

EE 105

Microelectronic Devices and Circuits

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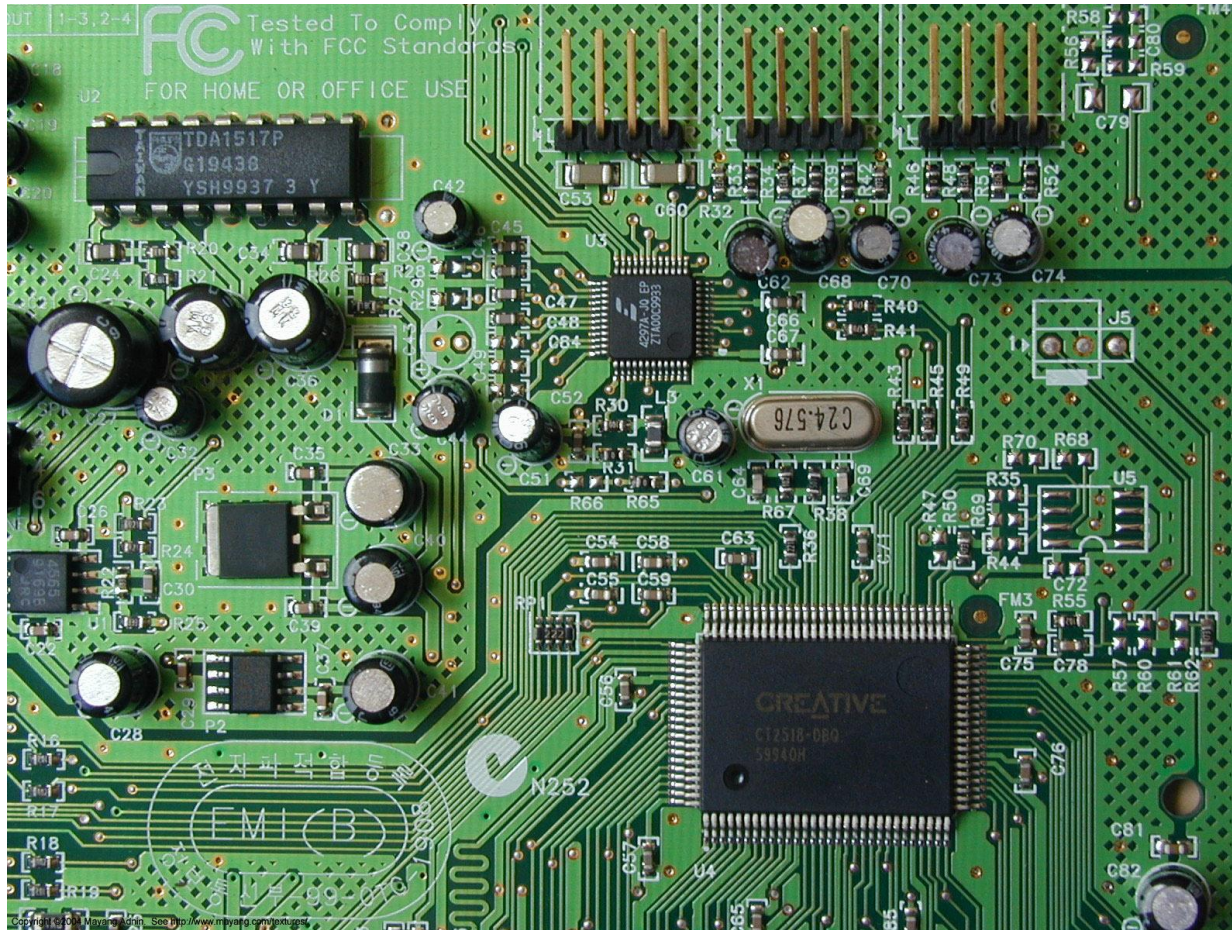
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Overview

