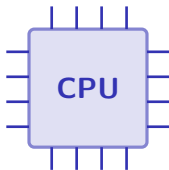


Hardware

AS Computer Science ■ Topic 3

A-Level Computer Science

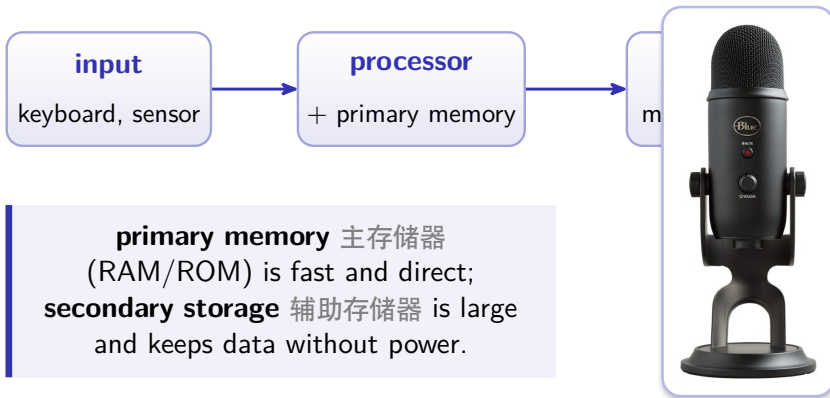


What we will cover

- 1 Components & embedded systems
- 2 Storage devices
- 3 Memory: RAM, ROM & variants
- 4 Monitoring & control
- 5 Logic gates & circuits
- 6 Recap



The four building blocks



microphone photo

Embedded systems

An **embedded system** 嵌入式系统 is a computer built **into another device** for one fixed job (washing machine, car engine, thermostat).

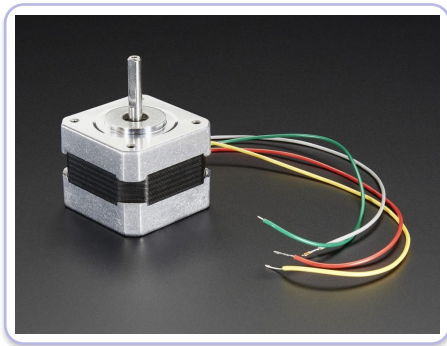
- + small, cheap, reliable, low power
- – one task; hard to update
(**firmware** 固件)



Input and output devices



keyboard



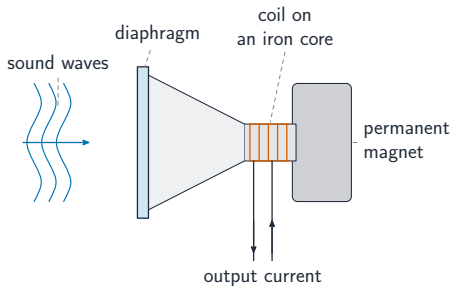
motor actuator



monitor

Laser printer 激光打印机: a charged **drum 感光鼓** attracts **toner 墨粉**, fused onto the paper.

Microphone and loudspeaker



microphone 麦克风: $sound \rightarrow signal$



mouse

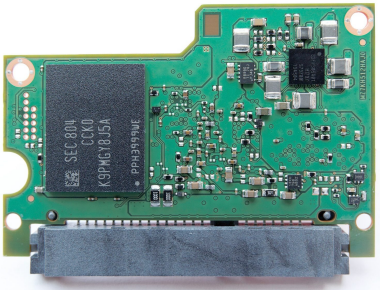
A microphone signal is digitised by an **ADC** 模数转换器.

Magnetic hard disk



thermistor

Solid-state and optical



SSD 固态硬盘: *flash, no moving parts*



touchscreen

SSD: faster, tougher, lower power – but dearer per GB and cells wear out.

Buffers

A **buffer** 缓冲 holds data temporarily between devices of **different speeds**. The CPU writes to a printer buffer quickly, then works on; the printer prints from it at its own pace.



