ARYAN SCHOOL OF ENGINEERING & TECHNOLOGY

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LECTURE NOTE

SUBJECT NAME- ADVANCE MANUFACTURING PROCESSES

BRANCH – MECHANICAL ENGINEERING

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Advanced Manufacturing

⇒ Manufacturing is a science or technolo[gy] through which the raw material is converted into finished product.

⇒ In Manufacturing there are various st[eps] these steps are known as Manufactur[ing] process.

Traditional Machining or Conventional Machinin[g]

⇒ It requires the tool which is harder than the workpiece to be Machined.

⇒ It removes certain portion or part of workpiece to change them into final product by penetrating the cutting tool upto certain depth in the workpiece.

⇒ There is relative motion between the tool and workpiece takes place.

⇒ Energy used is only mechanical ener[gy].

⇒ Micro-chip formation takes place.

Note :- Now-a-days development of harder Material in the world like Ceram[ic] carbide, tungusten cannot be Machi[ned]

Limitation of traditional Machining :-

⇒ Harder material is difficult to Machi[ne]

⇒ very Minute hole cannot be produce[d]

⇒ Tool must be harder than the work-piece.

⇒ Difficult to produce complex Shape in harder material.

Non-traditional Machining :-

⇒ It is a process of Manufacturing that removes the access material from the workpiece to obtained the desire[d] Shape and Structure by using variou[s] technique and energy like electrical energy, chemical energy, thermal energy or combination of these energy without interacting the cutting tool with the workpiece.

Characteristic :-

⇒ No physical contact between the tool and workpiece.

⇒ Tool Need Not to be harder than WIP.

take place.

⇒ Different energy domain are used f Machining.

⇒ Any material can be Machined irrespec of its hardness.

⇒ Any complicated shape can be produce

⇒ Minute hole can be easily drilled.

‑ Difference between conventional and unconventional machining

Conventional Machining	Unconventional
1.) Interaction between cutting tool and workpiece takes place.	1) Interaction betw cutting tool and workpiece not ta place.
2.) only Mechanical energy is involved.	2) various energy like electrical, them Mechanical, chemica are involved.
3.) Micro-chip formation takes place.	3) Micro-chip format No chip formation takes place.
4.) work hardening takes place.	4) work hardness doe not takes place.
5.) tool must be harder than workpiece.	5) tool need not be harder than w/p.

6) complex struct-ure is difficult to produce.	6) complex structu-re is very easy to produce.

⭐ Different type of machining operation.

1) EDM → It stands for electrode dischar Machining.

2) LBM → It stands for laser beam machi ng.

3). EBM → Electron beam machining.

4) USM → ultrasonic Machining.

5). ECM → electro chemical machining

6) AJM → Abrassive jet machining.

1) Electrode Discharge machining :—
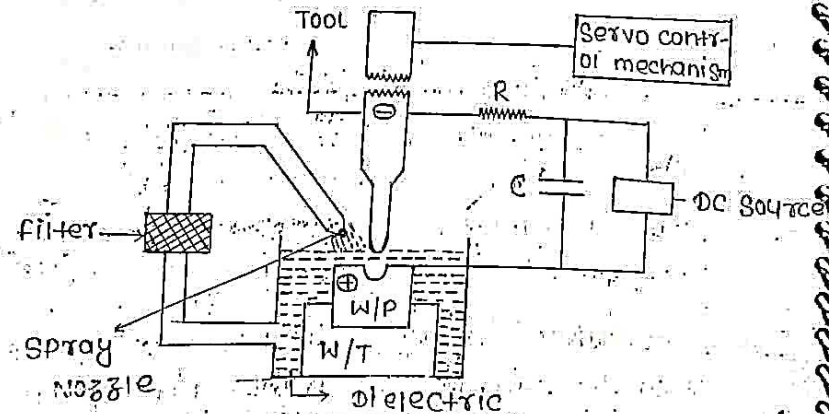
Element of EDM :—

i) DC Supply :—

⟹ It is use to connect the workpiece and the cutting tool and create a potential difference ranging between 50V – 450V between the tool and w/P.

ii) Tool :—

⟹ It is generally made up of graphite cast iron, silver, copper, tungsten i.e those material which have maximum no. of free electrons.

iii) Di-electric liquid :—

⟹ It's main function is to flash the melt material between the tool and workpiece. generally kerosene is used as di-electric liquid as it prevent the formation of bubble and eliminate the chance of cavit tion.

iv) Workpiece :—

⟹ Workpiece is mounted on the work-table and is connected to the DC source and act as anode.

↳ the workpiece must be a conducting material.

v) Nozzle :

from the workpiece by facing the di-electric liquid stream with high velocity through errosion process.

vi) RC circuit :—

⟹ A Resistance capacitor is attached to the DC source in which the capacitor is in parallel combination with the DC source when the voltage in the capacitor reach to the breakdown voltage. the di-electric liquid gets ionised and becomes ionised liquid.

vii) Servo control system :—

⟹ when spark is produced from the tool towards the workpiece then a propulsiv effect is generated which forces the tool to move away from the workpiece this increase the machining gap between the tool to move away from the w/P. this increases the machining gap b/w the tool and workpiece and the spark induced gets eliminated.

⟹ To continue the spark the tool must advances towards the workpiece to again establish the machining gap. this is done by a rack & pinion

pinion arrangement. this is known servo control.

* Working :—

⇒ when the DC supply source is switche on first the capacitor charges and wl the voltage across the capacitor is equ to breakdown voltage then di-electric liquid gets ionised and starts behal like conducting liquid.

⇒ the electron is in abandance at the tool and deficient at the wlp therefor flow of electron from the tool to the wlp takes place in form of spa this sparks generates high temperat at the region where it incident and melts the material which is further driven of by errosion process thro the di-electric liquid and in this way machining takes place.

-•- OUTPUT Characteristic Of EDM :—

i) MRR :—

⇒ It is the volume of material remove Per minute.

⇒ Material removal rate is directly proportional to voltage. As V increas I also increases and when I increase Heat developed to melt the materia increases which increases the material removal rate.

⇒ ex:- for a workpiece of steel when a voltage of 50v, material removal rate becomes 400 mm³/min. and when voltage is equal to 400 V material removal rate becomes 4800 mm³/min.

ii) ACCURACY :—

⇒ the tolerance value in EDM is ±0.05m However by controlling different variabl tolerance value equals to ±0.3 mm. these Minimum tolerance value indica the process is highly accurate.

iii) Heat affected zone :—

⇒ The workpiece material when melted is not completely expelled off, during this process as some melted material re-solidifies and forms a layer of

thickness 2-10 μm which is further removed by polishing.

⟹ Due to high temperature a layer of thickness 0.05mm - 0.2 mm in tempere condition as because the topmost layer must be hard enough to res the wear.

-ᵒ- Desirable property of di-electric liquid used in EDM.

⟹ It must have low viscosity.

⟹ It doesn't contain any toxic particle.

⟹ It must be inflammable.

⟹ It does not have tendency to produc bubble as bubble formation may crec cavitation.

⟹ It must be cheap and easily availat

-ᵒ- Advantage of EDM :-

⟹ very fine holes can be drilled very easily.

⟹ there is no direct contact between the tool and workpiece therefore there is less chance of tool wear.

⟹ extremely very hard material can be machined very easily.

⟹ Since, in this process micro-cheap formation takes place hence bette surface finished is obtained.
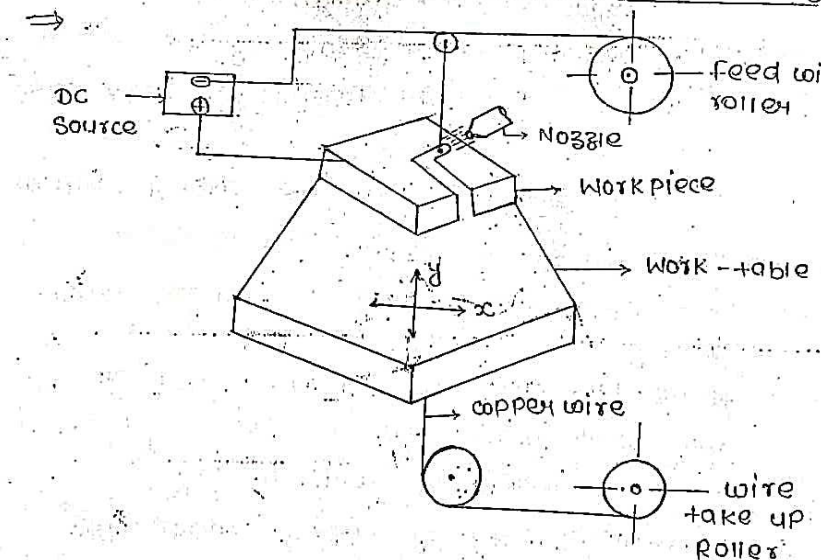
-ᵒ- Disadvantage of EDM :-

⟹ It is only used for conducting workp

⟹ Material removal rate is low.

