1.3.5 Operating System

1.3.6 Operating systems

Learning Outcome	To Read	Have Read	To Revise	Have Revised	Prepared
1.3.6: Operating systems					
• describe the purpose of an operating system (Candidates will be required to understand the purpose and function of an operating system and why it is needed. They will not be required to understand how operating systems work.)					
• show understanding of the need for interrupts					

Software:

Data and programs of computer are known as software.

There are two main types of software: systems software and application software

System Software

System software is a software that provides platform to other software.

Systems software includes the programs that are dedicated to managing the computer itself, such as the operating system and utility software.

Operating System

An operating system (OS) is a type of system software that manages computer's hardware and software resources.

It provides common services for computer programs. An OS acts a link between the software and the hardware. It controls and keeps a record of the execution of all other programs that are present in the computer, including application programs and other system software.

Most operating systems comprise a large set of programs, only some of which are stored in the computer's memory all the time. Many of the routines available in the OS are stored on the hard drive so that they can be accessed when required. This saves space in the computer's main memory.

When you are using applications software, you are not communicating directly with the computer hardware. Your applications software communicates with OS program modules that communicate with the computer hardware on its behalf. Without an operating system, a computer is useless no matter how many programs you have.

Why an operating system is need?

An **operating system** is the most **important** software that runs on a **computer**. It manages the **computer's** memory and processes, as well as all of its software and hardware. It also allows you to communicate with the **computer** without knowing how to speak the **computer's** language. The hardware is unusable without an OS. Operating system hides complexity of hardware from user. It acts as an interface/ controls communications between user and hardware, hardware and software. It provides software platform / environment on which other programs can be run.

Do all computer need operating system?

Not all computers have operating systems. The computer that controls the microwave oven in your kitchen, for example, doesn't need an operating system. It has one set of tasks to perform, very straightforward input to expect (a numbered keypad and a few pre-set buttons) and simple, never-changing hardware to control. For a computer like this, an operating system would be unnecessary baggage, driving up the development and manufacturing costs significantly and adding complexity where none is required. Instead, the computer in a microwave oven simply runs a single hard-wired program all the time.

The management tasks performed by the operating system are

1. **Memory Management**: The OS keeps track of every memory location and is responsible for making memory available for different processes, such as allocating free space in memory to programs. The OS also deals with virtual memory and swapping pages in and out of RAM.The OS keeps track of the primary memory and allocates the memory when a process requests it.

- Memory protection to ensure that two programs do not try to use the same space
- Use of virtual memory
- Deciding which processes need to be in main memory at any one time
- Location of processes within the memory
- By example, e.g. when process terminates, memory is made available

2. File Management: Allocates and de-allocates the resources and decides who gets the resources.

- Maintains directory structures
- Provides file naming conventions
- Controls access

3. Security: Prevents unauthorized access to programs and data by means of passwords.

- Makes provision for recovery when data is lost
- Provides usernames and passwords /encryption / user accounts
- Prevents unauthorised access
- Ensures privacy of data

4. Hardware Management

Programmers write software and users run this software. The software uses the hardware. The operating system has to ensure that the hardware does what the software wants it to do. Program development tools associated with a programming language allow a programmer to write a program without needing to know the details of how the hardware, particularly the processor, actually works. The operating system then has to provide the mechanism for the execution of the developed program.

5. Process /resource management

A program, during execution is referred as a process. Many process are running in computer at a time and each process needs access to computer resources.

The OS must manage the physical resources of the computer. Some resources are limited and must be managed to maximise the use of the computer system:

- A simple system has only one processor.
- Secondary storage is of a fixed size.
- Some input/output devices (e.g. printers) are shared.

Following process management tasks are done by operating system:

- Scheduling of processes / multi-tasking / multi-programming etc.
- Resolution of conflicts when two or more processes require the same resource

6. Provision of a software platform/ environment

- The OS provides a platform on which the applications software can run.

