# Fundamentals of Analog Integrated Circuit Design
# EL6403

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**Description:**

In this course, we will study the design and implementation of analog integrated circuits (ICs). Our focus is on the transistor-level design of circuits using the modern semiconductor fabrication processes, particularly CMOS. The blocks and circuit architectures discussed in this course are the core components of most integrated systems and essential in applications such as communications, multimedia, imaging, sensors, and biomedical.

The course will begin by providing a device-oriented overview of integrated circuits and silicon fabrication processes and their ramifications on the transistor models. Subsequently, we will discuss various amplifier topologies in ICs using these devices, and also examine in detail topics such as frequency response, linearity, biasing, feedback, operational amplifiers, compensation, and noise.

**Textbook:**

(Required): B. Razavi, "Design of Analog CMOS Integrated Circuits"
(Optional): P.R. Gray *et al.*, "Analysis and Design of Analog Integrated Circuits, 4$^{th}$ Ed.

# Syllabus

| Lecture | Topic |
|---|---|
| 1 | **Integrated systems**<br>Fabrication technologies<br>Integrated vs. discrete<br><br>**Active and passive devices in integrated systems** |
| 2-3 | **Single-stage amplifiers**<br>Common-source<br>Source-follower<br>Common-gate<br>Cascode stage<br>Intrinsic gain limitation vs. technology node |

(HW-1: Single-stage amplifiers)

**4** **Differential amplifiers**
Single-ended and differential operation
Differential pairs
Common mode
Differential amplifiers in integrated systems

(HW-2: Differential amplifiers)

**5** **Passive and active current mirrors**
Basic current mirrors
Cascode current mirrors
Active current mirrors

**6-7** **Frequency response**
Integrated amplifiers and frequency response

(HW-3: Frequency Response)

**8** **Feedback systems**
Feedback topologies
Effects of feedback on frequency response

(HW-4: Feedback)

**9** (MIDTERM: In-class and focused on amplifier design) – 125 min
(PROJECT: Opamp design)

**10** **Noise**
Thermal noise
Device noise
Noise in amplifier structures

(HW-5: Noise)

**11-12** **Operational amplifiers**
Performance parameters
One-stage op amp topologies
Multiple-stage op amp topologies
Frequency stability and compensation
Operational transimpedance amplifiers (OTAs)

(HW-6: Opamps)

**13** **Bandgap references**
Supply-independent biasing
Temperature independent references
Architectures

(No Homework)

**14** **Analog systems - overview**
Sampling circuits

Switched capacitor circuits
Testing analog

**15** (FINAL: In-class and open-book covering everything)