Chapter 3: Hardware

⇒ Data Storage

- → Primary
- → Secondary
- → Register is the component within the CPU

component	Category
Register	Processor Component
Cache Memory	Primary Storage
Main Memory	Primary Storage
Hard disk	Secondary Storage
Auxiliary storage	Secondary Storage

Access time increases down the group
Capacity increases down the group
Size increases down the group
Cost decreases down the group

⇒ Data Output (Devices)

- → Screen Display
- → Printer or Plotter
- → Virtual headset display
- → Speaker
- →

⇒ Data input (devices)

- → keyboard or keypad
- → interacting with touch screens
- → game controllers
- → Scanner
- → microphone

⇒ Embedded Systems

- → Any manufactured item that has mechanical or electrical parts will certainly contain one or more embedded system.
- → An embedded system must contain processor, memory and I/O capability. If these are constructed on one chip it is called microcontroller.
- → embedded system can provide full user interface, ex. mobile phones.
- → embeddes systems are special-purpose, possibly performing only a single function, this function is likely to be required in a wide variety of products
- → Embedded systems are less likely to be protected against unlawful actions than general-purpose systems.

⇒ Main Memory

→ Components of Main Memory

→ RAM (Random access memory)

→ ROM (Read only memory)

⇒ RAM

→ any byte of data stored can be accessed without affecting other bytes stored.

→ RAM can be repeatedly read from or written to

→ it is volatile

→ DRAM (Dynamic RAM)

→ constructed from capacitors that leak electricity and need regular charging.

→ SRAM (Static RAM)

→ constructed from flip-flops that continue to store data indefinetely

→ Difference in SRAM and DRAM

→ DRAM is cheaper, high density for data storage, slower access speed

→ SRAM is costlier, faster access speed.

→ Normally main memory is constructed by DRAM and cache is constructed by SRAM.

→ Embedded systems that need RAM for less storage use SRAMs

⇒ ROM

→ it can only be read to and not written to

→ it is non-volatile (data not lost when computer is switched off)

→ stores bootstrap program

→ used in many embedded systems

→ PROM (Programmable ROM)

→ The manufacturer of the chip supplies chips to a system builder, then he installs the program or data into the chips.

→ EPROM (Erasable Programmable ROM), erased using U.V light and new program can be installed, reprogramming usually requires the chip to be removed from the circuit

→ EEPROM (Electrically Erasable Programmable ROM) → does not need to be removed → erased using electrical signals

⇒ Buffers

→ whenever data has to be transfered from one part to another part of the computer, a problem occurs that data can be sent quicker than it can be recieved. So we use buffers. Buffer is a temporary storage created where the data is stored in a queue.

⇒ Secondary Storage

→ Magnetic Media
→ Optical Media
→ Solid State Media

⇒ Magnetic

→ The interaction is controlled by a read head and write head
→ read head uses basic laws of physics that a state of magnetisation will affect an electrical property. Write head uses the reverse law.
→ Physical construction
  → There is more than one platter (disk)
  → Each platter has a read-write head for each side
  → The platters spin in "UNISON" (all together at same speed)
  → The read-write heads are attached to actuator arms that help the heads to move over the surface of the platters
  → The motion of each read-write head is synchronised
  → a cushion of air ensures that a head does not touch platter
→ Data is stored in concentric tracks. Each track contains sequence of bits which is formatted into sectors, each sector contains defined no. of bytes the sector becomes the smallest unit of storage
→ to store a file a sufficient number of sectors have to be allocated but these might or might not be next to each other, because sectors are in continuous use (created, deleted or used), which degrades the performance of the platter (disk).
→ Magnetic media is direct access read-write device because any sector can be chosen for writing or reading. However the data in the sector has to be read sequentially (in order)

⟹ Optical

→ Compact Disc (CD) evolved into Compact Disc digital audio (CD-DA) which was used in CD-ROM. This could not compete with floppy disks, so then came CD-Read Write (CD-RW) which basically is an alternative to floppy disks. However now CD has given way to DVD (Digital versatile disc). Currently the best and most powerful optical media device is Blu-ray-disc (BD).

→ process of reading data from the disc

→ The optical disc has one spiral track running from the inner extreme of the surface to the outer edge

→ During operation, disc spins and simultaneously the laser moves accross ensuring that it is continously focused on spiral tracks

→ The track on the surface of the disc has what are referred to as 'pits' and 'lands'. The laser beams is reflected from the surface of the disc

→ The difference between pit and land can be detected by the reflection.

→ For CD-RW and DVD-RW, the reflective surface is a special alloy material.

→ When data is written on the disc (burn process) the heat changes material into liquid form. Depending on the intensity of laser the material converts to either crystalline or an amorphous solid form when it cools. When disc is read the crystaline reflects but amorphous does not

→ Optical media is direct-access as the lasers can move forward and backward

→ The data is formatted into sectors along the track.