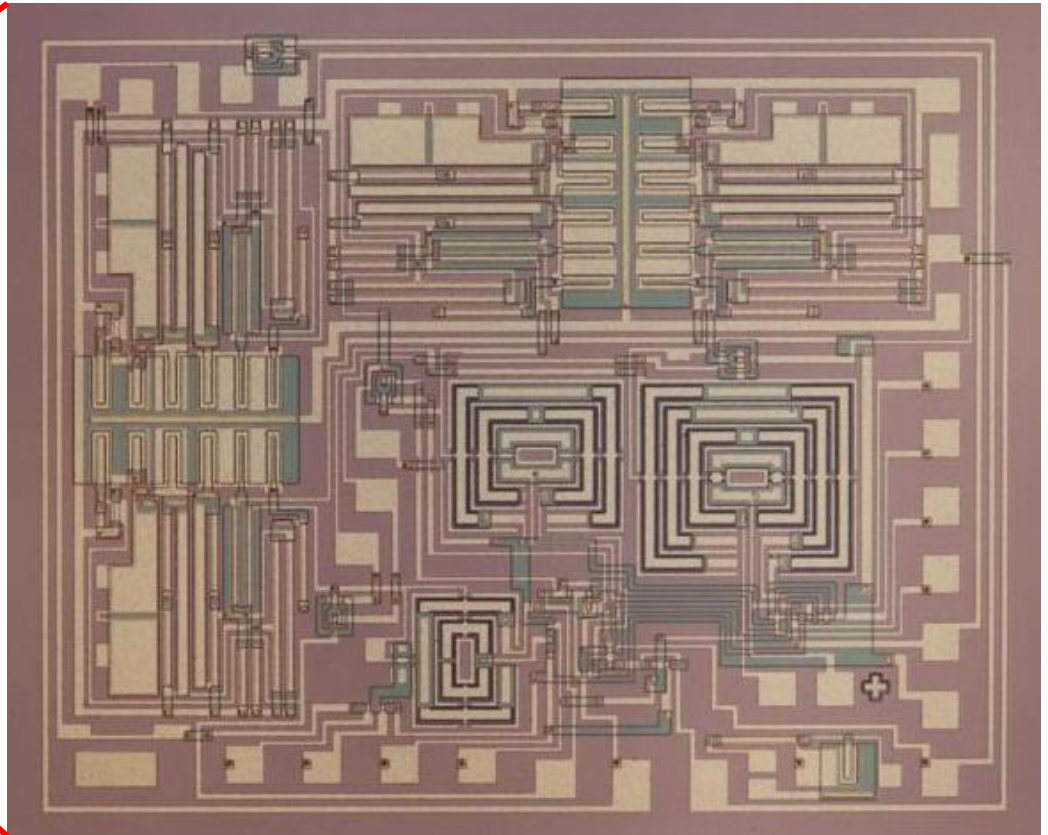
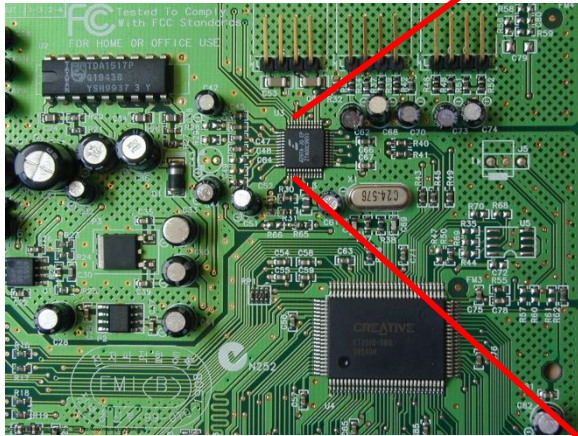
- Microelectronic Devices and Circuits
 - What is microelectronics?
 - What are microelectronic devices?
- Administrative
 - People (instructor, buddies, GSIs, reader)
 - Website(s)
 - Syllabus, exam dates
 - Textbook
 - Assignments
 - Discussions
 - Labs
 - Grades
- Microelectronic Devices

What is Microelectronics?