⟹ Power consumption is very high. hence process is expensive in nature

-ᵒ- Wire-cut electrode discharge machining

⟹

DC Source — feed wir roller — Nozzle — Workpiece — Work-table — copper wire — wire take up Roller

ii) It removes the used wire by wire take up roller.

iii) It maintain proper amount of tension in the wire which is approximately 50-60 of it's maximum tensile strength by proper positioning of the set of roll and pulley.

Principle :—

⇒ It works in same principle of EDM i.e the heat energy generated by the spark through the wire is used to melt the material from the workpiece which is further flushes out by di-electric liquid.

Working :—

⇒ first a through hole is drilled through out the workpiece. a wire of 0.3 mm diameter works as a tool is feed through the hole. so that the machining gap of 0.5 mm is maintained.

⇒ When the DC source supply the voltage to create the potential differential upto 50 volt between wire and workpiece, electric spark is generated

Construction :—

1) DC Source :—

⇒ the workpiece is connected at positive terminal of DC source and tool i.e copper wire is connected to the Negative terminal of DC source.

⇒ DC Source established a potential differential of 50 volt between the tool and workpiece.

2.) Di-electric :—

⇒ the Di-electric liquid used in this is water. A Nozzle is imployed to inject the di-electric liquid in the machining gap. the di-electric liquid flushes out the melted material from the workpiece.

3) CNC control System :—

⇒ Movement of table on which the workpiece is Mounted is controlled by CNC control System. table has movement only in two perpendicular axis.

4.) Wire drive System :—

liquid through the Nozzle.

⇒ Since the wire is of very small in di therefore the section of wire which pra the spark gets tilted and it is unable to produce the straight cut hence for straight cutting fresh wire is continuo feed through out the workpiece.

Output characteristic of wire-cut EDM

Discharge current :—

Material removal rate is directly proport al to the current developed i.e on incre sing the current material removal rate increases but since the wire is of ver small diameter. Hence the value of cur may increase upto 30 Ampere. Beyond t value wire cannot withstand.

Cutting rate / cutting speed :—

⇒ wire speed 2.5 to 150 mm/sec.

→ Average machining rate is 10-15 mm^2/n

Wire tension :—

⇒ In order to keep the wire straight prope tension in the wire must be maintaineo

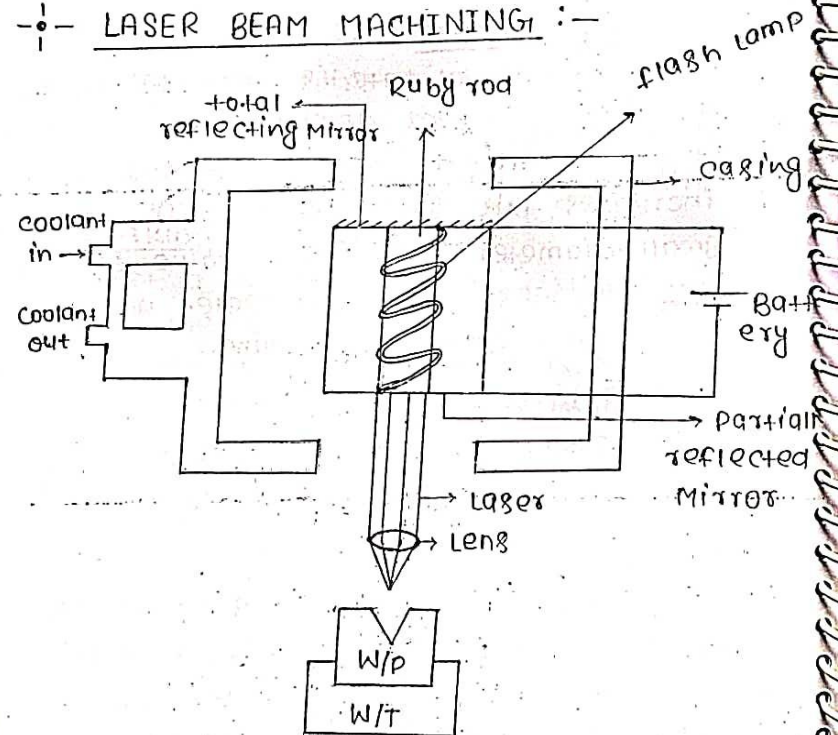⇒ to maintain the tension rollers and pulle are used at proper distance such that the tensile strength in the wire is

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50-60 of its maximum tensile strength

4.) Di-electric flow :—

⇒ the Nozzle is used to spray the di-elect in the machining area the flow should be continuous.

⇒ the used di-electric can be again use only by filteration.

LASER BEAM MACHINING :—

Construction :—

i) Laser generation unit :—

⇒ In this unit ruby rod, flash lamp power supply, Mirror are used for production of laser.

⇒ the ruby rod contains Aluminium oxid with chromium. the end of ruby rod are attached with mirror. one is tot reflecting while other is partially reflecting.

⇒ the flash lamp having Argen, Kripton xenon gas is wounded around the ruby rod. the flash lamp is conne- ted to electric power supply. the electric supply is so designed tha it will produced 250-1000 watt energ

ii) Cooling system :—

⇒ Ruby rod becomes less efficient at high temperature and it gives maximum efficiency when kent at a

⇒ Hence a cooling system is provid which liquid Nitrogen is used. Sometime air or water can also be used but it has less efficie then Nitrogen

Collimating Lens :—

⇒ the laser beam is pressed throug a collimating lens whose tendenc is to converse the laser beam at a particular point.

Work-Table :—

⇒ the work table is made up of Aluminium as because on Aluminium there is no hazardous (खतरनाक) effect.

Working :—

⇒ When the power supply is on the flash lamp emittes flashes of light.

⇒ the ruby rod absorb sufficient heat energy requires to excite the chromium ion.

⇒ the chromium ion goes in excited state where it is unstable and remains for only 10^{-8} sec after this the excited or ion releases its energy in form of photon with some wavelength.

⇒ But since the end of ruby rod is reflecting therefore after multiple number of reflection laser is produces.

⇒ the amplified beam of laser come out from partially reflecting

Mirror and then passes through colliting lens.

⇒ the lens converges this laser beam to a particular point where machining is required.

⇒ this melt the portion of a w/p where laser strikes and vapourises the w/p material thus machining is obtained.

Controlling parameter or output characteristic of laser beam machining :—

i) Intensity of laser beam :—

⇒ Intensity of laser beam decide whether the beam will produced cutting or welding.

⇒ for machining operation the min^m intensity require is 1.5×10^7 watt/cm^2, if intensity is less than 1.5×10^7 watt/cm^2 then welding will takes place.

ii) flash lamp frequency :—

⇒ flash lamp for good and efficient production of laser it should produced 12 flashes of light per min.

iii) focal distance :—

⇒ the workpiece should be kept as close towards the lens. if the distance will be more than divergens will be more

:- Difference between EDM and LBM.

EDM	LBM
1.) It works on the principle of spark errosion.	1) It works on the principle of laser.
2.) It is used for conducting material.	2) It is used for conducting as well as Non conducting material.
3.) Dielectric liquid is used.	3) Absence of Di-electric
4.) EDM requires a tool which may be soft and have abundance of electron.	4) LASER is itself a tool
5.) Due to cavitation tool wear takes place.	5) No chance of tool wear as cavitation doesnot te Place.
6.) EDt Heat affected zone are very high.	6) Heat affected zone are very low.