→ Shorter wavelength can be better focused. BD > DVD > CD

⇒ Solid State

→ The basis for this is 'flash' memory, which is a semiconductor technology with no moving parts

→ The circuits consist of arrays of transistors acting as memory cells

→ The most frequently used technology is NAND with memory cells connected in series

→ The writing to the memory and the reading from it is handled by a NAND flash controller

→ The special feature - blocks of memory cells can have their contents erased all at once (in a flash)

→ The most frequent use is in a memory card or USB flash drive This is currently the tech choice for removable data storage.

→ The alternative to hard disk is SSD. SSD is faster.

⇒ Output Devices

→ Screen Display → VR headset

→ Hard copy (text) → Hard copy (graphics)

⇒ Screen Display

→ A screen pixel consists of 3 sub-pixels typically one each for red, green and blue. Varying the level of light emitted from each pixel will form a full range of colours.

→ Cathode ray tube (CRT) is used to create a pixel.

→ In the CRT the inner surface of the screen is covered with phosphor, which is a material that emits light when e^- fall on it.

→ An individual pixel is lit up by controlling the direction of e^- beams used

→ LCD (Liquid crystal display). It has cells to create pixels which is illuminated by back-lighting.

→ Components of LCD

→ Backlight, TFT glass polariser, Liquid crystal (voltage), Colour filter glass, Colour filter, Polariser

→ Backlight is provided by LED or OLED (organic Light emitting diode)

⇒ Virtual Reality Headset

→ most important component = two eye pieces. These are fed paired images, when looked at together, gives the eyes a sensation of being in a 3d environment.

⇒ Printers

→ Inkjet

→ Laser

⇒ Inkjet

→ A sheet of paper is fed in

→ The printhed moves accross the paper depositing ink

→ The paper is moved forward the the printhead moves accross again.

→ This continues until fully printed

→ The printhead consits of nozzle that spray droplets on to the paper. An ink cartridge or cartridges is used it can contain only black or it can contain all 3 colours RGB.

→ The ink droplets are produced using

→ Thermal Bubble - Tiny resistors create localised heat which makes the ink vaporise, forms a bubble which causes the ink to be ejected from the print head onto the paper. Then the bubble collapses which creates a small vacuum allowing fresh ink to be drawn.

→ Piezoelectric - a crystal is located at the back of the ink reservoir for each nozzle. The crystal is given a tiny electric charge which makes it vibrate. This vibration forces ink to be ejected onto the paper.

→ A stepper motor and belt moves the print head.

⟹ Laser Printer

→ uses dry powder ink

→ prints the whole page in one go (unlike inkjet)

→ Colour laser printers use four toner cartridges - blue, cyan, magenta and black

→ Working of Laser Printer

→ Drum is given an electric charge

→ Drum starts to revolve step by step

→ At each step laser beam is directed by the mirror and lens to a sequence of positions

→ at each spot the laser is either switched off to keep the charge on or turned on to discharge the position.

→ This process repeats until a full page is electrostatic

→ The drum is coated with charged toner so it only sticks to places that are discharged.

→ Sheet of paper is given an electric charge

→ The sheet of paper is discharged and then is passed through heated rollers to fuse the toner particles and seal the image on the paper surface.

→ The drum is discharged before next paper.

⟹ 3d Printers

→ 3d design is created in CAD, design is split into layers

→ The data for the first layer is passed to the 3d printer

→ 3d printer uses nozzle to squirt material on to the printer bed to create a physical layer to match the design. Same process repeated for each layer

⟹ Input Devices

→ Keyboard

→ Screens

→ Input of graphics

⇒ Keyboard

→ allows user to input text data.

→ it has an electrical circuitry together with its own microprocessor and a ROM chip

→ the keys are positioned above a key matrix, which consists of set of rows of wires and another set of columns of wires.

⇒ Touch Screen

→ Considered as both output and input device

→ Two Types - Resistive and Capacitive

→ Resistive

→ Consists of two charged plates

→ Pressure causes plates to touch, completing circuit

→ Point of Contact registered with coordinates used to calculate position

→ Capacitive

→ Made from materials that store electric charge

→ When touched, charge transferred from finger.

⇒ Microphone

→ Incoming sound waves enter wind screen and cause vibrations about a diaphragm. Vibrations cause coil to move past a magnetic core. This generates an electric current which is digitised ADC.

⇒ Speaker - Takes electrical signals and translates into physical vibrations to create sound waves. Electric current in coil generates an electromagnetic field. Change in digital audio signal causes current direction to change which changes field polarity. Electromagnet is either attracted or repelled to a permanent magnet causing a vibration in the diaphragm. Vibration transferred to air. Degree of vibration determines amplitude and frequency of sound wave produced.