Chapter:-2 : Numerical control :

Defination:- NC, can be defined simply as control by numbers. ~~Electronic industries~~ It is defined as a system in which actions are controlled by the direct insertion of numerical data at some point. The system must ~~be~~ automatically interpret at least some portion of ~~to~~ these data. In numerical control machine tools, the input information for controlling the machine tool motion is provided by means of punched paper tapes, plastic tapes, floppy disk, hard disk or magnetic tapes in a coded language. Thus with numerical control the operation and motions of a machine tool are controlled electronically. NC machine tools are thus automated production machine.

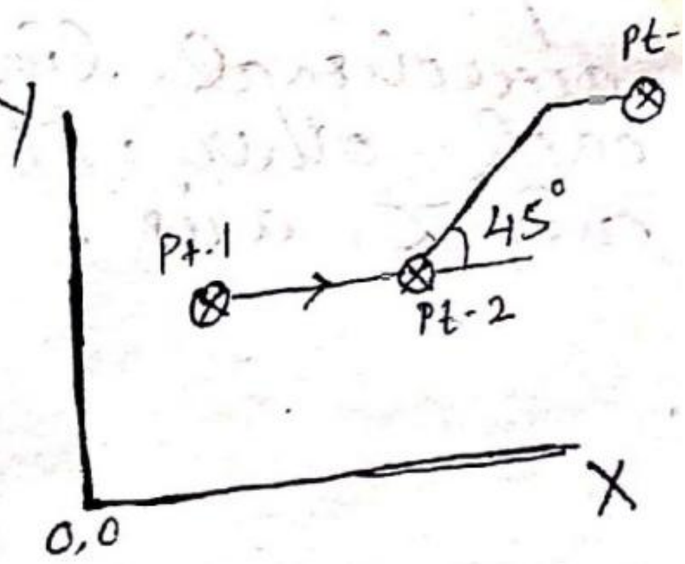
Classification Of NC machine:-

Based on control system characteristics:-

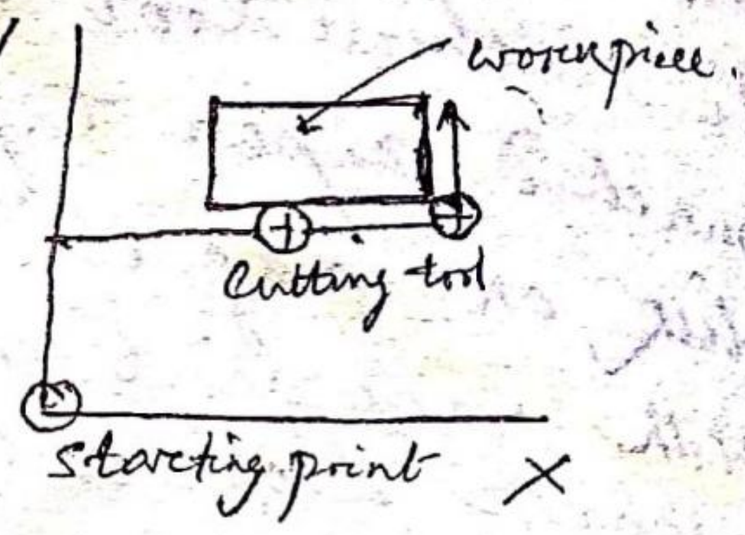
i) Point to Point system
ii) Straight line system
iii) Contouring system

A point to point NC system is basically a positioning system. Its primary purpose is to move a tool or workpiece from one programmed point to another for an operation such as drilling a hole. The speed or path by which this movement from one point to another is accomplished is not important in point to point NC.

Hole traveling machines, spot welding machines and assembly machine also use point to point NC systems.

