OCR GCSE (J277)

# Module A: Systems architecture

Workbooklet · 6 parts · 120 marks

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| | **Total** | **120** |

MODULE A SYSTEMS ARCHITECTURE · A1

# What a computer system is and what the CPU does

Original practice questions · ~25 minutes · 20 marks · OCR J277 spec 1.1.1

Name _____ Date _____

**Instructions.** Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

## 1

**Total: 6 marks**

A car park has a pay station. A driver types their car registration on a keypad, the pay station works out the charge, prints a ticket and keeps a record of each visit on a solid state drive.

**(a)** State what the letters CPU stand for. **[1]**

**(b)** State the purpose of the CPU in the pay station. **[1]**

**(c)** Tick (✓) **one** box in each row to show the job each part of the pay station does. **[4]**

| Part | Input | Processing | Output | Storage |
|---|---|---|---|---|
| Keypad | | | | |
| CPU | | | | |
| Ticket printer | | | | |
| Solid state drive | | | | |

**2** **Total: 5 marks**

The pay station runs a program to work out the charge.

**(a)** Tick (✓) **one** box to show where the CPU fetches the program's instructions from while the program is running. **[1]**

| Location | Tick (✓) |
|---|---|
| Keypad | |
| Main memory (RAM) | |
| Ticket printer | |

**(b)** Complete the description of the fetch-execute cycle. Use words from the list. Not all words are used. **[4]**

instruction · memory · carried out · repeats · printer · deleted · stops · keypad

The CPU fetches an ..... from main ..... . The CPU decodes it to work out what it means. The instruction is then executed, which means it is ..... . The cycle then ..... for the next instruction.

**3** **Total: 3 marks**

Describe what happens during the fetch-execute cycle. **[3]**

**4** **Total: 3 marks**

Tick (✓) **one** box in each row to show whether each statement is true or false. **[3]**

| Statement | True | False |
|---|---|---|
| A hard disk drive is part of the CPU. | | |
| The fetch-execute cycle is repeated continuously while a program runs. | | |
| The CPU processes data and instructions to run programs. | | |

**5** **Total: 3 marks**

A delivery driver opens a route-planning app on a tablet. The app is stored on the tablet's secondary storage.

Explain how the CPU and main memory (RAM) are used while the app runs. **[3]**

**Total for this worksheet: 20 marks**

MODULE A SYSTEMS ARCHITECTURE · A2

# Inside the CPU: ALU, CU, cache and registers

Original practice questions · ~25 minutes · 20 marks · OCR spec 1.1.1

Name _____ Date _____

**Instructions.** Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

## 1

**Total: 3 marks**

A ticket machine at a railway station has a CPU that works out the price of each ticket.

**(a)** State what the letters ALU stand for. **[1]**

**(b)** Give **two** types of operation the ALU carries out. Give an example of each from the ticket machine. **[2]**

## 2

**Total: 4 marks**

Tick (✓) **one** box in each row to show which CPU component does each job.

**(a)** Complete the table. **[4]**

| Job | ALU | Control unit | Cache | Registers |
|---|---|---|---|---|
| Decodes an instruction to work out what it means | | | | |
| Checks whether one number is greater than another | | | | |
| Keeps frequently used instructions and data inside the CPU | | | | |
| Very small, very fast locations that each hold one item the CPU is using right now | | | | |

**3** **Total: 6 marks**

The CPU in Von Neumann architecture uses the registers below.

**(a)** Complete the table by describing the purpose of each register. **[4]**

| Register | Purpose |
|---|---|
| Program counter (PC) | |
| Memory address register (MAR) | |
| Memory data register (MDR) | |
| Accumulator | |

**(b)** Identify the **two** registers from the table that store a memory address. **[2]**

**4** **Total: 2 marks**

A weather station's computer is part way through running a program. At one moment the MAR holds 12. A little later the MDR also holds 12.

**(a)** Explain what the number 12 means in the MAR and what it means in the MDR. **[2]**

**5** **Total: 2 marks**

**(a)** Describe the role of the control unit (CU). **[2]**

**6** **Total: 3 marks**

A library's self-service machine runs the same instructions every time a book is scanned.

