

**SABANCI UNIVERSITY**  
**Faculty of Engineering & Natural Sciences**  
**EE 440 – Mixed-Signal Integrated Circuits**  
**EE 540 – Mixed-Signal Integrated Systems and Applications**  
**Spring 2021/2022 Syllabus**

**Instructor**

Ömer Ceylan

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**Office Hours:** Thursday 14:40-15:30

**Teaching Assistant**

Cerin Ninan Kunnatharayil

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**Office Hours:** Wednesday 14:40-15:30

**Zoom Link:** <https://sabanciuniv.zoom.us/j/9757380583>

**Zoom Meeting ID:** 975 738 0583

**Class Schedule**

**Lectures**

**Tuesday:** 4:40 – 5:30 pm FASS G062

**Wednesday:** 9:40 – 11:30 am FMAN L018

**Recitation / Lab**

**Friday:** 3:40 – 4:30 pm FENS G032

**Textbooks**

Phillip E. Allen & Douglas R. Holberg: CMOS Analog Circuit Design

Franco Maloberti: Data Converters

Behzad Razavi: Design of CMOS Phase-Locked Loops

## Course Content:

**Building blocks for mixed-signal integrated circuits:** comparators, sampling circuits, amplifiers, digital-to-analog converters (DACs), voltage controlled oscillators, charge pumps, phase-frequency detectors, etc.

**Analog-to-digital converters (ADCs)**

**Phase-locked loops (PLLs)**

**Readout Integrated Circuits (ROICs)**

## Learning Outcomes:

1. To be able to understand the specifications of commonly used mixed-signal integrated circuit building blocks: comparators, sampling circuits, amplifiers, control logics, voltage-controlled oscillators, charge pumps, phase-frequency detectors
2. To be able to evaluate the power, speed, noise, and area trade-off for individual blocks and overall system of ADCs and frequency synthesizers.
3. To be able to combine individual blocks to design a more complex system such as ADC and PLL, and to be able to understand how parameters of a building block affect the others and overall system performance.
4. To be able to design custom and automated digital circuits to control ADC and frequency synthesizer operations.
5. To have knowledge on different ADC architectures: Single and Multislope ADC, SAR ADC, Flash ADC, Pipeline ADC, Sigma Delta ADC
6. To have knowledge on different frequency synthesizer architectures: Basic PLL, Integer-N, Fractional-N
7. To design, simulate and verify the individual blocks and overall system of ADCs and frequency synthesizers by using Computer Aided Design (CAD) tools.
8. To learn the possible use of ADCs and frequency synthesizers in different applications.
9. To learn the possible use of mixed-signal integrated circuits in different applications such as readout integrated circuits (ROICs), CMOS image sensors, etc.

## Tentative Course Schedule:

Date	Subjects
Week 1	Introduction, ADC specifications
Week 2	Overview of ADC architectures
Week 3	Sampling circuits
Week 4	Comparators
Week 5	DACs
Week 6	SAR ADCs
Week 7	Pipeline ADCs
Week 8	Flash ADCs, Slope ADCs

Week 9	Sigma-Delta ADCs
Week 10	Presentations
Week 11	Presentations
Week 12	PLL basics, Oscillators, Phase detector, Charge Pump
Week 13	PLL architectures
Week 14	Readout Integrated Circuits (ROICs)

### Course Policies:

- Cheating will not be tolerated.
- For homeworks, labs and projects late submission is penalized up to 2 days.
  - Up to 6 hours late 5% reduction
  - Up to 12 hours late 10% reduction
  - Up to 24 hours late 20% reduction
  - Up to 48 hours late 30% reduction
- There will be 4-5 labs.
- There will be a course project.
- There will be a presentation of a state-of-the art ADC or PLL paper.

### Grading Policy:

Homeworks/Labs	25%
Paper presentation	20%
Course project	25%
Final	30%
<b>Every three-day absence in lectures</b>	<b>-1%</b>

### Important Notes in case of online education:

- For proctored exams, your webcam and microphone should be on during the exam. In the case of non-compliance with this and other declared exam procedures, your exam will be void. Make sure to check that your webcam and microphone function properly before the exam.
- You may be given an oral exam to check the authenticity of the written exam by going through the questions of the written exam.
- You must attend the synchronous Zoom lectures, recitations, etc. and real-time online exams with your SU email account.