GCST

1.1.1 STRUCTURE AND FUNCTION OF THE PROCESSOR

TOPIC WISE EXAM QUESTIONS

A-LEVEL OCR

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SPEC

Components of a computer and their uses		Content clarification
1.1.1 Structure and function of the processor	a) The Arithmetic and Logic Unit; ALU, Control Unit and Registers (Program Counter; PC, Accumulator; ACC, Memory Address Register; MAR, Memory Data Register; MDR, Current Instruction Register; CIR). Buses: data, address and control: How this relates to assembly language programs. b) The Fetch-Decode-Execute Cycle, including its effect on registers. c) The factors affecting the performance of the CPU: clock speed, number of cores, cache. d) The use of pipelining in a processor to improve efficiency. e) Von Neumann, Harvard and contemporary processor architecture.	Candidates need to have an understanding of the purpose and function of the core components of a processor. Candidates need to understand the role and components of the ALU. Candidates need to understand the purpose and function or registers within the processor, including the PC, accumulator, MAR, MDR and CIR. Candidates need to understand the purpose, function and role of the data, address and control buses in the processor. Candidates need to understand how assembly language makes use of registers, and how data and addressed are transferred between registers. Candidates need to understand the purpose and stages within the FDE cycle. Candidates need to understand how and when the registers are used within this cycle, and how and where data and addresses are transmitted to/from in each part of this cycle. Candidates need to understand how the performance of the CPU can be affected by many factors. Candidates need to understand how and why the performance is affected by the clock speed, the number of cores and the size and speed of the cache. Candidates need to have an understanding of the Von Neumann and Harvard architectures. They should be aware of the different approaches the architectures take to storing instructions and data in memory and the benefits of each approach. Candidates will not be asked about specific aspects of "contemporary processor architecture" unless explicitly named in the specification. They may, however, be asked to show an awareness of how contemporary processors differ from a pure Von Neumann architecture in more open questions.

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2023

4 A team of programmers create a robot that will be used in a factory. The robot will be able to do the work of multiple humans.

(b) The robot uses a multi-core processor. The programmers assume that this means that the robot will execute programs more quickly than using a single core processor.

(i) Give **one** reason why this assumption can sometimes be true.

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..... **[1]**

(ii) Explain why this assumption is not always true.

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..... **[2]**

AS - Level

1 OCRSystems are designing a new CPU for a computer system that will be used for video rendering. Part of the video rendering process is when the video is exported. This is when the computer combines all of the separate video elements together to form the final video.

(a) Describe **two** factors that affect the performance of the CPU.

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2 .....

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[4]

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2022

1 A charity uses a desktop computer to record financial donations that it receives. The computer contains a single core, 2.4GHz processor with 2MB cache.

(a) The processor uses the Von Neumann architecture.

(i) Describe what is meant by the term 'Von Neumann architecture'.

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..... **[2]**

(ii) Give **one** way that the Harvard architecture differs from the Von Neumann architecture.

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..... **[1]**

(b) The charity is concerned that the performance of the computer is not sufficient and wishes to replace the processor.

Give **two** features of a replacement processor that would increase the typical performance of the computer.

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2 .....

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[2]

(iii) This program is run on a processor that allows pipelining.

Define the term 'pipelining'.

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..... **[3]**

(iv) Explain **one** benefit to the charity of using a processor that allows pipelining.

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..... **[2]**

(d) The processor contains registers including the accumulator and the program counter. The contents of these registers are modified during the Fetch-Decode-Execute cycle.

(i) Describe how the accumulator is used during the Fetch-Decode-Execute cycle.

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..... **[2]**

(ii) Describe how the program counter is used during the Fetch-Decode-Execute cycle.

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..... **[2]**

(iii) State the name of **three** other registers that are used during the Fetch-Decode-Execute cycle.

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2 .....

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3 .....

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[3]

AS - Level

(d) Different computing devices in Arnold's home use different processor architectures.

One processor architecture is the Harvard architecture.

(i) Describe the Harvard architecture.

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..... **[2]**

(ii) Arnold has a smart washing machine.

Explain why the Harvard architecture is suitable for a device like this.

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..... **[2]**

GCST

2021

1 OCR Insurance uses a computer system to calculate the price that customers pay for car insurance.

(a) The computer system contains a CPU, GPU, RAM and ROM.

(i) State **two** factors that affect the performance of a CPU.

1 .....

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2 .....

..... **[2]**

(b) The CPU uses pipelining to improve efficiency.

Explain what is meant by the term 'pipelining'.

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..... **[3]**

6 **(a)** Various registers are used when the program above is executed.

(i) State what is meant by the term 'register'.

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..... **[2]**

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2020

AS - Level

1 A company produces CPUs for desktop and laptop computers. Each CPU is designed around the Von Neumann Architecture.

(a) Describe what is meant by the term 'Von Neumann Architecture'.

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..... **[2]**

(b) A CPU will repeatedly run the Fetch-Decode-Execute-cycle shown in **Fig. 1**.