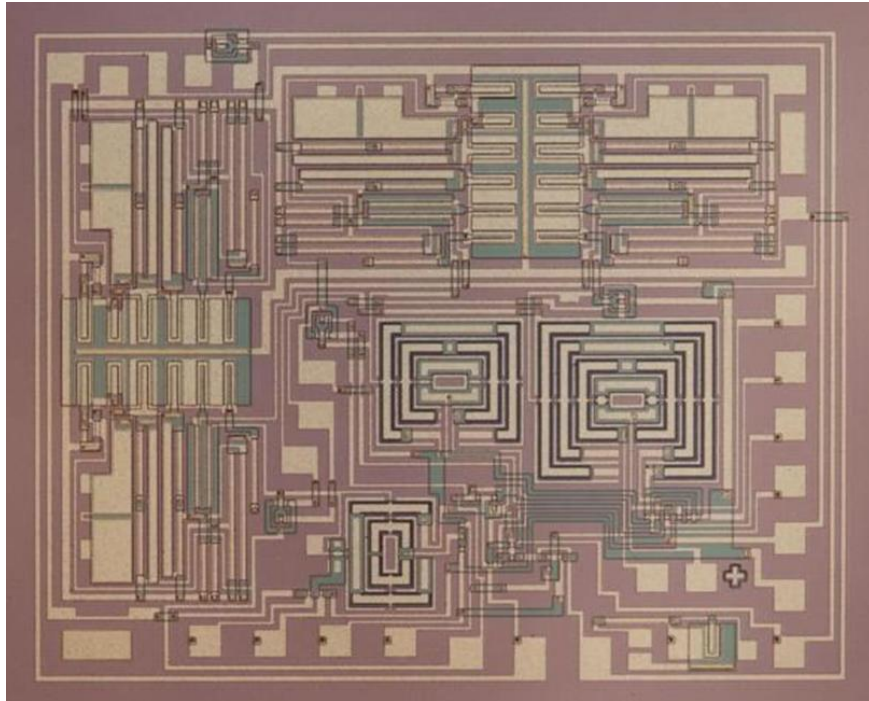
Electronic Circuits



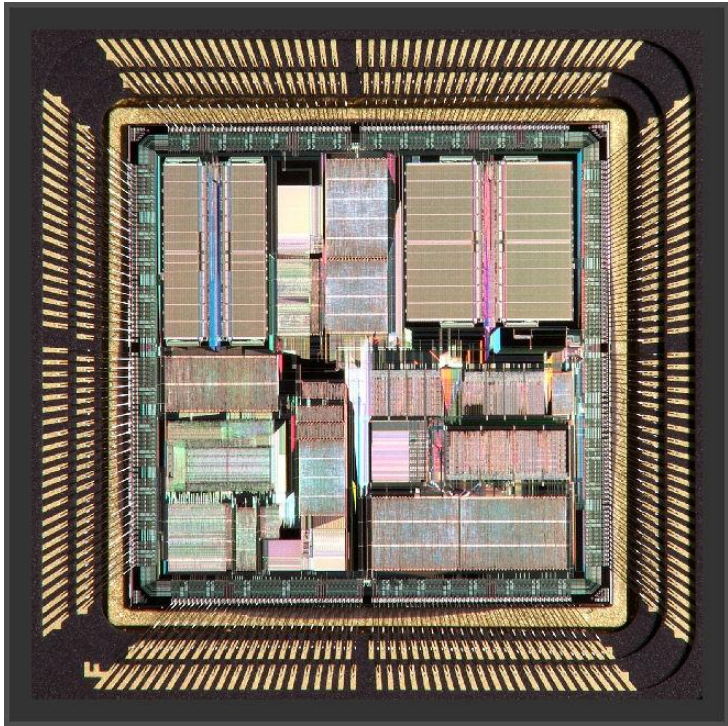
What's inside the box?



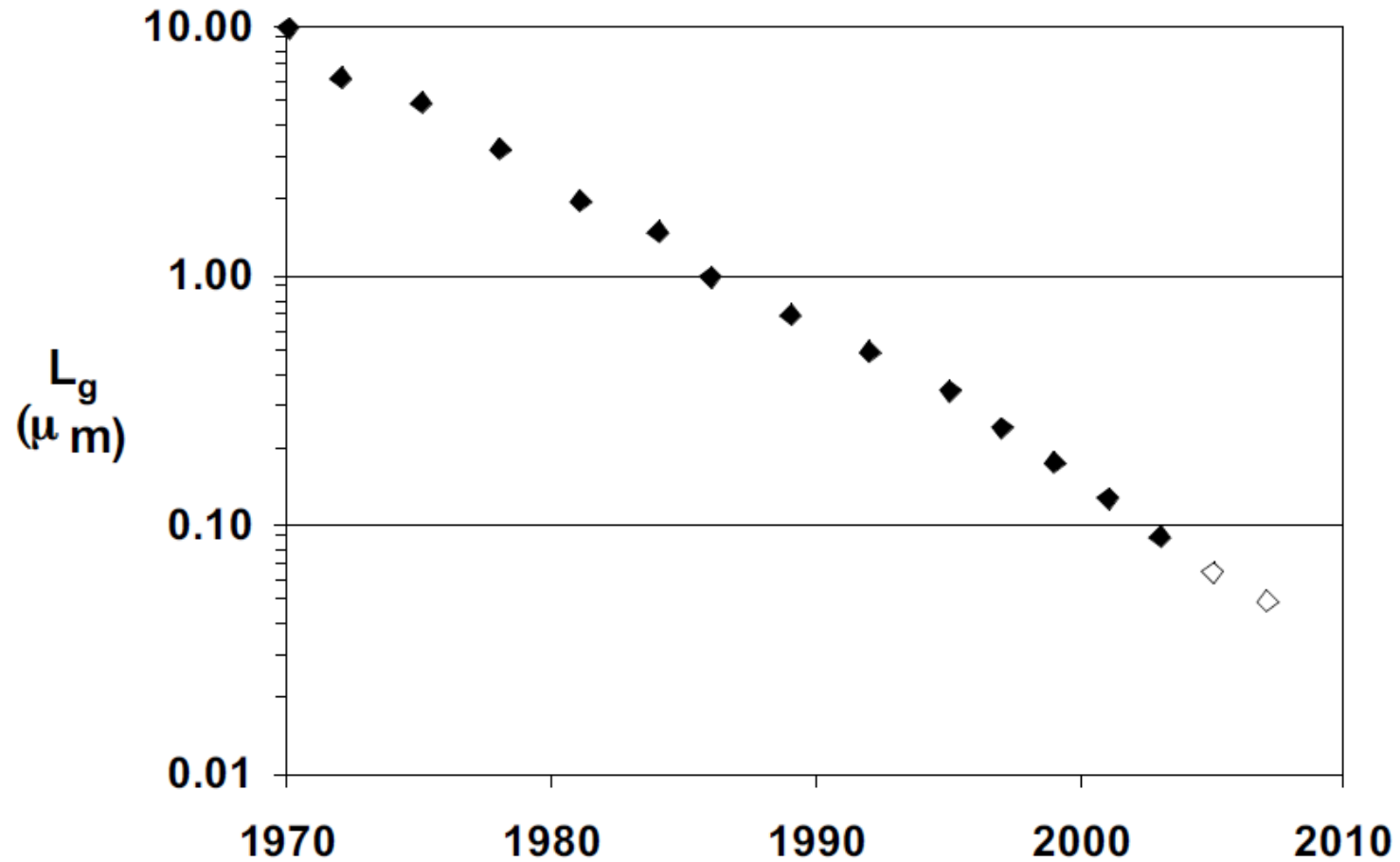
And are Microchips made of?



