Module 1 – Basic Computing Concepts

(Intermediate-level)

Basics of Computing

Hardware, Software, Data and Information

Raw data can only become meaningful (becomes information) once we start processing, organising and interpreting it. For example, an image file and a sound file contain data that is meaningless unless we know how that data is stored in the file (how it is organised) and what each piece of data (bits or bytes) signifies.

Data: raw facts that can be shaped and formed to create information.

Information: data that has been shaped by humans into a meaningful and useful form.

Knowledge: the stock of conceptual tools and categories used by humans to create, collect, store, and share information.

Introduction to Basic Business Systems and the Types/Categories of Software

A basic business system is an information system that serves the elementary day-to-day activities of an organisation (e.g. sales, receipts, cash deposits, credit decisions, flow of materials in a factory). Since ISs involve transactions, basic business systems are sometimes also referred to as transaction processing systems.

A basic business systems allows an organisation to perform its activities more efficiently and let management make important decisions based on the information the system provides. Sometimes the introduction of such systems can have far-reaching strategic consequences: the SABRE and Apollo systems for processing airline reservations gave American and United Airlines a lead in the computerized airline reservation market.

The software that makes up basic business systems can be very different (i.e., we can distinguish between very different applications). Examples include:

> Process Control software: monitors ongoing physical production processes (e.g. the production of paper, food products, and chemicals)
>
> Office Automation software: creates and processes information to increase the productivity of office workers (e.g. spreadsheets and wordprocessors)
>
> Industrial and Commercial/Financial software: e.g. CAD, CAM, Credit Card payments

Multimedia software: e.g. audio and visual editing, Graphics Design, Authoring tools (software that enables one to compose a document by means of linking objects, e.g. for e-learning purposes, and often include scripting languages such as Presenter 09 and Articulate Online from Articulate).

Sometimes the different applications are used together to form other more complicated systems, e.g. a Manufacturing System could include software for quality control, process control, numerical machine control (CAM), labour costing, purchasing, etc.

Evolution of Computer Systems

Classification and Generations of computers

Computers can be broadly classified as:

Mainframe computers – large computers generally (traditionally) used by large businesses and, for example, by the military. Can support hundreds of users.

Minicomputers – medium-sized computers generally (traditionally) used by universities or research laboratories, but also by small businesses. Can support, e.g., between 10 to 20 users, but can be expanded to support more users.

Personal computers – small desktop, portable or laptop computers used by individuals, schools, or small companies, especially when networked together. Also referred to as microcomputers.

In addition, we sometimes speak of generations of computers *as a convenient means of distinguishing between advances in computer technology*. Thus,

First Generation (c. 1946-1958): the early computers that used electronic valves (vacuum tubes). Very large, consumed enormous power and generated a lot of heat. Also, were rather unreliable. Example: ENIAC and UNIVAC I. Input and output was on punched card and paper tape.

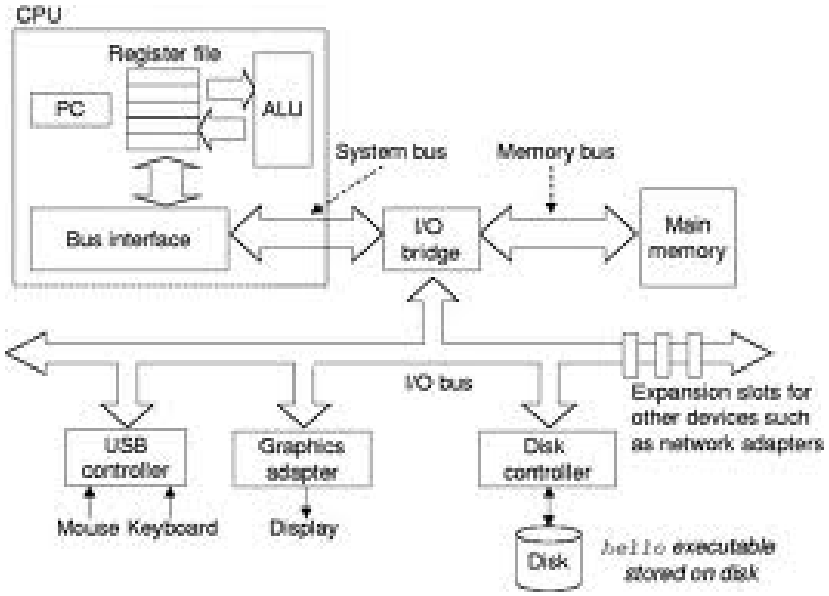
Second Generation (c. 1959-1964):used transistors and core memories. Transistors were faster, more reliable, smaller and cheaper to build than vacuum tubes. One transistor replaced the equivalent of 40 tubes. The transistor was invented in 1947 by 3 scientists, **John Bardeen**, **William Shockley**, and **Walter Brattain** working at **AT&T's Bell Labs**. First high-level programming languages and operating systems began to appear.