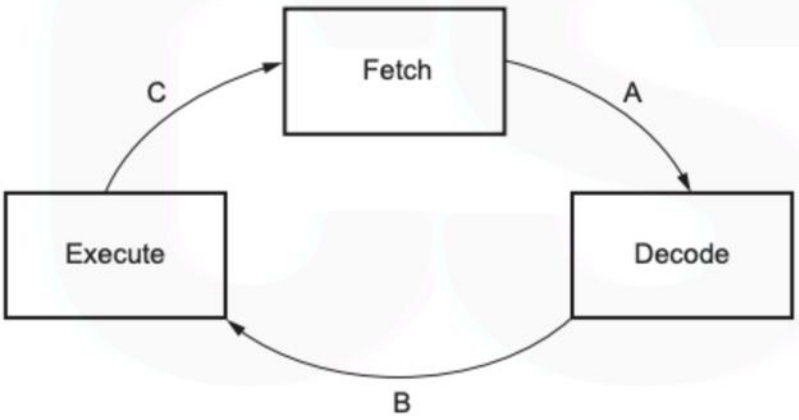

Fig. 1

(i) Describe what happens during the 'Fetch' stage shown in **Fig. 1**.

You should refer to the use of specific registers in your answer.

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..... **[4]**

(d) The Bertie Butler machine uses a multicore processor.

Define the term 'multicore processor'.

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..... **[2]**

3 A program written in the Little Man Computer instruction set is given below.

```
        INP
        STA    num
loop    LDA    total
        ADD    num
        STA    total
        LDA    count
        ADD    one
        STA    count
        SUB    num
        BRZ    end
        BRA    loop
end     LDA    total
        OUT
        HLT
one     DAT    1
num     DAT    0
count   DAT    0
total   DAT    0
```

(c) Explain which registers are used and their values when the line `STA count` is **executed** and the accumulator is holding the value 9. The label `count` refers to memory location 16.

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..... **[2]**

3* "The Megahertz Myth" is the name given to the argument that clock speed alone is an insufficient method to compare the performance of processors.

Discuss the extent to which you agree with this argument. You should include any other factors that might affect a processor's performance. [9]

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2018

1 A digital coffee making machine has a CPU that uses the Little Man Computer Instruction Set.

(a) Little Man Computer operates on a computer system based on the Von Neumann Architecture.

(i) State **two** features of the Von Neumann architecture.

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2 .....

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[2]

(ii) Describe **one** feature, **not** part of the standard Von Neumann Architecture, which contemporary CPUs may have in order to improve performance.

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..... **[2]**

(b) Part of the coffee making machine's code asks the user to press a button to select strength. The code outputs 1 which will switch on a green light to indicate a valid selection or outputs 0 to indicate an invalid selection.

The code is shown below:

```
                INP
                STA     entry
                LDA     max
                SUB     entry
                BRP     accept
                LDA     redLight
                BRA     printAndEnd
accept          LDA     greenLight
printAndEnd     OUT
                HLT
greenLight      DAT     1
redLight        DAT     0
max             DAT     5
entry           DAT
```

(ii) Explain which registers and buses are used, and the values they store/carry, when the line `LDA redLight` is executed (after it has been fetched and decoded). You should assume the address `redLight` refers to memory location 11. [6]

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2017

AS - Level

1 (a) Processors following the Von Neumann Architecture use registers.

(i) Describe what is meant by the term 'register'.

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..... [2]

(ii) Give **one** other feature of the Von Neumann Architecture.

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..... [1]

(b) An example of a register is the Accumulator (ACC).

Give a Little Man Computer instruction that will copy the contents of the accumulator into memory when executed.

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..... [1]

(c) Another register is the Program Counter (PC).

(i) State what the Program Counter holds.

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..... [1]

(ii) Give the name of **two** Little Man Computer instructions that may change the contents of the Program Counter when executed.

1 .....

2 .....

[2]

2* A student, Dan, on a limited budget finds his computer is running slowly. He uses his computer for university work and internet browsing.

Discuss what measures can be taken to improve Dan's computer's performance. You should explain what these measures are, why they improve the performance and justify whether you would recommend them.

[9]

1 See And Believe is a company that specialises in computer-generated imagery (CGI) for films.

Producing CGI requires lots of processing power and so the company has a large number of high-performance computers.

(b) The processors in the company's powerful computers have fast clock speeds and large amounts of cache memory. Describe how each of these improves the processor's performance:

(i) fast clock speed

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..... **[2]**

(ii) large cache memory

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..... **[2]**

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EXTRA

1(a). The following is a program written using the Little Man Computer instruction set.

```
start  LDA   one
       OUT
       LDA   zero
       OUT
       LDA   count
       SUB   one
       STA   count
       BRP   start
       HLT
one    DAT   1
zero   DAT   0
count  DAT   3
```

Explain, giving an example, how pipelining in a CPU could speed up the execution of this program.

---[3]

(b). Describe **one** issue the line `BRP start` may cause for a CPU using pipelining.

---[2]

(c). Pipelining is one factor that affects the performance of a CPU. Identify **one** other factor.

---[1]

2. A Little Man Computer (LMC) assembly language program is stored in memory as shown in Fig. 3.1.

0	LDA &7
1	ADD #4
2	OUT
3	HLT
4	6
5	2
6	10
7	15
8	16
9	17

Fig. 3.1

In this variant of LMC the symbols & and # are used to denote different modes of addressing.

Explain how pipelining would help a CPU execute the code in Fig. 3.1 more quickly.

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[3]

1. A processor contains a number of special registers.

Name and describe **three** buses used to convey information between the special registers.

1

2

3

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[6]

3. Computer architectures use registers including the accumulator.

Describe **two** ways in which the accumulator is used.

1

2

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[4]

4. A processor uses a number of different registers. One of these is the Current Instruction Register.

Describe the use of special registers and their functions during the fetch-decode-execute cycle, including jump instructions, reading from and writing to memory. [8]

The quality of written communication will be assessed in your answer to this question.

If you found this useful, drop a follow to help me out!

THANK YOU!

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