

# CPEG 460 / 660 - Introduction to VLSI Systems

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Fall 2019

# Course Info

**Instructor:** Peyman Barakhshan

**TA:** Jaclyn Singh

**Class Schedule:** Tu/Th: 11:00 to 12:15 in Colburn 046 (ECalc)

**Course / Discussion Website:** [piazza.com/udel/  
fall2019/19fcpeg460cpeg660010080/home](https://piazza.com/udel/fall2019/19fcpeg460cpeg660010080/home)

**Textbook:** CMOS VLSI Design: A systems and circuits perspective, N. Weste, Pearson, 4th Ed. (2010)

# Course Info

**Requirements:** Homework assignments, Tests, Projects, Quizes

**Grading Policy:**

- Homework: 10%
- Quizes: 10%
- Midterm Exam: 15%
- Design Projects: 50%
- Final Exam: 15%

# Course Objectives

- ❑ Learn to design digital integrated circuits
- ❑ Learn to use Cadence VLSI software
- ❑ Learn to debug & resolve circuit problems
- ❑ Learn MOS transistor circuits
- ❑ Improve project management skills

# Course Outline

- ❑ Textbook VLSI Lectures  
<http://pages.hmc.edu/harris/cmosvlsi/4e/index.html>
- ❑ MOS Transistor & Design Rules
- ❑ Cadence Training
- ❑ Guided Project #1
- ❑ Chip Fabrication and Testing Opportunity

# Prerequisites

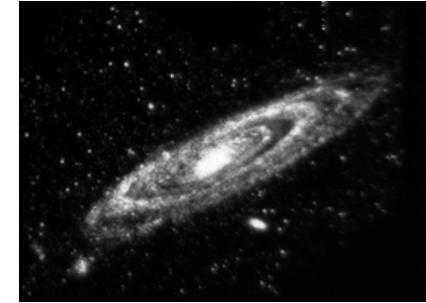
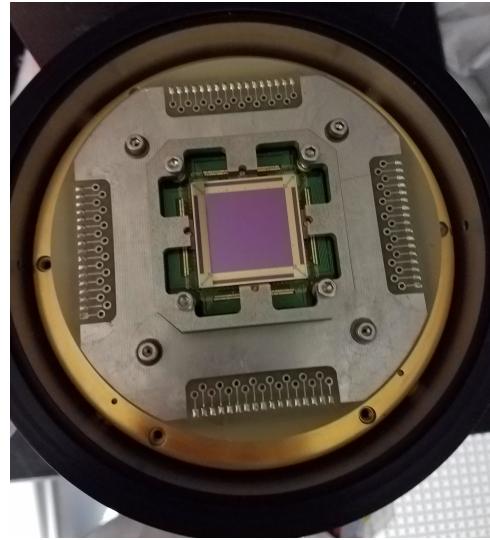
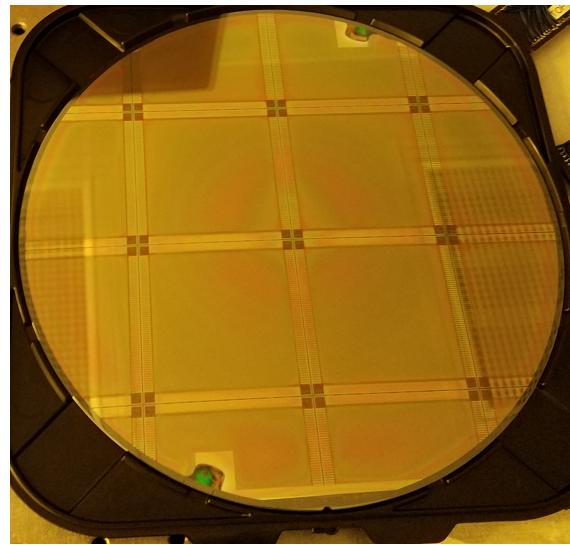
- Basic analog/digital circuit knowledge
- Previous knowledge of logic design
- Basic knowledge of MOS transistor operation
- Familiarity of Linux/Unix is helpful

# Software

- ❑ CADENCE EDA Tools
  - ❑ Widely used by chip designers
  - ❑ Composer Capture
  - ❑ Virtuoso Layout, Turbo XL
  - ❑ Analog Design Environment & SPECTRE Simulation
  - ❑ Front-to-Back Chip Design
  - ❑ CALIBRE Verification Tools (from Mentor Corp)
- ❑ A Linux Virtual Machine will be available to download that has all these tools installed. Check canvas for a link to download.