Third Generation (c. 1965-1970): used integrated circuits. It was the beginning of miniaturization. Thousands, and later milliions of transistors could be fitted in one IC. The IC (sometimes referred to as semiconductor chip) packs a huge number of transistors onto a single wafer of silicon. **Robert Noyce** of **Fairchild Corporation** and **Jack Kilby** of **Texas Instruments** independently discovered the amazing attributes of ICs. Placing such large numbers of transistors on a single chip vastly increased the power of a single computer and lowered its cost considerably. The first minicomputers were beginning to appear.

Fourth Generation (c. 1971-today): use microprocessors. A microprocessor is a complete processor placed on a single chip. Techniques known as large-scale and very-large-scale integration (LSI, VLSI) for producing integrated circuits were used. By putting millions of transistors onto one single chip more calculation and faster speeds could be reached. Since electricity has a finite speed—it travels about a foot in a billionth of a second—the smaller the distance (i.e. the smaller the size of the circuit) the greater the speed of computers. **Ted Hoff**, employed by **Intel** (**Robert Noyce's** new company) created the first microprocessor.

Components of a Computer System

Simple Block Diagram



The von Neumann Architecture and Its Significance

Aside from the internal storage of programs (i.e. programs would be stored in a memory – the *stored-program concept*), a major characteristic of a von Neumann computer is that *the units that process information are separate from those that store it*. Typically there is only a single communications channel between these two units (the processing unit and the memory unit), through which all transfers of information must go (the so-called von Neumann Bottleneck).

The main characteristic therefore is that instructions and data are stored in the same memory device, *from which any datum can be retrieved as quickly as another*. An instruction would be fetched from memory, decoded (i.e. determine what the instruction should do) and then executed (the fetch/execute cycle).

Practically all computers are based on the von Neumann architecture, which have the following 3 characteristics:

> A computer constructed from four major subsystems: the memory, input/output, the ALU and the control unit.
>
> The stored program concept, in which the instructions to be executed are represented as binary values stored in memory.
>
> The sequential execution of instructions (the fetch/execute cycle).

Difference between Parallel and Serial Data Transmission

Data can be transmitted as a series of bits (serially, one at a time), or in parallel (as a group of bits, for example 8 bits, or 16 bits, etc. at a time). When long distances are involved (e.g. telecommunications or transmission over a wide area computer network), serial transmission is used. In addition, a technique known as modulation (where the digital signal is first converted into an analogue signal and the analogue signal is then modulated – i.e. the waveform is modified to carry information) is used for long-distance data communications. Inside the computer data is sent in parallel over data buses.

Application and System Software

A computer program is a set of instructions held in the computer's memory which the computer is told to execute in order to produce a desired result.

A computer program can be very simple (a few lines of code) or very complex (millions of lines of code). Instead of computer programs we often talk about software. Very broadly, we distinguish between System Software and Application Software. System Software is software that is required by the computer to function, software that lets a user operate the computer, for example the Operating System. Application Software lets user do tasks which are independent of the O/S and are written to solve particular problems. They involve a variety of applications (e.g. commercial data processing; technical, mathematical or scientific uses; leisure and home use; etc.)

Apart from (or as part of) the operating system, system software can include:

> Utility programs: e.g. disk formatting, file transfer, CPU usage, date & time setting, etc.
>
> Library programs: e.g. a set of programs used for frequently required tasks, that could include utility programs. Library programs can usually be referenced and incorporated into a user's program (e.g. DLLs).
>
> Language translators: e.g. assemblers and compilers (to produce and maintain software – they convert the high-level instructions into machine code).

Algorithms

An algorithm is a prescribed set of well-defined rules (or instructions) for the solution of a problem (such as the performance of a calculation) in a finite number of steps. An algorithm may be expressed textually (e.g. using pseudo code) or diagrammatically (e.g. using a flowchart). Algorithms are extremely important to explain and break down a problem when designing a computer program.

Example of a simple algorithm to calculate the average kilometers per litres:

Step	Operation
1	Get values for *litres used*, *start kilometers*, *end kilometers*
2	Set *distance driven* to (*end kilometers – start kilometers*)
3	Set *average kilometers per litre* to (*distance driven* / *litres used*)
4	Print *average kilometers per litre*
5	Stop

The above is an example of a purely sequential algorithm. Apart from sequence, algorithms involve conditional and iterative (repetitive) operations. Sequence, condition and iteration are the three flows of programs (and algorithms). Conditional and iterative operations are also called control operations: *they allow us to alter the normal sequential flow*.