7. Interrupt handling

Interrupts are signals sent be a hardware or a software or a user to seek attention of operating system. Interrupts are handled by operating system like:

- Identifies priorities of interrupts
- Save current memory / process values /saves data on power outage
- Loads appropriate Interrupt Service Routine (ISR)

8. User- system interface

The OS provides a means of communication (the user interface) between the human user, or the outside world, and the computer. A user interface is needed to allow the user to get the software and hardware to do something useful. An operating system should provide at least the following for user input and output:

• a command-line interface

• a graphical user interface (GUI).

9. **Error-detecting Aids:** Production of dumps, traces, error messages, and other debugging and error-detecting methods.

10. **Scheduling:** The OS schedules process through its scheduling algorithms.

11. Device management

Every computer system has a variety of components that are categorised as 'devices'. Examples include the monitor screen, the keyboard, the printer and the webcam. The management of these requires:

- installation of the appropriate device driver software
- control of usage by processes.

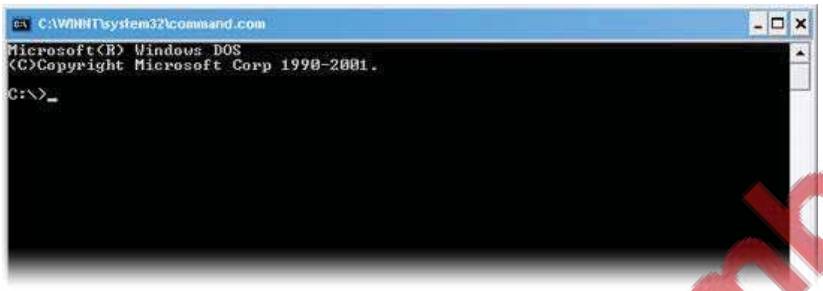
User interface

A user interface, or human-computer interface (HCI), consists of all the hardware and software through which a user provides input to a computer or receives information from it. Types of user interface controlled by the OS include:

- **Command Line Interface**
- **A Graphical User Interface**:

A Command Line Interface (CLI):

A command-line interface allows the user to interact with the computer by typing in commands. The computer displays a prompt, the user keys in the command and presses enter.
In the early days of personal computers, all PCs used command-line interfaces.



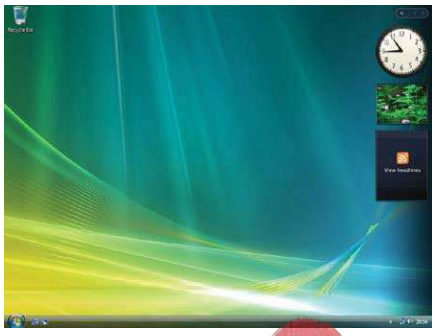
Features of a command-line interface

- Commands must be typed correctly and in the right order or the command will not work.
- Experienced users who know the commands can work very quickly without having to find their way around menus.
- An advantage of command driven programs is that they do not need the memory and processing power of the latest computer and will often run on lower spec machines.
- Command driven programs do not need to run in Windows.
- A command-line interface can run many programs, for example a batch file could launch half a dozen programs to do its task.
- An inexperienced user can sometimes find a command driven program difficult to use because of the number of commands that have to be learnt.

An example of a common command driven interface is **MS-DOS**. The MS-DOS command to display all files on c:\ would be: **dir c:**

A Graphical User Interface:

Graphical user interface is sometimes shortened to **GUI**. The user chooses an option usually by pointing a mouse at an icon representing that option.



Features of GUIs include:

- They are much easier to use for beginners.
- They enable you to easily exchange information between software using cut and paste or 'drag and drop'.
- They use a lot of memory and processing power. It can be slower to use than a command-line interface if you are an expert user.
- They can be irritating to experienced users when simple tasks require a number of operations.

When discussing user interfaces, it is important to note that Windows XP, Windows Vista, Apple OSX and Ubuntu all have **graphical user interfaces**.

