

Specification & learning objectives

<u>A Level</u>	<u>Specification point description</u>
1.1.2a	The differences between, and uses of, CISC and RISC processors
1.1.2b	GPUs and their uses (including those not related to graphics)
1.1.2c	Multicore and parallel systems

Resources

PG Online textbook page ref: 12-14

Hodder textbook page ref: 129-131, 134-135

[CraignDave videos for SLR 2](#)



Key question: What are the differences between the RISC and CISC architectures?

RISC (Reduced Instruction Set Computing)

A design of processor which has a smaller instruction set than CISC so single CISC requires require multiple instructions in RISC. The hardware is less complex and cheaper. Typically used in smartphones or tablets.

Compiler has a more difficult task to convert high-level code into a limited instruction set

More cost effective as there are fewer transistors so producing the chip is cheaper. Also the processors use less power and generate less heat.

Supports pipelining as simple instructions such as loading two variables can be done at the same time

Instructions take only one cycle to complete as each instruction is not split into further instructions

Programs require more memory to store a larger number of instructions

Simpler addressing modes allow data or instructions to be fetched quicker

Better suited to simpler, low demand task such as running a program on a mobile

CISC (Complex Instruction Set Computing)

A design of processor which has a wider instruction set than RISC and therefore has more silicon circuitry and is more expensive than RISC. Typically used in desktop PCs or laptops.

Compiler has an easy task to convert high-level code into a larger range of complex instructions

Less cost effective as there are more transistors required for the complex circuitry so producing the chip is more expensive. The processors use more power and generate more heat

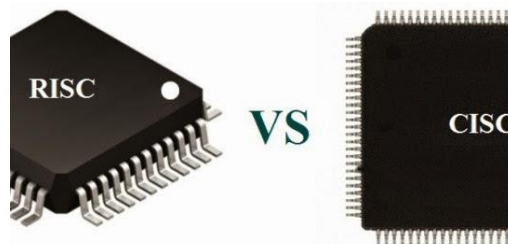
Doesn't support pipelining because instructions are more complex and difficult to split into stages

Instructions take more than one cycle to complete as reading and writing data from or to memory is included in the complex instruction

Programs require less memory as there are fewer more complex instructions

More complex addressing modes take longer to fetch data or instructions

Better suited to higher intensity tasks such as high end gaming

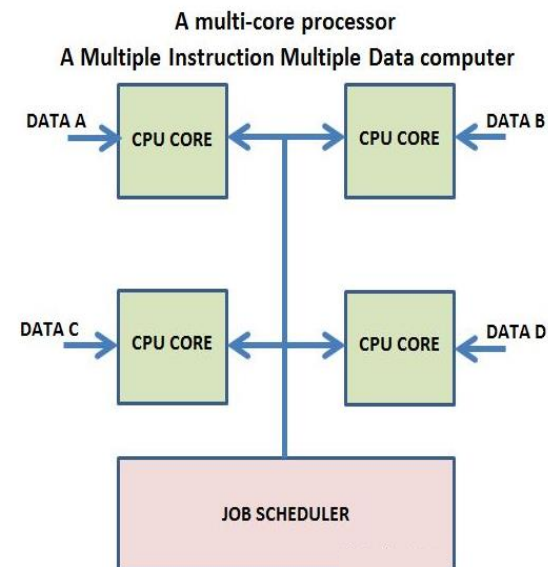
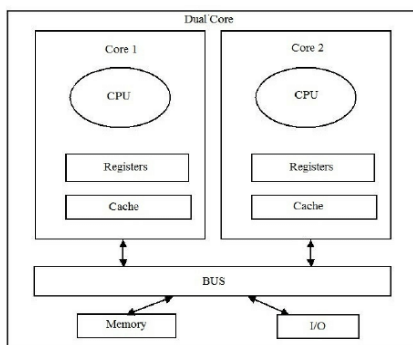
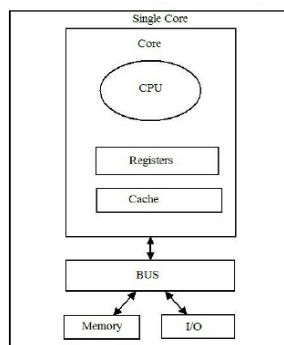


Key question: How does having multiple cores affect the speed of processing?

Multicore and parallel processing

Multicore processors are processors with multiple CPUs on a single die (also known as chip multiprocessors). Each CPU “core” can carry out the fetch-decode-execute cycle concurrently allowing for parallel processing of problems. Usually each core has some L1 & L2 cache individually with a shared L3 cache between the cores. It is important to note that increasing the core count of a processor does not lead to a linear increase in performance due to a variety of factors including the communication circuitry between the cores, the problem rarely being fully parallelisable and poor programming to make use of multiple threads.

Parallel processing is dividing a task amongst multiple processors or processor cores with the objective of running the program in less time. There are several different types of parallel processing systems. The most common being **SIMD** (Single Instruction Multiple Data) and **MIMD** (Multiple Instructions Multiple Data). The most common application for **SIMD** is graphics processing (see “The GPU” below). The most common application of **MIMD** is within multicore processors. Typically, a supercomputer is a parallel processing system that implements both **SIMD** & **MIMD**; a supercomputer is a cluster of **MIMD** computers, each executing **SIMD** instructions.



