Department of Mechanical Engineering

Lab Manual

Computer Aided Manufacturing

(MEC308)

Laboratory Location: New Building Central Workshop Room no-1 (2)

Indian Institute of Technology (Indian School of Mines)
Dhanbad - 826001

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Safety in the Lab

- You are only allowed in the laboratory when there is a 'responsible person' present such as a demonstrator or the laboratory staff.
- Do not touch any equipment or machines kept in the lab unless you are asked to do so.
- A tidy laboratory is generally safer than an untidy one, so make sure that you do not have a confused tangle of electrical cables. Electrical equipment is legally required to be regularly checked, which means it should be safe and reasonably reliable: do not tamper or attempt to repair any electrical equipment (in particular, do not rewire mains plug or change a fuse - ask one of the laboratory staff to do it). Never switch off the mains using the master switches mounted on the walls. Please make yourself aware of the fire exits when you first come into the lab. When the alarm sounds, please leave whatever you are doing and make your way quickly, calmly and quietly out of the lab. You must always follow instructions from your demonstrators and the laboratory staff.
- You must keep walkways clear at all times and in particular coats and bags must be stowed away safely and must not pose a trip hazard.
- It is important that you make a point of reading the "Risk Assessment" sheet included in the manuscript of each experiment before you start work on the experiment.
- Please take notice of any safety information given in your scripts. If an experiment or project requires you to wear PPE (personal protective equipment) such as gloves and safety glasses, then wear them.
- Always enter the lab wearing your shoes. It is strictly prohibited to enter the lab without shoes.
- There must be NO smoking, eating, drinking, use of mobile phones or using personal headphones in the laboratory. This last point is not because we dislike your choice of music but because you must remain aware of all activity around you and be able to hear people trying to warn you of problems.

Lab Report Format

- Provide a title that is a description of your lab followed by a lab number.
- The title should clearly identify the experiment's variables (independent & dependent)

Objective/Purpose/Problem:

- This is the place to explain what you are trying to find out or what you are going to doin the lab.
- Include information about the variables involved.

Hypothesis: "If………then………because………"

- This is a cause/effect statement.
- This is a prediction of what the expected outcome of the lab will be.
- Relate the hypothesis to the purpose/problem of the lab.
- Try to focus your hypothesis on the information/research you collected.

Materials:

- List all items in a column.
- Make sure to record the exact size and amount of each item required.

Procedures:

- List and number each step.
- Use complete sentences (begin with a capital letter and use end punctuation).
- Should be clear enough for someone else to use as instructions for repeating yourexperiment.

Observations/Data:

- Be sure to accurately record your observations/data in a chart or table.
- Create a graph to provide a visual of your data.
- Provide a verbal description of your data.
- List all quantitative (numbers) and qualitative (words) data.
- List all variables and explain what your control was.

Conclusion: "When…………….then…..................."

- Match your conclusion to the purpose or the problem.
- Base your conclusion on your analysis of your observations and any data that has beencollected.
- Explain: (The following are just suggestions and DO require elaboration.)
    - What you did in the experiment
    - What you observed (trends/patterns in your data that supported or did notsupport your hypothesis)
    - What you learned from the lab
    - If you think it was a fair test (i.e. – was there anything that may have impactedthe accuracy of your results)
    - Questions for further research and investigation

Application: Can you think of an analogous situation that applies to real life?

List of Experiments

Experiment 1: Introduction to CNC machine and part-programming

Objective: To understand different parts of a CNC machine and learn to write part programs for CNC lathe and milling machines.

Equipments Required: None

Principle:

Axis In CNC Machine: The basis of axis identification is the 3-dimensional Cartesian co-ordinate system and three axis of movement are identified as x, y and z axis

Z-axis: The Z axis of motion is always the axis of the main spindle of the machine. It does not matter whether the spindle carries the work piece or the cutting tool.

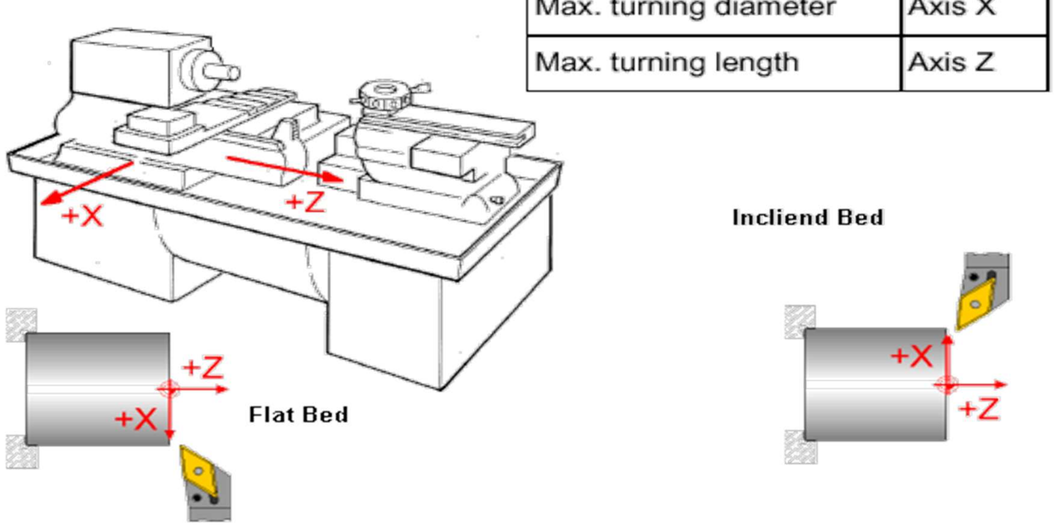
X-axis: The axis is always horizontal and is always parallel to the work holding surface. Positive X Axis movement is identified as being to the right, when looking from the spindle towards its supporting column.

Y-axis: The axis is always at right angle to both X-Axis and Z-Axis.

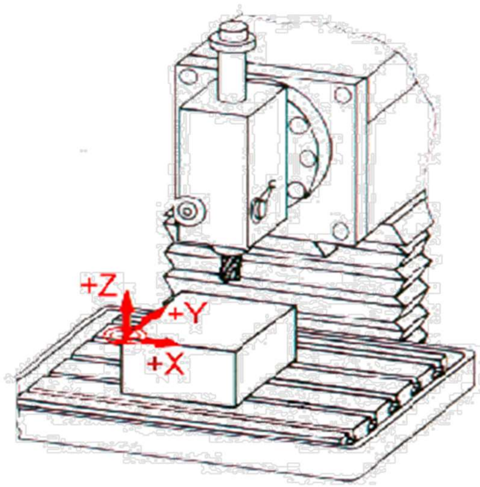
Rotary axis: The rotary motion about the X, Y and Z-Axis are identified by A, B, C respectively. Clockwise is designated as +ve. Positive rotation is identified looking in x, y and z direction respectively.

AXIS IN CNC LATHE

Max. turning diameter	Axis X
Max. turning length	Axis Z



AXIS IN CNC MILLING



Max. workpiece length	Axis X
Max. workpiece width	Axis Y
Max. workpiece height	Axise Z

The maximum workpiece dimensions correspond to the possible traversing path of the tool in the particular axis.

CNC Part Programming: The part program is a sequence of instructions, which describe the work, which has to be done on a part, in the form required by a computer under the control of a numerical control computer program. It is the task of preparing a program sheet from a drawing sheet. All data is fed into the numerical control system using a standardized format. Programming is where all the machining data are compiled and where the data are translated into a language which can be understood by the control system of the machine tool. The machining data is as follows:

(a) Machining sequence classification of process, tool start up point, cutting depth, tool path, etc.
(b) Cutting conditions, spindle speed, feed rate, coolant, etc.
(c) Selection of cutting tools.
While preparing a part program, need to perform the following steps:
(a) Determine the startup procedure, which includes the extraction of dimensional data from part drawings and data regarding surface quality requirements on the machined component.
(b) Select the tool and determine the tool offset.
(c) Set up the zero position for the work piece.
(d) Select the speed and rotation of the spindle.
(e) Set up the tool motions according to the profile required.
(f) Return the cutting tool to the reference point after completion of work.
(g) End the program by stopping the spindle and coolant.

Preparatory function (G-Codes).

Code	Description	Milling (M)	Turning (T)	Corollary info
G00	Rapid positioning	M	T	
G01	Linear interpolation	M	T	
GO2	Circular interpolation, clockwise	M	T	.
G03	Circular interpolation, counter clockwise	M	T	
G04	Dwell	M	T	Takes an address for dwell period (may be X, U, or P). The dwell period is specified in the controller's parameter, typically milliseconds.
G17	XY plane selection	M		
G18	ZX plane selection	M	T	
G19	YZ plane selection	M		
G20	Programming in inches	M	T	
G21	Programming in millimetres (mm)	M	T	
G28	Return to home position (machine zero, aka machine reference point)	M	T	Takes X Y Z addresses which define the intermediate point that the tool tip will pass through on its way home to machine zero. They are in terms of part zero (aka program zero), NOT machine zero.
G40	Tool radius compensation off	M	T	Cancels G41 or G42.
G41	Tool radius compensation left	M	T	**Milling:** Given right hand-helix cutter and M03 spindle direction, G41 corresponds to climb milling (down milling). Takes an address (D or H) that calls an offset register value for radius.