A Menu Driven Interface:

The user is offered a simple menu from which to choose an option. One menu often leads to a further menu. Part of the screen may have an instruction followed by a numbered list of options to choose from.

```
Select an option:

1. Start in MS DOS mode
2. Start Windows
3. Run system check
4. Shut down and log off
```

Peripheral device control

Methods of communication between the OS and peripheral devices include the use of:

- **Buffers:** Temporary memory area in memory used to compensate the difference in speed of two devices.
- **Spooling:** Acronym for ***s****imultaneous* ***p****eripheral* ***o****perations* ***on-line****, spooling* refers to putting jobs in a buffer, a special area in memory or on a disk where a device can access them when it is ready. Spooling is useful because devices access data at different rates.
- **Interrupts**: A signal sent from a peripheral device (hardware) or program event (software) to the printer to indicate that the sender needs attention.
- **Polling**: The process carried out by an operating system of periodically interrogating each peripheral device in turn to discover whether it needs the attention of operating system.
- **Handshaking**: The process by which two devices negotiate the protocol, (rules) they will use to communicate for the rest of the session, or signal their readiness to send or receive data.

Topical Questions from Past Papers

Summer 2014 P11:

(a) (i) A student wrote: "batch processing can be used when making airline bookings".
Why is this statement incorrect? [1]

.....

.....

.....

.....

(ii) The same student also wrote: "to launch an application, a graphical user interface (GUI) requires typing the name of the application using a keyboard".
Why is this statement incorrect?

.....

....[1]

(b) A user interface is a function of a typical operating system.

Write down four other functions of a typical operating system.

1: .....

2: .....

3: .....

4: ..... [4]

Q2) Summer 2011

Most operating systems provide a user interface.
(a) User interfaces can be either command line interfaces (CLI) or graphical user interfaces (GUI).
Give ONE advantage and ONE disadvantage of both types of interface.
Advantage CLI: .....
Disadvantage CLI: .....
Advantage GUI: .....
Disadvantage GUI: .....[4]

(b) Give THREE other tasks carried out by an operating system.

1: .....
2: .....
3: .....[3]

Q3) 9691_13w_qp11

(a) What is meant by an interrupt?

……

…… ……[1]

(b) A user starts the printing of a document, and then carries on editing a second document while printing continues.

Explain how interrupts make this possible.

……

……

……

…… [4]

(c) Once a week the user runs a virus checker.
What action will be taken if the virus checker detects a virus in a file?

……

…… [2]

(d) The computer is running a single-user operating system.
Describe what this means.

……

…… [2]

Q4) 9691_13s_qp11

(a) Describe the terms buffer and interrupt.

Buffer: _____

_____ [2]

interrupt: _____

_____

_____ [2]

(b) (i) Explain the role of the buffer and interrupts when a large document of over 200 pages is sent to a laser printer.

_____

_____ [3]

(ii) The use of two buffers would speed up the printing process. Explain why.

_____

_____

_____ [2]

1 **(a)** **buffer** – any **one** from:
temporary storage area used to hold data before being transferred
allows for difference in working speeds (of processors and peripheral devices)

interrupt – any **one** from:
signal sent to the processor/CPU (which causes break in the execution of current routine) [2]

(b) **(i)** Any **three** points from:

data is transferred from (primary) memory to printer buffer
when the buffer is full, the processor can carry on with other tasks
printer buffer is emptied to printer
when printer buffer is empty, printer sends an interrupt to the processor
requesting more data to be sent
according to priorities [3]

(ii) Any **two** points from:

first (block) of data sent to the *first* buffer
whilst this data is being printed by the printer
next block of data is sent to the *second* buffer
when the *first* buffer is empty
data from the *second* buffer is then printed
meanwhile more data is then sent to the *first* buffer
this continues until all data has been processed by the printer [2]

Topical Past Papers

Q 1) Winter 2015 P11

4 Six computer terms and six descriptions are shown below.
Draw a line to link each term to its appropriate description.[5]

Browser	Signal sent to a processor which may cause a break in execution of the current routine, according to priorities
HTML	Company that provides individual's access to the Internet and other services such as webhosting and emails
Internet service provider	Software application used to locate, retrieve and display content on the World Wide Web e.g. web pages, videos and other files
Interrupt	Hardware identification number that uniquely identifies each device on a network; it is manufactured into every network card and cannot be altered
IP address	Authoring language used to create documents on the World Wide Web; uses tags and attributes
MAC address	Location of a given computer/device on a network; can be a static or dynamic value

Examiners' Comments Question 4

Many candidates demonstrated a good level of knowledge about the computer terms, correctly matching a term to the most suitable definition.

