EECS 1

Introduction to Electrical Engineering And Computer Science

Electronic Circuit Design

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What are We Up to in NCIC Labs?

- We aspire to make a difference and to push the cutting edge
- We explore new and out-of-box ideas
- We bring forth the ideas on the paper
- We implement these ideas in silicon
- We fabricate these silicon chips
- We measure the fabricated silicon chips

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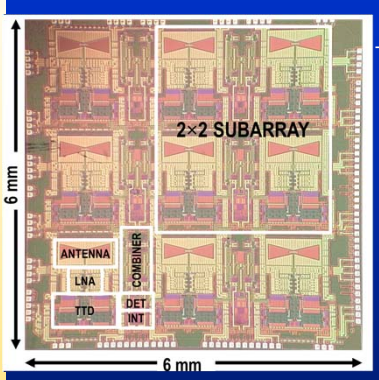
Example: Imaging Chip



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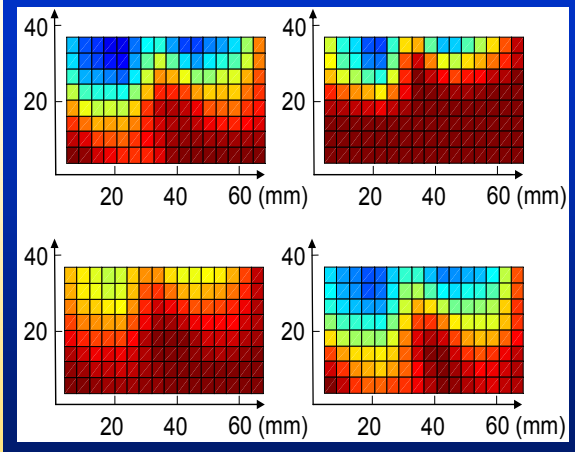
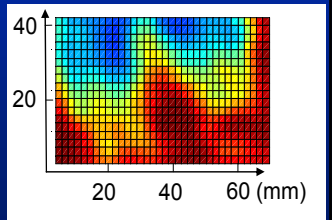
Example: Imaging Chip Experiment



Object Imaged



Composite Image

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NCIC Labs

Students

- **Alumni: 9 received Ph.D.; 11 received M.S.**
- **Current: 8 Ph.D. students and 1 M.S. student**
- **URL: http://newport.eecs.uci.edu/~payam**

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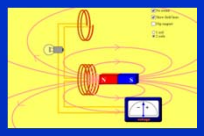
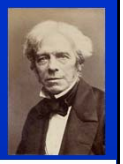
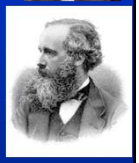
Electronics Technologies: Historical Perspective

- Michael Faraday (1791 – 1867) discovered magnetic field induction





- James Clerk Maxwell (1831 – 1879) discovered that electricity, magnetism, and light are all manifestations of the same phenomenon



- Edwin Howard Armstrong (1890 –1954) invented the FM radio and heterodyne and regenerative receivers

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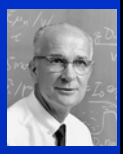
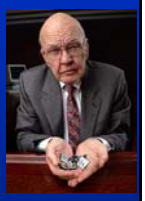
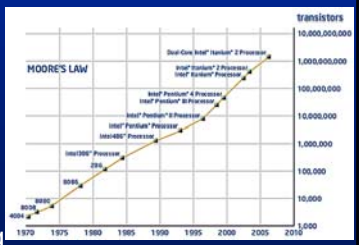
Electronics Technologies: Historical Perspective



- William Shockley (1910 – 1989) co-invented the transistor, a semiconductor device used to amplify and switch electronic signals
  - Led effort that made *Silicon Valley* a hotbed of innovation



- Jack Kilby (1923 –2005) contributed to the first integrated circuit, and invented the first handheld calculator



- Gordon Moore (1929 –) observed that the # of transistors on integrated circuits doubles approx. every two years.