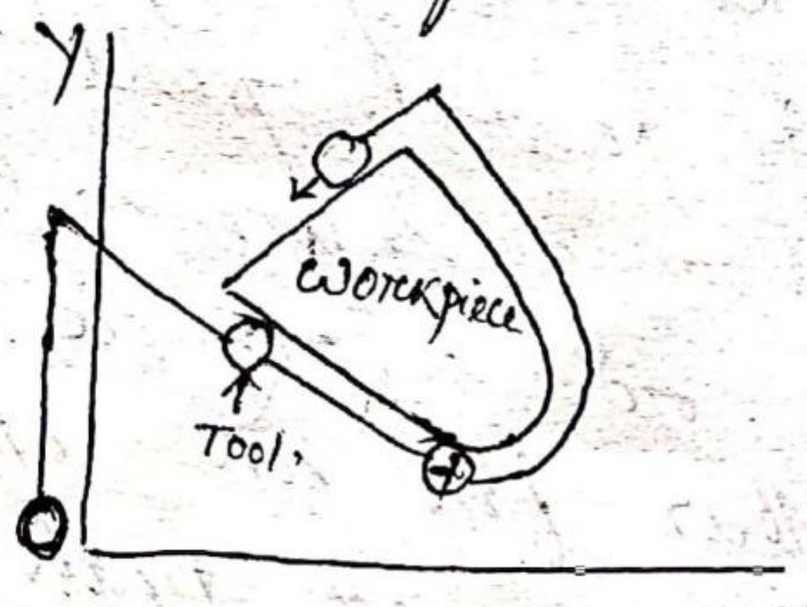


2- Straight Cut :- In straight cut ... moves parallel to one of the major axis at a desired rate suitable for machining. It is quite appropriate for milling workpieces of rectangular configuration. However in this process no angular cuts on the workpiece is possible. Any NC machine tool capable of straight cut movement can perform point to point operation also.



3- Contouring system :-

It is the complex, flexible and the most expensive types of machine tool control. It is capable of directing the tool or workpiece to move at any angle and any axis and also along curved paths. This system is ~~commonly~~ commonly used on milling machines.



NC Coordinates :-

The location of a NC tool at any point of time is controlled by cartesian co-ordinate system. The system is composed of three directional lines mutually intersecting at 90° with each other. The three axis are known as X, Y, and Z axis.

NC part programming :-

Part programming for NC comprises of the collection of all data required to produce the part the ~~collection~~ calculation of a tool path along which the machine operation will be performed, and the arrangement of those given and calculated data in a standard format, which could be converted to an acceptable form for a particular machine control unit (MCU).

There are three types of programming techniques.

1. Manual part programming
2. Computer assisted part programming
3. Manual data input

(1) Manual part programming :-

In manual part programming the data required for machining a part is written in a standard format on a special manuscript. The manuscript is a planning chart or list of instruction which describe the operation necessary to produce the part. The manuscript is typed with a flexo writer where typing causes the typed paper and the punched tape to be prepared simultaneously.

NC codes :- It refers to ~~the~~ a unit of information which is written in a codes. which control the functions like speeds, feeds, on or off

Sequence number (N-code) - It is used to identify the block.

A block is a group of words containing all the instruction for one operation. In a positioning system a block will includes the coordinates of the position and auxiliary functions necessary to complete an operation

prepare the controller ~~for~~ what types of motion or action is to be carried out. The mode of movement is indicated by the numerical value following the G address. For example the coord G02 is used to prepare the NC controller unit for circular interpolation along an arc in the clockwise direction. The G code is needed so that the controller can correctly interpret the data that follow it in the block.

Feed rate (F-code) — It indicates the rate at which the spindle moves along a programming axis. In English system the feed rate is inches per minute and in metric system it is millimeter per minute. For ex. F10 indicates 0.001 in/min.

Spindle speed (S-code) — specify the spindle speed (r.p.m) at which the spindle rotates.

Tool Number (T-code) - It indicates which tool is being used.

Miscellaneous Function (M-code) - The M-code is used to specify certain miscellaneous or auxiliary functions which may be available on the machine tool. An example would be M03 to start the spindle rotation. The miscellaneous function is the last coord in the block to identify the end of the instruction, an end of block (EOB) symbol is punched on the tape.

2. Computer assisted part programming :-

In this programming type the programmer prepares the set of instruction in high level computer language. The high

level computer languages uses simple english words which can be converted to machine tool level program with the help of processors.

