# Computer Notes

- **Topics** :

# Chapter 1

- The Number System can be represented by three systems :
  - Binary System
  - Denary System
  - Hexadecimal System

- **Binary System :**
- It is a base 2 number system and only 0 and 1 are used to represent values

- **Denary System :**
- It is a base 10 number system and 0 - 9 are used to represent values

- **Hexadecimal System :**
- It is a base 16 number system and 0 - 15 are used to represent values
  - A : 10
  - B : 11
  - C : 12
  - D : 13

- E : 14
- F : 15

## - Converting from Binary to Denary :

- To convert the binary number "11101110" into Denary, we first place it on this table.

| $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |

- Then we add the numbers
  - $2^7 + 2^6 + 2^5 + 2^3 + 2^2 + 2^1 =$
  - 128 + 64 + 32 + 8 + 4 + 2 = 238
  - Thus 238 is the Denary number

## - Converting from Denary to Binary :

- To convert the Denary number "142" to Binary, we successively divide it by 2.

| 2 | 142 | | |
|---|---|---|---|
| 2 | 71 | Remainder : | 0 |
| 2 | 35 | Remainder : | 1 |
| 2 | 17 | Remainder : | 1 |
| 2 | 8 | Remainder : | 1 |
| 2 | 4 | Remainder : | 0 |
| 2 | 2 | Remainder : | 0 |
| 2 | 1 | Remainder : | 0 |
| | 0 | Remainder : | 1 |

- Then we read the numbers from down to up
  - Thus the Binary number would be "1001110"

## - Converting from Binary to Hexadecimal :

- To convert the Binary number "101111100001" into Hexadecimal, we split into groups of 4 bits.
  - 101111100001
  - 1011   1110   0001          ( 1 + 2 + 8 )  ( 2 + 4 + 8 )  ( 1 )
  -   B        E        1
  - Therefore the Hexadecimal digit is BE1

## - Converting from Hexadecimal to Binary :

- To convert the Hex digit "45A" to Binary, we simply see the appropriate sum.
  - 45A
  - 4 : 0100
  - 5 : 0101

- A : 1010
- 010001011010 is therefore the correct Binary number

- To convert the Hex digit "45A" to Denary, we use $16^0$, $16^1$, $16^2$
    - 45A
    - $16^2$ $16^1$ $16^0$
        4     5     A
    - $16^2$ x 4 = 1024
    - $16^1$ x 5 =  80
    - $16^0$ x 10 = 10
    - 1024 = 80 + 10  = 1114
    - Therefore 1114 is the appropriate Denary number

- To convert the Denary digit "2004" to Hexadecimal, we successively divide it by 16

| 16 | 2004 | | |
|---|---|---|---|
| 16 | 125 | **Remainder :** | 4 |
| 16 | 7 | **Remainder :** | 13 |
| | 0 | **Remainder :** | 7 |

- Then we read the numbers from down to up
    - Thus the Hex digit would be 7 13 4 = 7D4

- Computers can only understand Binary because :
    - They process and store data using electronic switches ( ON / OFF )
    - These Switches can be represented by Binary as it is a base 2 number system

- Advantages of Hexadecimal compared to Binary :
    - Less prone to errors as there are lesser digits
    - Easier to read as there are lesser digits
    - One Hexadecimal digit can represent four bits of Binary Data

- **The Uses of Hexadecimal System :**
    - Error Codes
    - MAC addresses
    - IP addresses
    - HTML color codes
    - URLs
    - Assembly Language
    - ASCII / Unicode

- HTML color codes :
    - For Example, the color code : FF9966
    - FF = Red

- 99 = Blue
- 66 = Green

- There are a possible 256 values for each primary color making 16,777,216 colors in total

- Adding Values :
  - 0 + 0 = 0
  - 0 + 1 = 1
  - 1 + 0 = 1
  - 1 + 1 = 0  ( Carry 1 )
  - 0 + 0 + 0 = 0
  - 0 + 1 + 0 = 1
  - 0 + 1 + 1 = 0  ( Carry 1 )
  - 1 + 1 + 1 = 1  ( Carry 1 )

- Overflow is known as when a 9th bit is created in the addition of 8 bit Binary numbers.

- Overflow occurs when the addition of 8 bit binary numbers results in a value exceeding 255 ( maximum value for 8 bit )

- Computers can carry out a logical shift on a sequence of binary numbers, either left or right

- Each shift left means multiplying the binary number by 2
- Each shift right means dividing the binary number by 2

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |

- 1 + 4 + 16 = 21

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |

- A logical shift to the left has taken place
- 2 + 8 + 32 = 42
- 21 x 2 = 42 thus proven

- However, when Binary shifts don't give the expected outcome, that means the most significant bits are lost

- Two's complement makes use of representing negative integers in binary
- One minor change is made to the 8 bit register

| -128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| x | x | x | x | x | x | x | x |

- **Converting positive Denary numbers to Binary in Two's complement :**
- To convert 38 to Binary in Two's complement format, we simply put it on the table

| -128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|

| 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
|---|---|---|---|---|---|---|---|

- Therefore, 38 is 00100110

**- Converting positive Binary numbers to Denary in Two's complement :**
- To convert 01101110 to Binary in Two's complement format, we put it on the table

| -128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |

- Therefore 01101110 is 110

**- Converting negative Binary numbers to Denary in Two's complement :**
- To convert 10010011 to Denary in Two's complement format, we put it on the table

| -128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |

- -128 + 16 + 2 + 1 = -109
- Therefore the Denary value is -109

**- Converting negative Denary numbers to Binary in Two's complement :**
- To convert -67 to Binary in Two's complement format, we :
    - Put it on the table without minus
    - Invert the numbers
    - Add 1 at the end

| -128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |

- Then invert 01000011
- 10111100
- Add 1 at the end
- 10111101 is Therefore the answer

- The Standard ASCII code character set consists of 7 bit codes ( 0 to 127 in Denary )

- It represents the letters, numbers and characters found on a standard keyboard

- Extended ASCII uses 8 bit codes ( 0 to 255 in Denary ), this gives another 128 codes for characters in non English alphabets

- Disadvantages of ASCII Code :
    - Doesn't represent characters in non Western languages

- Unicode can represent all languages of the world

- Disadvantages of Unicode :
    - Larger file size

Amplitude = Loudness
Frequency = Pitch
Sampling rate : No. of sound samples per second
Sampilng resolution: Bit deth of sound sambles

- ● Slower Processing Time

- Each Sound wave has a frequency, wavelength and amplitude
  - ● Frequency : The number of times per second that a sound wave repeats itself
  - ● Wavelength : The distance between frequencies
  - ● Amplitude : The loudness of a sound

- **Sampling Resolution / Bit Depth is known as the number of bits per sample.**

- **Sampling Rate is the number of sound samples taken per second**

ASCII
0 is at 48
A is at 65
a is at 97

- Advantages of using a larger sampling resolution :
  - ● Larger Dynamic Range
  - ● Better Sound Quality
  - ● Less Sound Distortion

- Disadvantages of using a larger sampling resolution :
  - ● Produces larger file size
  - ● Takes longer to send or download
  - ● Requires greater processing power

- Bitmap images are made up of pixels
- An image is a two dimensional matrix of pixels

- Pixel is derived from the term picture element, it is the smallest element used to make up an image

- **The color depth is the number of bits used to represent each color.**
- An 8 bit color depth means each pixel can be of 256 colors ( $2^8$ **= 256** )

- **Pixel Density is the number of pixels per square inch**

- **Image resolution refers to the number of pixels that make up an image**

- A single binary digit is referred to as a bit.
- 8 bits make up a byte
- 4 bits make up a nibble

| | | |
|---|---|---|
| 1 KB | 1 000 | Bytes |
| 1 MB | 1 000 000 | Bytes |
| 1 GB | 1 000 000 000 | Bytes |
| 1 TB | 1 000 000 000 000 | Bytes |

- Another system :

| | | | |
|---|---|---|---|
| 1 KiB | Kibibytes | $2^{10}$ | 1024 bytes |
| 1 MiB | Mebibytes | $2^{20}$ | 1048576 bytes |
| 1 GiB | Gibibytes | $2^{30}$ | 1073741824 bytes |

| 1 TiB | Tebibytes | $2^{40}$ | 109951162776 bytes |
|-------|-----------|----------|---------------------|

- The file size of an image is calculated as :
  - Image resolution ( in pixels ) x color depth ( in bits )
    - First Multiply variable numbers to find Image resolution
    - Then Multiply variable product with the color depth
    - Then Divide by 8 to convert to bytes
    - Then Divide by 1024(KiB),1024 x 1024(MiB) or 1024 x 1024 x 1024(GiB)

- The size of a sound file is calculated as :
  - **Sampling rate  x Sampling resolution  x Length of sound**
    ( in Hz )              ( in bits )              ( in seconds )
    - First Multiply sampling rate with sampling resolution with length of sound
    - Then Divide by 8 to convert to Bytes
    - Then Divide by 1024(KiB),1024 x 1024(MiB) or 1024 x 1024 x 1024(GiB)

- For a stereo sound file, multiply the result by two

- **The network bandwidth is the maximum rate of transfer of data across a network**

- File compression can either be :
  - Lossless
  - Lossy

- **Lossy File Compression :**
- Original data can't be reconstructed once compressed
- A Compression Algorithm is used
- This algorithm eliminates unnecessary data from file such as sounds that can't be heard
- May reduce image resolution, color depth, sampling resolution and sampling rate
- Common compression algorithms are MPEG - 3, MPEG - 4 and JPEG

- **Lossless File Compression :**
- Original data can be reconstructed once compressed
- A Compression Algorithm is used ( RLE )
- Repeated patterns are identified and indexed with number of occurrences.

