Chapter-1

Non-conventional machining process / Non-traditional Machining process.

The machining process in which material removes takes place with the help of human force is known as traditional or conventional machining process.

The machining process in which the removal of material takes place from the workpiece surface with the help of modern automated machine is called non-conventional or non-traditional machining process.

Non-conventional / Non traditional machining process	conventional / traditional Machining process.
(i) Material removal takes place with the help of automated machine	(i) Material removal takes place with the help of human force.
(ii) It consume less time for machining	(ii) It consume more time for machining.
(iii) Workpiece produce in this case are more accurate.	(iii) Workpiece prouced in this process are less accurate.
(iv) surface finish of the work piece is high.	(iv) surface finishing of the work piece is low.
(v) there is less chance of error.	(v) there is more chance of error.
(vi) It is reliable for mass production of workpiece	(vi) Mass production is not possible in this case.

(vii) Machining process setup is more costly

(viii) It consume large amount of electricity

(vii) machining process is less costly.

(viii) It consume less amount of electricity.

Types of non-conventional Machining process

1. Abrasive jet machining (AJM)
2. electro chemical " (ECM)
3. Electro discharge " (EDM)
4. plasma arc " (PAM)
5. Leaser beam " (LBM)
6. Electron beam " (EBM)

Abrasive jet machining (AJM)

→ The non-conventional machining process in which material removal takes place with the help of abrasive particles is known as abrasive jet machining.

→ An abrasive is a particle having more than one cutting edge.

Types of Abrasive :-

There are two types of abrasives they are

(i) Natural :-

Ex sand, diamond, silica.

(ii) Artificial :-

Silicon carbide, tungsten carbide etc.

Properties of abrasive :-

→ It must be very hard.

→ Must have high toughness.

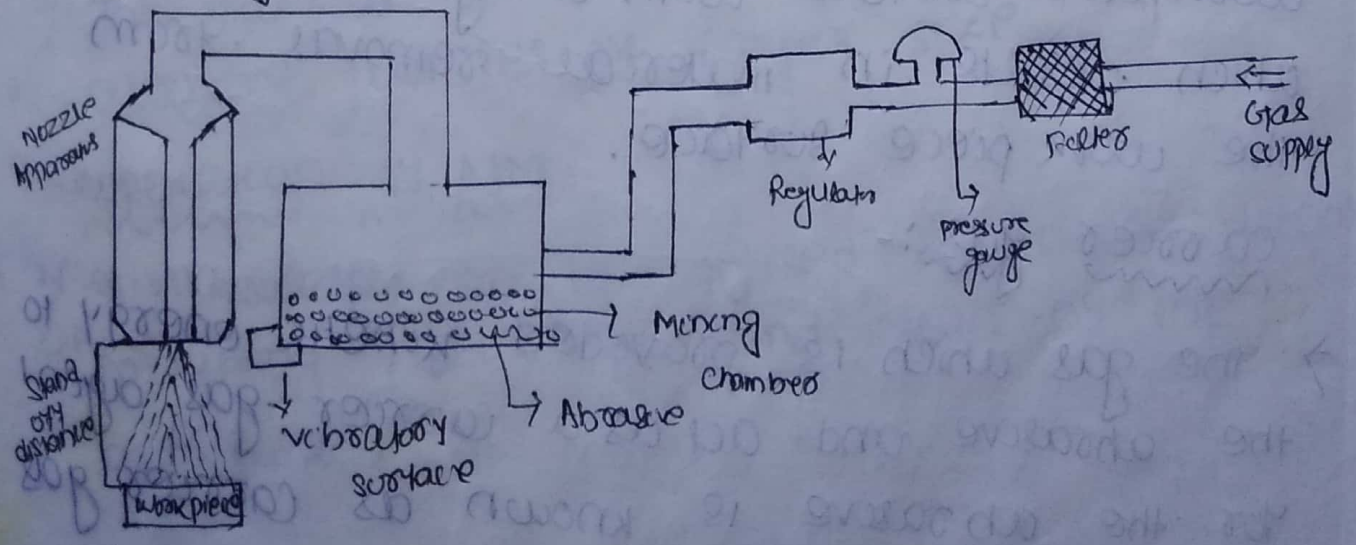
→ It should be irregular in shape.

→ The edge of abrasive should be very sharp.

construction of AJM :-

→ It consists of a gas supply a filter, pressure gauge to measure the pressure. It also consist of a regulator to maintain the pressure. It has a mixing chamber is associated with a vibratory source to mix the abrasive and the gas in well manner. The set up for AJM is consist of a nozzle apparatus through which abrasive are bombarded on the workpiece surface

Working principle :-



→ The air is passed through the filter to remove the impurities the pressure gauge measure the pressure of the gas and the regulator regulated the pressure of the gas then the gas is passed to mixing chamber containing abrasive particles

→ In the mixing chamber the gas is mixed with the abrasive particles due to the vaccation of the mixing chamber from the mixing chamber the mixture of the gas and abrasive particle passes on the nozzel apparatus having tungstcon carbide tip with a velocity of 200 m/sec to 400 m/sec. In this process the stand off distance (distance between nozzel tip and workpiece) must be taken as 0.7 mm to 1m and the size of nozzel abbrasive must be between 10 micron to 40 microns.

→ The abrasive with the gas-collides over the workpiece surface with a greater velocity which results in material removal from the work piece surface.

carrier gas :-

→ The gas which is provided kinetic energy to the abrasive and act as a carrier gas agent for the abrasive is known as carrier gas

Ex :- Carbon dioxide, Argon, Nitrogen

MRR → It is material removal rate or the amount of material removal in kg/cm^2 the MRR for AJM lies between $2.8\ kg/m^2$

Advantages :-

→ This process can be utilise for maching of brittle material like iron, tungston, carbide etc.

→ It can be utilise for having holes.

→ AJM result in less damage to the surface.

→ The surface have a good surface finish by controling the grain size.

→ The AJM process material removal rate is very high.

Disadvantages :-

→ The holes of the AJM process are not uniform and tapper in shape when the depth is more

→ The abrasive particles may remains embedded in the workpiece surface.

→ The material removal rate is very slow for abrasive particles of larger size.

Application of AJM :-

→ AJM process can be utilised for cutting drilling polishing deburring and clean of the workpiece.

Electro Discharge Machining (EDM)

→ The non conventional machining process where material removal takes place with the help of electrical spark and electron discharge from the tool is known as electron discharge machining. (EDM).

Dielectric fluid :-

→ A fluid which is capable of conducting electricity through it is known as dielectric fluid

Ex :- ethylene, kerosene etc.

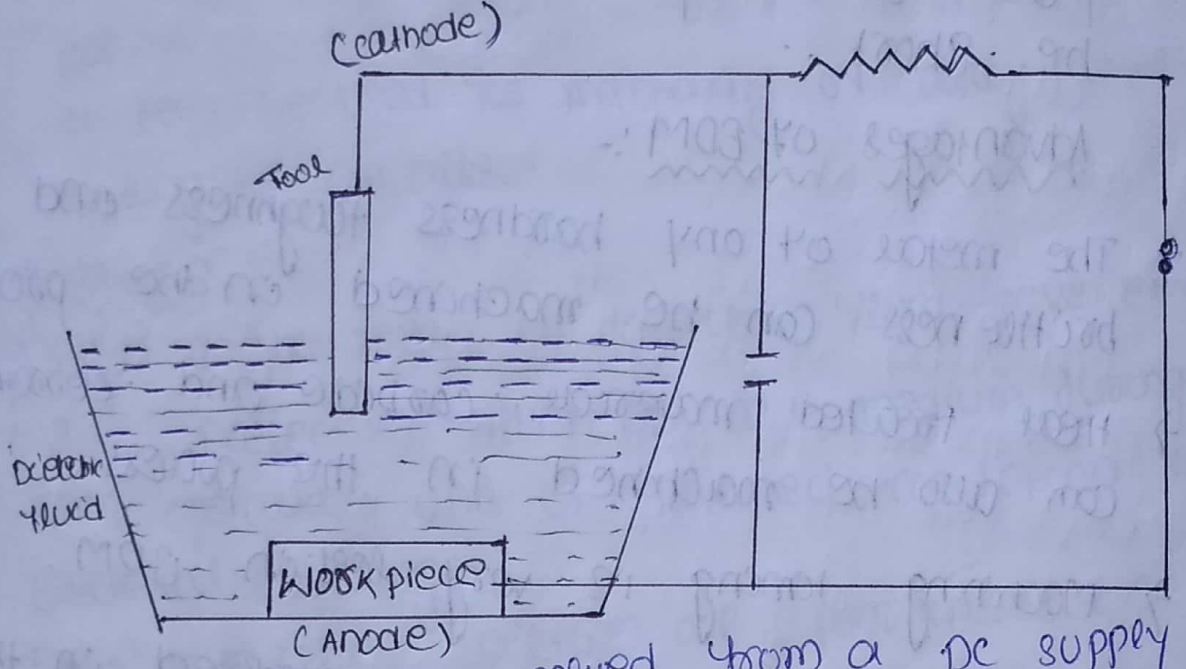
construction :-

→ The setup for EDM consist of a container of dielectric fluid the work place is taken as anode and it is fully immersed in dielectric fluid. The tool is made cathode and it is responsible for the emmission of electrons.

→ The electric ckt consits of a variable resistance capacitor and DC power suppey. A suetable spark gap of 0.001 to 0.05 MM A DC suppey sourced having 30v to 200 v is utilise to creare a spark between the tool and the work place material.

→ The capacitor in the ckt is used to store energy and the resistor is used to oppose the excess flow of electrons.

Working principle:-



→ When a voltage is supplied from a DC supply power source across the spark gap then the emission of free electrons takes place from the tool (cathode) with a very high velocity due to the electric field produced between the cathode and the anode. the electron start flowing towards the anode in dielectric fluid medium.

→ In other word electrical discharge takes place from cathode to the anode which result in heating. in anode surface upto temp of 12000°C. The anode surface become heated off and when the electron hit the surface. It melts and evaporate the melted particles on the workpiece surface are cooled and washed away with the help of dielectric fluid.

