These are Computer Science revision notes for IGCSE / GCSE to be used for mocks. Theory

1.1 Data representation

1.1.1 Binary systems

The circuits in a computer's processor are made up of billions of transistors. A transistor is a tiny switch that is activated by the electronic signals it receives. The digits 1 and 0 used in binary reflect the on and off states of a transistor.

Denary	Binary	Hex	Denary	Binary	Hex
0	0000	0	8	1000	8
1	0001	1	9	1001	9
2	0010	2	10	1010	A
3	0011	3	11	1011	B
4	0100	4	12	1100	C
5	0101	5	13	1101	D
6	0110	6	14	1110	E
7	0111	7	15	1111	F

1.1.2 Hexadecimal

Why use hex?

- Higher information density. (more information stored in fewer “digits” than binary.
- Used to simplify how binary is represented.

Therefore, It is much easier to write numbers as hex than to write them as binary numbers.
A hex digit can be any of the following 16 digits: 0 1 2 3 4 5 6 7 8 9 A B C D E F.

It is important to note that computers do not use hexadecimal - it is used by humans to shorten binary to a more easily understandable form.

Some examples of where hex is used include:

- MAC (media access control) addresses e.g F1D07654-A63C-4D82-8883-94F957F22888
- Error messages e.g. 0x8899FF
- HTML colour references e.g. #FF6600

1.1.3 Data storage

sound (music), pictures, video, text, and numbers are stored in different formats.
There are many types of file types for storing data, these may include: Mp3 for sound, Mp4 for video, JPEG for images, MIDI (Musical Instrument Digital Interface).

Compression is the method computers use to make files smaller by reducing the number of bits (1’s and 0’s) used to store the information.

Compression can be lossy or lossless. Lossless compression means that as the file size is compressed, the picture quality remains the same - it does not get worse. Also, the file can be decompressed to its original quality. Lossy compression permanently removes data.

Example of Even Parity

Byte		Parity Bit		
00000000	+	0	= 0	✓
10000001	+	1	= 3	✗
11100000	+	1	= 4	✓
10000000	+	1	= 2	✓

In even parity, the second one fails because one bit was read incorrectly, evaluating to an odd number.

A **parity bit**, or check **bit**, is a **bit** added to a string of binary code to ensure that the total number of 1-**bits**in the string is even or odd. **Parity bits** are used as the simplest form of error detecting code

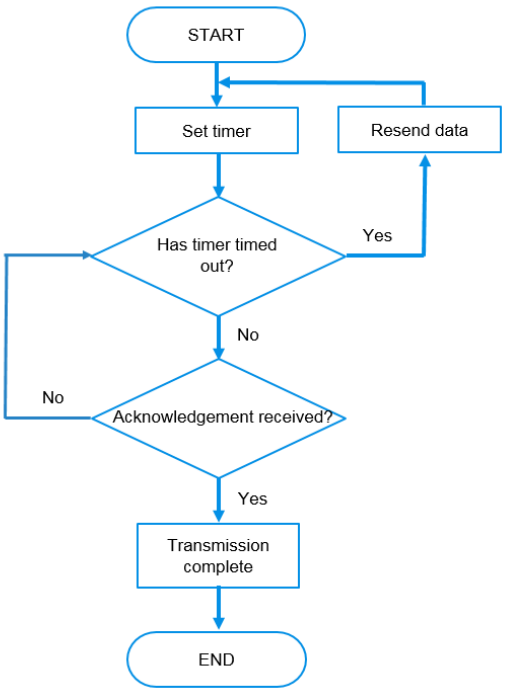
ISBN	2	0	1	0	0	2	9	0	2	0	5	1	9
Weight	1	3	1	3	1	3	1	3	1	3	1	3	
Multiplication	2	0	1	0	0	6	9	3	2	0	5	3	
Addition	Add all the numbers												31
Remainder	Find the remainder when divided by 10												1
Subtraction	Subtract the result from 10												9

The Luhn algorithm was devised as a checksum formula to ensure credit card numbers are valid when manually or automatically entered into a machine. The steps in the algorithm are as follows:

Credit Card Number	4	3	6	2	6	2	6	8	7	7	4	3	3	1	1	6
Double every other number	8		12		12		12		14		8		6		2	
Subtract 9 if number > 9			3		3		3		5							
Find sum of all digits	8	3	3	2	3	2	3	8	5	7	8	3	6	1	2	6	70

If the sum of all digits is a number divisible by 10, the number will be accepted. If not, it is rejected assuming an error in input.

