CAMBRIDGE UNIVERSITY PRESS

ENDORSED BY
CAMBRIDGE International Examinations

Cambridge IGCSE®

Computer Science

Revision Guide

David Watson and Helen Williams

Cambridge IGCSE®

Computer Science

Revision Guide

David Watson and Helen Williams

CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE
UNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education, learning and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: education.cambridge.org

First published 2015

Printed in Poland by Opolgraf

A catalogue record for this publication is available from the British Library

ISBN 978-1-107-69634-1 Paperback

Example answers and all other end-of-chapter questions were written by the authors

Contents

Introduction

This book has been written as a form of revision for students sitting for the IGCSE or O Level Computer Science qualification. It has been assumed throughout that the student/reader has already studied the topics to the required level and will use this book as a form of examination preparation, although it should be pointed out that this revision book is also a stand-alone source of information.

To get a good understanding of Computer Science, a student should not just rely on one source of information; it should be a combination of two or more of the following.

- Textbooks
- Notes from teachers/lesson notes
- Student's own research from libraries/Internet sites
- Revision of past papers and mark schemes
- Student's own experiences
- Revision notes based on all of the above
- A revision textbook.

This revision book closely follows the Cambridge Computer Science syllabus and covers all of the topics therein. It also takes the subject slightly further to take into account potential syllabus revisions within the near future.

There are a number of revision questions at the end of each chapter which test the understanding of the student/reader. At the very end of the book, you will find two practice papers which will cover most of the topics in the 12 chapters of this book. The two question papers closely follow the new Computer Science syllabus where papers will be sat for the first time in 2015. Sample answers have also been supplied so that the student/reader can self-assess his/her performance accordingly. The sample answers have been written by the authors. Cambridge International Examinations bears no responsibility for these answers or for the comments offered.

Computer Science is an ever-changing subject and no single textbook could hope to cover all aspects of any given topic. The student/reader needs to keep up to date with developments and keep a note of these changes to see how they impact on the subject matter of this textbook.

Different types of question

A review of Computer Science and Computer Studies past papers over the last 20 years reveals a number of different question types.

The following is a list of the most common types of question you may possibly encounter.

Name

In these questions, one word answers would suffice.

For example, '*Name three devices used to input data into a computer.*'

Acceptable answers would be: *(1) Keyboard (2) Barcode reader (3) Microphone*

Describe

In these questions, you are expected to write a sentence to describe the computing term, feature, process, etc.

For example, '*Describe what is meant by the term interrupt.*'

Acceptable answer would be: *This is a signal from a device, such as a printer, sent to the CPU; the CPU will then temporarily stop what it is doing.*

Advantages and disadvantages

In these questions, you need to write a sentence or more to describe the advantages (benefits) and disadvantages (drawbacks) of some computer process. Usually, the question may involve some comparison with another computer process.

For example, '*Give one advantage and one disadvantage of using emails rather than the normal post to send a message.*'

Acceptable answer could include: *Advantage: emails are delivered almost immediately; Disadvantage: emails require investment in a computer system.*

Trace tables

In these type of questions, you are likely to be given a flowchart and asked to trace through the flowchart using some given data. You would be expected to show the value of the variables in the table at all stages of the process.

It is a good practice to draw a line across the table after any output; this makes it easier to go back and rectify any mistake you may make. There are several examples of this type of question in chapter 6, but basically they will look like this.

x	y	z	TOTAL	OUTPUT
1 2 3 4 5	3 7 1 6	9 14 1 36	1 2	2
1 2 etc.	5 11 etc.	25 132 etc.	1 etc.	 etc.

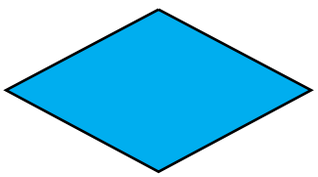
Flowcharts

In these questions, you would be given a computer process, such as '*using barcodes to carry out automatic stock control*'. The flowchart may have all the outline boxes but the actual items shown in these boxes might have been omitted. The items could be given in a numbered list and your task would be to place each stage in the appropriate box. You are well advised just to use the number of the item rather than trying to write the whole description in the given box.

Also remember the function of each flowchart box.

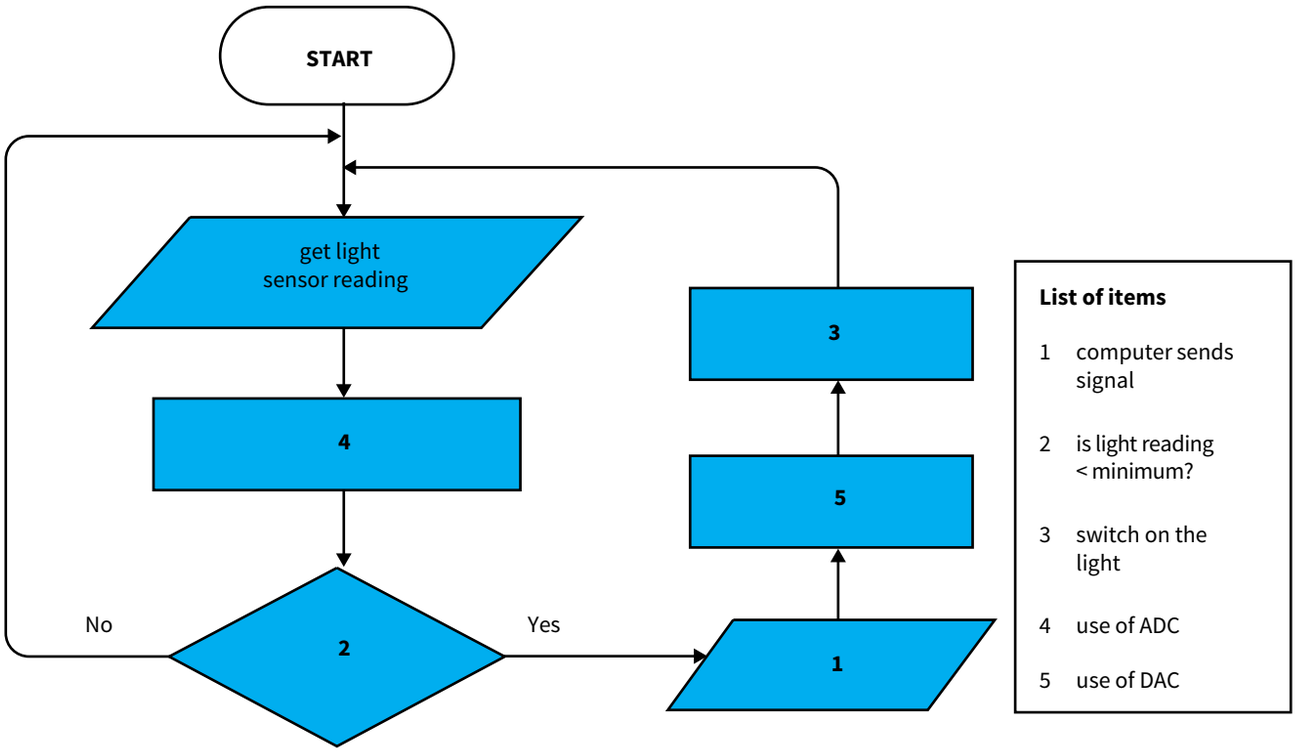
Instruction box – for example, *subtract 1 from the* ***total***

Input/output box – for example, *read data from the barcode*



Query box – for example, *have all barcodes been read?*

The following example illustrates this process.



Write an algorithm

In these questions, you are likely to be given a problem which needs to be solved using either a flowchart or pseudocode (whichever is easier).

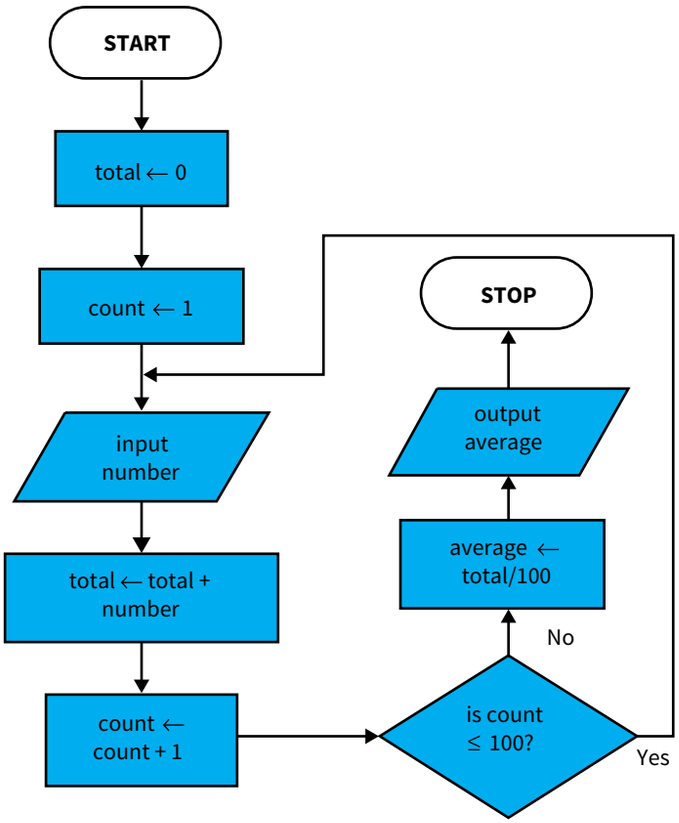
For example, '*Write an algorithm, using pseudocode or a flowchart, which inputs 100 numbers and outputs the average.*'

This can be done by pseudocode or by flowchart.