8 State **three** features of a typical operating system.

1: .....
.....
2: .....
.....3: .....
.....
.....[3]

Examiners' Comments Question 8

Most candidates were able to state one feature of an operating system, this was most commonly that it provides a user interface. Some were able to give two, but very few candidates could provide three.

Q 2) Summer 2016 P11 & P13

4 (a) Nikita wishes to print out some documents and connects her printer to the computer using one of the USB ports.

(iii) The printer runs out of paper while it is printing the documents. A signal is sent to the processor to request that the problem is dealt with.

Name this type of signal.

.....[1]

Q 3) March 2017 India

6 The diagram shows **five** operating system functions and **five** descriptions.

Draw a line between each operating system function and its description. [4]

Function	Description
Interrupt	Many processes appear to run simultaneously
Utility	Data are temporarily held in a buffer waiting for an output device to access it
Memory management	A signal that causes the operating system to take a specified action
Spooling	A program that performs a specific task required for the operation of a computer system
Multitasking	A process of assigning blocks of memory to programs running in a computer

Examiner Report

Nearly all candidates identified the correct description for most of the operating system functions. Common errors included mixing up, 'Interrupt', 'Memory management' and/or 'Spooling'

Q 4) Winter 2017 P12

6 Selma writes the following **four** answers in her Computer Science examination.

State which computer terms she is describing.

"It is a signal. When the signal is received it tells the operating system that an event has occurred."

Selma is describing .....

"It takes source code written in a high level language and translates it into machine code. It transla tes the whole of the source code at once."

Selma is describing .....

"The part of the central processing unit (CPU) that carries out calculations."

Selma is describing .....

"When data is transmitted, if an error is detected in the data received a signal is sent to ask for the data to be retransmitted. This continues until the data received is correct."

Selma is describing .....[4]

Q 5) March 2018 P12 (India)

13 State **four** functions of an operating system.

Function 1 .....

.....

Function 2 .....

.....

Function 3 .....

.....

Function 4 .....

.....[4]

Comments on Question 13

Many candidates provided a good level of knowledge about the functions of an operating system.

Q 6) Winter 2018 P12

8 Describe the purpose of an interrupt in a computer system.

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.....

.....

.....

.....

.....

.....

.....[4]

Q 7) Winter 2019 P13

7 (b) Computer systems often use interrupts.

Five statements are given about interrupts.

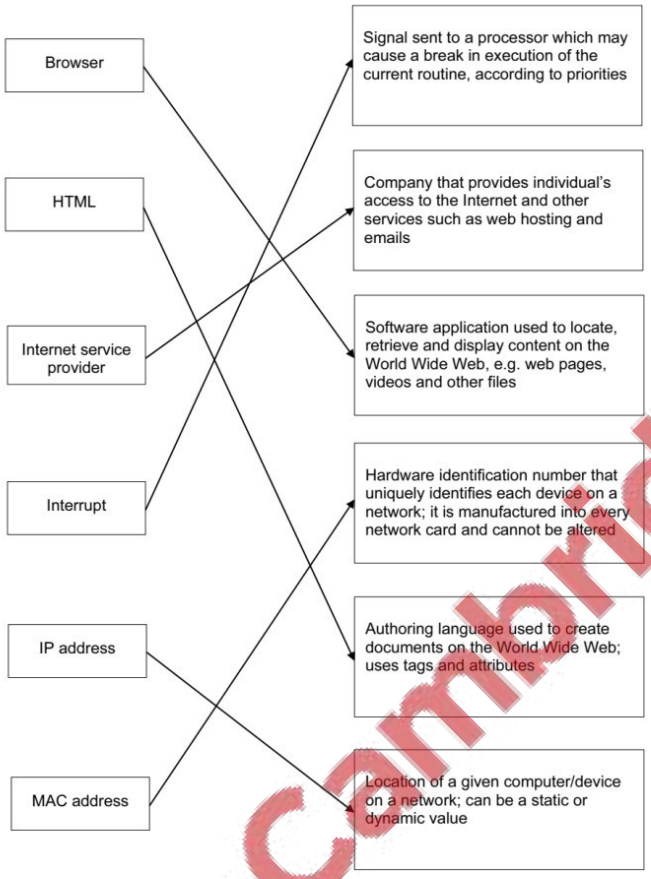
Tick (✓) to show if each statement is **True** or **False**. [5]