3) Manual Data Input :-

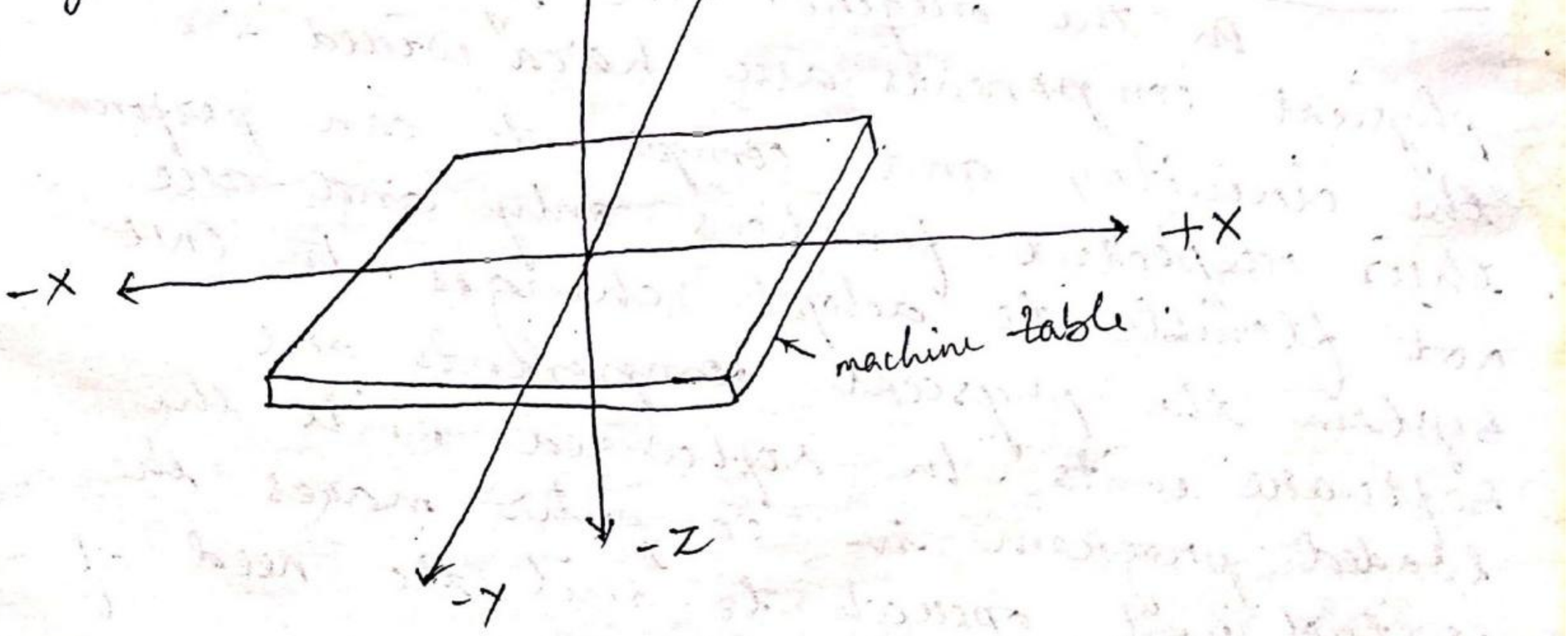
It is a procedure in which the part programmer directly keys in the program into the machine control unit of the machine tool. Most of the modern CNC machine is having this facility. This facility helps the programmer to change any existing program before the machine operations. However, the main limitation is that the data entry time is high and thus this online system may be useful for small change in the main program and for testing of machine parameters.

Reference Point :-

NC machine utilize a very accurate position along each axis as a starting point or reference point for the axis.

The Coordinate system and Machine motions :-

In order for the part programmer to plan the sequence of position and movements of the cutting tools relative to the workpiece, it is necessary to establish a standard axis system by which relative position can be specified.



Machine zero and work zero :-

The programmer must determine the position of the tool relative to the origin (zero point) of the coordinate system. NC machines have either of two methods for specifying the zero point. The first possibility is for the machines to have fixed zero. In this case the origin is always located at the same position is for the machine table.

The second and more common feature on modern NC machines allow the machine operators to set zero point at any position on the machine table. This feature is called floating point zero. The part programmer is the one who decided where the zero point should be located.

Tool Zero - Another option sometimes available to the part programmer is to use either an absolute system of tool positioning or an incremental system. Absolute positioning mean that the tool locations are always defined in relation to the zero point -

CNC machine :-

In the original NC system the physical components are hard wired i.e the circuitry and components can perform their respective functions only and are not flexible to adopt changes. In CNC system the physical components are software units. In soft wired units the loaded program in computer makes the control unit operate to suit the need of machinist. ~~The~~

DNC system :- Direct Numerical Control makes use of a large computer to manipulate operation of a number of NC machines. Devlopment of local area networking with high processing power of computer system faciliated the devlopment of DNC system.