:- ELECTRO-CHEMICAL MACHINING :— (ECM)

Construction :—

⇒ Workpiece is made Anode by connecti

fig :— Electro-chemical Machining
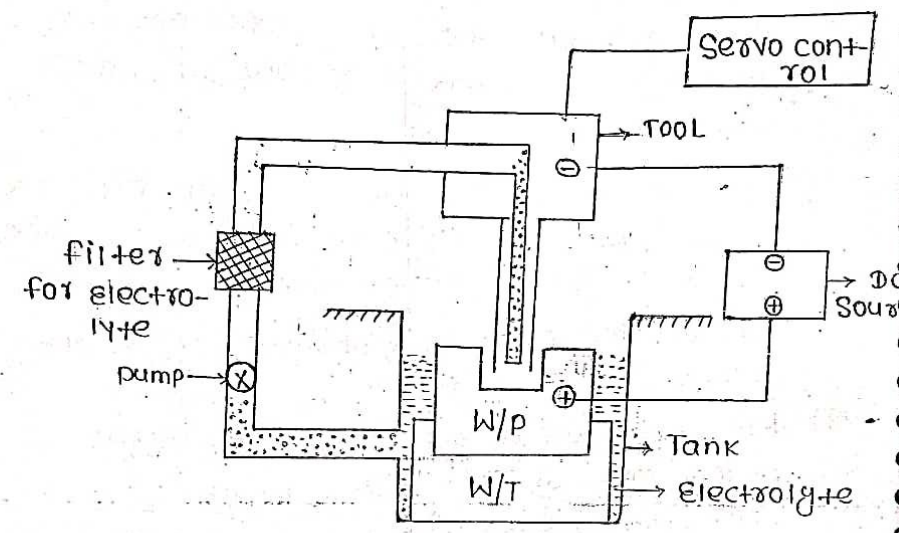
Material can be Machined by this proce

:- Tool :—

⇒ A special design tool is used for ECM. It will form cathode there must be passage inside the tool for the flow of electrolyte.

⇒ the tip of the tool is so design that its shape is replica of the shape

DC supply :—

⟹ the Power supply is of 3-4 V. the tool connected with Negative terminal and wor Piece is connected with positive termi

Electrolyte :—

⟹ Generally water soluble Nacl or water soluble $NaNO_3$ is used as electrolyte. electrolyte dissolve workpiece material an Percipitate it to facilated the remove of workpiece material this process of diffusion of the workpiece in electrolife is called Anodic dissolution.

Servo control :—

⟹ Servo control is used to feed the too towards the w/p.

⟹ During machining cavity forms where Material is removed.

⟹ due to which machining gap increases therefore Servo control move the tool towards the workpiece to maintain a constant gap of 0.5 mm between the too and workpiece.

-⊢ Fixture is used to fix the w/p in its position.

Filter :—

⟹ It is used to filter the workpiece mate: dissolved in the electrolyte.

Principle :—

⟹ It works on faraday law of electroly It is the reverse process of electroplating because in electroplating Material on the w/p is deposited Howev in ECM material from the w/p is removed.

Working :—

⟹ During ECM there will be electro chemica reaction takes Place in which both electrical energy and chemical energy are involved.

⟹ when the DC Source is on a potentia difference between the tool and w/p gets set up. due to which current Start flowing. the acquous Nacl gets split into gon.

$$H_2O \xrightarrow{\Delta} H^+ + OH^-$$

$$Nacl \xrightarrow{\Delta} Na^+ + Cl^-$$
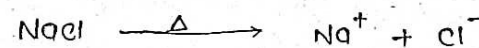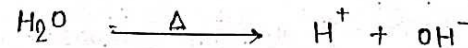
⇒ the H^+ ion move towards the tool cor it combine with the electron release by the workpiece and liberated a Hydrogen gas.

⇒ the other positive Na^+ ion react with Cl^- ion coming from the electrolyte coming from filter.

⇒ At Anode due to high current Fe get ionised by releasing electron.

$$Fe \xrightarrow{\Delta} Fe^{2+} + 2e^-$$
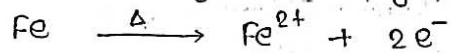
⇒ the Fe^{2+} ion combines with OH^- ion and Cl^- ion to form iron-hydro-oxide an Iron chloride in form of scale which get dissolve in the electrolyte coming from the tool passage and thus material will removed from W|P and machining takes place.

$$Fe^{2+} + 2OH \longrightarrow Fe(OH)_2$$
$$Fe^{2+} + 2Cl^- \longrightarrow FeCl_2$$
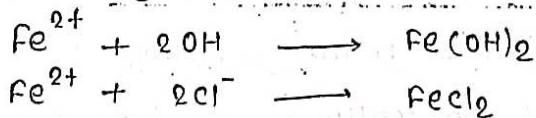
EDM	ECM
i) Dielectric liquid are used.	i) electrolyte are used.
ii) It works on spark Errosion Principle.	ii) It works on faraday law of electrolysis.
iii) material is removed by melting.	iii) material is remove by diffusion through electro chemical react
iv) only electrical energy is involved.	iv) both electrical & chem cal energy are involve
v) High voltage, low current (400v, 500A) is used.	v) low voltage high current (5ov, 40,000 A) is used.
vi) low metal removal rate (1000 m³/min)	vi) High metal removal rate (15000 m³/min).

LBW (Laser beam welding) :—

⇒ LBW is basically a joining process between surface of two workpiece with the help of a laser beam.

⇒ If the intensity of laser beam is

less than 15×10^7 watt/cm^2 then t workpiece material between the two surface get diffused into each- of

→ the two surface becomes a unit th is known as laser beam welding

$\dfrac{L-14 \Rightarrow E\cdot B\cdot M}{L-15 \Rightarrow USM}$

-:- CNC Milling :—

→ The word CNC means computerised Numeri Control.

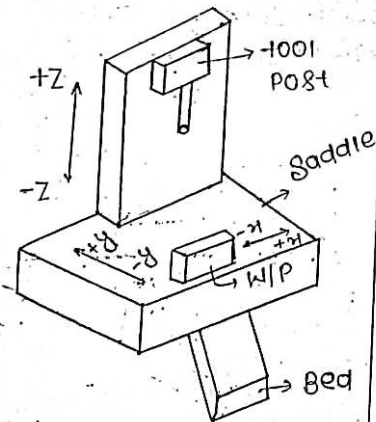→ therefore CNC milling machine are those milling machine in which various milling operation are obtained by computerised Numerical Control.

+ Difference between vertical and Horizontal milling machine center.

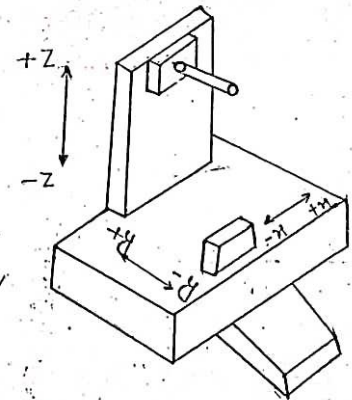| Vertical Milling Machine Center	Horizontal Milling Machine Cen
i)	i)
ii) In this the axis of the spindle is vertical	In this the axis of spindle is horizontal

3.) the tool post is mounted on the column with the help of a swivelling plate.	3.) Tool post is mount directly on the col
4.) the tool post has to be swivelled at any desired angle therefore it must be small and light in weight.	4.) the tool post has n to be swivelled alor the column therey it can be large ai heavy in weight.
5.) Less number of tool can be holded in the tool post.	5.) More number of tot can be holded in the tool post.
6.) It contains is simple in structure.	6.) It is rigid in structure.
7.) Material removal rate is low.	7.) Material removal ra is high.
8.) Mostly it is used in industry due to its versatile nature.	8.) It is not preferred be used in industr as it is less versa.

-¦- Axis identification :-

↳ According to axis identification in cnc m/c three type of axis are defined.
i) Linear axis   iii) parallel axis
ii) rotational axis

-¦- Linear axis :-

↳ It is defined for the three principle axis in which the motion of either workpiece or milling cutter are linear.

↳ It is of three types.

i) Z-axis :-

↳ It is the axis of the spindle or of the tool.

If the tool moves downward i.e towards the workpiece it will be negative z.

If the tool moves upward i.e away from workpiece it will be +z in vertical milling machine center.

ii) X-axis :-

↳ It is the axis along the longitudinal direction of the workpiece.

↳ If the workpiece move towards right it will be +x and if the workpiece move towards left it will be -x.
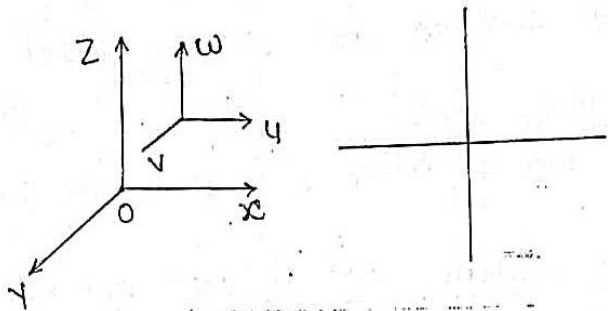
iii) Y-axis :-

↳ It is the axis perpendicular to both x-axis and z-axis. It is in lateral direction of workpiece.

If the workpiece move towards the

cutting tool it will be +y and away -
cutting tool it will be -y.

Parallel Axis :-

there are three parallel axis which
are parallel to the principle axis,

i) U-axis :-
→ those axis which are parallel to the x
axis are called u-axis.

ii) V- axis :-
→ those axis which are parallel to the y
axis are called v-axis.

iii) W- axis :-
→ those axis which are parallel to the z
axis are called w-axis.

