

Automated and emerging technologies

IGCSE Computer Science 0478 · Topic 6 revision notes

Everything from the 3 lessons of this topic on a few pages: the key idea of each lesson, the diagram to remember, the points to learn and the traps examiners set. Read it, cover it, test yourself.

1. Automated systems: sensors, microprocessors and actuators

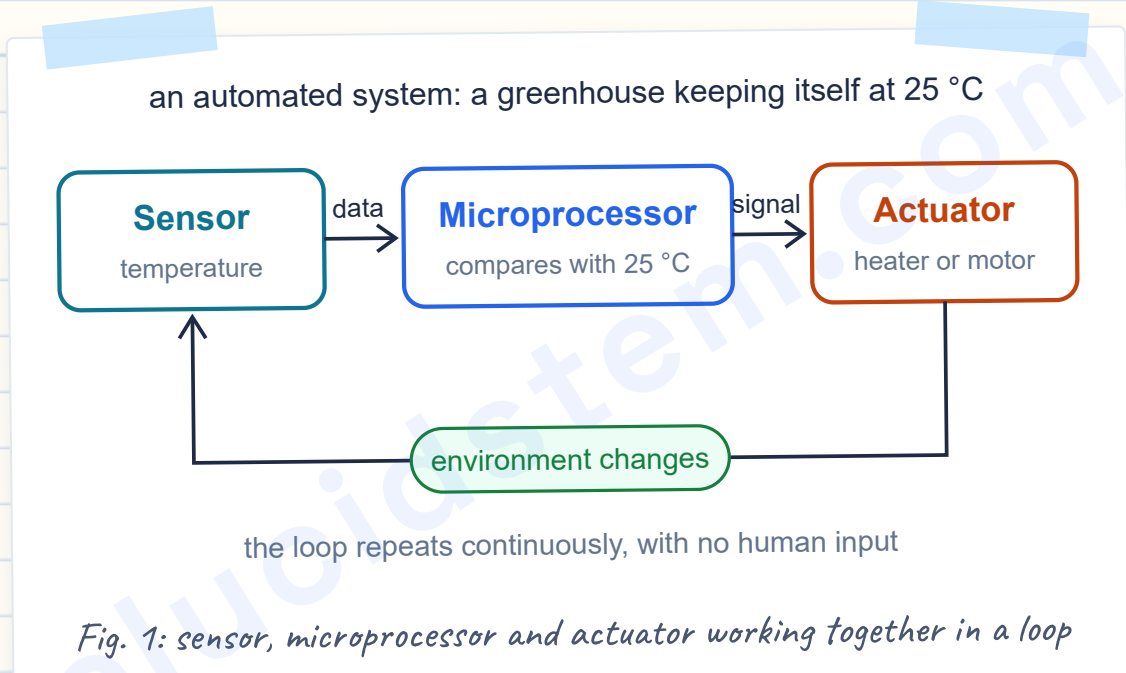
2. Robotics

3. Artificial intelligence: expert systems and machine learning.

1 Automated systems: sensors, microprocessors and actuators

Syllabus 6.1

An **automated system** carries out a task with little or no human input. A **sensor** measures a physical quantity (such as temperature or light) and sends data to a **microprocessor**. The microprocessor **compares** the data with stored values (a set point or range) and decides what to do. If action is needed it sends a signal to an **actuator** (such as a motor, valve, heater or pump), which changes the environment. The sensor keeps taking readings, so the process **repeats continuously**.



Worked example: Automatic greenhouse

Describe how sensors, a microprocessor and actuators keep a greenhouse at the correct temperature.

1. A temperature sensor measures the temperature in the greenhouse and sends the data to the microprocessor (via an ADC).
2. The microprocessor compares the reading with the stored set point, for example 25 °C.
3. If the temperature is below 25 °C, it sends a signal to an actuator to switch the heater on (and close the windows with a motor).
4. If it is above 25 °C, it signals the heater to switch off and a motor to open the windows.
5. The sensor keeps taking readings, so the process repeats continuously.

Answer: sense → compare with a stored value → signal an actuator → repeat

Every step, in order.

- ✓ **Sensor:** measures and sends data (via an ADC if analogue) to the microprocessor.
- ✓ **Microprocessor:** compares the data with stored values and decides.
- ✓ **Actuator:** receives a signal and physically acts (motor, pump, valve, heater).
- ✓ **Repeat:** say the process is continuous, and apply advantages and disadvantages to the scenario.

Watch out!

"The sensor turns on the heater" earns nothing. Sensors only measure and send data; the microprocessor makes the decision and the actuator does the action.