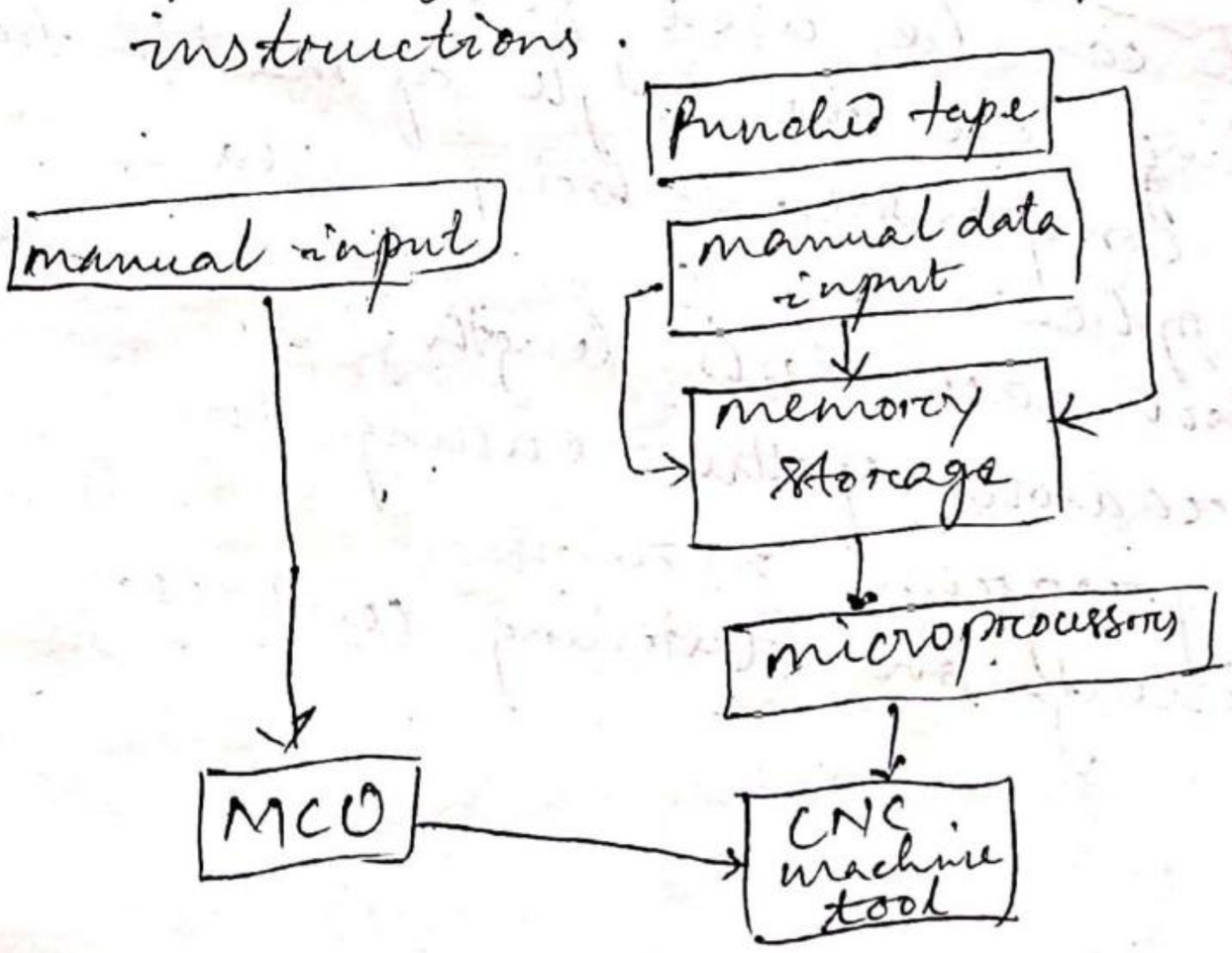
Difference bet" CNC and DNC :-

1- CNC computers control only one machine where as DNC computers manipulate more than one machine using local area networking.

