



# Chapter1: Computer System

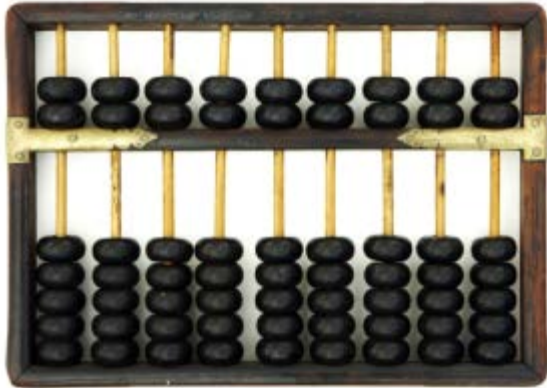
Asst.Prof.Dr.Supakit Nootyaskool

# Learning Outcome

- Express computer evolution from the mechanical to semiconductor.
- Describe the difference between the microprocessor and microcontroller.

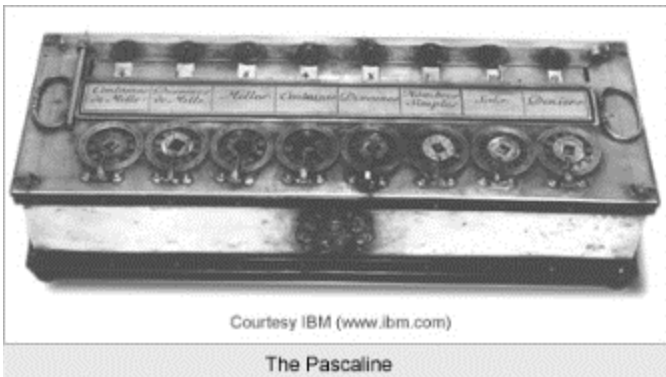
# FIRST COMPUTING DEVICE

# Mechanical computer



- Abacus
  - Used in China, Europa and Russia

- Mechanical calculator
  - Blaise Pascal (1642) developed a machine to help his father working in the shop.
  - Working only function of the addition and subtraction.

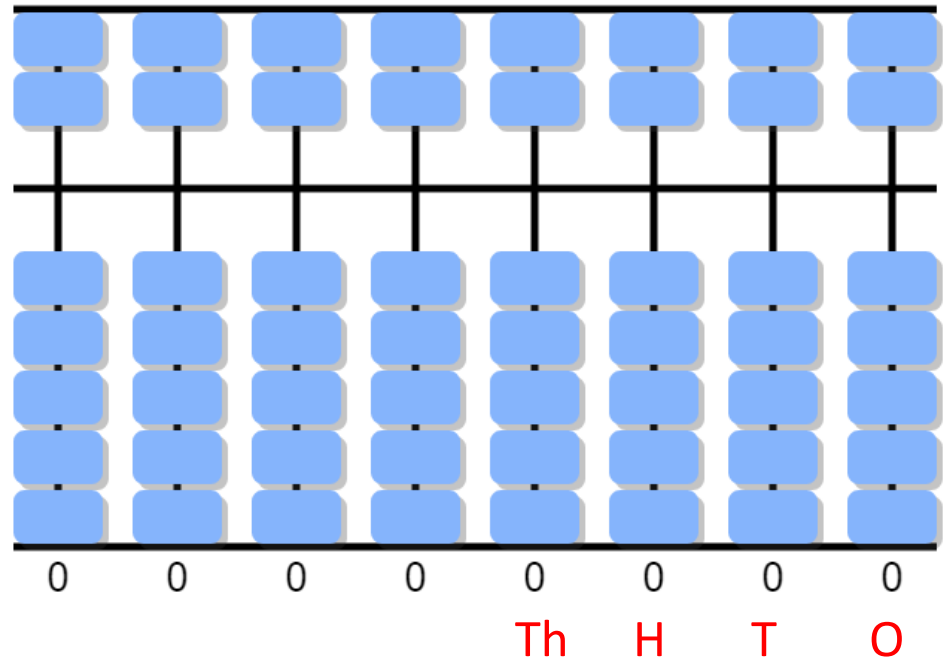


Courtesy IBM ([www.ibm.com](http://www.ibm.com))

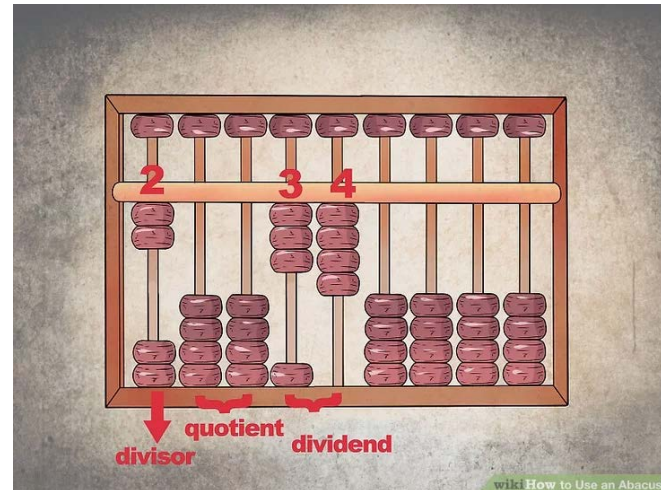
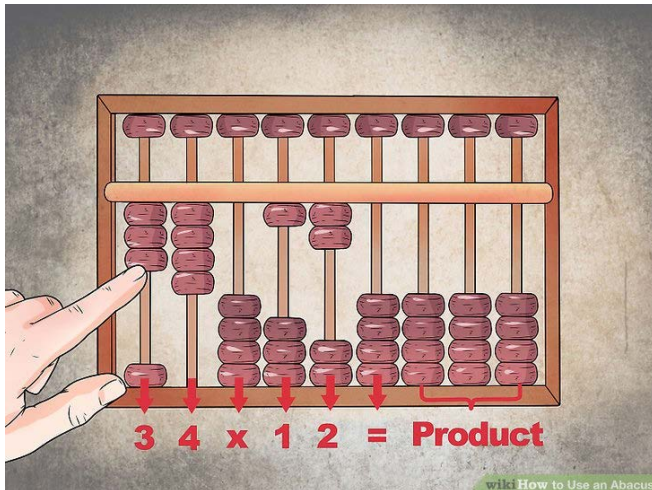
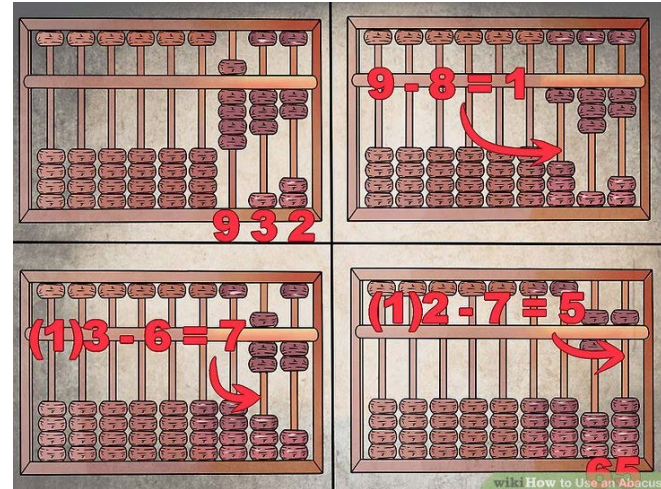
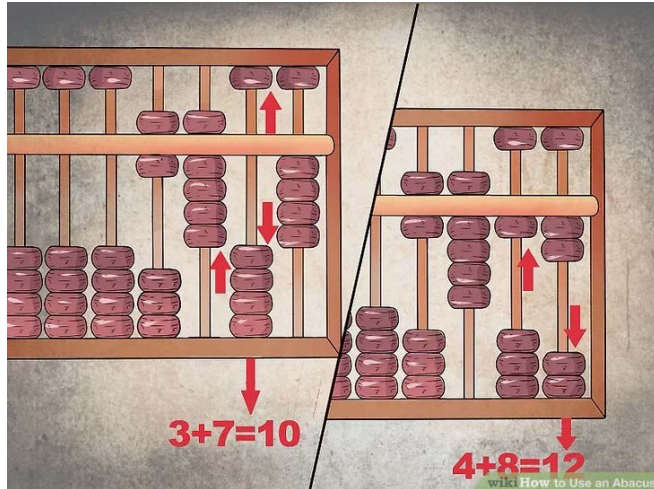
The Pascaline

# Activity 1.1 Play abacus

- Click on <https://www.mathematik.uni-marburg.de/~thormae/lectures/ti1/code/abacus/sanpan.html>
- Calculate
  - $83 + 12 = ?$
  - $112 + 12 = ?$