- Run Length Encoding is used when there is a repetition of digits

| String | aaaaaaaa | bbbbbbbbbb | c | d | c | d | c | d | eeeeeeee |
|--------|----------|------------|---|---|---|---|---|---|----------|
| Code | 08 97 | 10 98 | 01 99 | 01 100 | 01 99 | 01 100 | 01 99 | 01 100 | 08 101 |

- This string contains 32 characters and would occupy 32 bytes of storage

- Using RLE :

| 255 08 97 | 255 10 98 | 99 100 99 100 99 100 | 255 08 101 |
|-----------|-----------|----------------------|------------|

- The Flag "255" is used
- A Flag preceding data indicated that what follows are the number of repeating units

- The compressed version now uses 18 bytes of storage.

| Lossy Compression | Lossless Compression |
|---|---|
| Original File can't be reconstructed | Original File can be reconstructed |
| Is Smaller | Is Larger |
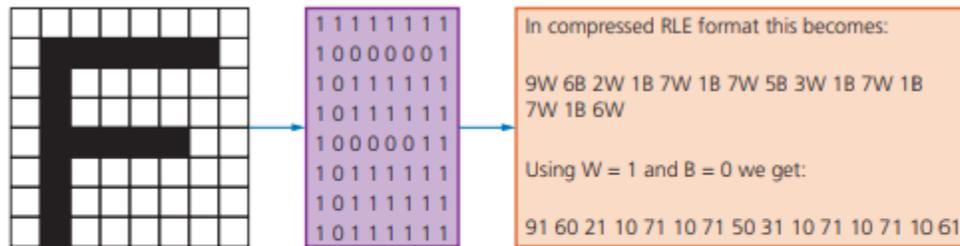


▲ **Figure 1.12** Using RLE with a black and white image

The 8 × 8 grid would need 64 bytes; the compressed RLE format has 30 values, and therefore needs only 30 bytes to store the image.

- **Sampling Resolution / Bit Depth is known as the number of bits per sample**
- **Sampling Rate is the number of sound samples taken per second**
- **Color Depth is the number of bits used to represent each color**
- **Pixel Density is the number of pixels per square inch**
- **Image resolution refers to the number of pixels that make up an image**


- **Chapter 2**

- Data sent over long distances is usually broken up into data packets. ( 64 KiB )

- A Packet is made up of :
  - Header
  - Payload
  - Trailer

- Header consists of :
  - IP address of sender and receiver
  - Sequence number of packet
  - Size of packet in bytes

- Payload consists of :
  - Actual Data being sent in the packet ( 64 KiB )

- Trailer consists of :
  - Method of identifying end of packet
  - Hex value of totalled 1 bits in payload, used for Cyclic Redundancy Checks

- Cyclic Redundancy Checks :
  - Sending Computer adds up all the 1 bits in the payload.
  - Sending Computer stores it as a hex value in the trailer.
  - Receiving Computer recalculates number of 1 bits in payload.

- ● If different, then error has occurred

- Packet switching is a method of data transmission in which a message is broken up into a number of packets.

- These packets are sent independently and will be received by nodes that contain a router.

- The router, based on the information in the header, decides where to send it.

- The shortest possible path available is always selected by the router to send the data to.
- This is known as Routing.

- Data can reach the destination in a different order than initially, so it is ordered using the sequence number in the header of the packet

- Benefits of Packet Switching :
  - ● Whole file doesn't need to be resent if a packet is lost
  - ● High data transmission rate is possible
  - ● No need to use a single transmission line

- Drawbacks of Packet Switching :
  - ● Packets can be lost and need to be re-sent.
  - ● Packet can be disordered
  - ● Delay at destination while the packets are being re-ordered.

- It is possible for packets to get lost if they keep bouncing around from router to router and never reach their destination.

- Because of this, the lost packets mount up and clog the system which halts the network.

- Hopping is a method to overcome the clogging up of the system by lost packets.

- In Hopping, a hop number is added to the header of each packet, this number is reduced by 1 every time it leaves a router.

- Each packet has a maximum number, and when this number reaches zero, the packet is deleted.

- The missing packets will then be flagged by the receiving computer and a request to resend the files will be made.

- Data transmission can be either over short distances or long distances.

- Three factors need to be considered when transmitting data :
  - ● Direction of Data transmission ( Unidirectional or bidirectional )
  - ● Method of Data transmission
  - ● Synchronization of Data

- Direction of Data transmission can be split into :
  - ● Simplex mode
  - ● Half Duplex mode
  - ● Full Duplex mode

- Simplex mode occurs when data can be sent in one direction only ( computer to printer )

- Half Duplex occurs when data can be sent in both directions, but not at the same time

- Full Duplex occurs when data can be sent in both directions, at the same time

- Methods of Data transmission can be split into :
    - Serial Data transmission
    - Parallel Data transmission

- Serial Data transmission occurs when data is sent one bit at a time over a single channel

- Parallel Data transmission occurs when several bits of data are sent over several channels

- Serial data works well over long distances as data can not be disordered.
- It is slower

- Parallel data works well over short distances, over long distances, data can become skewed.
- It is faster

| Serial | Parallel |
|---|---|
| Slower | Faster |
| Works well over long distances | Works well over short distances |
| More reliable | Less reliable |
| Less expensive | More expensive |

- Universal Serial Bus ( USB ) is a form of serial data transmission.
- It allows both half duplex and full duplex.

- USB stores data by :
    - Flashing data on silicon chips
    - Using millions of tiny transistors to store data as 0s and 1s
    - Using NAND/NOR gates to control the flow of electrons

    - ( Transistors include control gate and floating gate )

| Benefits | Drawbacks |
|---|---|
| Can only fit one way | Old USBs may not be compatible |
| Can support different transmission rates | Slow |
| Devices are automatically detected when plugged in | Only support a maximum length of 5m |

- Data loss can occur due to :
    - Hardware Failure
    - Software Failure
    - Power Out
    - Floods
    - Fire

- The solution to these problems is to make regular backups of the data and to add passwords when deleting files.

- Errors can occur during data transmission due to :
  - Interference ( damaged wires )
  - Problems during packet switching
  - Skewing of data

- Errors can be checked by :
  - Cyclic Redundancy Checks
  - Parity checks
  - Checksum
  - Echo check
  - Automatic Repeat Request
  - Check Digits

- **Parity checks** use parity bits, it can be either even or odd.
- The Parity bit is the left most bit in a byte.

- The Sender and Receiver must agree before the transmission to either use even parity or odd parity.

- If even parity is used, then all the bits in the byte + the parity bit must be even.
- If bits are odd, set parity bit to 1 to make it even
- If bits are even, set parity bit to 0 to remain even

- If odd parity is used, then all the bits in the byte + the parity bit must be odd.
- If bits are odd, set parity bit to 0 to remain odd
- If bits are even, set parity bit to 1 to make it odd

- Errors can be identified when the sender's byte has an even parity and the receiver's has an odd.

- Parity bits only identify if there is an error, but not where the error is located

- To overcome this, parity blocks are used with a parity byte

- A parity byte is set the same way as the parity bit, but only vertically

- Parity blocks compare the parity bytes of the senders and receivers.

- If there is an error, the location of it can be easily located

- **Checksum** is when an additional value is sent alongside the data during data transmission

- It is then calculated using a checksum algorithm before sending, and after sending.
- If there is a difference, that indicates an error.

- Checksum algorithms are agreed on beforehand and include :
  - ISBN
  - Barcode

- **Echo check** is when data is sent back to the sender, after being received by the receiver.
- The sender's computer then compares the two sets of data to check errors.

- The problem with this is errors can occur while sending so the Sender's computer compares the received value with the sent wrong value.

- A **Check Digit** is the final digit included in a code, it is calculated from all the other digits.

- It is used for barcodes and Vehicle Identification numbers.

- Check digits can detect the following types of errors :
    - Incorrect Digit ( 5327 - 5307 )
    - Transposition Errors ( 1023 - 1032 )
    - Omitted Digit ( 276 - 2706 )
    - Phonetic Errors ( 13 - 30 )

- A check digit can be calculated by :
    - ISBN 13
    - Modulo - 11

- ISBN 13 :
    - 123456789012
    - Add Odd Digits ( 1+3+5+7+9+1 = 26 )
    - Add Even and Multiply by 3 ( 3 x ( 2+4+6+8+0+2 = 66 ) )
    - Add Both and Divide by 10 ( 66 + 26 / 10 = 9.2 )
    - If Digit is whole number, use it as check digit
    - If not, subtract the remainder with 10 ( 10 - 2 = 8 )
    - 8 is Check Digit

- Modulo - 11 :
    - 1234567
    - Weightings are given to this value starting from left ( 8,7,6,5,4,3,2 )
    - 1 2 3 4 5 6 7
      8 7 6 5 4 3 2
    - Multiply the digit by its weighting and add them together
    - 1 x 8 + 2 x 7 + 3 x 6 + 4 x 5 + 5 x 4 + 6 x 3 + 7 x 2 = 106
    - Divide the value by 11 ( 106 / 11 = 9.6 )
    - Subtract remainder by 11 ( 11 - 6 = 5 )
    - 5 is Check Digit

- Checksum and Check Digit both calculate their value and report if an error is found.

- Parity checks and Echo checks are methods to verify data that has arrived unchanged at its destination, however ARQ is a third way.

- **Automatic Repeat Request** ( ARQ ) uses positive and negative acknowledgements.

- Acknowledgements are messages sent to the receiver indicating the data has / has not been received correctly.

- The receiving device receives an error detection code as part of data transmission.

- If no error is detected, a positive acknowledgement is sent back to the sending device
- If an error is detected, a negative acknowledgement is sent back to the sending device

- The negative acknowledgement requests re-transmission of data

- This acknowledgement has to be sent within a time period ( timeout ), and if no acknowledgement is received during this time, the sending device automatically re-sends the data until a positive acknowledgement is received.

- ARQ is often used by mobile phone networks to guarantee data integrity.

- When data is transmitted over any public network, there is a risk of interception by a hacker

- Under this circumstance, a hacker is referred to as an eavesdropper.

- Using Encryption, this risk can be minimized

- Encryption changes the data into a form that is unreadable by anybody for whom the data is not intended, this way, the data doesn't make any sense for them.

- The original data being sent is known as plaintext.
- Once the data goes through an encryption algorithm, it's known as ciphertext.

- There are two types of Encryption methods :
  - Symmetric Encryption
  - Asymmetric Encryption

- Symmetric encryption uses an encryption key, the same key is used to encrypt and decrypt the code.

- An encryption key is given ( 4291362856 )

- The data message ( computer science is man ) is applied to the key.

| C | O | M | P | U | T | E | R | S | C | I | E | N | C | E | I | S | M | A | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 2 | 9 | 1 | 3 | 6 | 2 | 8 | 5 | 6 | 4 | 2 | 9 | 1 | 3 | 6 | 2 | 8 | 5 | 5 |
| G | Q | V | Q | X | Z | G | Z | X | I | M | G | W | D | H | O | U | U | F | S |

- By following code, we add the number to the correspondence of the alphabets (+4:A=E )
- This is the encryption key

- To get the original message, we use the decryption key, which is just reversing the number to the correspondence of the alphabets ( -4:E=A )

- Symmetric encryption still has a security issue as it uses the same encryption and decryption key.