Example of an alogrithm that makes use of the three constructs of sequence, condition and iteration
(Algorithm to print the squares of integer numbers. The algorithm will only print even values of squares that are less than one hundred.)

```
Set n = 1
square = n*n
while (square < 100) do
        If ( (square div 2) is equal to 0 ) do          remark: if remainder on division = 0
                        display value of Square
                End if
        n = n + 1
        square = n*n
  End while
```

An important exercise that is often carried out is algorithm analysis to study the performance of algorithms. For example, the algorithm given above is not particularly efficient: there are other algorithms that can execute faster. When programs are complicated and involve a lot of repetitions, it is important to analyse the algorithm that is being proposed, not only for speed of execution but also for the use of computer memory.

Note: the “while” construct is used to check a condition at the start of the loop, whereas the “repeat” construct (or its equivalent – e.g. the do{}while() in Java) tests the condition at the end of the loop (i.e. the statements inside the “repeat” will always be executed at least once. (More about algorithms will be done as part of the Data Structures module).

E-Learning

Electronic learning is a complimentary form of learning. For this type of learning, a virtual learning environment (VLE) is used. A VLE may be described as a computer system (mainly software) designed to support teaching and learning in an educational environment. It is interactive and normally works over the Internet. A VLE provides a collection of tools for assessment, communication, uploading of files, and general administration of student groups. New features include wikis, blogs, RSSs and 3D virtual learning spaces. VLEs are often used to supplement face-to-face classroom learning (= Blended Learning).

There are advantages and disadvantages of e-learning compared with traditional, face-to-face, learning. Advantages include:

- *Tutors can track students (example, when & how often students use the VLE).*
- *Encourages collaboration and communication.*
- *Course information available in one place.*
- *Facilitates signposting (example, links to other material, i.e. widens access to material).*
- *Saves time (example, no photocopies for distribution are required).*

Disadvantages (compared with face-to-face learning) include:

- *Can become a 'dumping ground' for materials not designed to be delivered online.*
- *Copyright and IPR of materials need to be considered.*
- *Off campus access to hardware and networks can beproblematic and raises issues of equality.*
- *Need to plan online support carefully to avoid overload.*

Today a number of VLEs exist, for example WebCT, BlackBoard, and Moodle. Some of the VLEs are open source (i.e. the software is freely available and the source code can even be modified), whereas others are commercial (or proprietory).

Electronic Activities

Electronic activities include E-mail, E-Commerce, E-Business, and Remote Access.

E-mail

This is the sending of plain text messages and the attachment of files (document files, images, etc.)

E-Commerce

This involves business to consumer communication, for example, purchasing items on-line.

E-Business

This involves business to business communication, for example, electronic funds transfer (EFT).

Remote Access

This involves getting access to a computer system remotely, for example logging on to a university computer (or a company computer) from your PC at home (or wherever).

Social Implications of Computers

Computer-related Crime

Computer-related crime can involve different forms of activity, for example: computer fraud, hacking, and creating viruses.

Computer Fraud

Computer fraud is the attempt to secure some form of unauthorised and unwarranted financial benefit. Given that banks and other financial institutions were amongst the first large-scale computer users in the private sector the early cases of computer fraud involved these institutions. However attempts to target financial institutions are relatively rare: with customers now engaged in onlin banking, it it the customers that are becoming the target for attempts at fraud. For example identity theft, whereby the fraudsters steal sufficient information about individuals to be able to use it to obtain goods or services such as loans or credit cards (masquerading as other individuals). Phishing is one way of illegally obtaining personal information. It often involves sending emails to thousands of addresses at random, purporting to come from a financial institution and asking the recipients to supply personal details. A Trojan Horse attack is another method: it attempts to install software on the victim's computer that will examine what the victim types in (by connecting the victim's computer to some special website).

Hacking

Hacking involves the act of obtaining unauthorised access to a computer system, often by means of a telecommunications connection from another computer. Even if hacking is done purely to prove one's own ability at gaining access, it can still lead to conviction.

Viruses

A computer virus is essentially malicious software which replicates itself on a computer. A virus can be transmitted either as the result of the exchange of infected I/O storage devices (e.g. memory sticks), or transmitted when visiting a website, or by means of email attachments. Viruses that spread vary rapidly can be very costly to businesses because of the computer downtime required in order to recover from the attack.