A **check digit**, also known as a checksum character, is the number located on the far right side of a bar code. The purpose of a **check digit** is to verify that the information on the barcode has been entered correctly.



A ARQ flowchart shows a system of transferring data.

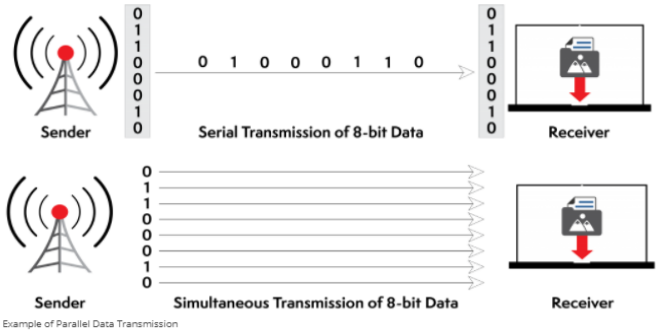
Data is sent and a timer starts when the recipient receives the data they send a confirmation back allow the next segment of data to be sent. If the timer runs out and confirmation hasn't been sent it resends the data.

1.2 Communication and Internet technologies

1.2.1 Data transmission

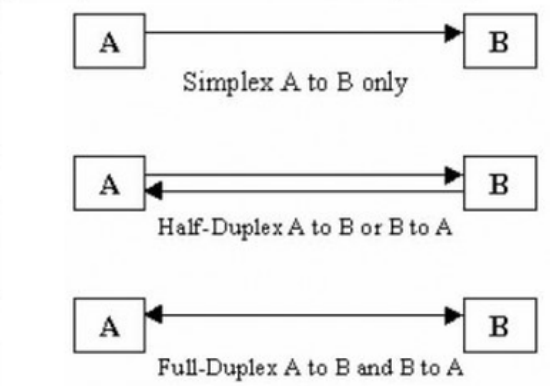
Data transmission refers to the process of transferring data between two or more digital devices. Data is transmitted from one device to another in analog or digital format.

In serial transmission, Data is organized in a specific order and is sent one bit at a time. Serial transmission is slow but reliable as data will always be in the correct order. (USBs use this)



Example of Parallel Data Transmission

In parallel data transmission, multiple bits are transmitted over multiple channels at the same time. Data is sent faster but runs the risk of becoming skewed (disordered). (Integrated Circuits use this)



In half-duplex, data can be transmitted in both directions on a signal carrier except not at the same time.
In a duplex, data can be transmitted both ways at the same time.
In simplex data can only be transmitted one way.
Data detection makes sure that the data we send to others is identical and unaltered when they receive it.

1.2.2 Security aspects

In section 1.4

1.2.3 Internet principles of operation

A web browser, or simply "browser," is an application used to access and view websites.
ISPs provide access to the Internet as well as other services including email, web hosting, and security services.

Internet is a global computer network consisting of interconnected networks using standardized communication protocols.	The world wide web (‘www’ or ‘web’ for short) is a collection of webpages found on the internet.

HTML (hypertext markup language) is a markup language that tells a browser how to display a document in the form of a website that makes sense to the user. It allows the browser to identify document heading, lists, paragraphs, and so on.

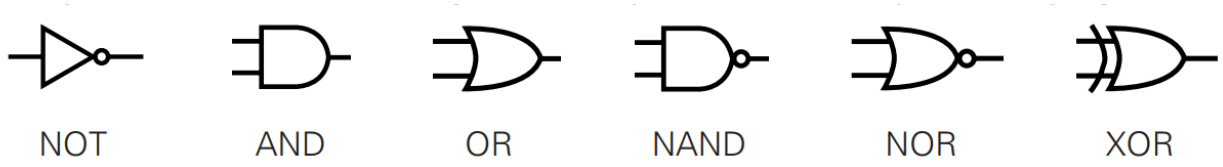
HTTP is a Hypertext transfer protocol. Simply put - Rules to sending, formatting, and receiving text-based messages.
HyperText Transfer Protocol Secure (HTTPS) is the secure version of HTTP, the protocol over which data is sent between your browser and the website that you are connected to. It means all communications between your browser and the website are encrypted.

The structure consists of the mandatory parts of an HTML document plus the semantic and structured markup of its contents. Presentation is the style you give the content (mainly how it looks).