By pseudocode

```
total ← 0
for count ← 1 to 100
    input number
    total ← total + number
next count
average ← total/100
print average
```

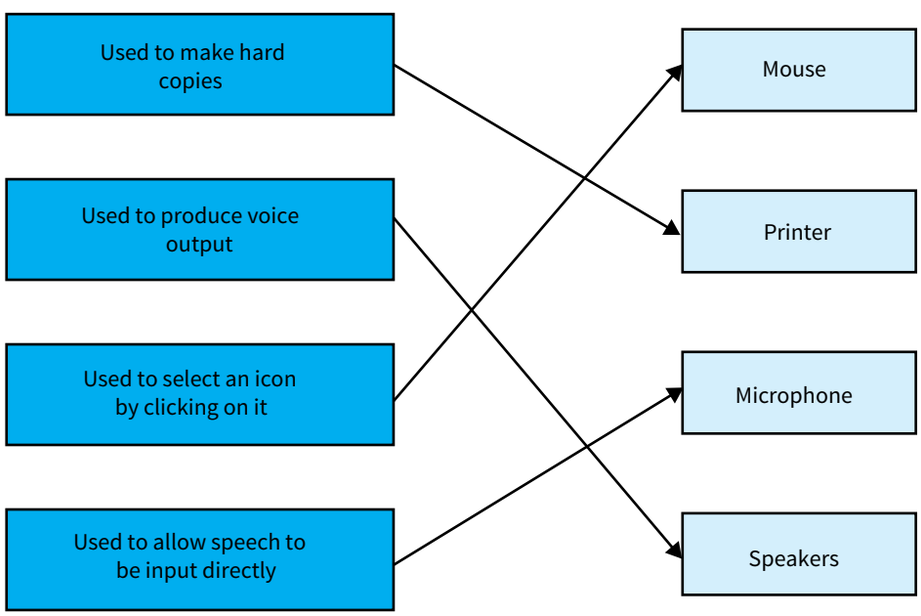
By flowchart



Linking boxes

In these questions, you would be given a description on one side and a computer term or application on the other side of the diagram.

You may be asked to draw arrows to show which description and computer term/application match. For example,



Truth tables

In these questions, you could be expected to complete a truth table to show the output from a logic gate (such as AND, OR, NOT, NAND, NOR or XOR) or from a logic network (which is a combination of these logic gates).

You may be given the binary inputs and it would only be necessary to complete the output part. For example,

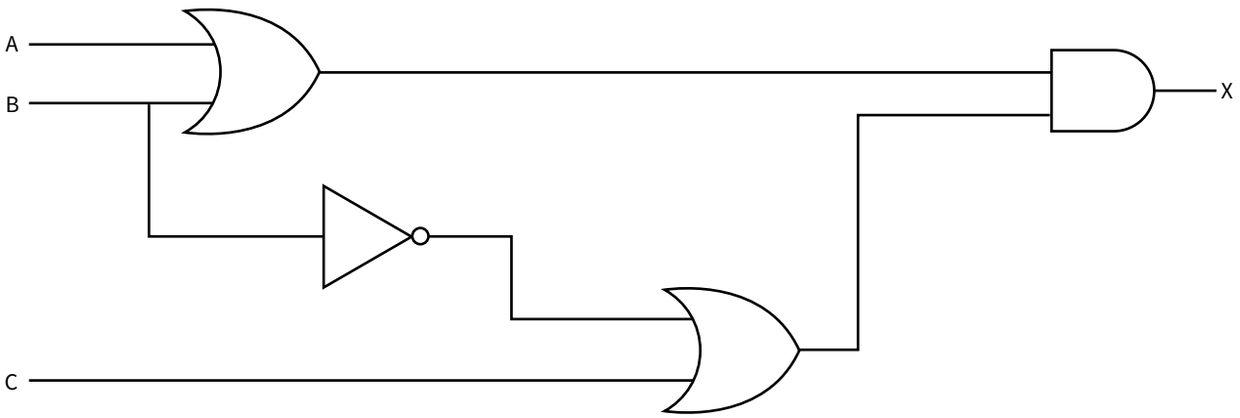
A	B	C	OUTPUT X
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

When calculating the output for a logic network, use a pencil to show the output after each logic gate – you are less likely to make a mistake if you do this. For more examples, see chapter 9.

Drawing of logic networks

As with above, these are a recent addition to the type of questions which may be asked. You may be asked to draw a logic network based on either a given problem or a logic statement. A blank space would be provided to allow you to draw your logic network (again there are many examples of this type of question in chapter 9).

Example 1: '*Draw the logic network for* ***X = 1 if (A = 1 OR B = 1) AND (B = NOT 1 OR C = 1)***'



Example 2: '*Draw the logic network for the following problem.*'

An alarm sounds (X =1) if certain conditions occur. These are summarised as following.

Input	Binary value	Description
H	1	height >= 0 metres
	0	height < 0 metres
S	1	speed <= 100 km/hour
	0	speed > 100 km/hour
L	1	landing gear OK
	0	landing gear failed

X = if

landing gear OK and height < 0 metres OR

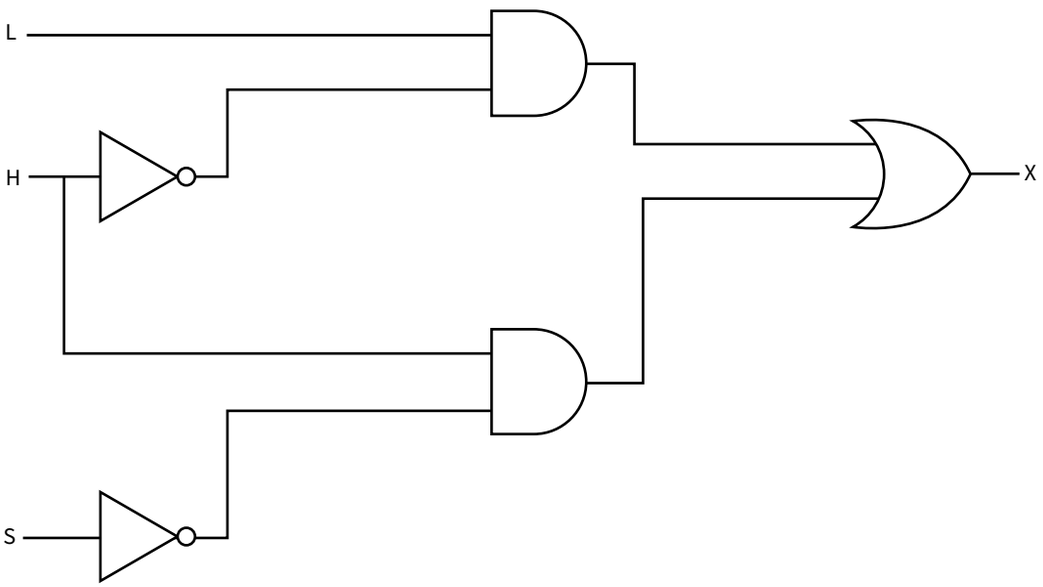
height >= 0 metres and speed > 100 km/hour

Possible solution:

Logic statement: X = 1 if [L = 1 AND H = NOT 1] OR

[S = NOT 1 AND H = 1]

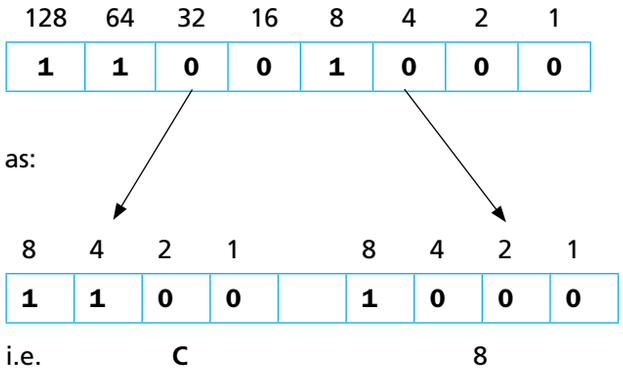
Giving the following logic network:



Miscellaneous types

There are many ***one-off*** question types set each year in Computer Science exams. Guidelines would always be given on how to set out your answers. The most common type seems to involve binary or hexadecimal registers in control applications such as elevators (lifts), robots, vending machines.

For example, the value 200 (base 10) would convert into binary as follows:



And into hex as:

Many more examples of the above question types can be found throughout the end of chapter exercises and in the two sample papers at the end of the book. When answering these questions, it is advisable to constantly refer back to this section to ensure you are correctly interpreting what is required.

