PURDUE UNIVERSITY | College of Engineering

TO: The Engineering Faculty

FROM: The Faculty of the Elmore Family School of Electrical and Computer Engineering

RE: New undergraduate course – ECE 40656

The Faculty of the Elmore Family School of Electrical and Computer Engineering has approved the following new undergraduate course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

FROM (IF ALREADY OFFERED WITH TEMPORARY NUMBER):

Not from a temporary number but so many changes to ECE 45500 that we are creating a new course at the request of the Office of the Registrar.

TO:

ECE 40656 CMOS Analog and Mixed Signal Integrated Circuits

3 total credits; 3 credit lecture

Requisites: ECE 20002

Learning Outcomes:

1. design a simple single-stage amplifier in a standard CMOS technology and verify the design using simulation.

2. design a simple CMOS operational amplifier and verify the design using simulation.

3. design an advanced operational amplifier in a standard CMOS technology and verify the design using simulation.

4. analyze a voltage comparator in a standard CMOS technology and verify the design using simulation.

5. analyze a sample and hold circuit and perform simulations.

6. analyze a switched capacitor circuit and perform simulations.

7. analyze a data-convertor circuit.

This course is a review of technology and modeling of CMOS transistors; Analysis, and design of CMOS monolithic integrated circuits for analog and mixed-signal applications. Consideration of amplifier circuit design, and fabrication techniques with circuit simulation using Cadence. Simple and advanced CMOS operational amplifiers, comparators, sample and hold circuits, switch capacitor circuits and data converters; Design of analog and mixed signal circuit building blocks.

RATIONALE:

This course ran as ECE 45500 but has evolved over time and it is time to update it in the catalog, including removing material on bipolar transistors and circuit implementations using it to more relevant up-to-date material including signal circuits, SMOS Comparators, data converters, hold circuits and switched-capacitor circuits.

Mithuna Thottethodi
Associate Head of Teaching and Learning
Professor of the Elmore Family School of Electrical and Computer Engineering

Link to Curriculog entry: https://purdue.curriculog.com/proposal:32655/form

Course: ECE 40656, CMOS Analog and Mixed Signal Integrated Circuits

Instructor:	Prof. Saeed Mohammadi
Office:	BRK 2264, email: saeedm@purdue.edu
Office Hours:	To be announced

CAD TA /TA office hours /Tutorial Hours: To be announced

CAD TA:	Dali Lai (lai127@purdue.edu)
Course TA	Bashi Sfar (bsfar@purdue.edu)
Pre-requisite:	ECE 20002 or (ECE 20200)
Textbook:	Analog Integrated Circuit Design, Tony Chan Carusone, David Johns and Kenneth Martin, 2nd Ed. Wiley 2012, ISBN: 9780470770108

Other helpful materials:

- ECE455 notes (Available on Brightspace)
- Lecture recording (Available on Brightspace)
- Design of Analog CMOS Integrated Circuits, Behzad Razavi, 2nd Ed. McGraw Hill 2016, ISBN 978007252493-2
- Analysis and Design of Analog Integrated Circuits, P. Gray, P. Lewis, S. Hurst, R. Meyer, 5th Ed. Wiley 2009, ISBN 978-0470245996

Schedule:

Week 1:	Chapter 1, Review of basic amplifiers, Device modeling and Technology
Week 2-3:	Chapter 2, Integrated CMOS Amplifiers and Current Mirrors
Week 4:	Chapter 3, Noise in Integrated Circuits
Week 5-6:	Chapters 4, Basic CMOS Operational Amplifiers
Week 7:	Review and 1st midterm
Week 8-9:	Chapter 5, Advanced Current Sources and Advanced OpAmps
Week 10	Chapter 6, CMOS Comparators, project report part I & presentations part I
Week 11:	Chapter 7, CMOS Sample and Hold Circuits
Week 12:	Chapter 8, Switched-Capacitor Circuits
Week 13:	Chapter 9, Data Converters
Week 14:	Review and 2nd midterm
Week 15:	Project report part II & presentations part II

Attendance Policy: All students are required to upload a photo of themselves to their Brightspace page. While attendance in the class is not mandatory, data from previous years shows students who attended the lectures received better grades. Do not come to lectures if you are sick. Missing an exam would require a letter from PUSH.

Academic Integrity: Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While

information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace under University Policies and Statements.

Learning Outcome:

1. Ability to design a simple single-stage amplifier in a standard CMOS technology and verify the design using simulation.
2. Ability to design a simple CMOS operational amplifier and verify the design using simulation.
3. Ability to design an advanced operational amplifier in a standard CMOS technology and verify the design using simulation.
4. Ability to analyze a voltage comparator in a standard CMOS technology and verify the design using simulation.
5. Ability to analyze a sample and hold circuit and perform simulations.
6. Ability to analyze a switched capacitor circuit and perform simulations.
7. Ability to analyze a data-convertor circuit.

Simulation: Cadence Spectre RF. Cadence 45nm PDK (45nm CMOS technology) is used for this course. Note that we reserve the right to check your class account at any time during the semester.

Grading: Homework (8 assignments) 20%
Your assignments include analysis, design, and simulations of passive and active circuits. We will not only pay attention to your results but most importantly to the approach in solving problems. In this course, academic honesty is of outmost importance. You are welcome to discuss how to solve a certain problem with your classmates. Do not copy HW problems from your classmate. Do not provide your HW to a classmate.

Exams (2 midterms) 40%
Midterm exams focus on your ability to analyze a circuit. Examples of previous midterms will be provided for your convenience.

Projects (Part 1, Part 2) 40%
A major part of the course is your individual project. We will provide project topics to you. You are responsible for doing research and literature search (part 1), design, optimization and simulation of the circuit (part 2) for your project. You will be asked to provide a report for each part and do a professional presentation for part 2 of the project. Note that we reserve the right to check your class account at any time during the semester.

- No make-up exam for midterms 1 and 2 will be scheduled. There will be no final exam.
- An A-4 sheet of formula is allowed for midterms.
- To pass the course, you must have passing grade from theoretical (exams) and simulation (project) parts. Possible grades in this course are A+ (>96%), A (>92%), A- (>88%), B (>80%), C (>70%), D (>60%) and F (<60%).
- The final date to withdraw from a course with a W for Fall 2024 is Monday, Nov. 19

> In the event of a major campus emergency, course requirements, deadlines, and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances.
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> Here are ways to get information about changes in this course:
> saeedm@purdue.edu
> https://purdue.brightspace.com/d2l/home/599863

Mental Health/Wellness Policy:

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack. Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 a.m.- 5 p.m.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc., sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is free and can be done on BoilerConnect.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.