

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	CMOS 模拟集成电路设计 CMOS Analog Integrated Circuit Design
2.	授课院系 Originating Department	深港微电子学院 School of Microelectronics
3.	课程编号 Course Code	SME307
4.	课程学分 Credit Value	3
5.	课程类别 Course Type	专业核心课 Major Core 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 (For team teaching, please list all instructors) Instructor(s), Affiliation & Contact	潘权 助理教授、深港微电子学院、panq@sustech.edu.cn
9.	实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact	待公布 To be announced
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	32		32		64
12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	SME201 集成电路基础 I Fundamentals of Integrated Circuit I 或 EE201-17 模拟电路 Analog Circuits 或 SME204 微电子基础 II Fundamentals of Microelectronics II 或 EE204 半导体器件导论 Introduction to Semiconductor Devices				
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

This course mainly teaches analog CMOS integrated circuit design theory, including the basis of MOS devices, basic CMOS amplifying circuit, frequency domain characteristics of CMOS amplifier circuit and CMOS differential amplifier circuit, CMOS circuit noise analysis, CMOS circuit feedback regulation, integrated CMOS op-amp design and the stability of CMOS integrated circuit and phase compensation, etc. At the same time, this course will show the research status of CMOS analog integrated circuits, and teach design techniques and experiments with the help of EDA tool, Cadence.

本课程主要讲授 CMOS 模拟集成电路设计的理论，包括金属氧化物半导体器件的相关原理、CMOS 基本放大电路、CMOS 放大电路的频域特性、CMOS 差分放大电路、CMOS 电路噪声分析、CMOS 电路的反馈调节、CMOS 集成运放设计、CMOS 集成电路的稳定性判断及相位补偿等；同时本课程将展示 CMOS 模拟集成电路的研究现状，以及基于 EDA 工具 Cadence 教授设计技术和实验课程。

16. 预达学习成果 Learning Outcomes

1. Understand the basic knowledge of MOS devices;
 2. Be proficient in the operation principles of common analog CMOS integrated circuits;
 3. Be proficient in the analog CMOS integrated circuit analysis and design skills;
 4. Be skilled in using EDA tools to design basic analog CMOS integrated circuits.
- 1.清楚地理解 MOS 器件的基础知识；
 - 2.熟练掌握常见 CMOS 模拟集成电路的工作原理；
 - 3.熟练掌握 CMOS 模拟集成电路的分析和设计技能；
 - 4.熟练地利用 EDA 工具设计基本的 CMOS 模拟集成电路。

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.)

理论课主要内容：

Course Content:

- CMOS 模拟集成电路设计简介 Introduction to design of analog CMOS integrated circuit design

(2 hours)

介绍 CMOS 模拟集成电路的背景知识和本课程的科学意义，并解释常见概念 Introduction to the background knowledge of analog CMOS integrated circuits and the scientific significance of this subject, and explains the common concepts.

- 金属氧化物半导体器件的相关原理 Basic MOS devices (3 hours)

介绍金属氧化物半导体器件的工作原理和基础知识，包括电流/电压特性、器件建模等 Introduction of basic MOS device working principle and basics, including Current/Voltage characterization and device modeling.

- CMOS 基本放大电路 Basic CMOS amplifier circuit (3 hours)

解释多种不同的 CMOS 基本放大电路的工作原理，包括 CS、CG、CD 电路 Explain different types of CMOS basic amplifier circuits and their working principle, including CS, CG, and CD stages.

- CMOS 差分放大电路 CMOS differential amplifier circuit (2 hours)

分析基本的 CMOS 差分放大电路的工作原理，包括定性分析、定量分析等 Analysis of basic CMOS differential amplifier circuit, including qualitative analysis, quantitative analysis and so on.

- CMOS 电流镜 CMOS current mirror (2 hours)

介绍各类 CMOS 电流镜，包括基准电流源/共源共栅/镜像负载等架构 Introduction to CMOS current mirrors, including reference current source/common source common gate/mirror load.

- CMOS 放大器的频率特性 Frequency characterization of CMOS amplifiers (3 hours)

介绍密勒定理和零极点分析等 Introduction to Miller's theorem and analysis of zeros/poles.

- CMOS 电路噪声分析 CMOS circuit noise analysis (3 hours)

介绍 CMOS 电路的噪声类型和产生原因，并介绍消除手段 Introduction to the noise types and causes of CMOS circuits, and the elimination methods.

