Electric Circuits;
13.	后续课程、其它学习规划 Courses for which this course is a pre-requisite	
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

本课程与数字集成电路是微电子专业本科生的两门专业基础课，其讲授内容是深港微电子学院先导课程 SME102 分别在模拟和数字集成电路设计两个重要基础方向的延伸和进阶。本课程针对传统板级模拟电路的功能逐渐在芯片级集成化的大趋势，在保留传统模拟电路和系统分析和设计的基础上，将重点专注于相关设计的芯片实现，同时穿插引入集成电路设计的基本概念和方法学，为学生后续深入学习集成电路设计方向专业核心课程和从事相关领域研究打牢基础。课程主要内容包括：

1. 电子技术及集成电路技术的发展历程；
2. 集成电路中常用电子元器件的工作原理和电路模型；
3. 模拟放大器和集成运算放大器的工作原理及分析方法；
4. 集成电路中通用电路的信号和频率响应分析方法；
5. 模拟电路模块实现及其在集成电路中应用实例介绍；
6. 集成电子电路的计算机辅助分析和设计。

此外，本课程还根据课程所讲授理论知识配套了相应的项目实验，从而让学生直观认识常用集成电路及其外部元器件，熟悉常用测试仪器的使用方法，学习模拟电路故障的判断与排除方法，并帮助学生在此基础上完成一个完整小型模拟电路系统的方案设计、PCB 原理图和版图设计、PCB 焊接、测试及故障排除的完整流程，最终完成项目展示及报告撰写。

This course (*Fundamentals of Integrated Circuit I*, SME201) and *Fundamentals of Integrated Circuit II* (SME202) together are two major foundational courses for the undergraduates majoring in microelectronics. They are the extensions of SME102 in two important aspects—analog and digital integrated circuit design. This course (SME201) is mainly about the anlaog circuits and analog integrated circuits. As more and more conventional board-level analog functional circuits are gradually integrated at the chip level, this course focuses on the chip implementation of analog circuits and systems besides the introduction of the fundamental analysis and design methods of analog circuits. In addition, the concepts and methodology of IC design are also included in this course, which lays a solid foundation for the students in their following course study and research in IC design field. The main content of the course includes:

1. The history of electronic and integrated circuit technology;
2. Working principles and circuit models of commonly used integrated electronic components;
3. Working principles and analysis method of the analog amplifier and integrated operational amplifier;
4. Analysis methods for signal and frequency response for integrated circuits;
5. The implementation of analog circuit modules and the introduction of examples in IC design;
6. Computer-aided analysis and design of integrated electronic circuits.

In addition, a lab project is also designed with the theoretical knowledge taught in the course, so that students can

intuitively understand commonly used integrated circuits and their external components, familiarize themselves with the commonly used test instruments and learn how to debug their analog circuits. Then, they will complete the whole process of design, analysis, and implementation of a small analog circuit system, and finally, complete the project demonstration and report writing.

16. 预达学习成果 Learning Outcomes

通过这门课程的理论学习和相关项目实验的动手实践，学生能够

1. 掌握分立和集成系统中的模拟电路的基本概念、基本电路和基本分析方法；
2. 掌握模拟电路中的工程定性分析和近似分析的方法；
3. 了解由分立器件搭建的板级模拟电路和模拟集成电路的实现差异；
4. 了解模拟电路在板级和集成电路中的应用实例；
5. 通过课程项目实验了解常用集成电路及其外部元器件，熟悉模拟电路设计流程，掌握相关设计软件的使用。
6. 通过课程项目实验掌握模拟电路测试的方法以及故障判断和排除方法。

After completing the lectures and the lab project of this course, the students will have the ability to

1. Understand the basic concepts, circuits, and analysis methods of analog circuits in discrete and integrated systems;
2. Master the methods of qualitative analysis and approximate analysis in analog circuits;
3. Understand the difference between board-level analog circuits built by discrete devices and analog integrated circuits;
4. Understand the application examples of analog circuits at the PCB level and IC level;
5. Understand commonly used integrated circuits and their external components, and be familiar with the design process and software of analog circuits.
6. Master the methods of analog circuit testing, fault judgment, and troubleshooting techniques through lab project.

