CONCORDIA UNIVERSITY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ELEC 413/6071 or 498N/691N: Mixed-Signal VLSI for Communication Systems
Course Outline, Fall 2017

INSTRUCTOR:
Glenn Cowan, Associate Professor, Electrical and Computer Engineering
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LECTURES:
- Tuesdays and Thursdays 10:15-11:30 AM in MB S2.445. Note that S2 is the second basement of the John Molson (MB) building.

REQUIRED TEXTBOOK
- B. Razavi, "Design of Integrated Circuits for Optical Communications," 2nd Edition, Wiley, 2012.

OTHER TEXTBOOKS WORTH CONSULTING:
- R. J. Baker, "CMOS Circuit Design, Layout, and Simulation," 3rd Ed., Wiley, 2010.
- R. Best, "Phase-Locked Loops Design, Simulation, & Applications," 6th Ed., McGraw-Hill, 2007.
- T. Chan Carusone, D. Johns & K. Martin, "Analog Integrated Circuit Design", 2nd Ed., Wiley, 2012
- B. Razavi, "Design of Analog CMOS Integrated Circuits," 1st Ed., McGraw-Hill, 2000.

CALENDAR DESCRIPTION:
ELEC 413 (4 credits) *Mixed-signal VLSI for communication systems*
Prerequisite: ELEC 312 and ELEC 372. Overview of wireline communication links, mechanisms of signal degradation, modulation formats, TX/RX synchronization options, IC technology limitations, transmitter front-end circuits, receiver front-end circuits, decision circuits, clock and data recovery systems, phase-locked loops, jitter, continuous-time and discrete-time equalizers, system metrics. Lab 30h. Lectures 3h/wk.

ELEC 6071 (4 credits) *Mixed-signal VLSI for communication systems*
Prerequisite: ELEC 312 and ELEC 372. Overview of wireline communication links, mechanisms of signal degradation, modulation formats, TX/RX synchronization options, IC technology limitations, transmitter front-end circuits, receiver front-end circuits, decision circuits, clock and data recovery systems, phase-locked loops, jitter, continuous-time and discrete-time equalizers, system metrics. A project. Lectures 3h/wk.

OVERALL COURSE OBJECTIVES:
This course prepares students for designing mixed-signal communication systems with a focus on electrical and optical links.

TENTATIVE LECTURE SCHEDULE:

Week	Date	Topics
1		Intro to course. Overview of data communication challenges and typical block diagrams. Channel limitations, technology limitations, modulation formats, synchronization.
2		Circuit review
3		TX circuits and optical devices
4		RX circuits
5		RX circuits
6		(Class test #1) Project discussion
7		Finish Rx ccts. Decision circuits. Maybe start oscillators
8		Oscillators
9		PLLs
10		CDRs
11		Equalization. Burst-mode considerations
12		Class test 2
13		**Project Due in class, project presentations**

PREREQUISITE MATERIAL:
This course assumes that students have a basic command of the following topics:

Background Topics	Sections from Microelectronics 6th Ed. (Sedra and Smith)
DC, square-law operation of MOSFETs	5.1, 5.2
Low- and high-frequency small-signal models of MOSFETs	5.5, 9.2
AC and DC analysis of single transistor amplifiers with resistive loads	5.3, 5.6, 5.7
AC and DC analysis of single stage amplifiers with active loads	7.2
Basic current mirrors	7.4
Differential pairs	8.1, 8.2, 8.5
Analysis techniques associated with multi-stage amplifiers	8.6
Analysis of circuits with operational amplifiers	2.1-2.3

Although we will do a lecture of review, we will not be able to cover all of these topics in depth. Therefore, if you have not taken a course such as ELEC 312 or ELEC 423/6051, these topics will be self-study topics.

ASSIGNMENTS/LABS:
A combination of paper/pencil and CAD based assignments will be given. For undergraduate students there will be a weekly lab session. The assignments will take the form of labs that will span 2-3 weeks of lab sessions each. These will reinforce concepts developed in class and prepare students for the project. Assignments will be done individually.