- CMOS 电路的反馈调节 Feedback regulation of CMOS circuits (4 hours)

简要分析各种 CMOS 电路的反馈结构及负载的影响 Brief analysis of the feedback structure of various CMOS circuits and the influence of load.

- CMOS 集成运放设计 Design of CMOS integrated OPA (2 hours)

介绍 CMOS 集成运放的性能指标和设计思路 Introduction to the performance index and design thinking of CMOS integrated operational amplifier.

- CMOS 集成电路的稳定性判断及相位补偿 Stability analysis and phase compensation of CMOS integrated circuits (2 hours)

分析 CMOS 电路的稳定性、相位裕度和其相位补偿方法 Analysis of the stability, phase margin and phase compensation method of CMOS circuit.

- CMOS 锁相环 CMOS Phase-locked loop (4 hours)

分析 CMOS 锁相环电路的类别、组成和原理 Analysis of the types, composition and principle of CMOS PLL circuit.

- CMOS 模拟集成电路的研究现状 Introduction to the research status of CMOS analog integrated circuits (2 hours)

介绍最新的高速 CMOS 模拟集成电路的结构及研究方向 Introduction to the structure and research direction of the latest high speed analog CMOS integrated circuits.

实验课主要内容:

Lab contents:

- 仿真环境和仿真工具基础知识 Basic knowledge of simulation environment and simulation tools (2 hours)

简要介绍 UNIX 仿真的环境配置和仿真工具 cadence 的背景知识 Brief introduction of UNIX setup and cadence background knowledge

- 金属氧化物半导体场效应晶体管电流/电压曲线特性 MOSFET I/V curve characterization (2 hours)

介绍如何仿真 MOSFET I/V 的特性 Introduction of how to simulate the I/V curves of MOSFET

- 原理图和仿真环境配置 Circuit schematic and configuration of simulation environment (4 hours)

介绍电路原理图的创建及仿真工具的使用 Introduction of schematic build-up and usage of simulation tools

- CMOS 单级放大器 CMOS single-stage amplifiers (6 hours)

仿真三种不同的 CMOS 单级放大器 Simulation of 3 different types of CMOS single-stage amplifier

- CMOS 差分放大电路 CMOS differential amplifier circuit (2 hours)

仿真不同的 CMOS 差动放大电路 Simulation of different types of CMOS differential amplifier circuits

- CMOS 电流镜 CMOS current mirrors (2 hours)

仿真不同的 CMOS 电流镜 Simulation of different types of CMOS current mirrors

- 电感/电阻/电容 Inductor/Resistor/Capacitor (2 hours)

仿真电感/电阻/电容器件，并解释其作用 Learn how to simulate Inductor/Resistor/Capacitor and explain their effects.

- CMOS 放大器的频率特性 Frequency response of CMOS amplifiers (4 hours)

仿真 CMOS 放大器的低频增益和带宽特性 Simulation of amplifiers' gain and bandwidth characterization.

• 课程项目 Course project (8 hours)

课程项目需要学生在期末完成。该课程项目要求学生设计一个满足设计指标的 CMOS 运算放大器。设计指标包括带宽、增益、线性度等。学生需要采用 CMOS 器件，可以采用 CMOS 电流镜，电容，电感和电阻等器件，可以采用多级放大电路。学生必须结合本课程中学到的理论知识，在理论的指导下完成分析，设计，仿真，最终完成课程项目的报告。

Course projects are required to be completed by the end of the semester. This course project requires students to design a CMOS operational amplifier that meets the design criteria. The design criteria include bandwidth, gain, linearity, etc. Students are required to use CMOS devices, including MOSFET, CMOS current mirrors, capacitors, inductors resistors and more. Multistage amplifier is allowed. Students must use the theoretical knowledge learned in this course to do the analysis, design, simulation, and finally complete the report of the course project.

注意事项:

课程最后考察的项目内容与前面分阶段的培训密切相关。

Note:

The final project is related to each step of the whole lab content.

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

Textbook:

Behzad Razavi, "Design of Analog CMOS Integrated Circuits," McGraw-Hill, 2001.

Reference Books:

Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, and Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits," John Wiley & Sons, 2001.

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		10		
课堂表现 Class Performance				
小测验 Quiz				
课程项目 Projects		35		
平时作业 Assignments		15		
期中考试 Mid-Term Test		40		
期末考试 Final Exam				
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

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