G42	Tool radius compensation right	M	T	Similar corollary info as for G41. Given right hand-helix cutter and M03 spindle direction, G42 corresponds to conventional milling (up milling).See also the comments for G41.
G43	Tool height offset compensation negative	M		Takes an address, usually H, to call the tool length offset register value. The value is *negative* because it will be *added* to the gauge line position. G43 is the commonly used version (vs. G44).
G44	Tool height offset compensation positive	M		Takes an address, usually H, to call the tool length offset register value. The value is *positive* because it will be *subtracted* from the gauge line position. G44 is the seldom-used version (vs. G43).
G49	Tool length offset compensation cancel	M		Cancels G43 or G44.
G50	Scaling function cancel	M		
G52	Local coordinate system (LCS)	M		Temporarily shifts program zero to a new location. This simplifies programming in some cases.
G53	Machine coordinate system	M	T	
G54 to G59	Work coordinate systems (WCSs)	M	T	
G54.1 P1 to P48	Extended work coordinate systems	M	T	Up to 48 more WCSs besides the 6 provided as standard by G54 to G59.
G70	Fixed cycle, multiple repetitive cycle, for finishing (including contours)		T	

G71	Fixed cycle, multiple repetitive cycle, for roughing (Z-axis emphasis)		T	
G72	Fixed cycle, multiple repetitive cycle, for roughing (X-axis emphasis)		T	
G73	Fixed cycle, multiple repetitive cycle, for roughing, with pattern repetition		T	
G73	Peck drilling cycle for milling – high-speed (NO full retraction from pecks)	M		Retracts only as far as a clearance increment (system parameter). For when chip breaking is the main concern, but chip clogging of flutes is not.
G74	Peck drilling cycle for turning		T	
G74	Tapping cycle for milling, left-hand thread, M04 spindle direction	M		
G75	Peck grooving cycle for turning		T	
G76	Fine boring cycle for milling	M		
G76	Threading cycle for turning, multiple repetitive cycle		T	
G80	Cancel canned cycle	M	T	**Milling:** Cancels all cycles such as G73, G83, G81, and G86 etc. Z-axis returns either to Z-initial level or R-level, as programmed (G98 or G99, respectively).
G81	Simple drilling cycle	M		No dwell built in

G82	Drilling cycle with dwell	M		Dwells at hole bottom (Z-depth) for the number of milliseconds specified by the P address. Good for when hole bottom finish matters.
G83	Peck drilling cycle (full retraction from pecks)	M		Returns to R-level after each peck. Good for clearing flutes of chips.
G84	Tapping cycle, right-hand thread, M03 spindle direction	M		
G85	Reaming Cycle	M		
G86	Boring Cycle	M		
G90	Absolute programming	M	T	Positioning defined with reference to part zero...
G91	Incremental programming	M	T	Positioning defined with reference to previous position.
G92	Threading cycle, simple cycle		T	
G94	Feedrate per minute	M	T	
G95	Feedrate per revolution	M	T	
G96	Constant surface speed (CSS)		T	Varies spindle speed automatically to achieve a constant surface speed. See speeds and feeds. Takes an S address integer, which is interpreted as sfm in G20 mode or as m/min in G21 mode.
G97	Constant spindle speed	M	T	Takes an S address integer, which is interpreted as rev/min (rpm). The default speed mode per system parameter if no mode is programmed.
G98	Return to initial Z level in canned cycle	M		

G98	Feedrate per minute (group type A)		T	Feedrate per minute is G94 on group type B.
G99	Return to R level in canned cycle	M		
G99	Feedrate per revolution (group type A)		T	Feedrate per revolution is G95 on group type

Miscellaneous functions

M Codes are instructions describing machine functions such as calling the tool, spindle Rotation, coolant on, door close/open etc.

Code	**Description**	**Milling (M)**	**Turning (T)**	**Corollary info**
M00	Compulsory stop	M	T	Non-optional—machine will always stop upon reaching M00 in the program execution.
M01	Optional stop	M	T	Machine will only stop at M01 if operator has pushed the optional stop button.
M02	End of program	M	T	No return to program top; may or may not reset register values.
M03	Spindle on (clockwise rotation)	M	T	The speed of the spindle is determined by the address S.
M04	Spindle on (counter clockwise rotation)	M	T	See comment above at M03.
M05	Spindle stop	M	T	
M06	Automatic tool change (ATC)	M	T	
M07	Coolant on	M	T	
M08	Coolant on (flood)	M	T	
M09	Coolant off	M	T	

M19	Spindle orientation	M	T	Spindle orientation
M21	Mirror, X-axis	M		
M21	Tailstock forward		T	
M22	Mirror, Y-axis	M		
M22	Tailstock backward		T	
M23	Mirror OFF	M		
M30	End of program with return to program top and Rewind	M	T	
M98	Subprogram call	M	T	Takes an address P to specify which subprogram to call, for example, “M98 P8979” calls subprogram O8979.
M99	Subprogram end	M	T	

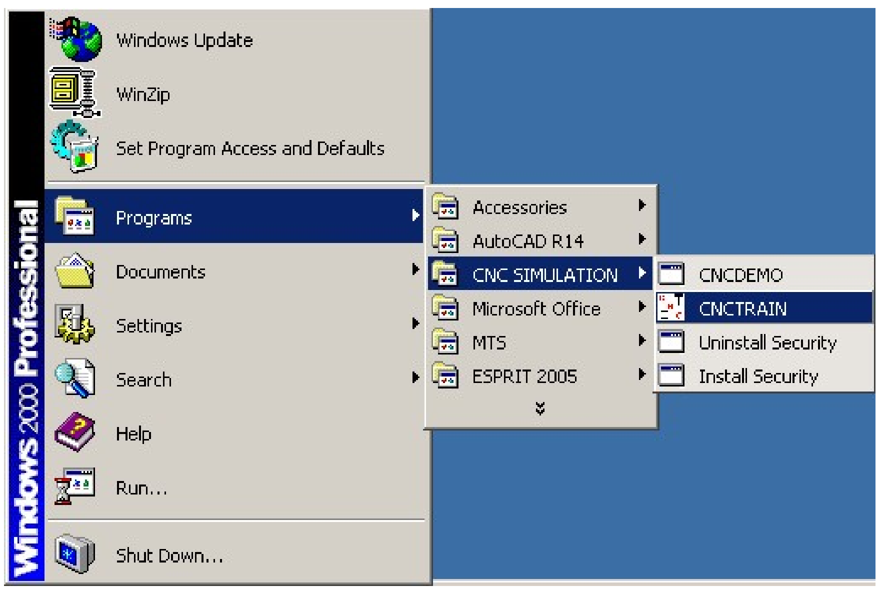
Experiment 2: Simulation of different part programs

Objective: To understand and use the simulation tool for simulating CNC part programs for lathe and milling machines.

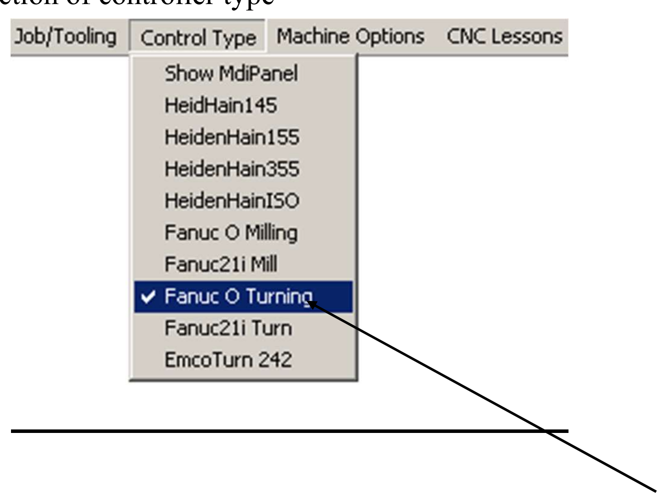
Equipments Required: CNC TRAIN software.

Procedure: The different steps involved in using the CNC TRAIN software are as follows:

Step 1: Click Start menu - Programs - CNC simulation - CNCTRAIN (or) Double click icon on the desktop

