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Module-3 Computer Numerical control

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Chapter 5

Computer Numerical control



CNC

Numerical control :

Numerical control is a system in which the actions are controlled by direct insertion of numerical data at some point. The system must automatically interpret at least some portion of this data

or

Numerical control can be defined as an operation of machine tools by the means of specially coded instructions to the machine control system

Conventional machines v/s NC machines

- High Precision
- Machining of complex shapes
- Better quality
- Higher productivity
- Multi operational machining
- Less skilled operators

Types of NC Systems

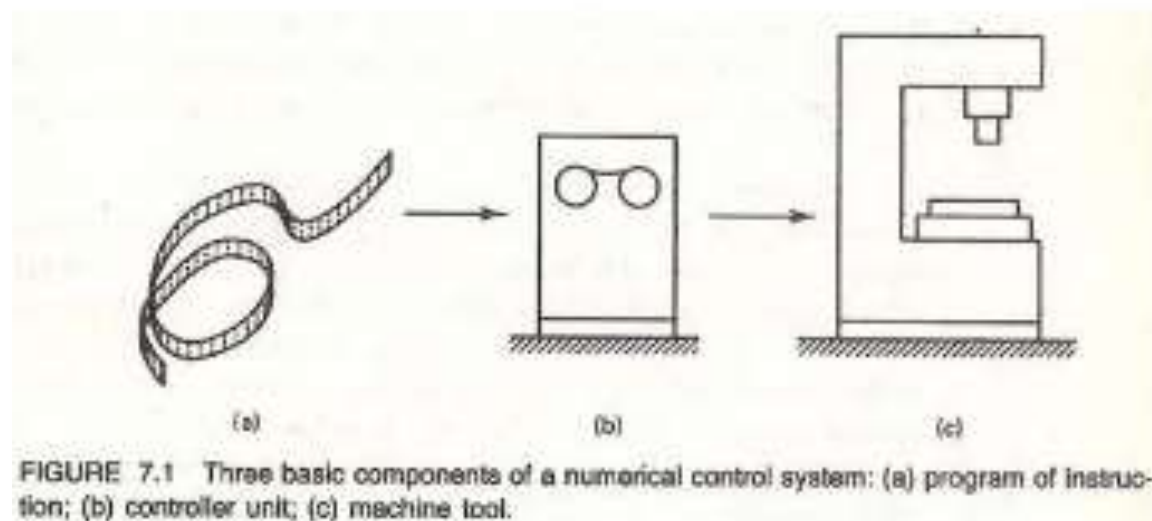
Traditional Numerical control (NC)

Computer Numerical control (CNC)

Distributed Numerical control (DNC)

Basic components of Numerical Control system

- Program of Instructions
- Machine control units
- Machine tool



Basic components of Numerical control system

(i) Program of Instruction

(ii) Machine control unit

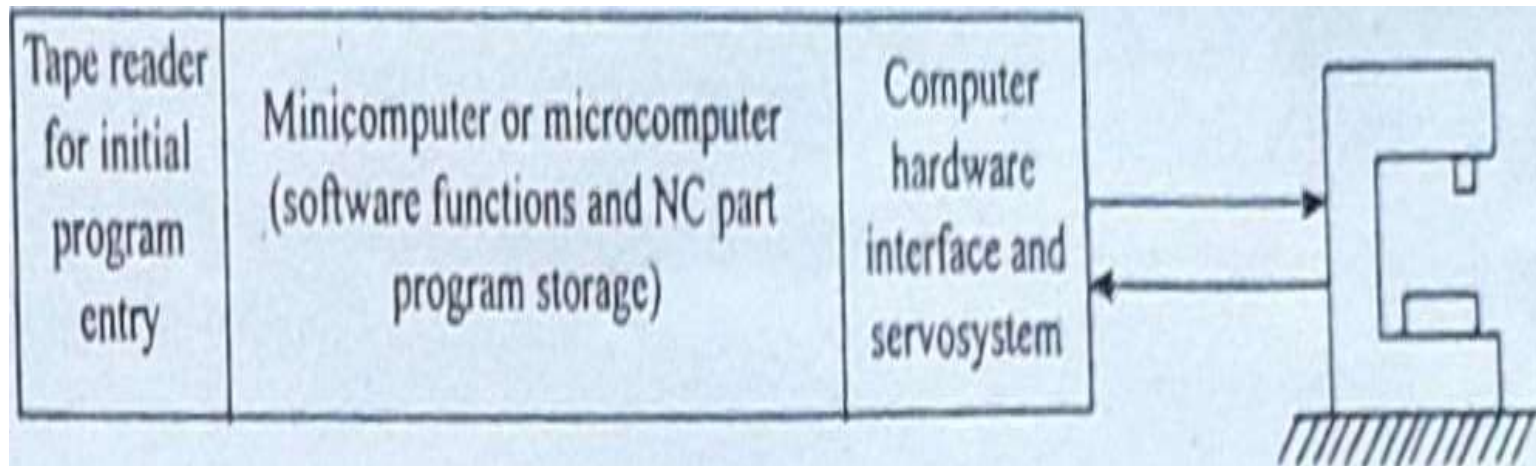
(iii) Machine Tool

(i) Program of Instruction : part program is detailed step by step instruction which tell the machine tool what to be done in what sequence. Part program is fed to machine through some input media .input media are punched cards, Magnetic tapes & floppy disk , paper tapes.

(ii) Machine control unit : This unit consists of electronic & hardware that can read and interpret the program of instruction And convert it into mechanical action of machine tool

(iii) Machine Tool : It performs the actual work. The machine tool or the processing equipment converts the starting work piece into completed part. Machine tool is controlled by machine tool

General configuration of CNC system





Features of CNC machines :

- Rigid machine structure is provided
- Guide ways are used in machine tools to control the direction or line of action
- CNC machine the function of feed rate drive is to provide motion to the slide per the motion commands
- Hydrodynamic bearings, Hydrostatic Bearings, Anti friction Bearings are provided the CNC machine
- Electronic measuring system is employed
- Increased capabilities in modern machine tools. higher spindle speed, higher rapid traverses, and more number of axes.
- Better work piece quality

Advantages of CNC machines

1. Setup time reduction
2. Reduced lead time
3. Accuracy and repeatability
4. Longer tool life
5. Elimination of special jigs and fixtures
6. Flexibility in change of component design
7. Reduced Inspection
8. Less Scrap
9. Accurate costing and scheduling



Disadvantages of CNC machines

- 1.Higher investment cost.
- 2.Higher maintenance cost
- 3.Required highly skilled personnel
- 4.Tools on CNC machines don't cut metal faster than conventional machines
- 5.CNC machines does not eliminate the need for expensive tools.



