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JNANASANGAMA, BELAGAVI-590018

An Internship Report on

"CNC PROGRAMMING AND OPERATIONS"

Submitted in partial fulfillment for the award of degree of
Bachelor of Engineering
In
Mechanical Engineering
Submitted by

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Internship Carried Out at

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2021-22

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CERTIFICATE

This is to certify that the internship work entitled **"CNC PROGRAMMING AND OPERATIONS"** is a bonafide work carried out by

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In partial fulfillment for the award of **Bachelor of Engineering** in **Mechanical Engineering** of the **Visvesvaraya Technological University, Belagavi** during the year **2021-22**. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the departmental library. The internship report has been approved as it satisfies the academic requirements in respect of internship work prescribed for the said Degree.

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INTERNSHIP CERTIFICATE

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Internship Letter

Certificate of competency is awarded for completion of Internship Program in **CNC Programming and Operating.**

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From: 01-09-2021 **To:** 30-09-2021

Her performance, interest, character and conduct are consistently good during the training period.

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DECLARATION

I, Student of Mechanical Engineering, K. S. School of Engineering and Management, hereby declare that the internship report entitled **"CNC PROGRAMMING AND OPERATIONS"** embodies the record of the internship carried out at **GT&TC** under the guidance of **Dr Abhishek M R** and **Mr. Pradeep**, for the fulfillmentof the requirement of the award of the Degree of Bachelor of Engineering.

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CHAPTER 1

1.0 INTRODUCTION

Government Tool Room and Training Centre (GTTC) was established in 1972 at Bangalore with the participation from the State Government of Karnataka, in collaboration with Government of Denmark under the Bilateral Development Co-operation Agreement. The excellent performance of GTTC, Bangalore and proactive State Government of Karnataka led to expansion, and a second unit of GTTC was started in 1992 with DANIDA assistance at Mysore.

GTTC is meeting the needs of industries which are developing due to proliferation of new technologies by skilling the students as per the requirements.

State Government of Karnataka has encouraged GTTC to start 20 more sub-centers, 5 upcoming project centers and a skill development center to train in the area of Precision Manufacturing and Tool and Die Making in Karnataka.

GTTC is an autonomous society, a recognized Scientific and Research Organization by the Government of India. GTTC is serving the industry by providing well trained skilled manpower in the area of Tool and Die Making, Mechatronics and Electronics

GTTC having acquired mastery in Precision Manufacturing, mould, tool and die making technology, has blossomed into an epitome centre for precision quality. It develops and manufactures sophisticated Aerospace components, Moulds, Dies and Tools.

Fully aware of the rapid advancement in technology all over the world, GTTC periodically adds new technologies to the existing set of advanced equipment like CAD / CAM, CNC machines for tooling, Precision Components, Laser for Industries, Rapid prototyping, vacuum casting etc.

GTTC is concentrating on the Integrated Development of the related segments of industries by providing international quality tools, trained personal and consultancy in tooling and related areas. In future, the focus would be more on turnkey projects in Tooling, Aerospace components & their assemblies, and support the development of small and medium scale enterprises

1.1 SIEMENS

Siemens is a German multinational conglomerate corporation and the largest industrial manufacturing company in Europe headquartered in Munich with branch offices abroad.

The principal divisions of the corporation are Industry, Energy, Healthcare (Siemens Healthiness), and Infrastructure & Cities, which represent the main activities of the corporation. The corporation is a prominent maker of medical diagnostics equipment and its medical health-care division, which generates about 12 percent of the corporation's total sales, is its second-most profitable unit, after the industrial automation division. The corporation is a component of the Euro Stoxx 50 stock market index. Siemens and its subsidiaries employ approximately 303,000 people worldwide and reported global revenue of around €62 billion in 2021 according to its earnings release

1.2 Products, services and contribution

Siemens offers a wide range of electrical engineering- and electronics-related products and services. Its products can be broadly divided into the following categories: buildings-related products; drives, automation and industrial plant-related products; energy-related products; lighting; medical products; and transportation and logistics-related products.

Siemens buildings-related products include building-automation equipment and systems; building-operations equipment and systems; building fire-safety equipment and systems; building-security equipment and systems; and low-voltage switchgear including circuit protection and distribution products.

Siemens drives, automation and industrial plant-related products include motors and drives for conveyor belts; pumps and compressors; heavy duty motors and drives for rolling steel mills; compressors for oil and gas pipelines; mechanical components including gears for wind turbines and cement mills; automation equipment and systems and controls for production machinery and machine tools; and industrial plant for water processing and raw material processing.

Siemens energy-related products include gas and steam turbines; generators; compressors; on- and offshore wind turbines; high-voltage transmission products; power transformers; high-voltage switching products and systems; alternating and direct current transmission systems; medium-voltage components and systems; and power automation products.

In the renewable energy industry, the company provides a portfolio of products and services to help build and operate micro grids of any size. It provides generation and distribution of

electrical energy as well as monitoring and controlling of micro grids. By using primarily renewable energy, micro grids reduce carbon-dioxide emissions, which are often required by government regulations. It supplied a sustainable storage produce and s micro grid to Engel Produzione SPA for the island of Ventotene in Ital. k.