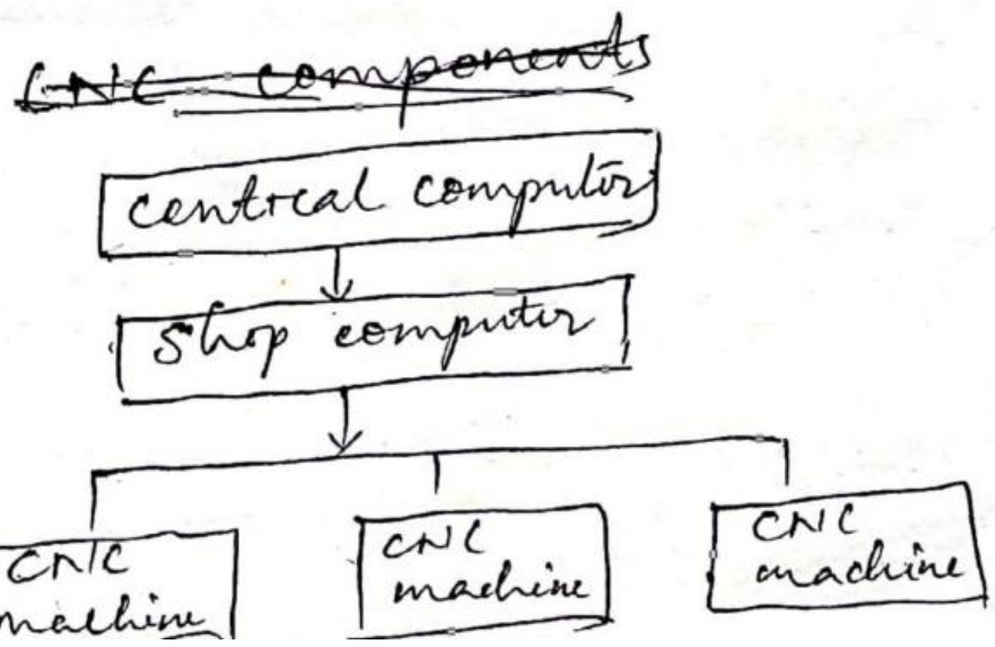
2- CNC computer is an integrated part of the machine whereas DNC computers is located at a distance from the machine

3- DNC computers are having higher processing power than CNC computers

4- DNC software conciders management of information flow to a group of machines apart from transferring machining instructions.



CNC components



DNC components

CAD, CAM & CIM

CAD :-

CAD means the use of a computer to assist in the design of an individual parts or a system. The design process usually involves completer graphics.

A CAD system is basically a design tool in which the computer is used to analyse various aspects of a designed product. The CAD system supports the design process at all levels - conceptual, preliminary, and final design. The computer can calculate various features of the product such as its strength, stiffness and weight. The designer can then test the product in various environmental conditions such as temperature changes or under different mechanical stresses.

The computer system consists of the hardware and software to perform the specialised design ~~for~~ functions required by the particular user firm.

CAD SYSTEM HARDWARE:- The CAD hardware typically includes the computer, one or more ~~pe~~ graphics display terminals, keyboards and other peripheral equipment.

The hardware for a typical CAD system consist of the following components ① One or more design workstation ② Digital computer ③ plotters, printers and other output devices and ④ storage devices.

Design workstations :-

The workstation is the interface between computer and user in the CAD system. Its function are the following ① communicate with the ~~cpu~~ CPU ② continuously generate a graphics image ③ provide digital ~~workstation~~ description of the image ④ translate user commands into operating functions and ⑤ facilitate interaction between the user and the system.

i) Improve engineering productivity.
ii) Reduced engineering personal requirements.
iii) Customer modification are easier to make.
iv) Improved accuracy of design.
v) Designs have more standardization.
vi) Fewer errors in NC Part programming.
vii) Save material and machine time.
viii) Assistance in inspection of complicated parts.
ix) Better engineering drawing.
x) Quality improved.
xi) Cost saving in tool design and other capital investment.

Computer Aided Manufacturing (CAM):-

CAM can be defined as the use of computer system to plan, manage and control the operations of a manufacturing plant through either direct or indirect computer interface with the plants production resources.

It approaches under ramp conditions such as (1) when cyclic demands are produced (2) when frequent design changes are made (3) when manufacturing process in complex (4) when multiple machining required (5) when expert operator skill and close control are required.