CNC Machine centers

- Mills and machining centres
- Lathes and turning centres
- Drilling machines
- Boring mills and profilers, EDM machines, punch presses and shears
- Flame cutting machines
- Water jet and laser profilers
- Welding machines etc, , ,



Conventional Milling Machine

Standard No. of axes on a milling machines are three x,y and z axes

The part set on a milling system is always mounted on machine table

The cutting tool may rotate , it may move up and down but it does not physically follow tool path

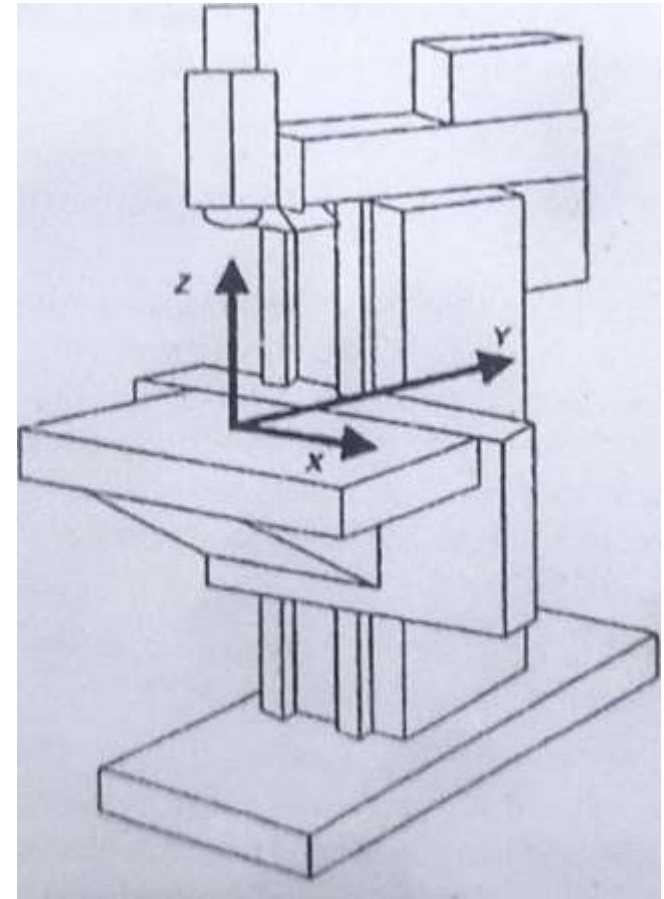


CNC Machining Centers

- CNC Machining centers are far more popular and efficient mainly for their flexibility
- CNC Machining centers can perform several diverse operations in single setup
- For e.g. Drilling , Boring, Counter boring, Tapping, spot facing and contour Milling can be incorporated into a single CNC program
- CNC machining centers has number of additional features like ATC and Pallets, indexing to a different side of part
- These are equipped with special software that control the speed and feeds, the life of cutting tool.

Vertical Machining Centers

- Structural Rigidity, ability to perform variety of functions
- Tool being able to generate complex surfaces
- Variety of accessory to cater large spectrum of jobs in single step
- Useful for tooling Industry for machining of dies and molds
- Generally Machines have 3 axes
some machines have more than 3 axes
- Variations in VMC's are Travelling column, Gantry structure, Multiple spindle