Rotational axis :-

then it will be positive and if the
rotation is in anti-clockwise direction
then it will be negative.

ii) B- axis :-
→ It is the rotational axis about y-axis.

iii) C- axis :-
→ It is the rotational axis about z-axis.

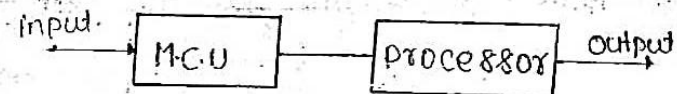## Control system used in CNC milling machine
→ there are two type of control system
used in CNC milling machine
   i) open loop control system.
   ii) closed loop control system.

i) Open-loop Control System :-

input → MCU → Processor → output

→ In this system there is no feedback
of output from given input.
→ the accuracy of the machine depends fully
on the response of processor.

, has less working electronic component r
, it is less expensive.

ii) CLOSE LOOP control System :—
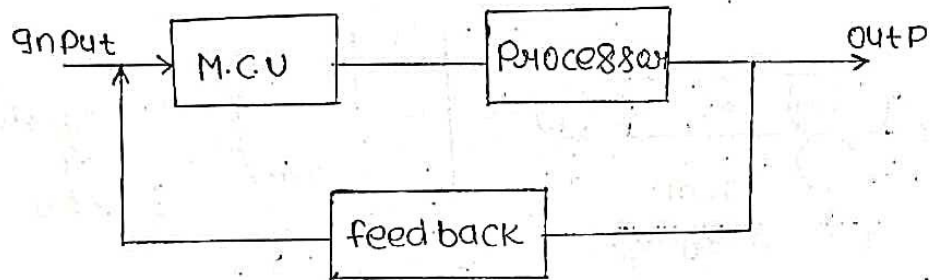
↳ In this System there is feed back Syst-
which Sense the deviation in the output
form its accurate value and therefor
by changing the input parameter de:
ed output is produced.

↳ the loop between input and output
closed.

↳ Due to feedback System a large numb
of electronic component are present
hence it is expensive.

—ı— Automatic tool exchanger :—
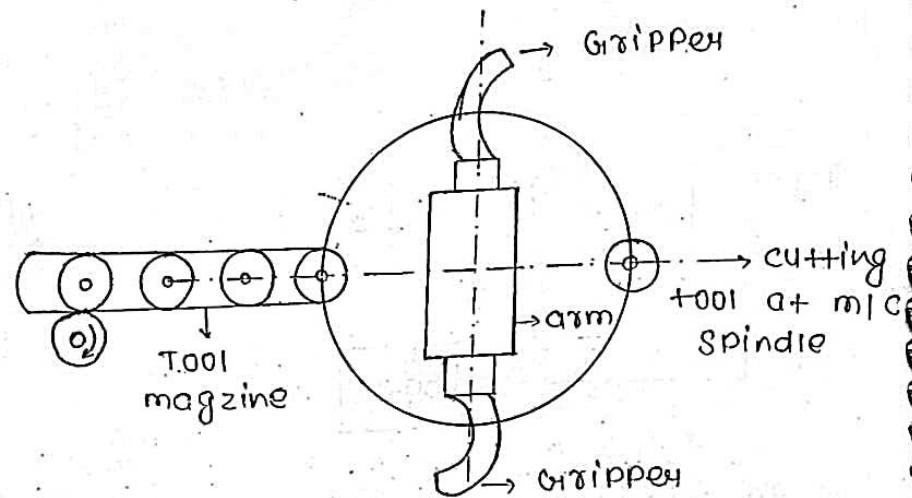
↳ Automatic tool exchanger is used in CN
Machine to improve the rate of produc
ion and tool carrying capacity of the
machine.

↳ Automatic tool exchanger changes the tool
very quickly, and reduces the Non
productive time and hence increase the
productivity.

↳ Generally it is use to improve the
capacity of machine to work with large

Arm :-

→ Arm rotate such that its one end with a gripper attached with it reaches to cutt tool machine spindle while other end arm with gripper reaches to the tool magzine.

gripper :-

→ Gripper attached with the arm grip and hold the cutting tool in the spindle a tool magzine and exchange them by rotating with the arm.

Tool Magzine :-

→ simple CNC machine work with a single turret type CNC machine hold upto six number of tool but if large number tools are required Automatic tool exchan is used and to accumudate these larger number of tool a magzine is required known as tool magzine.

Part - Programming :-

→ It is most important part of CNC opera ting system.

→ the shape, size and dimensional accura depends mainly upon how accurate the programme is prepared.

→ It is set of instruction about proces step and the sequence of processing step.

→ Part - programming have four basic compo nent

i) Word :-

→ word is a set of character composed of letter as well as numeric digit.

→ It gives command to the machine wha to perform and in what extent

EX:- (F)0.12 → feed 0.12 mm/rev.
       └ Address

ii) Address :-

→ Address is the single letter character in the begining of each word.

Address is used to define what the machine should do with numeric data.

iii) BLOCK :-   in mm

[G90   G21   G42   G95;]
  ↓   ↓   ↓   ↓
Absolute co-ordinate T.N.R.C   mm/rev.
setting   Right

→ A block is a series of word defines in a single instruction at the end

of each block; we use symbol (;) wor means end of block.

-:- Syntem :-

→ It is basically sequence of programm it is the systematic arrangement of block of programme in sequential manner.

-:- Codes used in programming :-

→ there are two codes used in CNC macl

i) G - codes (preparatory codes)

ii) M - codes (miscelleneous codes) -

i) G - Code :-

→ It is also known as preparatory coc It is starting function code and in this machine prepared itself to sta machining operation.

-:- G00 :-

→ G00 का उपयोग CNC machine को अपनी full speed पर चलाने के लिए किया जात Tool को तुरंत अपने Home position से Starting position पर आने के लिए किया जाता है। G00 से हम cutting नही कर सकते हैं।

Ex:- [G00 X 0.00 Z 0.00 ;]

-:- G01 :-

→ इसका उपयोग linear direction में cut करने के लिए किया जाता है। जब हमको workpie के ऊपर में linear direction में cut लगाना होता है। तो इसके साथ X, Z तथा feed में use करते हैं।

Ex:- [G01 X __ Z __ f __ ;]

-:- G02 & G03 :-

→ इसका उपयोग job पर arc cutting करने के लिए किया जाता है।

G02 का उपयोग clockwise direction में cut करने के लिए किया जाता है। और G03 का प्रयोग anti-clockwise direction में cut करने के लिए किया जाता है। इसमें X और Z के साथ R (radius) का प्रयोग किया जाता है।

Ex:- [G02 X __ Z __ R __ ;]

-:- G04 :-

→ G04 देने से tool अपने position पर dwellin करता है। इसका मतलब है इसके उपयोग से tool को हम एक ही जगह पर कुछ समय के लिए linear direction में move करने से रोक सकते हैं। इसका प्रयोग अधिकतम drilling के समय देखा जाता है।

EX:- [G104, Z 5.00, X 2sec] X represent +

G133 & G34 :-

→ G133 का उपयोग constant pitch thread cutting के लिए किया जाता हैं। इसमें pitch की value 1 ही होगी।

→ G34 का उपयोग variable pitch thread cutting के लिए किया जाता हैं।

G40 (tool nose radius compensation canc

→ इसका उपयोग हम पीछले programming में G41 or G42 को cancel करने के लिए किया जाता हैं।

G41 (tool nose radius compensation left

→ इसके प्रयोग से tool को इस प्रकार move करना हैं कि tool के पीछे बैठे observer के respect में जो tool के center or nose point के बीच में जो radial dir. होगा वो left की तरफ होगा।

G42 (tool nose radius compensation Right

→ इसके उपयोग से tool को इस प्रकार से move कराना हैं कि tool के पीछे बैठे observer के respect में जो tool के center or nose point के बीच

G21 → All dimension are in mm.

G90 → Absolute system

G91 → Incremental system

G92 → Co-ordinate system setting

G94 → feed in mm/min

G95 → feed in mm/revolution

G96 → constant surface speed contro It is the working speed.