The flow of electrons stops when the DC power supply source is switch off.

→ Due to the erosion of the metal, spark gap is increase and the spark next takes place at the point where the distance could be short.

Advantages of EDM :-

→ The metal of any hardness toughness and brittleness can be machined in the process

→ Heat treated material, carbide and ceramics can also be machined in the process.

→ Machining timing is very less in EDM.

→ The accuracy of the work produced in this process can be as high as 0.005 mm.

→ There is no contact between the workpiece and tool. so, there is no danger of wear and tear of tool and work piece.

Disadvantages of EDM :-

→ Power required is very high.

→ Material removal rate is very slow.

→ It cannot produce sharp corners.

→ work piece material must be electrical conductor.

→ In this process the surface finishing is not so good & smooth.

Application of EDM :-

→ It can be used to create mold cavities.
→ It can be used to make holes of 0.1mm diameter
→ It can be used to make external gear profiles.
→ It can be used to manufactured dies for process tool.
→ It can be used for machining of alloy steel and to tungsten carbide.

Questions

Q) What do you mean by dielectric fluid give example?

ANS:- Dielectric fluid act as a medium during the EDM operation and it produced condition for electrical discharge.

Ex:- Kerosene, silicon oil, paraffins oil etc.

Q) What are the function of dielectric fluid?

ANS:- It is act as a medium during EDM operation It is act as a coolant in the workpiece surface.

→ It act as a coolant for tool material.
→ It carries away the eroded material particles.
→ It provide suitable condition for electrical discharge.

Q) Give example of the tool used in EDM process.

ANS:- Tungsten, Carbide, Graphite, Brass tungsten, etc.

Electro chemical machining (ECM)

→ ECM can be defend as a non-conventional machining process in which material removal takes place with the help of controlled dissolution of an anode in a electrolytic cell.

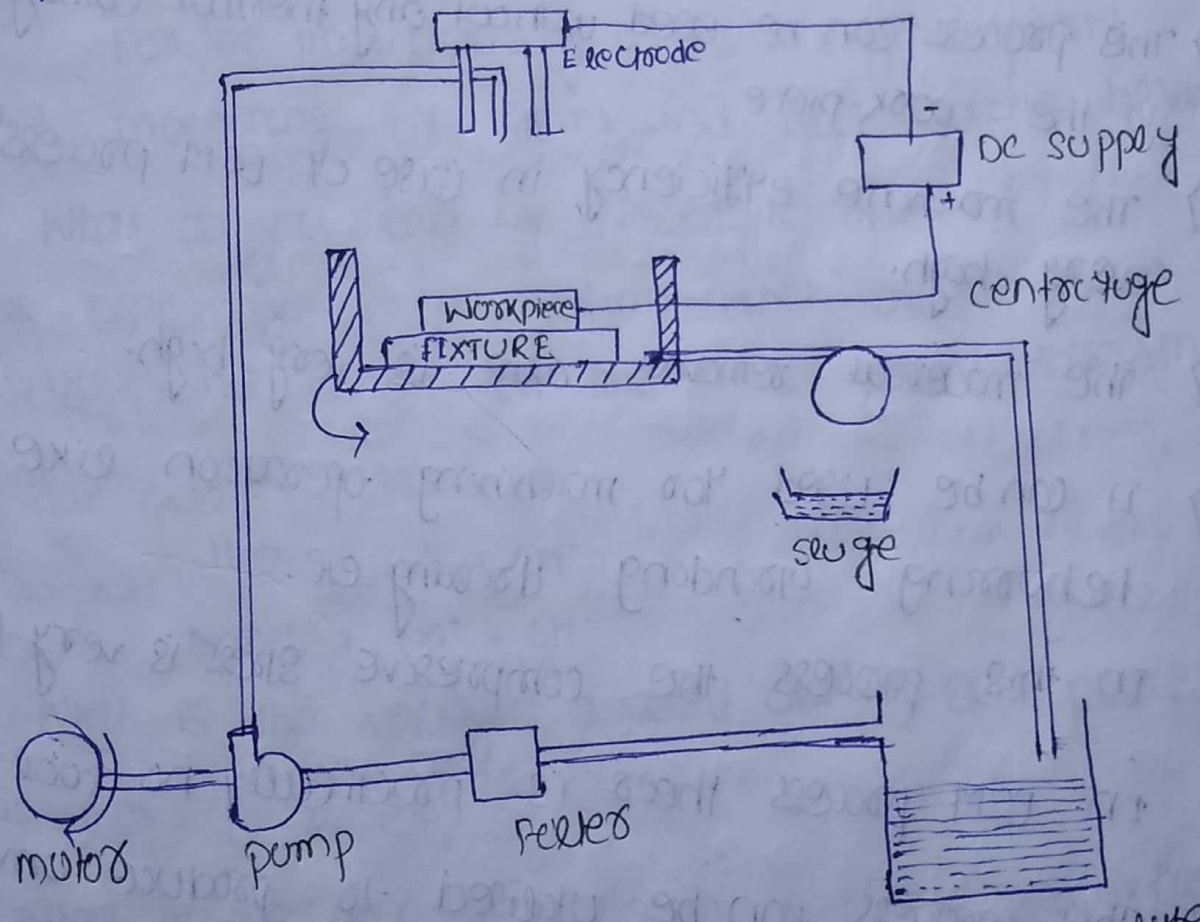
CONSTRUCTION :-

→ The ECM set-up consist of a tester vessel containing electrolyte it also consist of valves to remove the impurities present in the electrolyte. It consist of a pump which is used to supply the electrolytic cell consist of electrode which is taken as cathode and it also consist of workpiece that is taken as anode. Both the cathode and anode are dissolved or immersed in electrolytic solution. A DC supply is present between the cathode and anode.

Working principle :-

→ (In ECM process the workpiece is taken as anode and the electrode are taken as cathode the gap between the electrode and the workpiece is 0.05 mm to 0.5 mm and electrolyte usually is taken inside the electrolytic tank) [when the tank is filled a DC supply is provided between the electrodes

having the a magnitude of 6 ev. This voltage results in a very high motivating force which pulls the metallic ions from the work piece A high current ions from the work piece A high current density is used in this process. The process of the reaction between the metallic ions and electrolyte result in the formation of metalic hydroxide in this way metal is removed from the workpiece surface with the help of Chemical reaction. ECM also result in evolution of hydrogen gas.



Chemical reaction:

At Anode

$Fe \rightarrow Fe^{++} + 2e^-$

At Cathode (tank)

$H_2O \rightarrow H^+ + OH^-$

Chemical reaction of ECM

① $Fe^{++} + 2OH^- \rightarrow Fe(OH)_2$

Metallic Hydroxide

② $2H_2O + 2e^- \rightarrow H_2 + OH$

Advantages :-

→ ECM can be used for the machining of very tough and brittle material.

→ This process can be used without any thermal damage to the work piece.

→ The machine efficiency in case of ECM process is very high.

→ The material removal rate is very high.

→ It can be used for machining operation like deburring, Grinding drilling etc.

→ In this process the compresive stress is very less.

→ In ECM process there is practically no tool wear.

→ This process can be utilised to produce any shape of workpiece.

Disadvantages :-

→ In this process only metals which are good conductor of electricity can be machined.

→ The energy consumption for ECM set up is very high.

→ The surface finish achived during ECM process is not so smooth.

Application of ECM

(I) Deburring.

(II) Electrolytic Grinding.

(III) Deep hole drilling.

(IV) For the manufacturing of Aero engine parts.

(V) Machining of steam and Gas turbines blades.

Q What do you mean by electrolyte Give ex?

ANS Electrolyte is a solvent which breakes down into ions when electricity is passed throughout.

Ex :- $NaCl \rightarrow Na^+ + Cl^-$

$H_2O \rightarrow H^+ + OH^-$

$NaOH \rightarrow Na^+ + OH^-$

Q What is the voltage appered during ECM process

ANS 6 ev.

Q What is the Gap between the tool and workpiece in ECM process.

ANS:- 0.05 to 0.5 mm

Q What the function of an electrolyte?

ANS:- It removes the slag or sluges from the workpiece surface.

→ It cools down the heat produced during the reaction.

→ It completes the electrical ckt between the tool and the work piece.

→ It helps in the formation of sludges.

PLASMA ARC MACHINING (PAM):-

The non conventional machining process in which material removal takes place with the help of direct electron bombardment and high temperature is known as plasma arc machining.

construction of PAM :-

→ The setup for PAM consist of an electrode which is taken as cathode and a nozzle apparatus which is taken as anode. Gases like hydrogen Nitrogen etc are feed into the PAM set up. The electrical ckt between the electrode and the nozzel is completed with the help of a DC supply source. Insulators are also used in this process.

Working principle of PAM :-

When a flowing gas is heated up to a high temperature of 16500°c then the gas becomes partially ionised. These form of the gas is known as plasma.

→ In this process hydrogen or nitrogen gas is heated when they are subjected to the electron collision.

→ When the DC supply source is powered on, then an electrical arc is produced between the cathodic electrode and anodic nozzle. The molecule of gas gets dis associated due to the collision with the electron produce due to the electric arc.

→ This plasma is then passed through the anodic Nozzle towards the work piece. when the plasma hit's the work piece surface then it melts and erode due to the very high temp of the plasma. In this way material removal takes place in case of plasma arc machining.

→ The material removal rate can be increased by increasing the flow of gas or plasma towards the workpiece surface.

Application of PAM:

→ PAM can be use

(i) For cutting hard and tough material.

(ii) It is use for machining of stainless steel and carbon steel.

(iii) It can be used for machining of delicate products from ceramics.

