# **Introduction**

VE311 Electronic Circuits (Fall 2020)

Dr. Chang-Ching Tu

# Instructor Short Biography

- **台湾交通大学** (1998 – 2002)
  电子工程学系 B.S.
- **台湾交通大学** (2002 – 2004)
  电子工程学系 M.S.
- **University of Washington, Seattle** (2006 – 2011)
  Electrical Engineering, Ph.D.

- **UW MSE Postdoc** (2011 – 2012)
- **LumiSands, Inc. Co-Founder / CEO** (2013 – 2017)
- **NCTU Applied Chemistry Postdoc** (2014 – 2017)
- **UM-SJTU JI Assistant Professor** (2017 –)
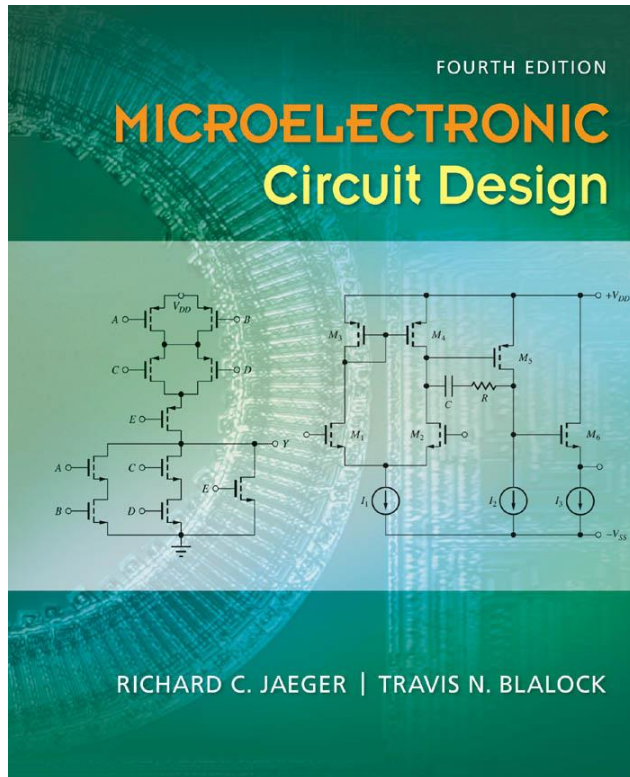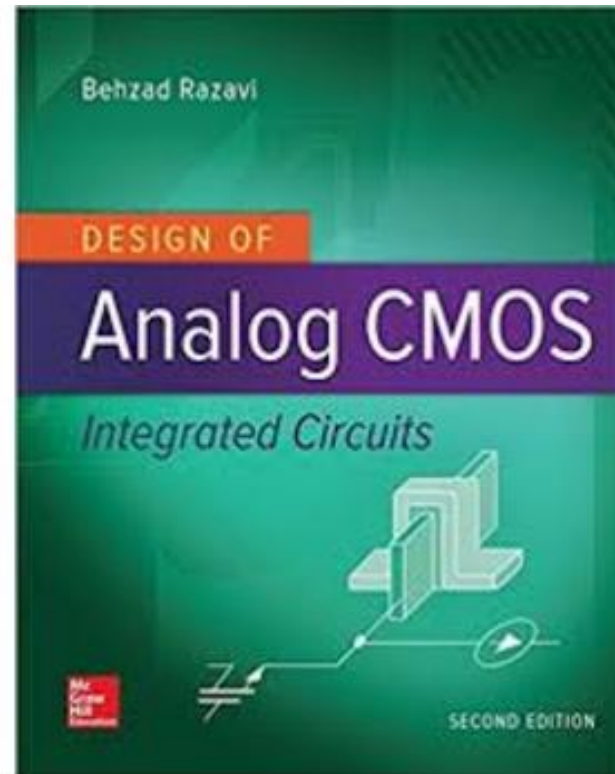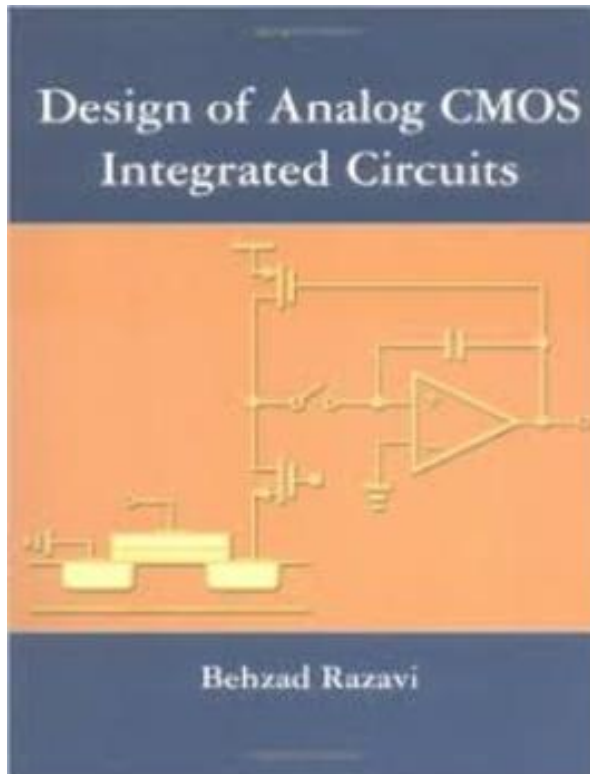
Textbook I