G28 :-

→ इसके प्रयोग से tool को space में कहीं से भी Home position पर लाने के लिए किया जाता हैं। इसमें X को U से replace करते हैं and Z को W से replace करते हैं

EX:- [G21 U 0.00 W 0.00 ;]

M-CODE (Miscelleneous code)

* **M03** → clock-wise direction में spindle को rotate कराने के लिए इसका उपयोग किया जाता हैं।

जाता है।

-:- M05 :-

→ spindle को stop करने के लिए किया जा

-:- M08 :-

→ इसका प्रयोग coolant on करने के लिए कि
जाता है।

-:- M09 :-
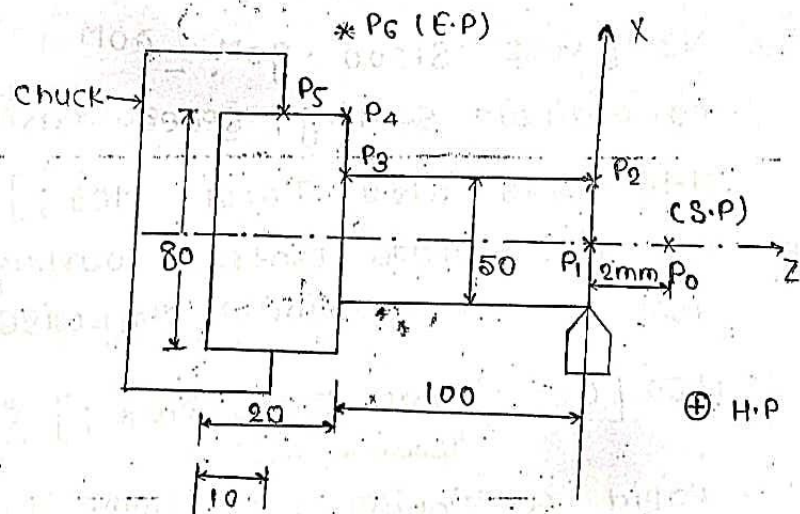
→ इसका उपयोग coolant off करने के लिए
किया जाता है।

-:- M30 :-

→ End of programming & save the progmme.

Q. Write down the Part programming for the plane turning operation performed to obtain the given workpiece.

Co-ordinate setting

	X	Z
P0	0.00	2.00
P1	0.00	0.00
P2	50.00	0.00
P3	50.00	-100.00
P4	80.00	-100.00
P5	80.00	-110.00
P6	85.00	-105.00

01234 — Programme Number

N10 [G28 U0.00 W0.00;] :-
→ Return the tool to Home Position

N20 [G90 G21 G42 G95 ;] :-
Absolute system, all dimension are in mm
T.N.R.C.R, feed in mm/revolution.

N30 [G92 S1200 ;] :-
co-ordinate setting, speed maximum

N40 [G96 S150 T0101 M03 ;] :-
→ constant speed control, working speed
tool selected spindle clockwise rotation

N50 [G00 X0.00 Z2.00 M08 ;] ←
↓(Common step)
→ Rapid positioning from Home position

to starting position Coolant ON.

N60 [G01 X0.00 Z0.00 f0.12 ;] :-
↳ Move tool to P_1, f = 0.12

N70 [X50.00 Z0.00 ;] :-
↳ Move to P_2

N80 [X50.00 Z-100.00 ;] :-
↳ Move to P_3

N90 [X80.00 Z-100.00 ;] :-
↳ Move to P_4

N100 [X80.00 Z-110.00 ;]
↳ Move to P_5

N110 [X85.00 Z-105.00 ;]
↳ Move to P_6

N120 [G100 G128 G140 U0.00 W0.00 ;]
Home Position & co-
na

N130 [M05 M09 ;]

N140 [M30 ;]

⟹ Every industry has to improve Quality of finished product. this objective have force the industry to convert the manual operation into mechanical activity i.e to replace the human by machine.

-:- Mechanisation :-

⟹ the term mechanization means that the operation are carried by machine instead being performed by human.

⟹ the movement of tool and workpiece are automatic but the operation like loading, unloading, clamping, checking the dimension of workpiece are done manually by the operator.

⟹ In mechanization there is no provision of feedback system hence it is open loop system.

-:- Automation :-

⟹ the term automation means high degree of Mechanization.

⟹ In this all the process or operation even material handling is also done automatically.

⟹ It means that operator is required only

for supervision and one operator can attend number of machine at a time.

⇒ thus, automation can be defined as the technology concerned with application of mechanical, electronic and computer based system to operate and control the production.

⇒ Automation is a close loop system in which there is a provision of feedback.

Types of automation : -

i) Fixed automation
ii) Programmable automation
iii) Flexible automation
iv) Integrated automation

i) Fixed automation : -

⇒ the machine are arranged as per sequence of operation to be performed.

⇒ It is in-flexible and cannot accomuded accomodate or allow the variation in prod

⇒ the product design is also constant.

⇒ Product are produced on large scale with high production rate.

⇒ Initial set-up cost is high.

ii) Programmable automation : -

⇒ the sequence of operation depends on programme.

→ a new programme has to be written for new product.

→ It is used for low production where variation in product is required.

→ It is inflexible w.r.t manufacturing proc but flexible to deal with variation and changes in product configuration.

Ex : - CNC Machine

iii) Flexible automation : -

⤷ It is capable of performing various manufacturing processes and produces variety of product.

→ Since, it is flexible in both manufacturing process as well as product design therefore no lost in time during any change in product is en-countered.

Ex : - A Robotic arm that can be programme for perform welding, forging, drilling painting etc.

iv) Integrated automation :-

↳ those automation in which the manufactur process are integrated by production, planning, control i.e, shareing the infortion of workshop floor, quality control, market research with the manufacturiu System.

→ It optimises the production industry (Computerised integrated manufacturing) Software is used for automation.

Benefit of Automation :-

⇒ Increase in productivity.

⇒ Human fatigue is greately minimised.

⇒ Good quality product is obtained.

⇒ Single operator can operate ~~many~~ more than one mach at a time.

Single Spindle automates :-

↳ those machine which have a single spind and used for operating single componen at a time are known as single spind automates.

→ Based on single spindle automate automat machine are classified in three ways.

i) Automatic cutting of machine :-

⇒ these machine are used for producing small

length shaft from a long bar.

⇒ they are used for cutting operation of an bar or rod to reduce any its length. the spindle carries the workpiece towo rds the cutting tool

ii) Swiss type automatic machine :-

→ In this the toolpost carrying the tool is fixed and the headstock carrying the wlp is movable.

→ the headstock moves towards the turning tool to feed the workpiece.

Turred type automatic machine :-

⇒ In this the headstock carrying the wlp is fixed at its position and the tool is move towards the workpiece.

⇒ It has a special design toolpost in which multiple number of tool can be mounted.

Transfer line :-

↳ transfer line is an automatic flow line to transfer the workpiece to different working station in a particular direction So that sequence of operation can be

Performed on the workpiece.

Drilling Reaming threading
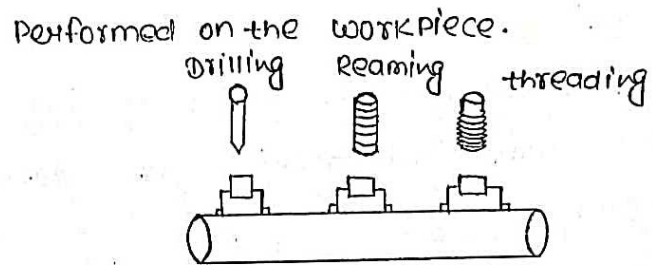
→ It is a combination of material process unit and material handling unit.

→ each machine in this are in series call machining op. station and performed oper. simultaneously on the workpiece.

Requirement of a transfer line :—

⇒ correct starting up and finishing up time i.e the time of operation at each working station must be synchronised

⇒ Accurate transfer of workpiece at each working station.

⇒ the fixture carrying the workpiece must be rigidly clamped on the transfer line

Advantage of transfer line :—

i) material handling is fast and automatic.

ii) faster machining there by reducing the cycle time and increasing the production rate.

iii) Since material handling is automatic therefore greater accuracy is achieved.

iv) less number of operator are required.

Disadvantage :—

i) A very high initial investment is required

ii) the failure of one machining station will temporarily stop production.

iii) the whole setup to be changed if component design changes.

iv) High maintainance is required.

type of transfer line :—

→ transfer line are of three types.

i) Inline transfer line

ii) rotary transfer line
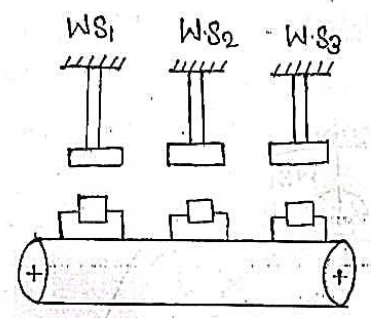
iii) drum transfer line

i) Inline transfer line :—

→ In this type of transfer line the machining station attached on the transfer line are arranged in straight line.