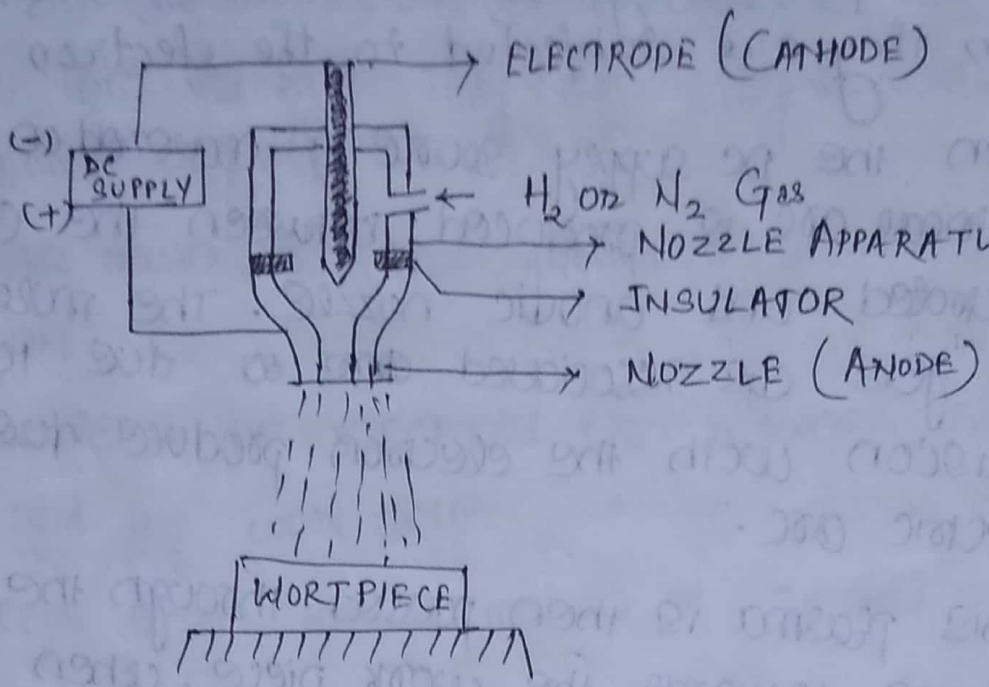


FIG - PLASMA

ADVANTAGES :→

→ Due to the high temperature of the plasma acc it can be used for the machining of hard and tough material.

→ PAM can be use for the production of Deep holes.

→ This process results in better surface finish.

→ The material removal rate of PAM process is also very high.

→ This process can be utilised for the machining of crysteline materials.

→ PAM process can be utilised for various profiles than can't be made by using other non conventional machining process.

Disadvantages:-

→ This process results in high energy consumptions.

→ Due to the high temp of the plasma arc the surface of the work-piece gets temp affected and results in heat affected area on it surface.

→ The plasma is suppose to be released out of the nozzle so, the nozzle apparatus must with stand high temp.

Q How much temp is produced during the production of plasma arc inside the nozzle apparatus.?

AN:- 16500°C.

Q What type of electrode are used in PAM. Give example?

ANS:- The electrode which are capable of producing electrons or electric arc are suitable for PAM.

Ex:- zinc, Alloys, Tungston carbide, Aluminium Graphite etc.

Q What is the function of insulator used in PAM?

ANS:- Insulator helps in controling the flow of gases or plasma arc from the nozzle as there not good conductor of electricity they can repel an electric arc very easily.

Q What is the material used for the nozzle?

ANS:- The nozzle of the PAM set up are Generally copper alloys.

Q What is the current density used in PAM process for the production of plasma are.?

ANS:- 1000 Amp/cm^2

Q Which gas are used in pam process.?

Ans. Hydrogen and Nitrogen.

LASER BEAM MACHINING (LBM)

- It is the non-conventional machining process in which material removal takes peace with the help of laser beam.

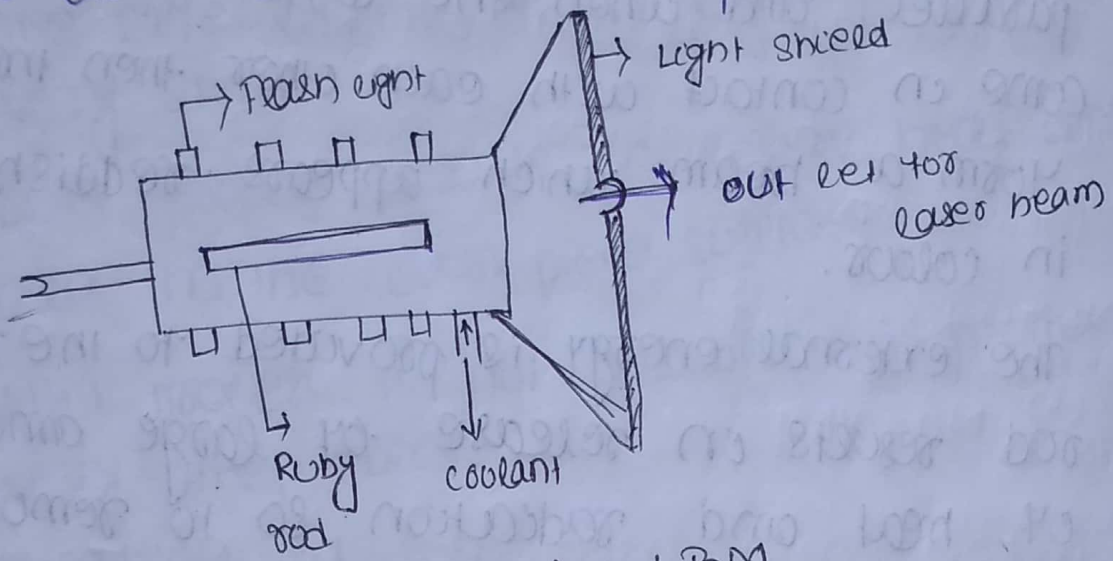
construction of laser beam machining:-

→ The apparatus for laser beam machining set up consist of a ruby rod in which Aluminium is the main ingredient. The impurities like chromium is also present in 1:5000 ratio. This impurities are very important for the production of laser beam.

→ The set up also consist of flash light that is use to provide excitation energy to the atoms coolant are also provided in this set up to remove the un wanted

heat produce during laser beam production.

→ A light shield is present to produce the laser beam into a desirable wave length the set up for the laser beam machining is accumulated inside a protected environment.



Working principle of LBM

→ Whenever an atom gets some energy from any external source then it shows three kin of behaviour.

(i) The atom is not excited as the magnitude of energy is less.

(ii) The atom ~~is not excited as the magnitude of~~ absorbs the energy and remain in the same energy level.

(iii) The atom gets excited and starts liberating different radiation.

→ When the flash light provide external energy to the ruby rod then the chromium particles recives the energy and starts emitting radiation of various colours.

→ This emission of radiation is not possible on ground level. The emission takes place in excited excitated state.

→ The ends of the ruby rod are flat and parallel and when the different radiation come on contact with each other then they form a beam which appears reddish in colour.

→ The external energy is provided to the ruby rod results on release of large amount of heat and radiation so to remove the excess amount of heat coolant are circulated across the L.B.M set up

Advantages :-

→ LBM process can be utilised for making a very small holes on hard and thin materials.

→ The surface finish produce during LBM process is very smooth.

→ In L.B.M process we can obtain an accuracy of 0.01 mm to 0.1 mm.

→ LBM process can also utilised during the machining of rotating parts.

Disadvantages :-

→ The LBM process results in very low material removal rate.

→ The set up for LBM is very costly.

→ The life of the flash light are also very short.

→ LBM process results in severe heat affected area in the work piece surface.

→ LBM process is not abable to produce very deep holes.

Application of LBM

→ LBM process can be used for micro machining production.

→ LBM process can be used for cutting complex profile during en

→ It can also be use during micro drilling.

→ LBM process can also be use for selective heat treatment of the materials.

→ It can also be use to project intense energy to a small area to melt weld or ignite materials on the workpiece surface.

→ It can also be used for drilling of very thin and small holes.

→ It can be utilised for the machining of parts during micro boring operation.

→ Laser beam also an important role to play during medical operation.

Q What is lases?

ANS:- Laser stands for light Amplification by Stimulated emission of Radiation.

Q Write down any two source for laser beam production.

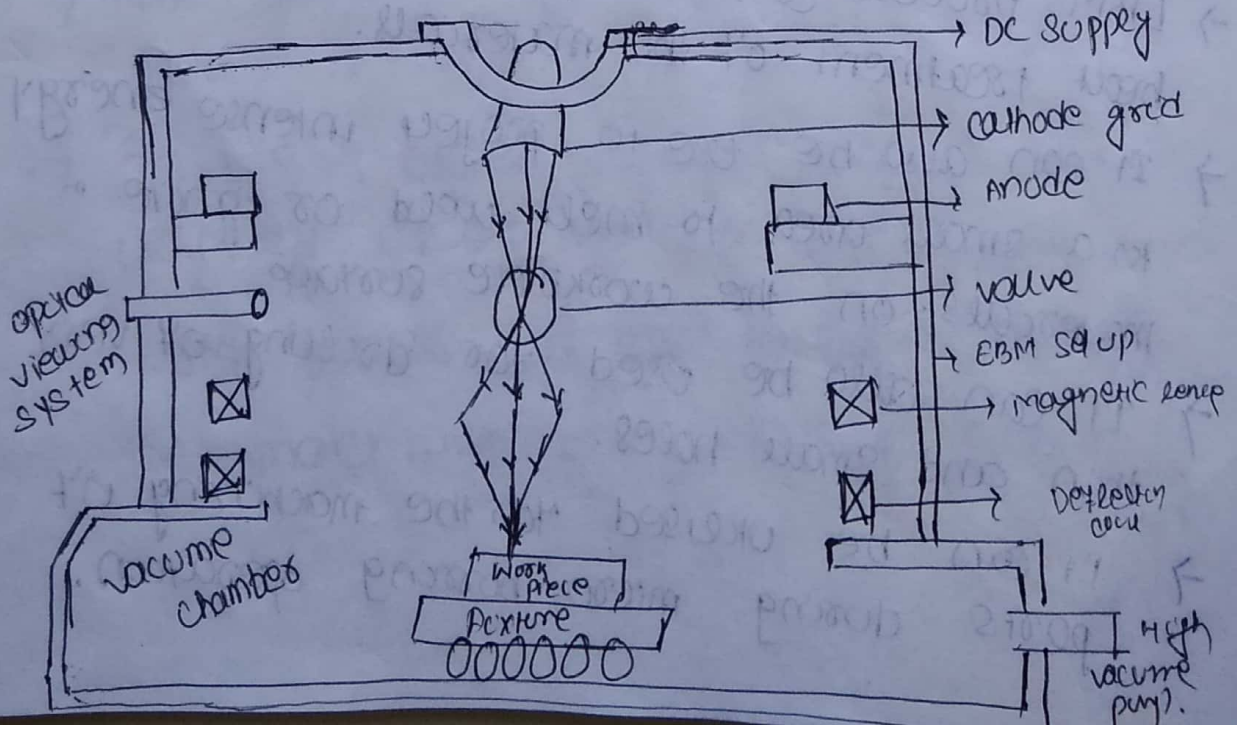
ANS: (i) Ruby rod

(ii) Nd-YAG

Electron Beam machining (EBM):-

It can be defined as a non-conventional machining process in which material removal takes place with the help of electron beam is known as EBM.

construction of Electron beam machining



The set up for EBM process consist of a DC supply source having a voltage intensity of 30 kV. The cathode grid which is -ve negatively biased is responsible for the emmision of current or flow of electrons The Anode used in EBM process is connected to the cathode so that the electron don't deviate from their path and approach to the next element.