- Asymmetric Encryption makes use of two keys, the public key and the private key.

- The public key is made available to everyone
- The private key is only known to the user.

**Chapter 3**

- The Central Processing unit is central to all modern computer systems

- The CPU is often installed as an integrated circuit on a single microchip

- The von neumann architecture consists of registers, buses and system clocks

- Structure of a CPU :
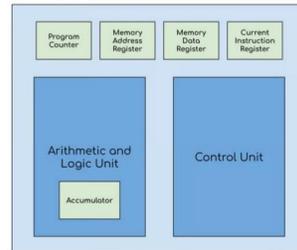


- The CPU consists of :
    - Control Unit
    - Arithmetic and logic unit
    - Registers and Buses

- **Arithmetic and Logic units ( ALU )** allow the Required arithmetic or logic operations to be carried out.

- **The Control Unit ( CU )** ensures synchronization of data flow, and decodes instructions

- **Registers** are small memory locations within the CPU, which temporarily store data, there are five :

| Register | Abb. | Function |
|---|---|---|
| Current Instruction Register | CIR | Stores Current Instruction being decoded and executed |
| Accumulator | ACC | Carries out ALU calculations |
| Memory Address Register | MAR | Stores address of memory currently being read |
| Memory Data Register | MDR | Stores data which has just been read from memory |
| Program Counter | PC | Stores address where next instruction can be found |

- A System clock is used to produce timing signals on the control bus.

- The RAM is often referred to as the Immediate Access Store (IAS)

- The Computer Memory is made up of a number of partitions, each partition consists of an address and its contents.

- System Buses are used in computers as parallel transmission components

- There are three common system buses :
    - Address Bus
    - Data Bus
    - Control Bus

- **Address Bus :** Carries addresses throughout the computer system from the CPU and Memory, is Unidirectional

- **Data Bus :** Carries Data From CPU to Memory and vice versa, Is Bidirectional

- **Control Bus :** Carries Signals from the Control Unit to all other computer components, Is Bidirectional

- The Fetch Decode Execute Cycle is used by the CPU to carry out a set of instructions

**Fetch :**
- PC sends Address of Next Instruction to MAR ( using address bus )
- MAR sends Instruction to MDR temporarily ( using data bus )
- MDR sends instruction to CIR
- PC is incremented by 1

**Decode :**
- CU decodes the instruction in the CIR to an operand and opcode

**Execute :**
- ALU executes the instruction and stores it in ACC

- **Factors that determine the performance of a CPU :**
  - **Cores :** More cores can execute more instructions each second
  - **Clock Speed :** Number of instructions the core can execute each second
  - **Cache :** Used for storing frequently used instructions
  - **The Width of the address and data bus**
  - **Overclocking**

- Disadvantages of Overclocking :
  - Unsynchronized Operations
  - Overheating

- Instructions are a set of operations which are decoded in sequence

- An **Operation** is made up of an **opcode** and **operand**

- An **Opcode** informs the CPU what needs to be done

- An **Operand** is the data which needs to be acted on

- An Instruction set is the list of commands that can be processed by a CPU.
- Each command has a unique binary number ( Like a Character Set )

- Example of Instruction set is the x86, a common CPU.

- An embedded system is a combination of hardware and software which is designed to carry out a specific set of functions

- Embedded Systems can be based on :
  - Microcontrollers
  - Microprocessors
  - System on chips

- A Microcontroller is a type of integrated circuit on a single chip. ( Contains Memory and CPU )
- A Microprocessor is a type of integrated circuit on a single chip. ( Contains Only CPU )

- **A Microprocessor processes data and executes Instructions.**

- Embedded systems are either programmable or non programmable

- Non programmable devices need to be replaced if they require a software upgrade

- Programmable devices permit upgrading by two methods
  - Connecting the device to a computer and allowing the download of updates
  - Automatic updates via. WiFi, satellite or hotspot

| Benefits | Drawbacks |
|---|---|
| Small and easy to fit | Difficult to update |
| Cheap to make | Open to hackers |
| Dedicated to one task | Pollute when thrown away |
| Consume little power | Confusing |

- A computer is not an example of an embedded device because they are multi functional

- Examples of the use of Embedded Systems :
  - Motor Vehicles
  - Set top box
  - Security Systems
  - Lighting systems
  - Vending systems
  - Washing machines

- Input Devices include :
  - Keyboards
  - Mouse
  - Microphone
  - Camera
  - Barcodes
  - QR Codes
  - 2D / 3D Scanners
  - Touch Screens
  - Sensors
  - All Types of Storage

- A Barcode is a series of dark and light parallel lines of varying thickness, from no. 0 to 9

- The digits on the left have an odd number of dark lines and always begin with a light bar ( LOL RED )
- The digits on right have an even number of dark lines and always begin with a dark bar

**Process of Scanning a Barcode :**
- The barcode is scanned by a red laser
- Black lines absorb the laser
- White lines reflect the laser
- The reflected light is read by sensors and converted to Binary

- Advantages to management of using barcodes :
  - Much easier and faster
  - No need to price every stock item

- Advantages to customers of using barcodes :
  - Faster
  - Given a bill

- Another type of Barcode is the Quick Response ( QR ) code, it is used for :
  - Advertising products
  - Storing boarding passes

- Advantages of QR codes compared to barcodes :
  - They can hold much more information
  - There will be fewer errors
  - Easy to send
  - Easy to read ( don't need laser or red LED )

- Disadvantages of QR codes compared to barcodes :
  - More than one QR format is available
  - Can be used to send malicious
    codes

- Frame QR codes are now being used because of their ability to put advertising logos

- Scanners are either 2D or 3D

- 2D Scanners are the most common and are used to input hard copy documents (paper)

- Computers equipped with **OCR ( optical character recognition )** software allow the scanned text from the document to be converted into a text file format, which can be edited.

- 3D Scanners scan solid objects and produce a 3D image

- The scanned image can be used in **CAD ( Computer aided design )** to produce a working model

- 2D Scanners are used at airports or in printers

- Computed tomographic scanners are used to create a 3D image of a solid object.

- Depending on how the image is formed, there are three other names for CT Scanners :
  - CT : Uses X-Rays
  - MRI : Uses Radio frequencies
  - SPECT : Uses Gamma rays

- Output Devices include :
  - Actuators
  - Screens
  - Projectors
  - Printers
  - Speaker

- There are three types of Touch Screens :
  - Capacitive
  - Infrared
  - Resistive ( most common method )

- Capacitive touch screens have two types, Surface capacitive and Projective capacitive :

| Capacitive Adv. | Capacitive DisAdv. | Infrared Adv. | Infrared DisAdv. | Resistive Adv. | Resistive DisAdv. |
|---|---|---|---|---|---|
| Better image clarity | Only work with finger | Can be used if cracked | Sensitive to water or moisture | Can be used with gloved hand | Vulnerable to scratches |
| **Durable screens** | Sensitive to electromagnetic radiation | **Durable screens** | Accidental activation | Resistant to dust and water | Poor visibility in sunlight |
| **Allow multi touch** | | **Allow multi touch** | Sensitive to light | Cheap | Doesn't allow multi touch |

- **Surface Capacitive :** Sensors are placed at the corners of a screen, small voltages are applied creating an electric field. When a finger makes contact, a microcontroller measures the decrease in capacitance and determines the location.

- **Projective Capacitive :** In the form of a X-Y matrix pattern, creating a 3D electrostatic field, when the finger makes contact, it disrupts the field thus revealing the coordinates.

- **Infrared** use a glass screen with an array of sensors and infrared transmitters, the sensors detect the infrared radiation.

- **Resistive** is made up of two layers of electrically resistive material with voltage applied across them, these two layers are separated by an inert gas ( argon ), when the top layer is touched, a circuit is completed with the bottom layer since they're both coated in resistive material.

- An actuator is used to control devices ex. Conveyor belt or valve

- There are two common types of Light projectors :
  - Digital light projectors ( DLP )
  - Liquid Crystal projectors ( LCD )

| DLP Advantages | DLP Disadvantages |
|---|---|
| More reliable | Tends to suffer from shadows |
| Higher contrast ratios | Use More power |
| Smaller and lighter | Not good color saturation |
| **LCD Advantages** | **LCD Disadvantages** |
| Better color saturation | Not good contrast ratios |
| More efficient in Energy Use | Limited Life |

- **DLPs** use millions of micro mirrors on a small digital micromirror device, the number of mirrors and the way they are arranged determines the resolution of the image.

- When the micro mirror tilts towards the light source, they are on and when they tilt away, they are off.

- A bright white light source passes through a color filter on its way to the DMD chip, the white light is split into the primary colors : red, green and blue.

- **LCDs** use a powerful beam of white light which is sent to a group of chromatic coated mirrors, these reflect the light back at different wavelengths.

- These wavelengths correspond to red, green or blue.

- These three coloured components pass through three LCD screens which can either block it or let it through, this produces a monochromatic image.

- Thus three different versions of the same image are produced, each image in shades of either red, green or blue.

- A special prism is used to produce a full image with these colors.

- Inkjet printers are used for printing high quality images ( Quality )
- Laser printers are used for printing multiple images ( Quantity )
- 3D printers are used to produce solid objects

- Inkjet use ink droplets, there are two methods this ink is produced :

- **Piezoelectric :** A crystal is located at the back of the ink reservoir for each nozzle, the crystal is given a tiny electrical charge which makes it vibrate, this vibration forces ink to be ejected onto the paper.
- **Thermal Bubble :** Tiny resistors create localized heat which makes the ink vaporize, this causes the ink to form a tiny bubble, as the bubble expands, some of the ink is ejected to the paper.

- 3D Printers use two types of Printing methods :
    - **Direct 3D Printing** uses inkjet technology, can move left and right as well as up and down
    - **Binder 3D Printing** uses two layers, first is a dry powder and then a type of glue

- 3D Printers are used for :
    - Making parts of a car
    - Aerospace
    - Fashion and Art
    - Prosthetic limbs

- LEDs produce their own light with tiny light emitting diodes, either red, green or blue.
- LCDs use some sort of backlighting because they don't produce their own light
- LCDs use LEDs as a form of backlighting but before that, they used CCFL

- Cold Cathode fluorescent lamps use two Fluorescent tubes behind the LCD screen which supply the light source.