→ but if the floor space is less the machining station can be arranged in various geometrical shape like- L, U, □, □ etc.
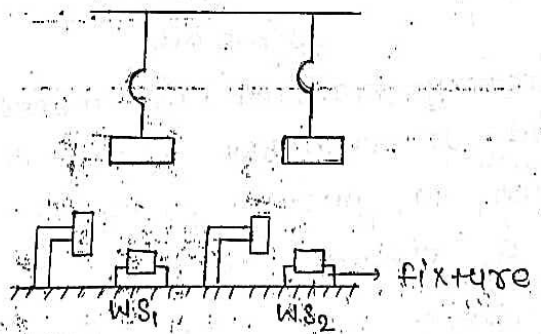
→ It is of two type :-
i) Pallet type
ii) Plain - type

i) Pallet type :-

WS₁   WS₂   WS₃

⤷ the workpiece is clamped in a holding fixe called Pallet.

→ In this type of transfer line the pallet carrying the workpiece moves from one machining station to another machining sta

### ii) Plain type :-

⤷

→ fixture

WS₁   WS₂

→ In this type of transfer line the w/p is moved itself through help of cran

---

→ the workpiece are located radially on the front and rear side of drum.

→ the workpiece are loaded and unloaded at same working station.

→ the station at the bottom of drum. is know as idle station. In this machining stati operation is not performed.

→ It is used for heavy workpiece but it has a limitation that only two machining operation can be performed on the w/p-

⊣⊢ Control System :-

⤷ control system is defined as an arrangement of electrical electronic and mechanical equipment in such a manner so that these combination will direct regulate and control any process or operation.

⊣⊢ Block diagram of control system

comparator

I/P   CONTRO   CONTROL   PROCE   O/P
               LLER   ELEMENT   SSER

Feed back
Sensor
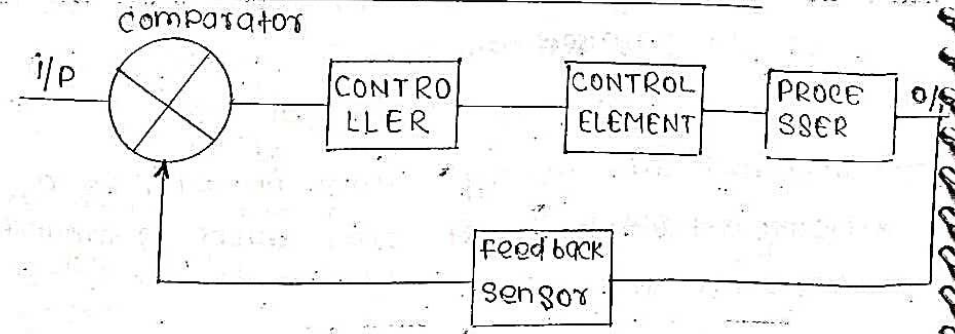
Comparator :—

↳ It is also known as error detector. In Comparator a value of desired produ is initially set and this value is kr as set point value.

→ After process the output value known a measured value is sensed by the sen and transmitted to the comparator, where if the measured value defer from the set value then error is detected which is send through the signal to the controller.

Controller :—

↳ the controller examines and analyse the detected error then determine the acti to be taken to make the measure value equal to set point value.

control element :—

↳ It is known as brain of contro syst

→ It accept the signal given by controll which then transformed into part programming which is further send to the processor.

Processor :—

↳ It is used for implementing direct action given by the control element to perform desired operation.

Sensor :—

↳ the main function of sensor is to sense the output measured value and send the signal to the comparator.

Limit Switches :—

↳ Limit switches is an electro-mechanical devices which have contact actuator.

→ when an object comes in contact with actuator the limit switches operate and then either it will make or break the electric circuit.

→ A limit switches is configured so that its actuator is at boundary limit of the object.

→ So that when object reaches its boundary limit it makes contact with the contac actuator which will either open or close the circuit.

→ this change in state of circuit will detect

the object from going beyond its bounda
level. Limit.

→ boundary wall
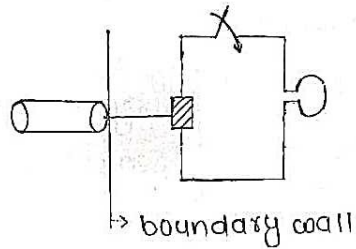
-¦- Proximity switches :–

└→ Proximity switches allow the user to de
the presence of object without having
Stablishment of physical contact.

→ Proximity switches open or closes the el
tric circuit when any object comes in t
domain of proximity switches.

→ therefore proximity switches can be def
d as the electronic switches which sen
the presence of any object without
touching it.

-¦- Difference between limit switches and
proximity switches.

Limit Switches	Proximity Switche
i) they required physical contact between the object and switch actuator.	i) they detect the pres ce of object without physical contact.

ii) they are completely slow in operation.	ii) they are fast in operation.
iii) Limit switches are less sensitive.	iii) they are highly sensitive.
iv) It is an electro-mechanical devices.	iv) It is an electron sensor.
v) It respond when the object reaches its boundary ter limit.	v) It respond when object comes in the domain of the switch
vi) they contain mechanical parts hence wear may take place.	vi) they do not have any mechanical par
vii) they are less costly	vii) they are more costl

-¦- Types of proximity switches :–

i) Infrared proximity switches :–

└→ they work by sending out beam of
invisible infrared light.

A photo detector is installed with the
proximity switches. when any object
comes in front of these beam light
gets reflected which is sensed by
photo detector.

In this way presence of object is te or sensed which open or close the cir

ii) Accoustic proximity switches :-

↳ they are similar in principle of the infrared type proximity switches b they uses radiographic sound wave instead of infrared light waves.

→ They uses two transducer one emi the sound wave and other receive the sound wave.

→ when the emitted sound waves strik any object it gets reflected back whi is sensed by second transducer c hence presence of any object can k felt or sensed which open or close the circuit.

iii) Inductive proximity switches :-

↳ these switches sense the object by the help of magnetic field lines.
In this a coil of wire is charged with electric current due to this magnetic field lines are generated around curr carrying wire.

→ when any metallic object comes in the region of magnetic field line flux in the wire changes this variation in flux to cause the open or close the circu
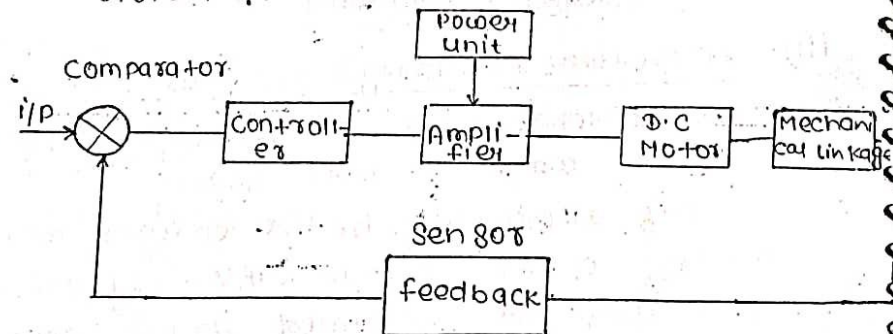
iv) capacity proximity switches :-

↳ In these switches two metal plate with a dielectric medium in between the metal plate is used known as capacitor.

→ when any object comes near the capa citor its dielectric strength varies which send signal to the proximity switches to open or closes the circuit

-¦- Servo control system :-

element Block-diagram of servo control system :-

→ It is a type of control system which used for the process and control of a process of a servo motor.

→ A servo motor is an electro mechanical devices which produces large output mechanical energy by means of small input electrical energy.

→ It is a closed loop system because It uses feedback sensor.

Objective of servo control system :—

→ Accurate and automatic control of moti without the need of human operator.

→ Control of high power output from low input.

→ operation is very fast with less err

element of servo control system :—

i) Controller :—

→ controller is a computer based system w receive signal from the comparator and it is so programmed to ser the signal to the amplifier to activa the motor so that desired output is produced.

ii) Servo-amplifier :—

→ the signal from controller is then pass into amplifier which amplify the signe upto appropriate level as required for the operation of servo motor to produce desired output.

iii) Servo-Motor :—

→ the motor is basically a dc motor whi generate very high forces to provide high torque and high speed.

iv) Sensor :—

→ It is a feedback element which sen signal to the comparator where the output is desired or not.

v) Mechanical Linkage :—

→ It e includes combination of mechanical parts to obtain different types of motion as required.

Programmable logic control :- (P.L.C)

→ It is a software and electronics based devices through which by varying the input parameter some logical decision are made to obtain the different desired output

Ex:- ATM Machine, petrol supply unit.