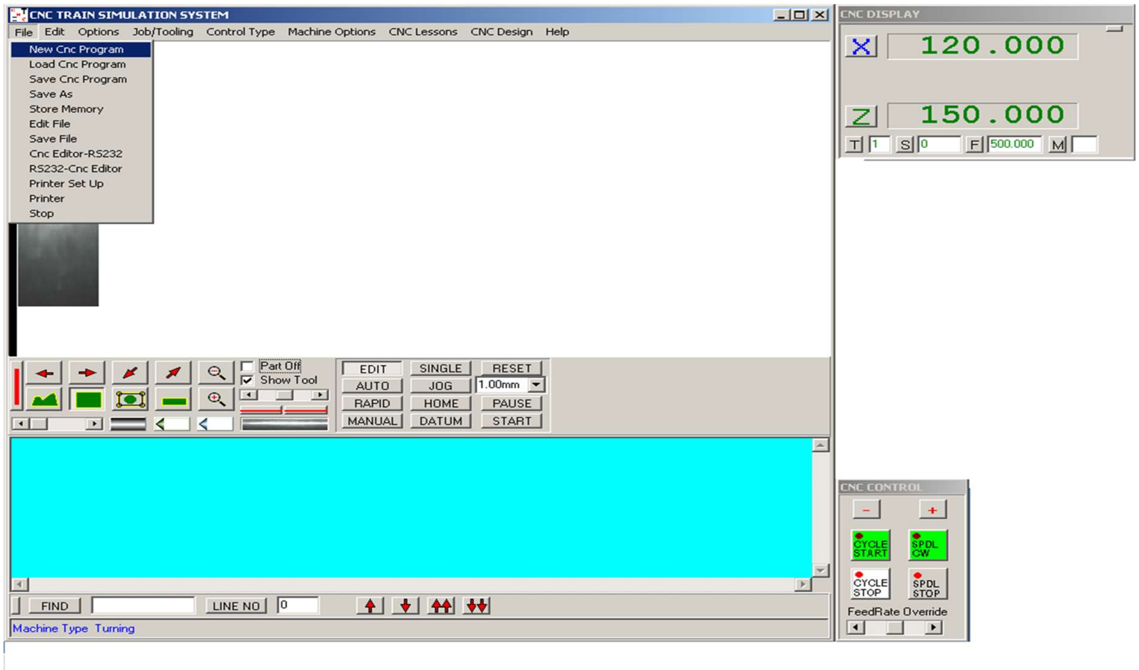


Step 2: Selection of controller type

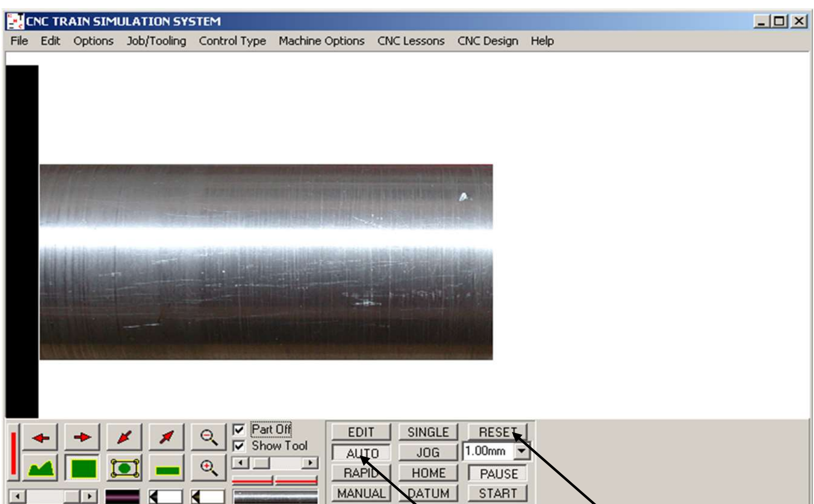


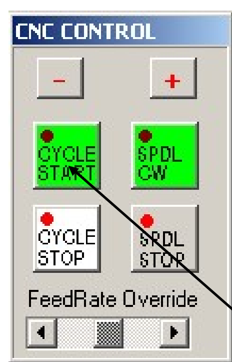
Click Control Type

Step 3: Write a new program. Click file on the main menu and click new CNC program and type the program in the CNC editor screen.



Step 4: Simulation



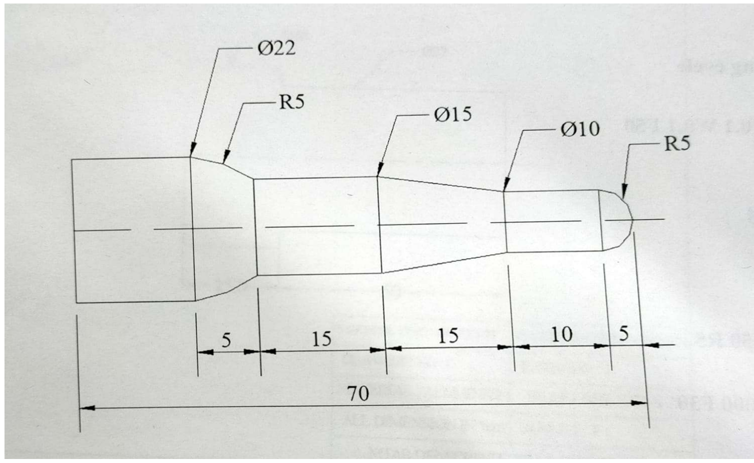


Step 3 Click Cycle start

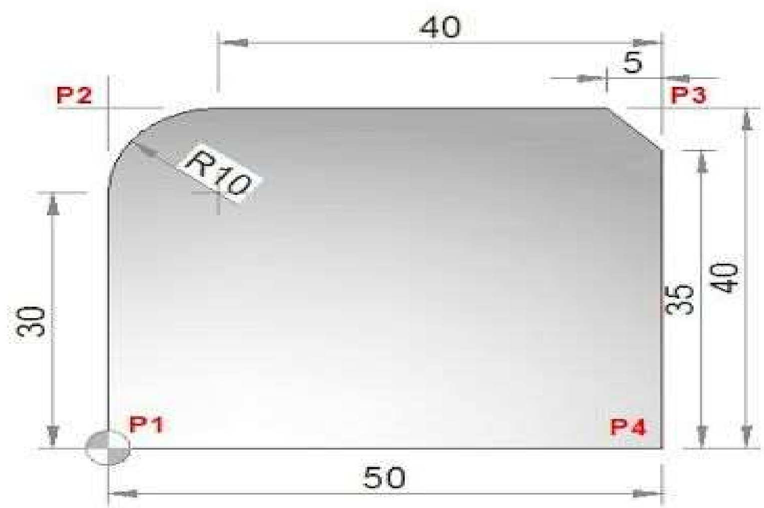
Step 1 Click Auto

Step 2 Click reset

Observations: Carry out the simulations of the following parts in CNC TRAIN software.



Turning Exercise



Milling Exercise

Experiment 3: Writing and execution of part programs for CNC Lathe Machine

Objective: To write a CNC part program for turning operation.

Equipments Required: CNC TRAIN software, CNC lathe, workpiece

Procedure:

COORDINATE SYSTEM FOR A CNC LATHE

Machining of a work piece by an NC program requires a coordinate system to be applied to the machine tool. As all machine tools have more than one slide, it is important that each slide is identified individually. There are two planes in which movements can take place

- Longitudinal.
- Transverse.

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

- Axis X
- Axis Z

The two axis are identified by upper case X, Z and the direction of movement along each axis (+) or (-). The Z axis is always parallel to the main spindle of the machine. The X axis is always parallel to the work holding surface, and always at right angles to the Z axis. The coordinate system for turning operations is shown in figure below

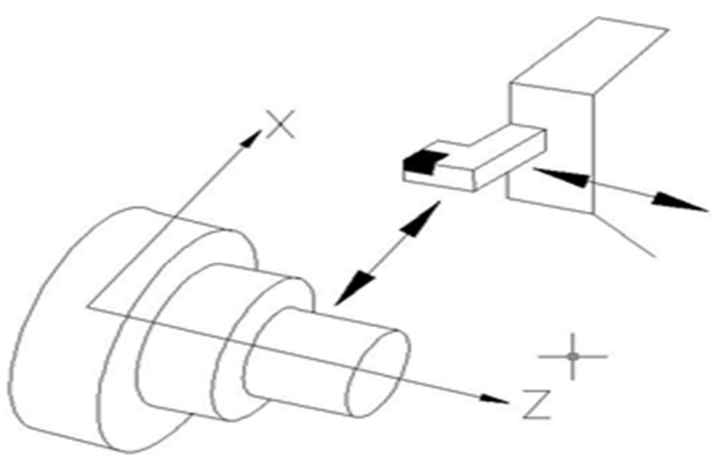
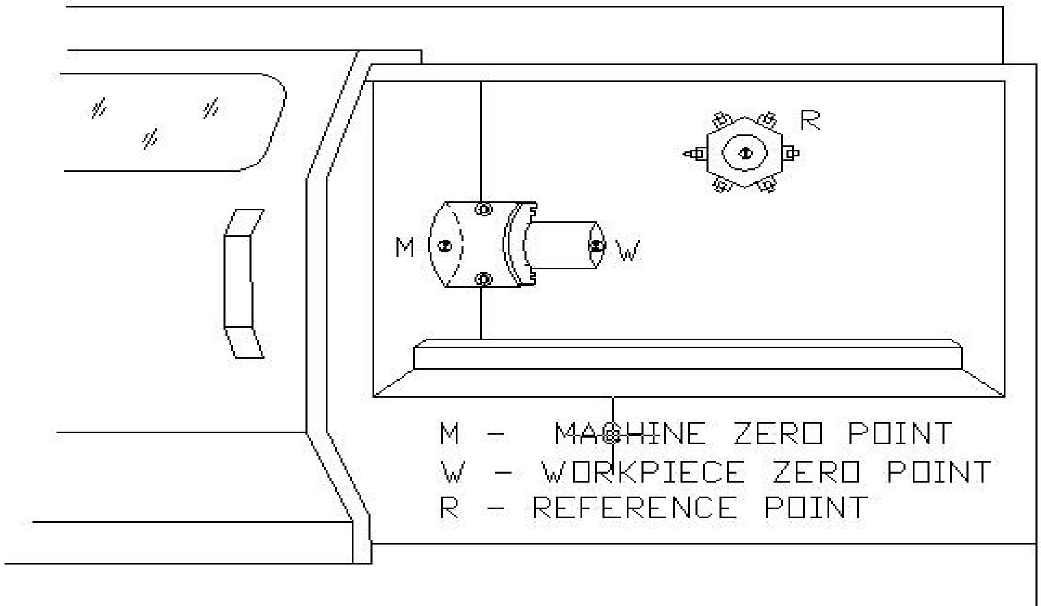


Fig 1. COORDINATE SYSTEM FOR TURNING OPERATIONS

ZERO POINTS AND REFERENCE POINTS

All CNC machine tool traverses are controlled by coordinating systems. Their accurate position within the machine tool is established by "ZERO POINTS".

MACHINE ZERO POINT (M): is specified by the manufacturer of the machine. This is the zero point for the coordinate systems and reference points in the machine. On turning lathes, the machine zero point is generally at the center of the spindle nose face. The main spindle axis (center line) represents the Z axis; the face determines the X axis. The directions of the positive X and Z axes point toward the working area as shown in figure below:



WORKPIECE ZERO POINT (W): This point determines the work piece coordinate system in relation to the machine zero point. The work piece zero point is chosen by the programmer and input into the CNC system when setting up the machine. The position of the work piece zero point can be freely chosen by the programmer within the work piece envelope of the machine. It is however advisable to place the work piece zero point in such a manner that the dimensions in the work piece drawing can be conveniently converted into coordinate values and orientation when clamping / chucking, setting up and checking, the traverse measuring system can be effected easily. For turned parts, the work piece zero point should be placed along the spindle axis (center line), in line with the right hand or left hand end face of the finished contour as shown in figure. Occasionally the work piece zero point is also called the "program zero point."