→ The magnetic lens are provided which gives a particular shape to the beam and to reduce the divergence of the electron beam and produce a high focused beam. Deflection coils are used to focous the electron beam on a particular spot on the workpiece surface. High vacume environment inside the EBM set up optical viewing system is also provided to check the formation and divergence of electron beam.

Working Principle of EBM

→ The EBM process is started when a high voltage 30 kV DC supply is provided to the cathode grid. when cathode grid is supply with the required voltage then it starts producing electric current. The electric current here produce high velocity electrons which moves towards the anode which is placed after cathode grid.

→ Now this high intensity electron beam passes through the anode and with the help of a valve it is controlled.

The diverged beam then passes through magnetic lense which is responsible for controlling the divergence of the beam and increasing the intensity of the beam.

→ The electron beam then reaches the deflection coils which focus it into a particular spot on the work piece surface. The material is removed when the high intense electron beam collied with the work piece surface and the kinetic energy of the electron beam is converted into heat energy. In this way the heat energy melts the work piece surface and eventually it vapourises.

Advantages:-

→ EBM process can be utilise for the drilling purposes in case of very tough material.

→ very hard and heat resistant material can also be machined and welded with the help of EBM process.

→ No physical damage occurs in the work-piece surface during electron beam machining.

→ No tool wear takes place occurs during EBM process.

→ In EBM process their is no contamination of the set up since the EBM process is carried out inside the vacume chamber.

→ Holes as small as 0.002 mm in dia. can be produced during EBM process.

Disadvantages :-

→ The critical cost for the EBM set up is very high.

→ EBM process can be carried out only in the vaccum chamber.

→ Skilled operated are required to perform the EBM process.

→ The power consumption in EBM process is very high.

→ In EBM process proper care should be taken to avoid heat affected area.

→ This process is not suitable for the machining of workpiece where less amount of material is to remove.

Application

→ EBM process is utilized in drilling industry to produce deep holes.

→ This process is suitable for welding of highly reactive material.

→ This process is suitable for machining of turbine blades for aero engines and orifices of the neuclear reactor.

→ very precies holes of 0.002 mm can be produced in EBM process.

Q Why electron beam machining is carried out in vaccum chamber. ?

EBM is carried out in vacume chamber because the kinetic energy of electron beam may get reduce due to its collision with the air molecules.

Q What is the DC voltage supplied during EBM process?

ANS 30 KV.

Q What is the function of magnetic lense, and deflection coils.

ANS :- magnetic lens control the divargance of the beam and increase the intensity of the beam. deflection coils use to focus the electron beam on a particular spot on the workpiece surface.

Q What is the accuracy that can be achieved during EBM process

ANS 0.002 mm

Automation

chapter 2

The technique, method or system of operating or controlling a process by highly automatic means and reducing the human involvement to a minimum level with the help of automatically operated devices with out continious input from an operator is known as automation.

Need for the automation :- (Advantages, Object)

→ Increased in overal productivity.
→ Improved quality of the manufactured product.
→ Increase in consistncy of the product.
→ Reduced human labour cost and expenses.
→ It can complete task where a high level of accuracy is required.
→ instolation in operation reduces cycle time.
→ It reduces injurys to the human labour.
→ Replases human operators in task that involve very hard and monotonous physical work
→ It performs task that are beyond human capabilities.
→ It replaces human in task done in dangerous environment.

→ It reduces operation time and work handling time.

→ It provides high level jobs in the development field.

→ It provides a safer working condition.

Disadvantages of Automation :-

→ It is very costly since the automated devices and electronic gadgets are very expensive.

→ It can result in unemployment for a large section of industry workers.

→ It consumes huge amount of energy.

Types of Automation :-

There are three types of automation. They are

(i) Fixed Automation
(ii) programmable Automation
(iii) Flexible automation

(i) Fixed Automation :-

In this automation process automated equipments are fixed in a sequence of producing assembly operations. Each of the operation in the sequence is very simple and mostly follows a simple linear path.

→ It is difficult to change the sequence of the process. This automation is also known as hard automation.

Advantages :-

→ Low unit cost.
→ Automated material handeling. and high production rate.

Disadvantage

→ High initial investment.

(ii) Programable Automation :-

In this automation process the production equipment is design with the capability to change the sequence of the operation to produce different products of different configuration. This operation is controled by a program so, that it can be read and interpreted by the system. New programs can be prepared and entered into the system to produce new products.

Advantages :-

→ Flexible to deal with design variation.
→ Suitable for batch production.

Disadvantages:-

→ High investment for the automated equipments.

ii) Flexible automation :-

A " " system is capable of producing a variety of parts with virtually no time loss. The changed for a new product is made which results in no time loss. The system is programmable and the physical set up can be altered.

Advantages :-

→ Continuous production of variable mixture of products.

→ Flexible to deal with product design variation.

Disadvantages :-

→ Cost of the equipment is extremely high.

→ It requires a highly skilled operator.

NUMERICAL CONTROL (NC) SYSTEM

Chapter - 5

NUMERICAL :-

Numerical stands for any think that contains numbers, symbols, and letters.

CONTROL :-

control means to direct, show direction and to assign different duties.

Numerical control system :

It can be defind as a method of automation in which various functions of the machine tools are controlled with the help of Numbers, Symbols, letters.

In other words NC system is the method of automation in which machine tool is controled with the help of numbers symobals and letters.

Function of NC system :-

→ Starting and stoping the motion of machine tool.

→ controling the speed of the machine tool.

→ possitioning the tool tip at a desired location

→ Guiding the machine tool to control the movement of the tool.

→ changing the tool in the spindle.

Main components of NC system.

The Numerical control system consits of these main components. They are.

(i) Machine control unit.
(ii) part program
(iii) program coding system.
(iv) NC tools.
(v) Servo electric mechanism.
(vi) control pannel.

(i) Machine control unit :- (MCU)

→ The MCU consits of important toolings for the part to be machine. It perform the various controling function under the program control. It is mounted separately and it also controls the motion of the cutting tools, spindle speed, feed rate, tool change, cutting fluid application and various other function of the NC system.

(ii) part program :-

part program is a very important software which contains numbers, symbols and letters. It is the detailed plan for the manufacturing of a particular product in any NC system. It is very similar to a computer program with a specific format that is codes.

some typical examples of part program are.

(i) S 125.0 X 120.0 Y 30.0

(ii) S 180.0 X 30.0 Z 20.0

(iii) F 50.0 Z 30.0 Y 50.0

(iii) programming coding system :-

The human characters can't be directly entered into the machine control unit. so we need a part coding system that can be easily understood by the machine control unit. The normal program is need to be converted into the form of codes.

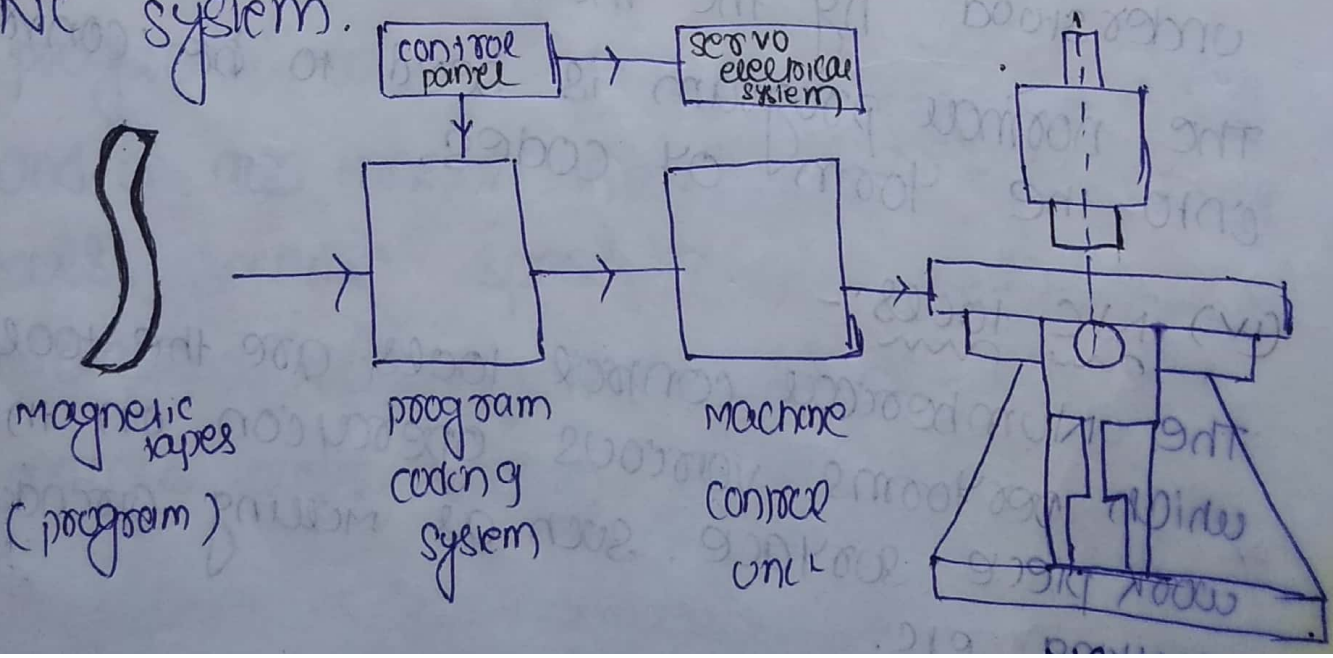
(iv) NC tools :-

The Numberical control tools are the tools which performs various operation on the work piece surface such as milling, grinding, cutting etc.