Element of P.L.C :—

programming unit
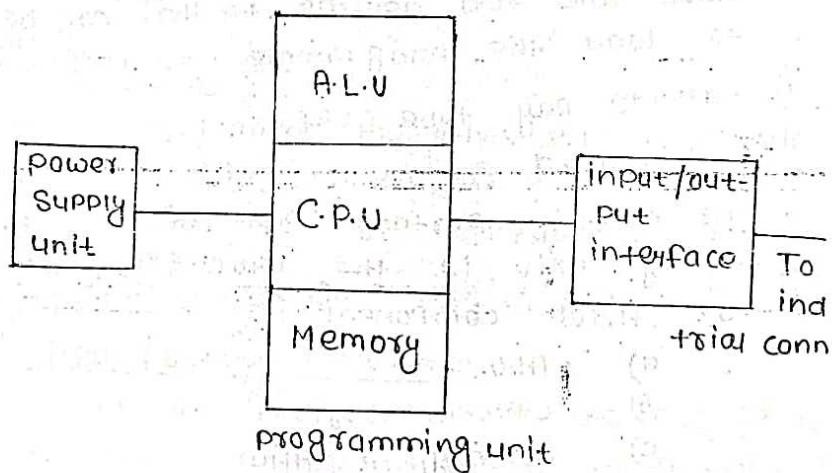
Power supply unit :-

→ the power supply unit provide voltage necessary to operate the circuit throughout the P.L.C.

Some circuit of PLC required AC voltage and some will require low AC voltage

this requirement of voltage is fulfilled by power supply.

Programming unit :—

→ programming unit is an external device that is connected to PLC.

→ It is used to enter the data and to edit the stored programme in the processor.

→ there are two devices i.e. that can be used to load the programme.

i) Cathode Ray tube (CRT)

ii) keyboard

→ the most important part of the programming unit is the processor which has three component :-

a) ALU
b) CPU
c) Memory

ALU (Arithmatical logic unit) :-

→ this unit perform mathematical calculation and make logic decision.

→ for desired output input also to be varied therefore ALU prepare logical decision according to varried input to

obtain output as required.

ii) **C.P.U (Central Processing Unit) :-**

↪ It stands for Central Processing unit

↪ It is the brain of PLC.

↪ It is a micro processor which work or process according to the logica decision made in the ALU. and gener the required electrical signal for des output.

iii) **Memory :-**

↪ the programme and other data required i the PLC is stored in the memory. in PLC two type of memory are used RAM & ROM.

Input/output interface :-

↪ It is an interface where the PLC is connected with industrial equipment.

↪ the output signal generated by the CP is received as an input signal by the industrial equipment hence it is known as input/output interface.

Advantage :-

↪ It is hundred percent (100%) error free.

↪ It is very quick in response

↪ It is more reliable.

↪ It increases the productivity.

↪ If the output is to be varied then only by varying the input without varying the programme can be achieve

Special Purpose machine

• General purpose Machine :-

⇒ General purpose machine is a machine w enables us to perform the operation of different machine.

⇒ A single general purpose machine enab us to avoide the use of some other machine, this result in large saving in investment.

⇒ They can be used for production of large variety of product having differe shape and sizes.

⇒ They are slow in operation and therefor rate of production is low.

⇒ GPM has less risk of absolence.

Example :- Lathe machine.

• Special Purpose Machine :—

⇒ Those machine which producess multiple number of product whose design i.e wh shape and size are exactly same.

⇒ They produce many number of identical items.

⇒ They are used in mass production.

⇒ The cost of special purpose machine is very high, but it can be justified by it mass production.

⇒ Special purpose machine are defined for a particular product and if the product design changes the machine may not be of use.

• Difference between General Purpose Machine and Special purpose machine.

GPM	SPM
⇒ It is flexible mlc which perform operation to produce different produ -ct.	⇒ It is inflexible in nature as it produces only one kind of product.
⇒ Initial investment cost is low.	⇒ Initial investment cost is high.
⇒ They are slow in operation	⇒ They are fast in operation.

on each workstation. this is known indexing hence the table is known as indexing rotary table.

ii) **Multiple tool head :—**
↳ gn SPM since different operation has to be performed on a particular workpie continuously therefore multiple tool is required for different operation. and to operate these tool multiple tool head is required.

iii) **Turret type tool post :—**
↳ Turret is a hexagonal shaped tool holder mounted on a saddle.
↳ gn this six type of tool are mounted on six faces of the turret.
↳ Turret can be rotated about it vertical axis to change the tool during operatio

iv) **Hydraulic slide table :—**
↳ gt is a hydraulic oil operated table which is used to move the turret which carry the tool towards and away from workpiece and it also

give the table a rotary motion so the the necessary tool interact with wor ce.

v) **Bar feed mechanism :—**
↳ when workpiece are to be machined a mechanism is required to transfer the workpiece from one machining station to another machining statio so that the tool on the machining s ion can feed the workpiece.

vi) **Bar stop mechanism :—**
↳ when machining operation is performe on the w/p to hold the workpiec at different machining station till the machining is achieved a bar stopped mechanism is required.

Principle of SPM design :—
↳ To design a SPM following principle are to be consider :—

i) operation are combined :—
↳ various operation are to be perform on a particular workpiece therefore while desiging of a SPM it should

be consider that the arrangement of different machining operation should be orderly so that operation must be combined in a definite sequence.

ii) **Automation :-**
↳ As far as possible manual operation should be eliminated i.e make the operation automatic it will increase the production rate.

iii) **faster cutting speed :-**
↳ to increase the production rate higher cutting speed are required for this hard tool made up of carbide, H.S.S (High speed steel), diamond, CBN (carbon boron Nitride) etc.

iv) **Less handling of workplace and workpiece**
↳ Design of SPM should be such that it would be very small and compact so that it could opp occupy the less working space.
↳ Design of SPM should be such that Minimum handling of workpiece is done.

-i- **Number of tool work simultaneously :-**
↳ Design of SPM should be such that maxi number of tool work simultaneously a the motion of each tool must be synchronized.

-i- **Benefit of SPM :-**
i) increased in productivity (mass produc
ii) less time consuming.
iii) since it is high degree of autom on therefore less requirement of staff and labour.
iv) highly durable with less maintainai
v) error free production.

Maintainance of Machine tool :-

Maintainance :-

⇒ the word maintainance Signifies an are or Science of maintaining any object. component or devices.

⇒ maintainance means a set of work of keeping something in proper condition. this means that it is an action take to prevent any device or component from failing.

⇒ this maintainance can also be defined as a set of activities that are carrie out to keep any equipment or devices in best operational condition to obtain maximum desired output.

⇒ the older concept of maintainance was to repair a machine or component only when the breakdown occurs but this leads into loss in production because if the breakdown occurs production will be stoped.

⇒ therefore now-a-days maintaince should be plan at regular interval to prevent the breakdown.

Objective of maintainance :-

→ To minimize the number of breakdo

→ To keep the plant, any component dev or object in good working condition with high production rate.

→ It prolong (बढ़ाना) the service life o machine tool, any equipment or devic

→ It minimize the hinderance (बाधा) ar interruption (अवरोध) at work.

→ to improve the Quality of manufact product upto desired Level.

It promotes constant supply of prod in market thus prevent sudden increment in its demand and stor rise in prise.

Cause of failure or cause of breakd

→ cause of failure or breakdown are as follows :-

⇒ excessive friction between two machine part due to improper or in-suffic lubrication.

⇒ failure to replace that part, compone equipment which are inverge (शुरुआत

of failing.

⟹ Neglecting the minner fott fault, for example — vibration and temperature over loading, working fuel and imprope supply of voltage as per requirement.

⟹ Unskilled, untrained operator may leads to failure of machine and its equipment.

⟹ Poor foundation leads to failure of m/c part as because the vibration produced in the machine can not be transmitte to the foundation and remains at the machine which leave to failure or breakdown of the machine and its equipment.

Types of Maintainance :—

⟹ there are four types of maintainance done in manufacturing.

i) preventive - Maintainance
ii) predective - Maintainance
iii) corrective Maintainance
iv) Break-down Maintainance

i) Preventive Maintainance :—

⟹ It is based on principle of preventic is better than cure.

⟹ Instead of doing breakdown mainta -ce It is better to prevent or avoi the breakdown if it occurs.

⟹ It is basically just like routine checkup.

⟹ Maintainance is done on regular basic with fixed time-interval.

ii) Predective Maintainance :—

⟹ During preventive maintainance there is problem that the maintainance time schdule is fixed but there is a chance that fault may create on component, tool, machinery etc before schedule time which may result in failure of the plant and machinery.

⟹ therefore we require a maintainance before the schedule time by predec the fault in component part tool & machinery.