RAM and ROM

RAM 随机存取存储器

volatile 易失性, read/write
– running programs

ROM 只读存储器

non-volatile 非易失性,
read-only – firmware

ROM: start-up firmware

power on: load

RAM: OS + programs run here

power off: RAM **cleared** ▪ ROM **kept**

Memory variants

SRAM 静态 RAM

flip-flops; fast, costly –
CPU **cache** 高速缓存

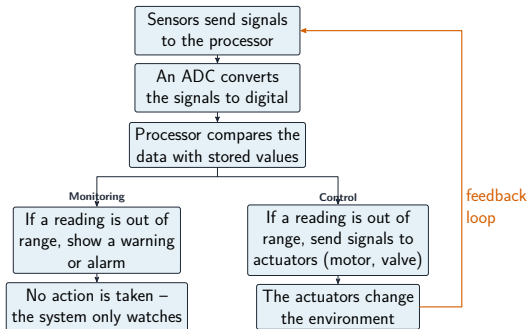
DRAM 动态 RAM

capacitors, must **refresh** 刷新;
dense – main memory

PROM / EPROM / EEPROM

write-once / UV-erase /
electrically-erase (flash)

Monitoring vs control



Both read **sensors** 传感器:

- **monitoring** 监控: reports data, **no action**
- **control** 控制系统: **acts** via **actuators** 执行器 in a **feedback** 反馈 loop

Logic gates



NOT



AND



OR



NAND



NOR



XOR

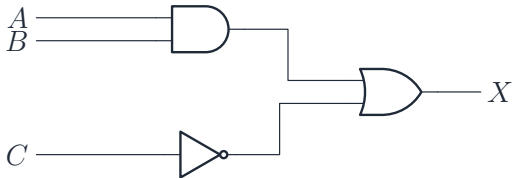
A **logic gate** 逻辑门 does one **Boolean** 布尔 operation; inputs/outputs are 0 or 1. Know the symbol, function and **truth table** 真值表 of each.

Truth tables

A	B	AND	OR	NAND	NOR	XOR
0	0	0	0	1	1	0
0	1	0	1	1	0	1
1	0	0	1	1	0	1
1	1	1	1	0	0	0

NOT: $0 \rightarrow 1, 1 \rightarrow 0$. **AND:** all 1. **OR:** any 1. **XOR:** inputs differ.

Logic circuits

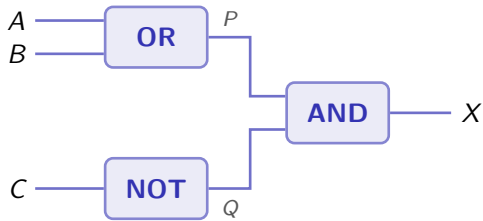


A **logic circuit** 逻辑电路 wires gates to do a Boolean expression – here

$$X = (A \text{ AND } B) \text{ OR } (\text{NOT } C).$$

Move freely between statement $\leftrightarrow$
expression $\leftrightarrow$ table $\leftrightarrow$ circuit.

Worked example: from circuit to truth table



$$P = A \text{ OR } B, \quad Q = \text{NOT } C$$
$$X = P \text{ AND } Q$$

A	B	C	P	Q	X
0	0	0	0	1	0
0	0	1	0	0	0
0	1	0	1	1	1
0	1	1	1	0	0
1	0	0	1	1	1
1	0	1	1	0	0
1	1	0	1	1	1
1	1	1	1	0	0

Work **gate by gate**: add a column for every intermediate signal, then combine.

Topic 3 – key takeaways

1

Components

input, output, primary memory,
secondary storage

2

Storage

HDD magnetic; SSD flash; optical
laser

3

Memory

RAM volatile; ROM non-volatile;
SRAM vs DRAM

4

Logic

six gates; build circuits from
expressions

Check yourself

- 1 Is RAM volatile or non-volatile?
- 2 Which memory is used for CPU cache?
- 3 A gate that outputs 1 only when inputs differ?
- 4 Monitoring or control: which acts on the data?



Answers 1. volatile 2. SRAM 3. XOR 4. control