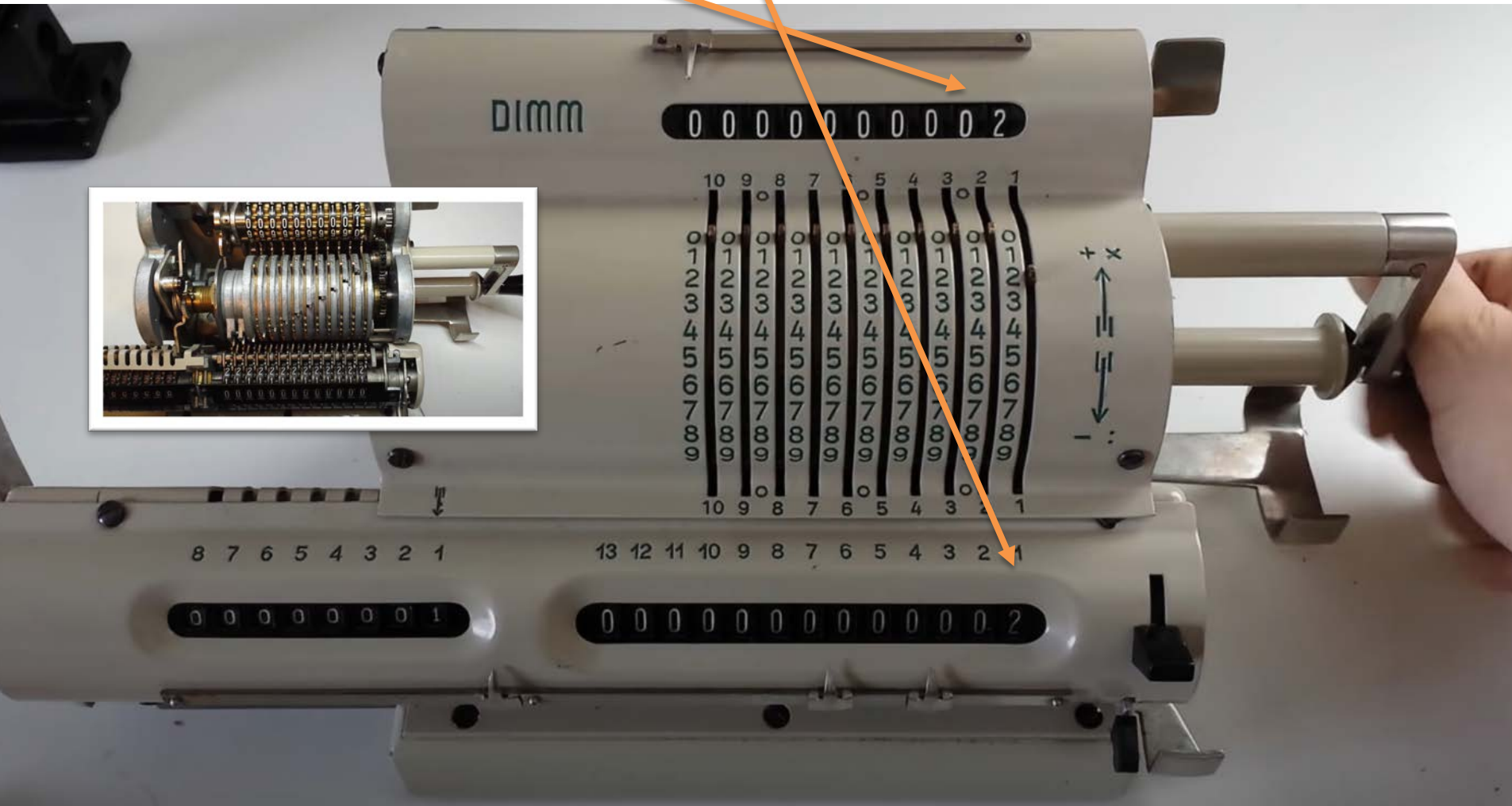
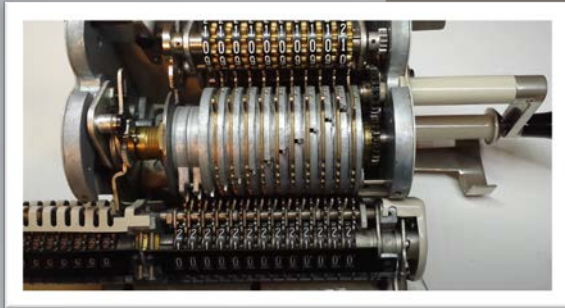


# More functions in Abacus



<https://www.wikihow.com/Use-an-Abacus>

$$2+2 = 4$$



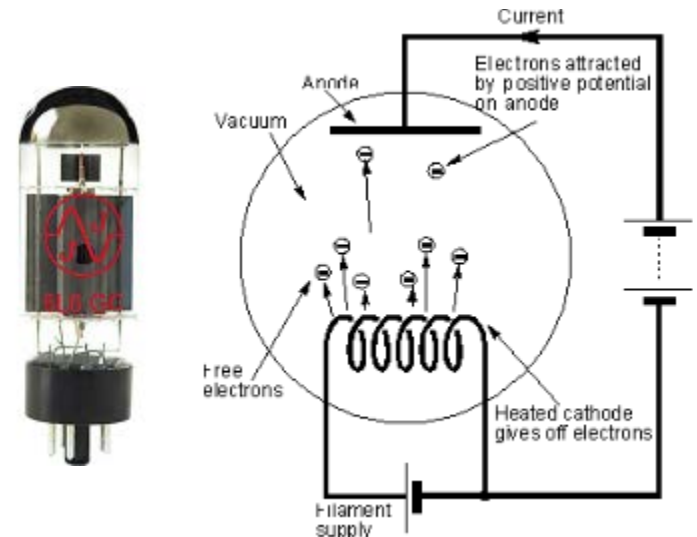
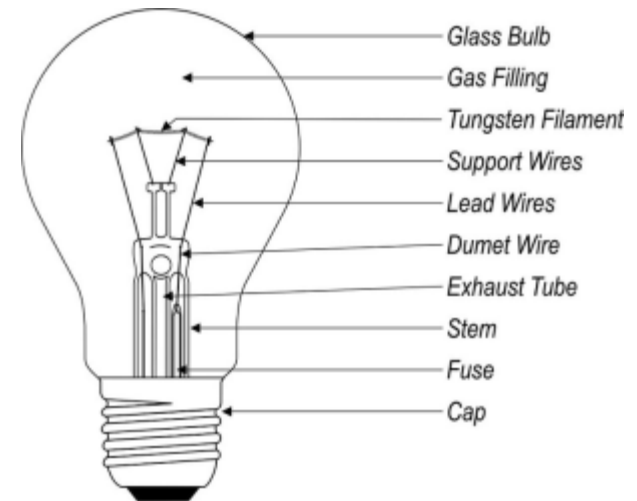
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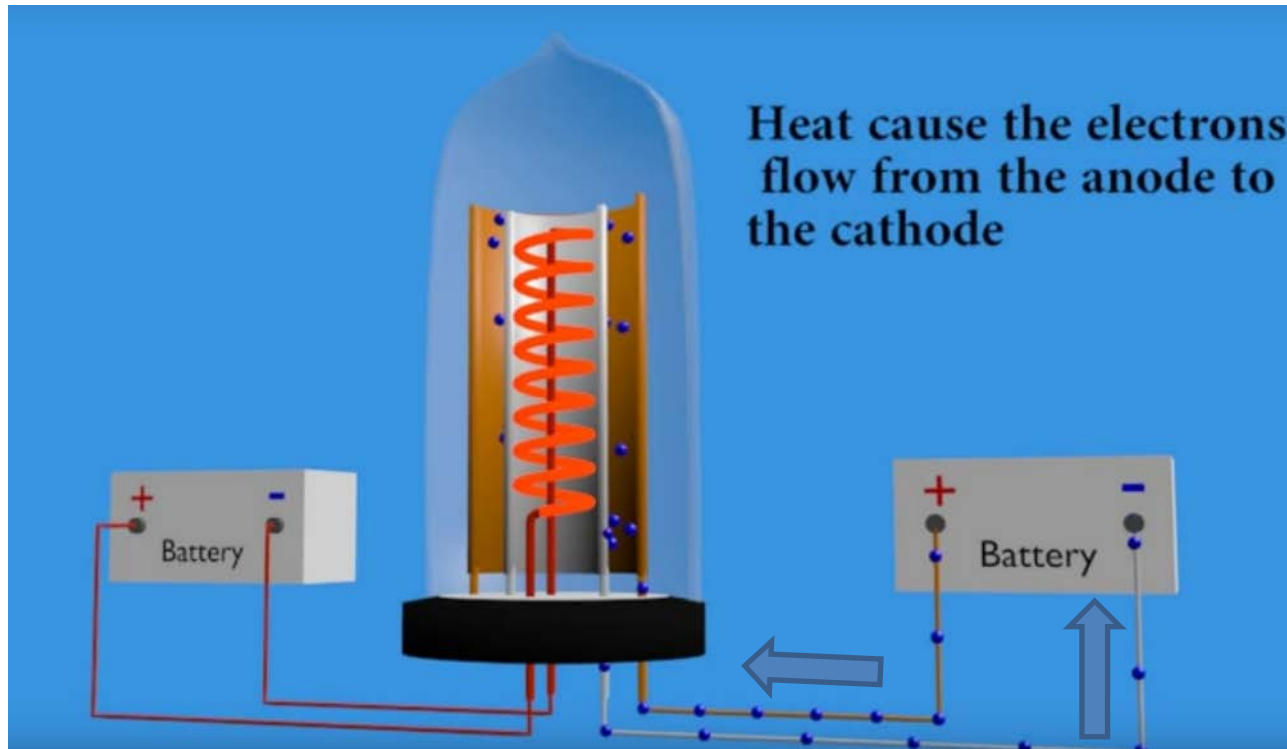
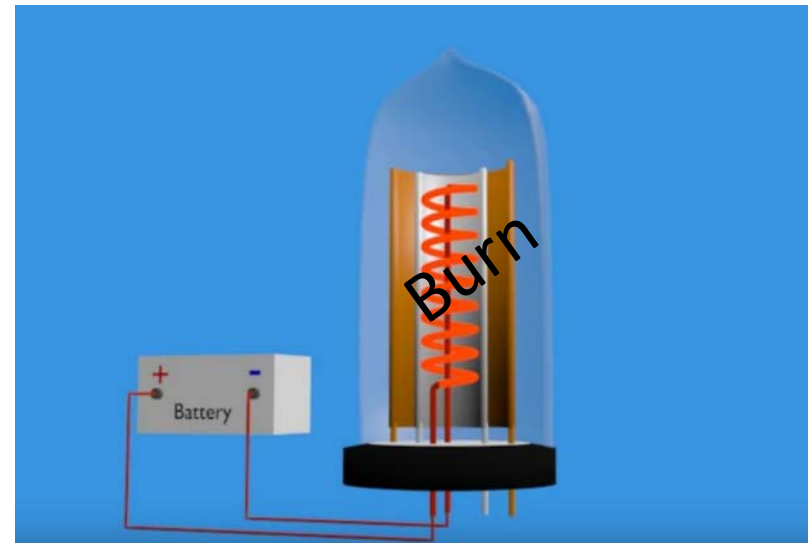
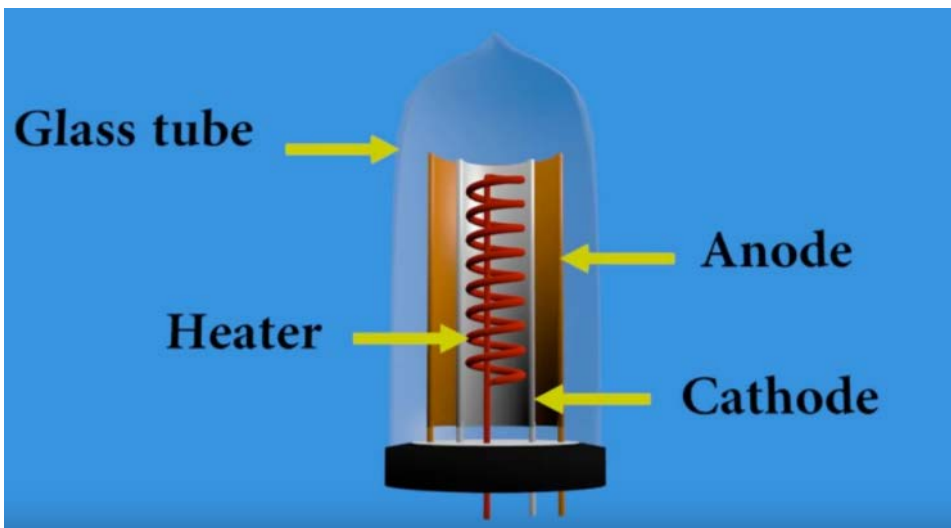
# **ELECTRIC AND ELECTRON**