⟹ It has three steps :—

i) Detection

ii) Analysis

iii) Correction

1) **Detection :-**

⇒ During this stage ᧒nitialisation of fault is detected through unusual symptons (unusual vibration, unusual sound, unusual heat etc).

ii) **Analysis :-**

⇒ this stage is for analysing the main cause of the fault and effectiveness of the fault. i.e, either it is majo. or minor in nature.

iii) **Correction :-**

⇒ During this stage after analysing the main root cause of the fault it is corrected in order to make it fault free.

3) Corrective Maintainance

---

the repair of component which are abc to fail through detection by the hel of different sensor, optical instrum and other measuring instrument mounted on every machine.

⇒ the unique feature of corrective main nance is that after maintainance th component gets automatically tested through sensor, optical instrument al other measuring instrument mounted on every machine.

4) **Breakdown Maintainance :-**

⇒ as the name suggest in breakdown maintaince, maintainance is carried ou after breakdown or failure of machi component.

⇒ the machine will not considered for maintainance until ᧒t gets completel fail.

Predective	Preventive
1) Predective maintainance is carried out as the machine are in production mode or in running mode i.e when fault is detected.	1) preventive Maintainance are carried out in a particular time schedule when the machine are complete shut off.
2) It is a need based Maintainance.	2) It is a time based Maintainance.
3) concerned is given to the actual performance with respect to optimum performance.	3) there is no concern to the actual performance w.r.t optimum performance.
4) It is not repeatitive w.r.t time.	4) It is repeatitive w.r.t time.
5) Predective Maintainance is done on the basis of continuous inspection and Monitering	5) Preventive maintainance is done on the basis of manufactur inspection.

-:- Difference between Preventive and breakdown Maintainance.

Preventive	Breakdown mainte
1) It is generally done before failure.	1) It is generally c after failure.
for Preventive maintainance the machine are shut down.	2) In breakdown main ance the machine shut down.
2) It is done at pre-schedule.	3) It is done when need occurs.
3) It is a time based maintainance.	4) It is a need ba maintainance.
4) Down time in maintainance is less.	5) Down time in maint ance is high.
6) It is independent of life of m/c and equipment.	6) It depends on life of machine and equ ment as the machi gets older frequenc of breakdown maint ance increases.

-:- Difference between corrective and breakdown maintainance.

Corrective	Breakdown maintain
i) It involve the repair or replacement of machine component which are about to fail.	i) It involve repair or replacement of machine component which has failed.
ii) the fault can be recorganised by the help of modern technique i.e through sensor and optical instrument.	ii) there is no any provision to recorganised the fault before failure.
iii) After correcting the fault inspection and testing can be done automatically.	iii) After correcting the fault the machine or component has to be inspected manually.
iv) Testing equipment cost is required.	iv) testing equipment cost is not required.
v) Down time is less because breakdown has not occured.	Down time is more because breakdown has occured.

-:- Stages of Preventive Maintainance :—

⟹ there are four three stages used in Preventive Maintainance.

i) Inspection :—

⟹ It is the first stage of Preventive maintainance. In this through inspection th fault in the machine component is recorganised.

⟹ In this no repair is done.

⟹ In this, inspection of all mechanism at different speed is checked.

ii) Small repair :—

⟹ It is the second stage of preventive maintainance. It involve following opera

→ Replace the used oil, coolant and cutt fluid and set new oil, coolant and cutting fluid upto required level.

→ tightening of the nut and bolt.

→ clean the oil filter and relative movi parts and then provide lubrication of them.

→ Adjust properly all the machine parts

iii) Medium repair :—

⟹ It is the third stage of preventive main nance.

After two small repair one medium repa

is done.

→ It involve following function.:—

i) It removes, repair the damaging relat[ed] moving parts such as - bearing, bushe[s], gears, belt, Axle etc.

ii) It eliminates the lickage through the pipe, joint by proper insulation.

iv) **Overhauling :—**

⇒ It is the last stage of preventive maintainance. It is also known as de-assembly assembly stage because in this every component is de-assemb[ly] and is inspected to detect the fault.

→ Repair and replace the damage part.

→ after this assembly of component is don[e] and is the machine is tested in no load condition.

Repair cycle :—

⇒ It is a cycle which represent the order or sequence of different stegeses used in preventive maintainance.

→ According to repair cycle after two sm[all] repair one medium repair is done & af[ter] two medium repair one overhauling [is] done.

$$(I_1 \ S_1 \ I_2 \ S_2 \ I_3 \ M_1 \ I_4 \ S_3 \ I_5 \ S_4 \ I_6 \ M_2 \ I_7 \ 9)$$

where, I = inspection

S = small repair

M = medium repair

C = overhauling

⇒ the above sequence of preventive main[te]nance is known as half repair cycl[e] and if this sequence is followed two[?] then it will represent one complete repair cycle.

Repair complexicity :

⇒ If the machine has more number of me[cha]nism and devices then it is called com[plex] le[x] machine and its maintainance is very complicated.

⇒ the complexity of a machine plays a ve[ry] important role in maintainance as & because it farecast the maintenance typ[e], maintainance cost, maintainance time &

equipment required.

⇒ the complexicity of any machine is decided through a number known as repair complexicity index. It is based on following factor :-

i) Number of component in the machine.
ii) number of mechanism involved.
iii) Number of labourer required.
iv) time in our to be spend.
v) Money required during maintainance.

Ex :- Lathe machine has repair complexicity index of 5 while for air compressor 8 therefore it indicate that the air compressor will required more time, money and labour in maintainance

-|- Maintainance Manual :-

⇒ when the customer purchases any new product (machine part, vehicle, electrical & electronic component etc) the manufacturer provides a booklet called maintainance manual.

⇒ It provides information about part draw assembly drawing technical information a maintainance schedule w.r.t time.

⇒ In the maintainance manual procedure o use and maintainance of each componen indicated.

⇒ Maintainance manual is created on the ba of experiment, experience, observation mad by the manufacturer of the product or component.

-|- Index of maintainance manual :-

⇒ It is collection of data containing all info ation about the product specification, i services and its maintainance.

⇒ Index of maintainance manual is placed the introductry page of the booklet.

-|- Contents of Index :-

i) Detail of part drawing / assembly drawing with bill of material.
ii) Instruction of using machine component.
iii) Table showing common fault (trouble-shooting).
iv) important term (abbreveration)
v) Maintainance schedule.

vi)   maintainance procedure.

vii)   Gurantee / warantee.

viii)   Service center in country.

Maintainance record :—

⇒ Maintainance department is engage in various activity and thus it is necessary to prepare document of maintainance work in order to obtain the required information of maintainance history done on particular machine.

⇒ the unique feature of maintainance record is that this record help for analysing and detecting the fault which occur in the equipment.

⇒ the maintainance record is prepared by the maintainance operator which gives two information :—

i) which component on which time it is under maintainance.

ii) It indicate the nature of maintainance i.e. whether it is preventive, preductive, corrective and breakdown.

House-keeping :—

⇒ House-keeping is a process of creating a pl where everything is placed in proper condi at its right place.

Benefit of house-keeping :—

→ good house-keeping at work-place benet both employer and employe.

⇒ It eliminates the clutter (waste material such as broken part, scrap of workpiece, used nut & bolt, nails, lubricating oil or greece sprayed on the floor) which is a common cause of accident such as slip fall, fire etc.

⇒ Reduces the chance of harmful material entering into the body.
Ex:— dust particle, poisoinous vapour.

⇒ Improve productivity (right tool & mate tool any job will be easy to find).

⇒ Help company or any organisation to impr its image which will impress employee customer.)

⇒ Help company to keep its inventory to a minimum (good house-keeping make it easi to keep accurate count of the product in the organisation.)

→ Helps any industry to make use of its sp..

+ Indication & symptom of poor house-keepin..

⇒ Leakage in any fuel can carrying contained..

⇒ dust & dirt particle sprayed on the floor.

⇒ items that are in excess and no longer in use.

⇒ over flowing of waste-bin.

⇒ tool and equipment left on any machine or in working area instead of being return to its proper placed.

⇒ Poor light or improper arrangement of window & ventilation.

+ Total productive maintainance :–

⇒ total productive maintainance is a preventiv.. maintainance plus continuing effort to modified and refine the machine compon.. during production to increase productive..

→ It is first adopted by Japan.

→ Total productive maintainance is defined as.. production management approach which induces responsibility of maintainance on the worker and operator.

→ It is operator oriented maintainance process.

→ It is also known as zero maintainance ze.. defect process.

→ It involve encouragement of operator an.. giving them proper education and trainin.. of basic maintainance.

+ Benefit of total productive maintainance:

⇒ It improves the overall equipment affec.. ness and overall efficiency.

⇒ It helps the operator in determining the exact location where the maintainance a.. what type of maintainance is required.

⇒ Since the operator is involve in maintai.. which will improve his job scale.

⇒ Productivity maximised and defect minimi..