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Electronics Technologies: Major Inventions

- Wireless technology and mobile telephony
- Audio amplifiers
- Radio transmitters and receivers
- Transistors and semiconductor devices
- Integrated circuits
- Computers ⇒ Microprocessors and Memory
- Smart and portable devices

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Revolution in Electronics

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Living in Analog World

- Signals (e.g., voice, audio, video) are all *analog* in nature
- The tools to process these signals were all analog
- Analog computers were bulky and extremely limited in computation power
- Telephones and broadcast systems based on analog processing were of poor quality and performance

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Digital Revolution

- Started in1980 and continues to the present day
- Refers to revolution in computing & communication technology during the latter part of 20th century
- The Digital Revolution marked the beginning of the Information Age
- Central to this revolution is the mass production and widespread use of digital circuits, and its derived technologies, including the computer, digital cellular phone, and fax machine
- Digital technology allowed high quality processing using a smaller size devices
- The enabling technology was silicon process

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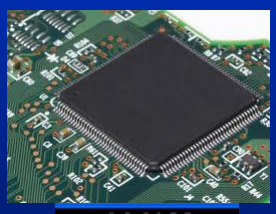
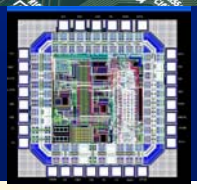
Integrated Circuits (IC's)

- Until early 60th's, the circuits were mainly built out of discrete components, such as resistors, capacitors, and transistors
- The cost and performance of systems using discrete components were prohibitive
- Building a set of electronic circuits on one small plate ("chip") of semiconductor material, normally silicon proves to be much smaller than a discrete circuit.
- ICs can be made very compact
- Today's chips can accommodate several billion transistors and other electronic components in an area the size of a fingernail





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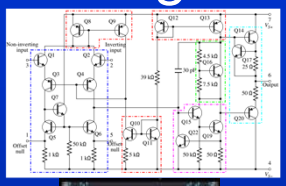
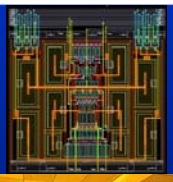
Integrated Circuits Design

- An integrated circuit is designed and simulated using computer
- Its performance is evaluated
- The layout for the circuit is developed
- The circuit is then sent for fabrication





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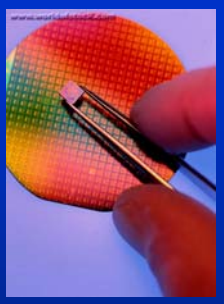
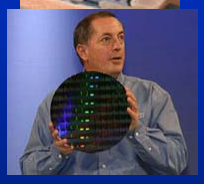
Integrated Circuits Design

- Wafers including many copies of the circuit chip are produced





- The chips are measured to report the performance

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Circuits/Electronics Curriculum

- Designing and implementing circuits require a deep and fundamental knowledge of:
  - Circuits
  - Analog and digital electronics
  - Physics of semiconductor devices
  - Knowledge of simulation tools (computer)
  - Familiarity with measurement equipment

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EE Core

Math 2A	1-D Calculus I	**EECS 1**	Introduction to EECS
Math 2B	1-D Calculus II	**EECS 10**	Computational Methods
Math 2D	M-D Calculus I	**EECS 31**	Digital Systems
Math 2E	M-D Calculus II	**EECS 31L**	Digital Logic Lab
Math 3A	Linear Algebra	**EECS 50**	Discrete-Time Systems
Math 3D	Differential Equations	**EECS 55**	Probability
Physics 7C/L	Force, Energy, Motion	**EECS 70A/L**	Network Analysis I
Physics 7D/L	Electricity, Magnetism	**EECS 70B/L**	Network Analysis II
Physics 7E	Fluids, Waves, Optics	**EECS 145**	Adv. EE Mathematics
Physics 51A	Modern Physics	**EECS 150**	Cont-Time Systems
Chem 1A	General Chemistry	**EECS 160A/L**	Intro Control Systems
Engr 190W	Tech Communications	**EECS 170A/L**	Electronics I
		EECS 170B/L	Electronics II
		EECS 170C/L	Electronics III
		EECS 180A	Electromagnetics I
		EECS 189A	Senior Design I
		EECS 189B	Senior Design II