# My research

## ❑ Infrared Scene Projectors (IRSP)



# Infrared Scene Projectors (IRSP)

Used to test infrared sensors and detection systems  
able to produce room-temperature and hot scenery  
simultaneously(77K to 1500K)

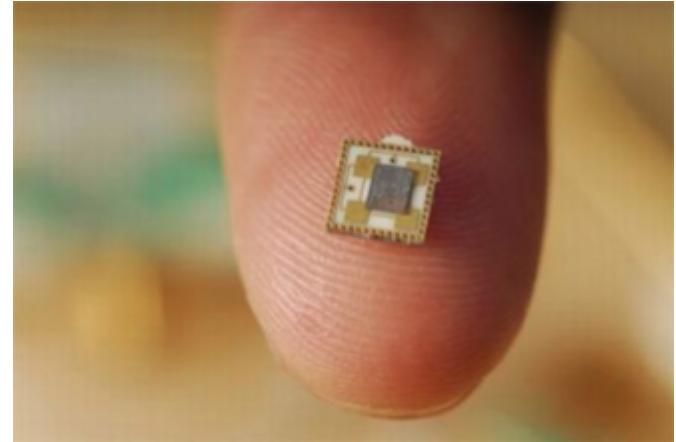
Often used in real time simulations

# Some Important Announcements

- ❑ Please use piazza to ask questions.
- ❑ You can work together for homework, but turn in your solution in sakai separately.
- ❑ Project #1 will be done individually.
- ❑ Project #2 will be done in groups.
- ❑ Late homeworks will get 50% off for a week.

# VLSI Chip

- ❑ VLSI *is the process of creating an integrated circuit by combining millions of transistors into a single chip.*
- ❑ Modern transistor size is about 14 nm
  - ❑ Human hair is about 100 microns
  - ❑ Smallest particle visible to naked eye is 10 microns

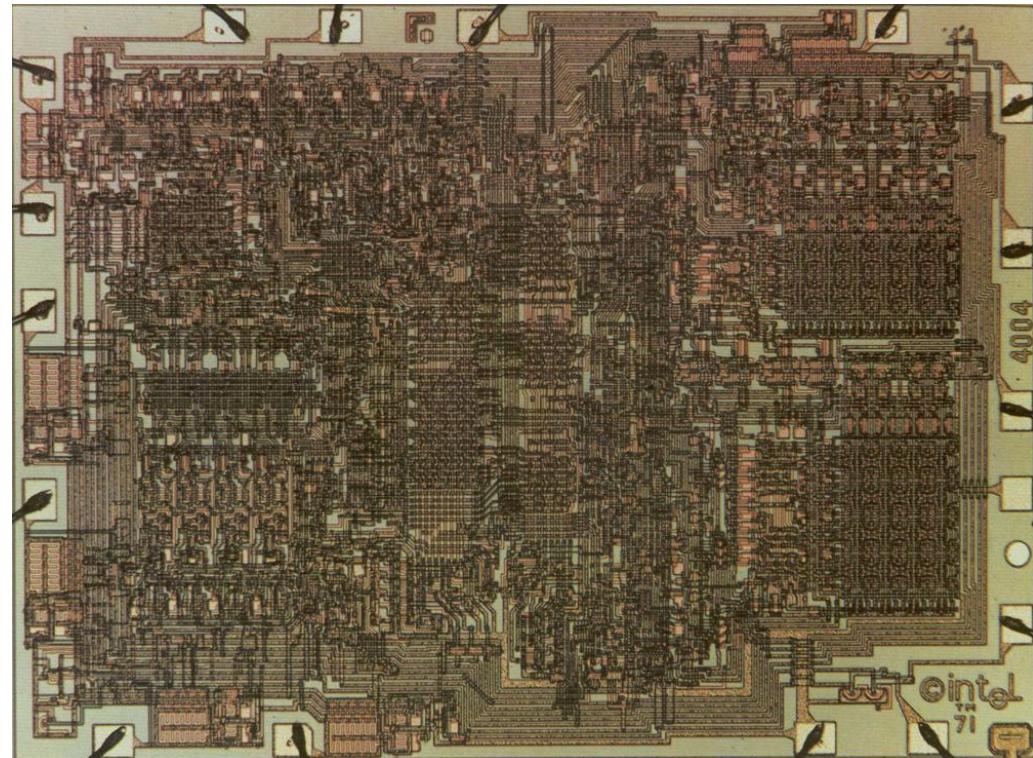


# The Microprocessor

- ❑ Why is the microprocessor the most important component in a computer system?
- ❑ Key Microprocessor Chip Metrics
  - ❑ Clock speed
  - ❑ Number of transistors
  - ❑ Manufacturing technology
  - ❑ Bandwidth