Richard C. Jaeger
Distinguished University Professor Emeritus
ECE Department
Auburn University

Travis N. Blalock
Visiting Associate Professor
ECE Department
University of Virginia
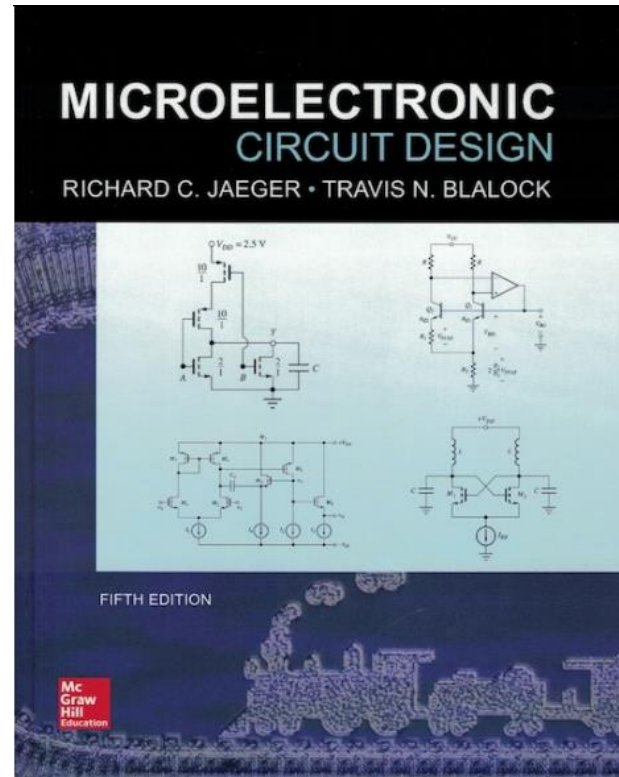
Behzad Razavi
ECE Department
UCLA

Lectures

Midterm Exam

- **Diode**
- **Diode Circuit**
- **BJT**
- **BJT Circuit**
- **MOSFET**
- **MOSFET Single Stage Amplifiers**
- **MOSFET Current Mirrors**
- **MOSFET Differential Amplifiers** (If time allows)

Final Exam

Labs

Lab 1

Diode Circuit (Rectifier)

Lab 2

BJT Circuit (Single-stage amplifier)

Lab 3

MOSFET Circuit (Single-stage amplifier)

Lab 4

MOSFET Circuit (Differential pair amplifier + Feedback)

