

## ELEC 7190/7196 - Advanced RFIC Design for Wireless Communications

**To be offered in Spring 2010**

**2009 Catalog Data:** ELEC 7190/7196. ADVANCED RFIC DESIGN FOR WIRELESS COMMUNICATIONS (3) LEC. (3). Pr. ELEC 5190 or ELEC 6190. Wireless standards and multi-standard transceiver architectures, SiGe and CMOS RFIC designs for wireless transceivers, digital phase locked loops, software defined radios, phase array radars, and MIMO wireless transceivers.

**Textbook:** none

**Reference Books:**

- *RF and Microwave Circuit Design for Wireless Communications* by Lawrence E. Larson
- *RF Microelectronics* by Behzad Razavi
- *Radio Frequency Integrated Circuit Design* by John Rogers and Calvin Plett
- *Integrated Circuit Design for High-Speed Frequency Synthesis* by J. Rogers, C. Plett, and F. Dai
- Course info located at AU Blackboard site: <https://blackboard.auburn.edu>

**Coordinator:** Fa Foster Dai, Professor, Electrical and Computer Engineering

**Objectives:** The boom of wireless and mobile networks leads to an ever-increasing request for high performance, low power, and low cost radio frequency integrated circuit (RFIC) designs. The advance in silicon and silicon-germanium based technologies has led to highly integrated systems on a chip. RFIC designs for wireless networks provide plenty of design challenges with both academic and commercial values. This course starts with a discussion on various mobile wireless standards and transceiver architectures for multi-standard coexistence (CDMA, GSM, WLAN, DVB, GPS, etc). It then focuses on advanced RFIC designs for wireless transceiver building blocks such as LNA, mixer, VGA, VCO, frequency synthesizers, digital phase locked loops, programmable filters, and so on. This course is aimed to cover the state-of-art technologies in RFIC designs and presents advanced topics on next generation radio platforms including software defined radios, phase array radars, and MIMO wireless transceivers.

**Prerequisite:** ELEC 5190/6190/6196 *Introduction to Digital and Analog IC Design*, or consent of the instructor.

**Topics:** (Classes assumed to be 75 minutes, twice per week)

- Wireless standards and multi-standard transceiver architectures (2 classes)
- Wireless modulation/demodulation and multiple access techniques (2 classes)
- RFIC design fundamentals (3 classes)
- Receiver front-ends (low noise amplifier and mixer) (4 classes)
- Frequency synthesizers (phase detectors, charge pumps, multi-modulus dividers and voltage controlled oscillators) (4 classes)
- All-digital phase lock loops (2 classes)
- Ultra-high speed direct digital synthesizers (2 classes)
- Integrated filters (2 classes)
- Variable gain amplifiers (1 classes)

- MIMO wireless transceivers (2 classes)
- Software defined radios (2 classes)
- Phase array radars (2 classes)
- Project presentations (2 classes)

**Grading:** Students enrolled in ELEC 6196 for distance learning can remotely access the IC design tools through College of Engineering's VPN network. ELEC 6196 students can give their final project presentations by submitting a presentation ppt file and a presentation audio file for grading purpose.

- Project I (10%), Design of a Bandgap Reference. Project topic may vary.
- Project II (10%), Design of a 5GHz LNA for WLAN applications. Project topic may vary.
- Project III (10%), Design of a Double-Balanced Mixer. Project topic may vary.
- Project IV (10%), Design of a 5GHz VCO. Project topic may vary.
- Final Project Report & Presentation (30%), Selected Building Block Designs For Wireless Transceivers
- Final Exam (30%)

**Primary program outcomes related to this course:**

- Outcome 1. Ability to apply knowledge of math, science and engineering to solve problems.
- Outcome 2. Ability to apply in-depth knowledge in one or more disciplines.
- Outcome 3. Ability to design an electrical component or system to meet desired needs.
- Outcome 6. Proficiency in the use of computers and other modern tools to solve engineering problems.
- Outcome 8. Proficiency in communicating ideas and information orally and in writing.
- Outcome 9. Appreciation of the need for, and an ability to learn new concepts as required for the continuing practice of ECE.

**Computer usage:** Cadence® Analog Artistit.

**Justification for Graduate Credit:** This course covers advanced radio-frequency integrated circuit (RFIC) design and related topics that are beyond the scope of undergraduate electronics courses.

**Attendance Policy:** Class attendance is strongly encouraged, and students are responsible for all business conducted in class, but class attendance will not be a factor in determining the course grade

**Special accommodations:** Students who need accommodations are asked to arrange a meeting during office hours the first week of classes, or as soon as possible if accommodations are needed immediately. If you have a conflict with my office hours, an alternate time can be arranged. To set up this meeting, please contact me by E-mail. Bring a copy of your Accommodation Memo and an Instructor Verification Form to the meeting. If you do not have an Accommodation Memo but need accommodations, make an appointment with The Program for Students with Disabilities, 1244 Haley Center, 844-2096 (V/TT).

**Academic Honesty Policy:** All portions of the Auburn University student academic honesty code (Title XII) found in the Tiger Cub will apply to this class. All academic honesty violations or alleged violations of the SGA Code of Laws will be reported to the Office of the Provost, which will then refer the case to the Academic Honesty Committee.

**Prepared by:** Fa Foster Dai      **Date:** Jan 4, 2008.