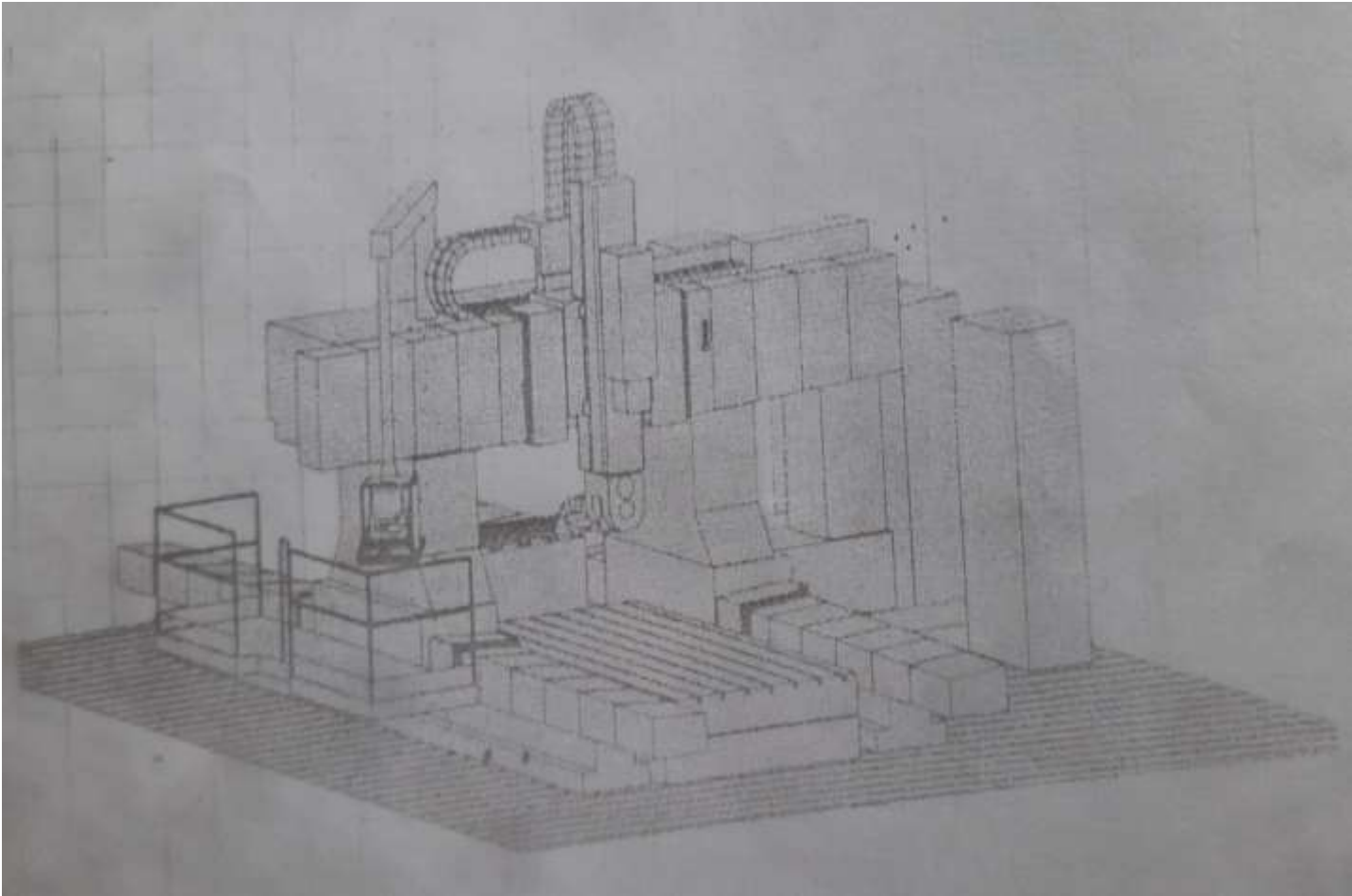




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VMC





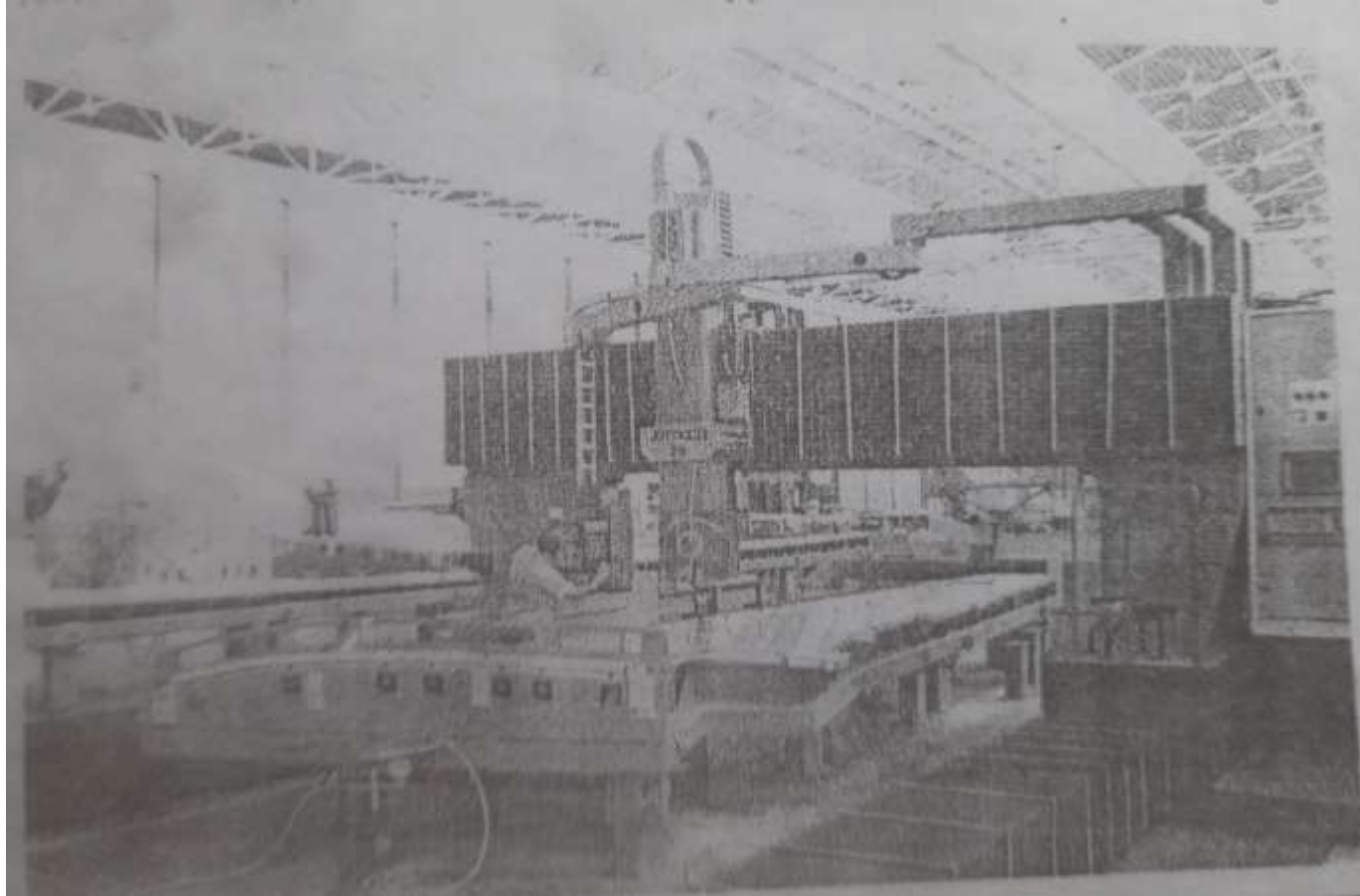
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VMC