PROJECT:
A design project will be given at the beginning of the semester. The project will involve system and transistor level simulation as well as the integrated circuit layout of part of a communication link. The project will be done either individually or in a team of two. For undergraduate students a portion of the project will be subdivided into biweekly deliverables carried out in the lab session.

GRADING SCHEME:
Assignments/Labs	20%
Class tests 1 and 2	40%
Project	40%
Total:	**100%**

During the Class tests, only one of the two ENCS-approved calculators (CASIO FX-300MS and SHARP EL-531) will be allowed. The first class test will be held during the midterm period. The second test will be toward the end of the term.

Labs/Assignments and the project must be accompanied by a signed copy of ENCS's Expectations of Originality form.
See: http://www.encs.concordia.ca/current-students/forms-and-procedures/expectation-of-originality/

DIFFERENCES BETWEEN ELEC 413 AND ELEC 6071

Class Tests:
Graduate students in ELEC 6071 will be asked to answer additional questions (extra ~20%) touching on theoretical concepts.

Assignments:
Graduate students in ELEC 6071 will be asked to do additional analysis in assignments.

Project:
The graduate students' projects will be more involved, dealing with larger portions of the communication system and taking the design farther by including the completed integrated circuit layout and post-layout simulation.

A NOTE ABOUT EXPECTATIONS OF PROFESSIONALISM

In addition to preparing students for the technical requirements of a career in Engineering, we sincerely feel that our program at Concordia University also prepares students for a wide variety of non-technical elements Engineering careers require. An aspect of this non-technical training is the maintaining of clear expectations of professionalism in the classroom, tutorials, and laboratories. We expect that students treat one another, their TAs, lab demonstrators, specialists, and professors with respect and act honestly. It is imperative that students do not talk or make other noise during lectures, when the teaching assistants are presenting material in tutorials, or when lab demonstrators and staff are addressing lab sections.

Another important component of professionalism is academic integrity. The copying of projects and assignments is not permitted, and will be dealt with seriously. Please review Concordia's guide to academic integrity:
http://www.concordia.ca/info/currentstudents/academicintegrity/

NOTES ON PLAGIARISM:

The following is taken from http://provost.concordia.ca/academicintegrity/plagiarism/

> The most common offense under the Academic Code of Conduct is plagiarism which the Code defines as "the presentation of the work of another person as one's own or without proper acknowledgement." This could be material copied word for word from books, journals, internet sites, professor's course notes, etc. It could be material that is paraphrased but closely resembles the original source. It could be the work of a fellow student, for example, an answer on a quiz, data for a lab report, a paper or assignment completed by another student. It might be a paper purchased through one of the many available sources. Plagiarism does not refer to words alone - it can also refer to copying images, graphs, tables, and ideas. "Presentation" is not limited to written work. It also includes oral presentations, computer assignments and artistic works. Finally, if you translate the work of another person into French or English and do not cite the source, this is also plagiarism.
>
> In Simple Words:
> Do not copy, paraphrase or translate anything from anywhere without saying where you obtained it!

LIST OF SERVICES

Concordia Counseling and Development offers career services, psychological services, student learning services, etc.
http://cdev.concordia.ca/

The Concordia Library Citation and Style Guides:
http://library.concordia.ca/help/howto/citations.html

The Academic Integrity Website
http://provost.concordia.ca/academicintegrity/

Advocacy and Support Services
http://supportservices.concordia.ca/

Financial Aid & Awards
http://web2.concordia.ca/financialaid/

Student Transition Centre
http://stc.concordia.ca/

Health Services
http://www-health.concordia.ca/

New Student Program
http://newstudent.concordia.ca/

Access Centre for Students with Disabilities
http://supportservices.concordia.ca/disabilities/

Student Success Centre
http://studentsuccess.concordia.ca/