Benifits of CAM:-

1. Higher production rate with lower workforce
2. Less likelihood of human error.
3. Increase in manufacturing efficiency.
4. Repeatability of production process via storage data.
5. Better production control.

CIM Hardware :- It comprises the following.

i) Manufacturing equipments such as CNC machines or computerized work centres, robotic work cells, DNC/FMS systems, work handling and tool handling devices, storage devices, sensors, shop floor data collection devices, inspection machines etc.

ii) Computers, controllers, CAD/CAM system, workstation terminal, data entry terminals, bar code readers, RFID tags, printer, plotters and other peripheral devices, modems, cables, connectors etc.

CIM Softwares :- It comprises computer programmes to carryout the following functions:

- Management Information system, ~~Sales~~ Sales, marketing, Finance, database management, modeling and design, analysis, simulation, production control, process planning, job tracking, quality management etc.

ROBOTICS

A robot is any mechanical device operated automatically to perform in a seeming human way.

An industrial robot is a reprogrammable multifunctional manipulator designed to move material, parts, tools or other specialized devices through variable programmed motions for the performance of a variety of tasks.

Some of the typical applications of industrial robots includes spot welding of automobiles, spray painting, machining operations, assembly, inspection, material handling etc.

Some of the benefits of robots are.

1. Cost saving through reduced labour.
2. Improvement in quality.
3. Increased capacity
4. More flexibility of low volume production equipment.

In addition Robots never complain

Robot v/s NC Technology :-

The most typical ~~anthropomorphic~~ human like characteristics of a robot is its arm. The robot is lighter, more portable piece of equipment than an NC machine tool.

Traditionally NC programming has been performed off-line with the machine commands being contain on a punched tape.

Robot programming has usually been accomplished on-line with the instruction being retained in the robots electronics memory.

① General purpose automation devices.
② Special purpose automation devices.

① General purpose automation devices are presently available as competitively priced, off the shelf mass produced items.

Robots have an articulated mechanical arm to which can be attached a variety of hand like fingers or grippers, vacuum cups or a tool such as welding gun or impact wrench. The fingers can be made to fit the given workpiece configuration and interlock can be easily located and adapted to a new job.

② Special purpose automatic equipment on the other hand is considerably less flexible to specific job demands. A lead time as long as six to seven months or longer may be required to design, build and make the necessary performance adjustment for satisfactory operation. In addition, certain installation cost may be necessary in altering the machine controls and replacing them with actuators or relays or in changing over other features of the machinery

End effectors:-

An end effetors is a device which is attached to the robot's wrist to perform a specific task. The task might be workpard handling, spot welding, spray painting etc.

The end effector is a special purpose tooling which enables the robot to perform a particular jobs.

End effectors may be classified as

i) Grippers

ii) Tools

Grippers are used to hold either workparts (in pick and place operations, machine loading or assembly work) or tools. There are

a) Mechanical grippers, where friction or the physical configuration of the gripper retains the objects.

b) Suction or vacuum caps used for flat objects.

c) Magnetized gripper devices used for ferrous objects.

d) Hooks used to lift parts off conveyors.

e) Scoops or ladles used for fluids, powders, pellets etc.

Tools are fastened directly to the robot wrist and become the end effectors.

A few examples of tools used with robots are

1) Spot welding gun.
2) Arc welding tools.
3) Spray painting gun
4) Drilling spindle.
5) Grinder, wire brushes etc

Sensors :- It is a device that convert a physical variable of one form into another form that is more useful for the given application.

Sensors used in industrial robots can be classified into two catagories ① Internal ② External.

Internal sensors are components of the robot and are used to control the position and velocity of the various joints of the robot.

External sensors are external to the robot and are used to coordinate the operation of the robot with the other equipment such as switches.

Tactile sensors :- These are used to determine whether contact is made between the sensor and another object. Tactile sensors can be divided into two types in robot application ① Touch sensors ② force sensors. Touch sensors indicate simply the contact has been made with the object Force sensors indicate the magnitude of the force with the object. This might be useful in a gripper to measure and control the force being applied to grasp a delicate object.

Proximity sensors :- These indicate when an object is close to the sensor. When this type of sensor is used to indicate the actual distance of the object it is called range sensors.

Optical sensors :- Photocells and other photometric devices can be utilized to detect the presence or absence of object and are often used for proximity detection.