Grading Policy

- **8 × Assignments (with Pspice) (12%)**
- **4 × Lab Reports (Proteus + Lab) (12%)**
- **1 × Midterm Exam (34%)**
- **1 × Final Exam (42%)**
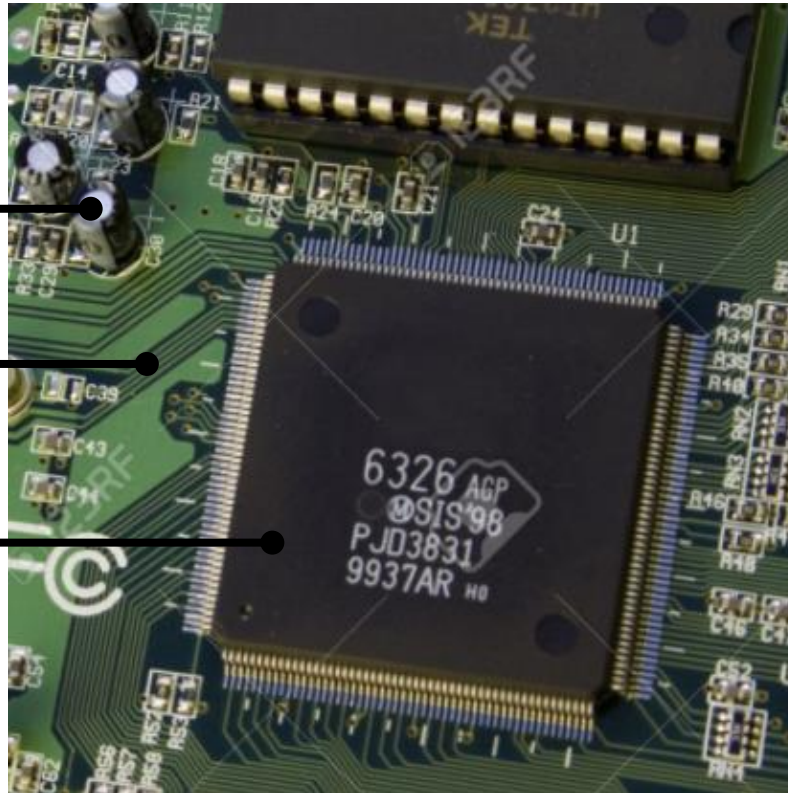
IT Hardware Industry Ecosystem

Apple
HP
Sony
Huawei
Samsung

Apple
Microsoft
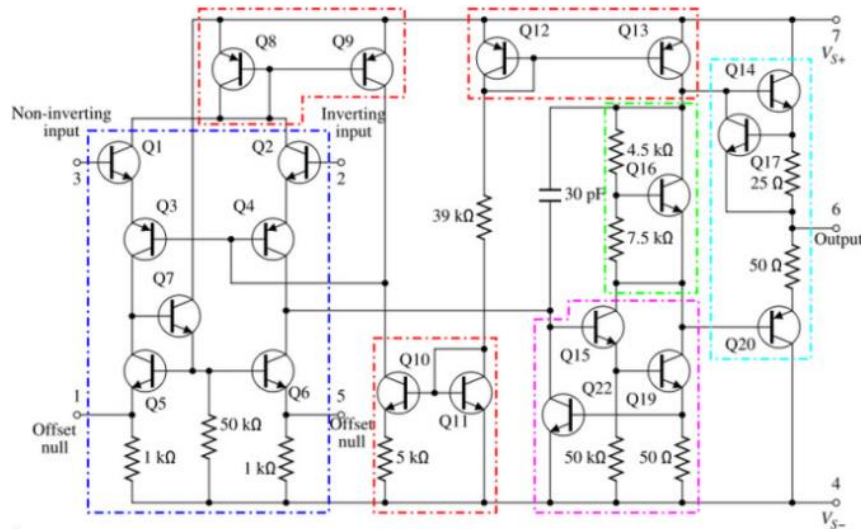Google
Amazon
腾讯
百度
阿里巴巴

Capacitor/Resistor
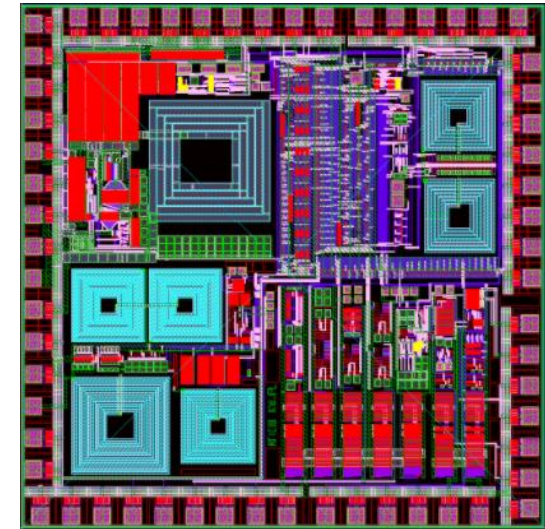
Printed Circuit
Board (PCB)

Integrated Circuit
(IC)