CNC LATHE PROGRRAME STRUCTURE (FANUC CONTROLLER)

<u>**Start of the program**</u>

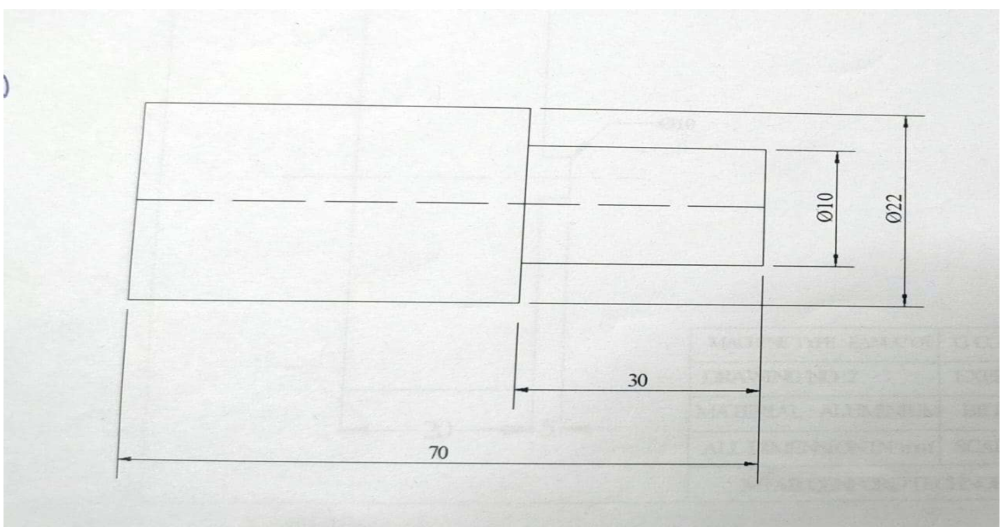
O1000	While writing a program on Fanuc controller first line has to be started with letter "o" followed by four digit number which specifies the program name.
G21/G20 G98/G99 G40	G21 – This code specifies that program is done in metric units G20 - This code specifies that program is done in Imperial units
G28 U0 W0	G28 U0 W0- Makes the tool to go to home position

M06 T0101	M06 T0101 Tool change. The first two digits after T specify the tool position in the turret and last two digits denotes the tool offset number.
M03 S1000	M03 – Makes the spindle rotate in clockwise direction S1000 – Spindle rotates at 1000rmp
G00	G00 -Gives rapid position of the tool to a point specified in the X and Z

<u>End of the program</u>

G28 U0 W0	G28 U0 W0- Makes the tool to go to home position.
M05	M05 –Stop the spindle rotation
M30	M30 – Program stop and rewind

Observation: Write a CNC part program for the following turning operation.



Experiment 4: Writing and execution of part programs for CNC Milling Machine

Objective: To write a CNC part program for milling operation.

Equipments Required: CNC TRAIN software, CNC milling machine, workpiece

Procedure:

PART PROGRAMMING GEOMETRY COORDINATE SYSTEM FOR A CNC MILL

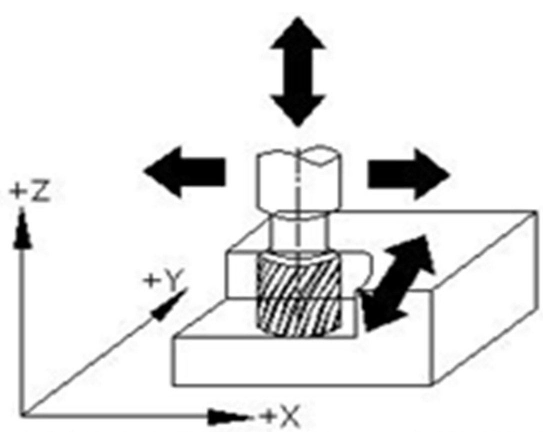
Machining of a work piece by an NC program requires a coordinate system to be applied to the machine tool. As all machine tools have more than one slide, it is important that each slide is identified individually. There are three planes in which movement can take place.

- Longitudinal
- Vertical
- Transverse

Each plane is assigned a letter and is referred to as an axis, i.e.

- Axis X
- Axis Y
- Axis Z

The three axes are identified by upper case X, Y and Z and the direction of movement along each axis is specified as either '+' or '-'. The Z axis is always parallel to the main spindle of the machine. The X axis is always parallel to the work holding surface, and always at right angles to the Z axis. The Y axis is at right angles to both Z and X axis. Figure shows the coordinate system for milling.



COORDINATE SYSTEM FOR MILLING

ZERO POINTS AND REFERENCE POINTS

MACHINE ZERO POINT (M): This is specified by the manufacturer of the machine. This is the x\zero point for the coordinate systems and reference points in the machine. The machine zero point can be the center of the table or a point along the edge of the traverse range as shown in figure the position of the machine zero point generally varies from manufacture. The precise position of the machine zero point as well as the axis direction must therefore be taken from the operating instructions provided for each individual machine.

WORKPIECE ZERO POINT (W): This point determines the work piece coordinate system in relation to the machine zero point. The work piece zero point is chosen by the programmer and input into the CNC system when setting up the machine. The position of the work piece zero point can be freely chosen by the programmer within the work piece envelope of the machine. It is however, advisable to place the work piece zero point in such a manner that the dimensions in the work piece drawing can be conveniently converted into coordinate values and orientation when clamping/ chucking, setting up and checking the traverse measuring system can be affected easily. For milled parts, it is generally advisable to use an extreme corner point as the "work piece zero point". Occasionally, the work piece zero point is called the "program zero point"

Dimensional information in a work piece drawing can be stated in two ways:

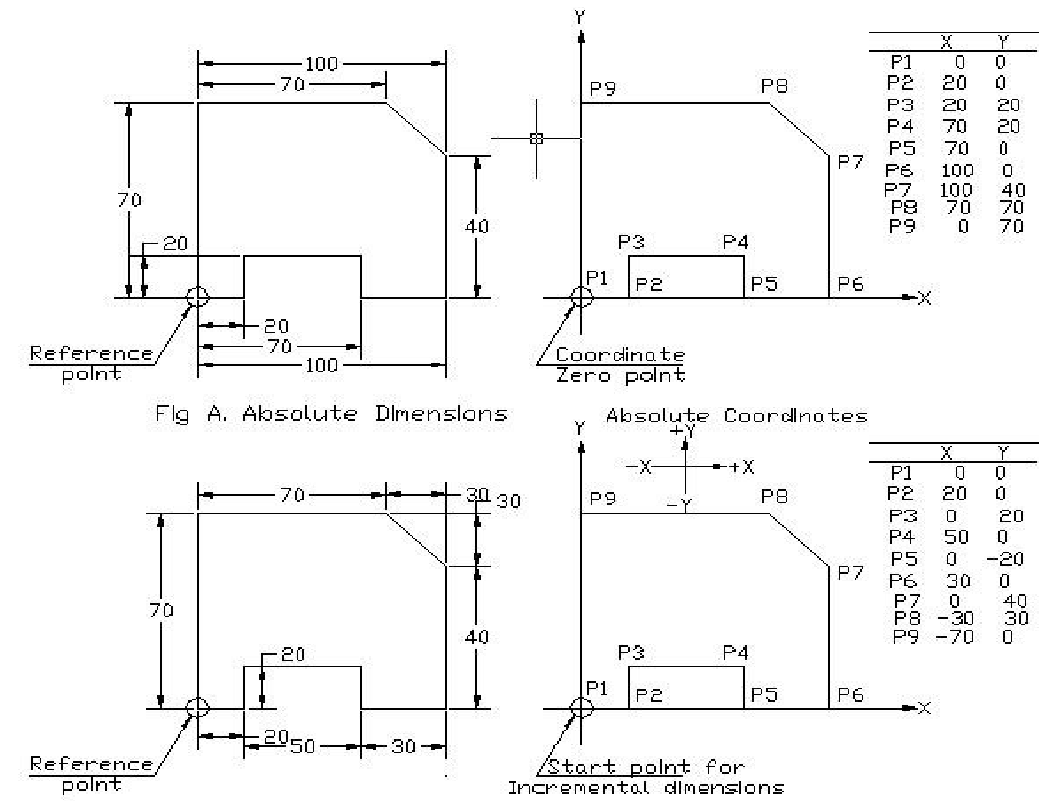
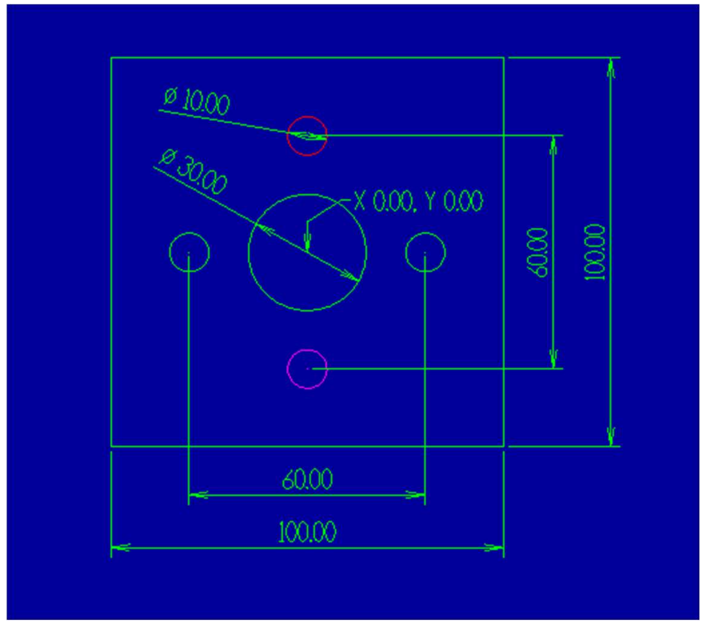


Fig A. Absolute Dimensions Absolute Coordinates

Fig B. Incremental Dimensions Incremental Coordinates

Observation: Write a CNC part program for the following milling operation.

