Fall 2016

ECE 4880: RF Systems

MWF: 11:15pm – 12:05pm Classroom: Bard 140

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Weekly Events	Monday	Wednesday	Friday
Fall semester starts on 8/25	**8/22** Semester not started	**8/24** Class introduction	**8/26** Review: Maxwell equations
Homework 1 due (Friday 5pm at dropbox)	**8/29** Review: Distributive and lumped-element transmission lines	**8/31** Review: Reflection and impedance in Smith Chart	**9/2** The history of radios
Homework 2	**9/5** Labor Day: no class	**9/7** Functional modules in transceivers: resonator	**9/9** Functional modules in RF transceivers: filters
Homework 3	**9/12** Functional modules in transceivers: amplifiers, LNA and PA	**9/14** Functional modules in RF transceivers: Mixer and others	**9/16** Functional modules in RF transceivers: Data converter
Homework 4	**9/19** Free space and channel modeling	**9/21** Idealized RF designs: Unilateral link budget	**9/23** Matrix representation in signal chain
Homework 5	**9/26** Matrix representation in signal chain	**9/28** Noise figure	**9/30** Noise: mismatch, mixing and image
Evening prelim exam 10/4: 7:30 – 9:30pm Olin Hall 245	**10/3** Introduction to Simulink signal models	**10/5** No Class	**10/7** No Class
	10/10 Fall break: No class	**10/12** No Class	**10/14** Nonlinearity in radio frequency modules
Homework 6	**10/17** Nonlinearity and intermodulation (IM)	**10/19** Interplay between noise and nonlinearity	**10/21** Noise and nonlinearity: desensitization and jamming
Homework 7	**10/24** Noise and nonlinearity: dynamic range	**10/26** Architecture to improve linearity: parallel	**10/28** Architecture to improve linearity: feedthrough and feedback
Homework 8	**10/31** Frequency strategy: Superheterodyne	**11/2** Frequency strategy: Superheterodyne	**11/4** Frequency strategy: Low IF and homodyne
Evening prelim exam 11/8: 7:30 – 9:30pm Olin Hall 245	**11/7** Phase noise in oscillators: sources and adverse effects	**11/9** Phase noise in oscillators: modeling	**11/11** Data converter: type and main effects

Homework 9	**11/14** Data converter: bandwidth and range	**11/16** Local area radios: Wifi, Zigbee, Bluetooth	**11/18** Cellular network: 3G, 4G and 5G
	11/21 No Class	**11/23** Thanksgiving: No class	**11/25** Thanksgiving: No class
Homework 10	**11/28** Broadcasting network: radios and TVs	**11/30** An outlook of RFID	**12/2** An outlook of UWB radio

Course description: This course addresses the design of radio-frequency links in the component view to enable eventual full-duplex, multi-access wireless network. The analysis will reside mostly in the signal (SIMULINK) level instead of the circuit implementation, although the nonideal circuit characteristics will be reflected in the signal representation. Federal Communications Commission (FCC) and Occupational Safety & Health Administration (OSHA) standards will be introduced. Existing standard protocols will be selectively introduced including FM, TV broadcast, Bluetooth, Z-wave, Zigbee and Wi-fi.

Pre-requisites: ECE 3030 or consent of the instructor

Related courses: ECE 4870 (Radar Remote Sensing); ECE 4670 (Digital Communication); ECE 5680 (Wireless Communication); ECE 5790 (RFIC Design).

Logistics: 3 units: Lectures only; 4 units: Lectures and Labs. There are two prelim exams and one final exam.

Office hour: Thursday 4:30pm – 6:00pm

Textbooks:

1. Required: W. F. Egan, *Practical RF System Design*, Wiley 2004.
2. Recommended: T. H. Lee, *The Design of CMOS Radio Frequency Integrated Circuits, 2nd Ed*, Cambridge, 2004. (Selected chapters that treat system aspects only. No transistor circuits will be included).
3. Reference: T. J. Rouphael, *Wireless Receiver Architecture and Design: Antennas, RF, Synthesizers, Mixed Signal and Digital Signal Processing*, Academic Press 2014.
4. Reference: M. Steer, *Microwave and RF Design: A System Approach, 2nd Ed*., 2013, SciTech.

TA hour for SIMULINK help: Thursday 5 – 6 pm in Phillips 303 when necessary.

Grades: (students taking **3 credits**): Homework (20%); first prelim exam (20%); second prelim exam (25%); final exam (35%); (students taking **4 credits**): Homework (15%); first prelim exam (15%); second prelim exam (20%); lab: (20%); final exam (30%).

Course outcomes:

1. The student can analyze the signal flow in a given block diagram of radio transceivers in both analytical and SIMULINK representations.
2. The student can analyze the fundamental tradeoffs in noise, nonlinearity and spectral/component costs in a given FCC-approved wireless system.
3. The student will acquire sufficient design skills for active participation in amateur radio clubs and remote-control robotics.

Final exam: TBA.