Statement	**True (✓)**	**False (✓)**
Interrupts can be hardware based or software based		
Interrupts are handled by the operating system		
Interrupts allow a computer to multitask		
Interrupts work out which program to give priority to		
Interrupts are vital to a computer and it cannot function without them		

Marking Scheme

Q 1) Winter 2015 P11

4

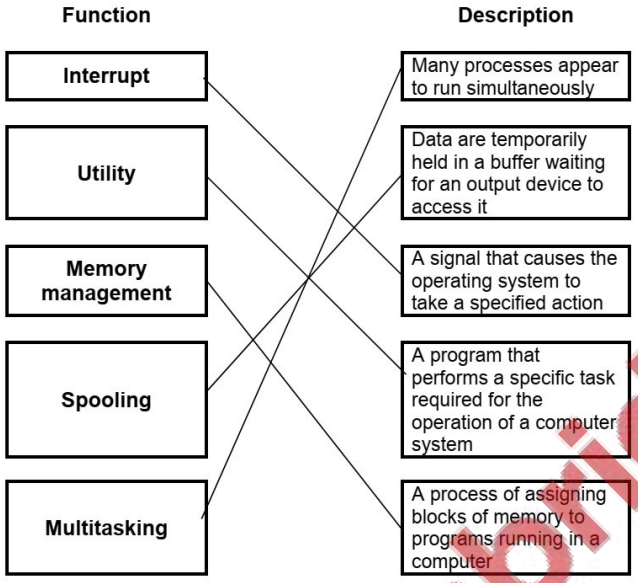


8 Any **three** from:
- provides a user interface
- input/output control/handling
- security
- (handling) interrupts
- spooling
- memory management
- processor management
- utilities (e.g. copy, save, delete, rename, etc.)
- maintain user accounts
- load/run software
- error reporting/handling
- multiprogramming
- batch processing/JCL
- multitasking

Q 2) Summer 2016 P11 & P13

(iii) interrupt [1]

Q 3) March 2017 India

Question	Answer	Marks
6	1 mark for each correctly drawn line from a function to its description to a maximum of 4 	4

Q 4) Winter 2017 P12

6	1 mark for each correct term, in this order: ∞ Interrupt ∞ Compiler ∞ ALU/Arithmetic and Logic Unit ∞ ARQ/Automatic repeat request	4

Q 5) March 2018 P12 (India)

Question	Answer	Marks
13	Any **four** from ∞ (Provides an) interface ∞ Loads / opens / installs / closes software ∞ Manages the hardware // manages peripherals // spooling ∞ Manages the transfer of programs into and out of memory ∞ Divides processing time // processor management ∞ Manages file handling ∞ Manages error handling / interrupts ∞ Manages security software ∞ Manages utility software ∞ Manages user accounts ∞ Multitasking // Multiprocessing // Multiprogramming // Time slicing ∞ Batch processing // real time processing	4

Q 6) Winter 2018 P12

Question	Answer	Marks
8	**Four** from: ∞ Used to attend to certain tasks/issues ∞ Used to make sure that **vital** tasks are dealt with **immediately** ∞ The interrupt/signal tells the CPU/processor (that its attention is required) ∞ A signal that can be sent from a device (attached to the computer) ∞ A signal that can be sent from software (installed on the computer) ∞ The interrupt will cause the OS/current process to pause ∞ The OS/CPU/ISR will service/handle the interrupt ∞ They have different levels of priority ∞ After the interrupt is serviced, the (previous) process is continued ∞ It enables multi-tasking to be carried out on a computer ∞ A valid example of an interrupt e.g. 'out of paper' message for a printer	4