# 1.1.2 Vacuum Tube

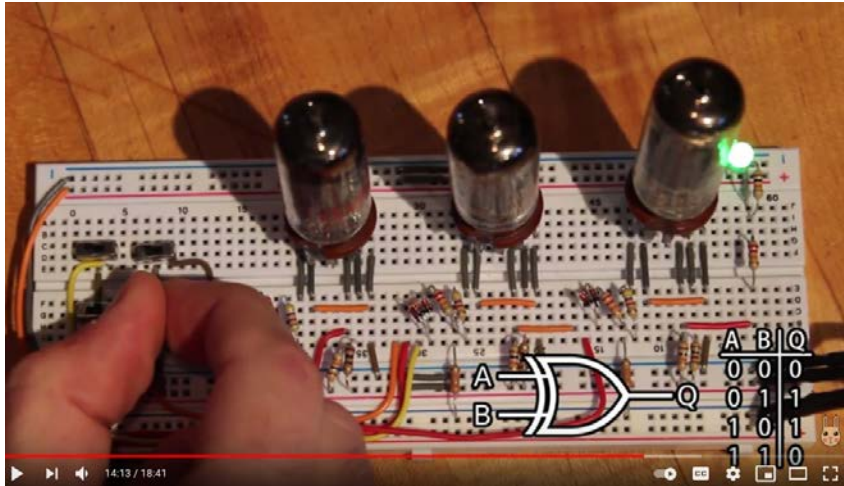
- Vacuum Tube was developed from *Incandescent lamp*.
- When a *tungsten*<sup>74</sup> lead gets heat, it spreads electron by moving to an anode plate.
- A grid plate uses controls number of electron moving from the tungsten lead to an anode plate.





<https://www.youtube.com/watch?v=K6BgZ8s1Vuw>

# Vacuum tube and future

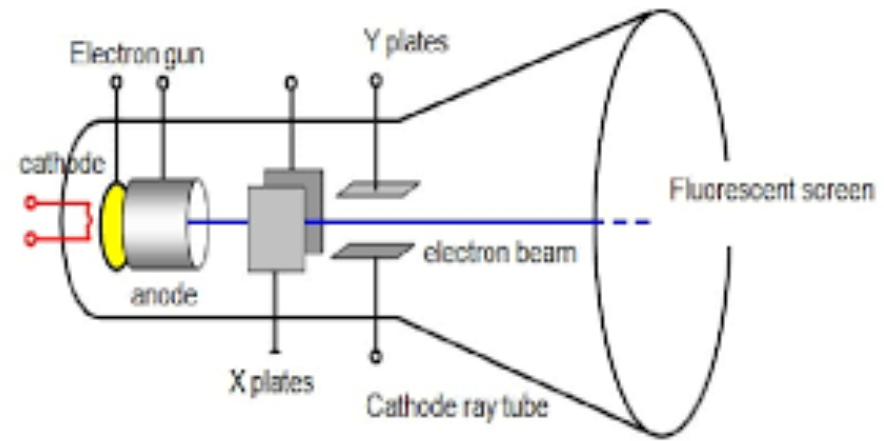


[https://youtu.be/N-Sc6k\\_rITM?t=853](https://youtu.be/N-Sc6k_rITM?t=853)

## 4.) Future: The Nano Vacuum Tube

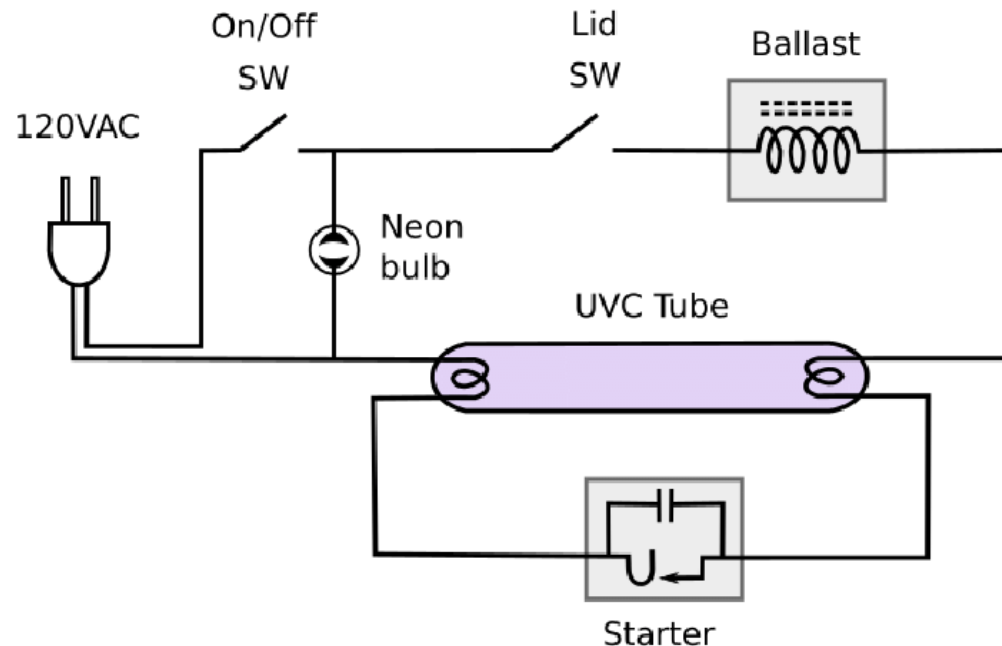
Vacuum tubes may make a comeback and replace standard microchips. Engineers have been able to build a structure in phosphorus doped silicon and use nanotubes to build a switch. These devices can operate 10 times faster than silicon transistors.

# Cathod Ray Tube (CRT)



# Activity1.2

- The fluorescence lamp has two small tungsten coils. Do you know why does the fluorescence lamp generates light? (Discussion)



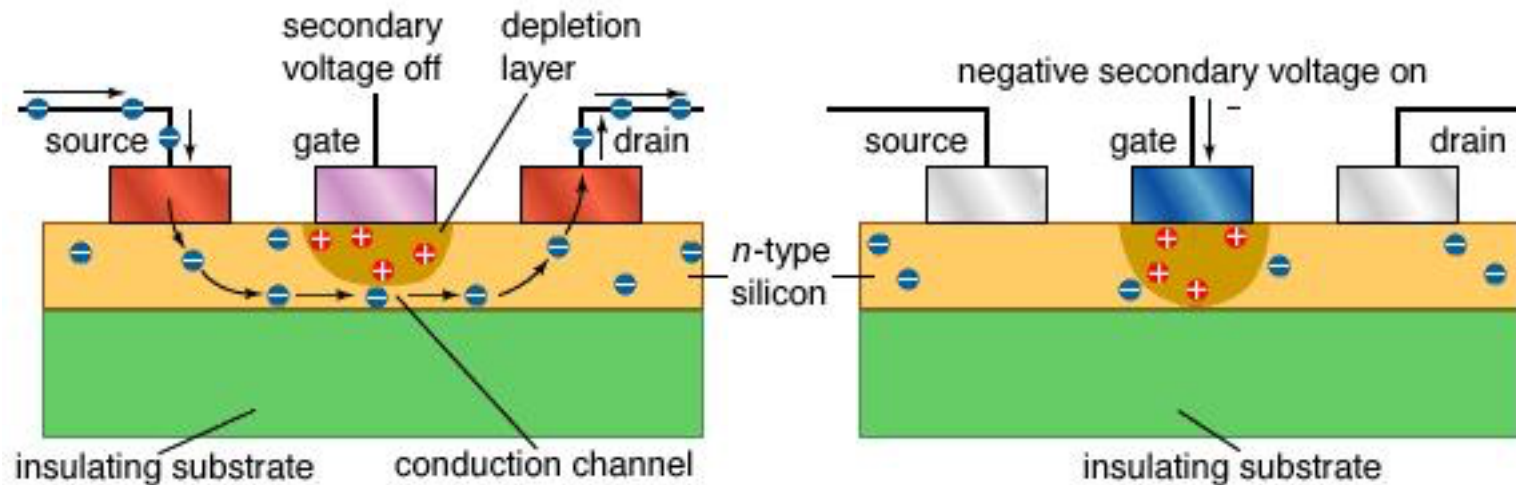
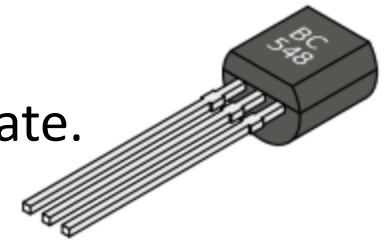


**SILICON CHIP**



# Silicon Transistor

- Semiconductor is created from Silicon<sup>14</sup> and Germanium<sup>32</sup>.
- Electron movement from a source pin to a drain pin is controlled by a gate pin.
- SGD pins are installed in a silicon or germanium substrate.