- Advantages of LEDs compared to CCFL:
    - They reach maximum brightness almost immediately
    - Whiter lights
    - Consume less power
    - Are much thinner

- OLED ( Organic light emitting diodes ) can bend, this ability is used in TVs

- Advantages of OLED compared to LEDs and LCDs :
    - Large field of view
    - Bendable
    - Less power
    - Thinner, lighter and more flexible
    - Brighter

- OLEDs are more expensive

- Sensors are input devices which read or measure physical properties from their surroundings

- Data which is sensed by Sensors are converted into Digital format using ADC.

- There are three main types of sensors :
    - Acoustic Sensor ( senses sounds )
    - Pressure Sensor ( senses pressure )
    - Infrared Sensor ( senses movements )

- Other types of Sensors include : Temperature, Light, Proximity, etc.

- Sensors are used in both monitoring and control applications.

- Monitoring applications monitor and send messages or warnings
- Control applications control and take action

- Examples of Monitoring :
    - Monitoring of a patient in a hospital
    - Monitoring of Intruders
    - Monitoring of Temperature

- Examples of Control :
    - Street lighting systems
    - Controlling Temperature

- Monitoring applications :
    - Security System
    - Hospital

- Control applications :
    - Street lighting
    - Anti lock braking system

- Any Exam Question on Sensors :
    - Type of Sensor Used
    - Sensor sends signals to Microprocessor
    - Data is converted to Digital using ADC
    - Data is compared with stored values
    - If different, signals are sent
    - Actuators are used to move
    - This is a continuous process

- Memory has two groups :
    - Primary Memory

- ● Secondary Storage

- **Primary Memory** includes RAM, ROM and Cache
- It is Directly Accessible by CPU

- **Secondary Storages** include Internal Secondary and External Secondary
  - ● **Internal** Secondary : HDD and SSD
  - ● **External** Secondary : DVD, CD, Blu Ray, USB and Flash memory

- Secondary Storage contains both types of software, even after shutting down.

| Primary Memory | Secondary Storage |
|---|---|
| Directly Accessible by CPU | Not Directly Accessible by CPU |
| Includes RAM, ROM and Cache | Includes Magnetic, Solid State and Optical Storage |
| Stores Data Temporarily | Stores Data Permanently |

| RAM | ROM |
|---|---|
| Temporary memory device | Permanent memory device |
| Volatile memory | Non-volatile memory |
| Can be written to and read from | Data stored can't be altered |
| Stores current data and program instructions in use | Stores BIOS |

- **RAM** stores current data and program Instructions in use
- **ROM** stores the Firmware
- **Cache** stores frequently used instruction
- **BIOS** is a program that provides low level control for devices

- RAM has two types : DRAM and SRAM

| DRAM | SRAM |
|---|---|
| Consists of transistors and capacitors | Uses flip flops |
| Needs to be constantly refreshed | Doesn't need to be constantly refreshed |
| Less expensive and Higher Memory | Faster data access time |

- Secondary storages fall into three groups :
  - ● Magnetic
  - ● Optical
  - ● Solid State

- **Magnetic Storage : HDD and Magnetic Tape**

- HDDs are the most common methods used to store data on a computer

- HDDs use platters which are divided in tracks and sectors
- HDDs have slow data access time compared to SSDs

- Removable HDDs are the same as normal HDDs but they can be plugged in by a usb port and can be removed, they are used as a backup

- HDDs store more data but are slow, HDDs suffer from latency ( delay ).
- Only HDDs have moving parts

- **Solid State : SSD and Flash memories**

- SSDs suffer from longevity ( long life ), most SSDs are rated at only 20 GB write operations per day, this is known as SSD Endurance

- SSDs compared to HDDs are :
    - More reliable
    - More Costly
    - Have a lower power consumption
    - Lighter
    - Faster Read / Write Speeds

- Solid State devices store data by :
    - Using NAND / NOR Gates to control the flow of electrons
    - Using millions of tiny transistors to store data as 0s and 1s.

- Transistors include floating gate and control gates.

- Flash memories make use of a matrix, at each intersection of the matrix, there is a floating and control gate.

- **Optical Media : CDs, DVDs and Blu Ray disks**

- DVDs have the ability to use dual layering technology which enables them to store more data and increase the storage capacity

- DVDs in general have more storage capacity than CDs and they both use red lasers

- Blu Rays compared to DVDs and CDs :
    - Use Blue laser instead of red
    - Have higher storage capacity
    - Are higher definition
    - Are faster

- The most common use of DVDs and Blu rays is the supply of movies and games

- Solid State use NAND / NOR
- Magnetic use Tracks / Sectors
- Optical use Pits / Lands


- Virtual memory is a method that computers use to manage storage space to keep systems running quickly and efficiently.

- Virtual memory acts as RAM when RAM is full.

- Uses of Virtual Memory :
  - To extend RAM Capacity
  - To stop crashing when RAM is full
  - To allow computer to process large amounts of data

- Benefits of Virtual memory :
  - Programs can be larger than physical memory and still be executed
  - No need to buy and install expensive RAM memory

RAM ← Transfer of pages → Virtual Memory | Hard Drive (Secondary Storage)
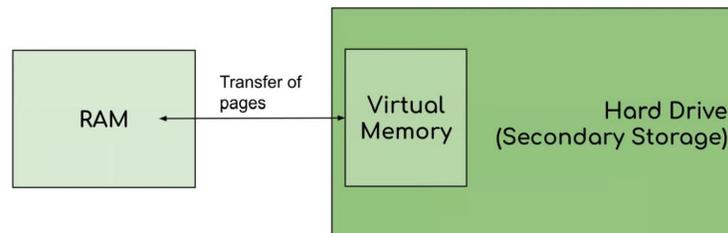
- When storage is required and there is none left in RAM :
  - The pages used least are transferred to virtual memory
  - When pages are required again, they are transferred back

- Disk thrashing is known as when more and more data needs to swapped in and out of virtual memory leading to a very high rate of read / write operations

- The trash point is known as when the process of the execution comes to a halt since the system is so busy moving data in and out of memory.

- Cloud storage is a method of data storage where data is stored on remote servers. The same data is stored on more than one server in case of maintenance or repair. This is known as Data redundancy.

- There are three systems of cloud storage :
  - **Public cloud** : Customer and Cloud storage provider are different companies
  - **Private cloud** : Customer and Cloud storage provider operate as single entity
  - **Hybrid cloud** : some data in private cloud while other in public cloud

- Benefits of Cloud storage :
  - Can be accessed anytime from any device if internet is available
  - Almost unlimited storage capacity
  - Can be used for backup

- Drawbacks of Cloud storage :
  - Can't be accessed if customer has a slow or unstable internet connection
  - Potential failure
  - Open to hackers and viruses

- A **NIC** ( Network interface card ) is needed to allow a device to connect to a network

- When a device connects to a private network, a router assigns a private IP address to it

- When a router connects to the internet, it is given a unique public IP address

- Every device connected to a router have their own public and private IP addresses

- WNIC ( Wireless network interface card ) are the same as NICs, however they use wireless connectivity utilizing an antenna to communicate

- A MAC, Media access control is located in the NIC, If the NIC card is replaced, the MAC address will also change

- **What is a MAC address ?**
    - A unique alphanumeric code used to identify the physical address of devices connected on a network
    - Consists of 6 pairs of hexadecimal digits, separated by a colon and is 48 bits



a1:34:f6:1f:82:ff

Manufacturer ID          Device/Serial ID
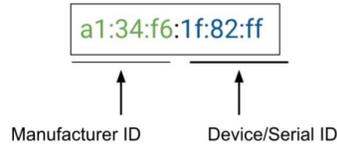
- There are two types of MAC addresses :
    - Universally Administered Address ( UAA )
    - Locally Administered Address ( LAA )

- UAA is by far the most common type of MAC address, UAA is administered by the manufacturer but LAA is used when wanting to change the address.

- **What is an IP address ?**
    - A unique string of numbers used to identify the global address of devices connected on a network
    - Is Separated by dots

- There are two types of IP addresses :
    - IPv4, Based on 32 bits and is written in 4 groups  : xxxx:xxxx:xxxx:xxxx
    - IPv6, Based on 128 bits and is written in 8 groups : **xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx**

- Advantages of IPv6 over IPv4 :
    - Removes the risk of collisions
    - Allows for more efficient packet routes
    - Has built in authentication checks

| MAC addresses | IP addresses |
|---|---|
| Identifies the physical address | Identifies the global address |
| Assigned by manufacturer | Assigned by ISP using DHCP |
| Separated by Colons | Separated by Dots |
| Use 48 bits | Use either 32 bits or 128 bits |
| Can be UAA or LAA | Can be Static or Dynamic |

- IP addresses can be either :
    - Static ( don't change )
    - Dynamic ( change frequently )

| Dynamic IP addresses | Static IP addresses |
|---|---|
| Greater Privacy since they change | Traceable since they dont change |
| Less reliable and slower | More Expensive and faster |

- Routers enable data packets to be routed between different networks.
- A router is used to connect one network to another network

**Chapter 4**

- There are two types of Software :
  - System Software
  - Application Software

- System Software provides what the computer needs
- Application Software provides what the user needs

- **Features of System Software :**
  - Provides a platform on which other software can run
  - Required to allow hardware and software to run without problems
  - Provides a human computer interface. ( HCI )

- **Features of Application Software :**
  - Used to perform various applications on a computer
  - Allows a user to perform specific tasks
  - User can execute the software when they require

- Application software includes :
  - Word Processing Software
  - Spreadsheet Software
  - Presentation Software
  - Multimedia Software
  - Web Browser

- System Software is divided into :
  - Utilities
  - Operating System

- Utilities include :
  - Virus checkers
  - Defragmentation software
  - Security
  - Screensavers
  - Translators

- Operating Systems include :
  - Windows
  - MAC OS
  - Android

- Operating systems are stored on the HDD or SSD since they are very large programs, mobiles and tablets store them in SSD since they are too small to hold HDD.