MAC addresses are unique codes assigned by a manufacturer to a device.
IP addresses are unique addresses that identify a device on the Internet or a local network.
A uniform resource locator (URL) is the address (location) of a resource (websites) on the Internet.
Cookies are small pieces of data sent from a website and stored on the user computer by the users web browser.
Disadvantages- privacy of users, sometimes not secure
Advantages- more effective marketing, recalls information for logins, etc

1.3 Hardware and software

1.3.1 Logic gates



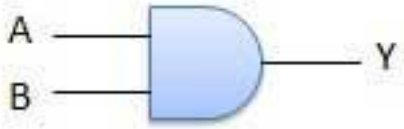
Logic gates are the basic building blocks of any digital system. It is an electronic circuit having one or more than one input and only one output. The relationship between the input and the output is based on a **certain logic**. Based on this, logic gates are named as AND gate, OR gate, NOT gate, etc.

AND Gate

A circuit that performs an AND operation is shown in the figure. It has n input (n >= 2) and one output.

Y	=	A AND B AND C ..... N
Y	=	A.B.C ..... N
Y	=	ABC ..... N

Logic diagram



Truth Table

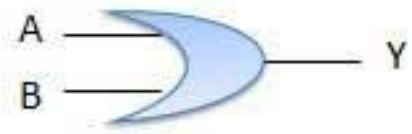
Inputs		Output
A	B	AB
0	0	0
0	1	0
1	0	0
1	1	1

OR Gate

A circuit that performs an OR operation is shown in the figure. It has n input (n >= 2) and one output.

Y	=	A OR B OR C ..... N
Y	=	A + B + C ..... N

Logic diagram



Truth Table

Inputs		Output
A	B	A + B
0	0	0
0	1	1
1	0	1
1	1	1

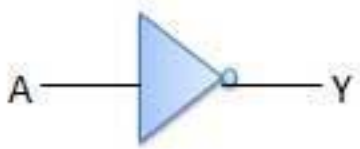
NOT Gate

NOT gate is also known as **Inverter**. It has one input A and one output Y.

Y = NOT A

$Y = \overline{A}$

Logic diagram



Truth Table

Inputs	Output
A	B
0	1
1	0

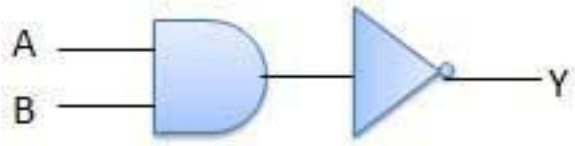
NAND Gate

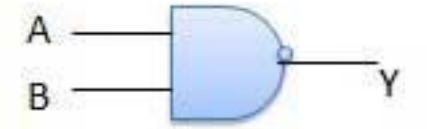
A NOT-AND operation is known as a NAND operation. It has n input (n >= 2) and one output.

Y = A NOT AND B NOT AND C ..... N

Y = A NAND B NAND C ..... N

Logic diagram





Truth Table

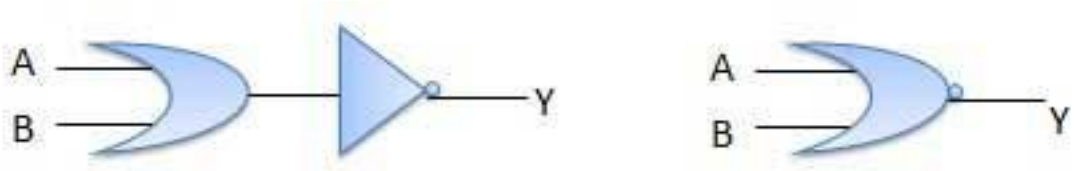
Inputs		Output
A	B	$\overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

NOR Gate

A NOT-OR operation is known as a NOR operation. It has n input (n >= 2) and one output.

Y = A NOT OR B NOT OR C ..... N
Y = A NOR B NOR C ..... N

Logic diagram



Truth Table

Inputs		Output
A	B	$\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

XOR Gate

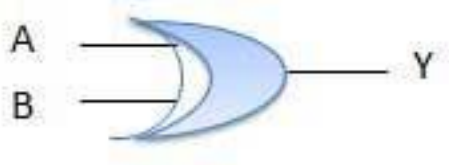
XOR or Ex-OR gate is a special type of gate. It can be used in the half adder, full adder and subtractor. The exclusive-OR gate is abbreviated as EX-OR gate or sometimes as X-OR gate. It has n input (n >= 2) and one output.