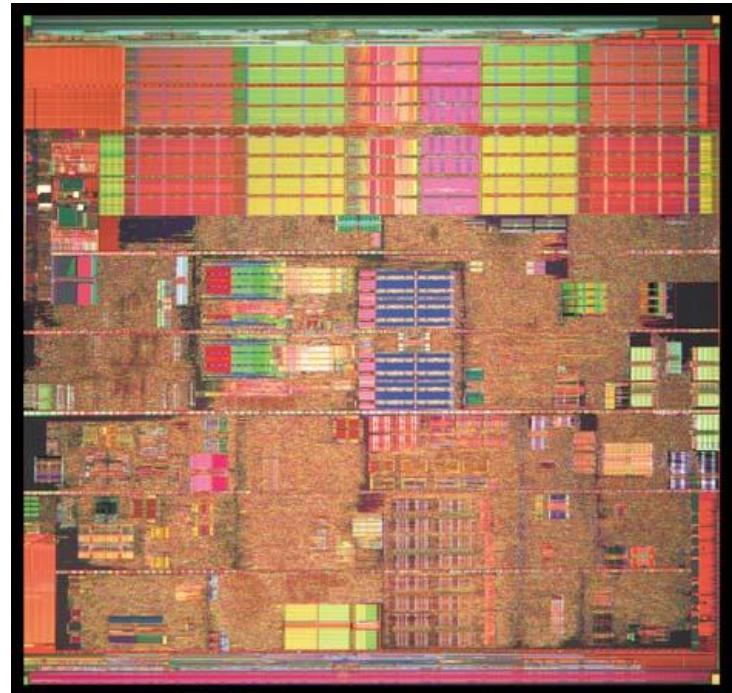
# Intel 4004

- ❑ Intel, 1971
- ❑ 2300 transistors
- ❑ 740 kHz clock
- ❑ 10  $\mu\text{m}$  PMOS technology
- ❑ 12  $\text{mm}^2$



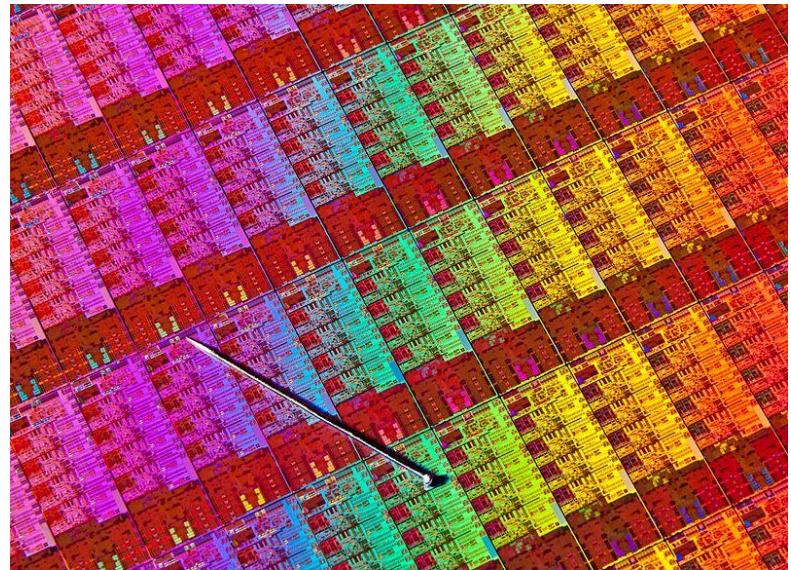
# Intel Pentium 4

- ❑ Intel, 2005
- ❑ 125,000,000 transistors
- ❑ 3.8 GHz clock
- ❑ 90 nm CMOS technology
- ❑ 112 mm<sup>2</sup>



# Intel i3/5/7 (Haswell)

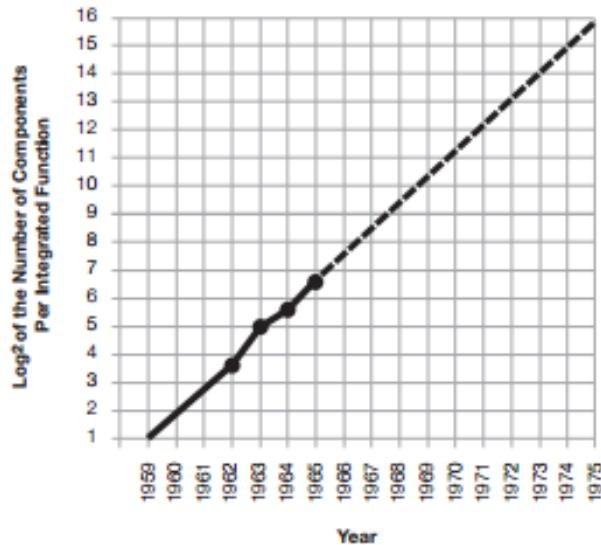
- ❑ Intel, 2013
- ❑ 1.4 billion transistors
- ❑ 3-4 GHz clock
- ❑ 22 nm process