- Features of an Operating System :                    ( HMM How U Feeling Son )
    - Human Computer Interface
    - Multitasking
    - Memory Management
    - Hardware Management
    - User Account Management
    - File Management
    - Security Management

- Human Computer Interface ( HCI ) is in the form of Command Line Interface ( CLI ) or Graphical User Interface ( GUI )

- It is also in the type of Voice Command Interface

- CLI requires a user to type in instructions to execute a command
- GUI allows a user to interact with a computer using icons or symbols

- GUIs use WIMP ( Windows Icon Menu and Pointing Device )

- Touch Screens use post-wimp interactions which allow them to pinch and rotate the screen

| Interface | Advantages | Disadvantages |
| --- | --- | --- |
| CLI | User is in direct communication with the computer<br><br>User is not restricted to predetermined options<br><br>Uses small amount of memory | User needs to learn commands |
| GUI | User doesn't need to learn any new commands<br><br>More User friendly<br><br>Cursor is used to open applications rather than typing in a command | Uses more memory<br><br>User is limited to options |

- A Programmer would use CLI Whereas a normal user would use GUI

- Bootstrap loader / Booting up the computer is when a computer starts up and part of the operating system needs to be loaded into ROM.

- The BIOS is often referred to as firmware and is defined as a program that provides low level control for devices.

- The BIOS is stored in a special type of ROM, EEPROM. ( Electrically Erasable Programmable ROM )

- EEPROM is a flash memory chip, which means its contents remain even when the computer is powered down.

-   The BIOS settings are however stored on a CMOS Chip. ( Complementary Metal Oxide Semiconductor )

-   The CMOS is powered via a rechargeable battery, therefore the settings would be reset if the battery was removed or disconnected.

-   An interrupt is a single sent from a device or software to the microprocessor requesting its attention

-   The microprocessor suspends all operations until the interrupt has been serviced by ISR.

-   Interrupts can be either software or hardware.

-   Software Interrupts :
    ●   Division By Zero
    ●   Two processes accessing the same memory location

-   Hardware Interrupts :
    ●   Printer Jam
    ●   Printer runs out of ink
    ●   Moving a mouse
    ●   Pressing key on keyboard

-   Interrupt Priority deals with which interrupt to be serviced first and which interrupts are to be dealt with quickly.

-   A buffer is a memory area that stores data temporarily.

-   Interrupt Service Routine ( ISR ) is a software that handles interrupt requests.

-   Source code is the name of the language written by a programmer before conversion to binary.
-   Machine code is the name of the language written by a programmer after conversion to binary.

-   Computers only understand their own language called machine code, therefore a program needs to be translated into machine code to be understood by a computer.

-   A Computer program is a list of instructions that enable a computer to perform a specific task, they can be written in :
    ●   High level languages  ( Most common )
    ●   Low level languages

| Language | Advantages | Disadvantages |
|---|---|---|
| High Level | Easy to understand and debug<br><br>Easy to maintain<br><br>Fast<br><br>Portable | Can't make use of special hardware<br><br>Takes a lot of Space |

| Low Level | Can make use of special hardware<br><br>Doesn't take up much space | Difficult to Understand and debug<br><br>Difficult to Maintain<br><br>Slow |
|---|---|---|

- Examples of High Level Languages :
  - Python
  - Java
  - C++

- Examples of Low Level Languages :
  - Machine Code
  - Assembly Language

- Fewer programmers write programs in an assembly language ( Low Level language )

- Assembly language is written in mnemonics which are translated to binary with an instruction set.

- A program must be translated into binary / machine code before a computer can use it
- It is done so by a utility program called a translator

- Translators :
  - Compilers
  - Interpreters
  - Assemblers

- A Compiler is a computer program that translates an entire program written in high level language into machine code in one go.

- An Interpreter is a computer program that executes a statement from a program written in high level language, one statement at a time

- An Assembler is a computer program that translates a program written in an assembly language into machine code.

- Compilers :
  - Translate High Level Languages in one go
  - Errors can't be found during development
  - Produce an Executable file

- Interpreters :
  - Translate High Level Languages line by line
  - Errors can be found during development
  - Don't Produce a Executable File

- Compilers create an error report file after compiling that displays all errors which require correction.

- IDE is a Software that provides useful functions for a programmer writing a program.

- Features of IDE :

- Auto Correction
- Auto Completion
- Translators
- Error Diagnostics
- Run Time Environment
- PrettyPrint

**Chapter 5**

- The word Internet comes from Interconnected Network.
- The Internet is a collection of Interconnected networks and devices

- The World Wide Web is only a part of the internet that can be accessed using a browser
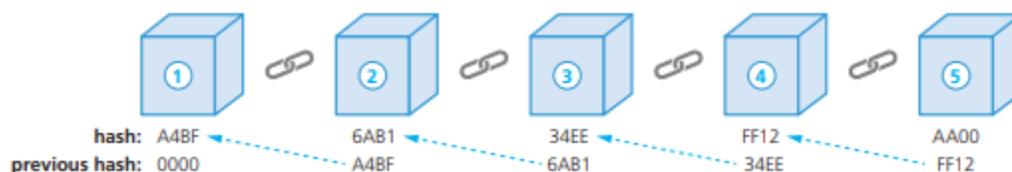- It is a collection of websites and webpages.

| Internet | World Wide Web |
|---|---|
| Collection of interconnected networks and devices | Collection of web pages and websites |

- Web Pages are hypertext documents displayed on the world wide web
- Web Servers contain a bunch of web pages

- Flow of Accessing a Web Page :
  - User Enters URL into Browser
  - User's browser sends URL to DNS server for IP address
  - DNS server gives User's browser IP address
  - User's browser sends IP address to web server requesting web page
  - Web server gives User's browser web page and cookies if stored

- Browsers are software that allow users to access and display web pages on their device screens, they interpret HTML.

- Features of Browsers :
  - Store bookmarks and history, and data as cache
  - Contain multiple tabs and address bars
  - Make use of JavaScript, cookies and Hyperlinks.

- Hyperlinks can be used to open links in two ways :
  - Click on the link for it to open in the current tab or window
  - Click on the link while holding control for it to open in another tab or window

- Uniform Resource locators ( URLs ) are text addresses used to access websites.

- URLs are typed into a browser using the following format :
  - **Protocol** :// **website address** / **path** / **filename**

- The **Protocol** is usually either **:**
  - Http
  - Https

- The **Website address** is :
  - Domain host ( www. )
  - Domain name ( website name )

- - Domain type ( .com, .org, .net )
  - Country Code ( .uk, .de, .cy ) { sometimes }

- The **Path** is the web page.

- The **file name** is the item on the web page.


- Hypertext transfer protocol ( http ) is a set of rules that must be obeyed when transferring files across the internet.

- When some form of security is used ( SSL or TLS ), then http changes to https, indicating "secure", this shows by the padlock next to the url.

- HTTP is vulnerable to interception
- HTTPS is secured as it is encrypted

- HTML is a language used to display content on browsers.

- HTML can be separated to :
  - Structure
  - Presentation

- Structure includes :
  - Margins of Page
  - Line Break
  - Padding

- Presentation includes :
  - Font Size
  - Font Color
  - Background Color

- They both are separated so that when any changes to the presentation need to be made, it can undergo changes without altering the functionality of the website.

- All websites are written in HTML and hosted on a web server that has its own IP address.

- The Domain Name Server ( DNS ) is a system for finding IP addresses for a domain name given in a URL.

- DNS servers contain a database of URLs with the matching IP addresses.

- The DNS Process :
  - The User types in a URL on a Browser
  - Browser sends the URL to the DNS Server to obtain the IP Address
  - Browser sends IP Address to the Web Server requesting for its Web Page

- DNS Cache Poisoning is known as when the IP address of a website is changed to a malicious one in order for pharming to take place.

- Cookies are small files of code stored on a user's computer, on the browser or the hard disk.

- They are sent by a web server to a browser on a user's computer.

- Each cookie contains pairs of ( **<span style="color:blue">key</span>**, **<span style="color:red">data</span>** ) { **ex. <span style="color:blue">Surname</span>**, **<span style="color:red">charles</span>** }

- Everytime a user visits a website, they may have previously saved cookies which hold information by the user's previous browsing history, currency or language.

- There are two types of cookies :
    - Session Cookies ( Stored on RAM )
    - Persistent Cookies ( Stored on HDD )

- Session cookies are temporary and are used when making online purchases by keeping the user's items in a virtual shopping basket.

- These cookies don't exist after the browser is closed.

- Persistent cookies are permanent and remember a user's credentials when logging in to a website.

- Flow of accessing Cookies :
    - Web Server sends cookies file to User's Browser
    - Cookies data is encrypted
    - Cookies are stored on User's HDD / SSD
    - When user revisits website, Web Server requests cookies file
    - Browser sends cookies to web server

- Features of Cookies
    - Store log in details
    - Store User preferences
    - Store items in virtual basket

- Digital currency exists purely in an electronic format.

- Digital currency can be transferred between various accounts when carrying out transactions.

- Digital currency relies on a central banking system :
    - Person X wishes to send money to Person Y
    - Person X → Bank X → Central Bank → Bank Y → Person Y

- Maintaining confidentiality and security are issues with centralisation, however an example of digital currency known as cryptocurrency overcomes these issues.

- Cryptocurrency introduces decentralization :
    - Person X wishes to send money to Person Y
    - Person X → Person X's Wallet → Person Y's Wallet → Person Y

- Cryptocurrency uses cryptography to track transactions in order to deal with the problems associated with the centralisation of digital currency.

- Traditional digital currencies rely on central banks and governments, whereas cryptocurrency is independant.

- The Cryptocurrency system works by being within a blockchain network

- Blockchain is a decentralized database which stores all the transactions of networked members.

- Blockchain consists of a number of interconnected computers which are not connected to a central server, all transaction data is stored on all computers in the blockchain.

- This helps remove the risk of hacking as all the networked computers get a copy of the transaction and it can't be changed without the consent of all.

- Blockchain is used in :
    - Cryptocurrency exchanges
    - Politics
    - Education

- Whenever a new transaction takes place, a new block is created which consists of :
    - Data
    - Hash Value
    - Previous Hash Value

- The **Data** may include the name of sender and receiver or amount of money.

- The **Hash Value** is a unique value given to each block by an algorithm ( usually a cryptographic algorithm called SHA 256 ).

