INTRODUCTION

- CNC is the acronym for Computer Numerically Controlled. Replacement of hard or rigid automation by flexible automation has made a great breakthrough since mid seventies in the field of machine tools control.

- CNC milling machine can perform face milling, End milling, slot cutting drilling, boring and threading operations on the components of diff. parts in every industrial field.

- In CNC machine functions and slide movements are controlled by using computer programs rather than by hand.

- Some Examples:-
  1) Mills
  2) Lathes
  3) Plasma Cutters
  4) Drills
  5) Surface Grinder
  6) Laser Cutting

ADVANTAGES

- High Repeatability and precision.
- Volume of production is high.
- Complex countours / surfaces need to be machine.
- Flexibility in job change, Automatic Tool setting, less scrap.
- More safe, higher productivity and better quality.
- Less paper work, faster prototype production, reduction in lead times.

DISADVANTAGES

- Costly Setup
- Requires skilled workers
- Computer, Programming knowledge required
- Maintenance is very difficult.

CLASSIFICATION

- Nature of Purpose
  1.) General Purpose
  2.) Single Purpose
  3.) Special Purpose

- Configuration of Holding Table
  1.) Rotatory Table type
  2.) Bed Type
  3.) Knee Type
  4.) Planar Type

- Orientation of Spindle
  1.) Vertical Spindle
  2.) Universal Head Milling
  3.) Plane Horizontal Knee
  4.) Horizontal axis and Swivelling Bed type

- Mechanization or Automation and Production Rate
  1.) Computer Numerically Controlled
  2.) for short thread
  3.) Tracer controlled copy milling machine
  4.) Hand mill
  5.) Planar and Rotatory table type vertical axis

CNC Principles

- All computer controlled machines are able to accurately and repeatedly control motion in various directions. Each of these motion's direction is called an axis. Depending on the machine type there are commonly two to several axes.

- Additionally, a CNC axis may either be a linear axis in which movement is in straight line, or a rotatory axis with motion following circular path.

- All CNC machines begin with a part program, which is a sequential instruction or coded commands that direct the specific machine functions.

- The part program may be manually generated or more commonly generated by computer aided programming systems

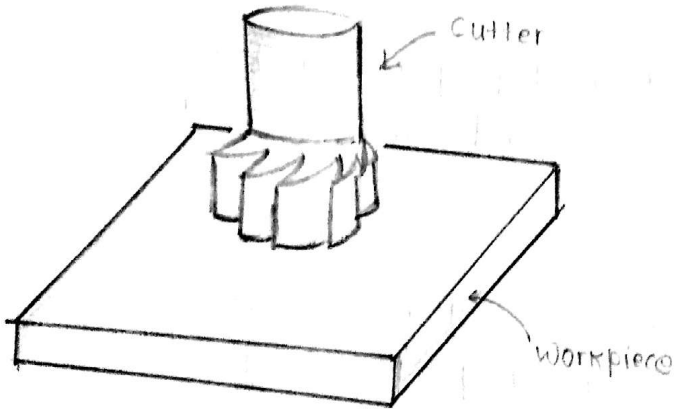
- Conversational control :- It lets the programmers use simple descriptive language to program the part. This control then displays a graphical representation of the instructions so that the programmer can verify the tool path.

- It is controlled by G and M codes.
- Movement is controlled by motors - actuators
- Feedback is provided by sensors - transducers

TOOLS

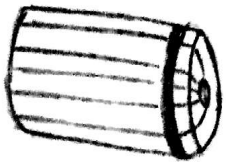
DRILLS

FACE MILLING



End Mill cutter Digram is missing

CLAMPS



WORKING

- Conventionally, an operator decides and adjusts various machining parameters like feed, depth of cut etc depending upon the type of job and controls the slide movements by hand.