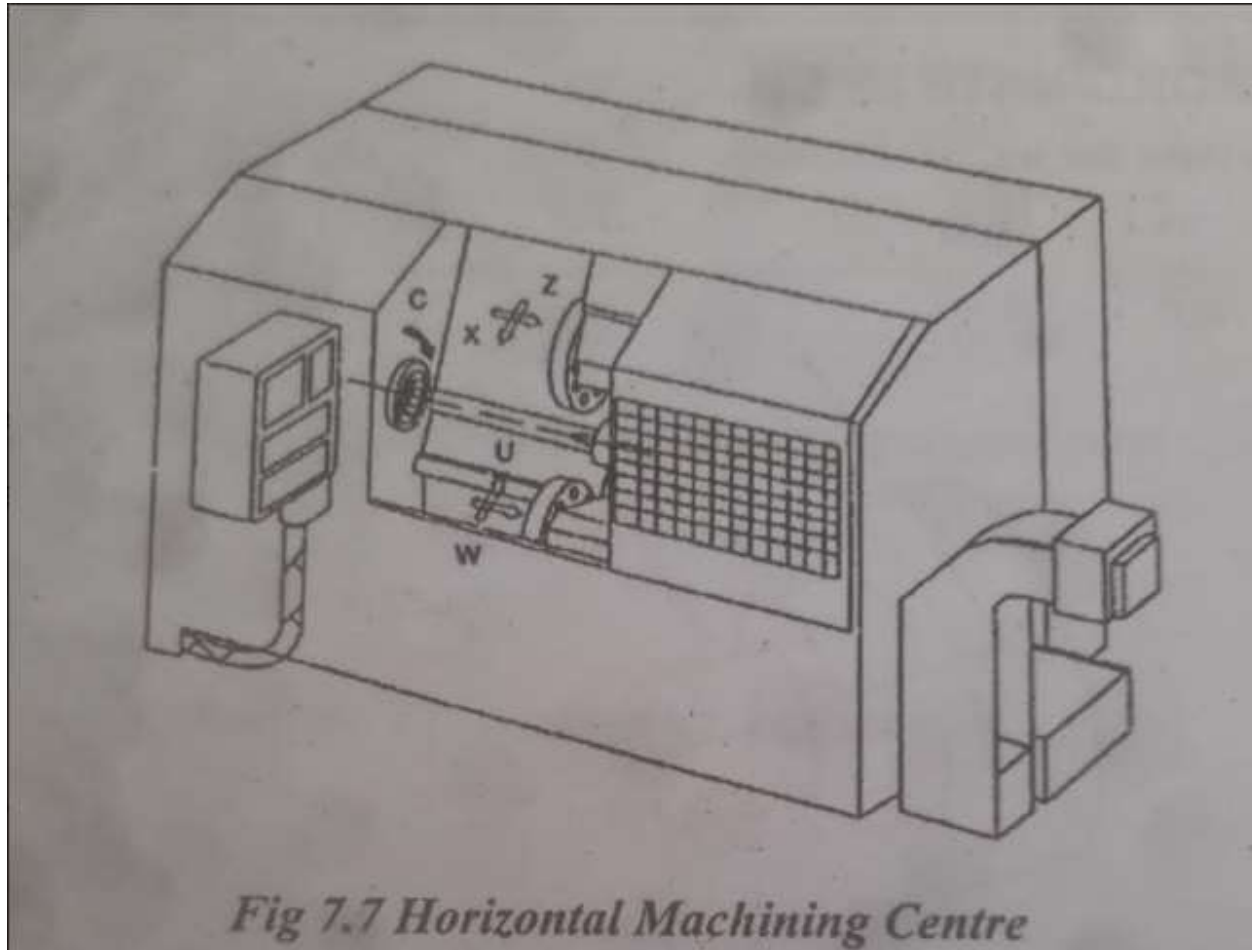




Horizontal machining Center

- HMC's are sturdier than vertical machining centers
- It is used for machining heavier work pieces and large metal removal rates
- The cutting tools used would normally be big
- HMC's have Tool magazines with high capacity e.g., Mikran HCE 400, Cincinnati Milacran, Makino A55
- Rotary Table is one of the common accessories in HMC
(It is used for machining prismatic bars)
- HMC's consist of automatic tool changers (ATC), Automatic Pallet Changers (APC)

Horizontal Machining Center





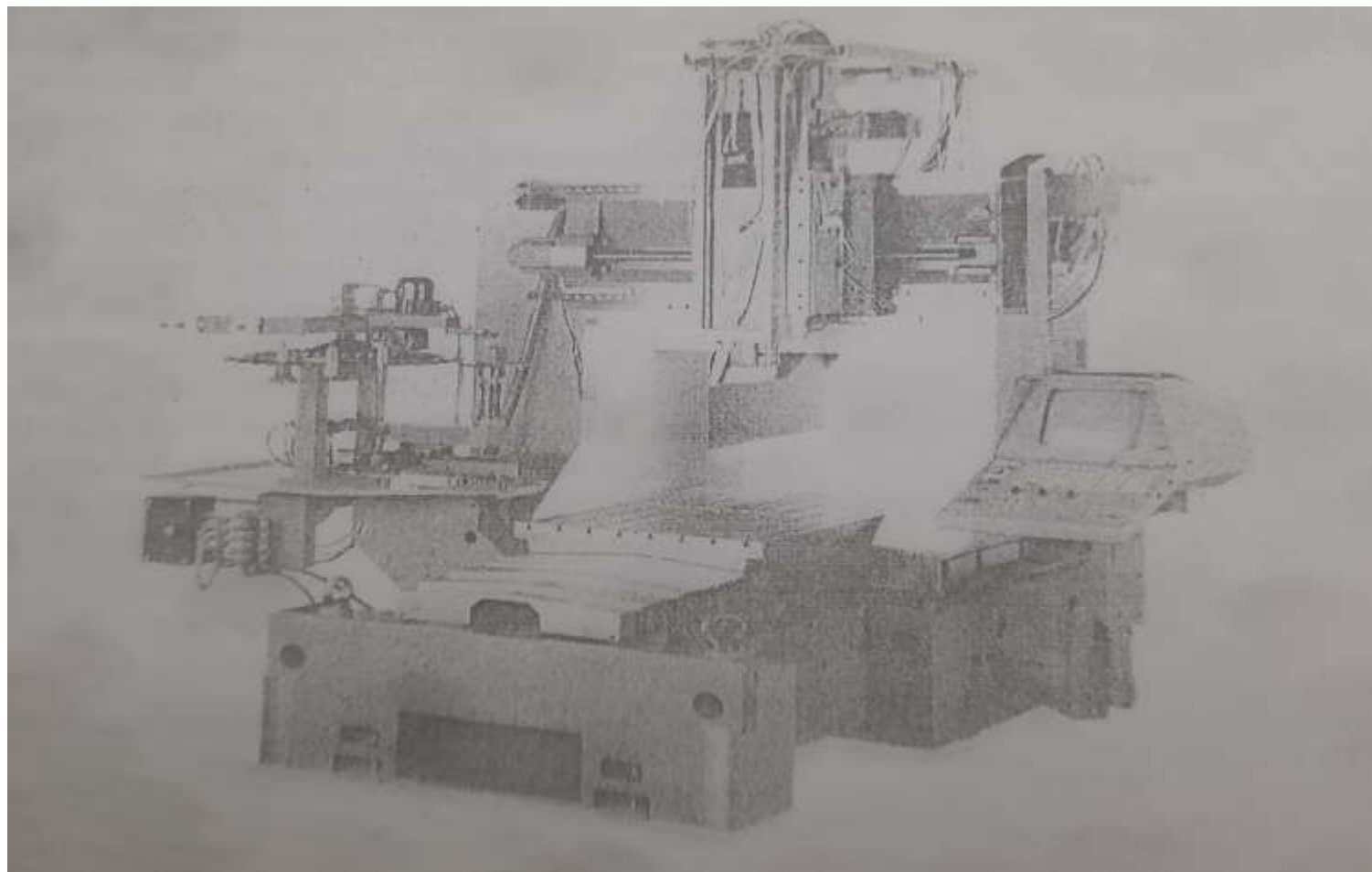
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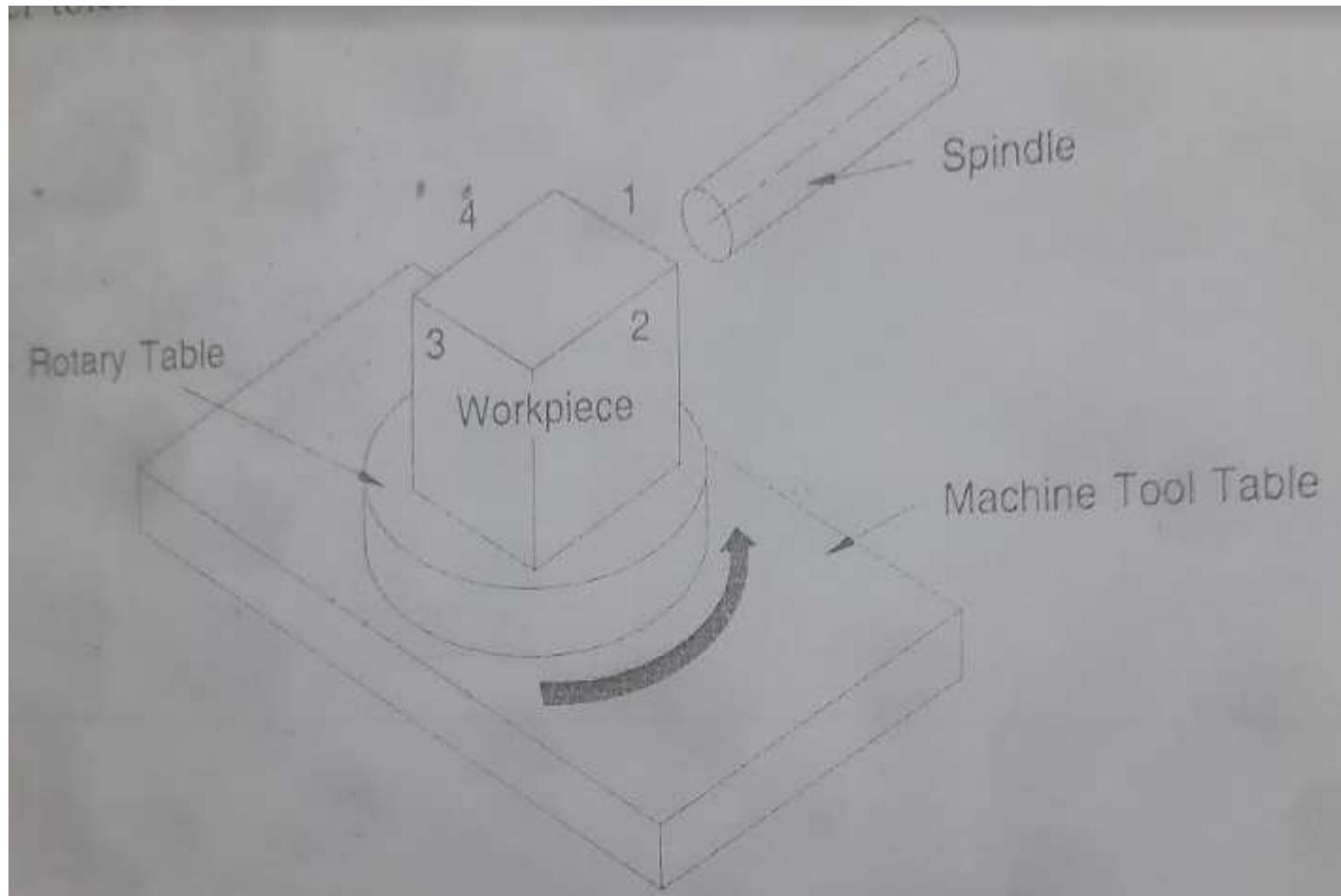