What's the fuss about Microelectronics?

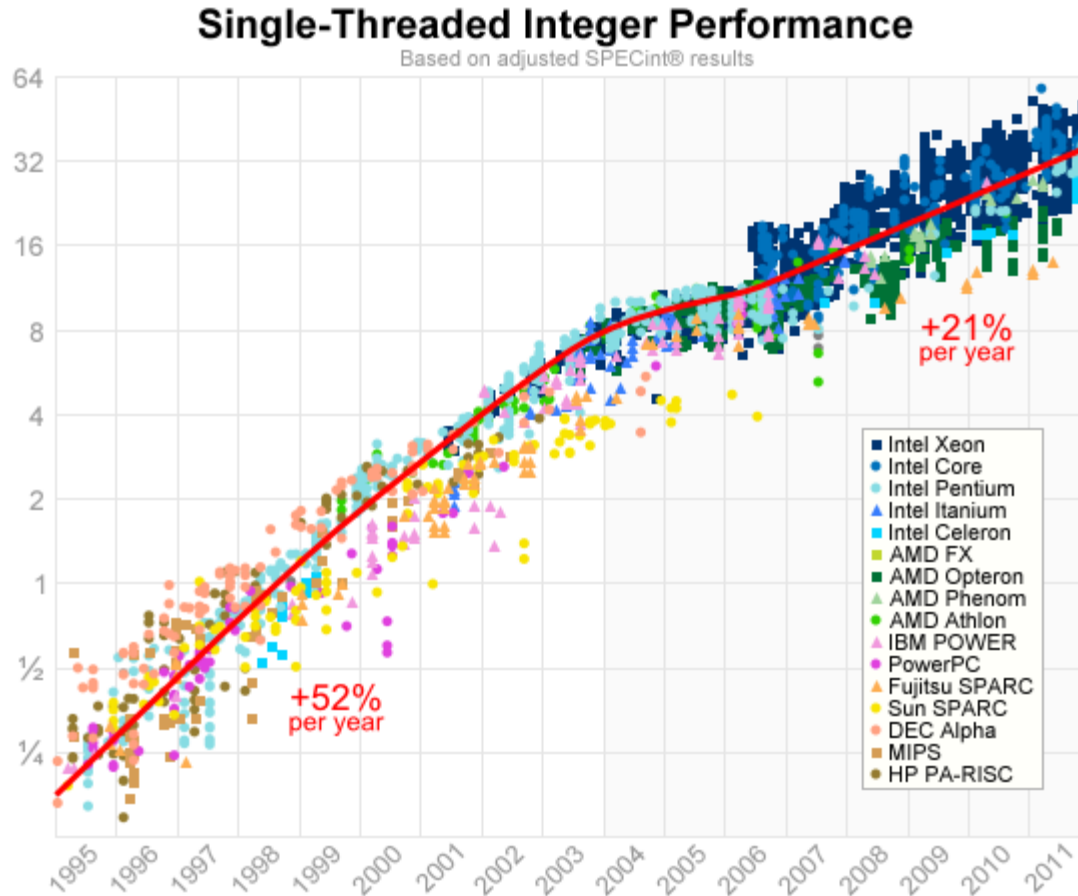


Size



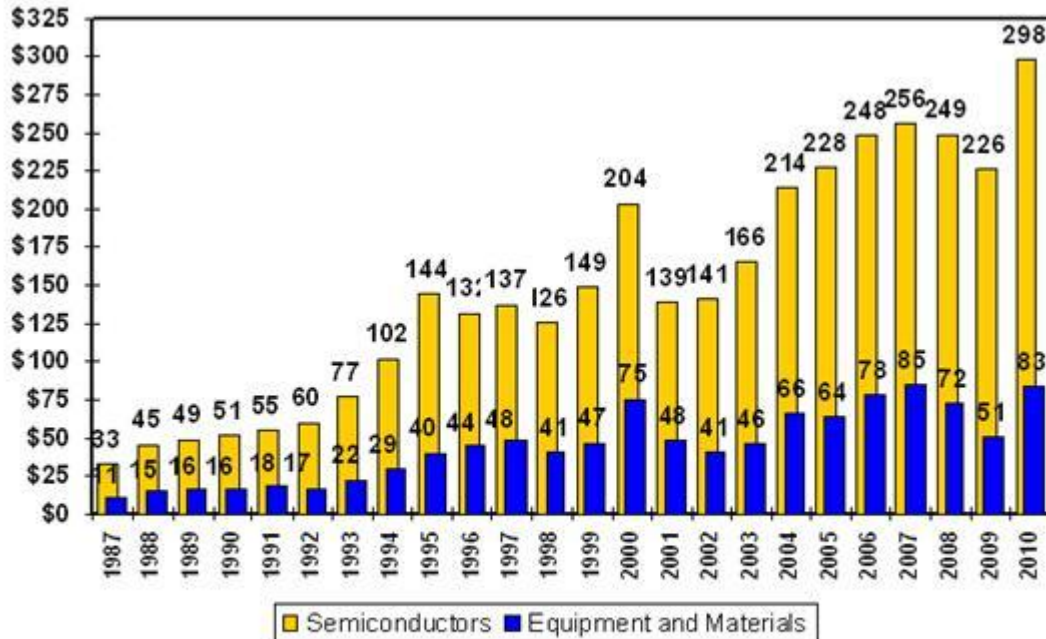
Ref: Gordon Moore, ISSCC 2003

Performance



Ref: preshing.com

Moore's Law



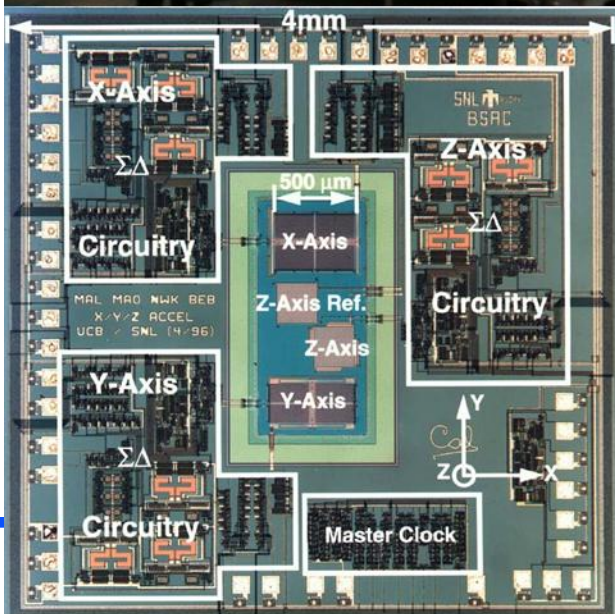
Source: SEMI/WSTS