- In CNC, machine functions and slide movements are controlled electronically by using computer programs rather than by hand

The earliest Numerically Controlled machines performed limited functions and movements were controlled using punch cards or punched tapes. Language of CNC machines is a fairly standard set of G and M codes

CNC WORKS AS FOLLOWS:-

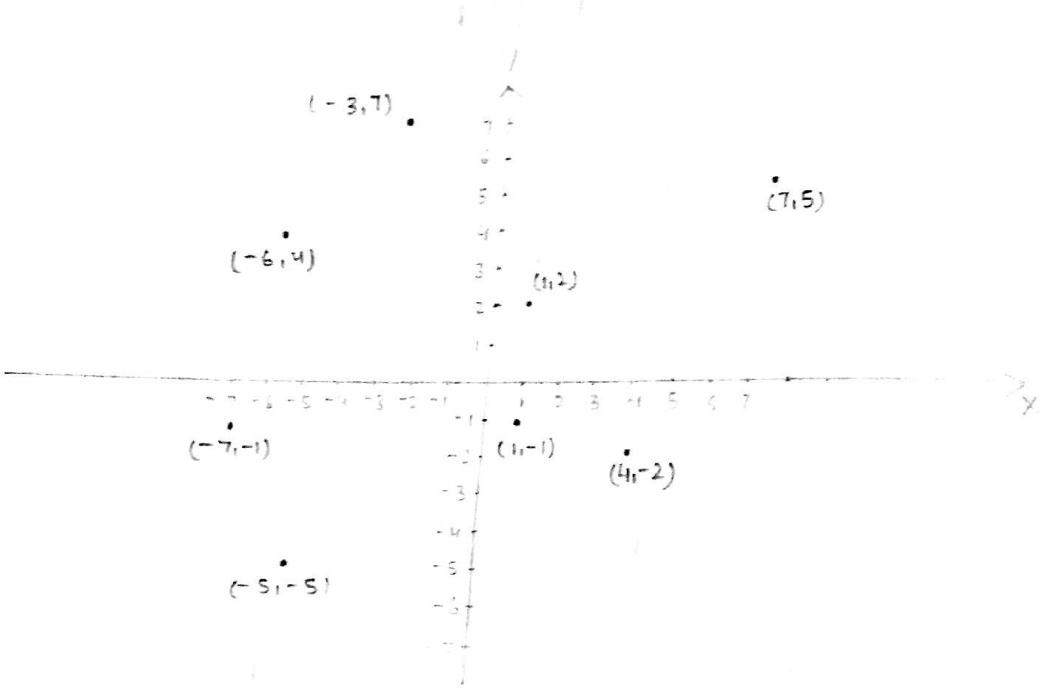
- Controlled by G and M codes. These are values and coordinates
- Typed in manually by machine operators or automatically generated by computer software
- Movements are controlled by motors - actuators
- Feedback is provided by sensors - transducers
- Tool magazines are used to exchange tools automatically.

TOOLS

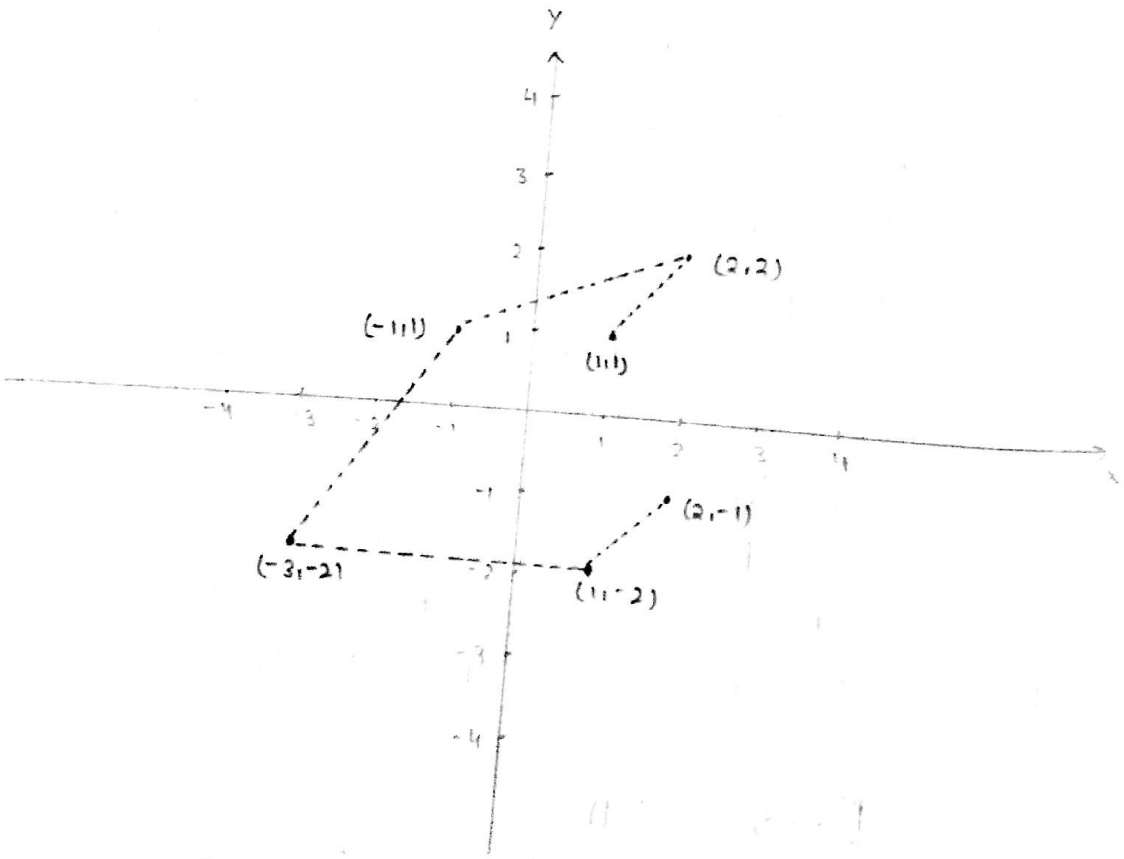
Most are made from high speed steel (HSS), tungsten carbide or ceramics.
Tools are designed to direct waste away from the materials
Some tools need coolants such as oil to protect tool and work