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HMC





CNC Turning centers

- A CNC Lathe can be very versatile and is often called as CNC turning center
- A CNC turning center is machine tool with two axes , the vertical axes and horizontal axes
- The main feature of lathe that distinguishes it from mill is that part is rotating about the machining center line
- The Modern Lathe design can be horizontal or vertical type

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CNC Turning Centers



Method of listing the coordinates of points in NC/CNC System

1. Absolute Coordinate system : The coordinates of point are always referred with reference to the same origin .The origin will be defined by the user.

Advantage of absolute system is that it is very easy to check and correct a program

Point P1:(0,0)

Point P2:(5,0)

Point P3:(5,6)

Point P4:(0,6)

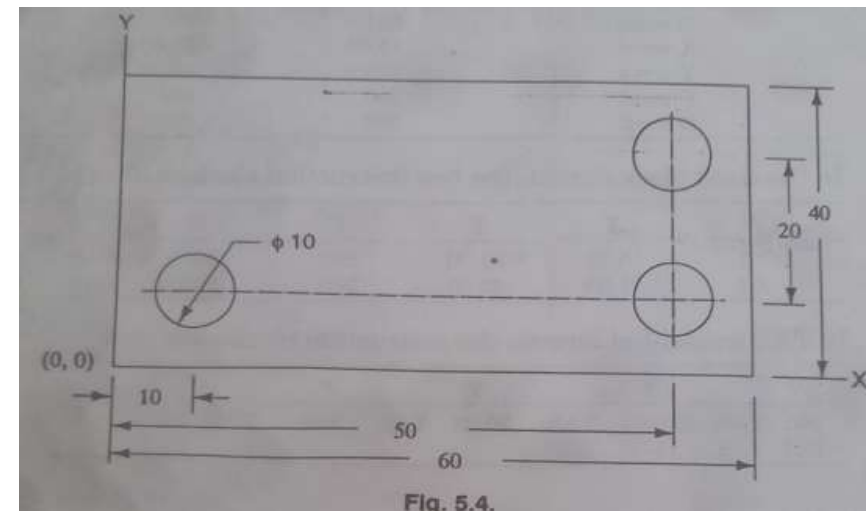
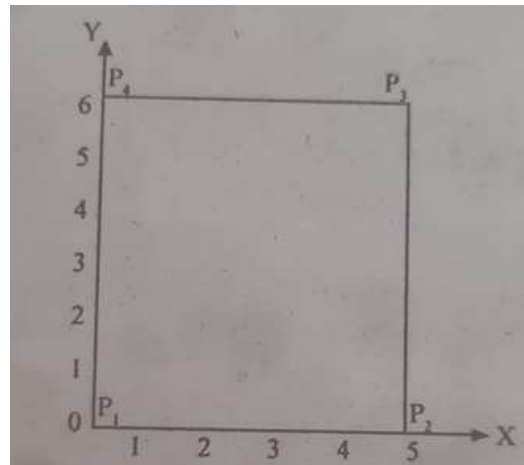


Fig. 5.4.

2. Incremental Co-ordinate System : The coordinates of point are Calculated with reference to previous point. i.e., the previous point will act as origin to the next point.

