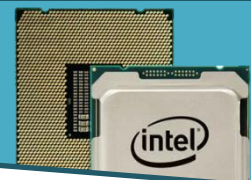# GCSE Computer Science
Topic 1.1 Systems Architecture

Von Neumann designed the first 'stored program' computer, where data and instructions are stored **together** in memory.

The *Central Processing Unit* processes data and instructions following the FDE cycle.

A computer systems is a combination of *hardware* and *software* that work together to process data.

Hardware: physical components that make up a computer system.
Software: programs/applications that run on a computer.

An *embedded system*: a dedicated system built into a larger system to control it.

Embedded systems are restricted by price and physical size. They are not programmable.

Benefits of embedded systems:
- ✓ Easier to design.
- ✓ Cheaper to produce.
- ✓ More **efficient** at doing their job.

Registers are the smallest & fastest type of memory in a computer system. **They hold data the CPU needs immediately.**

The *PC* holds the address of the next instruction to be fetched.

The *Accumulator* holds the results of any calculations done by the ALU.

The CPU

The Control Unit
- Program Counter
Arithmetic and Logic Unit
- Accumulator
Registers
- Memory Address Register
- Memory Data Register
Cache

Memory (RAM)

FETCH Instruction
DECODE instruction
EXECUTE instruction

The *MAR* holds the address of the memory location to fetch the data from / write to for the current cycle.

The *MDR* holds the data fetched from memory.

The CU copies the memory address from the Program Counter to the MAR.

The CU requests the instruction or data stored in the address held in the MAR, to be brought to the MDR.

The CU updates the Program Counter with the address of the next instruction, ready for the next cycle.

The instruction in the MDR is decoded by the Control Unit(decoder).

The CU carries out the instruction using the ALU for any calculations (and stores the results in the Accumulator).

Clock Speed: the number of instructions single processor can process per second.
The HIGHER the clock speed, the faster the data can be processed.

Number of cores:
each core in the CPU can process data independently.
The MORE cores, the FASTER the data can be processed.

The *cache* is memory inside the CPU. The MORE cache, the faster data can be fetched to be processed.

- The *control Unit* is in overall control of the CPU.
- Its main job is to execute instructions by following the FDE cycle.
- It also controls the flow of data inside and outside the CPU.
- The control unit contains the decoder.

- The *Arithmetic Logic Unit* performs all the calculations.
- It completes arithmetic operations (+ , - , *, /).
- It also completes logic operations using logic gates.
- The ALU contains the accumulator register.

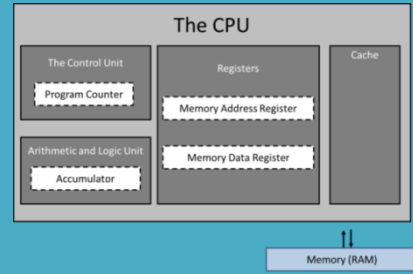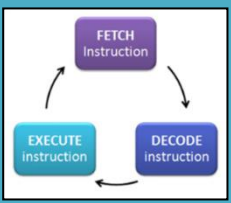- *Cache* is very fast memory.
- It is slower than the registers but faster than RAM.
- It stores regularly used data so that the CPU can access it quickly next time it is needed.
- If the data is not in cache, it will be fetched from RAM.
- Caches have very low capacity and are expensive compared to RAM.

What I need to know:

State the purpose of the CPU.
What does CPU stand for ?
Describe the Von Neumann architecture.
Define register
What does MAR stand for? State what data the MAR holds.
What does MDR stand for? State what data the MDR holds.
What does PC stand for? State what data the PC holds.
State what data the Accumulator holds and which component the accumulator is within.
Common CPU components and their function:
What does ALU stand for? Describe the function of the ALU.
What does CU stand for? Describe the function of the CU.
Define cache memory? Describe the function of cache memory.
What does FDE stand for?
State what happens each stage of the FDE Cycle.
Explain what happens at each stage of the FDE Cycle.
How common characteristics of CPUs affect their performance:
Define clock speed. Explain how clock speed affects the speed of processing.
Explain how the amount of cache affects the speed of fetching data.
Explain how the number of cores affect the speed of processing
What is an computer system?
Define the terms hardware and software.
Define embedded system.
Explain the benefits of using embedded systems over general purpose systems.
Give 3 examples of embedded systems.

Fergus owns a desktop computer with a 2.2 GHz quad-core CPU. He uses it to play video games and edit photographs that he takes with his digital camera.

(a) State the purpose of the CPU in a computer system.

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[1 mark]

State **one** characteristic of Von Neumann architecture.

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[1 mark]

The CPU has a clock speed of 3.8 GHz.

Describe what is meant by a clock speed of 3.8 GHz.

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Explain, with reference to memory and specific registers, the steps of the CPU fetch-execute cycle.

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[4 marks]