NC tools performs there function according the program decoded by the part coading system or program coading system and the NC tools are controlled by MCU.
Machine control unit.

(v) Servo electric mechanism :-
It contains all the servo electrical equipment such as motors, transducers etc. which helps in the movement of the NC tool and it also measured the speed of the machine tool.

(vi) control pannel :-
A control pannel consits of various fuse and switches which control the flow of electricity to the different parts of the NC system.



Types of NC coordinate system :-

There are various types of NC coordinate system which can be classified according to the relative movement of the tool with respect to the work. They are

i) point to point NC system.
ii) straight cut NC system.
iii) contouring NC system.

(i) point to point NC system :-

→ " " " " " is also known as positioning system.

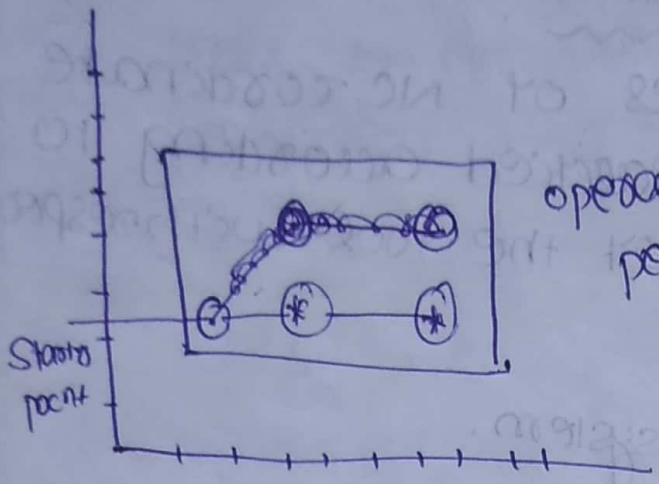
→ In PTP system, the objective of the machine tool is to move the cutting tool in a predefined location.

→ The speed and path of the movement is not imp in P.T.P system.

→ once the tool reaches the desired location. the machining operation is performed at that location.

→ For Ex NC drill machine is a good example of P.T.P system. The spindle first is positioned at the particular location and the drilling of the hole takes place under P.T.P system.

→ P.T.P system can be used in drilling and spot welding operation.



operation performed in PTP system

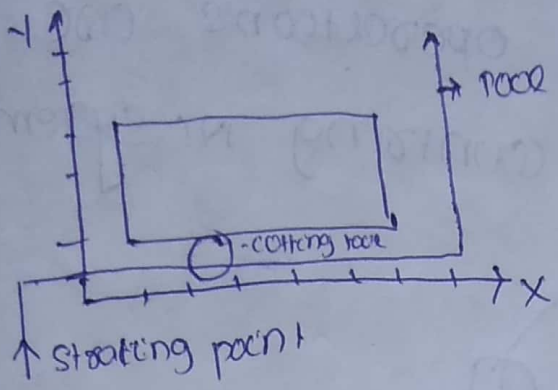
(ii) Straight cut NC system :-

→ " " " " is capable of moving the tool parallel to one of the measure axis. At a suitable rate for machining.

→ It appropriate for performing milling operations of rectangular configuration work piece

→ In this type of NC system, it is not possible to combine movements in more than a single axis. Therefore angular cuts are not possible in the workpiece surface in case of straight cut NC system.

→ This type of system is also abable to perform operation which are performed by P to P NC system.



(iii) contouring NC system :-

→ " " " is the most complex, most flexible and most expensive type of NC system.

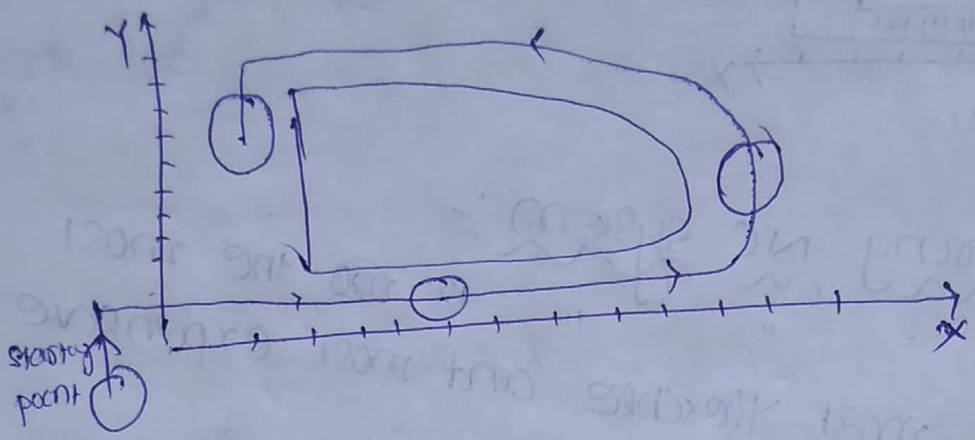
→ This NC system is capable of performing operation's which are performed in PTP NC system and straight cut NC system.

→ The most imp feature of contouring NC system is there capacity for controlling the movement of the tool in more then one axis.

→ The path of the cutting tool is continously controlled to generate the desired geometry of the work piece. For this reason contouring NC system is also known as continuous path NC system.

→ circular path, conical shapes, straight or plane surfaces of any orientation can be machined easyle with the help of contouring NC system.

→ Milling and turning operations are common exaple of contring NC system.



Part programing :-

The " " in the NC system can be defend as the procedure by which the sequence of the processing steps to be performed on the NC machine is planned and documented.

→ It involves the preparation of punched tapes which are used to transmit the information of the operation to the cutting tool.

→ The part programming consits of a various codes used by the manufacture during the machining operation. Sum of the imp cod or function are

(i) coordinate function.
(ii) feed function or F-code
(iii) speed function or S-code

(iv) Tool function or T code.
(v) preparatory function or G-code.
(vi) Miscellaneous function or M-code.

(i) coordinate function :-
The " of the tool tip are program for generating a given component geometry. The coordinate value are specified using the word address. x, y, z etc. This are used along with the decimal point depending upon the resolution according to the need.
For Example x 45.0 Y 35.201
z 289.208 x 46.51

(ii) Feed function or - F-code :-
The feed is determine in terms of velocity of the tool into the work piece. The feed function generally signified the feed of the tool and it is designated with the word 'F' The feed function or feed rate is program and controlled by the NC system. This is actually the speed with which the tool moves penetrating into the work-piece.
For example:-
x 38.26 F 45.00

(iii) Speed function or S-code :-
The " " " " is designated with the word S. The speed function signified the speed of the spindle.

In most of the CNC machine they need to have a propre S-code to control the speed of the tool. The speed can be set directly in the revolutions per minit. (Rpm) mode.

For Example

S1500 where spindle speed is set to be 1500 rpm.

(iv) Tool function / T code :-

The " " signifies the selection of the tool during the various stages of the machining operation. The tool function is designated with the word 'T'. All NC machine are generally provided with various types of tool with automatic tool changers which changes the tool and set the tool in few seconds. The T code maye have two or more degits depending upon the capacity of the NC system.

For Example T 15 which means tool number 15 is to be brought into the spindle replacing the already present tool on the spindle.

(v) preparatory function / G-code Imp

The " " or G code is a preset function which is associate with the movement of machine axis & the gemometry of the workpiece.

It is designated by the word 'G'.

It is possible to include more than one G-code in a NC part program.

The G-code are operationale when the NC control system is working.

The G-code which remain operational can be canceled by using anathore G-code from the same group.

The preparatory function are generally present is all machining centre to control the movement of the machine in various axis.

G-code are also instrumental in active peane selection. They are also used for repied possitioning of the tool in various axis.

Code	function
G00	point to point positioning.
G01	Line interpolation.
G02	circular interpolation - clockwise.
G03	Circular - interpolation ant clockwise.

G04 Dwell

G05 Hold

G06 parabolic interpolation

G07 unassigned

G08 Acceleration of feed rate

G09 Deceleration of feed rate

G10 Linear interpolation for long dimension (10 to 100 inches)

G11 Linear interpolation for short dimension (upto 10 inches)

G12 unassigned

G13 - G16 - Axis designation.

G17 XY designation.

G18 ZX "

G19 YZ "

G20 circular interpolation for long dimension clock wise.

G21 circular interpolation for short dimension clock wise.

G22 - G29 unassigned.

G 30 circular interpolation for long dimensional anti clockwise.

G. 31 circular interpolation for short dimension anticlockwise

G. 32 unassigned.

(vi) Miscellaneous function / M code :- Imp

This function actually operate some controls on the machine tool and this function also effect the running of the machine.