Key question: What are the different characteristics of CPUs vs GPUs, and what else besides graphics can GPUs be used for?

A **GPU** is a specialised coprocessor designed to manipulate computer graphics and image processing through the use of **SIMD parallel processing**. Unlike a CPU, a GPU typically has over a thousand cores. Each of these cores are much less powerful than a CPU core however the huge amount of them allows a GPU to be used effectively for **SIMD** (Single instruction Multiple Data parallel processing (below is a diagram depicting the difference in core count.

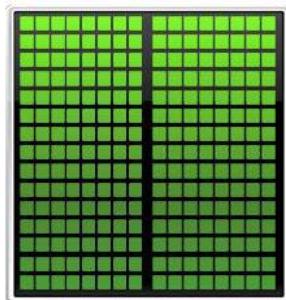
GPUs, like CPUs contain RAM, cache and registers to perform their calculations and likewise these factors plus core count and clock speed govern their performance. They are designed and manufactured by two main companies; NVIDIA and AMD however Intel also produces basic GPUs to go in its CPUs. Integrated GPUs like this are rarely as powerful as a GPU on a dedicated daughter board such as the one below. The GPU shown below is one of NVIDIA's highest end GPU featuring 2560 cores operating at a "blistering" 1733MHz and 8GB of GDDR5 RAM.

GPUs were designed with **SIMD** because of the advantages this hold for graphical processing such an application might involve adding a value to the brightness of every pixel according to the inverse square law. Such an operation can be done in the same way for every pixel but there is many pixels for it to be applied to simultaneously hence **SIMD parallel processing** with many cores is used.



However, **GPUs** have been used for many other things besides graphics processing. Due to their optimisation for **SIMD parallel processing** they are used for any problem that SIMD is optimal for. Examples of alternative uses for GPUs are: machine learning, many forms of modelling including climate, science and economic, financial transactions (either a decentralised cryptocurrency mining network or in a server for a main bank.

CPU



GPU

Typical exam questions

1. Modern games consoles come with GPUs. Describe the role of the GPU and explain how it works with the CPU to order to help speed up processing. [4]

2. Explain two advantages of and two disadvantages of a CISC processor architecture over a RISC processor architecture. [4]

3. Some computer systems take advantage of multiple cores and parallel processing. Explain these concepts making reference to how they help to improve a computers performance. [5]

Target:

Overall grade:

Minimum expectations & learning outcomes

<input type="checkbox"/>	Terms 22-26 from your A Level Key Terminology should be included and formatted.
<input type="checkbox"/>	You must include a section which clearly compares the differences between, and uses of CISC and RISC processors, including the benefits.
<input type="checkbox"/>	You must include the benefits and limitations of parallel processing.
<input type="checkbox"/>	You must include a diagram which illustrates the different types of processor systems such as multicore systems, parallel systems and co-processor systems (e.g. GPUs)
<input type="checkbox"/>	You need to explain what GPUs can be used for in addition to graphics and what makes them more suitable to those tasks.
<input type="checkbox"/>	Answer the exam questions.

Feedback

<u>Breadth</u>	<u>Depth</u>	<u>Presentation</u>	<u>Understanding</u>
<input type="checkbox"/> All	<input type="checkbox"/> Analysed	<input type="checkbox"/> Excellent	<input type="checkbox"/> Excellent
<input type="checkbox"/> Most	<input type="checkbox"/> Explained	<input type="checkbox"/> Good	<input type="checkbox"/> Good
<input type="checkbox"/> Some	<input type="checkbox"/> Described	<input type="checkbox"/> Fair	<input type="checkbox"/> Fair
<input type="checkbox"/> Few	<input type="checkbox"/> Identified	<input type="checkbox"/> Poor	<input type="checkbox"/> Poor

Comment & action required

Reflection & Revision checklist

<u>Confidence</u>	<u>Clarification</u>
☹️ 😐 😊	Candidates need to understand the differences between the CISC and RISC processors and the key features and benefits of each.
☹️ 😐 😊	Candidates should be aware of the relative benefits of each architecture.
☹️ 😐 😊	Candidates need to understand what is meant by a parallel system and the benefits and limitations of parallel processing.
☹️ 😐 😊	Candidates need to understand that parallel processing can be achieved through different (i.e. multiple processors in the same computer or distributed or multiple cores in a CPU or GPU).
☹️ 😐 😊	Candidates need to understand the benefits of a multicore system in terms of parallel processing and running multiple programs at the same time.
☹️ 😐 😊	Candidates need to understand the purpose of GPUs and what applications they are used for (candidates need to understand how GPUs are used to aid graphics, but also other applications for example their use in modelling, data mining, etc.).
☹️ 😐 😊	Candidates should understand the benefits and using GPUs and why they are suited to certain tasks (specialist instructions, multiple cores and SIMD processing).