TOOLS USED

- Drills
- End milling & Face milling tools
- Clamps



ABSOLUTE COORDINATE SYSTEM



INCREMENTAL COORDINATE SYSTEM

COORDINATE SYSTEMS

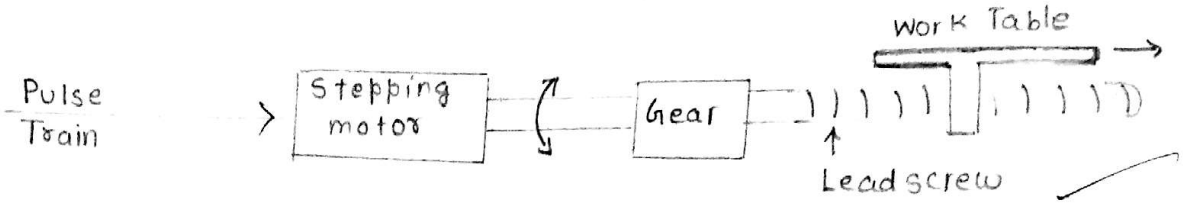
- The machine tool uses Cartesian coordinate system.
  X, Y, Z axis - right handed coordinate system.

- The CNC Machine can have at max 5 axes

- 5 axes :- → Linear axes : X axes, Y axes, Z axes
  → Rotatory axes : rotation along Z axis (+C)
  rotation along Y axis (+B)

- With respect to cartesian coordinate systems, there are 2 coordinate systems in CNC machine
  1) Absolute Coordinate System
  2) Incremental Coordinate System

- With respect to machine or workpiece there are two coordinate systems
  i) Machine coordinate system
  ii) Workpiece Coordinate system