Microelectronics in 3 bullets

Administrative

Prof. Bernhard Boser





Introductions

- Ashkan Borna
- Brian Lambson
- Michael Roe
- YongKeong Yap

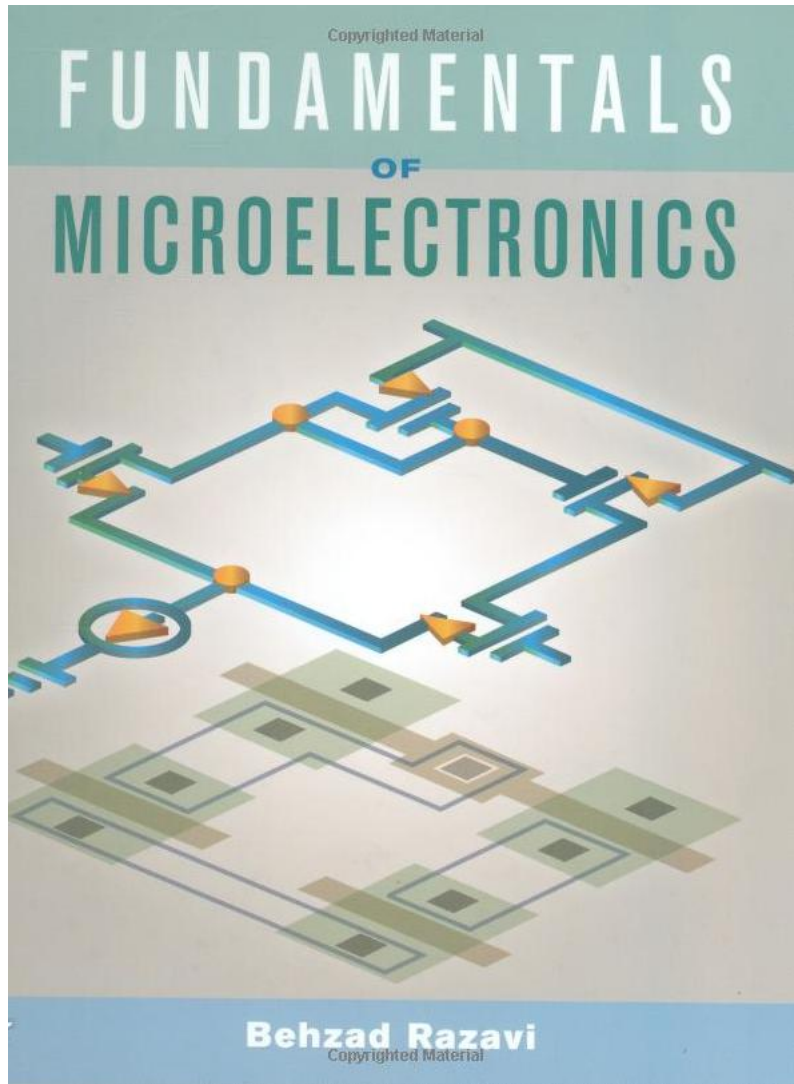
Course Web

- Bspace
 - Links to everything
 - Grades (check regularly!)