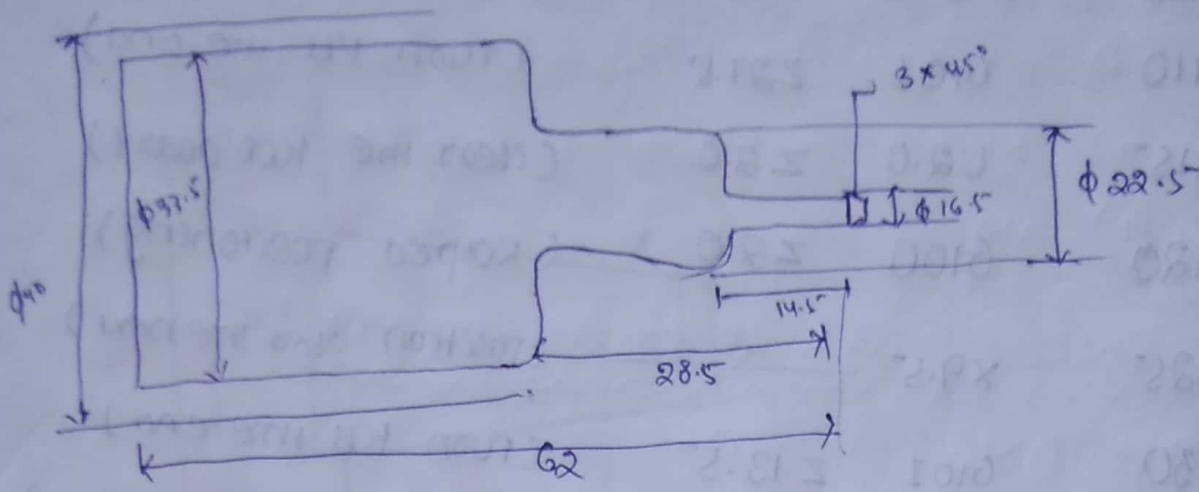
→ The miscellaneous function is designated by the word M. The M code used in case of automatic NC system are always standardised by the ISO.

- The miscellaneous function generally control the other important function which are not assigned to any of the coding system.

code	function
M00	program stop / Spindle stop.
M01	programming stop.
M02	End of program.
M03	spindle on cw.
M04	spindle on ccw.
M05	spindle stop.
M06	Tool change.
M07	coolant supply NO1 on.
M08	coolant supply NO2.

M09	coolant off.
M10	clamp
M11	unclamp.
M12	~~unclamp~~ unassigned
M13	spindle on c.w.t coolant on.
M14	spindle on ccw t coolant on.
M15	Rapid transverse in positive direction
M16	Rapid transverse in negative direction.
M17 - M18	unassigned.
M19	spindle stop at specified angular position.
M20 - 29 -	unassigned
M30	program stop at end of tape
M31	Interlock by-pass.
M 32 - 35	constant cutting
M 36 - 39	unassigned
M 40 - 45	Gear change.
M 46 - 49.	unassigned

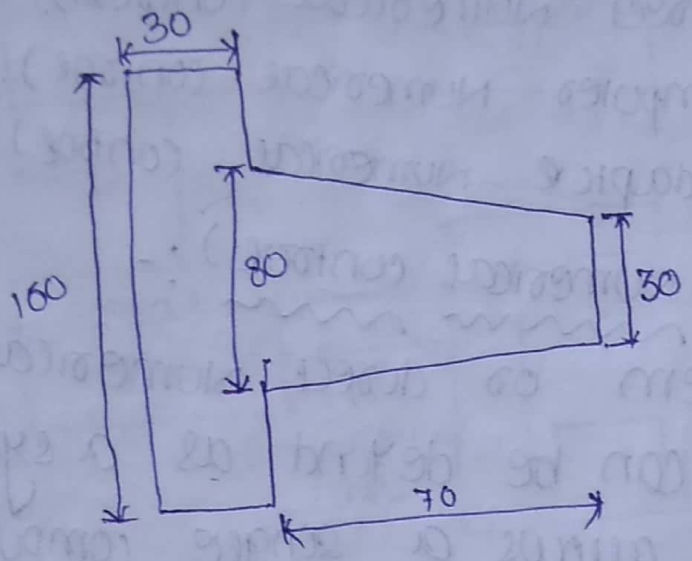
Q Write a part program ~~for~~ for the machining operation on lath.




```
N010 G21
N015 G150  S4000 (set spindle at 4000 rpm)
N020 M06  T0101 (facing tool)
N030 G96  S3000 (set spindle speed at 300rpm)
N035 G100  X22.0  Z0 M03 (position at clearance plane
                          for facing)
N040 G141  (Nose radius)
N045 G101  G98 X.0.5 F0.3 (Feed 0.3)
N050 G140  G100  X50.0 Z240.0 (position of the tool)
N055 S200  S200 M06 T0202 (Rough turning tool)
N060 G142  (Nose radius)
N065 G100  X17.75 Z2.0 (position at clearance plane for rough
                        turning)
N070 G101  Z 33.5  F0.35 (Turning till the end)
N075 U20  W2.0  (clear the tool
N080 G100  Z2.0  (Rapid positioning)
N085 X15.75  (position for next cut)
N090 G01 Z27.5  (Turn till the end)
N095 U2.0  Z2.0  (clear the tool)
N0100 G00  z2.0  (Rapid positioning)
```

```
N105    X13.75                          (position for next)
N110    G01   Z27.5                     (turn till the end)
N115    U2.0  Z2.0                      (clear the tool away)
N120    G00   Z2.0                      (Raped positioning)
N125    X9.5  ____________              (position for the next)
N130    G01   Z13.5                     (turn till the end)
N135    U2.0  W2.0                      (clear the tool away)
N140    G00   Z2.0                      (Rapid positioning)
N145    X9.5                            (position for the next)
N150    G01   Z13.5                     (turn till the end)
N155    U2.0  Z2.0                      (clear the tool from the material)
N160    G40   G00 X50.0 Z40.0           (position the tool)
N165    S300  M06 T0303                 (Finish turning)
N170    G42                             (G40 Give nose radius)
N175    G00   X5.0  Z2.0                (Rapid positioning)
N180    G01   X5.25 Z0  F0.15           (start the contour
N185    X2.85 Z 3.0                     (position the tool)
N190    Z12.5                           (position the tool)
N195    G02   X10.25 Z14.5 R2.0        (Rapid positing)
N200    G01   X11.25                    (Finish turning)
N250    M02                             (End of program)
```

Wocte the part program for the fig given




```
N05  G94   M06  T0101
N10  G00   X0   Z0  M04  S600
N15  G01   X30  F30
N20  G01   X80  Z 70
N25  G01   X100
N30  G01   Z 30
N35  G00   X 120
N40  G00   Z 10
N55  M05
N60  M30
```

Extension of NC system :-

The Numerical control system can be extended and produced into advanced NC system this advance NC system have the qualities of the basic Numerical control system and it also had some advance technogly associated wit it.

The extended NC system are.

i) DNC (Direct Numerical control).
ii) CNC (computer Numerical control).
iii) ANC (Adaptive Numerical control).

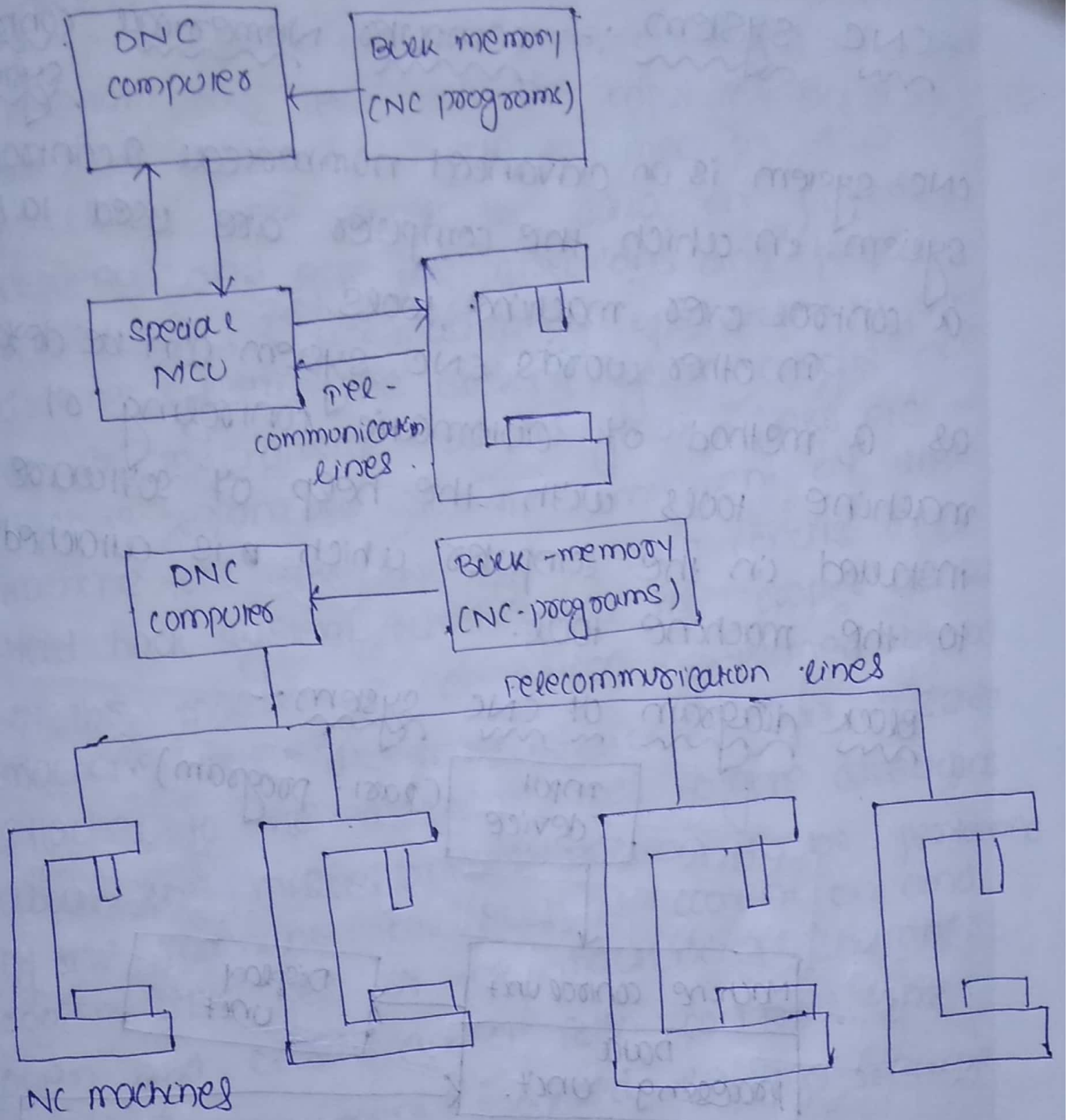
(i) DNC (Direct Numerical control):-

The DNC system or direct Numerical control system can be defind as a system in which that allows a single computer to be networked with one or more machine that used computer. This network is typically a broad band version.