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Circuits/Electronics Curriculum at UCI

- EECS 70 A and B: Basic Network Theory
- EECS 170 Series
  - EECS170 A, Electronics – I: Overview of fundamentals of device physics, IC components including transistors, diodes, and basic electronic circuit
  - EECS170 B, Electronics II: Overview of silicon-based amplifier design, design of basic digital circuits
  - EECS170 C, Electronics III: designing operational amplifiers, frequency response of amplifiers
  - EECS170 D, Integrated Electronic Circuit Design: overview of IC fabrication & digital very large scale integrated (VLSI) circuits
  - EECS170 E, Analog and Communication IC Design: overview of design of high frequency integrated circuits including amplifier and oscillators

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Circuits/Electronics Curriculum at UCI

- EECS 160 A and B, Power Electronics I – II: Power switching devices, pulse width modulation (PWM) methods, switching converter topologies, control, and magnetics.

- EECS 174, Semiconductor Devices
- EECS 176, Solid State Electronics
- EECS 179, MEMS
- EECS 182, MMIC Design
- EECS 188, Optical Electronics

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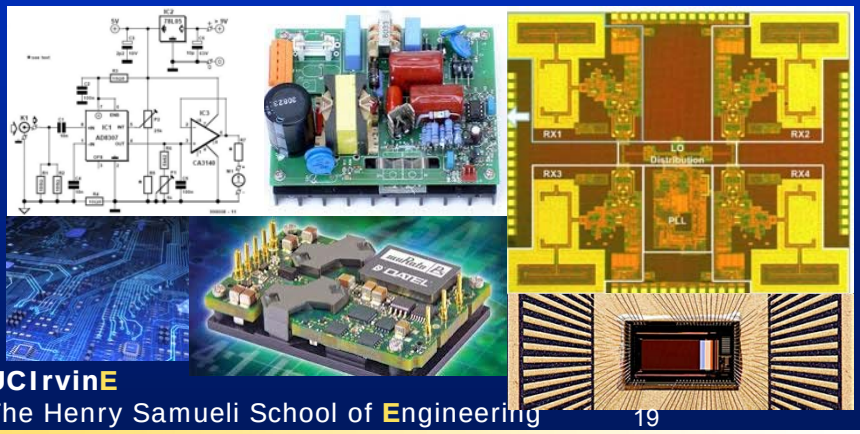
Electronic Circuits Design

EECS 170D*	IC Design	EECS 174	Semiconductor Devices
EECS 170E*	Analog/Comm IC Design	EECS 176	Solid State Electronics
EECS 166A	Power Electronics I	EECS 179	MEMS
EECS 166B	Power Electronics II	EECS 182	MMIC Design
		EECS 188	Optical Electronics

Specialized Electives 4 courses
*Required for Specialization



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Electronic Circuit Design

EECS 170D*	IC Design	EECS 174	Semiconductor Devices
EECS 170E*	Analog/Comm IC Design	EECS 176	Solid State Electronics
EECS 166A	Power Electronics I	EECS 179	MEMS
EECS 166B	Power Electronics II	EECS 182	MMIC Design
		EECS 188	Optical Electronics

Specialized Electives 4 courses
*Required for Specialization

Ahmed Eltawil
VLSI Architectures for Wireless

Stuart Kleinfelder
High Speed Digital Cameras, Sensor Systems

Michael Green
Analog IC Design, Nonlinear Circuits

Keyue Smedley
Power Electronics, Energy, Control Systems

Payam Heydari
High Speed Analog RF/Analog/Mixed Signal Circuits

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Where Can I Go for More Info?

Catalogue

www.editor.uci.edu/catalogue/engr/engr.8.htm
www.editor.uci.edu/catalogue/engr/engr.9.htm

Department Website

www.eng.uci.edu/dept/eecs

Course Outlines

plaza.eng.uci.edu/course/outline/eecs/2012-2013

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