Foxconn
Huawei
Samsung

Qualcomm
Broadcom
MediaTek
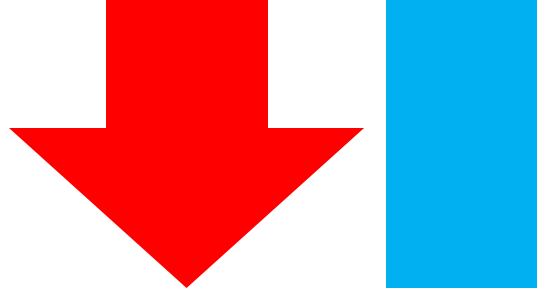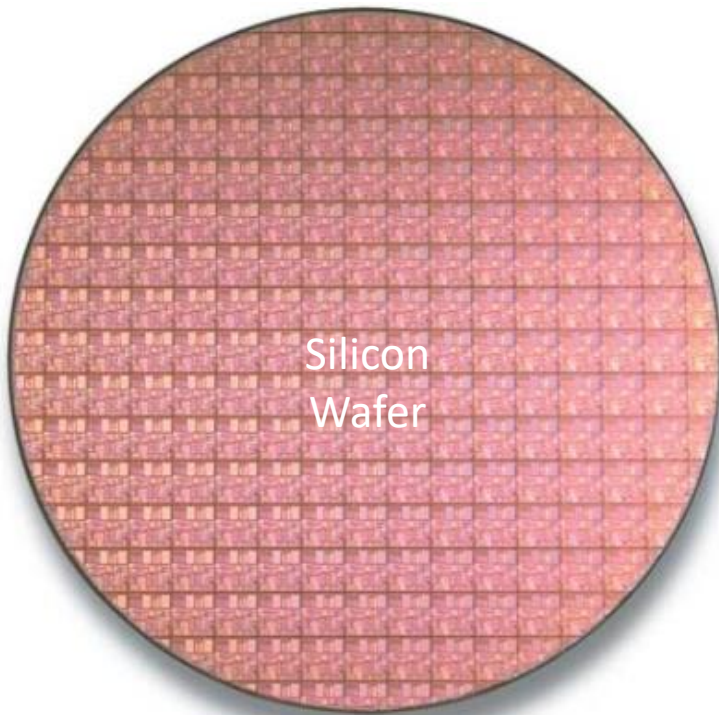NVIDIA
Marvell
Apple
Intel
Huawei (海思)
Samsung

Schematic
(Spice)

Layout
(Cadence)
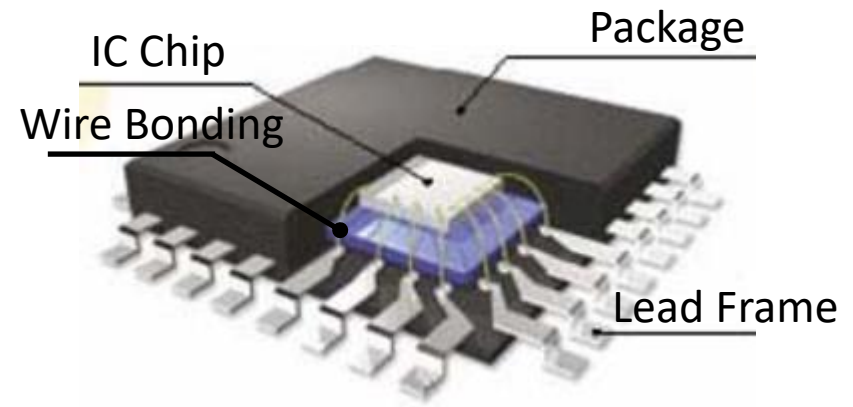
VE215: Introduction to Circuits
VE311: Electronic Circuits
VE312: Digital Integrated Circuits
VE413: Monolithic Amplifier Circuits

TSMC
Intel
GlobalFoundries
Samsung
中芯半导体

Silicon
Wafer

IC Chip

Wire Bonding

Package

Lead Frame

VE320: Introduction to Semiconductor Devices
VE421: Properties of Transistors

Top IC Design Companies

Table: 2019 Revenue Ranking of Top 10 IC Design Companies (Unit: Million USD)

Ranking	Company	2019 Revenue	2018 Revenue	YoY
1	Broadcom	17,246	18,547	-7.0%
2	Qualcomm	14,518	16,370	-11.3%
3	NVIDIA	10,125	11,163	-9.3%
4	MediaTek	7,962	7,882	1.0%
5	AMD	6,731	6,475	4.0%
6	Xilinx	3,236	2,868	12.8%
7	Marvell	2,708	2,823	-4.1%
8	Novatek	2,085	1,813	15.0%
9	Realtek	1,965	1,518	29.4%
10	Dialog	1,421	1,442	-1.5%
Top 10 Total		67,997	70,901	-4.1%

联发科 (row 4)

联詠 瑞昱 (rows 8, 9)