Chapter

1 Introduction to Computer Science

Learning Summary

In this chapter you will learn about:

- ***An overview of chapters 2 to 12***
- ***Components of a typical computer system***

1.1 An overview of chapters 2 to 12

Computer systems are now a very common part of our everyday lives. Nearly every application used at school/college or at work involves a computer system to some extent. Historically, not everybody has been an advocate of computer advancement. Look at the following three famous quotes and decide whether any of them have true merit.

Programmers are in a race with the Universe to create bigger and better idiot-proof programs; while the Universe is trying to create bigger and better idiots. So far, the Universe is winning!!!

Rich Cook

Computers are useless. They only give you answers!

Pablo Picasso

There's word in business circles that the computer industry likes to measure itself against the Big Three (USA) car-makers. The comparison goes this way: If automotive technology had kept pace with Silicon Valley, motorists could buy a V-32 engine that does 10,000 m.p.h. or a 30-pound car that gets 1,000 miles to the gallon — both at a selling price of less than $50. Detroit's response: "OK. But who would want a car that crashes twice a day?"

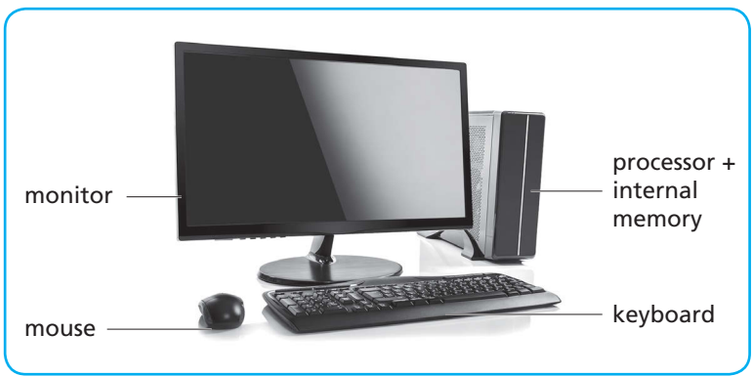
Popular 1997 joke

Whatever any of us may think, computers are here to stay. We have come a long way since the Manchester 'baby' computer of 1948 – this machine could make about 700 instructions per second and used about 3.5 kilowatt of power. Sixty years later, a typical embedded computer can make 200 million instructions per second and uses only 20 milliwatts of power. The computer in 1948 nearly filled a room, whereas now a computer occupies only about 0.5 m^2 – a considerable size reduction! These advancements continue at an amazing rate and will be further discussed in chapter 12 as part of the future predictions.

Chapters 2 to 12 of this book will take the reader through a number of applications, discuss the impact of the Internet, look at problem-solving tools, give an insight into hardware and software currently available and how computer systems operate. The final chapter will discuss some of the possible advancements we all might see in the coming decades.

1.2 Components of a typical computer system

A typical modern computer system is a combination of hardware and software.



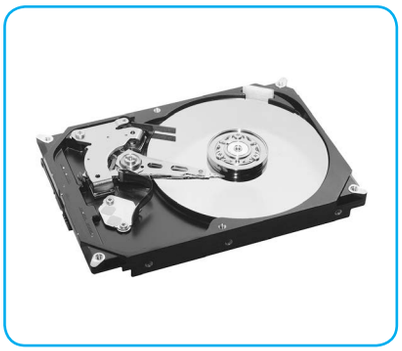
Computer system

Printer

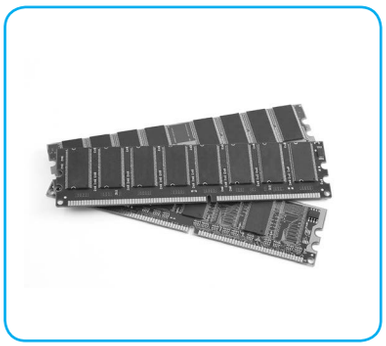
The function of the above components will be discussed in greater depth in the following chapters.

The hardware usually comprises the following.

- Input devices (such as keyboard, mouse, microphone)
- Output devices (such as monitor, printer, speakers)
- Secondary storage (such as DVD/CD reader/writer).



Hard drive



Random access memory

There are also internal components such as the following.

- Random access memory (RAM)
- Read only memory (ROM)
- Internal hard drive
- Central processing unit (CPU) or microprocessor.

These are covered in several sections of chapter 11.

Key Point	**The CPU interprets and executes commands from the computer hardware and software; it is now usually on a single integrated circuit.**

Software is usually of two types.

- Systems software which are programs that allow the hardware to run properly (for example, operating systems)
- Applications software which are programs that allow users to perform specific tasks (for example, using spreadsheets and wordprocessors).

Refer to chapter 11.

It is worth mentioning here that most input/output devices use buffers and interrupts to communicate with the CPU allowing efficient use of all devices and the CPU itself.

A ***buffer*** is a temporary store where data is held until it is ready to be processed. For example, data will be held in a printer buffer until the printer is ready to print out the buffer contents; a keyboard buffer will store key presses until they can be processed, etc.

They prevent slower devices holding up faster devices.

Since input/output devices work more slowly than the CPU, buffers allow the data to be stored until it can be processed (for example, printed) enabling the CPU to do other tasks in the meantime.

Also refer to chapter 12.

Key Point **Buffers compensate for the different operational speeds of the various components that make up a typical computer system.**

Interrupts also allow for more efficient operation of a computer system. A device will send an interrupt signal to the CPU indicating that it needs attention (for example, a printer is out of paper or out of ink and a CD is almost full). The CPU will suspend what it is doing to service the interrupt and then return to its task once the problem is cleared.

Interrupts can also be generated by software, for example, division by zero and out of data error – these interrupts again will need to be serviced and the system cannot return to normal until the issue is resolved.

Chapter

2 Computer applications

Learning Summary

In this chapter you will learn about:

- ***Computer interfaces***
- ***Communication systems***
- ***Monitoring and control of processes***
- ***Robotics***

The applications discussed in this chapter are by no means the only ones that exist, but have been chosen for their diversity and also to reflect the wide range of special applications now available to the individual and to industry. You will learn about how these applications work and their advantages and disadvantages.

2.1 Computer interfaces

To permit any application to work effectively, there needs to be an interface which is user friendly and generally easy to use. This section outlines the two main types of interface that the reader will normally encounter.

Command line interface (CLI)

In this method, the user has to type in instructions to open an application, choose something from a menu and so on. Frequently, a number of instructions are required to carry out a single task such as open or launch an application. This tends to be very slow, prone to errors and the user has to have some computer knowledge. The advantage is that the user is in direct communication with the computer which gives them greater flexibility than the next type of user interface.

Some of the many ways of capturing data (manually and automatically) are discussed in depth in chapter 10.

Example of CLI: ***c:\my program files\graphs\graphs.exe***

This would open and launch an application called ***graphs*** when typed in by the user. Some CLI instructions can run to several lines of text.

Graphical user interface (GUI)

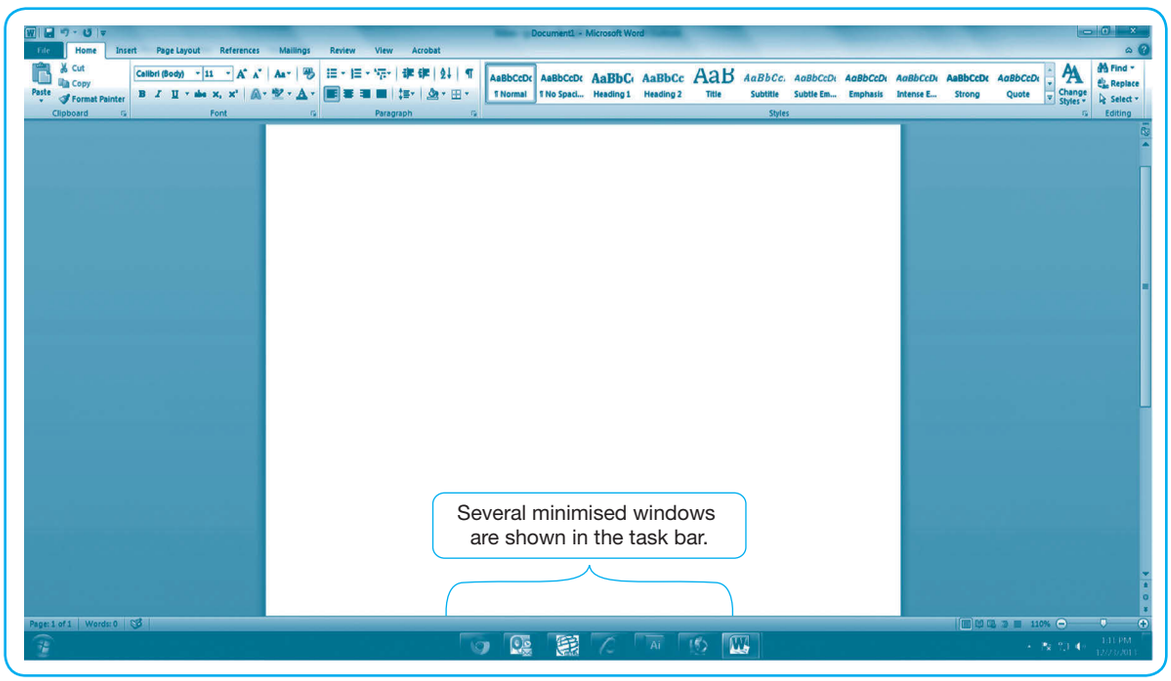
In this method, the user is allowed to interact with the computer by using pictures known as ***icons***.