Program for Circular Pocket




```
O0001
G28X0.0Y0.0Z0.0
M06T01
G0G54G90X0.0Y0.0
G0G43H1Z50.0
M03S1500
G01Z20.0F1500
N10
G01G90G54X0.0Y0.0F1500
G01 Z-1.0 F1000
G01 G90 G54 G42D1 X15.0 Y0.0F1500
G02X15.0Y0.0I-15.0J0.0
G01G40X0.0Y0.0
G0Z50.0
G28Z0.0
G28X0.0Y0.0
M05
M30
```

Program for Drilling

```
O0002
G28X0.0Y0.0Z0.0
M06T02
G0G54G90X30.0Y0.0
G0G43H1Z50.0
M03S1200
G01Z20.0F1500
N10
G01G90G54X30.0Y0.0F1500
G01 G83Z-10.0R1.0Q0.2F100
X0.0Y30.0
X-30.0Y0.0
X0.0Y-30.0
G0Z50.0
G28Z0.0
G28X0.0Y0.0
M05
M30
```

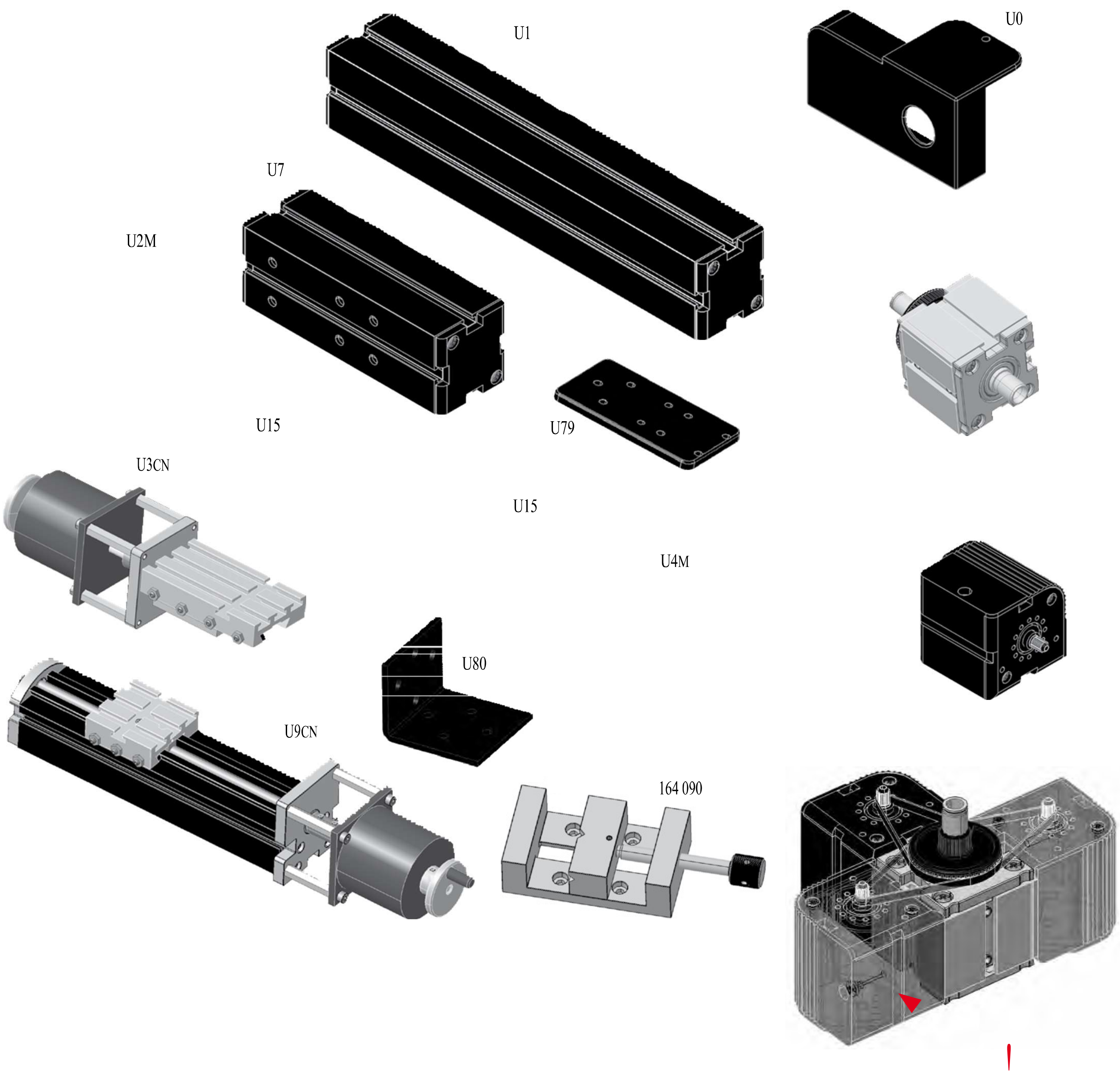
Experiment 5: Assembly and dis-assembly of a CNC trainer kit

Objective: To identify different components of a CNC machine and assemble and dis-assemble a CNC trainer kit.

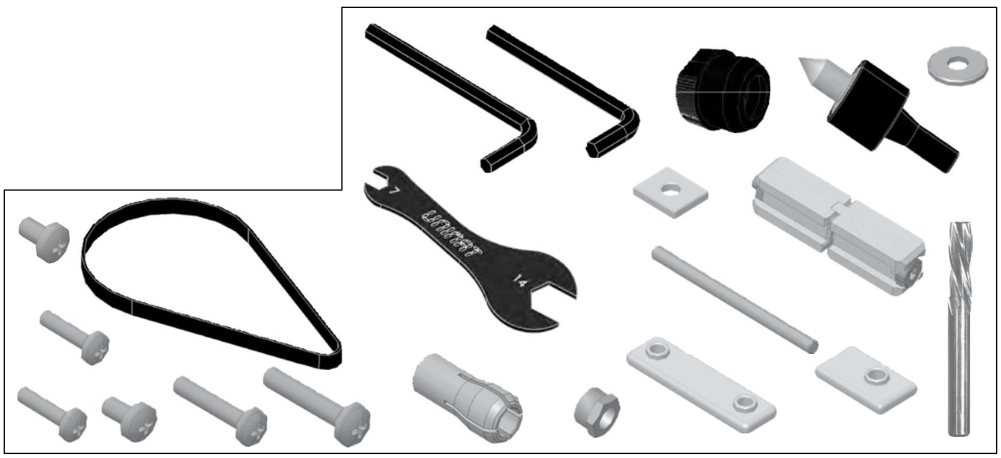
Equipments Required: CNC trainer kit, workshop tools, etc

Principle:

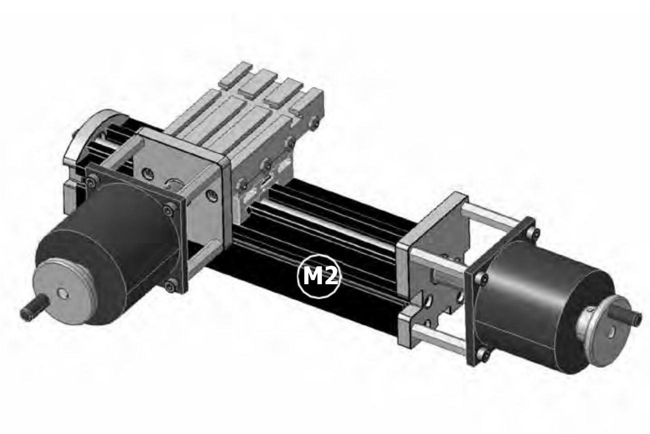
Part list of 4-Axis CNC Vertical Mill

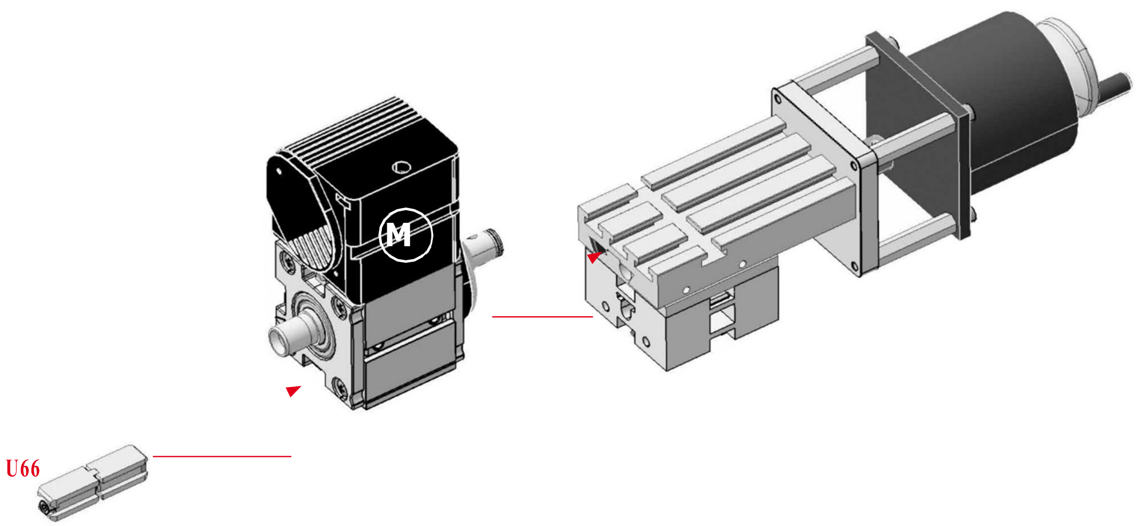


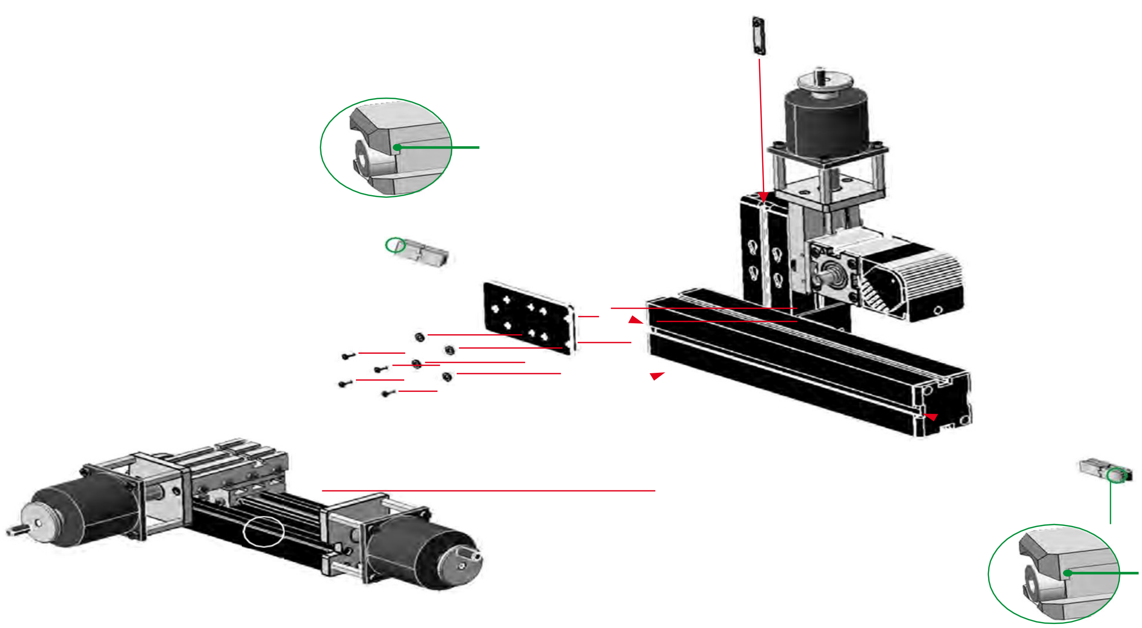
Tool List for setup 4 axis CNC Vertical mill

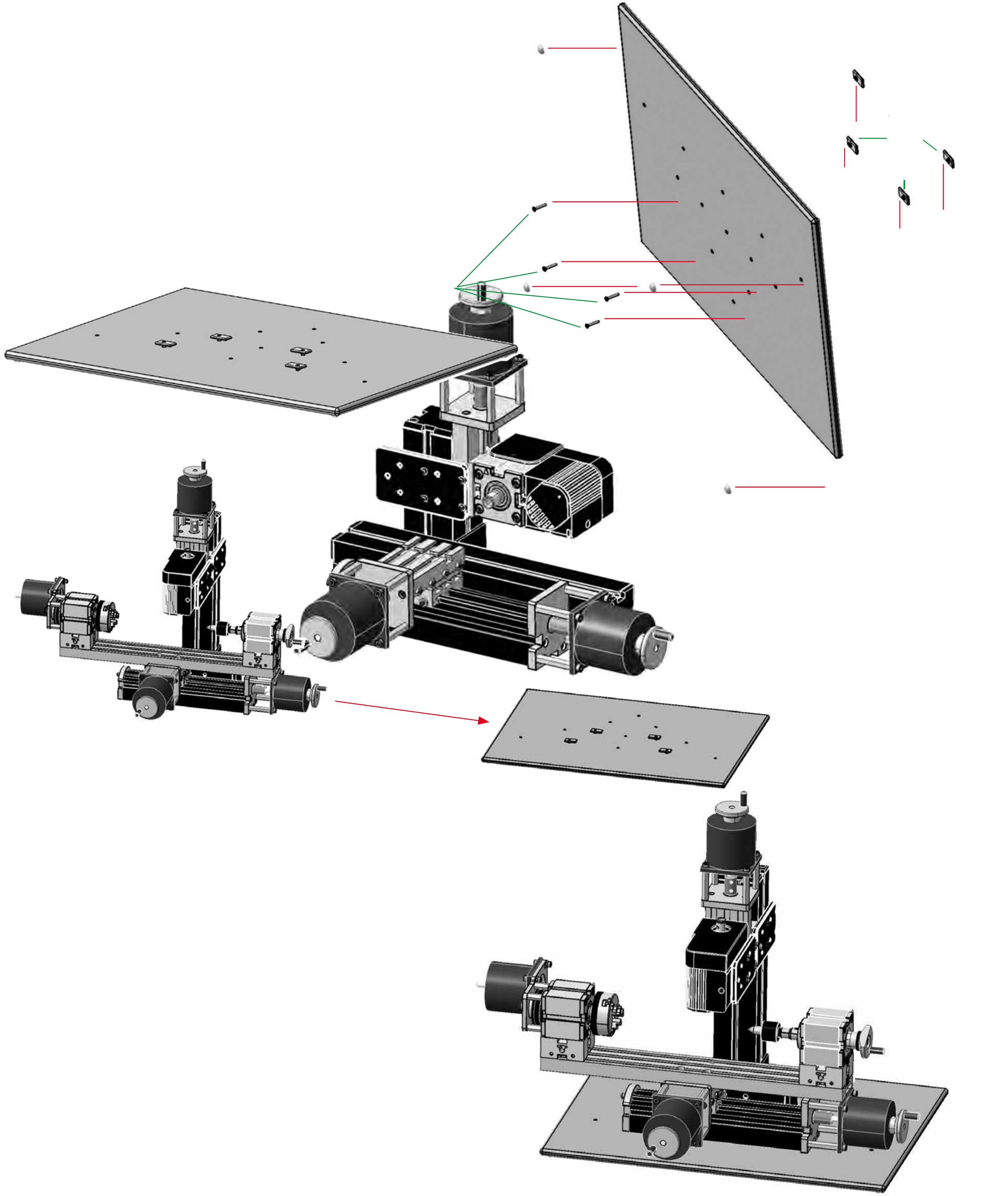


Assembling Process of 4 Axis CNC Vertical Mill

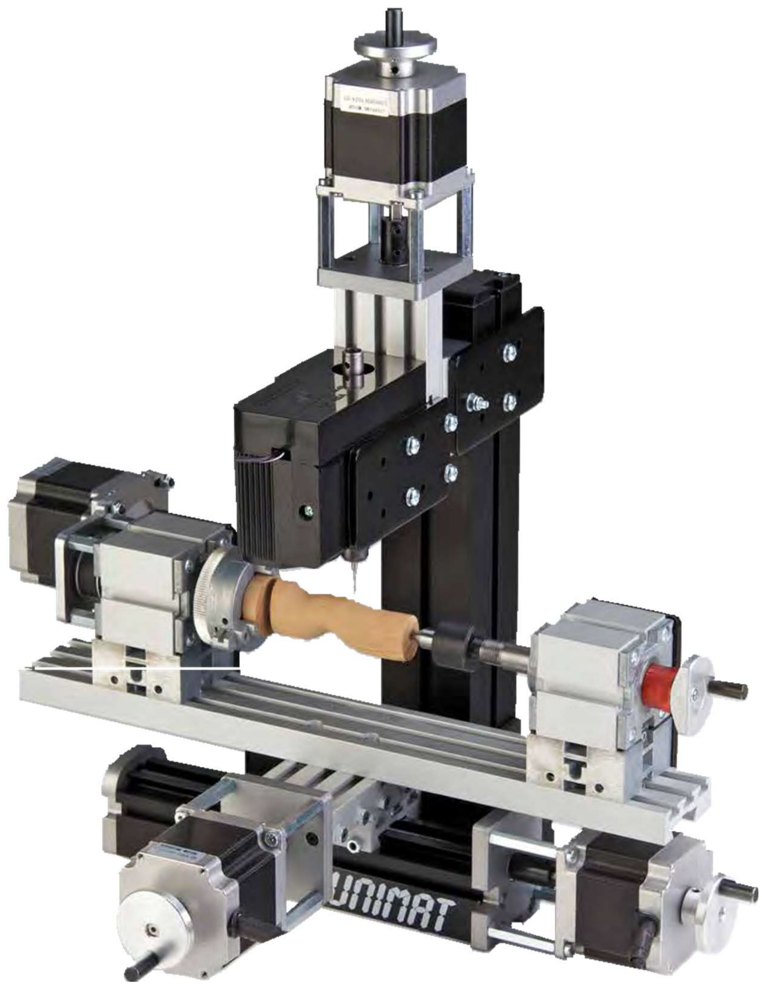



U66





Observation: Complete assembling of 4 axis CNC Vertical Mill



Experiment 6: Programing and practices of Flexible manufacturing systems (FMS)

Objective: To study the working of Single Machine Cell (SMC) and writing a code to operate it.

Equipments Required: Workstation (CNC Machine Tool), Automated Material Handling and Storage system, Computer Control System, Conveyors, Workpiece, etc.

Principle:

Introduction to FMS: FMS consists of a group of processing work stations interconnected by means of an automated material handling and storage system and controlled by integrated computer control system. FMS is called flexible due to the reason that it is capable of processing a variety of different part styles simultaneously at the workstation and quantities of production can be adjusted in response to changing demand patterns.