# 1.1.3 Silicon Transistor

- Where are Silicon, Germanium, Boron, and Antimony on the periodic table?

Periodic Table of Elements

**Legend:**

- State of matter (color of name):** GAS, LIQUID, SOLID, UNKNOWN
- Subcategory in the metal-metalloid-nonmetal trend (color of background):**
  - Alkali metals
  - Alkaline earth metals
  - Transition metals
  - Lanthanides
  - Actinides
  - Post-transition metals
  - Metalloids
  - Reactive nonmetals
  - Noble gases
  - Unknown chemical properties

**Callout for Hydrogen (1):**

- Atomic Number: 1
- Symbol: H
- Name: Hydrogen
- Atomic Weight: 1.008
- Electrons per shell: 1

**Main Table Elements (Selected):**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57-71 Lanthanides	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89-103 Actinides	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

**Inset Table (f-block elements):**

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

# 1.1.3 Silicon chip-making process

- Silicon
  - Make from the ordinary sand, quartz, rock crystal, amethyst, agate, flint, jasper, and opal.



# 1.1.3 Silicon chip-making process



Burn

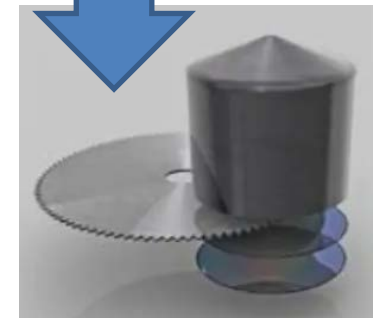


set



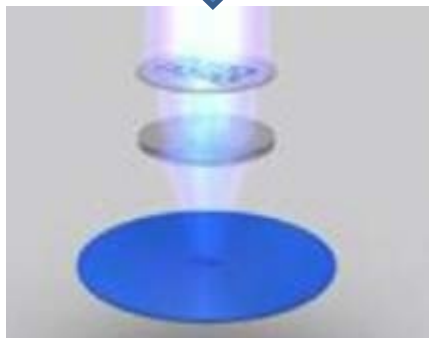
Pure silicon

Cut



Wafer

Exposure

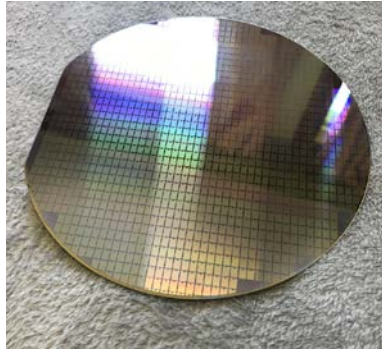


Engineer design circuit

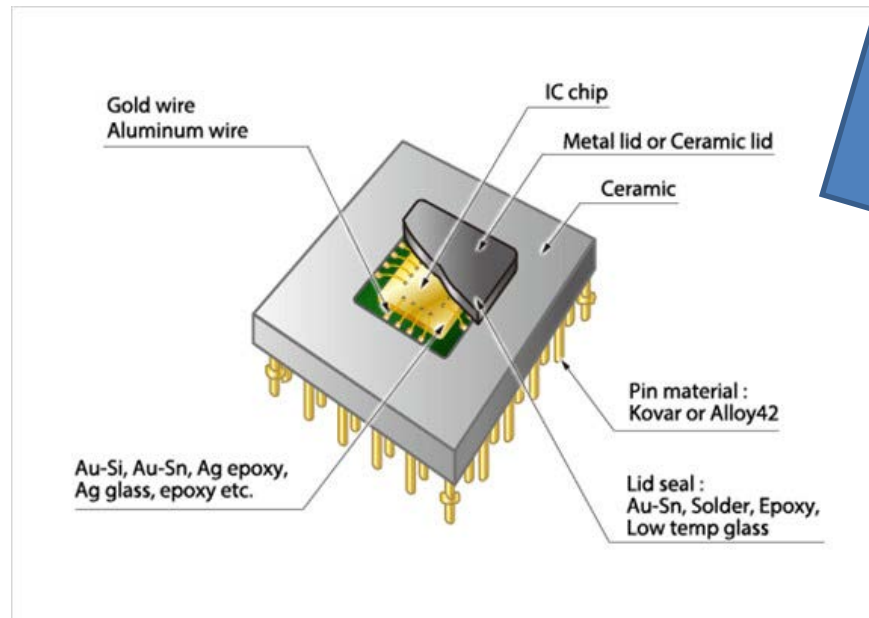
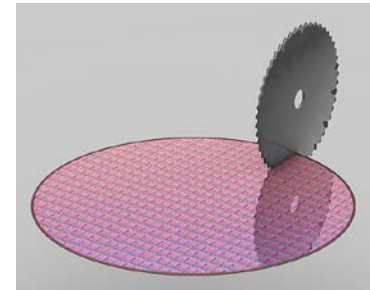


