课程大纲
COURSE SYLLABUS

1.	**课程代码/名称** **Course Code/Title**	先进电源转换器分析与设计 Advanced Power Converters Analysis and Design
2.	**课程性质** **Compulsory/Elective**	专业选修课 Major Elective Courses
3.	**课程学分/学时** **Course Credit/Hours**	3/64 (32 理论 lecutre + 32 实验 lab project)
4.	**授课语言** **Teaching Language**	英 English
5.	**授课教师** **Instructor(s)**	高源 Gao Yuan
6.	**先修要求** **Pre-requisites**	模拟电路、信号与系统 Analog Circuits, Signals and Systems
7.	**教学目标** **Course Objectives**	
	本课程重点讲授包括电感开关电源、电容开关电源、无线功率传输等电源转换系统的拓扑结构、工作原理及其相应控制芯片的设计方法。通过该课程以及实验项目培养学生掌握对不同应用领域电源转换系统基本的分析能力以及结合系统需求设计实现相应芯片的能力。 This course introduces the topologies and principles of power conversion systems for different applications as well as the design techniques for the related controller IC implementation. Three main parts are included: inductive switching converters, capacitive switching converters, and wireless power transfer systems. After the completion of the lectures and the lab project, students should not only be able to analyze the steady and dynamic performance of a power converter but also be capable of designing a transistor-level IC to meet the system requirement.	
8.	**教学方法** **Teaching Methods**	
	讲授 Lectures，习题/辅导/讨论 Tutorials, 实验项目 Lab Project	
9.	**教学内容** **Course Contents**	
	Section 1 (2 hours)	Introduction to Power Converter Systems and Applications
	Section 2 (4 hours)	Inductive Switching Converters: power stage steady state analysis, volt-second balance equation, operation modes, efficiency analysis
	Section 3 (2 hours)	Inductive Switching Converters: voltage mode control, current mode control
	Section 4 (4 hours)	Inductive Switching Converters: feedback and stability, type-I type-II and type-III compensator
	Section 5 (4 hours)	Inductive Switching Converters IC design: error amplifier and compensator, comparator, ramp generator, power transistor and gate drive, active diode, integrated current sensor
	Section 6 (4 hours)	Capacitive Switching Converters: operation principle, efficiency analysis and charge redistribution loss, topologies of step-up and step-down converters
	Section 7 (4 hours)	Capacitive Switching Converters IC design techniques: reconfiguration, multi-phase, interleaving, bottom-plate parasitic capacitor loss reduction, gate drive
	Section 8 (2 hours)	Capacitive Switching Converters: control and regulation

	Section 9 (6 hours)	Wireless Power Transfer: introduction of capacitive and inductive WPT systems, operation principle, compensation design, data communication
	Lab Project (32 hours)	The lab project helps the students to better understand the design and analysis approaches taught in the lectures with a practical design procedure of switching power converter IC from the design specifications to the transistor level implementation. The lab project includes: 1. Learn to use the EDA tools (i.e. Cadence spectre) for IC design and learn to be familiar with the basic simulation methods. (4 hours) 2. Learn to design and simulate the power stage of a monolithic switching converter. (4 hours) 3. Learn to run simulations of PWM DC-DC converter with the PSS/PTSB analysis approach. (2 hours) 4. Design the commonly used building blocks in the controller of a power converter IC, such as Error amplifier, comparator, relaxation oscillator, and ramp generator (10 hours) 5. Design a power converter chip in the transistor level, which includes the key blocks and meets the given specs on efficiency, input/output voltage range, loop bandwidth, and phase margin, and transient response time. Students need to give a presentation about their project and also write a project report. (12 hours)

10. 课程考核
Course Assessment

出勤及课堂表现 Attendance and class performance 10%
测试 Quiz 25%
平时作业 Assignments 25%
课程项目及报告 Project and presentation 40%

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

- R. W. Erickson and D. Maksimovic, *Fundamentals of Power Electronics*, 2nd Edition, Springer, 2001.
- Daniel W. Hart, *Power Electronics*, McGraw-Hill, 2009.
- Behzad Razavi, *Design of Analog CMOS Integrated Circuits*, McGraw-Hill, 2000.