

**University of Southern California**  
Ming Hsieh Department of Electrical Engineering

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|-----------------------------------|---|
| <b>Course Number &amp; Title:</b> | EE 632, Integrated Communication Systems                              |
| <b>Units:</b>                     | 3   |
| <b>Semester:</b>                  | Spring 2018   |
| <b>Schedule:</b>                  | Mondays & Wednesdays 10:00 am – 11:50 am                              |
| <b>Location:</b>                  | GFS 111   |
| <b>Instructor:</b>                | Hossein Hashemi   |
| <b>Office:</b>                    | PHE 616   |
| <b>Office Hours:</b>              | Mondays & Wednesdays 8:45 am – 9:45am                                 |
| <b>Contact Information:</b>       | <a href="mailto:hosseinh@usc.edu">hosseinh@usc.edu</a> , 213-740-3596 |
| <b>Teaching Assistant:</b>        | N/A   |

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**Catalogue Description:**

Analysis and design of high-frequency and high-speed integrated communication circuits at both transistor and system levels. Transceiver architectures, integrated circuit technologies, impedance matching, transmission lines, noise, distortion, wideband amplifiers, low-noise amplifiers, mixers, oscillators, phase-locked loops, power amplifiers.

**Course Description:**

EE 632 covers theory, analysis, and design of radio frequency integrated circuits at the transistor level. The course includes a few design projects as homework assignments and a comprehensive final design project using state-of-the-art semiconductor technologies and computer aided design environments. The principles covered in this course enables designing wireless transceiver building blocks and complete systems.

**Learning Objectives:**

EE 632 is a graduate course covering radio frequency communication systems and circuits. At the completion of the subject students will be able to analyze and design radio frequency

integrated circuits for wide range of applications such as cellular communications, wireless local area networks, and emerging wireless applications.

**Prerequisite:** Analog Circuits (EE 536a, EE 448L, EE 479)

**Main Text Book:** B. Razavi, *RF Microelectronics*, Prentice Hill, 2<sup>nd</sup> Edition, 2012.

**Supplementary Texts:**

- Thomas H. Lee, *The Design of CMOS Radio-Frequency Integrated Circuits*, Cambridge University Press, 2<sup>nd</sup> Edition, 2004.
- D. Pozar, *Microwave and RF Design of Wireless Systems*, John Wiley & sons, 2001.
- Thomas H. Lee, *Planar Microwave Engineering*, Cambridge University Press, 1<sup>st</sup> Edition, 2004.

**Readings:** All lecture notes will be available on Blackboard.

**Grading:**

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|----------------------------|-----|
| Homework & Design Projects | 40% |
| Midterm Exam               | 20% |
| Final Exam                 | 40% |