This avoids the need to know where the application resides in your computer and involves simply clicking on the icon (using a mouse usually) rather than having to type in a set of instructions. Thus, the CLI instruction above could be represented by a single ***graphs*** icon.

Example of GUIs includes the ***WIMP environment (windows, icons, menu and pointing device)***. Here each application to be opened is called a ***window***. An icon from the windows environment is selected using a pointing device (for example, mouse) and this opens and runs the application.

Key Point	**Modern systems are capable of allowing several windows and applications to be opened at the same time.**

The following is a screen shot showing several windows (applications) open.



Several minimised windows

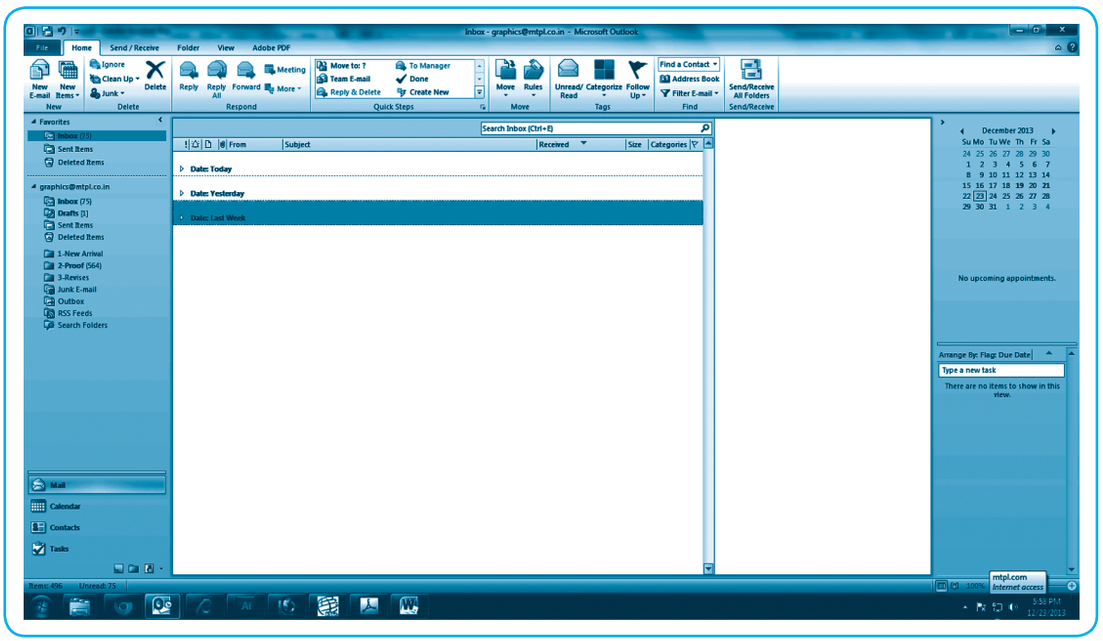
2.2 Communication systems

A microprocessor is basically a computer processor on a single chip.

There are many ways in which computer systems or microprocessors are used in methods of communication. The four most common computer- or microprocessor-based communication methods are discussed in the following pages.

Electronic mail

A very common way of communicating is via ***electronic mail (email).*** This has some advantages over video conferencing in that you can read emails whenever you like (which overcomes time zone differences) and also the equipment needed is nothing more than a computer and a modem link. It also has obvious advantages when compared to traditional mail; i.e. it is faster to deliver the email (and get a reply) and you need not leave your house or office to send the email (very useful if you are disabled, elderly or even just very busy).



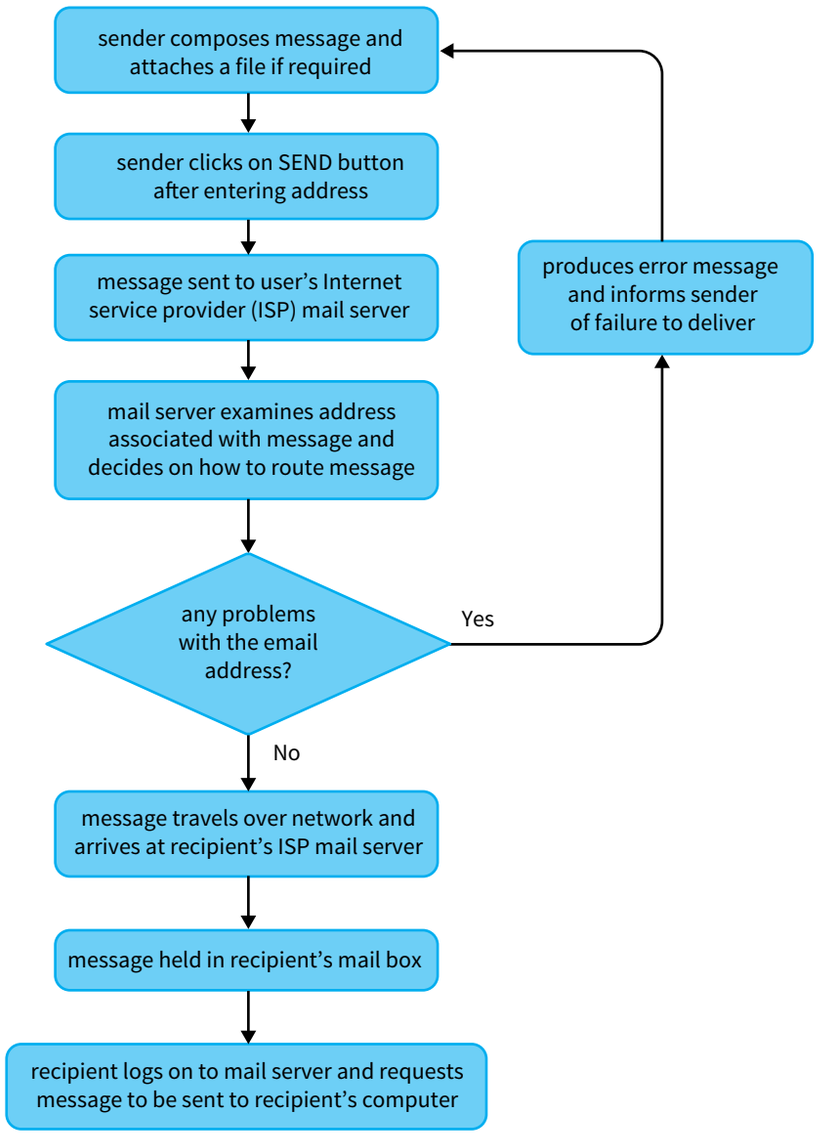
An email page

Frequently, emails are sent with ***attachments***. There are a number of issues associated with this.

- If the attachment is large, it takes a long time to download and upload and in some cases may not open due to its size.
- It is possible to send viruses through attachments.
- It is possible that the recipient does not have the necessary software to open the attachment.
- The attached file may become corrupted during data transmission.

Other aspects of security are covered in chapter 4.

So what happens when an email is sent?



The ISP is the company that provides access to Internet and hosts data.

Key Point	**Email addresses must be typed in exactly or an error message such as 'can't be delivered' will be sent back to the sender.**

Voice over Internet protocol

This is a system that allows a user to talk to another user using the Internet. The user has three options.

computer ⟷ computer

computer ⟷ mobile phone

computer ⟷ landline phone

The user can either plug in a compatible telephone (via one of the USB ports) or use a headset to allow audio communication to take place over the Internet. The main advantage of this is cost; for example, option 1 (computer to computer) is essentially free. In option 2 (computer to mobile phone) the costs are in many cases 90 per cent less than with mobile to mobile.

Universal serial bus (USB) is a standard for connection, communication and power supply between two electronic devices.

The main disadvantages are:

– the caller needs to have a broadband connection and computer
– sound quality can be poor (drop out, echoes, etc.).