- If you cannot access bspace:

<http://www.eecs.berkeley.edu/~boser/courses/105>

Textbook



- You'll have to read it
- Homework tells you what
- The lecture does not repeat the book
- Typically the reading is ahead of the lecture
- Enables meaningful in-class discussions

Webcast

Lecture Notes

- Posted on course-web after the lecture

Syllabus & Exam Dates

EE 105: Microelectronic Devices and Circuits

Prof. Bernhard E. Boser

[Home](#) [Information](#) [Lectures](#) [Piazza](#) [Webcast](#) [Archive](#)

Week	Date	Topic	HW	Lab
1	8/23	Electronics		
2	8/28	Semiconductors	HW1	Introduction to SPICE
	8/30	pn Junction		
3	9/4	Diodes		Test Equipment
	9/6	Bipolar Transistors (BJTs)		
4	9/11	Transistor Models		BJT Characterization
	9/13	Small & Large Signal Behavior		
5	9/18	Midterm Review		Makeup Labs
	9/20	Midterm 1		
6	9/25	Transistor Amplifiers		Common Emitter
	9/27	Biasing		
7	10/2	Voltage Gain		Common Collector & Base
	10/4	Input/output resistance		
8	10/9	Transistor Configurations		Bias Circuits
	10/11	Current Mirror		
9	10/16	Midterm Review		Makeup Labs
	10/18	Midterm 2		
10	10/23	Frequency Response		Frequency Response
	10/25	Miller Approximation		

Assignments

- Posted Friday
- Due following Friday
- 6-10 hours to complete
 - Reading
 - Problem solving
- Get help from
 - Instructor
 - GSIs
 - Friends
 - Discussions
 - Piazza
 - Google
 - ...
- But turn in your own work!

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EECS 105

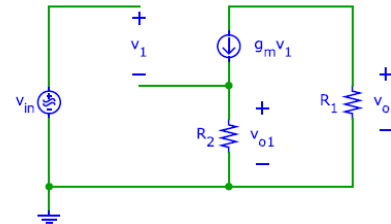
B. E. Boser
H1: EE40 Review & Semiconductors

Due in the "EE 105 box" near 125 Cory Hall by 5pm on Friday 8/31/2012.

Read Chapters 1 and 2 in B. Razavi: Fundamentals of Microelectronics

Review

1. A 16 Megapixel digital camera chip capable of operating 1000 frames per second (i.e. 1000 frames are recorded each second). How many analog-to-digital converters (ADCs) are required to operate in parallel if a single ADC requires 6.9 ns to convert the output from one pixel of the camera chip?
2. The peak output from a microphone is 2.7 mV. Calculate the voltage gain in dB (deci-Bel) required to produce a 6.3 V peak input for a headset.
3. Calculate v_{o1}/v_{in} and v_{o2}/v_{in} for $g_m = 4.9$ mS, $R_1 = 9.8$ k Ω , $R_2 = 44$ k Ω . We'll recognize this seemingly arbitrary circuit later in the course as the small signal model of a transistor amplifier.



4. Find the value of g_m such that $-v_o/v_{in} = 3.6$ for $R_1 = 21$ k Ω , $R_2 = 1.8$ k Ω . The circuit represents an important transistor configuration.



Discussions

Laboratories

- You must complete all labs to pass the course!
- 3 hour lab sessions
 - Do prelabs to finish on time
 - Makeup labs if you miss one or do not finish
- Work in groups of two
 - Not three (or four or ...)
 - One feels lonely
- Sign up for lab NOW
 - Mike to mike

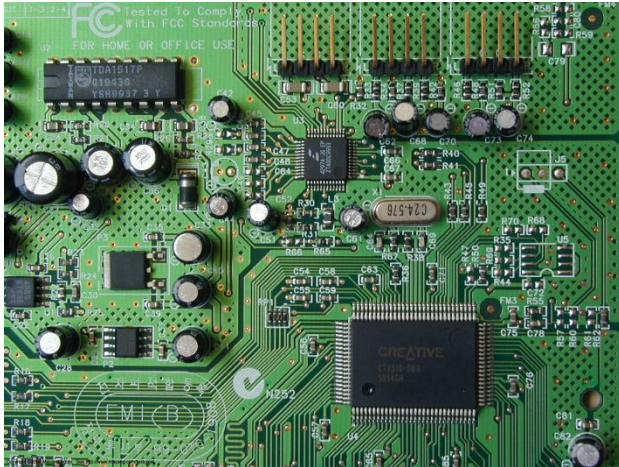
Grades

- Homework (15%)
- Labs (15%)
You must complete all labs to pass the course!
- Midterms (30%)
- Final (40%)

Questions ...