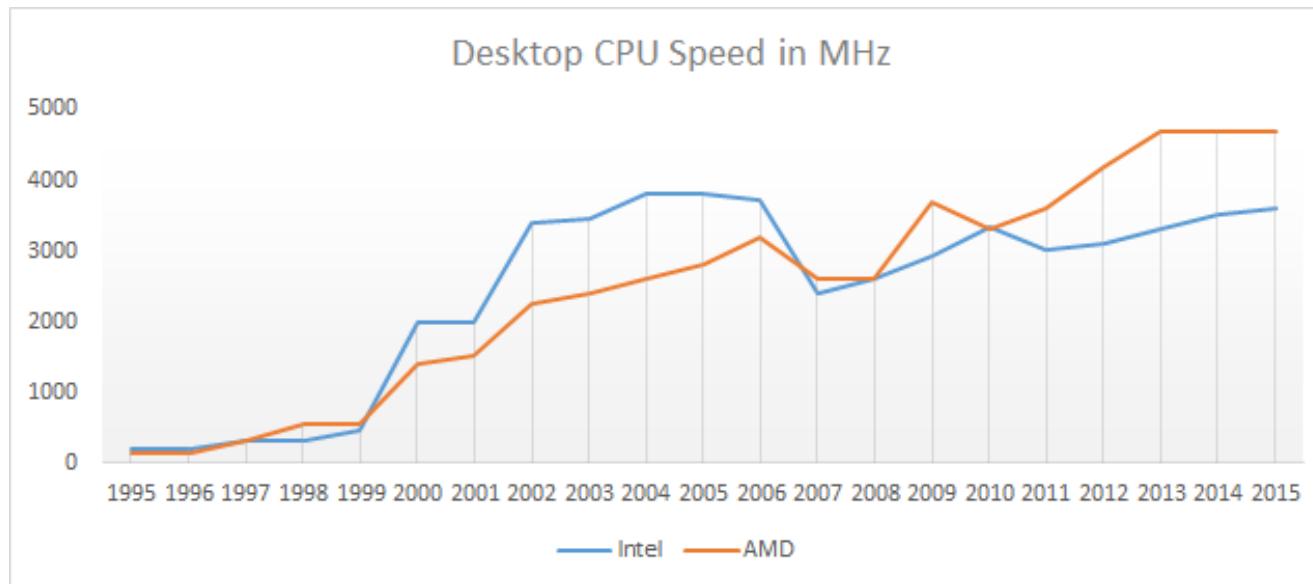
# Moore's Law

*“The number of transistors incorporated in a chip will approximately double every 24 months.”*

