

课程大纲

COURSE SYLLABUS

1.	课程代码/名称 Course Code/Title	射频集成电路与系统设计 Radio-Frequency Integrated Circuits and Systems Design
2.	课程性质 Compulsory/Elective	专业核心课 Major Core Course
3.	课程学分/学时 Course Credit/Hours	3 学分/64 学时 3 credit/64 hours
4.	授课语言 Teaching Language	中英 Chinese/English
5.	授课教师 Instructor(s)	潘权 Pan Quan
6.	先修要求 Pre-requisites	无
7.	教学目标 Course Objectives	
	<p>This course introduces integrated circuits designs for communications. Topics covered include the core RF principles, transceiver architectures, basics of RFIC systems, low-noise amplifiers, passive and active mixers, voltage-controlled oscillators, phase-locked loops, frequency synthesizers, power amplifiers, clock and data recovery, transimpedance amplifier, equalizers, drivers. Intuitions, concepts, and rigorous analysis are presented to help the students master the design skills of communication integrated circuits, which are also intensified through the practical designs delivered in the lab sessions.</p> <p>本课程主要讲授通信集成电路设计的相关原理，包括核心射频电路原理，通信收发机架构，射频系统的基础知识，低噪声放大器，混频器，振荡器，频率综合器，功率放大器；并结合主流 EDA 工具传授设计技术和实验课程。</p>	
8.	教学方法 Teaching Methods	
	<p>讲授理论，开展实验等，期中/期末双实验报告考查</p> <p>Theoretical course with both mid-term and final projects</p>	
9.	教学内容 Course Contents	
	Section 1	<p>通信芯片设计绪论，通信系统发展历程，设计难点，模拟和数字系统，工艺介绍</p> <p>Introduction to communication circuits. A brief history of communication systems, Design bottleneck, analog and digital systems, and choice of technology</p>
	Section 2	<p>UNIX 设置和 Cadence 基础知识，如何登陆服务器开设账号及使用，基础的 Cadence 使用指令</p> <p>UNIX setup and cadence basic, how to login to Cadence server, and use the account, Cadence UNIX commands learning</p>
	Section 3	<p>通信收发机架构，接收机架构，发射机架构，收发机性能测试，各种实际的例子</p> <p>Transceiver architectures, including receiver architectures, transmitter architectures, transceiver performance tests, various case studies</p>
	Section 4	<p>Cadence 原理图的使用，晶体管 I-V 特性曲线分析，电阻电容电感仿真设计，射频系统的基础知识</p>

	<p>Cadence schematic entry, MOSFET I-V curve characteristics, simulations and designs of resistors/capacitors/inductors, basics of RFICs, including matching networks, RF general concepts, and designs of basic passive and active components</p>
Section 5	<p>低噪声放大器设计</p> <ol style="list-style-type: none"> 1. 输入输出匹配; 2. 各类 CMOS LNA 结构的分析和应用 3. LNA 噪声分析 <p>Design of Low-noise amplifier</p> <ol style="list-style-type: none"> 1. Input and output matching; 2. Analysis of different types of CMOS LNAs 3. Noise analysis of LNA
Section 6	<p>ADE 仿真环境, 原理图的绘制和使用方法, 单级放大器的仿真, 差分放大器的仿真, 有源电流镜的仿真</p> <p>Simulation with ADE. Schematic drawing and using methods, simulation of single-stage amplifier, simulation of differential amplifier, and simulation of active current mirrors</p>
Section 7	<p>混频器设计</p> <ol style="list-style-type: none"> 1. 通用设计考虑 2. 各种 CMOS 混频器结构的分析和应用 3. 混频器噪声分析 <p>Design of mixer</p> <ol style="list-style-type: none"> 1. General considerations 2. Analysis of different CMOS mixers design 3. Noise analysis of mixer
Section 8	<p>课程期中报告内容/要求培训和基本的设计方法</p> <p>Mid-term project content/requirement tutorial, basic design methods.</p>
Section 9	<p>频率综合器</p> <ol style="list-style-type: none"> 1. 频率综合器概述; 2. 基本的频率综合器结构; 3. 电荷泵型锁相环设计的设计及其优点。 <p>Frequency Synthesizers</p> <ol style="list-style-type: none"> 1. General considerations; 2. Basic phase-locked loop concepts and architecture and their basic principles; 3. Designs of Charge-pump PLL and introduction of its advantages.
Section 10	<p>课程期中报告和频率综合器#2</p> <ol style="list-style-type: none"> 1. I 型/II 型锁相环的分析; 2. 相位噪声分析;

	<p>3. 频率倍频/分频电路分析</p> <p>Mid-term project & Frequency Synthesizers Part2</p> <ol style="list-style-type: none"> 1. Type I and Type II PLLs; 2. Analysis of phase noise; 3. Frequency division and multiplication
Section 11	<p>振荡器设计</p> <ol style="list-style-type: none"> 1. 概述; 2. 基本的 LC 型振荡器的架构; 3. 压控振荡器的设计; 4. 相位噪声的分析; 5. 正交信号的生成 <p>Design of oscillators</p> <ol style="list-style-type: none"> 1. General considerations; 2. Basic LC oscillator topologies; 3. Voltage-controlled oscillators; 4. Phase noise analysis from different angles; 5. Quadrature signal generation
Section 12	<p>功率放大器#1</p> <ol style="list-style-type: none"> 1. 功率放大器概述; 2. 线性和非线性功率放大器的设计; 3. A 型和 B 型功率放大器的设计和难点 <p>Power amplifiers Part1</p> <ol style="list-style-type: none"> 1. General considerations; 2. Linear and nonlinear PAs; 3. Design and its difficulties of Class A and B PAs
Section 13	<p>期末报告培训，包括报告要求，基本的设计方法等等</p> <p>Final project tutorial about the requirements, report formats, basic design methods, and etc.</p>
Section 14	<p>课程报告实验，功率放大器#2</p> <ol style="list-style-type: none"> 1. C 型功率放大器的设计; 2. 高转换效率的功率放大器的设计; 3. 大信号阻抗匹配的实现; 4. 各种提高电路线性度的设计方法：前馈/反馈等 <p>Project experiments & Power amplifiers Part2</p> <ol style="list-style-type: none"> 1. Design of Class C PAs; 2. High-efficiency power amplifier; 3. Large-signal impedance matching 4. Multiple linearization techniques: Feedforward, feedback, and etc.
Section 15	<p>课程报告实验：需要在 Cadence 仿真环境中具体实现某一个特定的电路结构，并通过仿真验证电路性能</p>

	Project experiments with detailed design contents in Cadence environment. Students are required to choose one specified circuit block and implement it in Cadence and demonstrate its performance.
Section 16	课程期末结题报告（口头报告和正式报告文档） Final project with oral presentation and formal report
10.	课程考核 Course Assessment
	出勤（10%）+期中课程项目（25%）+平时作业(10%)+测试（15%）+期末报告（40%） Attendance (10%)+Mid-Term Projects (25%)+Assignments (10%)+quizzes（15%）+Final Presentation (40%)
11.	教材及其它参考资料 Textbook and Supplementary Readings
	Behzad Razavi, RF Microelectronics, Prentice Hall, 1998. (optional) Thomas H. Lee, The Design of CMOS Radio Frequency Integrated Circuits (2ndEd.), Cambridge University Press, 2004. (Optional)