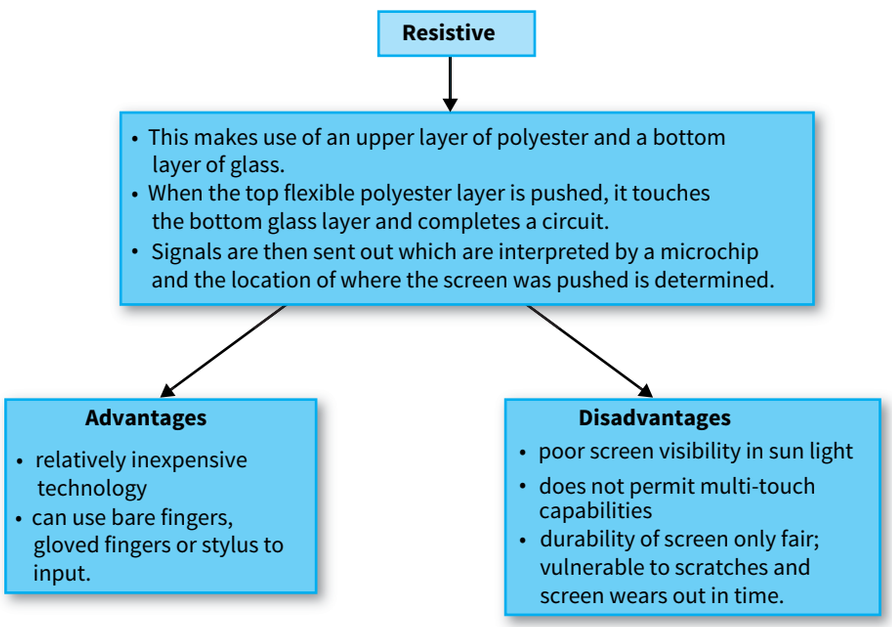
Touch screens on mobile phones

Mobile phones are another very common form of communication. They are mentioned here since many of them now have features only found previously in a computer system, such as touch screens.

There are three basic types of touch screen technologies used by mobile phone manufacturers.

- Resistive
- Capacitive
- Infra red.

The following diagram compares these three technologies by describing how they work and what are the relative advantages and disadvantages of each method.



Capacitive

- This is made up of many layers of glass that act like a capacitor creating electric fields between the glass plates in the layers.
- When the top glass layer is touched, the current is changed and the position where the screen was touched is then determined using a microchip.

Advantages

- medium cost technology
- good screen visibility in sun light
- permits multi-touch capabilities
- good durability; glass shatters on major impact only.

Disadvantages

- allows only the use of bare fingers as the form of input.

Infra red

Two types exist:

Heat sensitive
– Uses glass for screen material
– Touch screen needs a warm object (for example, fingers) to register input point.

Optical
– Uses glass for screen material
– Uses an array of sensors in the form of a grid; point of impact calculated based on which grid position touched.

Advantages

- both systems allow multi-touch capabilities
- optical system allows the use of bare fingers, gloved fingers or stylus to input
- both systems have good durability; glass shatters on major impact only.

Disadvantages

- relatively expensive technology in both systems
- allows only the use of bare fingers as the form of input
- both have 'fairly good' visibility in sun light but strong ambient light impacts on precision and on productivity.

2.3 Monitoring and control of processes

Computers use devices known as ***sensors*** to gather information from the outside world. Since most information gathered is ***analogue*** in nature (i.e. constantly varying with no discrete values) it has to be converted using an ***analogue to digital converter (ADC)*** into ***digital*** data to enable the computer to understand and process the data. When controlling devices such as pumps, valves, heaters, etc. signals from the computer need to be converted back into analogue form (for example, electric signals) a ***digital to analogue converter (DAC) is used***.

Digital refers to the discrete data made up from the binary values 0 and 1.

Key Point	**Many monitoring and control applications do not use a computer system; a microprocessor is used instead but the methodology and the outcome are the same.**

There are many applications that use sensors. The following table shows which sensors are used in a number of common applications.

Sensor type	Possible applications
temperature	→ used in controlling central heating systems → used to control/monitor temperatures in a chemical process
moisture/ humidity	→ control or monitor moisture levels in the soil in a greenhouse → control or monitor the humidity levels in the air in a greenhouse → monitor the dampness/humidity in the air in an industrial process or application
oxygen/ carbon dioxide	→ environment monitoring (for example, measuring the oxygen content in a river to check for pollution) → measure carbon dioxide levels in a greenhouse
light	→ monitoring the light levels in a greenhouse → in a dark room monitoring for light levels → automatic doors to detect the presence of a person
infra red	→ detecting an intruder by the breaking of an infra red beam → counting things (every time the beam is broken it counts as one)
pressure	→ detecting intruders in a burglar alarm system → counting vehicles as they pass over a bridge
acoustic	→ picking up sounds (for example, footsteps when used in a burglar alarm system) → detecting liquids or solids moving in pipes/check for blockages in pipes

Sensor type	Possible applications
motion	→ detecting movement (as in virtual reality interface devices)
pH	→ used to measure acid/alkaline levels in a river (pollution monitoring) → used in a greenhouse to monitor soil acidity/alkalinity → used to monitor acidity in a chemical process
proximity/ distance	→ these tend to be another name for the above sensors such as infra red, motion.
magnetic field	→ devices where changes in magnetic field occur (e.g. mobile phone or CD/DVD players) → used in anti-lock braking systems in cars/vehicles → used in traction control systems in cars/vehicles

The sensors are part of a system which is used to either ***monitor*** or ***control*** a process or application. There are subtle differences between the two methods.

Examples of monitoring

- Monitoring a patient's vital signs in a hospital
- Monitoring for safety in a chemical or nuclear process
- Burglar or security alarm (where monitoring for intruders is carried out)
- Pollution monitoring in rivers and the atmosphere.

Examples of control

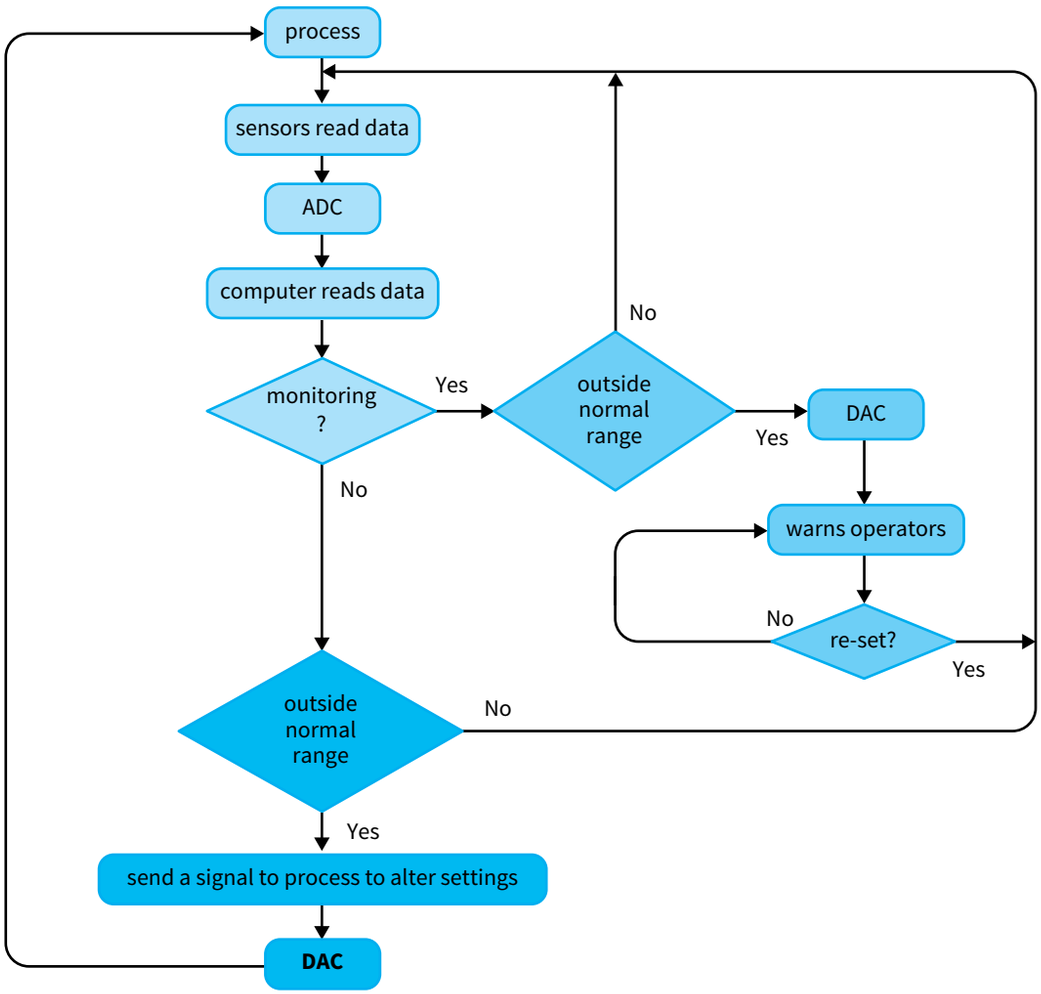
- Controlling the operation of industrial process; for example:
  - Conditions in chemical reactions for safety and quality control
  - Nuclear power stations (maintaining correct conditions)
  - Production/reprocessing of nuclear fuels (safety and quality control)
- Controlling the temperature in a central heating system
- Controlling the environment in a greenhouse (temperature, moisture, soil pH, carbon dioxide/oxygen levels and so on)
- Traffic control (timing of traffic lights, etc.)
- Street lighting (controlling the switching on and switching off the street lighting).

In ***monitoring,*** the sensors send data/signals to a computer via an ADC. The computer analyses the data received and if it is 'outside normal values', it emits a warning and/or gives out some form of a readout on a screen or printer. The computer cannot change anything to alter the data being read by the system.

