ENSC-852 Spring 2019

Analog Integrated Circuits

INSTRUCTOR: Marek Syrzycki, ASB 8837, marek@cs.sfu.ca, phone: (778) 782-3659

LECTURES: Tuesdays and Thursdays: 18:00 – 19:20, SECB (TBA)

OFFICE HOURS: Wednesdays, 11:30 -12:30, ASB 8837

COURSE DESCRIPTION:

ENSC 852-3 ANALOG INTEGRATED CIRCUITS

Models for integrated circuits activity and passive devices and their implementation; computer-aided design tools and their use in designing analog integrated circuits; analysis of single transistor amplifiers; current sources, current mirrors, and voltage references; op-amps characteristics, analyses and circuit design examples; frequency response of integrated circuits; noise in integrated circuits; low-power integrated circuits; non-linear analog integrated circuits. The students will be required to either design, fabricate and test simple analog ICs in the microelectronics lab, or do a project which involves the design, analysis, modeling and simulation of an analog integrated circuit. *Prerequisite: ENSC 850 (Silicon Semiconductor Devices) or permission of instructor*.

COURSE GRADING POLICIES:

Homeworks (3)	30%
Project	30%
Exam (take home)	40%

TEXTBOOK:

1. Phillip E. Allen, Douglas R. Holberg **"CMOS Analog Circuit Design"**, Oxford University Press, 2012, ISBN 978-0-19-976507-2, 3rd edition, or 2nd edition (2002, ISBN 0-19-511644-5).

SUPPLEMENTARY BOOKS:

1. Paul R. Gray, Paul J. Hurst,, Stephen H. Lewis, Robert G. Meyer, **"Analysis and Design of Analog Integrated Circuits"**, John Wiley & Sons, 2009, 5th edition, ISBN 978-0-470-24599-6.

2. Behzad Razavi, "**Design of Analog CMOS Integrated Circuits**", McGraw-Hill, 2001, ISBN 0-07-238032-2.
3. David A. Johns, Ken Martin, "**Analog Integrated Circuit Design**", John Wiley & Sons, 1997, ISBN 0-471-14448-7.
4. Willy M. C. Sansen, **"Analog Design Essentials"**, Springer, 2006, ISBN 0-387-25746-2.
5. Christopher Saint, Judy Saint, **"IC Layout Basics"**, McGraw_Hill, 2001, ISBN 0-07-138625-4.
6. Christopher Saint, Judy Saint, **"IC Mask Design – Essential Layout Techniques"**, McGraw_Hill, 2002, ISBN 0-07-138996-2.
7. Dan Clein "**CMOS IC Layout: Concept, Methodologies and Tools**", Newnes, 2000, ISBN 0-7506-7194-7.
8. Erik Brunvand, "**Digital VLSI Chip Design with Cadence and Synopsys CAD Tools**", Addison-Wesley, 2009, ISBN 13: 97803215479960, ISBN 10: 0321547993.

TENTATIVE COURSE SCHEDULE

Date	Lecture	Chapter	Deadlines
Jan 3	Analog IC Design. CMOS Analog IC Design – Introduction. Basic Semiconductor Processes. CMOS Technology Process.	1.1 - 1.4 2.1 - 2.2	
Jan 8	Active Devices: p-n junction, n-channel MOSFET, p-channel MOSFET.	2.2 – 2.3	
Jan 10	Passive Devices: Capacitors, Resistors. BJTs in CMOS. Latchup.	2.4 – 2.5	
Jan 15	CMOS IC Layout. MOSFET Layout. Capacitor Layout. Matching. Layout Design Rules.	2.6 (2nd) App.B (3rd)	H1
Jan 17	Layout Design case study		
Jan 22	MOS FET Large-Signal Model and Its Parameters.	3.1 – 3.2	
Jan 24	MOS FET Small-Signal Model. MOS Subthreshold Model.	3.3 – 3.5	H1 due
Jan 29	SPICE Simulation of CMOS Analog ICs.	3.6	
Jan 31	CMOS Subcircuits: MOS Switch, MOS Diode/Active Resistor.	4.1 – 4.2	H2
Feb 5	Current Sinks and Sources. Current Mirrors.	4.3 – 4.4	
Feb 7	Current and Voltage References. Bandgap Voltage Reference.	4.5 – 4.6	H2 due
Feb 12	Active Load CMOS Inverter Amplifiers.	5.1	
Feb 14	CMOS Differential Amplifiers.	5.2	
Feb 26	Cascode Amplifiers.	5.3	
Feb 28	Current Amplifiers.	5.4	
Mar 5	CMOS Op Amps: Classification and Design.	6.1	H3
Mar 7	Compensation of Op Amps.	6.2	
Mar 12	Design of the Two-Stage Op Amp.	6.3	
Mar 14	PSRR. Cascode Op Amp.	6.4. - 6.5	Project
Mar 19	Design of the Folded-Cascode Op Amp.	6.5	H3 due
Mar 21	Simulation and Measurement of Op Amps.	6.6	
Mar 26	High-Performance Buffered Op Amps.	7.1	
Mar 28	High Speed/Frequency CMOS Op Amps.	7.2	
Apr 2	Differential Mode Op Amps. Low-Power Op Amps.	7.3 - 7.4	Project due
Apr 4	Low-Voltage Op Amps.	7.6	