Microelectronic Devices

Devices



- Resistors

Active Devices

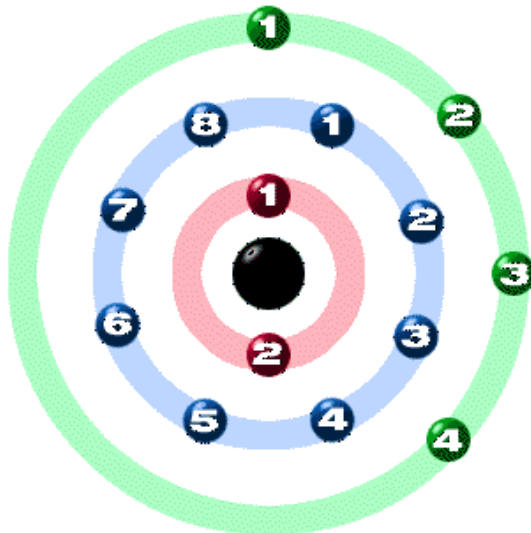
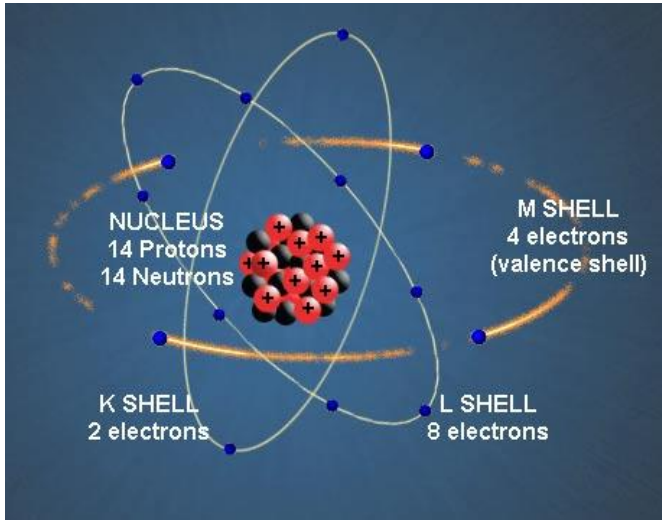
Active Device Requirements

- Modulate current flow

Active Device Examples

Semiconductors

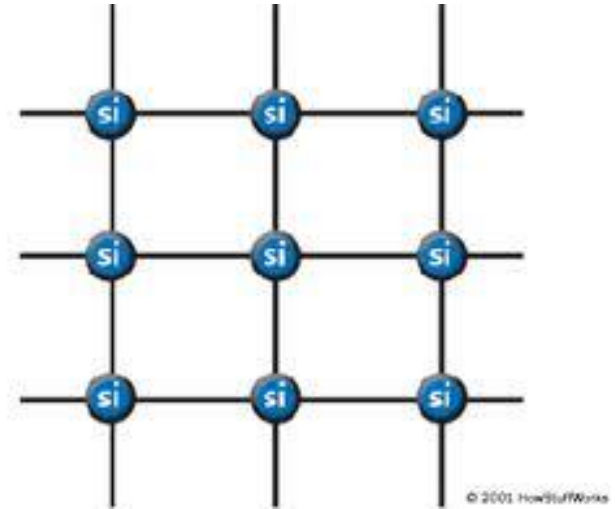
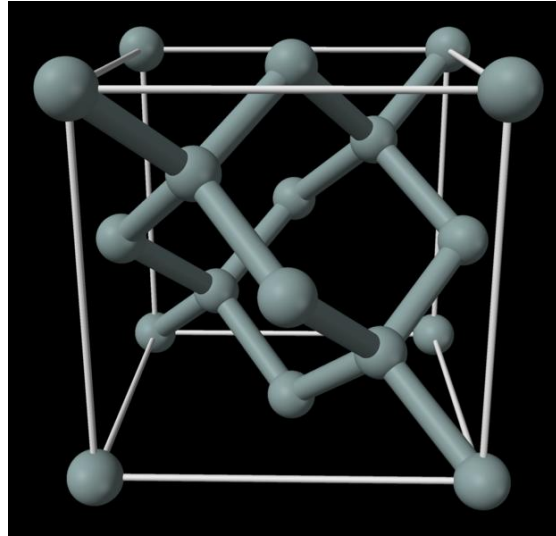
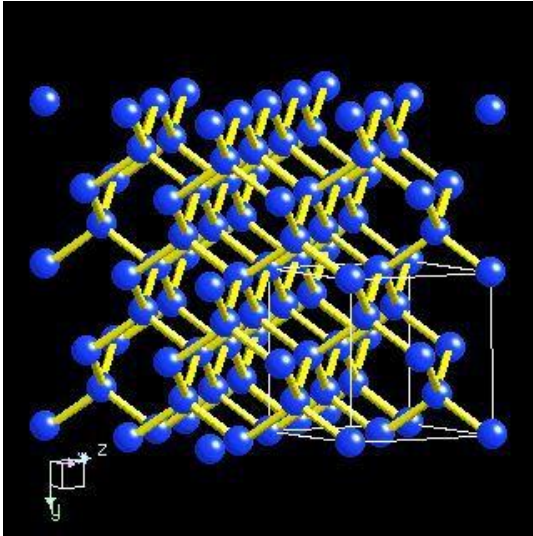
Conductors, Insulators, Semiconductors