**(a)** Explain how cache helps the machine's CPU run these instructions quickly. **[3]**

**Total for this worksheet: 20 marks**

MODULE A SYSTEMS ARCHITECTURE · A3

# Von Neumann architecture

Original practice questions · ~25 minutes · 20 marks · J277 spec 1.1.1

Name _____ Date _____

**Instructions.** Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

## 1

**Total: 3 marks**

A car park pay machine contains a CPU that uses Von Neumann architecture.

**(a)** State where the program instructions and the data are stored in Von Neumann architecture. **[1]**

**(b)** Describe the stored program concept. **[2]**

## 2

**Total: 4 marks**

The CPU in the pay machine has several registers.

**(a)** Complete the table by giving the missing register names and purposes. **[4]**

| Register | Purpose |
|---|---|
| | Holds the address of the next instruction to be fetched. |
| MAR (Memory Address Register) | |
| MDR (Memory Data Register) | |
| | Holds the result of calculations carried out by the ALU. |

**3** Total: 2 marks

**(a)** Identify the **two** registers from Question 2 that hold a memory address. **[2]**

**4** Total: 5 marks

Part of the pay machine's main memory is shown below.

| Address | Contents |
|---|---|
| 40 | LOAD 45 |
| 41 | ADD 46 |
| 42 | STORE 47 |
| 45 | 250 |
| 46 | 150 |

**(a)** State the address of the location that holds the value 150. **[1]**

**(b)** The program counter holds 41. The next instruction is fetched.

**(i)** State the value the MAR will hold. **[1]**

**(ii)** State what the MDR will hold. **[1]**

**(c)** Explain the difference between an address and the data stored at that address. Use the memory table in your answer. **[2]**

**5** Total: 3 marks

**(a)** Tick (✓) one box in each row to show whether each statement is true or false. If a statement is false, rewrite it so that it is true. **[3]**

| Statement | True | False | Rewritten statement (if false) |
|---|---|---|---|
| The program counter counts how many programs are running. | | | |
| In Von Neumann architecture, data and instructions are held in the same memory. | | | |
| The MDR holds the address of the memory location being used. | | | |

**6** Total: 3 marks

The car park company changes its prices. A new program is sent to every pay machine. The hardware inside the machines is not changed.

**(a)** Explain how Von Neumann architecture allows the machine to run the new program without changing its hardware. **[3]**

**Total for this worksheet: 20 marks**

MODULE A SYSTEMS ARCHITECTURE · A4

# The fetch-execute cycle

Original practice questions · ~25 minutes · 20 marks · OCR J277 spec 1.1.1

Name _____ Date _____

**Instructions.** Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

## 1

Total: 2 marks

**(a)** State the purpose of the CPU. **[1]**

**(b)** State where the CPU fetches each instruction from while a program is running. **[1]**

## 2

Total: 5 marks

Each statement describes something that happens during the fetch-execute cycle.

**(a)** Tick (✓) **one** box in each row to show whether it happens when the instruction is **fetched** or when it is **executed**. **[5]**

| Statement | Fetch | Execute |
|---|---|---|
| The next instruction is brought from memory (RAM) into the CPU | | |
| The ALU adds two numbers together | | |
| The program counter is incremented | | |
| The result of a calculation is stored in the accumulator | | |
| The program counter is used to find the address of the next instruction | | |

**3** **Total: 4 marks**

Each register used in the fetch-execute cycle stores either an **address** or **data**. Instructions count as data.

**(a)** Tick (✓) **one** box in each row to show what each register stores. **[4]**

| Register | Address | Data |
|---|---|---|
| Program counter (PC) | | |
| Memory address register (MAR) | | |
| Memory data register (MDR) | | |
| Accumulator | | |

**4** **Total: 5 marks**

A self-service parcel locker runs a program that counts how many lockers are free. The program's instructions are stored in memory, starting at address 40. At the start of a cycle, the program counter holds 40.

**(a)** State the value held in the program counter after the instruction at address 40 has been fetched. **[1]**

**(b)** Identify the CPU component that decodes the instruction. **[1]**

**(c)** The instruction at address 40 is: *add the value stored at address 90 to the value in the accumulator*. Describe what happens when this instruction is executed. **[3]**

**5** **Total: 4 marks**

**(a)** Describe the fetch-execute cycle. **[4]**

**Total for this worksheet: 20 marks**

MODULE A SYSTEMS ARCHITECTURE · A5

# CPU performance

Original practice questions · ~25 minutes · 20 marks · J277 spec 1.1.2

Name _____ Date _____

**Instructions.** Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

## 1

**Total: 7 marks**

An architecture firm buys new desktop computers for drawing building plans. Each computer has a CPU with a clock speed of 3.2 GHz.