# 1.1.3 Silicon chip-making process

Expose  
build each layer

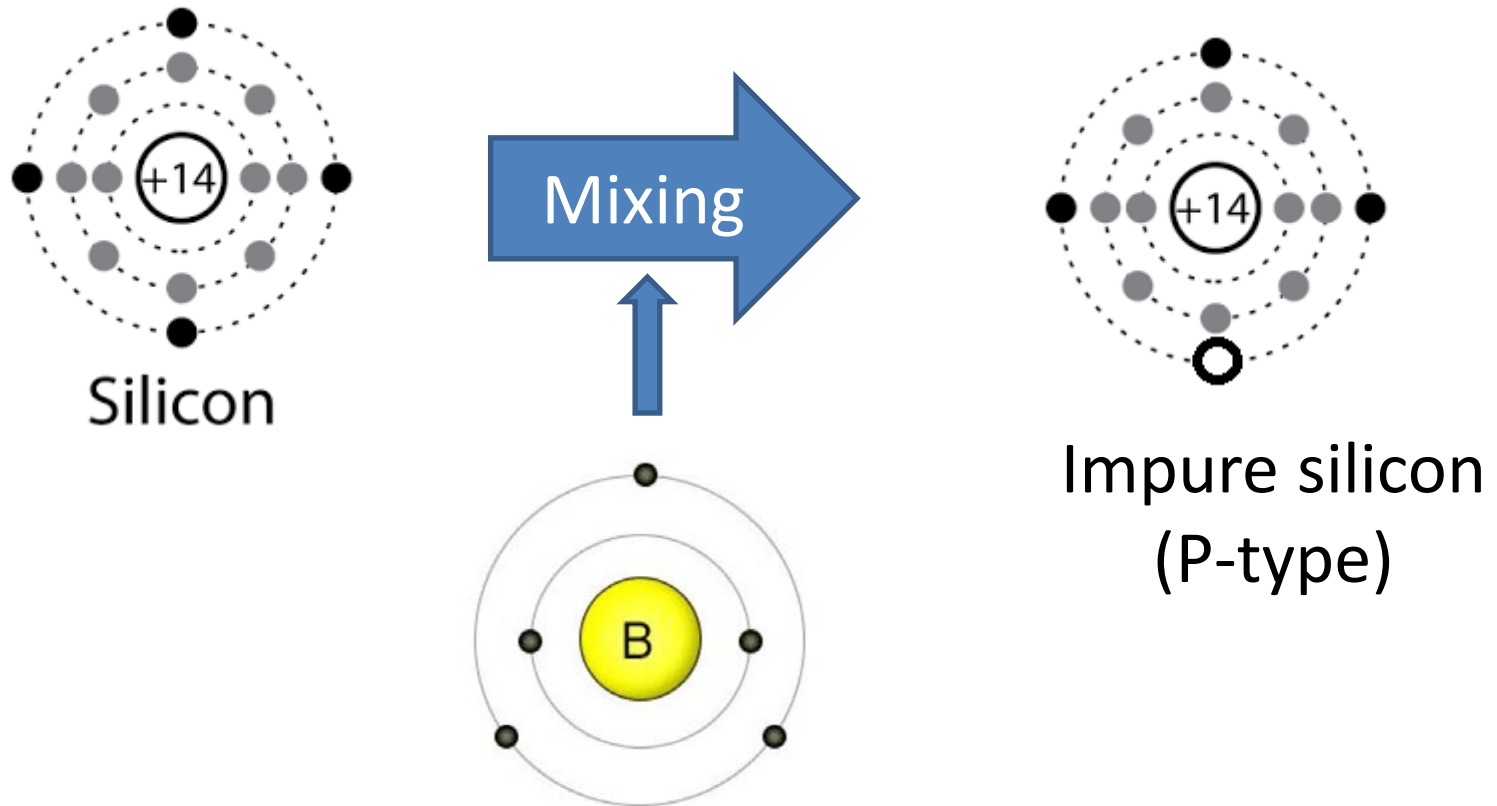


Cut and place  
to package



# The main point of silicon chip

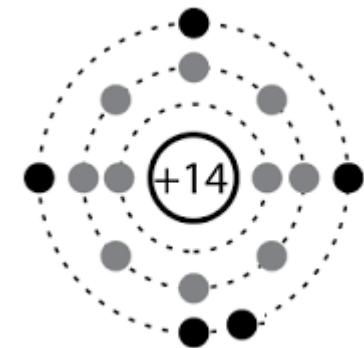
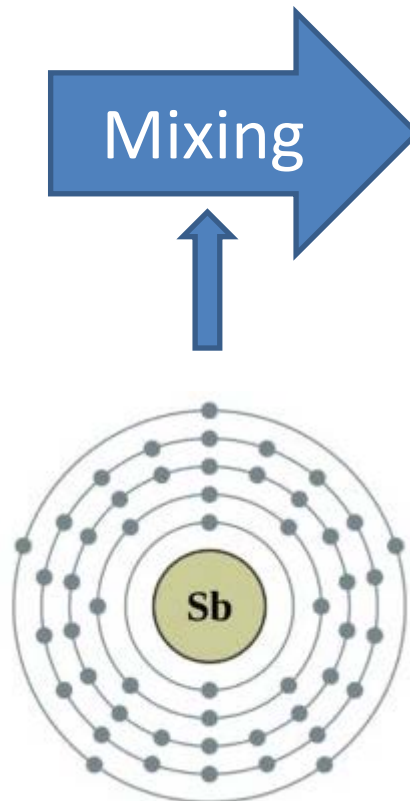
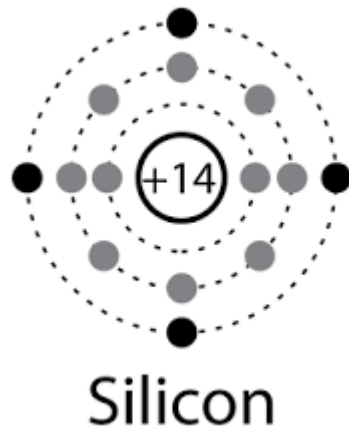
- Change from pure silicon to impure silicon by mixing boron to be P-type





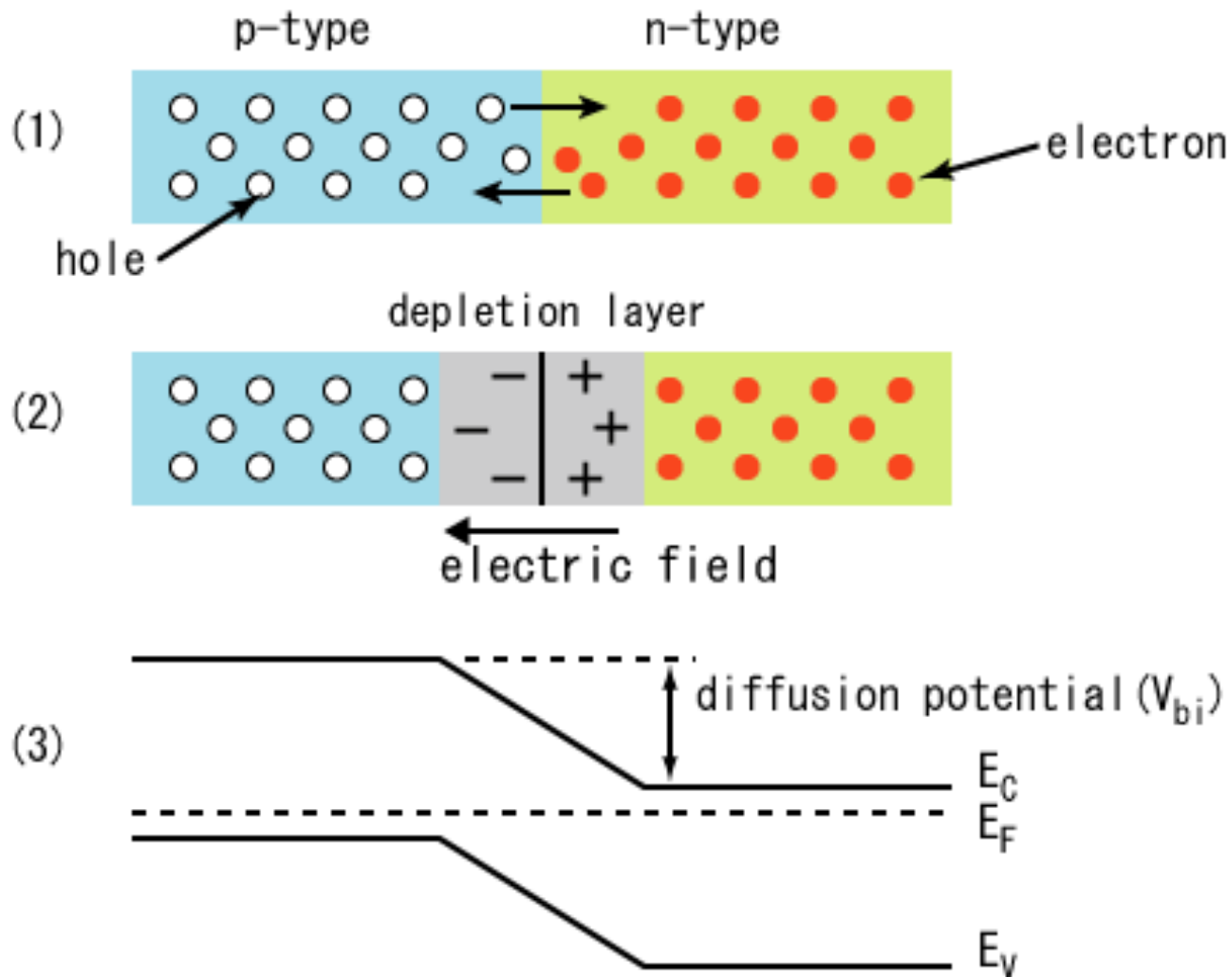
# The main point of silicon chip

- Change from pure silicon to impure silicon by mixing antimony แร่พวง to be N-type



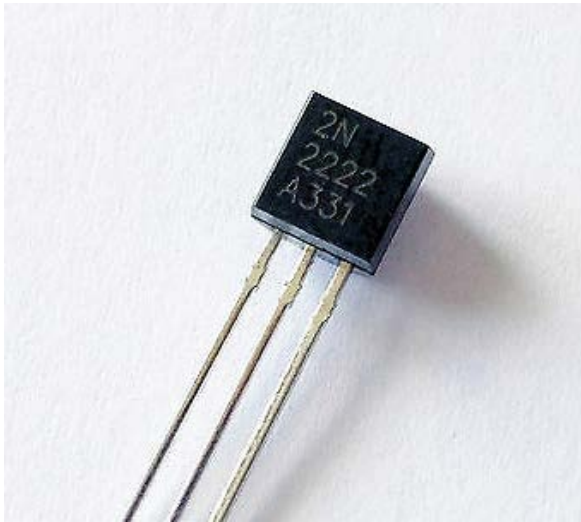
Impure silicon  
(N-type)

# N-type and P-type



# Activity1.3

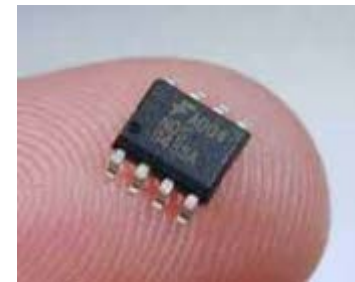
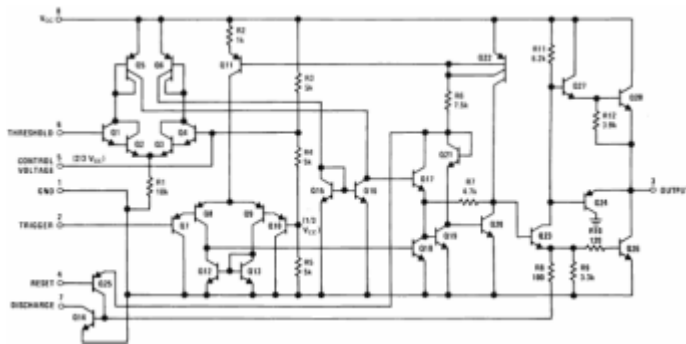
- Find information or specification of IC or Transistor from Internet.





