UF EDGE

Electronic Delivery of Gator Engineering

Fall 2016

EE 4306/5320 Analog IC Design I (available on EDGE/ONLINE)

Note: This course shows as "EE4306/Electronics Circuit II" for Undergraduate section, and "EE5320/Bipolar IC Design" for Graduate section. These names will be updated to "Analog IC Design I" later on.

This course explores the fundamentals of the analog IC design, ranging from single stage amplifiers to switched-capacitor networks and multi-stage frequency compensation schemes. Throughout the semester, the students will be introduced to various critical circuits which the analog IC depends upon. The state of the art applications will be discussed for each of these circuits, and the past and future challenges and the roadmap of analog IC will be tackled. In this course, the students will be introduced to Cadence® platform, an industry preferred simulation and layout engine, not only to analyze the provided circuits, but also to design several commonly used structures including switched-capacitor fully differential opamps. An extensive tutorial to Cadence will be provided to help familiarize the students with this simulation platform. The course objective is to provide a thorough background of analog circuits, discuss the real world applications, IC design challenges and prepares students for other areas of analog and digital IC design. ***If you plan to pursue career in IC design, either analog or digital, this course is "a must", and it is recommended by ALL IC design companies.***

Class location & dates:

Location: NEB 201

Tuesdays (1:55 PM - 2:45 PM)

Thursdays (1:55 PM - 3:50 PM)

Exams and office hours:

Midterm 1: Sep 22th during class hours

Midterm 2: Nov 10th during class hours

Final Exam: 12:30-2:30pm Friday Dec 16th

Office hours:

Dr. Maghari: Tuesdays 10-11am NEB 531 (maghari@ece.ufl.edu)

Changsok Han: Wednesday, 1:00 PM - 2:30 PM NEB 589

Thursday, 10:00 AM - 11:30 PM NEB 589

Arun Javvaji: Monday, 11:30 AM - 1:00 PM NEB 589

Pavan Terdal (for EDGE students) : Saturday 8:00-10:00 PM via Skype
Skype ID : pavanterdal95

TA email list:

Changsok Han (Course material) changsokhan@ufl.edu (mailto:changsokhan@ufl.edu)

Pavan Terdal (EDGE+ Grading + Course Material) pavanterdal@ufl.edu (mailto:pavanterdal@ufl.edu)

Arun Javvaji (Cadence setup + Projects) arun.javvaji@ufl.edu (mailto:arun.javvaji@ufl.edu)

(mailto:pavanterdal@ufl.edu) ***Please put EE5320 or EE4306 in the subject of your email for any email correspondence.***

Quizzes (Campus only):

	Sep 1	Sep 8	Sep 15	Sep 22	Oct 13	Oct 20	Oct 27	Nov 3	Dec 1
Reg. Quiz	**X**		**X**		**X**		**X**		**X**
Ext. Quiz		**X**		**X**		**X**		**X**	

Quiz time: beginning of the class. Duration=5 minutes.

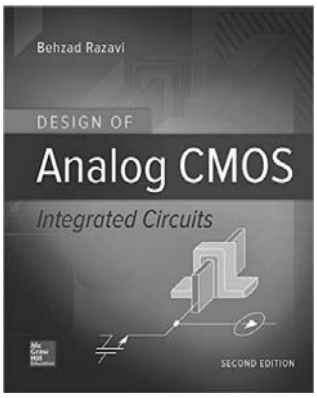
*Reg. Quiz: Each quiz counts as **3 points** of the overall 100 points (**highest 4 out of 5**).*

*Ext Credit: Extra credit quizzes, each will count as **2.5 extra points** of overall 100 points.*

EDGE Students:

For the EDGE students, instead of required quizzes, mini projects will be given. For the extra credit quizzes, you will have extra credit questions on your exams.

Textbooks



Analog Integrated Circuit Design (2nd edition) (highly recommended)

By Tony Chan Carusone, David Johns and Kenneth Martin

Publisher: Wiley; 2 edition (December 13, 2011)

ISBN-10: 0470770104

ISBN-13: 978-0470770108

Fundamentals of Microelectronics by Behzad *Razavi* *(mainly for undergraduates)*

Hardcover: 928 pages

Publisher: Wiley; 2nd edition (April 8, 2013)

Language: English

ISBN-10: 1118156323

ISBN-13: 978-1118156322

DESIGN OF ANALOG CMOS INTEGRATED CIRCUITS, B. Razavi (optional)

Grading basis

Homework & Cadence	**23%**
Quiz	**12%**
Midterm 1	**20%**
Midterm 2	**20%**
Extra Credit Quiz	**10%**
Final Exam (4306)/ Final Project (5320)	**25%**
Total	**100%+ 10% extra credit quiz**

Note: The final project for the graduate section (5320) is mandatory, but the undergraduates section (4306) can chose between the final exam OR the final project.

Note: In each midterm, there will be an additional question which is required for 5320 students, but it will count as extra credit for 4306 students.

Note: Undergraduate who have enrolled this course as 5320 are treated as graduate students for the exams and projects.

Email: maghari@ece.ufl.edu

Please put EE5320 or EE4306 in the subject of your email.

Course Outline

- Review
  - MOS & *Bipolar* Basics (*Bipolar* is optional and may be discussed at the end of the semester)
    - Large signal
    - Small signal
  - Amplifiers

        - Single Stage
            - Transistor level simulation in Cadence
            - Analog Layout
        - Multi-Stage
    - Cascode and Current mirrors
        - Current mirrors
            - Layout and matching
        - Cascode mirrors and amplifiers
    - Differential circuits
        - Fully Differential OTAs
            - Inter-digit and common-centroid layout
        - Common-mode setting
        - Multi-stage
    - Frequency Response
        - Single-stage
        - Multi-stage OTA
        - Miller compensation
    - Feedback
        - Loop Analysis
        - Frequency Response
        - Non-linearity
    - Voltage and Current References
        - Fixed-Gm Bias
        - Bandgap Voltage Reference
    - Introduction to Switched Capacitor circuits

What you need to know:

- Good understanding of circuits (KVL/KCL)
- Ideal opamps/diodes
- First order circuits (RC time-constant)
- Basics of Fourier and Laplace Transforms
- Frequency response/Bode plot

About the instructor:

Nima Maghari received the B.S. degree in electrical engineering from the University of Tehran, Iran, in 2004 and the Ph.D. degree in electrical engineering from Oregon State University in 2010.

He is currently an assistant professor at the school of electrical and computer engineering, University of Florida, Gainesville. From 2004 to 2006, he was with IC-LAB, University of Tehran, where he was involved with audio delta-sigma converters and low-voltage bandgap references. In 2008 he was recipient of CICC-AMD outstanding student paper award. He is currently serving as an Associated Editor of IEEE Transactions on Circuits and Systems-I. He has published more than 40 conference and journals papers in IEEE and IEE.

His research interests include high performance analog-to-digital converters, delta-sigma modulators, phased-locked loops, synthesizable analog circuits, time-assisted data conversion techniques and low-power low-voltage regulators.