## Tentative Weekly Schedule

| Week | Date           | Subject                                     | Readings                 | HW           |
|------|----------------|---|--------------------------|--------------|
| 1    | Mon 01/08/2018 | Basic Concepts                              | Chapters 1, 2, 3         | HW 1 Assign  |
|      | Wed 01/10/2018 | Communication Concepts                      |                          |              |
| 2    | Mon 01/15/2018 | Martin Luther King's Birthday               | Chapter 2                | HW 2 Assign  |
|      | Wed 01/17/2018 | Nonlinearity                                |                          | HW 1 Due     |
| 3    | Mon 01/22/2018 | Transceiver Architecture                    | Chapter 4, Lecture Notes | HW 3 Assign  |
|      | Wed 01/24/2018 | Transceiver Architecture                    |                          | HW 2 Due     |
| 4    | Mon 01/29/2018 | Passive Resonators                          | Chapter 2, Lecture Notes | HW 4 Assign  |
|      | Wed 01/31/2018 | Impedance Transformation                    |                          | HW 3 Due     |
| 5    | Mon 02/05/2018 | Passive Devices                             | Chapter 7                | HW 5 Assign  |
|      | Wed 02/07/2018 | Low Noise Amplifier                         |                          | HW 4 Due     |
| 6    | Mon 02/12/2018 | Low Noise Amplifier                         | Chapter 5                | HW 6 Assign  |
|      | Wed 02/14/2018 | Low Noise Amplifier                         |                          | HW 5 Due     |
| 7    | Mon 02/19/2018 | President's Day                             | Chapter 6                | HW 7 Assign  |
|      | Wed 02/21/2018 | Mixer                                       |                          | HW 6 Due     |
| 8    | Mon 02/26/2018 | Mixer                                       | Chapter 6                | HW 8 Assign  |
|      | Wed 02/28/2018 | Mixer Noise                                 |                          | HW 7 Due     |
| 9    | Mon 03/05/2018 | Passive Mixers – Impedance Translation      | Chapter 6                | HW 8 Assign  |
|      | Wed 03/07/2018 | Mid-term Exam                               |                          | HW 7 Due     |
| 10   | Mon 03/12/2018 | Spring Recess                               |                          |              |
|      | Wed 03/14/2018 |   |                          |              |
| 11   | Mon 03/19/2018 | Feedback                                    | Lecture Notes            | HW 9 Assign  |
|      | Wed 03/21/2018 | Feedback – Root Locus                       |                          | HW 8 Due     |
| 12   | Mon 03/26/2018 | Feedback – Oscillator                       | Lecture Notes            | HW 10 Assign |
|      | Wed 03/28/2018 | Oscillator Topologies                       |                          | HW 9 Due     |
| 13   | Mon 04/02/2018 | Oscillator Transient Analysis               | Chapter 8, Lecture Notes | HW 11 Assign |
|      | Wed 04/04/2018 | Oscillator Transient Analysis               |                          | HW 10 Due    |
| 14   | Mon 04/09/2018 | Oscillator Phase Noise Analysis             | Chapter 8, Lecture Notes | HW 12 Assign |
|      | Wed 04/11/2018 | Oscillator Phase Noise Analysis             |                          | HW 11 Due    |
| 15   | Mon 04/16/2018 | Voltage Controlled Oscillator               | Chapter 9                |              |
|      | Wed 04/18/2018 | Phase-Locked Loops – Basics                 |                          | HW 12 Due    |
| 16   | Mon 04/23/2018 | Phase Locked Loops – Type I and Type II PLL | Chapter 9                |              |
|      | Wed 04/25/2018 | Phase Locked Loops – Phase Noise            |                          | HW 12 Due    |

## Homework

Unless otherwise stated, homework assignments are due on Wednesdays at the beginning of the class. Solutions will be posted on the class website on the same day.

Late homework will not be accepted. No exceptions except institution-established emergency reasons; credit for such late homework is with the discretion of the professor.

Limited collaboration in solving homework problems is allowed. This includes reviewing and discussing the problems with current EE 536a students and TA prior to writing down your solution. Everybody has to write his/her own solution independently and make sure to fully understand it. Exchanging solutions, consulting with people other than class members, finding solutions on the web or elsewhere, etc. are not allowed. Violations result in losing the credit for the entire homework set in addition to a significant percentage of the overall course grade, all with the discretion of the professor.

All answers should be clearly and fully justified. If we can't figure out your steps from is turned in, points will be deducted, even if your final answer is correct.

One or more of the homework assignments include design problems as well as the typical analysis problems. Simulation and performance verification of the design problems will be in the Cadence environment.

## Statement on Academic Conduct and Support Systems

### Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* <https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/>. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct/>.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* <http://equity.usc.edu/> or to the *Department of Public Safety* <http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us>. This is important for the safety whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* <http://www.usc.edu/student-affairs/cwm/> provides 24/7 confidential support, and the sexual assault resource center webpage [sarc@usc.edu](mailto:sarc@usc.edu) describes reporting options and other resources.

### Support Systems

A number of USC’s schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* <http://dornsife.usc.edu/ali>, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* [http://sait.usc.edu/academicsupport/centerprograms/dsp/home\\_index.html](http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html) provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* <http://emergency.usc.edu/> will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.