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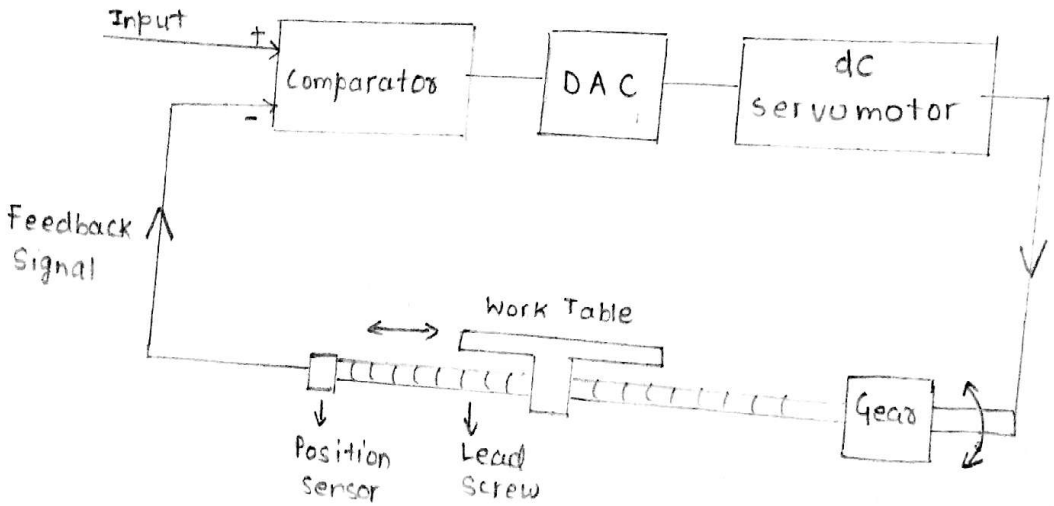
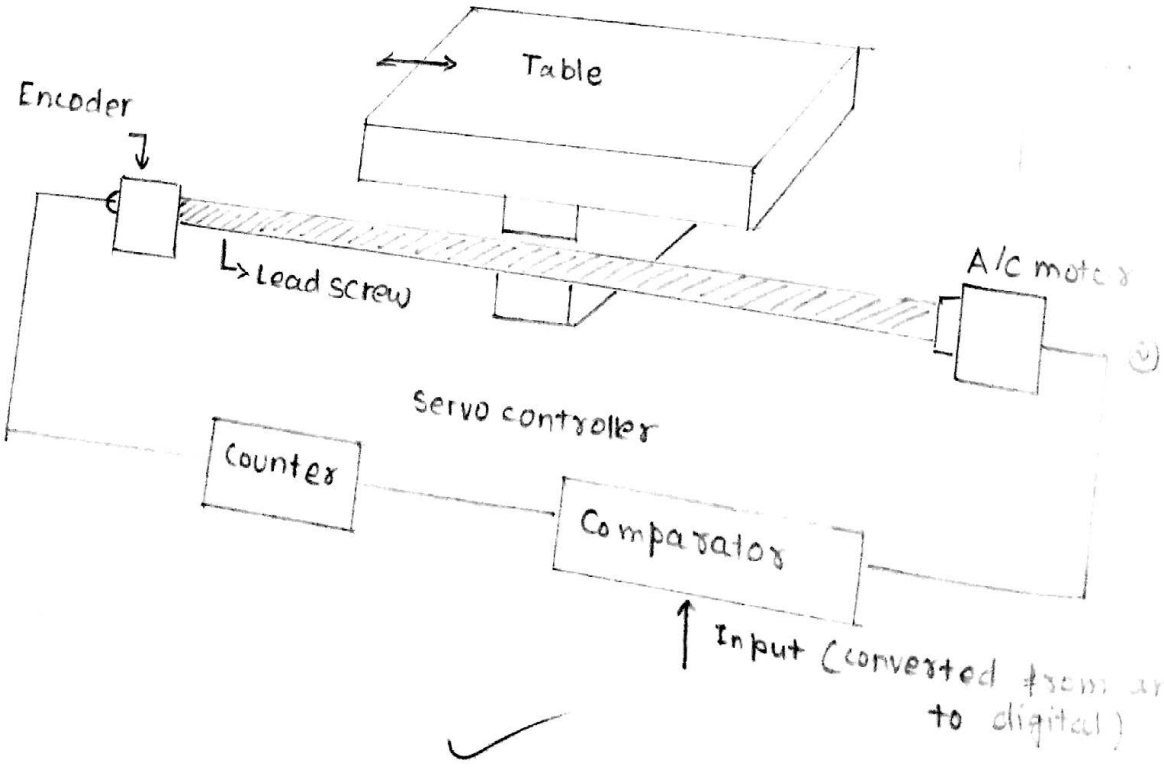


~~Name~~ Name Required

DC Motor & Gear should be in a line with Lead screw



BASIC LENGTH UNIT

- In Numerically controlled machine, the displacement length per one pulse output from machine is defined as Basic Length Unit.

- In CNC each bit represents BLU i.e 1 Bit = 1 BLU

- Ex:- If one pulse makes a servomotor rotate by 1 degree and the servometer moves the table by 0.001 mm, 1 BLU = 0.001 mm

CNC Movement

- Each axis consists of a mechanical component, such as slide that moves, a servo drive motor that powers the mechanical movement, and a ball screw to transfer the power from the servo drive motor to mechanical component.