In ***controlling,*** again sensors are used to gather data and send it to a computer via an ADC. If the received values are 'outside the acceptable range', the computer sends signals to devices (such as pumps, valves, motors) to open/close, switch on or off, etc. so that the computer, in effect, is controlling the process. Consequently, the next sets of sensor readings are different.

Most industrial applications use **monitoring** and **control** since it is necessary to see what is happening in the process; but for safety reasons, the processes are controlled by computer systems as their response time is much quicker than humans.

The following flowchart summarises the key differences.



Let us now consider in detail **two** very different systems.

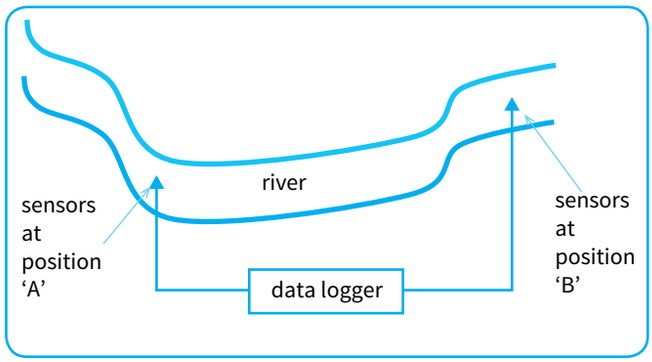
(1) Monitoring

Example 1 – a burglar/security alarm system

- gather data from sensors (pressure, infra red, motion) in the house
- signals are sent to an ADC where they are converted into digital
- the information is then sent to the computer
- the computer compares this information with pre-set data

DAC is used to convert signal to analogue so that computer can interface with alarm.

- if it is out of range (for example, pressure too high and beam has been broken) then a signal is sent to sound an alarm
- alarm continues to sound until system is re-set
- system continues to monitor sensors until turned off.

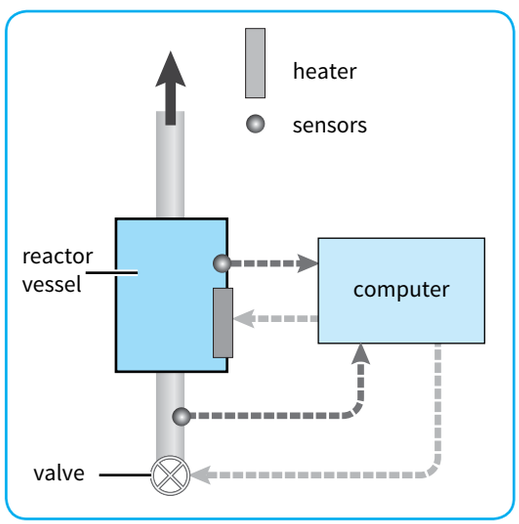


Example 2 – monitoring the pollution in a river

- sensors at position 'A' take readings (pH, carbon dioxide/oxygen levels and temperature)
- sensors at position 'B' also take readings to measure the same set of parameters
- the sensor data is converted to digital using an ADC
- the data is then stored in the data logger
- the collected data is downloaded every 24 hours from the data logger or is sent automatically via a communications link …
- … to a computer in the research laboratory
- readings from the sensors at position 'A' and position 'B' are compared by the computer
- the results are shown on a screen in the form of graphs, for example, or stored in a spreadsheet for further analysis
- the results from the sensors are also compared to data stored in the computer memory (for example, acceptable values or data readings taken on previous days)
- this allows predictions of pollution levels to be made or supply evidence that pollution is getting worse or better.

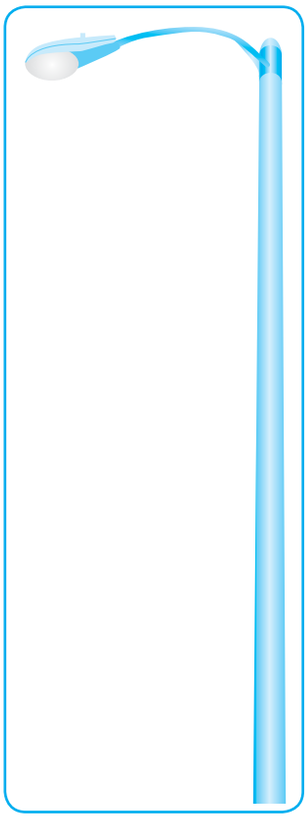
(2) Control

Example 1 – a chemical process which is temperature (must be 80°C) and pressure (must be 2 bar) dependent



- temperature sensors and pressure sensors constantly collect data from the reactor vessel
- this data is sent to an ADC where it is converted to digital
- the information is then sent to the computer
- temperature reading is compared to pre-set value
- if temperature < 80°C a signal is sent to an actuator to switch on the heater
- pressure reading is compared to pre-set value
- if pressure < 2 bar a signal is sent to an actuator to open the valve
- DAC is used to convert signals to analogue to control heater and valves
- this continues until the chemical process is completed.

Example 2 – control of street lighting



- light sensors on the top of the lamp measure how strong the light is
- a signal is then sent to a microprocessor in the lamp body …
- … an ADC is used if the signal is analogue since the input to the microprocessor must be digital
- the microprocessor will contain 'light' values which are compared to the input data
- if the input is less than the stored value …
- … the microprocessor sends a signal to the lamp unit and the lamp is switched on
- to prevent the lamp keep switching off and on as light changes (for example, heavy cloud cover), the microprocessor will send signals to keep the lamp on for a pre-determined time duration
- after this time duration has passed, the data from the light sensors is again read within an acceptable range, the microprocessor sends out a signal …
- … and the lamp is switched off
- otherwise the lamp stays on for another time duration before it is checked again
- this monitoring of the sensors continues until the system is deactivated.

Note

Some street lights work using electronic clocks rather than using light sensors and automatically switch the lamp on or off at fixed times during the day. Since the on or off times are dependent on the time of year, a microprocessor is used to store these on or off times and it sends out signals to switch the lamp on or off. The microprocessor will check the actual time against the stored times (which will be different for every day in the year) and when a match is made, a signal will be sent out to switch the lamp on or off.

Why do we use such systems to monitor and control processes?

- It is safer due to faster response to problems in a process.
- Computer systems work 24/7 (even though human workforce can operate in shifts, key data can still be missed during, for example, a shift handover).
- Computers can take and analyse readings more frequently (for example, every 10 seconds which would be very difficult for a person to do).
- Computers are generally more accurate so there is less chance of misreading data.
- Computers have the ability to automatically display and analyse data without the need to transfer data (as would be the case when taking data manually.

Computers do not get tired or miss key data which could lead to an incident.

Actuators

Actuators are used in many control applications involving sensors and computers or microprocessors. They are usually electromechanical devices such as a motor, relay or solenoid. Actuators can be digital (solenoid) but others require a digital to analogue converter (DAC) since the actuator needs an electric current/voltage to operate a motor or a valve, for example.

The use of actuators is mentioned in a number of applications in this chapter. The reader is advised to look at a number of applications involving sensors and actuators to find out some of the many ways these interact with a computer or microprocessor in a control environment.

2.4 Robotics

Robots are used in many industrial applications. They basically carry out the same functions as humans but have many advantages which will be discussed later. They are usually either linked to a computer system or have their own embedded microprocessor. Before carrying out any tasks, they are programmed by one of two methods.

(1) The robot is programmed with a series of instructions which allows it to carry out a set of pre-determined tasks.
(2) One of the skilled workers carries out the tasks manually and the movements/actions are relayed back to a computer; these actions are converted into instructions which are then stored in the memory. The robot is then operated under computer control copying the movement/actions of the human operator.

Robots rely on the use of sensors which continually gather data about its surroundings. Example is a car in the correct position to be sprayed with paint, is the paint spray gun empty, is there an obstruction in the way, is a part missing off a circuit board, etc. They are capable of doing some pseudo-intelligent tasks (for example, different sized cars needing to be painted) but in reality any non-standard routine is better carried out by a human operator. There are a number of advantages and disadvantages of using robots as discussed below.

Advantages

- Robots are capable of working in conditions which may be hazardous to humans.
- They can work non-stop, only needing a break when maintenance is due.

- They are less expensive in the long run since they do not need a salary.
- Robots are generally more productive (they can usually do a given task in a shorter time than a human).
- They are not necessarily more accurate than humans – however, the work that they do is much more consistent.
- They remove the need for humans to do boring, repetitive tasks leaving them free to do operations such as quality control.
- Less cost on factory environments – if human workers are absent from the factory floor then heating and lighting, for example, only need to be a minimum.

Disadvantages

- Robots can find it difficult to deal with non-standard situations, for example, a door missing from a car waiting to be sprayed; a windscreen about to be fitted to a car being cracked.
- They tend to reduce the need for human operators causing unemployment.
- Also since robots often take over the tasks done by humans, there is a risk of de-skilling within the work force.
- Since work can be done anywhere using robots, factories are often moved to countries where labour and operation costs are much lower.

2.5 End of chapter questions

2.5.1 Sensors are being used to monitor the environment in a greenhouse.

(a) What is the main difference between monitoring and controlling of a process?

(b) Describe how a computer and sensors are used to monitor the greenhouse environment; the temperature must be between 25°C and 30°C and the soil pH must be between 4 and 5.