$Y = A \text{ XOR } B \text{ XOR } C \ldots\ldots N$

$Y = A \oplus B \oplus C \ldots\ldots N$

$Y = \overline{A}B + A\overline{B}$

Logic diagram



Truth Table

Inputs		Output
A	B	A ⊕ B
0	0	0
0	1	1
1	0	1
1	1	0

XNOR Gate

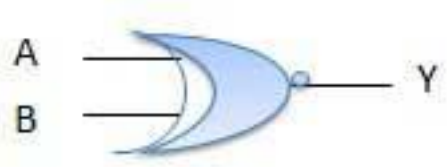
XNOR gate is a special type of gate. It can be used in the half adder, full adder and subtractor. The exclusive-NOR gate is abbreviated as EX-NOR gate or sometime as X-NOR gate. It has n input (n >= 2) and one output.

$$Y = A \text{ XOR } B \text{ XOR } C \ldots\ldots N$$

$$Y = A \odot B \odot C \ldots\ldots N$$

$$Y = \overline{A}B + A\overline{B}$$

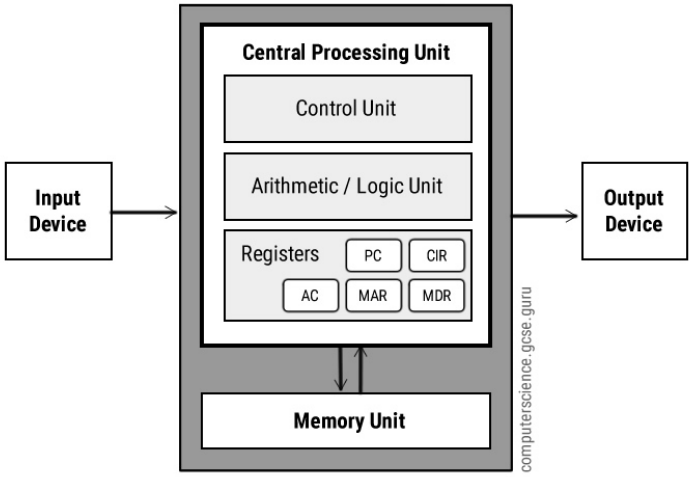
Logic diagram



Truth Table

Inputs		Output
A	B	A NOR B
0	0	1
0	1	0
1	0	0
1	1	1

1.3.2 Computer architecture and the fetch-execute cycle



Von Neumann architecture design consists of a Control Unit, Arithmetic and Logic Unit (ALU), Memory Unit, Registers, and Inputs/Outputs.
The Central Processing Unit (CPU) is the electronic circuit responsible for executing the instructions of a computer program.

Arithmetic and Logic Unit (ALU)
The ALU allows arithmetic (add, subtract, etc) and logic (AND, OR, NOT, etc) operations to be carried out.

Control Unit (CU)

The control unit controls the operation of the computer's ALU, memory, and input/output devices, telling them how to respond to the program instructions it has just read and interpreted from the memory unit. Clock speed measures the amount of functions being carried out by the CPU

Registers
Very fast small memory stores for data such as numbers

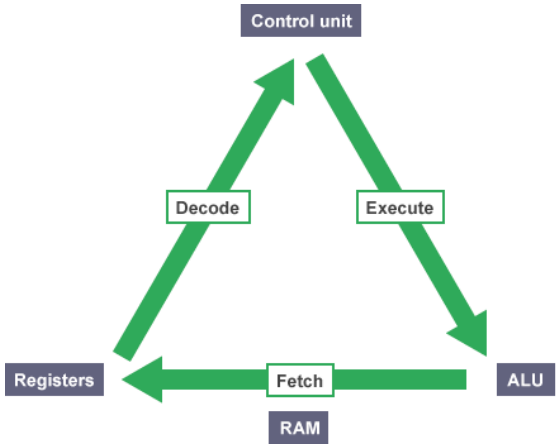
Memory Unit
The memory unit consists of RAM, sometimes referred to as primary or main memory. Unlike a hard drive (secondary memory), this memory is fast and also directly accessible by the CPU.

Buses
Buses are the wires through which data is transmitted from one part of a computer to another, connecting all major internal components to the CPU and memory.

Address Bus	Carries the addresses of data (but not the data) between the processor and memory
Data Bus	Carries the actual data between the processor, the memory unit and the input/output devices
Control Bus	Carries control signals/commands from the CPU (and status signals from other devices) in order to control and coordinate all the activities within the computer.