- These components along with the computer controls that govern them, are referred to as an axis drive system which controls all the movement of mechanical parts of the CNC machine.

ENCODER

- An Encoder is a sensor of mechanical motion that generates digital signals in response to motion. As an electromechanical device, an encoder is able to provide motion control systems users with information conurning position velocity and direction:-

- There are two types of Encoders:-

- Linear
Linear encoder responds to motion along a line

- Rotatory
Rotatory encoder responds to rotational motion

Encoder can also be classified on basis of output:-

- Incremental
- Absolute

PROGRAMMING KEY LETTERS

- O : Program numbers (used for program identification)
- R : Radius designation
- N : Sequence Number (used for lines)
- G : Preparatory function (Identification)
- X : X-axis designation
- Y : Y-axis designation
- F : Feed rate designation
- S : Spindle rate designation
- T : Tool designation
- M : Miscellaneous / Machine function

G Codes

- G00 – Rapid transverse
- G01 – Linear Interpolation
- G02 – Circular Interpolation (clockwise)
- G03 – Circular Interpolation (anticlockwise)
- G15 – Polar Coordinate System off
- G16 – Polar Coordinate System on
- G17 – XY plane
- G20/G70 – Inch Units
- G21/G71 – Metric Units
- G28 – Return to Reference Point
- G40 – Cutter compensation Cancel
- G41 – Cutter compensation left
- G42 – Cutter compensation right
- G43 – Tool Length compensation (plus)
- G44 – Tool Length compensation (minus)
- G49 – Tool Length compensation cancel
- G51.1 – X0 – X mirror on
- G50.1 – X0 – X mirror off
- G54 – G59 – Work Coordinate System
- G90 – Absolute positioning
- G91 – Incremental positioning
- G94 – Feed per minute

M codes

- M00 – Program STOP
- M03 – Spindle on clockwise
- M05 – Spindle stop
- M08 – Coolant on
- M30 – Program stop, reset to start
- M01 – Program end
- M04 – Spindle on counterclockwise
- M06 – Tool change
- M09 – Coolant off

JOB

OBJECTIVE :- To develop and design an object of required shape using CNC milling machine with suitable coordinate system and coding.

Tools utilized :-

- CNC milling machine
- Metal Slab
- A cutting tool

Procedure :-

1. To start the machine :
   1. Switch on from main switch board
   2. Switch on three phase stabiliser
   3. Switch on machine isolator switch
   4. Press CNC on button (green color)
   5. Release CNC emergency stop button (red colored)
   6. Press Reset button (white button)

2. Procedure to use offset :
   1. Press MPG button.
   2. Put the tool cutter to corner of the job.
   3. Press offset button
   4. Press work
   5. Press measure
   6. Take Y0- press measure
   7. Press ◁◁ button
   8. Press offset button
   9. Bring cursor on (001) line
   10. Press Ry (Z+ I Y+ X+)
   11. Press POS button

Procedure to start the program :