The DNC system is utilised to control a network of computers through a single computer basically known as server. DNC system have a very easy and effective programming.

The DNC system consits of high level of decision making through computers.

Block diagram of DNC system:-



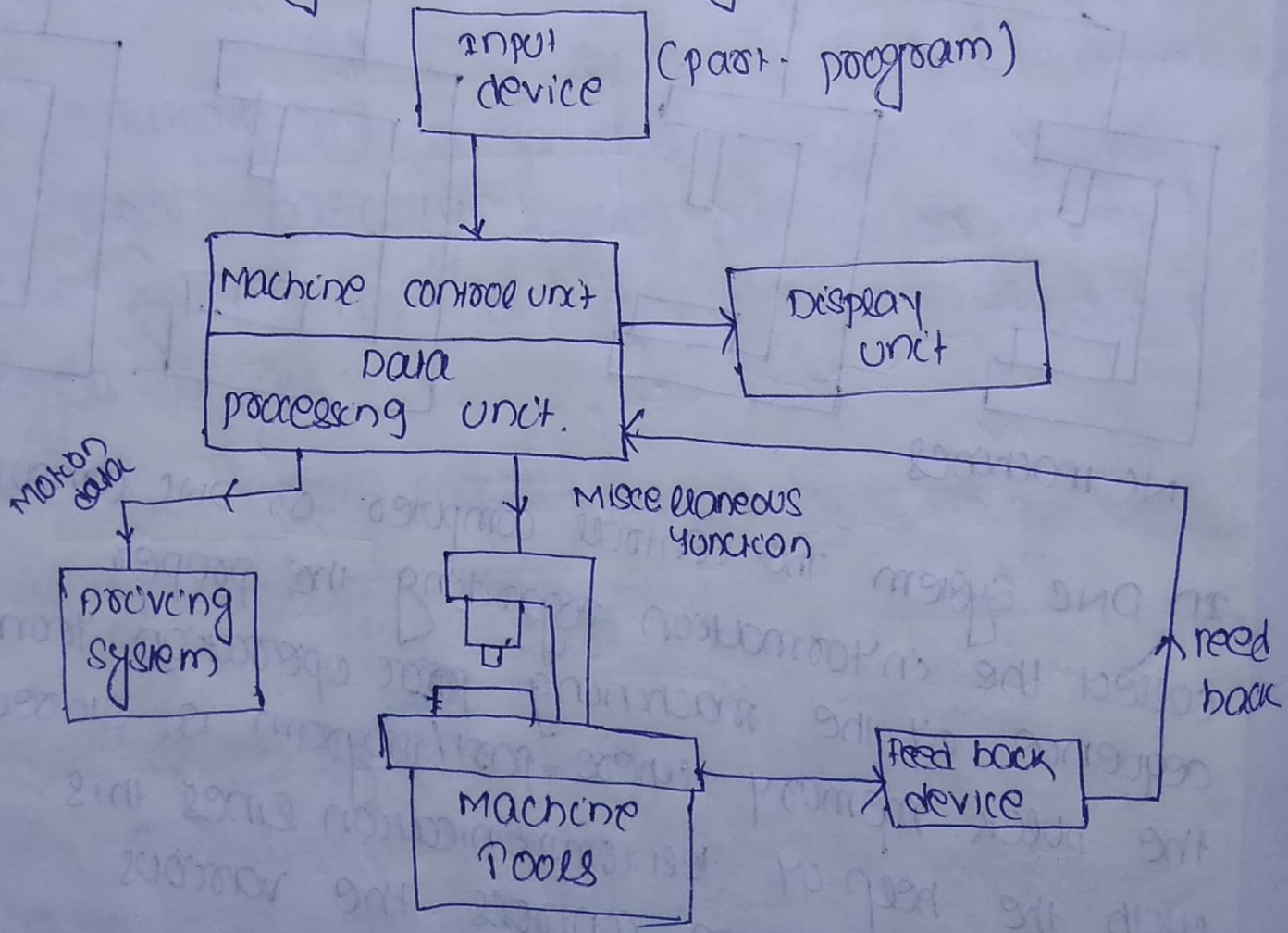
In DNC system the central computer or DNC computer collect the information regarding the proper sequence of the machining operation from the bulk memory where the part program is stored with the help of teli communication lines this central DNC system controls the various machine tools. In this type of system one central computer can be utilised to control a number of machine tools.

CNC system :- computer Numerical control system

CNC system is an advanced numberical control system in which the computer are used to have a control over machine tools.

In other words CNC system can be defind as a method of automatic controling of machine tools with the help of software installed in the computer which is attached to the machine tool.

Block diagram of CNC system :-



In CNC system the input data in terms of part program are feed into the input device. The machine control unit with the help of data processing unit process the data in proper sequence and give the directions and proper procedure of the machining operation to the driving system. The driving system consits of all the mechanism such as gears, links etc which is responsible for the movement of the machine tool. The CNC system also consits of a feed back system which gives the proper details of the machining operation performed by the machine tool. The machine control unit is also attached to the machine tool to give directions about the miscellaneous function to be performed by the machine tool. such as coolent on and coolent off, axis of the machining chamber open and close and it also controls the various displacement required in the machine tool.

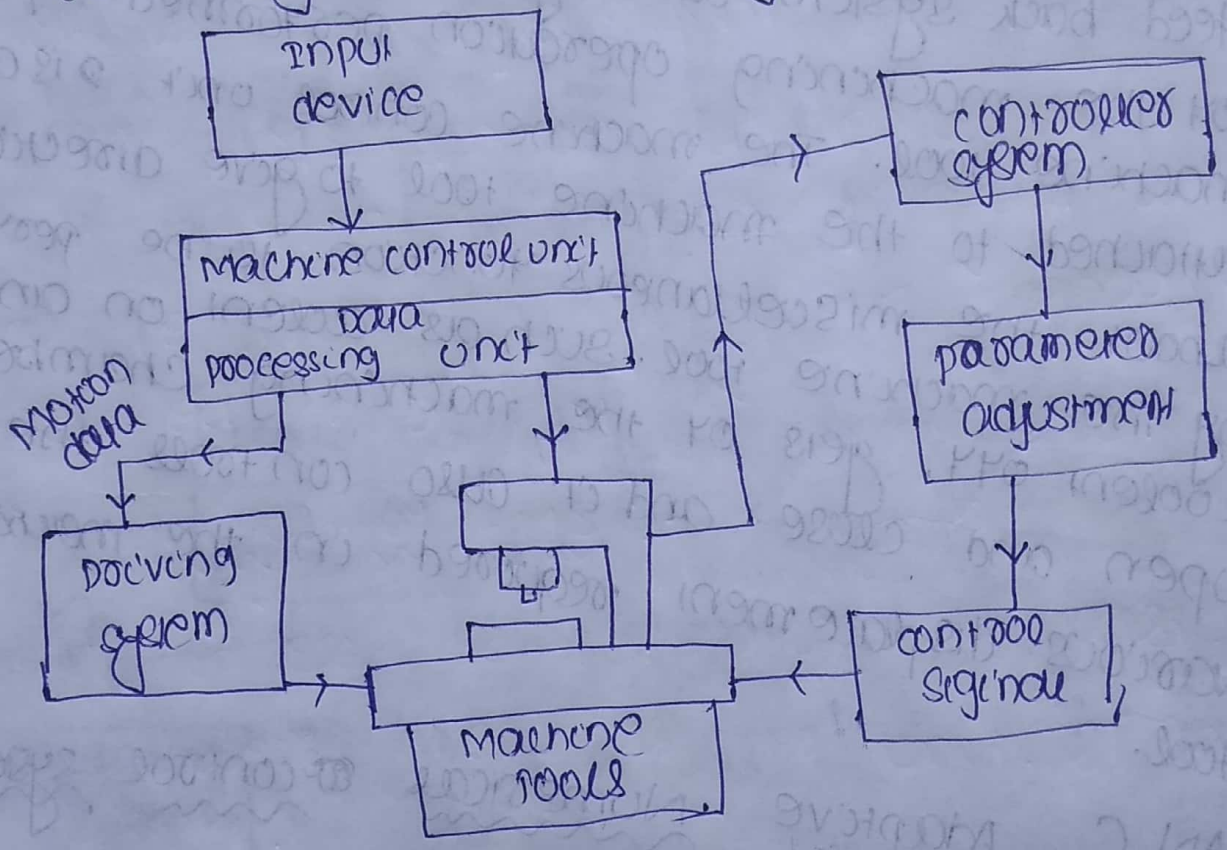
AN C Adaptive Numerical control sysem

→ The adaptive control system is the system in which, it has the ability to modify it's own operation to achive the best possible mode of operation.

In other words ANC system can be defend as the system which is capable of automatically adapting them selfs to the machining process going on.

→ ANC system is a very versatile system which can modify the machining operation at any time during the production according to the changing need.

Block diagram of ANC system



The ANC system consits of an input device into which the part program is feed the machine control unit with the help of the data processing unit process the data and the required

information regarding the machine operation is send to the driving system. The driving system give direction and information required for the machine tool to perform the machining operation.

simontaneously the machine tool is attached to the controller system which inspect the every motion of the machine tool. Any variation needed during the machining operation is adjust by the parameter adjustment system. The parameter adjustment system sends a control signal to the machine tools which helps in the adjustment of a particular parameter or variation needed during the machining operation.

Chapter-4

ROBOT

Flexible Manufacturing System (FMS)

It can be defind as the manufacturing system in which the manufacturing process can be modified at any point of time and the process which allows any kind of changes on the quality quantity as well as the replacement of the product.

FMS can be concidered as a most flexible manufacturing system which has the ability to change the operation executed on a part.

Advantages of FMS :-

-> It reduces the manufacturing coast.
-> It lowers the coast per unit of the product.
-> It increases the efficiency in the manufacturing process.
-> It results in greater productivity.
-> It results in improved quality.

→ It increases the system reliability.
→ It reduces the coast of inventories.
→ It increases the production rate.
→ It reduces the cycle time

Disadvantages of FMS :-
→ The FMS results in high set up coast.
→ It can be concidered as a compleated system.
→ The machanance of FMS is very compleated.
→ It requires skilled labours.
→ FMS process requireds a lot of research and pre planning.