Source: TrendForce, March, 2020

Top IC Manufacturers

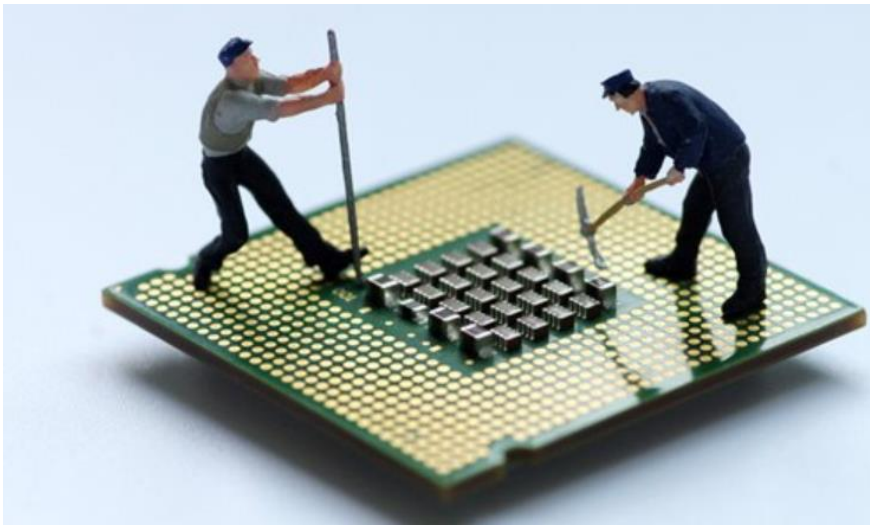**Table: Ranking of the Global Top 10 Foundries by Revenue, 1Q20 (Unit: Million USD)**

台积电

联电

中芯

力晶

华虹

Ranking	Company	1Q20E	1Q19	YoY	M/S
1	TSMC	10,200	7,096	43.7%	54.1%
2	Samsung	2,996	2,586	15.9%	15.9%
3	GlobalFoundries	1,452	1,256	15.6%	7.7%
4	UMC	1,397	1,057	32.2%	7.4%
5	SMIC	848	669	26.8%	4.5%
6	TowerJazz	300	310	-3.3%	1.6%
7	VIS	258	224	14.9%	1.4%
8	PSMC	251	178	41.2%	1.3%
9	Hua Hong	200	221	-9.4%	1.1%
10	DB HiTek	158	139	13.8%	0.8%
Top 10 Total		18,060	13,737	31.5%	95.7%

Source: TrendForce, March, 2020

Moore's Law

Microprocessor Transistor Counts 1971-2011 & Moore's Law

Latest: TSMC 5 nm Technology

The number of transistors in IC doubles approximately every two years.

Moore's Law approaching its end now?

Semiconductor Talent Gap in China


China faces talent gap in chips

- *环球时报*, May 20th, 2019

There are only 400,000 semiconductor professionals in China, which needs more than 720,000 by 2020, leading to a gap of 320,000 in the talent pool, according to an industry white paper released last year by research firm CCIDC Consulting.
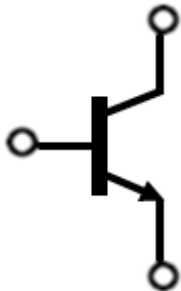
Active vs Passive Components

Active Components
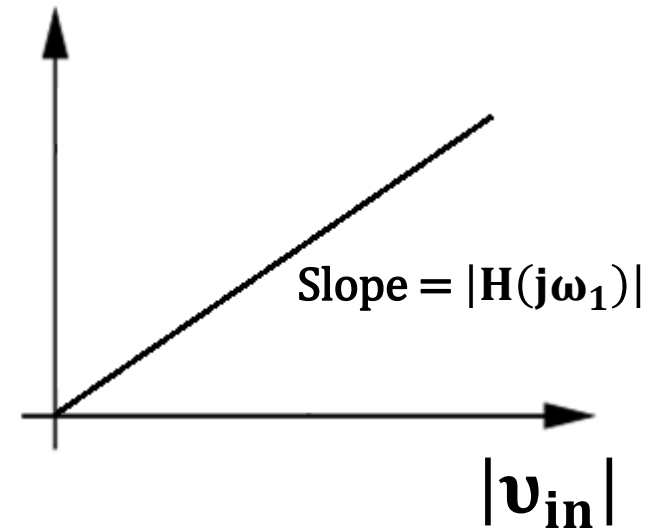
Passive Components

MOSFET BJT Diode
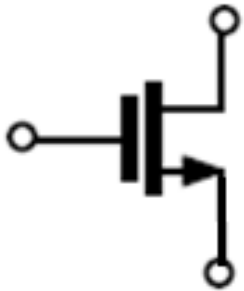
Resistor Capacitor Inductor

