University of Utah
Electrical and Computer Engineering Department
ECE 6730: Radio Frequency Integrated Circuit Design

Meeting Times:	Tuesday and Thursday, 9:10-10:30 in WEB 1248
Course Website:	`http://www.ece.utah.edu/~ccharles/ece6730/index.htm`
Textbooks:	"The Design of CMOS Radio-Frequency Integrated Circuits," Thomas H. Lee [**required**], "RF Microelectronics," Behzad Razavi [**optional**]
Prerequisite[1]**:**	ECE 5720: Analog Integrated Circuit Design (or equivalent)
Instructor:	Prof. Cameron Charles (`ccharles@ece.utah.edu`)
Office Hours:	Tuesday, Wednesday, and Thursday, 10:30-11:30 (MEB 4108)

Course Description:

This course will cover the design and analysis of radio frequency integrated circuits (RFICs) for communications. We will begin with an overview of RF and wireless technology, and cover some fundamental concepts in RF design such as nonlinearity, sensitivity, and dynamic range. Matching and impedance transformation networks will be discussed, as well as S-parameters. Following this we will discuss transciever architectures (Heterodyne, Direct Conversion, etc.), and review modulation and upconversion concepts. The latter half of the course will be devoted to a detailed examination of each of the blocks in the transciever architectures discussed: Low Noise Amplifiers, Mixers, Oscillators, Frequency Synthesizers, and Power Amplifiers.

[1] If you are unsure if you meet the prerequisite or would like to take the course despite not meeting it, come and talk to me after class and we can discuss your situation.

Assignments:

There will be 6 assignments throughout the term. Assignments will be distributed in class, and will be due in class one week later. Each assignment will be composed of problems covering the material currently being taught in class. Your lowest assignment grade will be dropped.

Projects:

The project for this class will involve the design and simulation of a down-conversion chain for a radio frequency receiver in a 0.18 μm CMOS process. The project will be split into three subprojects: the first will be to design a low noise amplifier (LNA), the second will be to design a mixer, and the third will be to design a VCO and combine the three blocks into a complete down-conversion chain. Several different performance metrics will be given (noise figure, power, area, linearity), and students will be ranked against one another in each category to determine an overall performance score. Most of the emphasis will be placed on having a well thought-out and justified design approach (i.e., analytical design rather than "SPICE monkeying").

Exams:

There will be an in-class midterm exam and a final exam. Students will be allowed to bring one one page of notes to the midterm and two pages of notes to the final.

Feedback:

I would like to provide students with an opportunity to give anonymous feedback throughout the semester. I have set up an anonymous e-mail account on Gmail that can be used for this purpose. If you have any feedback or changes you would like made to the course format, lectures, project, etc., go to `http:\\mail.google.com` and log in with the user name `ece6730feedback` (the password will be distributed in class). Select my e-mail address under contacts, and send me an e-mail with your suggestions.

Grading:

Assignments	5%
Project	40%
Midterm Exam	20%
Final Exam	35%

Late Policy:

No late homework assignments or projects will be accepted.

Tentative Schedule:

Date	Lecture Topics	Reading	Assignments
Tues. Jan. 13	Introduction, Applications, RF Transceiver Overview	Lee 2.1-2.2, Razavi 1.1-1.5	
Thurs. Jan. 15	RF Concepts: Nonlinearity	Lee 12.6 (omit 12.6.2), 19.2.2, Razavi 2.1	
Tues. Jan. 20	RF Concepts: Noise	Lee 11, 19.2.1, Razavi 2.3	A.1 out
Thurs. Jan. 22	RF Concepts: Sensitivity, Dynamic Range	Lee 12.7, Razavi 2.4	
Tues. Jan. 27	RF Concepts: Passive RLC Networks, Smith Chart	Lee 3, Razavi 2.5	A.1 due
Thurs. Jan. 29	RF Concepts: Modulation	Lee 2.3, Razavi 3.1-3.3	A.2 out
Tues. Feb. 3	Architectures: Receivers	Lee 19.1-19.3, Razavi 5.1-5.2	
Thurs. Feb. 5	Architectures: Receivers (cont'd)		A.2 due
Tues. Feb. 10	No class (ISSCC)		A.3 out
Thurs. Feb. 12	Architectures: Transmitters	Lee 19.4, Razavi 5.3	
Tues. Feb. 17	Circuits: Low Noise Amplifiers	Lee 12.1-12.4, Razavi 6.1 (omit 6.1.3)	A.3 due
Thurs. Feb. 19	Circuits: Low Noise Amplifiers		A.4 out
Tues. Feb. 24	Circuits: Low Noise Amplifiers		
Thurs. Feb. 26	Review		A.4 due
Tues. Mar. 3	Midterm Exam: 9:10-10:30am		P.1 (LNA) out
Thurs. Mar. 5	Circuits: Mixers	Lee 13.1-13.5, Razavi 6.2 (omit 6.2.2)	
Tues. Mar. 10	Circuits: Mixers		
Thurs. Mar. 12	Circuits: Voltage Controlled Oscillators	Lee 17.5-17.6, Razavi 7	P.2 (Mixer) out
Tues. Mar. 17	No class (Spring break)		
Thurs. Mar. 19	No class (Spring break)		
Tues. Mar. 24	Circuits: Voltage Controlled Oscillators		P.1 due, A.5 out
Thurs. Mar. 26	Circuits: Frequency Synthesis	Lee 16,17.7, Razavi 8	
Tues. Mar. 31	Circuits: Frequency Synthesis		A.5 due
Thurs. Apr. 2	Circuits: Frequency Synthesis		
Tues. Apr. 7	Circuits: Frequency Synthesis		P.2 due, P.3 (VCO and system) out
Thurs. Apr. 9	Circuits: Power Amplifiers	Lee 15, Razavi 9	
Tues. Apr. 14	Circuits: Power Amplifiers		A.6 out
Thurs. Apr. 16	Design Example		
Tues. Apr. 21	Design Example		A.6 due
Thurs. Apr. 23	Guest Lecture		
Tues. Apr. 28	Review		P.3 due
Mon. May 4	Final Exam: 8:00-10:00am		