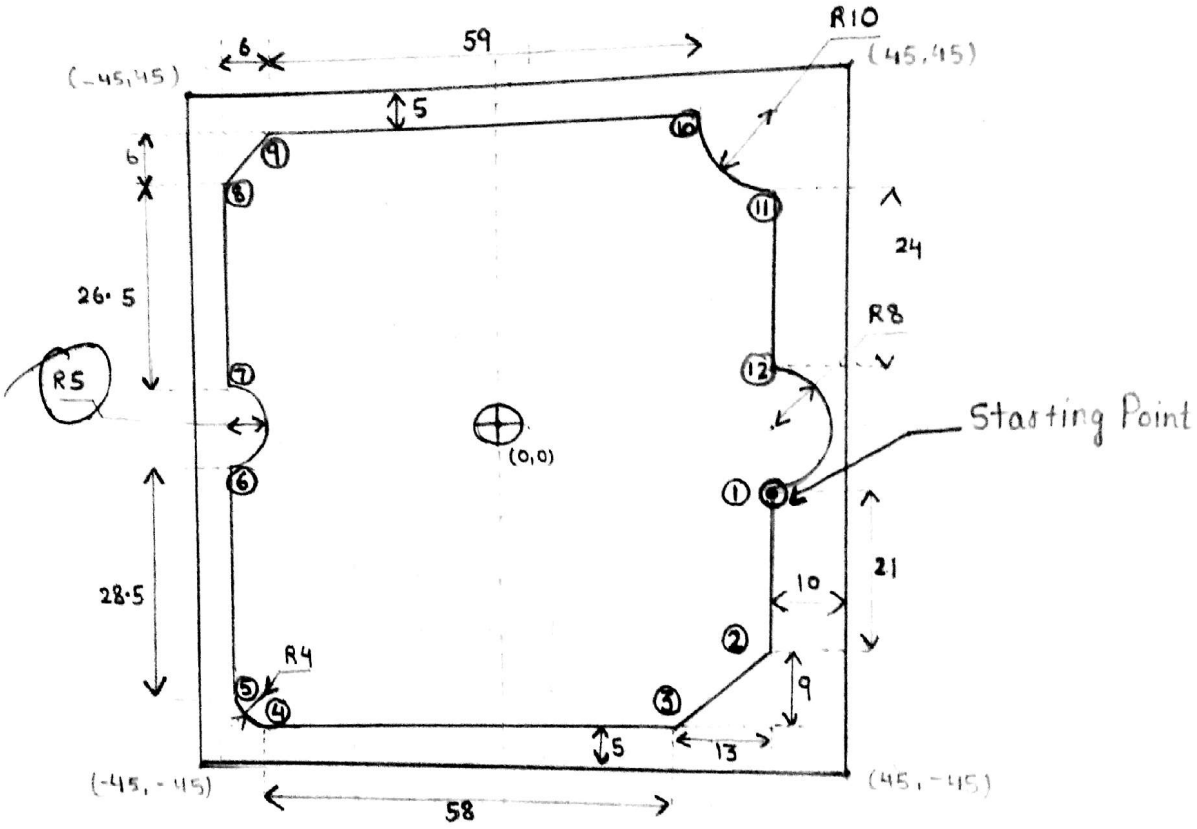
1. Press edit
2. Press program
3. Write O with 4 digit no.
4. Press insert
5. Press EOB button
6. Press inserst button

Procedure to check simulator :

1. Open Program
2. Press Auto button
3. Press MLK button
4. Press DRN button
5. Press CSTM/GR button graph
6. Press cycle start button

Procedure to on machine :

1. Press PROG button
2. Press MLK button
3. Press DRN button
4. Press AUTO button
5. Press CNC-on button



Coordinates

①	(35, -10) Starting Point	⑦	(-40, 7.5)
②	(35, -31)	⑧	(-40, 34)
③	(22, -40)	⑨	(-34, 40)
④	(-36, -40)	⑩	(25, 40)
⑤	(-40, -36)	⑪	(35, 30)
⑥	(-40, -7.5)	⑫	(35, 06)

- Code for current job is :-

```
O0
G28 G91 Z0 ;
G28 G91 X0 Y0 ;
T01 M06 ;
G00 G17 G40 G54 G80 G90 X35 Y-10 ;
G00 Z20 ;
M03 S1000 ;
M08 ;
G01 Z-1 F100 ;
G01 G42 X35 Y-31 F200 ;
G01 X22 Y-40 ;
G01 X-36 Y-40 ;
G02 X-40 Y-36 R4 ;
G01 X-40 Y-7.5 ;
G03 X-40 Y 7.5 R5 ;   X R7.5
G01 X-40 Y34 ;
G01 X-34 Y40 ;
G01 X25 Y40 ;
G03 X35 Y30 R10 ;
G01 X35 Y06 ;
G02 X35 Y-10 R8 ;
G00 Z0 ;
M05 M09 ;
G28 G91 Z0 ;
G28 G91 Y0 ;
M30 ;
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SAFETY AND PRECAUTIONS

- There are high voltage terminal on electrical control panel motor and other equipments. Do not touch them under any circumstances.
- Control Panel should be operated only if we have complete knowledge of it.
- Do not touch control panel with wet hands
- Ensure that workpiece and tool are screwed firmly.
- Never touch any rotating part under any circumstances.
- Always stop the machine to clear the chips on the workpiece. Never wipe the workpiece with bare hands, use brush.
- Press the emergency stop button before anything goes beyond the control to avoid damage.