(c) Name three other sensors and describe three different applications which use these sensors.

2.5.2 Robots are being used to spray some metal components with paint.

(a) Describe: (i) Two problems the robots might encounter when spraying these metal components.

(ii) How these problems could be overcome.

(b) In general, what are the advantages and disadvantages of using robots rather than using human workers in a manufacturing company?

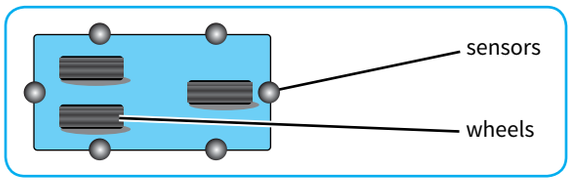
2.5.3 A computer system has been set up with a graphical user interface and windows environment. Icons are used on the screen to identify applications.

(a) What devices could be used to select and open the appropriate applications?

(b) A command line interface could have been offered instead of GUI. What are the relative benefits and drawbacks of using both GUI and CLI to communicate with the computer system?

2.5.4 A mobile robot is used to enter harsh environments to take samples and to carry out maintenance work.

(a) The mobile robot is fitted with sensors.



The robot is also equipped with an on-board computer.

Describe how the sensors and computer are used to guide the robot as it travels remotely. It needs to travel straight or go around corners without bumping into anything.

2.5.5 Name two types of mobile screen technology.

Give two advantages and two disadvantages of each of the chosen technologies.

2.5.6 A chemical process is being monitored using temperature sensors and pH sensors.

These sensors send data to a microprocessor. If the temperature in the process drops to below 50°C then a heater is switched on and if the acidity rises to a pH of 5, then a valve is opened to admit more acid (pH must be kept below 5).

Describe how the sensors and microprocessor are used to control the chemical process.

Chapter

3 The Internet

Learning Summary

In this chapter you will learn about:

- ***HTML***
- ***The Internet***
- ***Broadband and dial up***
- ***Recent developments***
- ***Intranets***

Studying the Internet is a large topic on its own. This chapter will deal with some of the key features and you will learn about website designing and how developments, such as social networking sites, have changed the way we interact and communicate.

3.1 The Internet

The Internet is a worldwide system of computer networks. It is possible to access any computer connected to this network provided you are given the necessary permissions.

However, what makes the Internet different is its use of ***protocols*** called TCP or IP (transmission control protocol or Internet protocol), which were introduced in 1974.

The Internet was initiated in 1969 by a research agency in the US government.

Key Point	**A protocol is a set of rules which is used by computers to communicate with each other across a network.**

In reality, the Internet took off in the 1990s with the introduction of ***HTML*** *(hypertext markup language)* and ***WWW*** *(world wide web)*, which uses ***HTTP*** *(hypertext transfer protocol).*

HTML (hypertext markup language)

Hypertext markup language (HTML) is a markup language and not a programming language. It allows the computer to identify a document's headings, lists, paragraphs and so on. Using HTML, a web browser would know how to display a document from a website in a way that makes sense to the user. It is easy to see the use of HTML when looking at the extension name in a URL since either ***.htm*** or ***.html*** would be shown at the end, for example:

http://www.programs.com/definitions.htm.

The following is an example of the use of HTML code when defining part of a document (the parts shown in < > are known as tags and the use of the '/' symbol signifies the end of a particular feature, for example, use of italic writing).

```
<html>
<head>
<title> This is an example of the use of HTML code </title>
</head>
<body>
<p> This shows you how the home page for a web page can be created in
HTML </p>
<h2> HTML examples </h2>
</body>
</html>
```

HTML structure and presentation

When HTML is used, it is very important to realise that there is a difference between ***structure*** and ***presentation:***

structure: this includes the semantics (i.e. the meaning) and structural markup of the document

presentation: this is the document style (i.e. how the document will look or sound)

It is important to keep structure and presentation separated throughout the design of the web page. Once the design is completed, the writer will end up with an HTML document (containing the structure and content) and a ***css file*** (cascading style sheet) which contains everything to control how the web page will be presented to the web browser.

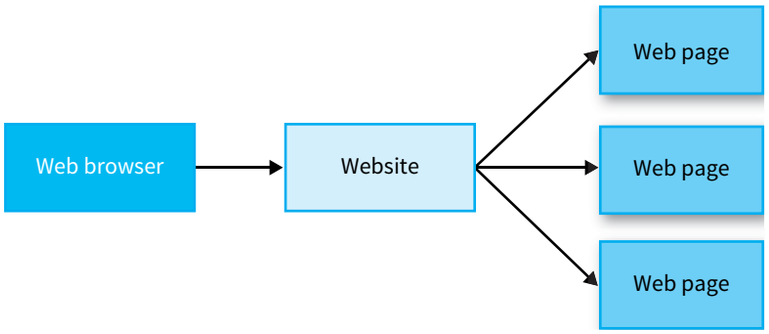
HTTP (hypertext transfer protocol)

This is a set of rules for transferring files on the web (see example above); ***http*** was later developed to allow secured transactions on the web to take place. The http protocol works by transmitting the information using some form of encryption. In theory this should mean that the information cannot be accessed by anybody other than the user and web server.

Key Point	**Encryption is a process of transforming information using an algorithm which makes it unreadable to all except those possessing special knowledge.**

It is worth pointing out here the differences between the Internet and the world wide web (www) since they are often confused or regarded as the same thing. The Internet is the actual network itself; www is something which uses the Internet.

To view pages on the Internet, ***web browsers*** are used. The process can be summarised diagrammatically.



Search engines

They are a way of finding information (i.e. from websites and web pages) on the Internet. A user, however, needs to be very careful when carrying out such searches for the following reasons:

- not all websites are accurate (anybody can set up a website)
- it is possible to access 'unwanted' or 'dangerous' websites, therefore controls are needed to prevent access to certain sites
- the number of results (called ***hits***) from a search engine could be massive.

Search results can be narrowed down by using AND, (+), OR, or quotes ( ); for example:

Type in CUP and the search engine returns ~ 284 million hits

Type in CUP+sample papers and the search engine returns ~ 817 000 hits

Type in CUP+sample papers+Geography and the search engine returns ~ 29 900 hits.

The order in which search engines display websites is based on a number of factors. Search engine optimisation allows typed key words to pick up websites. The success and popularity of certain websites is down to complex ranking algorithms used by the search engines. It has also been suggested that website ranking by certain search engines is revenue induced.

3.2 Broadband and dial up

Two common methods offered by ***Internet service providers (ISPs)*** for connecting a computer system to the Internet are:

- dial up
- broadband.

Dial up

Broadband

Kbps = kilobits per second

Features of dial up	Features of broadband
– this offers a fairly slower data transfer rate (typically ~ 60 kbps)	– this has a much faster data transfer rate (> 50 000 kbps)
– there is a need to dial one of the numbers supplied by the ISP every time one wants to connect to the Internet; therefore, dial up is not on all the time	– there is often an upper limit on the monthly download/upload file size (typically 20 Gbyte)
– the ISP contracts are usually for a number of hours per month and if this is exceeded additional charges are incurred	– it has the advantage of always being on and it does not tie up the phone line
– another drawback is that the phone line is tied up while the user is accessing the Internet.	– allows systems such as voice over Internet protocol (VoIP), online chatting in real time, C2C (webcam to webcam) to take place effectively.

Phone calls can still be made even when the Internet is being accessed.

Sample calculation

Suppose an ISP offers the following broadband data transfer rates:

- 40 megabits/seconds **download** speed
- 16 megabits per second **upload** speed.

(i) If the user wants to **download** 30 music tracks which are each 3.5 Mbyte in size, how long would this take?

(ii) The user also wanted to **upload** 40 photographs onto a website so that his friends can access the photos. Each photograph is 1.5 Mbyte in size. How long would this take?

These are the answers.

(i) 30 tracks = 30 x 3.5 Mbyte = **105 Mbyte**
40 megabits/second = 40/8 = **5 Mbyte/second**
thus, time to download 30 tracks = 105/5 = **21 seconds**

(ii) 40 photos = 40 x 1.5 = **60 Mbyte**
16 megabits/second = 16/8 = **2 Mbyte/second**
thus, time to upload 40 photos = 60/2 = **30 seconds**

3.3 Recent developments

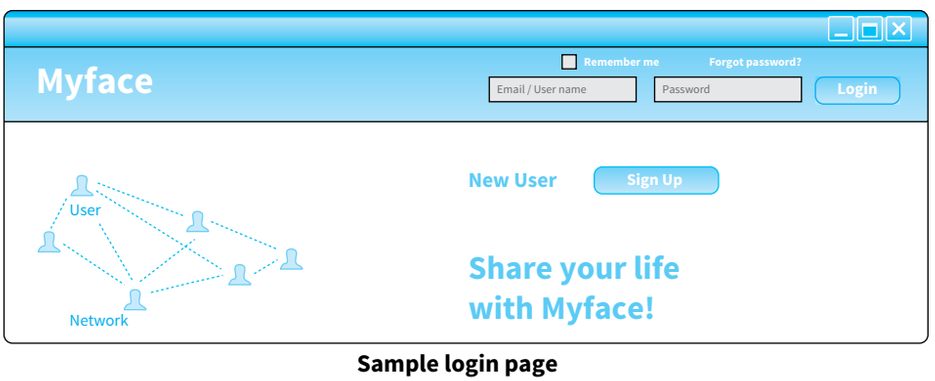
Wikis

'Wiki' means fast in Hawaiian. ***Wikis*** are a type of software which allows a user to create and edit web pages using any available web browser. They support the use of hyperlinks and have a very simple syntax (rules) for page creation. Example of wiki: *wikipedia*.