# Integrated Circuit

- Discrete Circuit
- Integrated Circuit



# Integrated Circuit: Chip Scale

Name	Number of Transistors
Small Scale IC (SSI)	10
Medium SI (MSI)	10 – 1000
Large SI (LSI)	1K – 100K
Very LSI (VLSI)	100K – 1M
Ultra LSI (ULS)	> 1M

Year	Size of the transistor in chip
1971 - 1985	10 $\mu\text{m}$ – 1 $\mu\text{m}$
1989 - 1999	800nm – 180nm
2001 - 2010	130nm – 32nm
2012 - 2017	22nm – 10nm
App. 2018	7nm
App. 2020	5nm

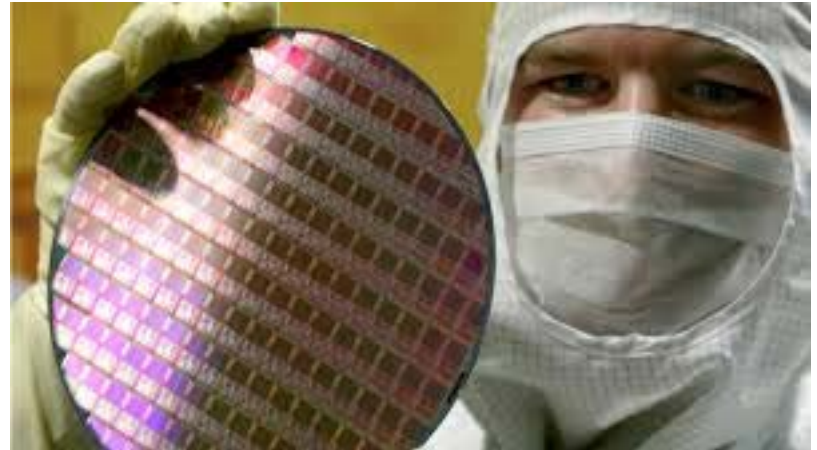
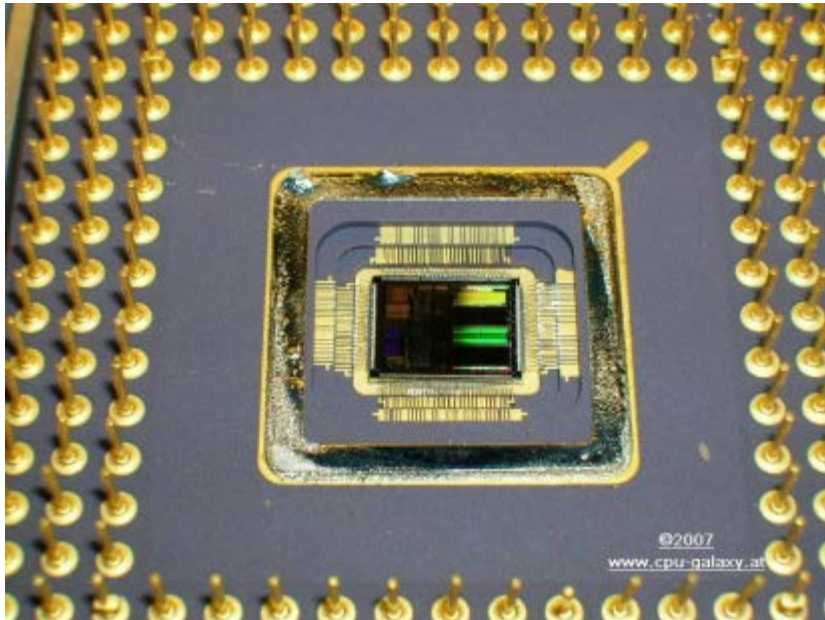
What is the effectiveness when developing small size of the chip?

# CPU die size

Years	Marketing names	Fabrication process
1971	Intel 4004	10um
1982	Intel 80286	1.5um
1994	Intel 80486	180nm
2004	Pentium IV (Prescott)	90nm
2006	Pentium IV (Cedar Mill)	65nm
2007	Core 2, Dual-core	45nm
2010	Core i3-i7	32nm
2012	Core i3-i7 (ivy bridge)	22nm
≈2014		14nm
≈2016		10nm
≈2018		7nm
≈2020		5nm



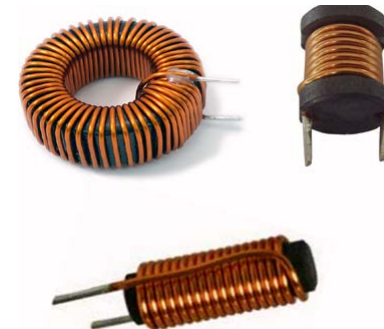
# Chip



# **ELECTRONIC DEVICES**

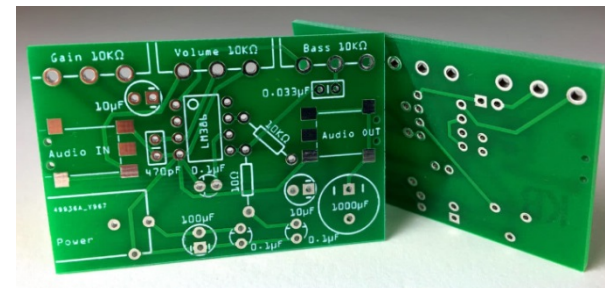
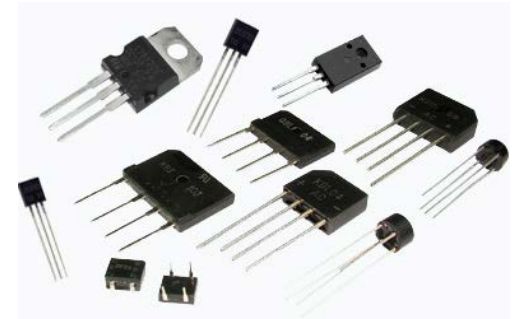
# Electronic devices

- Passive device
  - Capacitor
  - Resistor
  - Inductor
  - Transformer



# Electronic devices

- Active device
  - Diode
  - Transistor
  - Light Emitting Diode (LED)
  - IC, Chip
- Component
  - Print Circuit Board (PCB)