Summary of the fetch-decode-execute cycle

Fetch:
The CPU fetches the next instruction from the RAM (or cache)
Decode:
The CPU decodes the instruction to found out what it is asking the CPU to do
Execute:
Using the ALU the CPU carries out the task specified by the instruction. The CPU may need to fetch more data from the main memory.



1.3.3 Input devices
Input devices are peripherals used to provide data and control signals to a computer. Input devices allow us to enter raw data for processing.

- **Microphones** are input devices that take analogue sound waves and convert them into electrical signals, suitable for a computer to understand.
- **Digital cameras** are input devices that capture images (and sometimes video) digitally.
- **2D scanners** perform the task of turning a 2D document or image into a digital file.
- A **3D scanner** is an input device that creates a 3D model of the object scanned.
- Developed long before touchscreens became affordable, **interactive whiteboards** combine a large touch-sensitive board with a projection screen.
- A **barcode** is a machine-readable code represented by an image consisting of black and white lines. The lines in a barcode relate to numbers 0 to 9. Black and white surfaces reflect light differently, this is how the scanner is able to identify the corresponding digits from the lines. Scanning a barcode is easier and faster than typing in a series of numbers by hand.
- A **QR code** is a computer-generated pattern capable of holding a modest amount of data. This data is accessed when the QR code is read by a QR scanner. We often see a smartphone used as the scanning device although this doesn't have to be the case.œ
- A **touchscreen** is an electronic visual display that also incorporates an input device that responds to touch. This allows users to select options from a screen by simply touching them.

Capacitive touchscreens. Electrical current is sent from the four corners of the screen. When your finger (or stylus) touches the screen, the current changes. This allows the location of the touch to be calculated.

Benefits	Drawbacks
Good visibility in sunlight	Glass screen can shatter/break on impact
Very durable surface	Cannot use wearing standard gloves
Allows multi-touch	

Resistive touchscreens use multiple layers of material that transmit electrical currents. When the top layer of the screen is pushed/touched into the bottom layer the electrical current changes. This allows the location of the touch to be found.

Benefits	Drawbacks
Inexpensive to manufacture	Poor visibility in sunlight
Can use stylus, finger, gloved finger or pen to operate	Vulnerable to scratching
	Wears through time
	Does not allow multi-touch

Infra-red touchscreens use a pattern of LED infra-red beams to form an 'invisible' grid on the screen. Sensors detect where the screen has been touched by detecting a break in the infra-red beams. The position of touch is then calculated.

Benefits	Drawbacks

Good durability	Expensive to manufacture
Allows multi-touch	Glass screen can shatter/break on impact
Can use stylus, finger, gloved finger or pen to operate	Sensitive to dust and dirt

Sensors are input devices that record data about the physical environment around it.
Sensors send data to a microprocessor (computer). They do not make judgments, decisions or control any output devices. Sensors convert analog data into electronic signals that a computer can interpret.

1.3.4 Output devices

Display screens output information for the user to see.
LCD screens are made from millions of tiny blocks called pixels. Each pixel contains a red, green, and blue light filter which can be individually adjusted to create any color when combined.
LED screens work in a similar way to LCD screens but with one major difference, the light source. Small LED bulbs are used to provide light to the LCD pixels, not fluorescent tubes.

Data projectors are output devices used to project the digital output from a computer device onto a large screen or wall.

Inkjet printers are output devices usually used for home or small office printing.
A moving print head sprays ink droplets onto the paper from a cartridge filled with liquid ink.
Thermal bubble technology is used to fire these microscopic ink droplets from the cartridge.

Laser printers are output devices usually found in businesses and organizations. Using static electricity, the way they work is completely different from inkjet printers. It makes a laser beam scan back and forth across a drum inside the printer, building up a pattern of static electricity. The static electricity attracts onto the page a kind of powdered ink called toner. Finally, as in a photocopier, a fuser unit bonds the toner to the paper.

3D printers are output devices used to create three-dimensional objects from a 3D computer model. The computer model can be created by using a 3D scanner, or by hand using CAD modeling software.

Speakers and headphones are the output devices responsible for producing sounds. Speakers and headphones convert digital signals into analog sound waves that are audible to our human eardrums.
An actuator is a type of motor. Actuators are the output devices responsible for creating real-world movement in a computer control system.