Basic components of FMS

The basic components of FMS are:

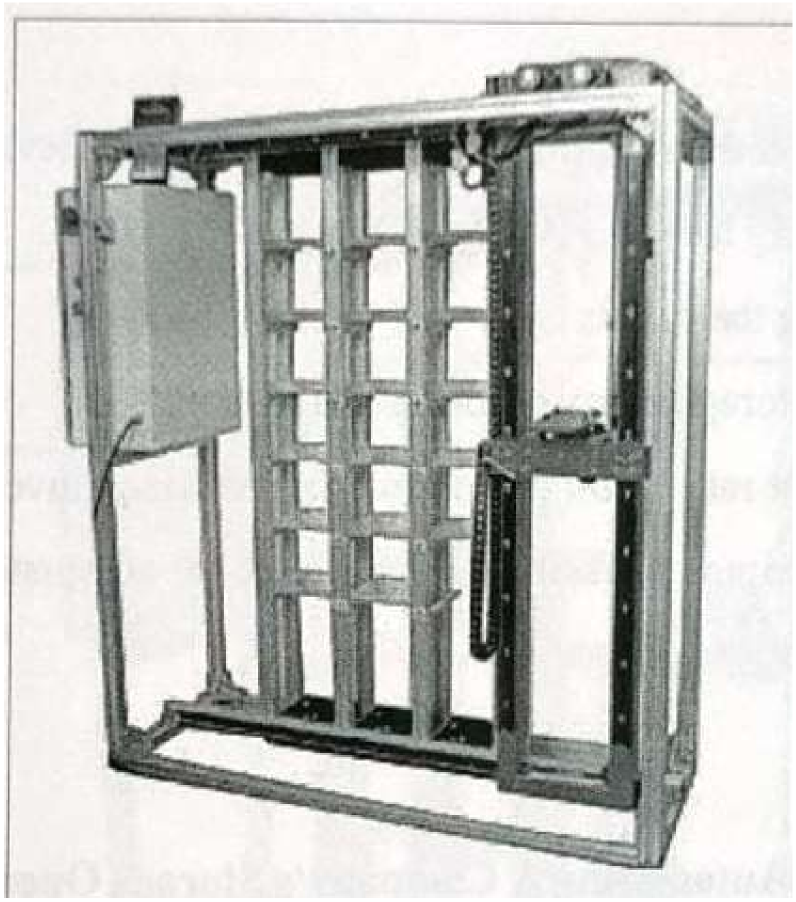
1. Workstations
2. Automated Material Handling and Storage system.
3. Computer Control System

Workstations: In present day application these workstations are typically computer numerical control (CNC) machine tools that perform machining operation on families of parts. Flexible manufacturing systems are being designed with other type of processing equipment's including inspection stations, assembly works and sheet metal presses. The various workstations are

1. Machining centres
2. Load and unload stations
3. Assembly work stations
4. Inspection stations
5. Forging stations
6. Sheet metal processing, etc.

Automated Material Handling and Storage system: The various automated material handling systems are used to transport work parts and sub-assembly parts between the processing stations, sometimes incorporating storage into function. The various functions of automated material handling and storage system are

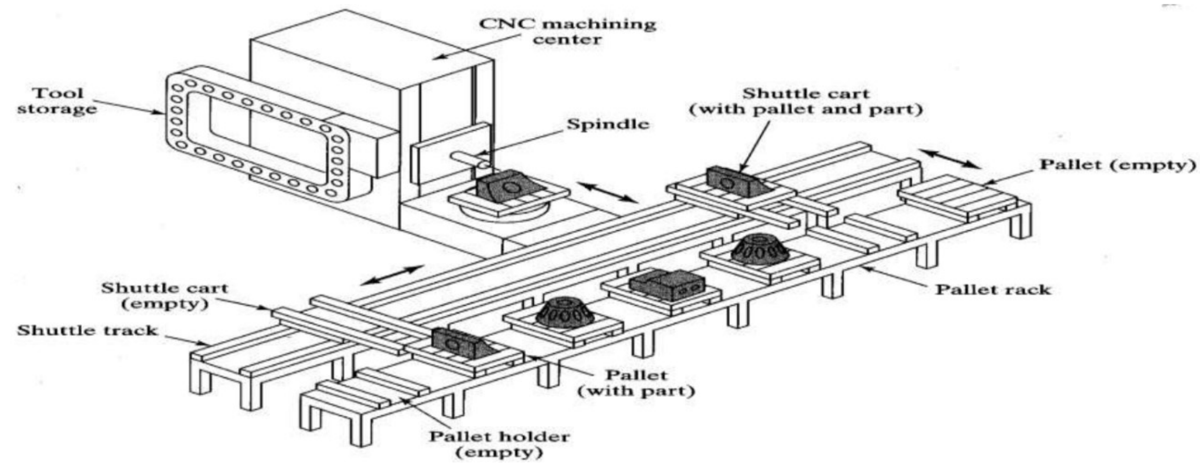
1. Random and independent movement of work parts between workstations
2. Handling of a variety of work part configurations
3. Temporary storage
4. Convenient access for loading and unloading of work parts
5. Compatible with computer control.



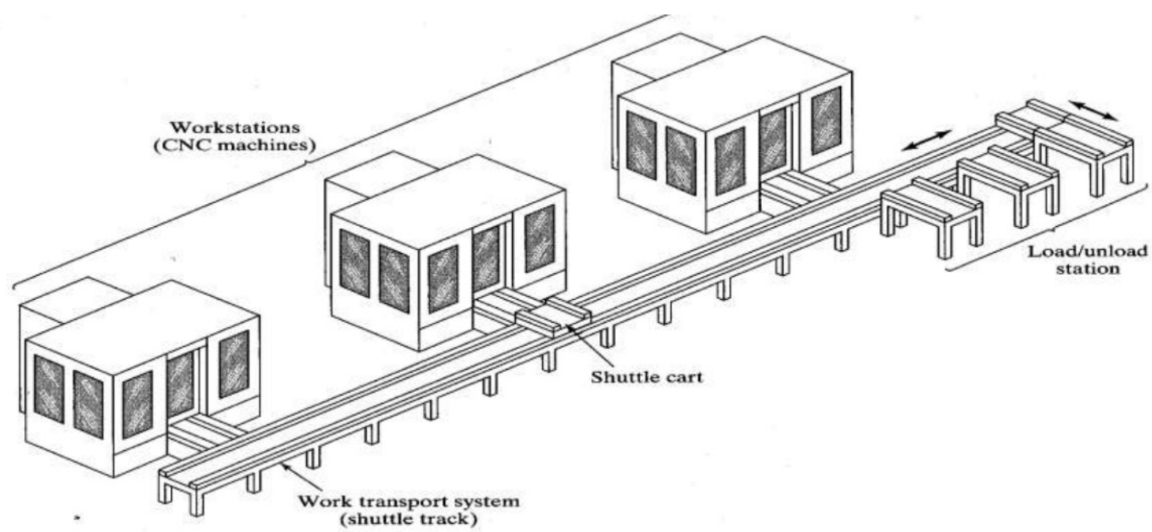
Computer Control System: It is used to coordinate the activities of the processing stations and the material handling system in the FMS. The various functions of computer control system are:
1. Control of each work station
2. Distribution of control instruction to work station
3. Production control
4. Traffic control
5. Shuttle control
6. Work handling system and monitoring
7. System performance monitoring and reporting

Types of FMS: FMS is designed for a specific application that is a specific family of parts and processes. Therefore each FMS is custom engineered, each FMS is unique.

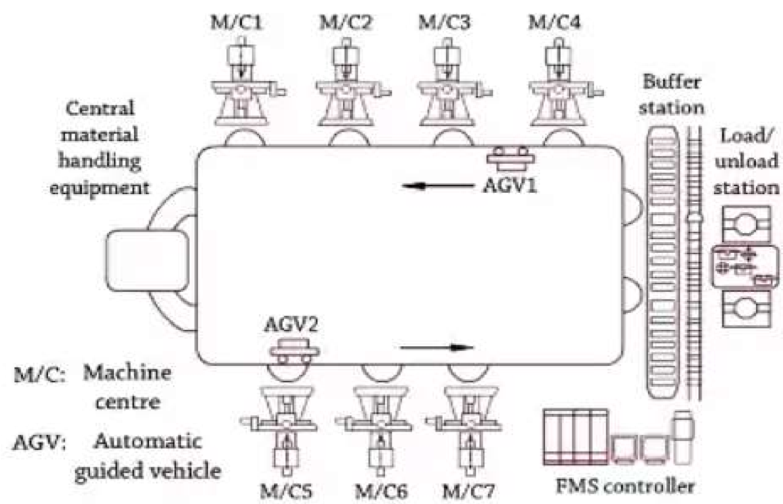
1. Single Machine Cell (SMC): It consists of one CNC machining centre combined with a parts storage system for unattended operation.



2. Flexible Manufacturing Cell (FMC): It entails two or three dispensing workstations and a material handling system. The material handling system is linked to a load/unload station.



3. Flexible Manufacturing System (FMS): It has four or more processing work stations (typically CNC machining Centre's or turning Centre's) connected mechanically by a common part handling system and automatically by a distributed computer system. It also includes non-processing work stations that support production but do not directly participate in it e.g., part / pallet washing stations, co-ordinate measuring machines. These features significantly differentiate it from Flexible manufacturing cell (FMC).



Report:

1. Make a code to perform the following operations:
    a) Move the blank work piece from AS/RS to workstation.
    b) Perform the turning operation in the workstation.
    c) Move the finished work piece from workstation to AS/RS.

2. Write a brief report on the above operation (Min 500 words).

Experiment 7: Robot programming for material handling system

Objective: To perform pick and place operation using a YASKAWA GP-12 industrial robot

Apparatus:

Sl. No.	Quantity	Nos.
1	Compressor Air Source	1
2	YASKAWA GP-12 Industrial robot	1
3	Power supply 3 Phase	1
4	Gripper for holding the cylinder	1
5	Pneumatic Tubes	-

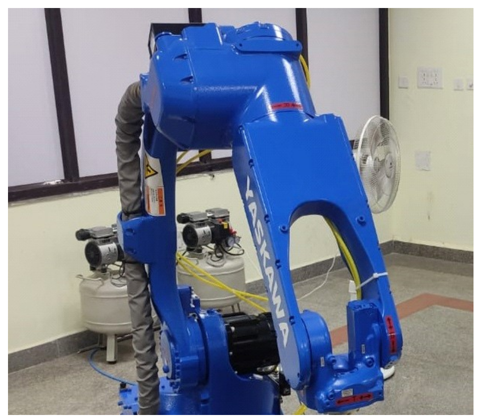
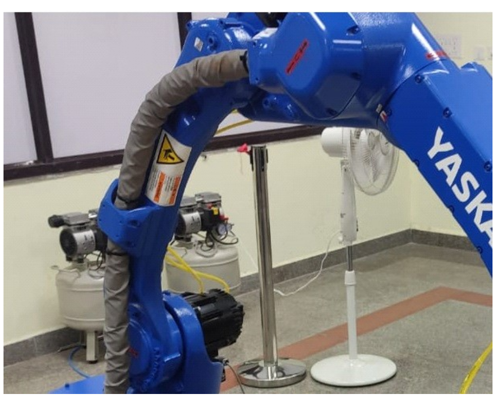


Fig: Picking up the job piece from the one desired position.