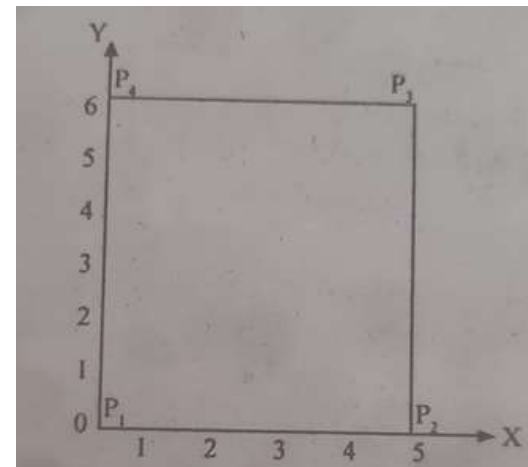
It is difficult to check part program written in incremental mode

Point P1 :(0,0)

Point P2 :(5,0)

Point P3 :(0,6)

Point P4 :(-6,0)



NC-Coordinate System

All Machines have more than one slide ,each slide is identified individually

There are two planes :

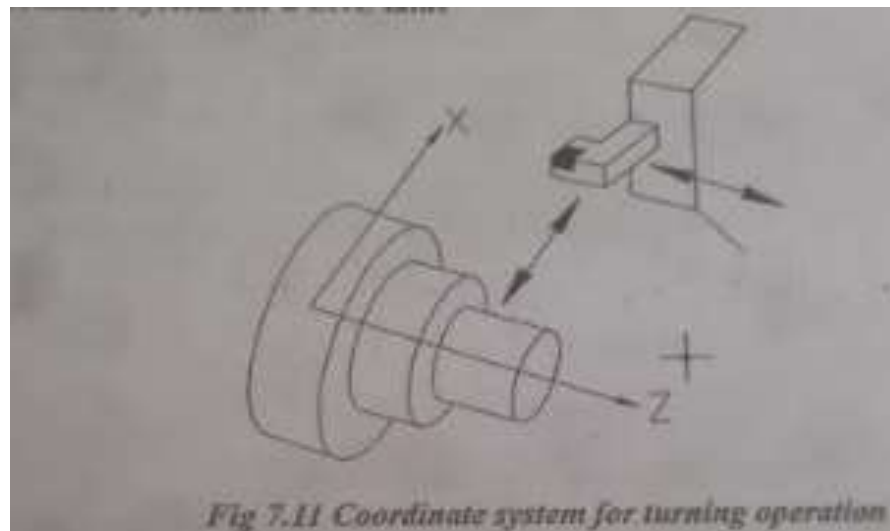
Longitudinal

Transverse

Each plane is assigned a letter and is referred to as an axis

Axis X

Axis Z

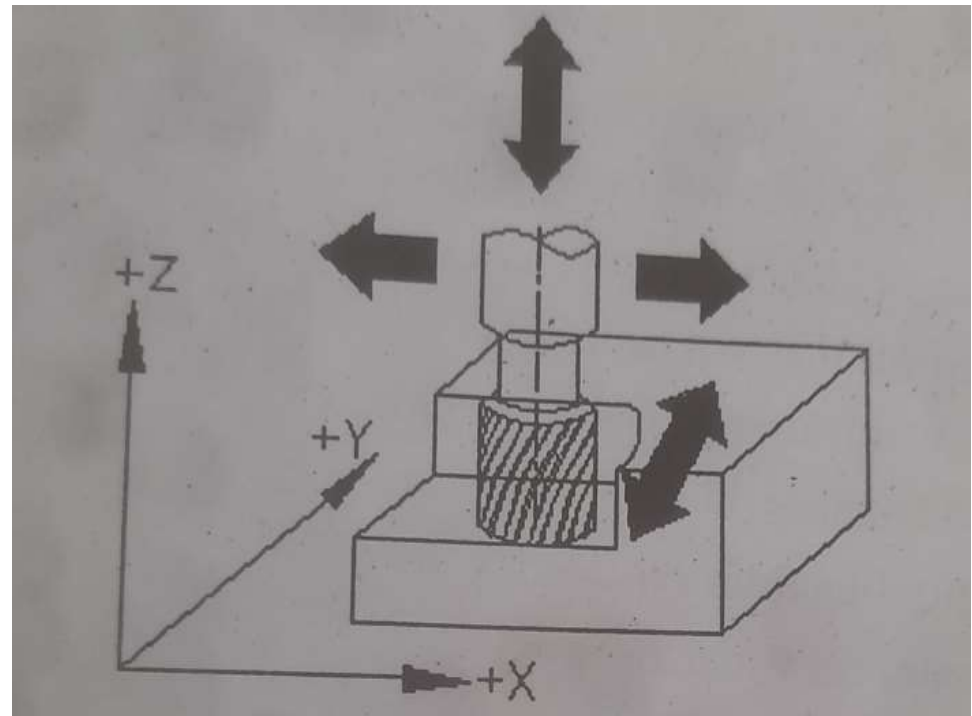


Coordinates system for CNC mill :Machining of work piece by an NC program requires a Coordinate system to be applied to machine tool . All Machines have more than one slide ,each slide is identified individually. There are three planes in which movement can takes place

