# Fall 2016 Special Topic

| CRN | Title | Units | Instructor | Days/Time |
|---|---|---|---|---|
| 31815 | 289K – RF Integrated Circuits for Wireless Communications | 4 | Gu | TR 4:40-6:00pm |

**Title- RF Integrated Circuits for Wireless Communications**

**4 units – Fall Quarter**

**Prerequisite:** EEC 132A, EEC 112 or equivalent

**Grading:** Letter; Final exam (40%), mid-term exam (30%), design project (20%), and homework assignments (10%).

**Catalog Description:**
Integrated RF front end circuit design of receivers and synthesizers for wireless communications, such as LNA, mixers, VCO, divider; noise and linearity analysis and specifications; Theory and working mechanism of synthesizers, phase noise analysis and individual block contribution;

**Expanded Course Description:**

**I. Basic concept of RF design for wireless communications**
- A. Review of transistor noise type, model, NF
- B. Device nonlinearity and their effects in RF systems, gain compression, intermodulation, desensitization etc.
- C. System sensitivity and dynamic range
- D. Signal evaluation: EVM, constellation, PAR

**II. RF Transceiver Architecture Analysis and Design**
- A. Review of heterodyne and homodyne architecture
- B. Image rejection receiver, Hartley and Weaver receiver
- C. Polyphase Filter

**III. Integrated Low Noise Amplifier Design**
- A. Input matching for integrated LNA
- B. Integrated LNA topologies, common gate, common source, inductive degeneration LNAs
- C. LNA design examples, transformer coupled, noise cancellation LNAs

**IV. Integrated Mixer Design**

A. Integrated passive and active mixer design and comparison, linearity, noise analysis. Noise folding effects
B. Mixer linearization and noise improvement techniques, source degeneration, offset transconductance

**V. VCO**

A. Review of oscillator and VCO model
B. Phase noise generation mechanism, analysis and effects
C. Quadrature signal generation

**VI. Phase locked loop and Components**

A. Type-I and Type-II charge pump PLL
B. Dividers including static, dynamic and programmable dividers
C. PFD/CP design and nonidealities
D. Phase noise contribution and analysis from individual blocks
E. Integer-N and Fraction-N Synthesizers

**Textbook:**

Behzad Razavi, RF Microelectronics, Prentice Hall, 2012
Thomas Lee, The Design of CMOS Radio-Frequency Integrated Circuits, Cambridge, 2009

**Instructor:** Jane Gu, Omeed Momeni

**Course Overlap:**

This course has minor overlaps with Prof. Momeni's graduate course in Section 1 nonlinearity and dynamic range and Section 2 RF transceiver architecture. Since the topics are very important and fundamental, instructions taught more than once and from different angles are very helpful. Other Sections are either no overlap or complementary with Prof. Momeni's graduate course. For Sections 1 and 3, this course has minor overlaps with EEC132C. EEC132C discusses noise modeling of

microwave transistor, noise figure. This course therefore briefly reviews these topics. EEC132 discusses LNA for microwave and mm-wave. This course focuses on integrated LNA circuits and topologies, which are based on different design angles and use different design approaches. There is minimum overlaps with EEC222. EEC222 focuses on non-linear circuit analysis and power amplifier. This course focuses on receiver and synthesizer design.