VE 311

VE 215

Linear vs Nonlinear Circuit

Linear Circuit

VE 215

Nonlinear Circuit

VE 311
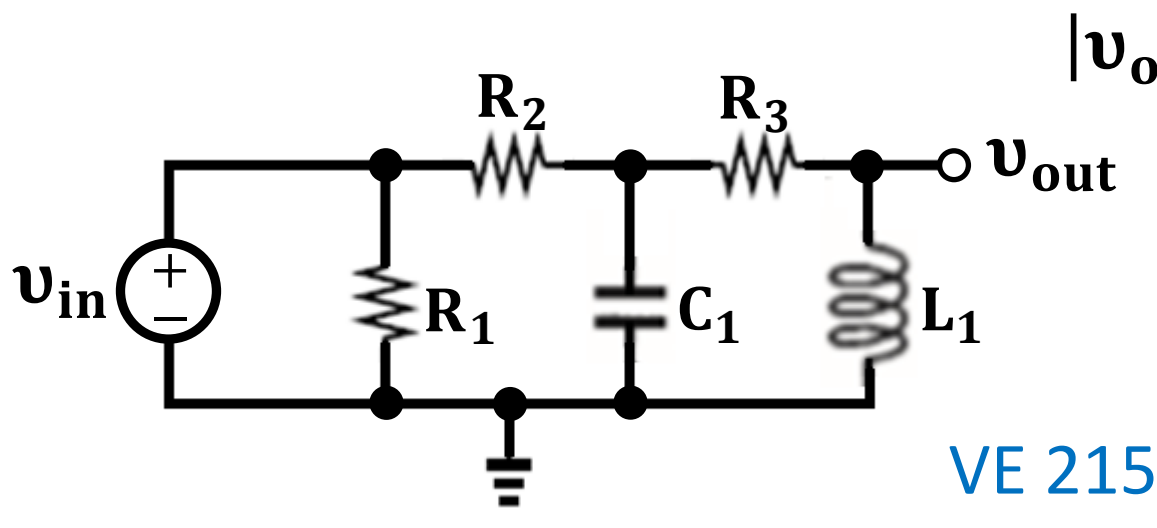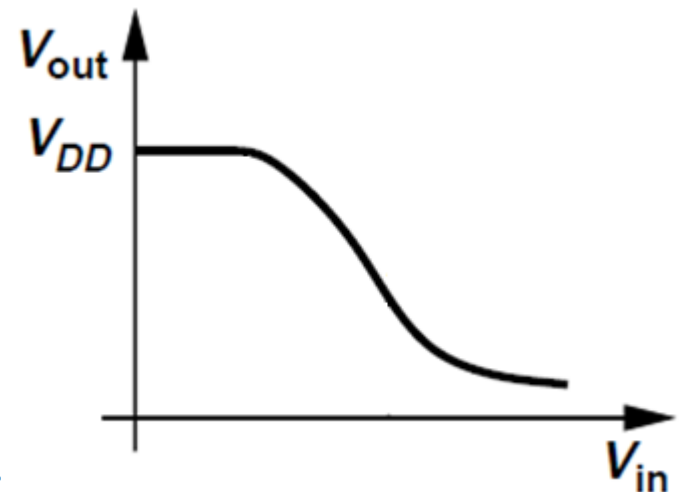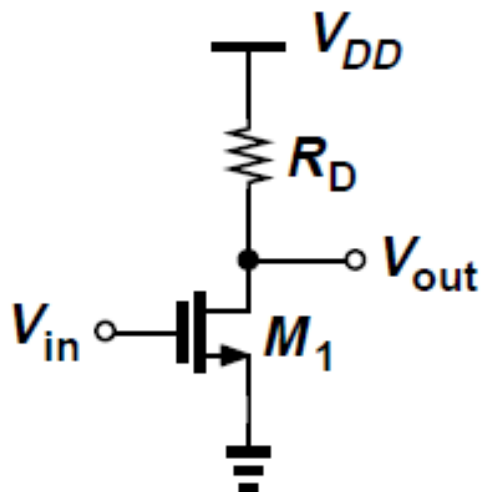
Analog vs Digital