# **TYPE OF PROCESSOR**



# Computer Inside

- Processor
- Main memory
- System bus
- I/O Module

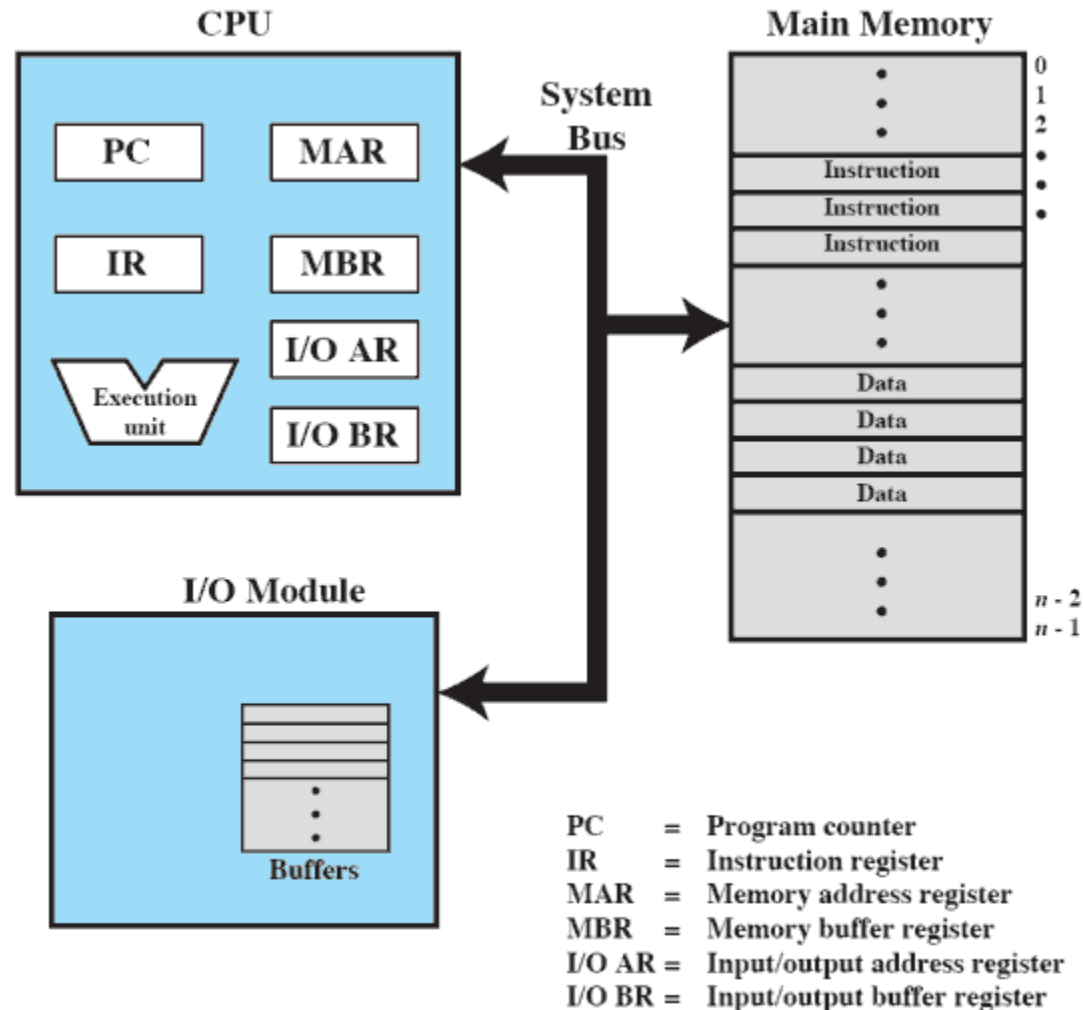


Figure 1.1 Computer Components: Top-Level View

Processors

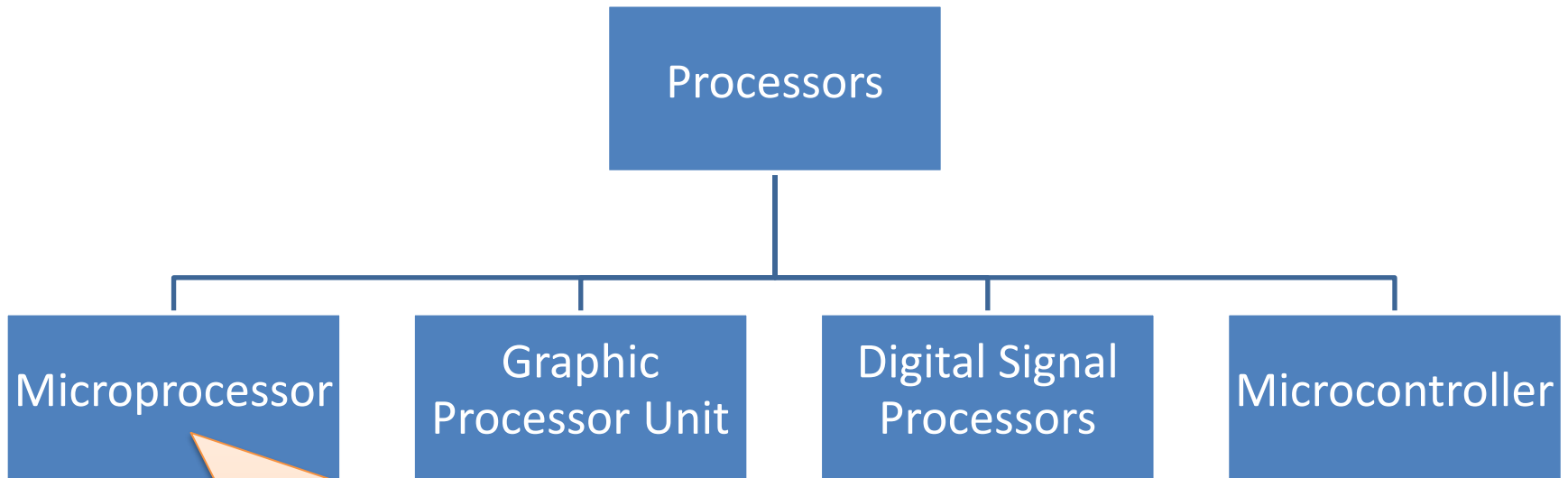
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graph TD; A[Processors] --> B[Microprocessor]; A --> C[Graphic Processor Unit]; A --> D[Digital Signal Processors]; A --> E[Microcontroller];
```

Microprocessor

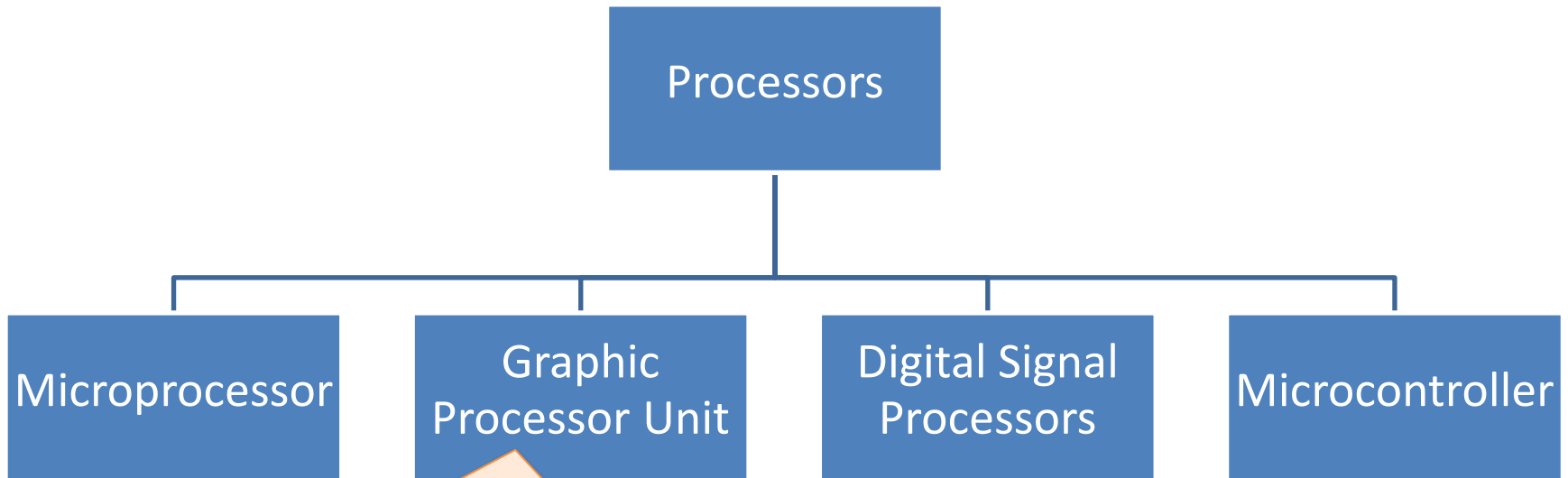
Graphic  
Processor Unit

Digital Signal  
Processors

Microcontroller

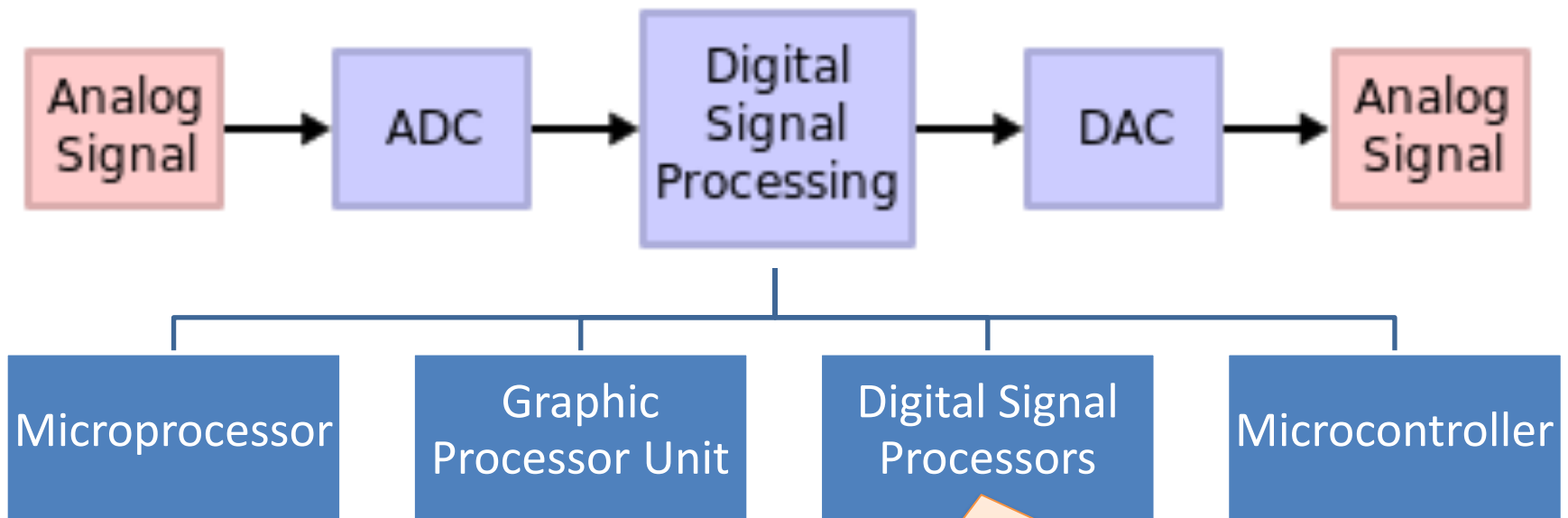


- General instruction set for general works
- No I/O ports directly
- Example
  - x86 CPUs
  - x64 CPUs



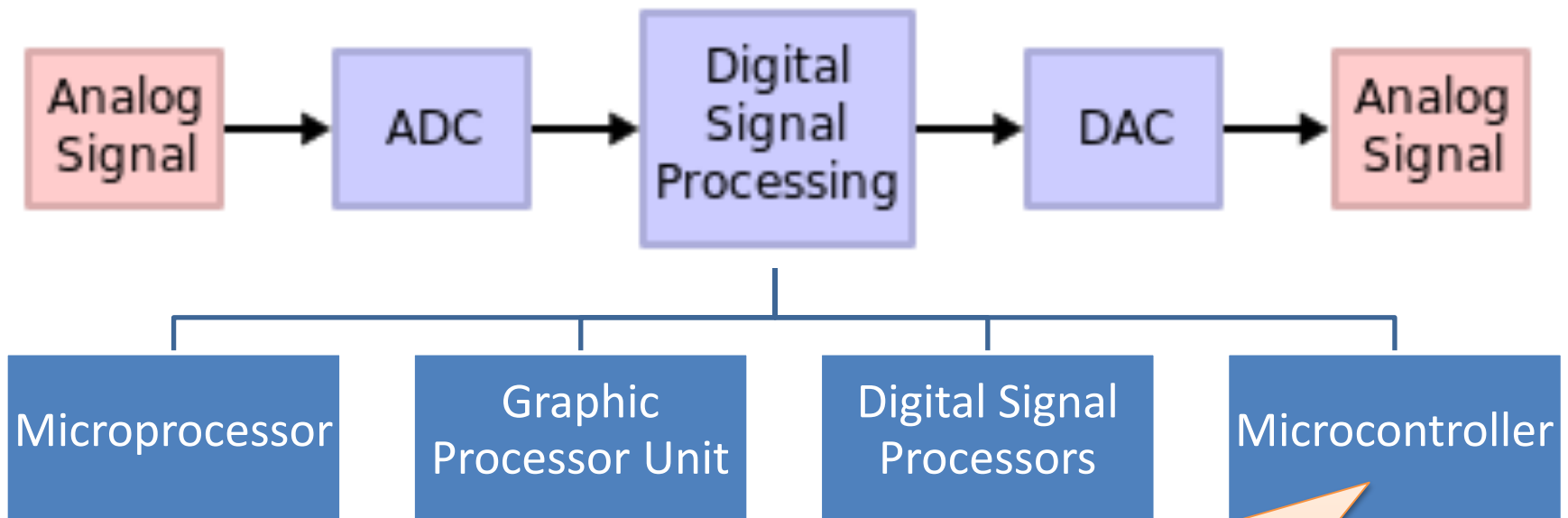
- Specific instruction set for vector and graphic computing and video rendering
- Dual ports memory interface