- It also includes a timestamp which identifies when an event takes place

- The **Previous Hash Value** is just the previous block's hash value in a blockchain.

- In a blockchain, the first block is referred to as the genesis block as it does not have any previous hash value, but it has its own hash value.

- The Second block attains a new hash value and the previous block's hash value becomes the new block's "previous hash value".



| | ① | ② | ③ | ④ | ⑤ |
|---|---|---|---|---|---|
| hash: | A4BF | 6AB1 | 34EE | FF12 | AA00 |
| previous hash: | 0000 | A4BF | 6AB1 | 34EE | FF12 |

- This order of this blockchain prevents any tampering with it, if the order is changed, then it can be determined that it has been tampered with in some way.

- A hacker can't change every single block in a block chain without it being noticed.

- This is because of proof of work which makes sure it takes exactly 10 minutes to create a new block in a blockchain.

- This is protected by miners which are special network users that get a commission for each new block created

- Cryptocurrency is safe because of :
    - The Order of the Blockchain
    - Blockchains being stored on every computer

- Proof of Work

Cyber Security Threats :
1. Brute Force Attack        [ Stronger Passwords ]
2. Data Interception        [ Anti Virus ]
3. DDoS Attacks        [ Proxy Server ]
4. Hacking        [ Firewall ]
5. Malware ( Viruses, Worms, Trojan Horses, Spyware, Adware, Ransomware )
6. Phishing        [ Anti Virus ]
7. Pharming        [ Anti Virus ]
8. Social Engineering

1. **Brute Force Attack** is known as when hackers get your password by trying every single possible combination of letters, numbers and other symbols.

    **Effect :** Access to Personal Data
    **Solution :** Use Stronger Passwords / 2FA

2. **Data Interception** is a form of stealing data by tapping into a wired or wireless communication link.

- When using <u>wired</u> networks, a packet sniffer is used which examines data packets being sent over a network in order for interception.

- When using <u>wireless</u> networks, wardriving is used which uses wireless internet connections illegally.

    **Effect :** Delete / Corrupt Files
    **Solution :** Use Anti Virus

3. **DDoS** ( Distributed Denial of Service Attack ) is an attempt at preventing users from accessing part of a network such as a website.

    - In a <u>DDoS</u> attack, these requests are sent from many different computers.
    - In a <u>DoS</u> attack, it's sent from the same computer.

- A website server can handle a limited number of requests, so an attacker sends out thousands of requests to flood the server which makes it hard for the server to service the real request.

    **Effect :** Damaged Company Reputation / Revenge
    **Solution :** Use Proxy Server

4. **Hacking** is the act of gaining illegal access to a computer system without the user's permission.

    - <u>Malicious Hacking</u> is when data is hacked and then changed, sent or deleted.
    - <u>Ethical Hacking</u> is when companies authorize paid hackers to test their security.

    **Effect :** Access to Personal Data and Delete / Corrupt Files
    **Solution :** Use Firewall

5. **Malware** has many types :
    - Viruses
    - Worms
    - Trojan Horse

- Spyware
- Adware
- Ransomware

- <u>Viruses</u> are programs that replicate themselves to delete or corrupt files, they need an active host program to operate.

- <u>Worms</u> are standalone viruses that replicate themselves to spread to other computers in a network; they don't need an active host program to operate.

- <u>Trojan Horses</u> are malicious programs disguised as legitimate software to harm the computer.

- <u>Spyware</u> is software that gathers information by monitoring the activity on a user's computer.

- <u>Adware</u> is a software that floods a user's computer with unwanted advertising, usually in the form of pop-ups.

- <u>Ransomware</u> are programs that encrypt the data on a user's computer and hold it hostage until payment is received by the user.

   **Effect :** Delete / Corrupt Files
   **Solution :** Use Anti Malware

6. **Phishing** is when a legitimate looking email is sent to the user asking for personal data such as bank details. <u>Spear phishing</u> is when specific users are targeted.

   **Effect :** Access to Personal Data
   **Solution :** Don't Open Suspicious Emails

7. **Pharming** is a code that redirects the user's browser to a fake website without the user's knowledge by using DNS cache poisoning, it doesn't require the user to input personal data, it can take it regardless.

- DNS cache poisoning is when an IP address is changed in the DNS to redirect users to malicious websites.

   **Effect :** Access to Personal Data
   **Solution :** Use Anti Virus

8. **Social Engineering** is when users are manipulated in these ways :
   - Instant Messaging : False Update Warnings ( **Curiosity** )
   - Scareware : False Virus Warnings ( **Fear** )
   - Emails : False Emails Which Look Genuine ( **Trust** )
   - Baiting : Memory Stick left publicly outside with malicious codes embedded ( **Curiosity** )
   - Phone Calls : False Warning Calls ( **Fear** )

- <u>Cyber Security Solutions :</u>
1. Physical Methods
2. Anti Malware
3. Authentication
4. Firewalls
5. Proxy Servers
6. Secure Sockets Layer

1. **Physical Methods include :**
   - Locking it in a safe place
   - Bodyguards
   - CCTV


2. **Anti-Malware Protects Against Viruses and Spyware :**
   - Anti Virus
   - Anti Spyware

- <u>Features of Anti Virus :</u>
   - Detects and Quarantines Viruses
   - Prevents User from downloading Viruses

- <u>Features of Anti-Spyware :</u>
   - Detects and Removes Spyware
   - Prevents User from Downloading Spyware
   - Encrypts Data to make it more Secure

3. **Authentication Protects Against Brute Force Attacks by Either :**
   - Something You Know ( Password or PIN )
   - Something You Have ( Phone Number or Email )
   - Something Which Is Unique To You ( Biometrics )

- <u>Passwords or PINs are used when :</u>
   - Accessing Email Accounts
   - Carrying Out Online Banking or Shopping
   - Accessing Social Networking Sites

- Strong Passwords Should Contain :
   - At Least One Capital Letter
   - At Least One Number
   - At Least One Character

- <u>Phone Numbers or Emails are used when carrying out Two-Step Authentication :</u>
   - User Logs Into His Account
   - A Code Is Sent To User's Phone Number or Email
   - User Enters the Code to Verify His Authentication

- <u>Biometrics rely on certain unique characteristics of human beings such as :</u>
   - Fingerprints
   - Retina Scans
   - Face Recognition
   - Voice Recognition

- Images of Fingerprints are compared against previously scanned fingerprint images stored in a database to see if they match.

- Retina Scans use Infrared light to scan the unique pattern of Blood vessels in the Retina.

| Biometric | Benefits | Drawbacks |
|---|---|---|

| | | |
|---|---|---|
| Fingerprints | - Unique<br>- Impossible To Hack<br>- Can't Be Misplaced | - Expensive<br>- Won't Work If Injured |
| Retina Scans | - Unique<br>- Impossible To Hack<br>- Can't Be Misplaced | - Expensive<br>- Slow<br>- Intrusive |
| Face Recognition | - Non-Intrusive<br>- Inexpensive | - Affected by Age<br>- Affected By Lighting |
| Voice Recognition | - Non-Intrusive<br>- Inexpensive | - Affected By Age or Sickness<br>- Can Be Hacked |

- There are four things to look out for when emails are sent to you :
  - The Email Address ( @gmail.com is never used )
  - The Tone and Grammar
  - Misspelling of Domain Names ( Known As Typosquatting : Amozon, Gougle, etc )
  - Suspicious Links

4. **A Firewall is the Primary Defense of a computer :**
   - It is both Software and Hardware
   - It Protects against Hacking, Malware, Phishing and Pharming.

- <u>The Tasks of A Firewall :</u>
  - Examines the Traffic Between User's Computer and A Public Network
  - Checks Whether Incoming or Outgoing Data meets a given set of Criteria
  - Allows or Denies access to an external data source based on the Criteria

5. **Proxy Servers Act as an Intermediate between the User and a Web Server.**
   - It Protects against DDoS

- <u>The Tasks of a Proxy Server :</u>
  - Filters the Traffic Between User's Computer and Web Server
  - Allows or Denies Access to a web server
  - Keeps Users IP address secret
  - Acts as Firewalls
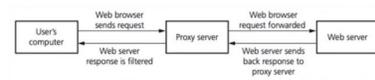


- In a DDoS attack, the requests hit the proxy server instead of the web server

6. **Secure Sockets Layer ( SSL ) is a set of rules used by computers to communicate with each other across a network.**

- A user can know when SSL is being applied by checking if https or the small padlock is being shown.

- When A User wants to access a website which uses SSL :
  - User opens a Secure Website
  - User's Browser sends a message to the Website to identify itself
  - Website sends a copy of its SSL certificate to User's Browser
  - Communication can now begin

- The Data being exchanged between the both parties is now encrypted

- An SSL certificate is a form of digital certificate which is used to authenticate a website.

- TSL is the successor of SSL and has two layers :
  - Handshake Layer
  - Record Layer

**Chapter 6**

- An Automated System is a Combination of Software and Hardware that is designed to work automatically without the need of human interference.

- Automated Systems have :
  - Sensors ( To Gather Data And Send To Microprocessor )
  - Microprocessors ( To Process Data and Send To Actuator )
  - Actuators ( To Be Used As A Form Of Output )

- Automated Systems are used in the following areas :
  - Industrial
  - Transport
  - Agriculture
  - Weather
  - Gaming
  - Lighting
  - Science

| Advantages of Automated Systems | Disadvantages of Automated Systems |
|---|---|
| Faster | Expensive |
| Better Success Rate | Requires Maintenance |

- Robotics is a branch of Computer Science that brings together the design, construction and operation of Robots.

- Robots can be found in :
  - Factories
  - Houses
  - Drones

- Robots have the following characteristics :
  - Have Electrical Components
  - Have a Mechanical Structure
  - Are Programmable

- **Robots can be classified as :**
  - Physical Robots
  - Software Robots ( Not True Robots )

- Physical Robots have two types :
  - Independant
  - Dependant

- Independant Robots :
  - Don't Require Human Interaction
  - Can Replace a Human Entirely

- Dependant Robots :
  - Require Human Interaction
  - Can Only Help Humans, Not Replace Them.