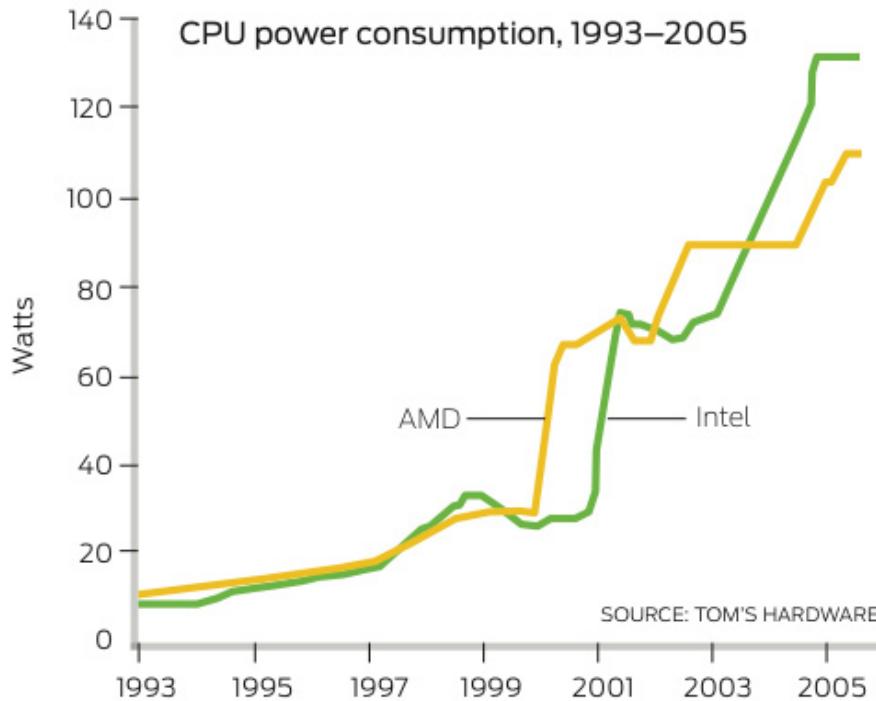
-- Gordon Moore

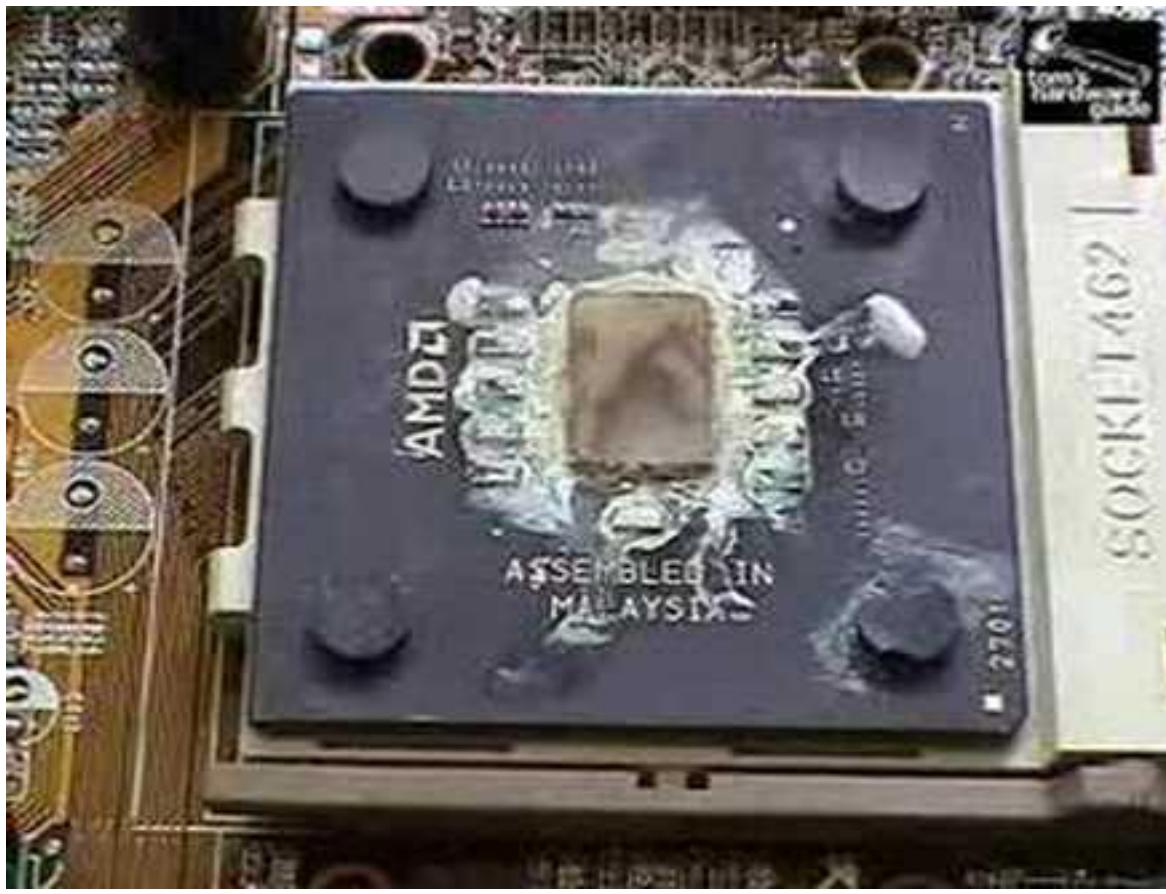


# Frequency



# Power Consumption





Cooling experiment from 2001 <https://www.youtube.com/watch?v=y39D4529FM4>

# Assignment for 8/29

- ❑ Sign-up for piazza
  - [piazza.com/udel/fall2019/19fcpeg460cpeg660010080](https://piazza.com/udel/fall2019/19fcpeg460cpeg660010080)
- ❑ Read Book Sections 1.1 to 1.3 - available online at
  - <http://pages.hmc.edu/harris/cmosvlsi/4e/index.html>
- ❑ Install VMWare - free from the University.
  - <http://udeploy.udel.edu/software-categories/virtualization/>
- ❑ Download the VM, instruction is on canvas