Denial of Service Attacks

In the case of some viruses such as 'Melissa' (Spring 2000) and the 'I Love You' attachment (also in 2000), the main consequence has been to create such a surge in the volume of email traffic that network performance has been significantly degraded. A denial of service attack is very similar. Often aimed at businesses engaged in e-commerce, the aim is to generate a huge volume of spurious messages that the victim site becomes clogged up and will be unable to accept more messages. (The technique is analogous to repeatedly dialling someone's telephone number with the intent of occupying the line so that other callers cannot get through).

National and International Responses to Computer Crime: Legislation

Originally, computer criminals were prosecuted under normal criminal acts (such as the UK's Criminal Damage Act of 1971). However, beginning from the 1980s a trend began for the adoption of *computer-specific statute* (law). For example, in the US, the first law to be enacted was called the Computer Fraud and Abuse Act (of 1984). Other countries followed suit. More recently (from about 2000) the European Union also began addressing the problem of computer crime by proposing what legislative measures EU members should take.

In Malta, a Computer Misuse Bill was passed in 2001 to combat computer-related crime. The Maltese Criminal Code was amended in order to introduce computer misuse as a criminal offence. Important amendments included the unauthorised access to data; unauthorised prevention or hindrance of others from accessing data; unauthorised destruction or transfer of data; and unauthorised use of other persons' passwords or access codes. Contravention of any of these acts carries a maximum penalty of over one hundred thousand Euros, and up to ten years of imprisonment.

Privacy of Data

Data Protection Act – Maltese Legislation

Legislation was also passed in 2001 when the Data Protection Act 2001 was endorsed and put into force in 2003. Based on the EU Directive on data protection, this act aimed to build the public's trust by outlining the rights of the individual and providing help—through the Data Protection Commissioner—on how to safeguard one's rights. The requirements and criteria for the processing of personal data—nine data protection principles (for example, processing of data fairly and lawfully; in accordance with good practice; etc.)—are clearly indicated in Part III of the Act, article 7 (*Data Protection Act 2001*).

Web 2.0

Web 2.0 is the term given to describe what may be considered a second generation of the World Wide Web *that is focused on the ability for people to collaborate and share information online*. Web 2.0 basically refers to

the transition from static HTML web pages to a more dynamic Web that is meant to be more organized and is based on serving Web applications to users. The traditional WWW has retroactively referred to as Web 1.0.

Originally, data was posted on Web sites, and users simply viewed or downloaded the content. Increasingly, users have more input into the nature and scope of Web content and in some cases exert real-time control over it. For example, users can now upload book reviews as well as find rare and out-of-print books at a minimum price, and dynamic encyclopedias such as Wikipedia allow users to create and edit the content of a worldwide information database in multiple languages. Internet forums have become more extensive and led to the proliferation of blogging. The dissemination of news evolved into RSS.

There is no clear-cut demarcation between Web 2.0 and Web 1.0 technologies. The distinction is, to a large extent, subjective. Here are a few characteristics often noted as descriptive of Web 2.0:

- blogging
- Ajax and other new technologies
- Google Base and other free Web services
- RSS-generated syndication
- social bookmarking
- mash-ups
- wikis and other collaborative applications
- dynamic as opposed to static site content
- interactive enccyclopaedeas and dictionaries
- ease of data creation, modification or deletion by individual users
- advanced gaming.

Plagiarism

According to some dicitionaries, to “plagiarise” means:

- to steal and pass off (the ideas or words of another) as one's own
- to use (another's production) without crediting the source
- to commit literary theft
- to present as new and original an idea or product derived from an existing source.

In other words, *plagiarism is an act of fraud*. It involves both stealing someone else's work and lying about it afterward. This means that to avoid plagiarism you must write (describe/explain something, etc.) in your own words and *cite sources* wherever necessary.

Computer Language Translation

Objectives of Language Translation

Programming languages are used to write programs in either assembly language or a higher-level language such as Pascal, C and Java. Apart from an editor to enable the programmer to key in the source program, a language translator (an assembler, an interpreter, or a compiler) contains a translator progam that converts the input (source code) into machine code. Apart from this, a language translator includes the following objectives:

- identify errors
- produce efficient object code
- produce a quick translation

Syntax and Semantics

The syntax of a programming language refers to the form of the language, i.e., to the grammar rules that govern that language. For example, the syntax of the while statement in Java is:

while (*condition*) {*statement 1*; *statement 2*; ... *statement n*};

The semantics refer to the meaning of the language statements. For example the statement A = B; might mean assign the value of B to A rather than the value of A to B.

The compilation process

The main stages of compilation include:

- Lexical analysis, which removes redundant text, handles simple errors, and convert lexemes to tokens (gives reserved words special codes)
- Syntax and semantic analysis
- Code optimisation, which improves on the code that is initially generated
- Final Code generation (machine code that is understood by the computer hardware and can therefore be executed)