- Robots are used in the following areas :
  - Industry
  - Transport
  - Agricultural
  - Medicine
  - Domestic
  - Entertainment

| Advantages of Robots | Disadvantages of Robots |
|---|---|
| Don't Require Sleep | Lead To Unemployment |
| Can Work in Hazardous Areas | Expensive |
| More Productive | |
| Less Likely To Make Mistakes | |

| Advantages of Autonomous Vehicles | Disadvantages of Autonomous Vehicles |
|---|---|
| Safer | Can Be Hacked |
| Operate More Efficiently | Expensive |
| Smooth Out Traffic Jams | High Maintenance |
| Can Self Park | Reluctance to Use the New Technology |

- Autonomous Trains use LiDar ( Light Detection And Ranging ).

- LiDar uses lasers which build up a 3D image of the surroundings.

- Phenotyping is the process of observing physical characteristics of a plant in order to assess its health and growth.

- Artificial Intelligence is another branch of Computer Science which deals with the simulation of intelligent human behavior by a computer.

- The Cognitive functions of a Human Being can be replicated in a Machine.

- AI can be split into three categories :
  - General AI : When a Machine has a similar performance to a human in a specific task
  - Narrow AI : When a Machine has a superior performance to a human in a specific task
  - Strong AI : When a Machine has a superior performance to a human in many tasks

- Examples of AI :
    - Smart Home Devices ( Alexa, Siri, Cortana )
    - Chatbots
    - Autonomous Cars

- There are two types of AI systems :
    - Expert System
    - Machine Learning

- In an Expert System, AI is used to mimic the judgment and behavior of an organization that has expert knowledge.

- In Machine Learning, Computers are trained with sample data so they can make predictions about new unseen data, it improves over time.

- Expert Systems have a :
    - Knowledge Base ( Database of Facts to solve problems )
    - Rule Base ( Database of Rules and Logic to solve problems )
    - Inference Engine ( Applies facts from Knowledge Base and Rules from Rule Base to solve problems )
    - Interface ( Way for Users to Interact with System )

| Expert System | Machine Learning |
|---|---|
| Mimics Human Behavior | Makes decisions without being programmed |
| Aim is to build machines that think like humans | Aim is to build machines that learn through practice so they can solve future problems. |

**Chapter 7**

- The program development life cycle is divided into four stages :
    - Analysis
    - Design
    - Coding
    - Testing

- The **Analysis** stage uses abstraction and decomposition tools to identify what is required

- Abstraction keeps the key elements and discards any unnecessary details

- Decomposition breaks down a complex problem into smaller parts, which can then be subdivided into even smaller parts

- When the **Design** stage is complete, the programmer should know what is to be done

- Design stage uses structure charts, flowcharts and pseudocode

- Each module of the program is written using a suitable programming language in the **Coding** Stage

- Iterative testing means that modular tests are conducted and tests repeated until the module performs as required

- The complete program or set of programs is run many times with different sets of test data in the **Testing** stage

- A computer system is made up of :
    - Software
    - Data
    - Hardware
    - Communication
    - People

- **Top down design is the decomposition of a computer system into a set of subsystems.**

- **The process of breaking down into smaller subsystems is called stepwise refinement**

    - ( Structure Charts ) ( Structure Diagrams ) ( Top Down Design ) ( Stepwise Refinement ) Are All Breaking down into subsystems

- The component parts of any computer system are :
    - **Inputs :** Data used by the system that needs to be entered
    - **Processes :** Tasks that need to be performed using input data or other previous
    - **Outputs :** Information that needs to be displayed for the users of the system
    - **Storage :** Data that needs to be stored in files on an appropriate medium for use in the future

- Methods used to design and construct a solution to a problem :
    - Structure diagrams
    - Flowcharts
    - Pseudocode

- **Structure diagrams** can be used to show top down design in a diagrammatic form
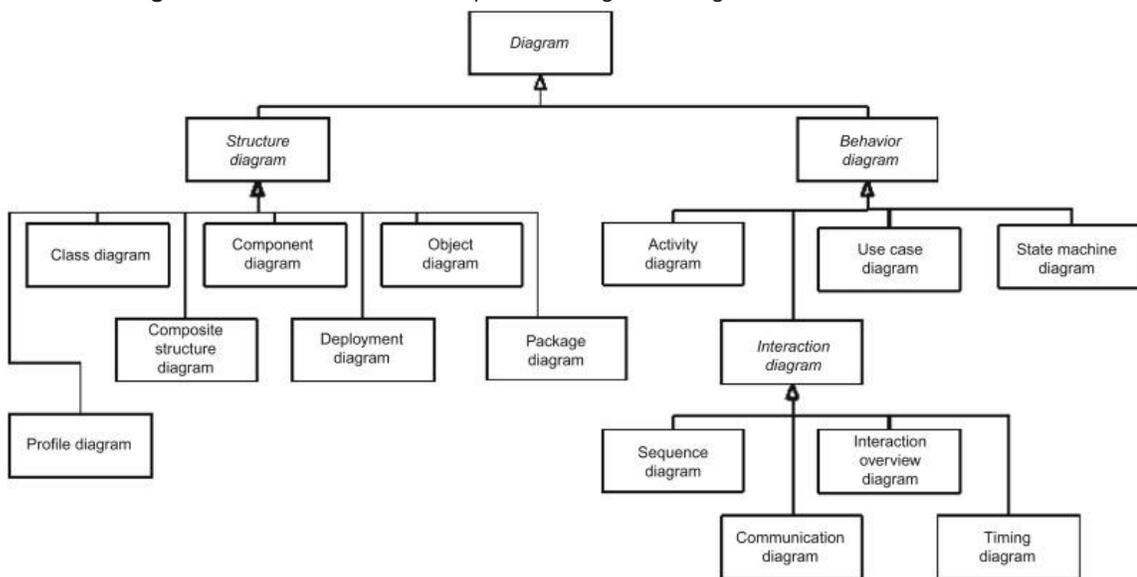


- A **flowchart** shows diagrammatically the steps required to complete the task and the order that they are to be performed.

- These steps, together with the order, are called an algorithm

- **Flowchart :**
    - Oval : Start / Stop
    - Rectangle : Process
    - Parallelogram : Input / Output
    - Rhombus : Decision
    - Lines : Show direction of flow

- **Pseudocode** is a simple method of showing an algorithm.

- OUTPUT / PRINT is used to display information to the user
- INPUT / READ is used to take in data entry from the user

- Pseudocode for Conditional Statements :
    - IF..THEN.. ELSE.. ENDIF
    - CASE-OF.. OTHERWISE.. ENDCASE

- **IF..THEN.. ELSE..ENDIF :**
    - IF is used to show the conditions
    - THEN is used to show what would happen if the IF condition is true
    - ELSE is used to show what would happen if the IF condition is false
    - ENDIF is used to end the statement

- **CASE-OF..OTHERWISE.. ENDCASE :**
    - CASE-OF is used to show the conditions
    - OTHERWISE is used to show what would happen to the conditions not included in CASE-OF
    - ENDCASE is used to end the statement

- Pseudocode for Iteration :
    - FOR..TO..NEXT Loop
    - REPEAT..UNTIL Loop
    - WHILE..DO..ENDWHILE Loop

- **FOR..TO..NEXT LOOP :**
    - Used when set number of repetitions is known

- **REPEAT..UNTIL LOOP :**
    - Used when set number of repetitions is unknown but will happen until given condition becomes true

- **WHILE..DO..ENDWHILE LOOP :**
    - Used when set number of repetitions is unknown but will happen until given condition is no longer true

- An Algorithm sets out the steps to complete a given task.

- Standard Methods Used in Algorithms :
    - Totalling
    - Counting
    - Finding Max, Min and Average
    - Searching using linear search
    - Sorting using a bubble sort

- **Totalling :**

- ● Totalling means keeping a total that values are added to

- **Counting :**
    - ● Counting means keeping a count of the number of times an action is performed

- **Max, Min and Average :**
    - ● MaximumMark <~ 0
    - ● MinimumMark <~ 100
    - ● IF Grade > MaximumMark
    - ● THEN
    - ● MaximumMark <~ Grade
    - ● ENDIF
    - ● IF Grade < MinimumMark
    - ● THEN
    - ● MinimumMark <~ Grade
    - ● ENDIF

- **Linear Search :**
    - ● Linear Search inspects each item in a list to find the value searched for by the user

- **Bubble Sort :**
    - ● Bubble Sort sorts elements in an order

- Validation is the automated checking by a program that data is reasonable before it is accepted, the types include :
    - ● Range checks
    - ● Length checks
    - ● Type checks
    - ● Presence checks
    - ● Format checks
    - ● Check digits

- A range check checks that the value of a number is between a given range
    - ● IF Number < 0 OR > 100
      THEN
      OUTPUT "Invalid"

- A length check checks that data contains an exact number of characters or a reasonable amount.
    - ● IF LENGTH (Password) <> 8
      THEN
      OUTPUT "Invalid Amount"

- A type check checks that the data entered is of a suitable given data type.
    - ● IF Number <> DIV(Number, 1)
    - ● THEN
    - ● OUTPUT "Must be a whole number"

- A presence check checks to ensure that some data has been entered and not entirely left blank.
    - ● IF Email = ""
    - ● THEN
    - ● OUTPUT "*=Required"

- A format check checks that the characters entered conform to a pre-defined pattern.

- A check digit is the final digit included in a code.

- Verification is checking that data has been accurately copied from one source to another, methods include :
    - ● Double Entry

- ● Visual Manual Check

- For double entry, the data is entered twice, and the computer system compares both entries, and if they are different, an error message is displayed.

- Types of Test Data include :
    - ● Normal Data ( Data that is accepted by a program )
    - ● Abnormal Data ( Data that is rejected by a program )
    - ● Extreme Data ( Largest and Smallest values out of a given range of data )
    - ● Boundary Data ( One value which is accepted while the other is rejected)

- A trace table is used to record the results from each step in the algorithm.