Name the right sensor for the scenario. A greenhouse that waters plants needs a **moisture** sensor; a temperature sensor alone cannot tell if the soil is dry.

"It is more efficient" on its own is too vague to earn a mark. Say what is better, e.g. "it responds to a pressure rise faster than a human operator could".

2 Robotics

Syllabus 6.2

Robotics is a branch of computer science that incorporates the **design, construction and operation** of robots. A robot has three characteristics: a **mechanical structure or framework** (body, arms, wheels, joints); **electrical components** such as **sensors, microprocessors and actuators** that let it sense and move; and it is **programmable**, so it follows a stored program and can be reprogrammed to do a different task. Examples include **factory equipment, domestic robots and drones**.

the three characteristics of a robot

Mechanical structure

frame, arm, joints, wheels

Electrical components

sensors, microprocessor, actuators (motors)

wrist motor + gripper

Programmable

runs a stored program;
can be reprogrammed

sensor (teal), microprocessor (blue), motor (orange)

Fig. 1: a robot arm shows all three characteristics of a robot

Worked example: Domestic robot

Describe how a robot vacuum cleaner uses its components to clean a room.

1. Sensors (e.g. infrared or bump sensors) detect walls, furniture and stairs, and send data to the microprocessor.
2. The microprocessor processes the data and decides which way to go, following its stored program (and may build a map of the room).
3. It sends signals to actuators: the wheel motors to steer and the brush and suction motors to clean.
4. A sensor detects when the battery is low, and the robot returns to its charging base.

Answer: sensors → microprocessor → actuators, guided by a program

Three characteristics.

- ✓ **Robotics:** the design, construction and operation of robots.
- ✓ **Characteristics:** mechanical structure; electrical components (sensors, microprocessor, actuators); programmable.
- ✓ **Areas:** industry, transport, agriculture, medicine, domestic, entertainment.
- ✓ **Evaluate:** link every advantage and disadvantage to the robot in the question.

Watch out!

"A robot is a machine that looks like a human" is wrong. Most robots look nothing like people; what matters is the structure, the electrical components and being programmable.

A drone is a robot when it is programmed to fly a route or uses its sensors to act on its own (e.g. a crop-spraying drone). Say what it does in the scenario, not just "it flies".

"Robots are cheaper" needs care: they are expensive to buy, but can be cheaper to run over time. Say which one you mean.

3 Artificial intelligence: expert systems and machine learning

Syllabus 6.3

Artificial intelligence (AI) is a branch of computer science dealing with the **simulation of intelligent behaviours** by computers. Its main characteristics are: a **collection of data** and **rules for using that data**; the **ability to reason** (apply the rules to reach conclusions); and it can include the **ability to learn and adapt**. At IGCSE you study two kinds: **expert systems**, which have a **knowledge base**, **rule base**, **inference engine** and **interface**; and **machine learning**, where a program can **automatically adapt its own processes and/or data**.

the four components of an expert system



the inference engine applies the rules to the facts to reach a conclusion

Fig. 1: how the parts of an expert system work together

Worked example: Medical diagnosis

Describe how an expert system helps a doctor diagnose an illness.

1. The interface asks the doctor questions about the patient's symptoms, e.g. "Does the patient have a temperature above 38 °C?"
2. The doctor enters the answers through the interface.
3. The inference engine compares the answers with the facts in the knowledge base, using the rules in the rule base.
4. It chooses the next question based on the answers so far, narrowing down the possible illnesses.
5. The interface displays the most likely diagnosis (often with a percentage probability) and an explanation of how it was reached.

Answer: interface → inference engine + rule base + knowledge base → conclusion

Use the syllabus words.

- ✓ **AI:** the simulation of intelligent behaviours by computers.
- ✓ **Characteristics:** data and rules for using it; ability to reason; can learn and adapt.
- ✓ **Expert system:** knowledge base (facts), rule base (rules), inference engine (reasons), interface (questions and answers).
- ✓ **Machine learning:** the program automatically adapts its own processes and/or data.

Watch out!

"AI is when a computer thinks like a human" is too vague for marks.

Use the syllabus words: *simulates* intelligent behaviour, using data and rules, the ability to reason, and possibly to learn and adapt.

Do not mix up the knowledge base and the rule base. The *knowledge base* holds the facts; the *rule base* holds the rules; the *inference engine* uses the rules on the facts.

"Machine learning is when a computer learns" just repeats the question. Say it *automatically adapts its own processes and/or data*, without being reprogrammed.