1.3.5 Memory, storage devices, and media

primary: Read Only Memory (ROM), and Random Access Memory (RAM)
secondary: hard disk drive (HDD) and Solid-State Drive (SSD); off-line: Digital Versatile Disc (DVD), Compact Disc (CD), Blu-ray disc, USB flash memory, and removable HDD

Magnetic devices store data in the form of tiny magnetized dots. These dots are created, read, and erased using magnetic fields created by very tiny electromagnets. (HHDs)

Optical storage is the storage of data on an optically readable medium. Data is recorded by making marks in a pattern that can be read back with the aid of light, usually, a laser beam light precisely focused on a spinning optical disc. (DVDs and other offline storage)

An SSD uses microscopic electronic switches to store data.
Millions of transistors are either on or off and remain so as long as electricity is applied to the system. (SSDs and other flash memory)

1.3.6 Operating systems
An operating system (or 'OS') controls the general operation of a computer and provides an easy way for us to interact with computers and run applications.
The operating system performs several key functions:

- **interface** - provides a user interface so it is easy to interact with the computer
- **manages the CPU, memory, and peripherals** - runs applications and executes and cancels processes.
- **multi-tasks** - allows multiple applications to run at the same time
- **organizes** - creates a file system to organize files and directories
- **security** - provides security through user accounts and passwords
- **utilities** - provides tools for managing and organizing hardware

In system programming, an interrupt is a signal to the processor emitted by hardware or software indicating an event that needs immediate attention. Interrupts are used by devices to communicate that they require attention from the operating system

The application system is any installed software the performs additional functions

1.3.7 High- and low-level languages and their translators
High-level languages are written in a form that is close to our human language, enabling to programmers to just focus on the problem being solved.
Advantages

- Easier to modify as it uses English like statements
- Easier/faster to write code as it uses English like statements
- Easier to debug during development due to English like statements
- Portable code – not designed to run on just one type of machine

Low-level languages are used to write programs that relate to the specific architecture and hardware of a particular type of computer.
They are closer to the native language of a computer (binary), making them harder for programmers to understand. Quicker running times and fewer instructions
Advantages

- Can make use of special hardware or special machine-dependent instructions (e.g. on the specific chip)
- The translated program requires less memory
- Write code that can be executed faster
- Total control over the code
- Can work directly on memory locations

An assembler translates assembly language into machine code. Assembly language is a low-level language written in a syntax that closely reflects the operations of the CPU.

An interpreter translates code into machine code, instruction by instruction - the CPU executes each instruction before the interpreter moves on to translate the next instruction. Interpreted code will show an error as soon as it hits a problem, so it is easier to debug than compiled code.

A compiler translates the whole program into machine code before the program is run. It can be difficult to test individual lines of compiled code compared to interpreted languages as all bugs are reported after the program has been compiled.

1.4 Security
1.4.1

- show understanding of the need to keep data safe from accidental damage, including corruption and human errors
- show understanding of the need to keep data safe from malicious actions, including unauthorized viewing, deleting, copying and corruption

1.4.2
show understanding of how data are kept safe when stored and transmitted, including:

- use of passwords, both entered at a keyboard and biometric
- use of firewalls, both software and hardware, including proxy servers
- use of security protocols such as Secure Socket Layer (SSL) and Transport Layer Security (TLS)
- use of symmetric encryption (plain text, cypher text, and use of a key) showing understanding that increasing the length of a key increases the strength of the encryption

1.4.3

In computing, a **denial-of-service attack** is a cyber-attack in which the perpetrator seeks to make a machine or network resource unavailable to its intended users by temporarily or indefinitely
disrupting services of a host connected to the Internet.
Phishing is a fraudulent attempt to obtain sensitive information such as usernames, passwords, and credit card details by disguising as a trustworthy entity in an electronic communication.
Pharming is a cyber-attack intended to redirect a website's traffic to another, fake site.

1.5 Ethics

Freeware is software that is distributed without demanding a fee for its usage.
Free at the point of use but maybe a demo version.
These programs are available either as fully functional software for an unlimited period. (NO SOURCE CODE) e.g. Google chrome
Free software is software that gives a user freedom to run, copy, distribute, study, change and improve the software. (ACCESS TO SOURCE CODE) e.g Mozilla Firefox
Open-source software - gives users access to the source code e.g. Linux
Shareware is demonstration software that is distributed for free but for a specific evaluation period. Freeware may also be shareware. After the trial period it must be paid for.

Malware, or malicious software, is any program or file that is harmful to a computer user.