Q16 Main component of FMS :-
The FMS conits of the following main components. They are
1) Workstation
2) Material handling & storage system.
3) computer control system.
4) operators.

1). Workstations :-

→ A workstation is the peace where the actual manufacturing process is carried out. There are various workstations involved in a FMS.

→ The time required to move one component from one workstation to another workstation is knows lead time.

→ The work station used in the FMS as a processing unit which is designed for different type of machining operation.

→ The Load/unload station in the FMS is the physical interface of the FMS.

→ The raw materials enter the work station and finished parts exist the work station.

→ The loading & unloading of the components are done either manually or with the help of automated material handling system.

The most common example of workstation is a CNC machine unit.

2. Material handling & storage systems :-

→ The second most important component of FMS is material handling & storage system.

→ The material handling system is the system which is responsible for the transfer of components from one work station to another work station.

→ The various other function of material handling system are (i) It is capable of moving any component in the system from one machine to another machine.

(ii) It also helps in loading & unloading of components in various work stations. The loading & unloading can be done with the help of human involvment and automated machine like robots.

(iii) It also act as a temporary storage because the component travelling from one work station to another work station requires some amount of time.

(iv)

→ Material handling equipment involves various automated machine as well as human involvement.

③ computer control system :-

→ The FMS includes a distributed computer system which consits of a central computer which controls the individual machine as well as the other components.

→ The function of the computer control system are

(A) It controls the work stations for performing the machining operation.

(B) It also distributes the instructions to various work stations.

(C) It control the production by providing the desired daily production rates.

→ The computer control system is also responsible for controlling the traffic at a particular work station.

→ The various other function performed by the computer control system are tool control, product control, tool location, tool life monitoring, performance monitoring etc.

(4) Operators :-

→ The operators are the human force involved in the FMS process.

→ Humans are needed to manage the operation in the FMS.

→ The common function performed by the operators in FMS are

(A) Loading raw materials in to the work-station.

(B) On loading the finished parts from the work stations.

(C) Changing and setting the tools.

(D) Maintenance and repair of the equipments.

(E) NC part programming

(F) Overall management of the system.

ROBOTICS

Chapter 5

Robot :-

According to industrial robot association, a robot can be defind as a multi functional manipulator design to move materials, parts, tools and other devices with the help of programmed motion for the performance very similar to a human being.

Robot Anatomy :-

The anatomy of a robot refers to the basic structure of a robot.
In other words the robotic anatomy includes the different part of the robots that are used to move material, parts, tools and other devices from one workstation to anathore workstation.
The robotic anatomy consits of the following main components they are

(i) Manipulator :- The manipulator is the most important component of the robot. Manipulators are developed by the integration of links and joints.

They are the parts of the robot which are used for moving the tool onto the work piece. Manipulators are also used to adjust the tools. They are similar to the wrist of the human.

2) End-effectors :- The end-effectors is considered as the hand of the robot. The end-effectors are the components which are used to hold the manipulator. The tools and grippers are the main components of the end-effectors.

i) The grippers are used to pick and place different objects.

ii) The tools are used to carry out operations such as spray painting, spot welding on a particular work piece surface.

3) Robot joints :- The robot joints in a robot's are capable of performing sliding and rotating moments of a components.

4) Kinematic :- The science behind the assembling of robots is based on the principle of kinematics. In other words kinematic of the robot is responsible for performing all its various functions whether it is movement, holding, the tool or unloading and loading of the work piece.

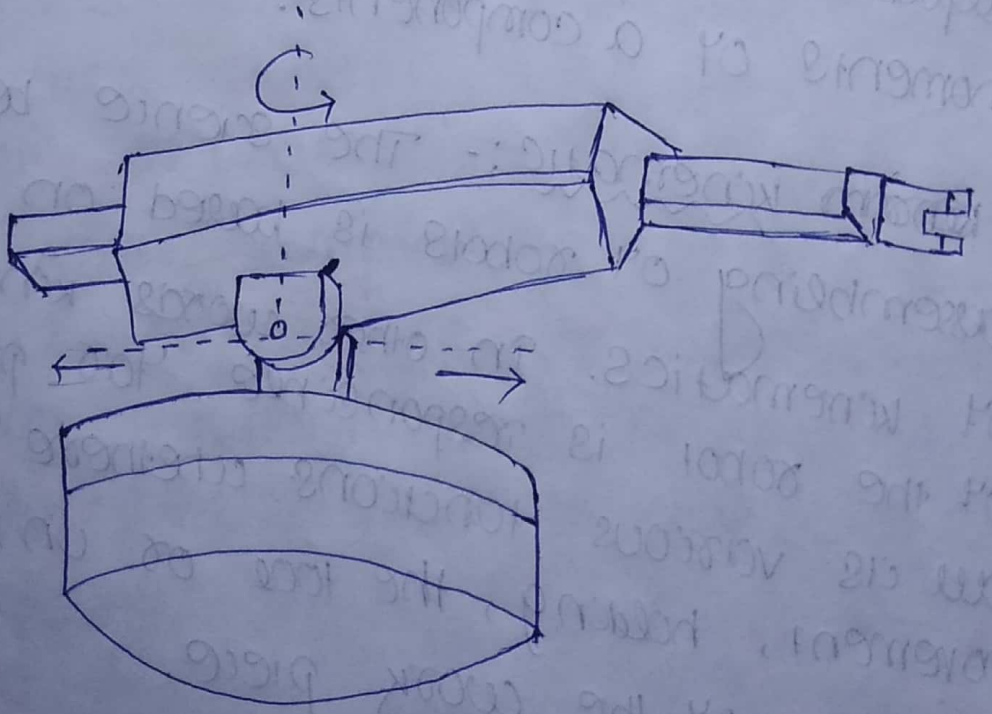
Robot configuration:-

The robotic configuration of a robot refers to the configuration in which the robot is capable of moving.

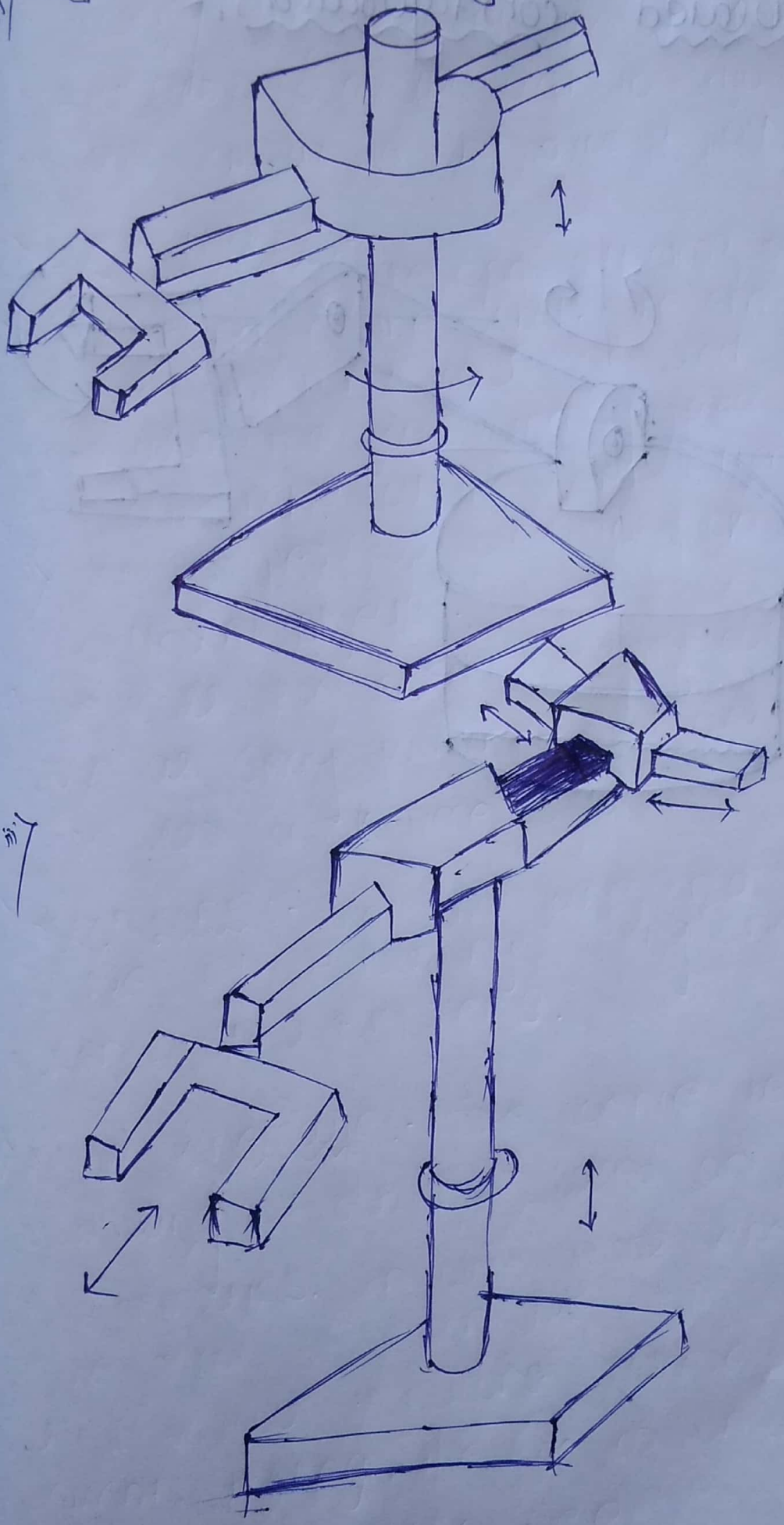
For Ex:- In the direction like x, y & z o axis, in an articulated manner. cylindrically, ~~Spherically~~ spherically etc.

There are basically 4 robotic configurations they are
i) polar coordinate (spherical) configuration.
ii) cylindrical configuration.
iii) cartesian configuration.
iv) Articulated configuration.

i) polar coordinate configuration:-



cylindrical configuration.



- cartesian configuration.

iv) Articulated configuration:-