Contents of wikis should be treated with some caution since anyone can create or edit them.

Social networking sites

These sites are designed to promote the building of online communities who in general share the same interests and activities. They are aimed primarily at the younger generation who like to share photos, videos, music, favourite foods and so on.



Sample login page

They are usually free of charge and allow the interaction of people. Users can add friends, post messages to each other ('write on my wall') and update their personal profiles to notify friends about their likes and personal information, for example, *Facebook*. These sites are expanding quickly and there are some recent concerns about their safety and security.

Key Point	**They do allow easy interaction between like-minded people from different parts of the world which is a very positive move forward.**

Blogs are an abbreviation for weB LOGs.

Blogs

These are personal Internet journals where a writer (called a blogger) can write some text about a topic or person; it is even possible to include links to certain websites. No real training is needed to create a blog.

Blogs can be day-to-day gossip (for example, my favourite rock star) to serious topics such as car safety issues, politics or even to organise a protest rally. However, it is still important to remember that comments made on blogs are still subject to the usual libel laws (which vary from country to country).

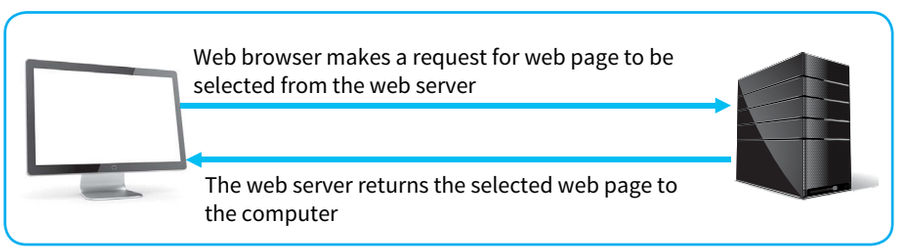
Web browsers

Web browsers are software that allow a user to display and interact with web pages and files from the Internet.

The software interprets the coding language of the websites and displays the *translation* instead of showing the *actual coding*. Consequently, a user can simply launch a web browser by clicking on the appropriate icon from the desktop and there is no need to know the commands which are required to interpret the website coding once it has been accessed. Every web browser has a screen toolbar with functions such as:

- go forward or backward to select previous sites already visited
- go to the first page since you first started to access the Internet during this session (known usually as the home page)
- save your favourite pages/websites for future use
- have the ability to view your website history.

Whenever a user clicks on or enters a *URL* (*uniform resource locator*), the web browser will request information (such as web page) from the web server selected.



The web browser will break up the typed URL into three distinct components. For example, imagine we had typed in:
http//www.cambridge.org/computer_science_revision_guide.html

Then the three parts in this URL would be:

- the protocol (i.e. http)
- the web server name (i.e. www.cambridge.org)
- the file name (i.e. computer_science_revision_guide.html).

The web browser translates the web server name into an *IP address* which is used to connect to the web server. Following the http protocol, the web browser asks for file: computer_science_revision_guide.html.

The web server returns the HTML text for the selected web page to the web browser; this reads the HTML <tags> and shows the correctly formatted page on the computer screen.

Digital media sharing websites

These websites allow users to upload video files and other multimedia files for other users to access as required.

The video files are stored on the server and allows either free access to anyone or some form of code is required before the videos can be viewed. For example, *YouTube*.

Since most users do not have unlimited web space, this type of website is becoming increasingly popular as a way of storing/archiving a number of videos.

Internet service providers (ISPs)

These are the companies that provide the user with access to the Internet. Customers normally pay a monthly fee for this service.

Once a user signs up to an Internet service provider (ISP), an account is set up and a user name and password is created. Every time the user accesses the Internet this will be via their user account; it also allows the ISP company to monitor Internet usage.

A user name and password is required each time the user accesses the ISP from a computer.

Podcasts

Podcasts are essentially a series of media files (audio and video) that are released at regular intervals and downloaded to a user's computer. Because of the method of delivery, this is a different way of accessing media files.

All of the media files are stored and maintained centrally and the listener or viewer simply employs the appropriate application software to access these files, check for updates and download new files in the given series.

Key Point	**It is possible to automatically download each episode/track of your favourite programme or artist as soon as it is made available.**

Tagging

Tagging is a type of ***bookmarking*** where a user *tags* a web page or photograph using some text to describe its contents. Anyone can view the web page or photographs corresponding to the tags.

For example, you have taken a photograph of your new car in 2010 showing Ipanema Beach in the background. Which folder do you place your photograph in so that you can easily find it again at a later stage? Tagging helps you resolve this dilemma. It is now possible to tag the photograph with key words such as: *my cars, Ipanema Beach, 2010*. So when you (or a friend) come to find this photo 2 or 3 years later, you do not have to remember where you stored it. Simply search on the tag and all the matching photos will be displayed.

Key Point	**Tagging is essentially a form of 'bottom up' classification where there is almost an unlimited number of ways to classify an item.**

Bit (data) streaming

This refers to data sent in a compressed form over the Internet that can be displayed in real time on the user's computer. The downloaded data is sent to a ***buffer***; it is not saved on the user's computer and needs to be ***streamed*** every time the video or audio file is to be accessed.

Bit (data) streaming can be either true (i.e. real time) or on-demand.

True is when the information is sent straight to the user's computer and there is no need to save it first on the website server; the data is actually streamed live (i.e. in real time).

On-demand is when the files are first saved on a hard disk on the web server and played back to the user when they are requested.

There is a need to have a media player software on the user's computer that uncompresses the data and then sends it to a buffer before being played back on a monitor or through speakers.

Key Point	**Buffering is an important component as it enables continuous playback to an acceptable standard.**

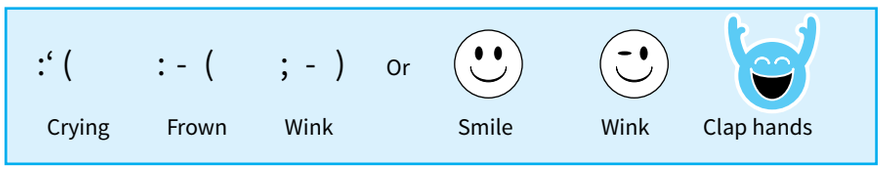
The main advantage of this is that there is no need to store media files and it is possible to always download the latest version from the central web host.

However, if the buffering is slow or the broadband connection is slow, there will be delays in the playback which can be very annoying. Many webcams also use this method to send video data over the network.

Chat rooms and instant messaging

Chat rooms use instant messaging (IM) to allow communication in real time. A user registers with a chat room and chooses a user name and password that is to be used every time the user wishes to log in to the chat room.

Once they have entered the chat room, a list of people currently online will be alerted to them. To chat, the user types into a text box and may sometimes use ***emoticons***.



The message becomes immediately visible to those online. It is possible to enter a chat room to read messages only and not contribute – this is known as ***lurking***.

As a safeguard, users of chat rooms are warned about their language and use of the facility. It is important to prevent abuse, hassling other members, etc. and there is a code of conduct which, if breached, would lead to a user being blocked from taking part in the future. A controller monitors these chat rooms to ensure that any code of practice is not breached by the users.

Instant messaging (IM) is sending real time messages to another Internet user. It is similar to chat rooms but is generally on a one-to-one basis and is therefore, more private. Instant messaging is also a faster method of communication than using emails since it is in real time.

Interactive maps

On many websites (for example, hotels, shops, or general advertising involving the whereabouts of something) interactive maps are available. These usually show 3 options:

- road maps (conventional naming of roads)
- satellite views (aerial views of the area)
- a hybrid of both the above.

Satellite maps are a bit of a misnomer since satellites currently can only pick up something about 2 square metres on the earth surface. As you ***zoom in***, at some point the satellite image is replaced with an aerial view showing the close details of the area.

The combination of aerial views and conventional maps is very useful since it gives users ‘a feel for the area’ (for example, is it built up, or are there any parks/green areas nearby?).

An example of a satellite/aerial view superimposed with traditional road mapping (option 3 on page 27) is shown below.

Satellite mapping

The most common features of interactive maps include:

- zoom in and out (shown as '+' and '–' keys on the map)
- the ability to move north, south, east and west (shown by arrow keys on the map)
- ability to get detailed directions from your house to the venue
- ability to use post code, street name or zip codes to do a search
- 'pins' to show exact locations of hotels, shops, etc.

Differences between IP addresses and MAC addresses

MAC addresses are discussed in some detail in chapter 11. A MAC (media access control) address is a unique number that identifies any device connected to the Internet. This address consists of the identity number of