Digital

V_{in}

V_{DD}

time

V_{DD}

V_{in} ○— —○ V_{out}

VE 312

V_{out}

V_{DD}

time

Analog

V_{in}

V_{DD}

time

V_{DD}

R_D

V_{in} ○— M_1 —○ V_{out}

VE 311

V_{out}

V_{DD}

time

Analog Circuit in IC

Analog Circuit **Digital Circuit**

Environment
Biological Signals
RF Signals

Receiver / Transducer → Amplifier → Analog-to-Digital Converter (ADC) → Digital Processing

Digital Processing → Digital-to-Analog Converter (DAC) → Amplifier → Transmitter / Transducer

VE 311
VE 413

VE 312
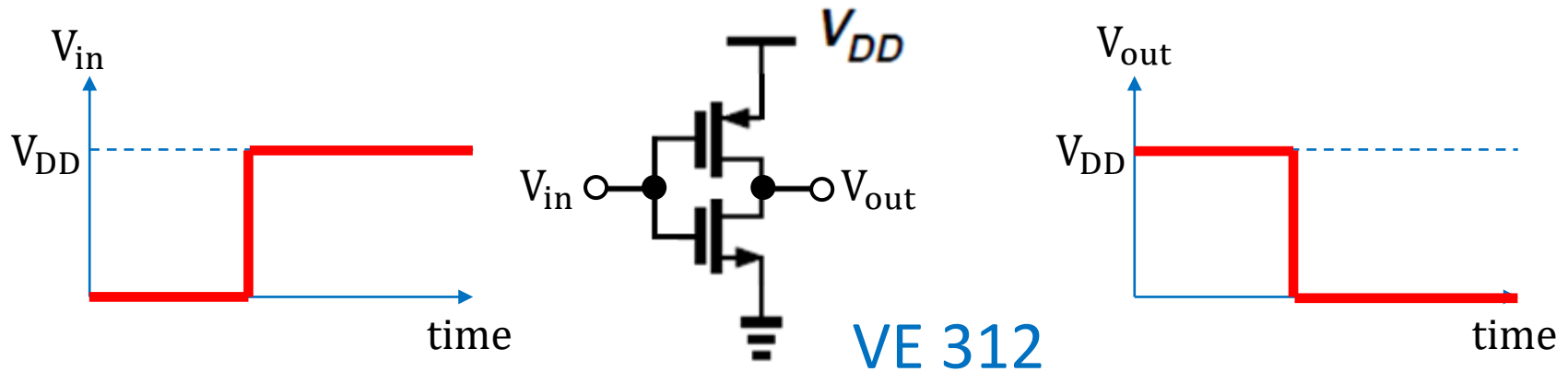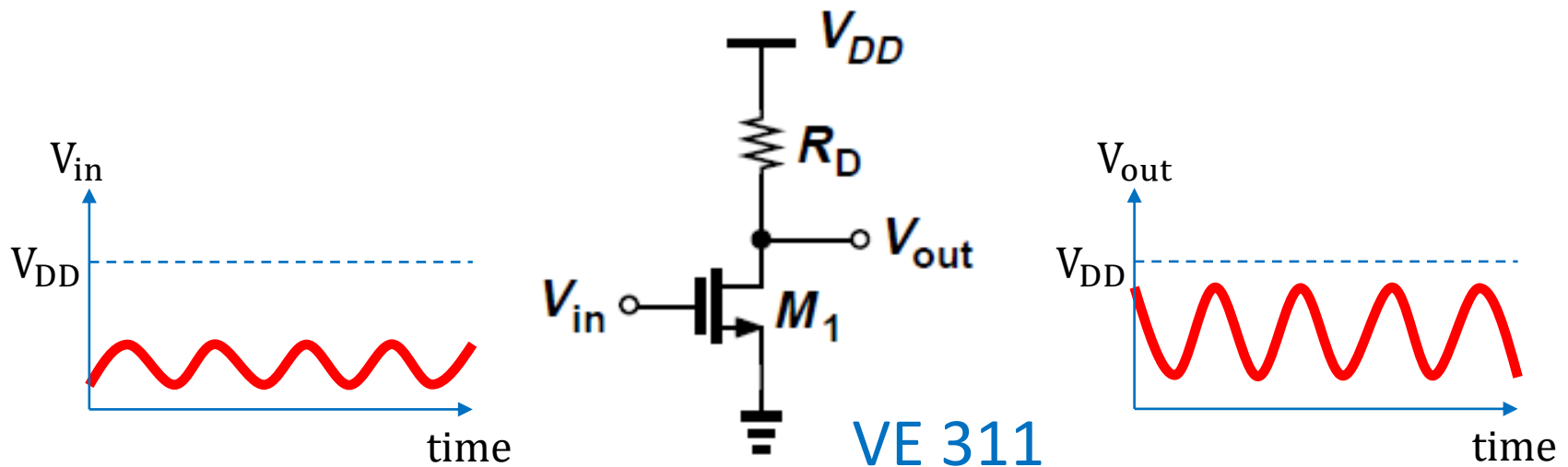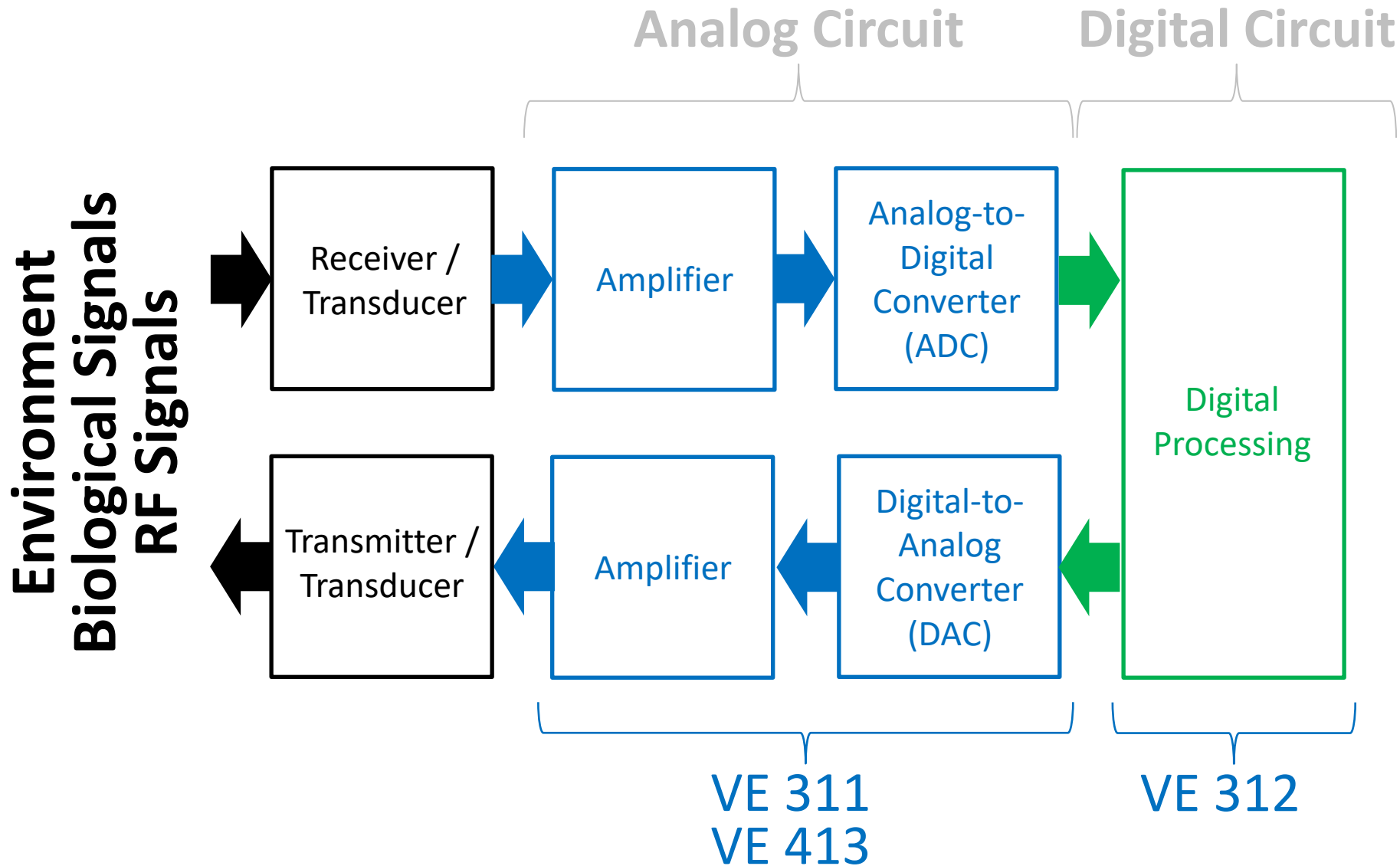
IC Design Process

Hand calculations on paper, based on proper approximations.

↓

Pre-simulation: Schematic design and simulation on Spice.

↓

Post-simulation: Layout drawing, simulation and design rule check on Cadence.

↓

Tapeout: Layout design sent to IC manufacturers.

VE 311