6 Automated & Emerging Technologies

6.1 Automated Systems

An **automated system** is a computer system that collects information and can react and perform tasks based on the data. **Automated systems** use **sensors**, a **microprocessor** and **actuators**

Advantages of Automated Systems	Disadvantages of Automated Systems
+ Reduced **labour costs** + Improved **efficiency** (e.g. energy, fuel) + Improved **accuracy** + **Consistent** results + Improved **safety** + Able to collect large amounts of data **quickly**	- High **initial investment** - High **maintenance costs** - Significant testing must be done before being used - can result in major job losses

There are also scenarios where specific advantages and disadvantages are important such as:

Scenario	Advantages	Disadvantages
Industry	- Increased production - Improved quality control	- High investment costs - Job losses
Transport	- Less accidents & traffic congestion - Increased logistical efficiency	- Transportation drivers lose jobs - Technology reliability
Agriculture	- Less manual labour - Increased crop yield & resource management	- High start-up costs for equipment and sensors
Weather	- Accurate forecasting - Improved early warning systems	- May not 100% accurate all the time
Gaming	- Personalised experience - Able to create interactive games	- Reduced creativity & problem solving for players - May be affected by technical glitches
Lighting	- Increased energy efficiency - Better security with motion-activated systems	- Lack of human control with light adjustments
Science	- Faster & more precise - Reduced risk of human error	- High cost development and maintenance - May not be suitable for all types of experiments

6.2 Robotics

Robotics is a branch of computer science that incorporates the design, construction, and operation of robots (to perform tasks)

- Examples
  - **Factory equipment** (welding, painting, assembling)
  - **Domestic robots** (household chores e.g. vacuuming)
  - **Drones** (unmanned aerial vehicles e.g. photography, delivery, surveillance)
- Characteristics
  - **A mechanical structure or framework** – a physical body that can move and interact with the environment
  - **Electrical components** e.g. sensors, microprocessors, actuators – allow robots to receive and respond to information
  - **Programmable** – can follow a set of instructions, complete a variety of tasks, respond to changing situations

Robots are used in: industry (manufacturing and assembly lines), transport, agriculture, medicine (surgical procedures), domestic, entertainment	
Advantages of using Robots	**Disadvantages of using Robots**
+ Increased **productivity** (can work continuously without breaks) + Performs tasks with high **accuracy** and **consistency** + Performs tasks that are **dangerous for humans** + Reduces **labour costs** in the long run	- High **initial cost** - High **maintenance cost** - Lack of **flexibility** (programmed for specific tasks and cannot adapt easily to new situations) - **Unemployment** (increased use of robots can lead to job loss) - May **deskill** the workforce - If they **malfunction**, production stops

6.3 Artificial Intelligence (AI)

AI is a branch of computer science dealing with the simulation of intelligent behaviours by computers

- Characteristics
  - **Collection of data and rules**: large amounts of data are processed using rules to make decisions/predictions
  - **Ability to reason**: AI systems use logical reasoning to evaluate information and make decisions
  - **Ability to learn and adapt**: can learn from past experiences and change its data and rules accordingly

Advantages of AI	**Disadvantages of AI**
- Increased efficiency - Increased accuracy - The system can serve more users without delay	- Job losses - Need to collect many data - High development cost

Operation & Components of AI Systems

Expert Systems

Expert systems are AI software that gives expert-level advice or decisions by using rules and knowledge. (e.g. patient diagnosis in medical field)

Expert systems share four key characteristics:

- **Knowledge base** – a database of facts to generate rules that make decisions
- **Rule base** – a set of rules to apply the knowledge in the knowledge base to specific problems
- **Inference engine** – a program that applies the rules in the rule base to the facts in the knowledge base to solve problems
- **Interface** – a way for users to interact with the system and provide input

Advantages of Expert System	Disadvantages of Expert System
- Consistent results - Faster response - Can store large amount of data	- Only good as the data entered - Requires training to use correctly - Expensive to develop and maintain

Machine Learning

- The program has the ability to automatically adapt its own **processes** and/or **data**, without being written in programmed

1. Collects **data** (e.g. about where robot has been, obstacles, etc)
2. Store **successful/unsuccessful actions**
3. Uses **ML algorithms** to analyse data and identify patterns/relationships