- The manual exercise of working through an algorithm step by step is called a dry run.

| Operator | Meaning |
|----------|---------|
| > | Greater than |
| < | Less than |
| = | Equal to |
| >= | Greater than or equal to |
| <= | Less than or equal to |
| <> | Not equal to |
| AND | Both |
| OR | Either |
| NOT | Neither |

**Chapter 8**

- The five basic constructs to use when programming are :
    - ● Data Use ( variables, constants and arrays)
    - ● Sequence
    - ● Selection
    - ● Iteration
    - ● Operator Use

- A Variable is a named data storage that contains a value which may change during the execution of a program

- A Constant is a named data storage that contains a value which does not change during the execution of a program

- Declaring in Pseudocode :
    - ● DECLARE FirstVar : INTEGER   ( Explicit Declaration )

- CONSTANT FirstConst = 500     ( Implicit Declaration )

- The basic data types are :
  - INTEGER ( 200, 300, 400)
  - REAL ( 200.5, 300.5, 400.5)
  - CHAR ( A, B, C)
  - STRING ( Saim )
  - BOOLEAN ( True Or False)

- A Prompt is known as the output that states a user to do something ( "PLEASE ENTER NAME" )

- A message is known as the actual output shown to the user ( "YOUR NAME IS", Name )

- The following concepts need to be understood when writing a program :
  - Sequence
  - Selection
  - Iteration
  - Counting & Totalling
  - String Handling
  - Use Of Operators

- **Sequence :**
  - The sequence or order of steps must be correct

- **Selection :**
  - Selecting which type of conditional statement to use

- **Iteration :**
  - Count Controlled Loops : Set Number of Repetitions ( FOR.. TO.. NEXT )
  - Pre-Condition Loops : May Have no Iterations ( WHILE.. DO.. ENDWHILE )
  - Post-Condition Loops : At least One Iteration ( REPEAT.. UNTIL )

- **Totalling & Counting :**
  - Totalling and Counting..

- **String Handling :**
  - Every data value is automatically assigned a string, until it is declared something else.

- String Handling includes writing programs for :
  - Finding Length
  - Extracting Substring
  - Converting To UpperCase
  - Converting To Lowercase

- Finding Length :
  - LENGTH ( "Computer Science" )
    LENGTH ( MyString )

- Extracting Substring :
  - SUBSTRING ( "Computer Science ",  10, 7 )
  - SUBSTRING ( MyString, 10, 7 )
  - First Parameter : String
  - Second Parameter : Position of start of Desired Substring
  - Third Parameter : Length of Desired Substring

- Converting To UpperCase :
  - UCASE ( "Computer Science" )
  - UCASE ( MyString )

- Converting To Lowercase :
  - LCASE ( "Computer Science" )
  - LCASE ( MyString )

- **Use Of Operators :**

- Mathematical Operators

| | |
|---|---|
| + | Add |
| - | Subtract |
| * | Multiply |
| / | Divide |
| ^ | To The Power Of |
| MOD | Remainder Division |
| DIV | Integer Division |

- Logical Operators

| | |
|---|---|
| > | Greater Than |
| < | Less Than |
| = | Equal |
| >= | Greater Than or Equal |
| <= | Less Than or Equal |
| <> | Not Equal |

- Boolean Operators

| | |
|---|---|
| AND | Both True |
| OR | Either True |
| NOT | Not True |

- When writing a program, there are often similar tasks to perform that make use of the same group of statements.

- Instead of repeating these statements, subroutines are used.

- Subroutines include :

- Procedures
- Functions

- A Procedure is a set of programming statements grouped together that can be called at any time during the program.

- A Function is a set of programming statements grouped together that can be called at any time during the program, which returns a value back.

- Parameters are the variables that store values of arguments passed to a procedure or function.

- Procedures without Parameters :
    - PROCEDURE Stars
    - OUTPUT "********"
    - ENDPROCEDURE

    - CALL Stars

- Procedures with Parameters :
    - PROCEDURE Stars ( Number : INTEGER )
    - DECLARE Counter : INTEGER
    - FOR Counter = 1 TO NUMBER
    - OUTPUT "*"
    - NEXT COUNTER
    - ENDPROCEDURE

    - CALL Stars (7)

- Functions with Parameters :
    - FUNCTION Celsius ( Temperature : REAL ) RETURNS REAL
    - RETURN ( Temperature - 32 ) / 1.8
    - ENDFUNCTION

    - MyTemp = Celsius ( MyTemp )

- When Procedures and Functions are defined, the first statement in the definition is a header.

- A Header contains :
    - The name of Procedure or Function
    - Any Parameters given to Procedure or Function, and their data type
    - The Data Type of the return value for a Function

- A Global Variable can be used by any part of the program, its scope covers the whole program.

- A Local Variable can be used by the part of the program it was declared in, its scope is restricted.

- Library Routines include :
    - MOD ( Returns Remainder of Division)
    - DIV ( Returns Quotient of Division )
    - ROUND ( Returns Value rounded to given number of decimal places )
    - RANDOM ( Returns A Random Number)

- A Maintainable Program should  :
    - Always use meaningful names
    - Be divided into Modules for each task
    - Be fully commented using // feature

- An Array is a data structure containing several elements of the same data type.

- The position of each element in an array is identified using the array's index.

- The first element of an array can have an index of zero or one, some programming languages automatically set the first index to zero.

- Array's are either  :
  - One Dimensional
  - Two Dimensional

- One Dimensional Arrays can be referred to as a list.

- These Elements are included when declaring a One Dimensional array  :
  - Name of Array
  - First Index Value
  - Last Index Value
  - Data Type

  - DECLARE MyList : ARRAY( 0:9 ) OF INTEGER

- Two Dimensional Arrays can be referred to as a table.

- These Elements are included when Declaring a Two Dimensional Array  :
  - Name of Array
  - First Index Value for Row
  - Last Index Value for Row
  - First Index Value for Columns
  - Last Index Value for Columns

  - DECLARE MyTable : ARRAY( 0:9, 0:2) OF INTEGER

**Chapter 9**

- A database is a structured collection of data that allows people to extract information out of it.

- A single table database contains only one table.

- In a Database :
  - Data is stored in tables
  - These tables consist of records and fields

- The records ( rows ) consist of several fields ( columns )

- A table contains only one type of data, be it a patient's info or a book's.

- These are the basic data types that can be stored in a Database :
  - Text ( Short / Long Text )
  - Character
  - Boolean ( Yes / No )
  - Integer ( Whole Number )
  - Real ( Decimal Number )
  - Date/Time

- Each field will require a data type to be selected.

- In order to identify an item from the data stored about it in a record, primary keys are used.

- Primary keys are fields that uniquely identify an individual item ( 6 digit code, etc )

- Structured Query Language ( SQL ) is the standard language to obtain information from a Database.

- A SQL Script is a list of SQL commands that perform a given task

- SQL Statements :

| | |
|---|---|
| SELECT | Fetches specified fields from a table. |
| FROM | Identifies the table to use |
| WHERE | Includes only records that match a given condition |
| ORDER BY | Sorts the results from a query either alphabetically or numerically |
| SUM | Returns the sum of all values in a field, used with SELECT |
| COUNT | Counts the number of records where the field matches a specified condition, used with SELECT |

- An SQL command :
    Starts with   SELECT  ( Identifies fields )
                        FROM    ( Identifies table )
                        :
                        :
    Ends with    ;


- SELECT Statement :
    - SELECT FirstName, FamilyName
    - SELECT * ( Specifies all fields )

- FROM Statement :
    - FROM TableName

- WHERE Statement :
    - WHERE TableNumber = 80

- ORDER BY Statement :
    - ORDER BY FamilyName ( Sorts in Ascending order )
    - ORDER BY FamilyName DESC ( Sorts in Descending order )

- SUM Statement :
    - SELECT SUM ( Field )

- COUNT Statement :
    - SELECT COUNT ( Field )


**Chapter 10**

- Logic Gates take binary inputs and produce a binary output.
- Several Logic Gates combine to form a Logic Circuit.

- Truth Tables are used to trace the output from a logic gate or circuit.

- There are six different Logic Gates :
    - NOT Gate
    - AND Gate
    - OR Gate
    - NAND Gate
    - NOR Gate
    - XOR Gate

- NOT Gate :

| INPUT | OUTPUT |
|-------|--------|
| **A** | **X** |
| 0 | 1 |

    - OUTPUT would be 1 if INPUT is 0
    - X = NOT A.

- AND Gate :

| INPUT | OUTPUT |
|-------|--------|
| **A  B** | **X** |
| 1  1 | 1 |

    - OUTPUT would be 1 if both INPUTS are 1
    - X = A AND B

- OR Gate :

| INPUT | OUTPUT |
|-------|--------|
| **A  B** | **X** |
| 0  1 | 1 |
| 1  1 | 1 |

    - OUTPUT would be 1 if one or both INPUTS are 1
    - X = A OR B

- NAND Gate :

| INPUT | OUTPUT |
|-------|--------|
| **A  B** | **X** |
| 0  1 | 1 |

    - OUTPUT would be 1 if both INPUTS aren't 1
    - X = A NAND B

- NOR Gate :

| INPUT | OUTPUT |
|-------|--------|
| **A  B** | **X** |
| 0  0 | 1 |

    - OUTPUT would be 1 if neither INPUTS are 1
    - X = A NOR B

- XOR Gate :

| INPUT | OUTPUT |
|-------|--------|
| **A  B** | **X** |
| 0  1 | 1 |

    - OUTPUT would be 1 if either INPUT is 1
    - X = A XOR B

- The Order of Precedency :
    - ()
    - NOT Gate
    - AND Gate
    - OR Gate

- The Gate with the higher precedence will get drawn first in a Logic Circuit.

- Boolean Algebra consists of
    - Logic Circuits
    - Logic Expressions

- Truth Tables

- Converting from Logic Circuits to Logic Expressions :
  - X = D  [ D doesn't exist ]
  - X = NOT C OR B  [ C doesn't exist ]
  - X = [ NOT A ] OR B

- Converting from Logic Expressions to Logic Circuits :
  - The Gate with the highest precedence gets drawn first [ Usually the one in () ]
  - Then the ones with the lower precedence

- Converting from Logic Circuits to Truth Tables :
  - Split the Circuit into parts with alphabets representing the output of each gate
  - Make smaller Truth Tables of the parts
  - Join all Tables to form a Truth Table

- Converting from Truth Tables to Logic Circuits :
  - Only consider the Output that equals to 1
  - Write which kind of Gate would equal to 1, considering given alphabet input
  - Join all Gates with an OR Gate and convert to a Logic Circuit

- Converting from Logic Expressions to Truth Tables :
  - Convert the Logic Expression into a Logic Circuit first
  - Then Convert the Logic Circuit into a Truth Table

- Converting from Truth Tables to Logic Expressions :
  - Only consider the Output that equals to 1
  - Write which kind of Gate would equal to 1, considering given alphabet input
  - Join all Gates with an OR Gate