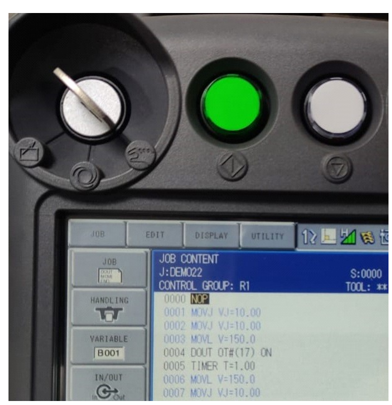


Fig: Placing the job piece **Fig: Programming in teach pendant**

Procedure:

- Calibrate the robot for the given grippers.
- Feed the programming code for pick and place using Teach Pendant.
- Place the object in the desired intial position.
- Jog the robot to the desired place sequentially and save its position with desired velocity in the JOB file.
- Place the GRIPPER ON and GRIPPER OFF input at the desired position in space with the TIMER.
- After teaching, test the programming code in TEACH mode.
- Change the mode of the robot to PLAY mode for the automatic operation.

Observation: The pick and place operation of an object through teach pendant and programming should be same.

Experiment 8: Circuit design for pneumatic systems used in Automation – Part 1

Objective: Design a pneumatic circuit diagram for control of a single-acting cylinder using AND / OR logic.

Apparatus:

Sl. No.	Quantity	Nos.
1	Compressor Air Source	1
2	Single-Acting Pneumatic Cylinder	1
3	Shuttle (OR) Valve and Dual Pressure (AND) Valve	1
4	3/2-Way Push Button operated DCV with Spring-Return	4
5	Tubes and Connectors	2
6	Junction box with slide valve	1
7	FRL with Pressure Gauge	1

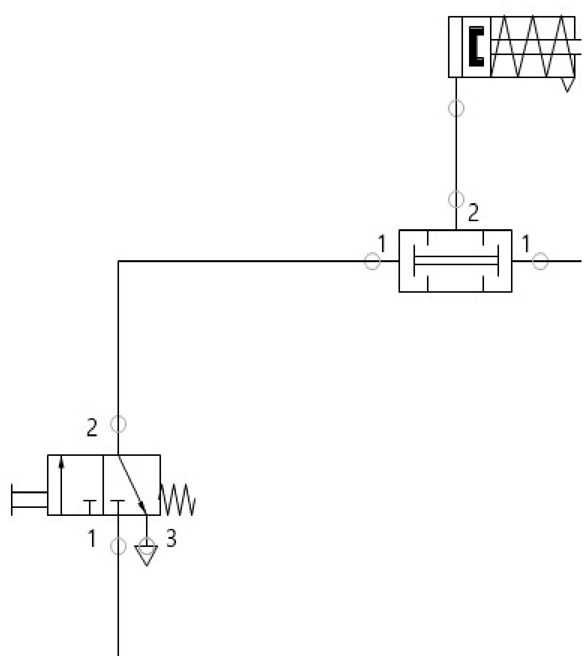


Fig: Pneumatic Circuit Diagram of AND Circuit.

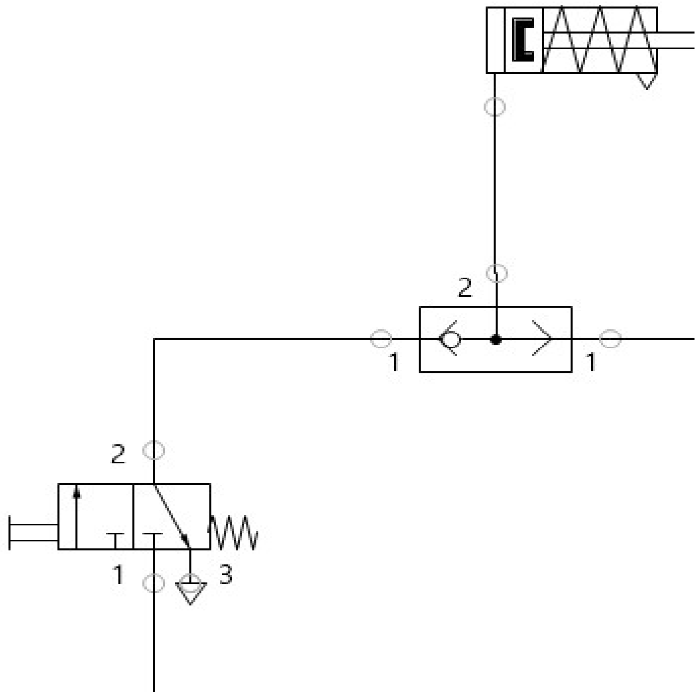


Fig: Pneumatic Circuit Diagram of OR Circuit.

Procedure:

- RUN the compressor and store the pressurized air in the receiver tank.
- Connect the FRL unit inlet to the Tank Outlet
- Make the Circuit Connection as per the circuit diagram for AND logic in Fig 1 and OR logic in Fig. 2.
- Turn ON the tank outlet valve and receive the pressurized air to the system.
- Regulate and set the required pressure (3 - 5 bar) using the FRL unit's regulator.
- Operate the slide valve of the junction and allow the air into the system.
- Observe the system's operation by actuating appropriate valves and controls.

Observation:

The Single Acting Cylinder should extend forward by pressing any one push button valve in case of an OR circuit and the same should only extend when both push button valves are pressed in case of AND circuit.

Precaution:

- Pneumatic components for the pneumatic circuit should be connected correctly.
- Do not leave the primary air pressure valve open after the experiment is done.
- Setting on air supply to medium pressure.
- Do not Unplug the pneumatic component during operation time.

Experiment 9: Circuit design for pneumatic systems used in Automation – Part 2

Objective Design a pneumatic circuit diagram for two pneumatic double acting reciprocating cylinders for sequences such as A+ B+ A- B-.

Apparatus:

Sl. No.	Quantity	Nos.
1	Compressor Air Source	1
2	Double-Acting Pneumatic Cylinder	2
3	Flow Control Valve	4
4	5/2-Way DCV Pilot Operated	2
5	3/2 NC Roller Lever Valve	4
6	Junction box with slide valve	1
7	FRL with Pressure Gauge	1

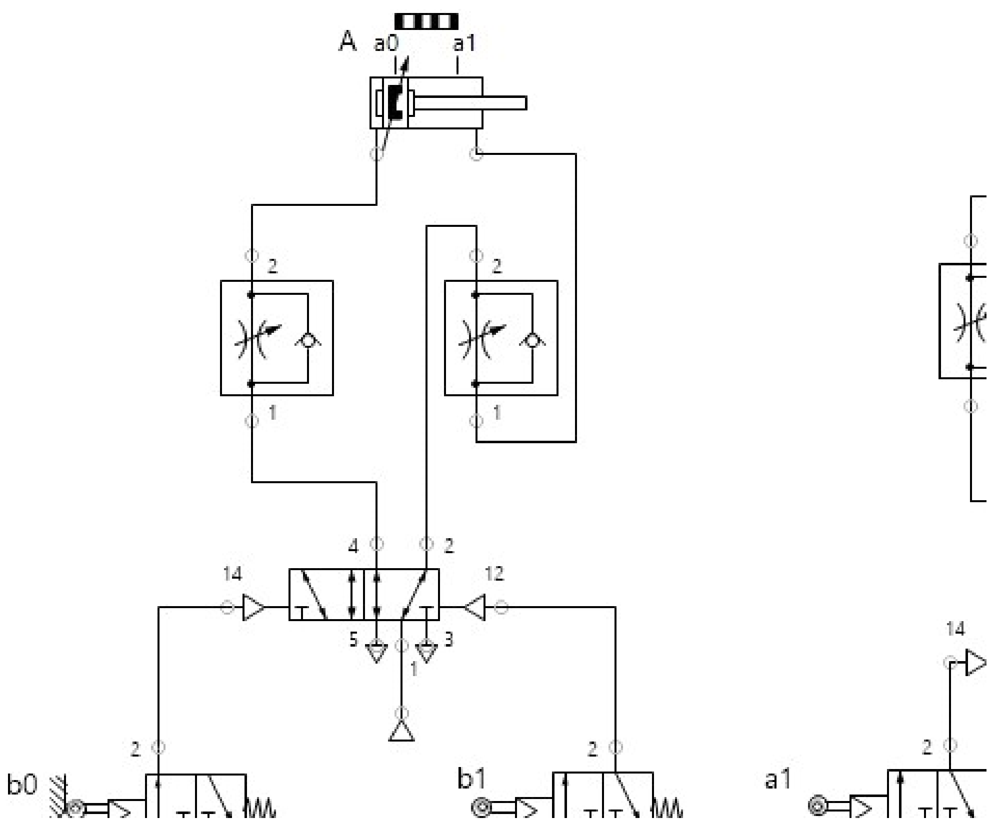


Fig: Pneumatic Circuit Diagram for sequences such as A+ B+ A- B-

Procedure:

- RUN the compressor and store the pressurized air in the receiver tank.
- Connect the FRL unit inlet to the tank outlet
- Make the circuit connection as per the diagram
- Turn ON the tank outlet valve and receive the pressurized air to the system
- Regulate and set the required pressure (3 - 5 bar) using the FRL unit's regulator
- Operate the slide valve of the junction and allow the air into the system
- Build the pneumatic circuit as per the given diagram as shown in Fig 3.
- Connect the pipes as per the pneumatic circuit given with the help of the components.
- Connect the signal tubes to get the desired sequence operation as shown in the diagram.
- Switch ON the junction box switch (Slide Valve).

Observation:

- The speed control circuits of double-acting cylinders are studied.
- The pneumatic circuit using a two-way pressure valve was constructed and executed.

Precaution:

- Pneumatic components for the pneumatic circuit should be connected properly.
- Do not leave the main air pressure valve open after the experiment is done.
- Setting on air supply to medium pressure.
- Do not Unplug the pneumatic component during operation time.