- Longitudinal
- Vertical
- Transverse

Each plane is assigned a letter and is Referred to as an axis

- Axis X
- Axis Y
- Axis z

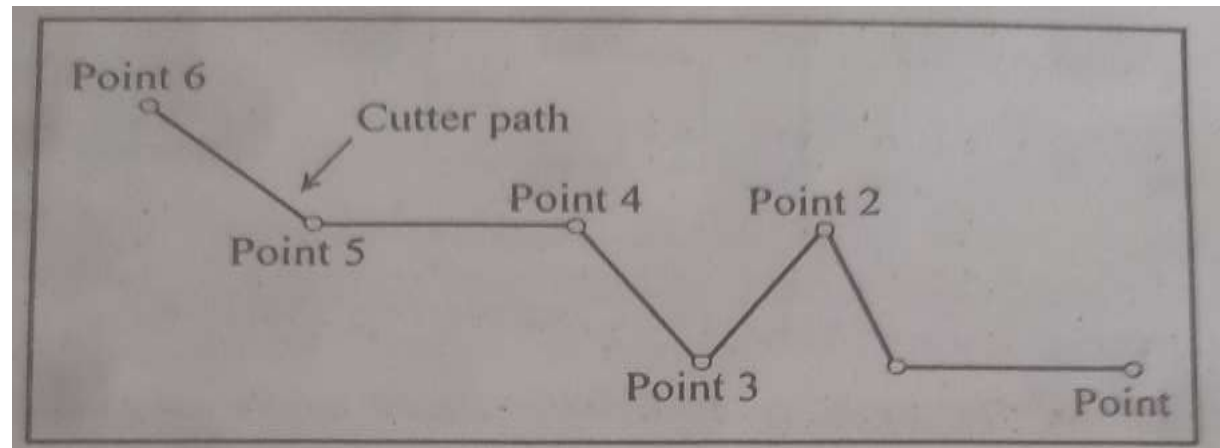


1.Types of NC/CNC based on Motion control system

1. Point to point control system
2. Straight line control system
3. Continuous path or Contouring control system

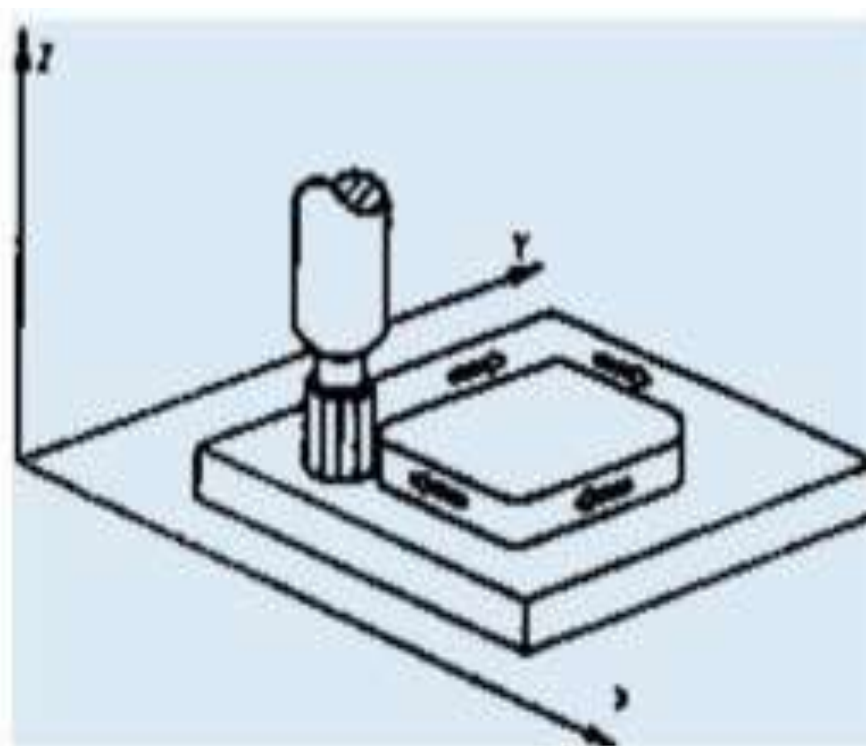
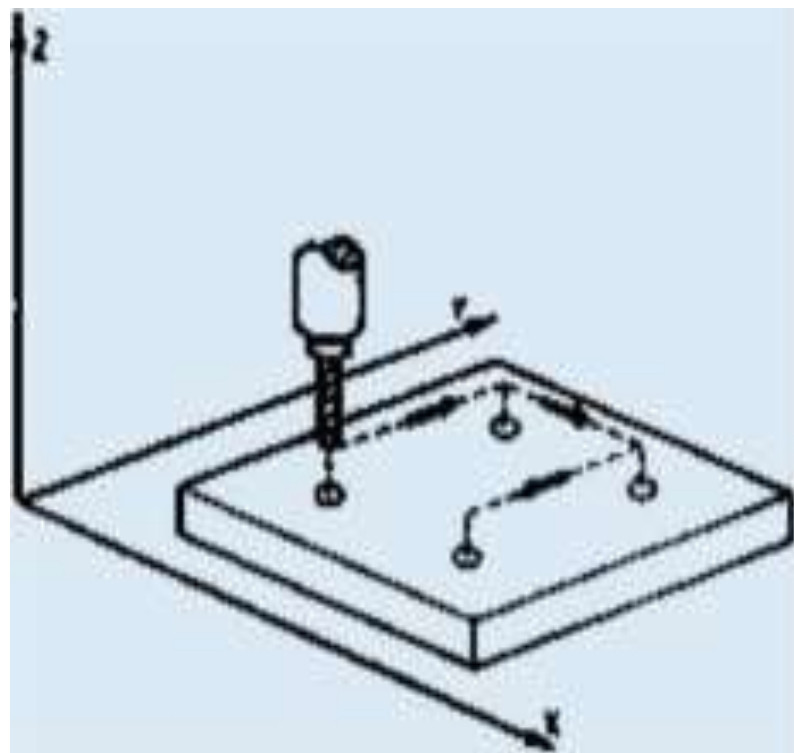
1.Point to point Control system :accurate positional control is required only to place machine slides in fixed position i.e., machining operations are performed at specific points.

e.g., Drilling,boring,tapping, Punch presses and jig boring machines

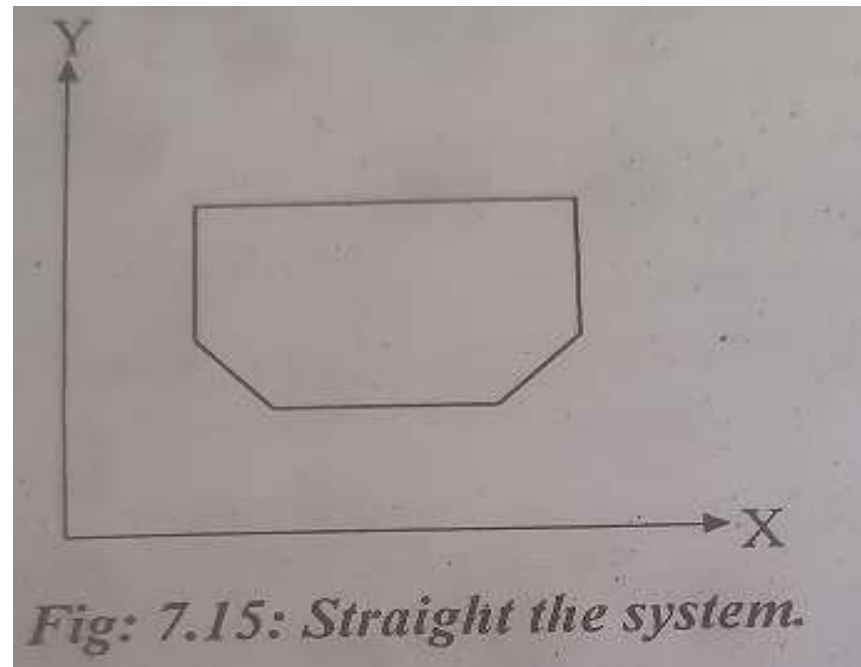




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2.Straight line control system : Straight line CNC system is extension of point to point control system with provision of machining along straight line as in case of milling and turning
Movement at controlled feed rate along the axis