**(a)** Tick (✓) one box in each row to show which CPU characteristic is being described. **[3]**

| Description | Clock speed | Cache size | Number of cores |
|---|---|---|---|
| How many fetch-execute cycles the CPU can carry out each second | | | |
| How many processing units in the CPU can each fetch and execute instructions | | | |
| How much fast memory in the CPU is available for frequently used data and instructions | | | |

**(b)** State how many cycles per second a clock speed of 3.2 GHz represents. **[1]**

**(c)** Explain how increasing the clock speed of the CPU can affect the performance of the computer. **[2]**

**(d)** A different CPU has a clock speed of 2.5 GHz. State how many fetch-execute cycles it can carry out each second. **[1]**

**2** **Total: 3 marks**

The firm's IT technician says the new CPUs have a larger cache than the old ones.

**(a)** State what is stored in cache. **[1]**

**(b)** Explain why a larger cache can improve the performance of a CPU. **[2]**

**3** **Total: 6 marks**

The technician is choosing between two CPUs. All other parts of the computers are the same.

| CPU | Clock speed | Cache size | Number of cores |
|---|---|---|---|
| CPU P | 2.0 GHz | 6 MB | 4 |
| CPU Q | 3.5 GHz | 6 MB | 2 |

**(a)** The firm's older drawing program can only use one core at a time. Identify which CPU is likely to run this program faster. Justify your choice. **[3]**

**(b)** The firm also uses a rendering program that splits its work into many tasks that can run at the same time. Explain why CPU P might run this program faster than CPU Q, even though CPU P has a lower clock speed. **[3]**

**4** **Total: 4 marks**

**(a)** Tick (✓) one box in each row to show whether each statement is true or false. **[4]**

| Statement | True | False |
|---|---|---|
| Doubling the number of cores always doubles the speed of every program. | | |
| Cache memory is faster to access than RAM. | | |
| A CPU with a clock speed of 4 GHz can carry out more cycles per second than one with 2.5 GHz. | | |
| Increasing the cache size means data must be fetched from RAM more often. | | |

**Total for this worksheet: 20 marks**

MODULE A SYSTEMS ARCHITECTURE · A6

# Embedded systems

Original practice questions · 20 marks · ~25 minutes · OCR J277 spec 1.1.3

Name _____ Date _____

**Instructions.** Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

## 1

Total: 1 mark

**(a)** Define the term **embedded system**. **[1]**

## 2

Total: 4 marks

An office building contains the devices below.

**(a)** Tick (✓) **one** box in each row to show whether the device is an embedded system. **[4]**

| Device | Embedded system | Not an embedded system |
|---|---|---|
| The digital thermostat that controls the heating | | |
| A laptop that staff use for email, spreadsheets and video calls | | |
| The controller in the lift that moves it between floors | | |
| A desktop PC that runs any software the IT team installs | | |

**3** **Total: 8 marks**

A garden centre has a greenhouse with an automatic watering controller. A small circuit board inside the watering pump reads a soil moisture sensor. When the soil is too dry, it switches the pump on. When the soil is wet enough, it switches the pump off. It has no screen, only a power light.

**(a)** State the dedicated function of the watering controller. **[1]**

**(b)** Explain why the watering controller is an embedded system. **[3]**

**(c)** Describe **two** characteristics of embedded systems. Link each one to the watering controller. **[4]**

1

2

**4** **Total: 5 marks**

A hotel room contains: an electronic key-card door lock, a wooden wardrobe, an air-conditioning unit with a temperature setting, a paper guidebook, a coffee machine with programmable brew settings, and a guest's own laptop.

**(a)** Identify **three** items in the room that are likely to contain an embedded system. **[3]**

1

2

3

**(b)** The guest's laptop is a computer, but it is **not** an embedded system. Explain why. **[2]**

**5** **Total: 2 marks**

A delivery company runs a fleet of vans.

**(a)** Give **two** examples of embedded systems that could be found in a van. **[2]**

1

2

**Total for this worksheet: 20 marks**