Semiconductors

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.008																	2 He 4.0026
3 Li 6.94	4 Be 9.0122											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.085	15 P 30.974	16 S 32.06	17 Cl 35.45	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.63	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.798
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.96	43 Tc [97.91]	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	* 71 Lu 174.97	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po [208.98]	85 At [209.99]	86 Rn [222.02]
87 Fr [223.02]	88 Ra [226.03]	** 103 Lr [262.11]	104 Rf [265.12]	105 Db [268.13]	106 Sg [271.13]	107 Bh [270]	108 Hs [277.15]	109 Mt [276.15]	110 Ds [281.16]	111 Rg [280.16]	112 Cn [285.17]	113 Uut [284.18]	114 Fl [289.19]	115 Uup [288.19]	116 Lv [293]	117 Uus [294]	118 Uuo [294]

Silicon Crystal

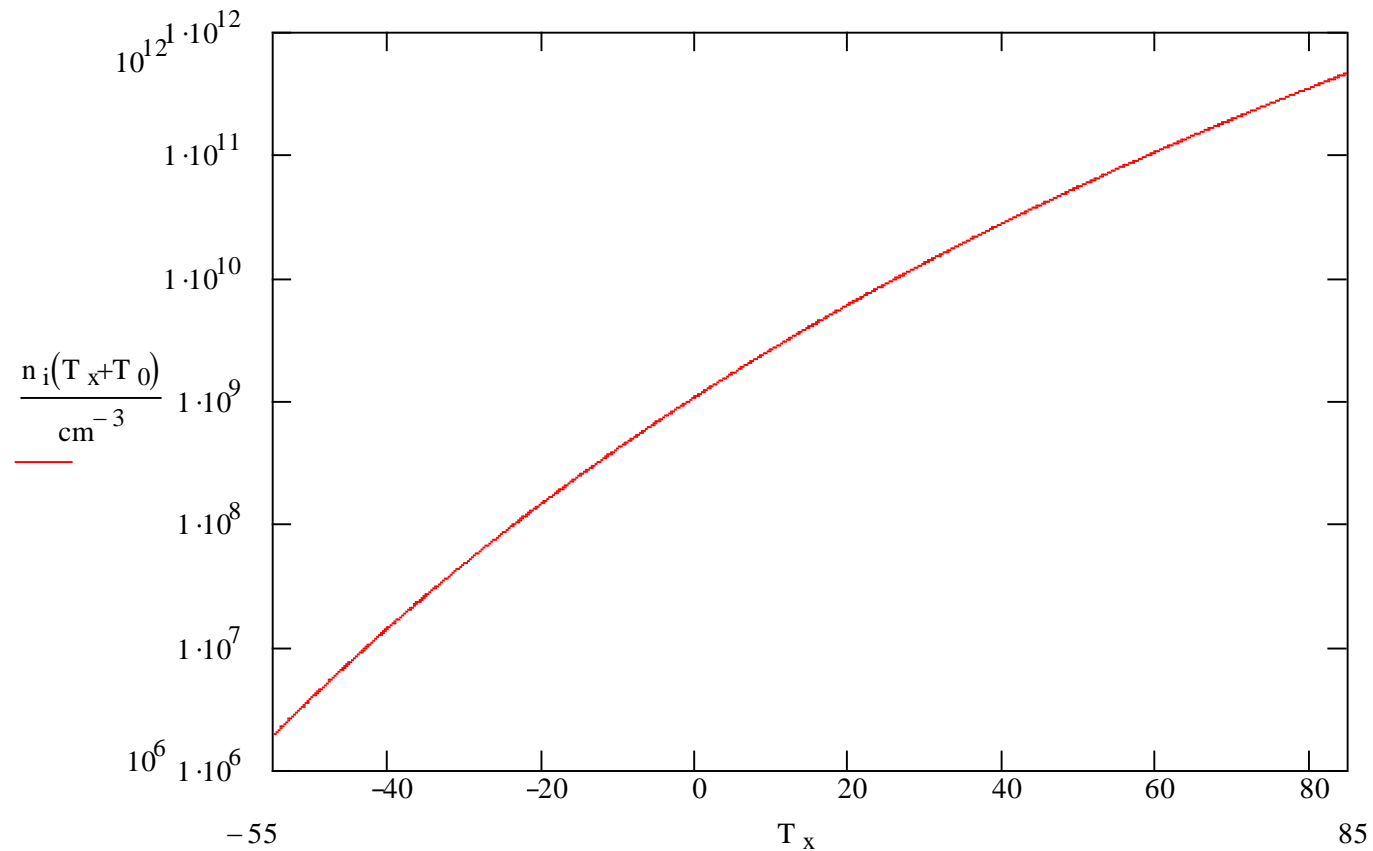


Density:
 5×10^{22} atoms / cm^3

Distance between atoms:
0.22 nm

Bandgap

Intrinsic Carrier Concentration n_i



Semiconductors Summary