- Multicores
- Example family chips
  - GeForce, Radeon
  - Quadro, FirePro



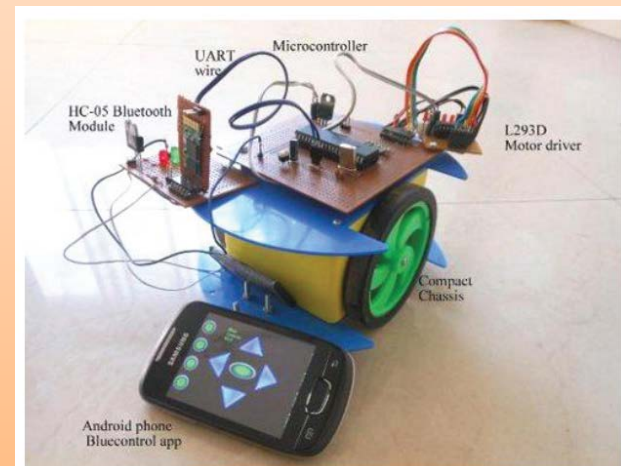


- Specific instruction set for streaming signal
  - Encoding audio/video
  - Decoding audio/video
- Example family chips
  - C6000 (Texas Instrument)
  - SHARC (Analog Devices)
  - EMU10K (Creative)

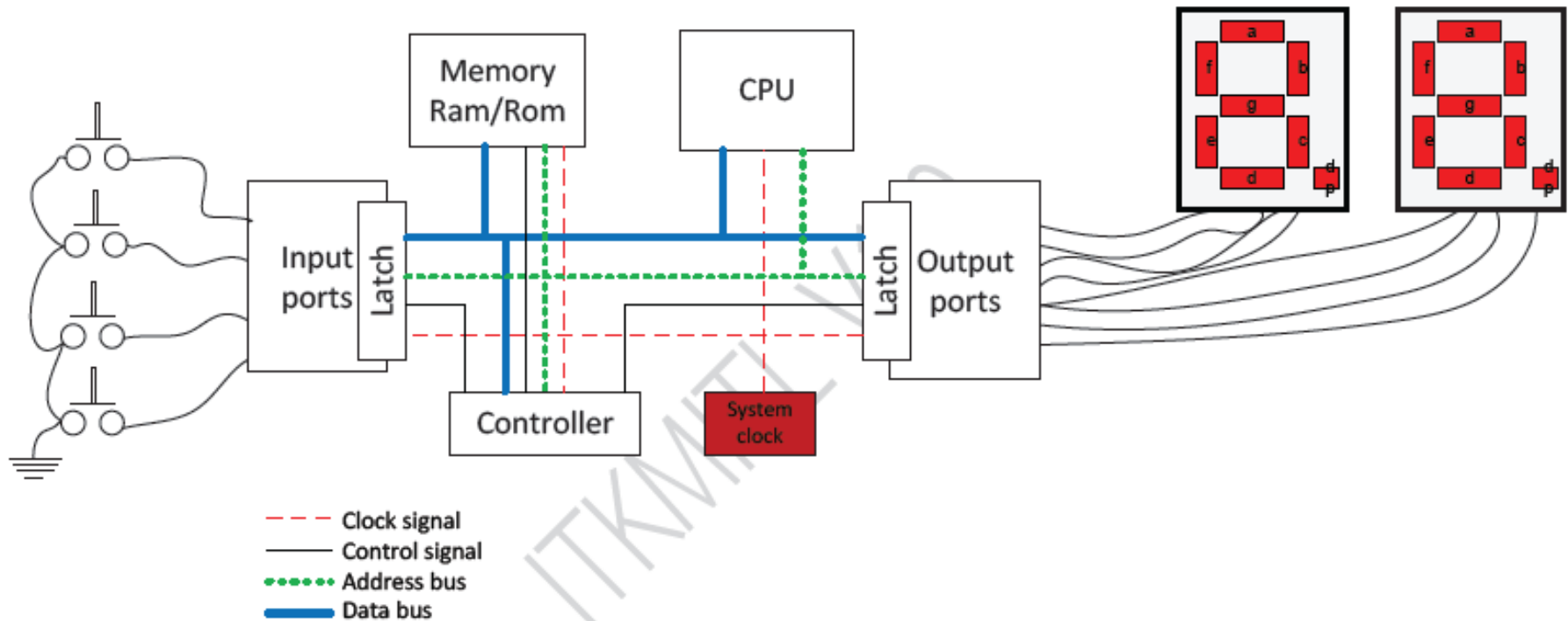




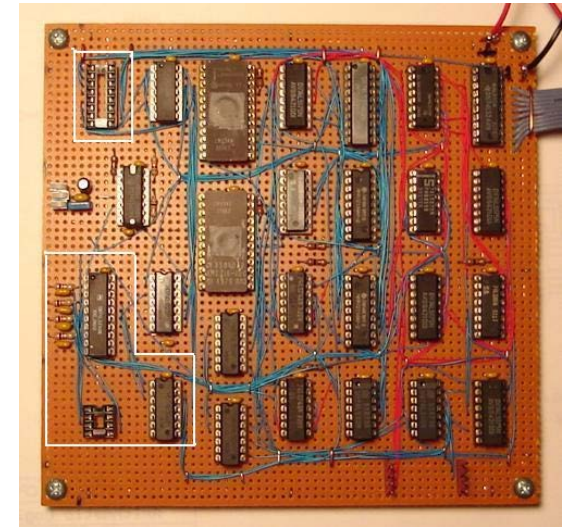
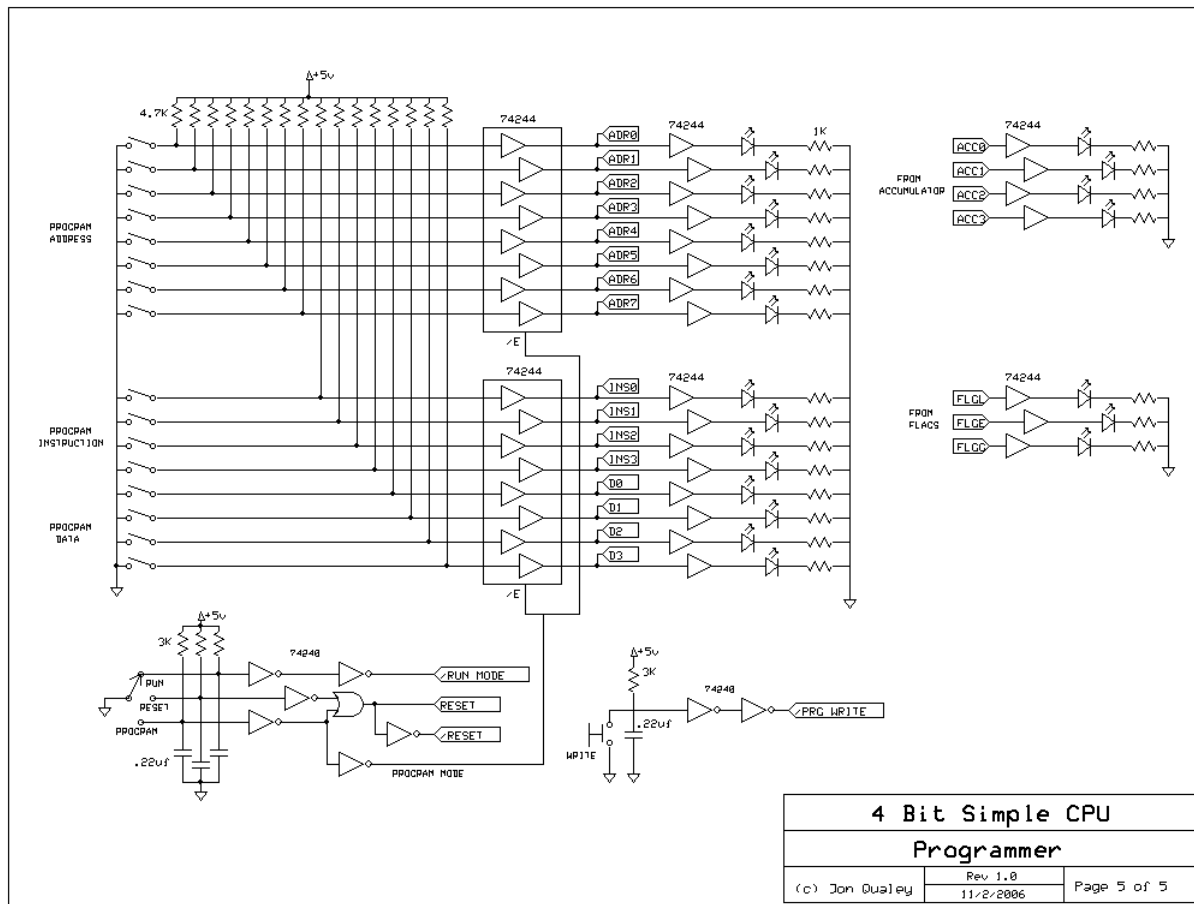
- Specific instruction set for input/output controlling
- I/O ports and timers
- Example family chips
  - PIC
  - MCS-51
  - ARM



# Device Connectivity in the computer



# Why does the digital circuit become the computer?





# Activity1.4

- Find the CPU specification from the list below with the Internet.
  - Z80
  - 8051
  - 68HC11
  - PIC 16Fxx
  - Arduino
  - 8088
  - 80286
  - 80386
  - Pentium

# Summary