ECE Special Topics in Microelectronics
Advanced Analog Integrated Circuits

COURSE OUTLINE

Please refer to course website for updated information.

CALENDAR DESCRIPTION

This course offers a comprehensive understanding of analog integrated circuits (ICs) using CMOS technology, covering their operation, analysis, modeling, design, layout, and applications. It provides both foundational principles and advanced techniques, including a detailed study of key analog blocks, operational amplifiers, and oscillators. It will also discuss advanced topics in analog design such as frequency response, noise, and feedback. Emphasis is placed on applying these concepts to cutting-edge applications in domains like IoT, biomedical devices, and high-speed communications.

SCHEDULE And MODE OF DELIVERY

The material for this course will be delivered through a mixture of in-person lectures, textbook readings, assignments and projects.

Lecture: TBD

INSTRUCTOR

Dr. Mohamed Elamien
Email: Elamienm@mcmaster.ca
Office: ITB-109
Phone: 905-525-9140 ext. 21151
Office Hours**:** Open office hours or by appointment.

COURSE WEBSITE/S

http://avenue.mcmaster.ca

COURSE OBJECTIVES

By the end of this course, students should be able to:

- Analyze and design fundamental analog circuits and blocks used in modern ICs.
- Implement advanced design and automation techniques for optimizing analog circuits.
- Develop ultra-low power analog front-end (AFE) ICs for IoT and biomedical applications.
- Design high-speed analog circuits for optical communication systems.

ASSUMED KNOWLEDGE

Basic understanding of transistor operation and good knowledge of course material from COMPENG 4EK4.

COURSE MATERIALS

Textbooks:
Behzad Razavi, Design of Analog CMOS Integrated Circuits 1st or 2nd edition, McGraw-Hill Education.

Other:
All lecture notes and selected research papers will be provided to students.

COURSE OVERVIEW

Week	Topic
1	**Introduction:** Course introduction, Overview of IC Design and Applications
2	**CMOS Device Physics**: Semiconductor Basics and MOS Transistor Modeling
3	**Fundamental Circuits and Blocks:** Single-Stage and Differential Amplifiers
4	**Fundamental Circuits and Blocks:** Advanced Current Mirrors and Biasing Techniques
5	**Frequency Response, Noise and Feedback in Analog Design**
6	**Operational Amplifiers:** Stability and Frequency Compensations
7	**Layout and Packaging**
8	**Analog Automation Techniques**
9	**Advanced Oscillator Concepts**
10	**Ultra-Low Power Analog ICs for IoT:** Design Challenges and Techniques and Energy Harvesting Circuits
11	**Sensor Interface ICs for Biomedical Applications:** Bioimpedance Measurement Circuits and Biopotential Amplifiers
12	**High-Speed and Optical Communication:** Transimpedance Amplifiers, Equalizers and Drivers for Optical Communication

At certain points in the course, it may make sense to modify the schedule. The instructor may modify elements of the course and will notify students accordingly (in class or on the course website).

ASSESSMENT

Component	Weight	Due Date
Assignments	40%	One week after the assignment is given
Project	40%	Last day of classes
Presentation	20%	One week's notice is given
Total	100%	

The instructor may modify the assessment components and will notify the students accordingly.

Late submissions of assignments or project report are subject to 20% penalty per day (less than one day is counted as one day).

CONDUCT EXPECTATIONS

As a McMaster graduate student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

ACADEMIC ACCOMMODATIONS OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office ***normally within 10 working days*** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf.

www.eng.mcmaster.ca/ece