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.)

理论课程内容安排如下 (Course contents for the lectures)：

1. 电子技术发展历程及模拟电路与模拟集成电路简介（2 学时）；
   Introduction to history of electronics; introduction to analog circuits and analog ICs (2 hours);
2. 模拟集成电路中的常用半导体器件工作原理及电路模型（4 学时）；
   Working principles and models of the semiconductor devices used in analog integrated circuits (4 hours);
3. 集成电路中有源器件和无源器件的实现（2 学时）；
   Implemenation of active and passive devices in integrated circuits (2 hours);
4. 单管放大电路设计与分析（8 学时）；
   Design and analysis of single-transistor amplifiers (10 hours);
5. 差分放大电路设计与分析（4 学时）；
   Design and analysis of differential amplifiers (6 hours);
6. 多级放大电路设计与分析（4 学时）；
   Design and analysis of multi-stage amplifiers (6 hours);
7. 集成运算放大器基本工作原理（2 学时）；
   Working principles of operational amplifiers (2 hours);
8. 集成运算放大器的频率响应及反馈电路分析（10 学时）；
   Frequency response and feedback analysis of operational amplifiers (10 hours);

9. 基于集成运算放大器的模拟运算电路（4 学时）；

Analog comuptation circuits with operatioanl amplifiers

10. 滤波器和振荡器（4 学时）；

Implementation of filters and oscillators (4 hours);

11. 模拟电路在集成电路中的应用实例：AD 转换电路, DA 转换电路, 开关电源电路等（4 学时）。

Design examples of analog integrated circuits：AD converters, DA converters and switching power converters (4 hours).

项目实验内容安排如下 (Course contents for the lab project)：

1.认识常用集成电路及其外部元器件及熟悉常用测试仪器的使用方法（4 学时）；

Understand the commonly used integrated circuits and their external components and be familiar with the use of commonly used test instruments (4 hours);

2.熟悉板级模拟电路设计流程和 PCB 设计软件使用方法（6 学时）；

Familiar with the PCB-level analog circuit design process and PCB design software (6 hours);

3.学生在熟悉测试仪器，掌握测试方法和设计软件的基础上，可选择课程参考题目或自拟题目完成一个小型电路系统的项目设计，并完成测试和展示。具体内容包括：通过从所学理论知识以及查找资料完成电路结构及元器件选型；电路的基本分析；PCB 原理图及版图设计；在制作好的 PCB 上完成元器件的焊接；进行测试及故障排除；作品展示；撰写报告（22 学时）。

Students will work on a small analog system (choose from topics provided by the instructor or designed by themselves). They need to complete circuit structure and component selection with the knowledge they learned, analyze the circuits, design the PCB schematic and layout. Then, after completing soldering on the fabricated PCB, they also need to test, debug, and demonstrate and report on this system. (22 hours)

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

教材 Textbooks：

1. Microelectronic Circuits, 8th Edition, Adel S Sedra & Kenneth C Smith & Tony Chan Carusone & Vincent Gaudet, Oxford University Press, 2019.

2. Design of Analog CMOS Integrated Circuits, 2nd Edition, Behzad Razavi, McGraw-Hill, 2017.

3. 模拟电子技术基础，第五版，童诗白 华成英编，高教出版社，2015 年。

参考书 References：

1. Analysis and Design of Analog Integrated Circuits, 5th edition, P. R. Gray, P. J. Hurst, S. H. Lewis, and R. G. Meyer, Wiley, 2009.

2. 电子技术基础，第六版，康华光 编，高等教育出版社，2014 年。

3. Troubleshooting Analog Circuits: Edn Series for Design Engineers, By Robert A. Pease, Butterworth-Heinemann,1991.

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				
课堂表现 Class Performance				

小测验 **Quiz**		10		
实验项目 **Lab Projects**		20		
平时作业 **Assignments**		10		
期中考试 **Mid-Term Test**		25		
期末考试 **Final Exam**		35		
期末报告 **Final Presentation**				
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

方小虎