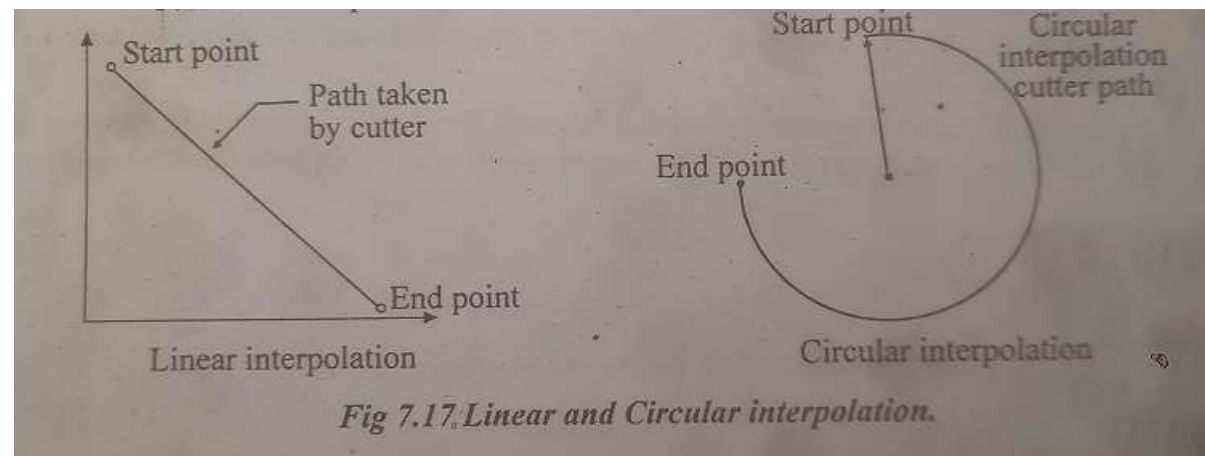
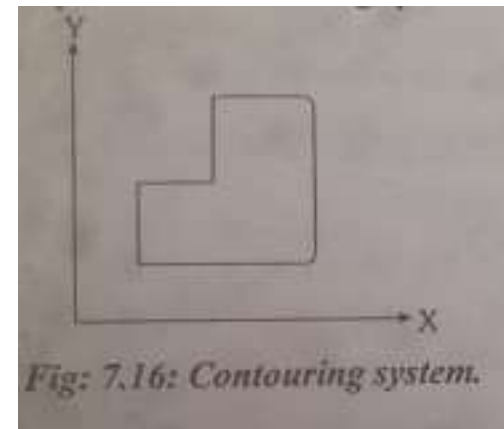
3. Continuous path or Contouring system : contouring system generates continuously controlled motion of tool and work piece along different co ordinate axes

Interpolation:

Linear interpolation

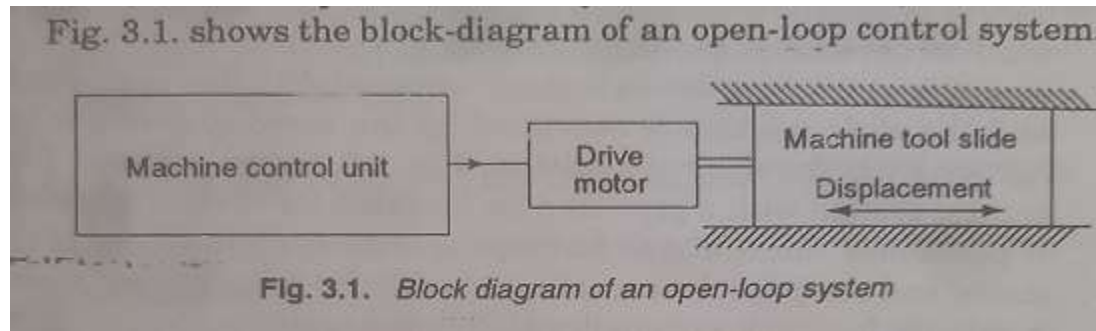
Circular interpolation

Parabolic interpolation

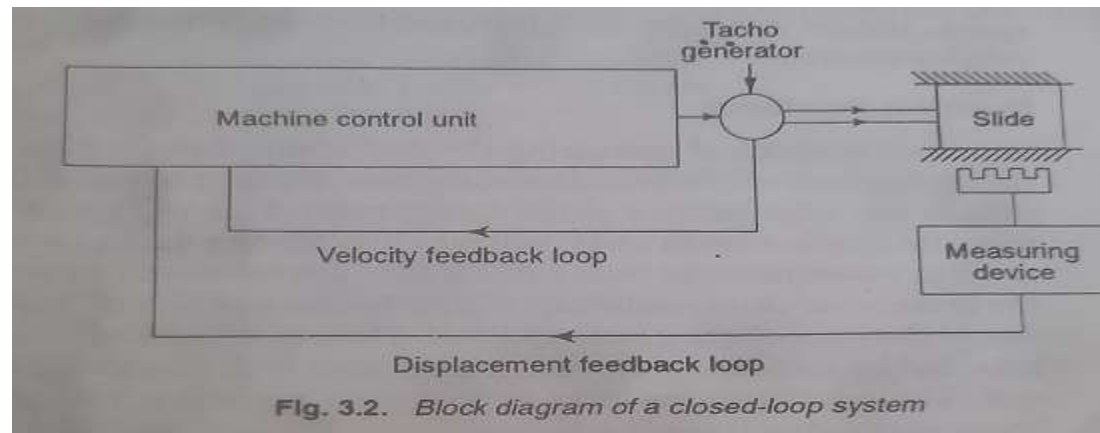


2. Classification based on feedback Control

Open loop Control system :



Closed Loop Control system :



NC Words

- 1.Sequence number (N-word)
- 2.Preparatory functions (G-words)
- 3.Co-ordinates (x,y and z words)
- 4.Feed functions (F-word)
- 5.Spindle speed function (S-word)
- 6.Tool selection function(T-word)
- 7.Miscellaneous function (M-word)
- 8.End of block (EOB)



Programming Procedure

1. Study the initial information (drawing and methods)
2. Material stock (blank) evaluation
3. Machine tool specification
4. Control System Features
5. Sequence of machining operations
6. Tool selection and arrangement of cutting Tools
7. Setup of the part
8. Technological data(speed , feed rates)
9. Determination of Tool Path.
10. Working sketches and Mathematical Calculations
11. Program writing and preparation for transfer to CNC
12. Program testing and debugging
13. Program documentation



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THANK YOU