Siemens OSRAM subsidiary produces lighting products including incandescent, halogen, compact fluorescent, fluorescent, high-intensity discharge and Xenon lamps; opto-electronic semiconductor light sources such as light emitting diodes (LEDs), organic LEDs, high power laser diodes, LED systems and LED luminaries; electronic equipment including electronic ballasts; lighting control and management systems; and related precision components.

Siemens medical products include clinical information technology systems; hearing instruments; in-vitro diagnostics equipment; imaging equipment including angiography, computed tomography, fluoroscopy, magnetic resonance, mammography, molecular imaging ultrasound, and x-ray equipment; and radiation oncology and particle therapy equipment. As of 2015, Siemens finalized the sale of its hearing-aid (hearing instruments) business to Sivantos.

Siemens transportation and logistics-related products include equipment and systems for rail transportation including rail vehicles for mass transit, regional and long-distance transportation, locomotives, equipment and systems for rail electrification, central control systems, interlocking, and automated train controls; equipment and systems for road traffic including traffic detection, information and guidance; equipment and systems for airport logistics including cargo tracking and baggage handling; and equipment and systems for postal automation including letter parcel sorting.

1.3Computer-aided design (CAD)

CAD is the use of computers (or workstations) to aid in the creation, modification, analysis, or optimization of a design. This software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing

CAD software enables engineers and architects to design, inspect and manage engineering projects within an integrated graphical user interface (GUI) on a personal computer system. Most applications support solid modeling with boundary representation (BRep) and NURBS geometry, and enable the same to be published in a variety of formats. A geometric modeling

kernel is a software component that provides solid modeling and surface modeling features to CAD applications.

Based on market statistics, commercial software from Autodesk, Assault Systems, Siemens PLM Software, and PTC dominate the CAD industry. The following is a list of major CAD applications, grouped by usage statistics

1.4Commercial software

- AC3D
- Alibre Design
- ArchiCAD (Graphisoft)
- AutoCAD (Autodesk)
- Autodesk Inventor
- AxSTREAM
- BricsCAD
- CATIA (Dassault Systèmes)
- Cobalt
- CorelCAD
- Fusion 360 (Autodesk)
- IntelliCAD
- IRONCAD
- KeyCreator (Kubotek)
- Landscape Express
- MEDUSA
- MicroStation (Bentley Systems)
- Modelur (AgiliCity)
- Onshape
- Promine
- PTC Creo (successor to Pro/ENGINEER)
- PunchCAD
- Remo 3D
- Rhinoceros 3D
- Siemens NX

- SketchUp
- Solid Edge (Siemens)
- SolidWorks (Dassault Systèmes)
- SpaceClaim
- T-FLEX CAD
- TurboCAD
- Vectorworks (Nemetschek)

1.5Open-source software

- BRL-CAD
- FreeCAD
- LibreCAD
- OpenSCAD
- QCAD
- Salome (software)
- SolveSpace

1.6 Freeware

- BricsCAD Shape
- Tinkercad (successor to Autodesk 123D) CAD kernels
- ACIS by Spatial
- C3D Toolkit by C3D Labs
- Open CASCADE Open Source
- Parasolid by Siemens
- ShapeManager by Autodesk

CHAPTER 2

2.0Siemens NX

NX, formerly known as "unigraphics", is an advanced high-end CAD/CAM/CAE, which has been owned since 2007 by Siemens Digital Industries Software. In 2000, Unigraphics purchased SDRC I-DEAS and began an effort to integrate aspects of both software packages into a single product which became Unigraphics NX or NX.

It is used, among other tasks, for:

- Design (parametric and direct solid/surface modeling)
- Engineering analysis (static; dynamic; electro-magnetic; thermal, using the finite element method; and fluid, using the finite volume method).
- Manufacturing finished design by using included machining modules.
- NX is a direct competitor to CATIA, Creo, and Autodesk Inventor.

2.1 Key functions

- Computer-aided design (CAD) (Design)
- Parametric solid modeling (feature-based and directmodeling)
- Freeform surface modeling, class a surfaces.
- Reverse engineering
- Styling and computer-aided industrial design
- Product and manufacturing information (PMI)
- Reporting and analytics, verification
- Knowledge reuse, including knowledge-based engineering
- Sheet metal design
- Assembly modeling and digital mockup
- Routing for electrical wiring and mechanical piping
- Computer-aided engineering (CAE) (Simulation)
- Stress analysis / finite element method (FEM)
- Kinematics
- Computational fluid dynamics (CFD) and thermal analysis
- Computer-aided manufacturing (CAM) (Manufacturing)
- Numerical control (NC) programming

2.2 Supported operating systems and platforms

NX runs on Linux, Microsoft Windows and Mac OS.

Starting with version 1847, support for Windows versions prior to Windows 10 as well as for macOS was completely removed, and the GUI was removed from the Linux version.

2.3 Architecture

NX uses Para solid for its Geometric modeling kernel and D-Cubed as Associative engine for sketcher and assembly constraints as well as using JT (visualization format) for lightweight data and Multi-CAD

CHAPTER 3

3.0 MODELS

3.1 2D-MODELS

2D-modeling involves creating blueprints, drawings and plans in two dimensions. These documents can describe the basic layout of a site, and where objects are placed, but they don't include the dimension of depth. These 2D plans can be created on paper or in computer programs that are designed for creating models in two dimensions.

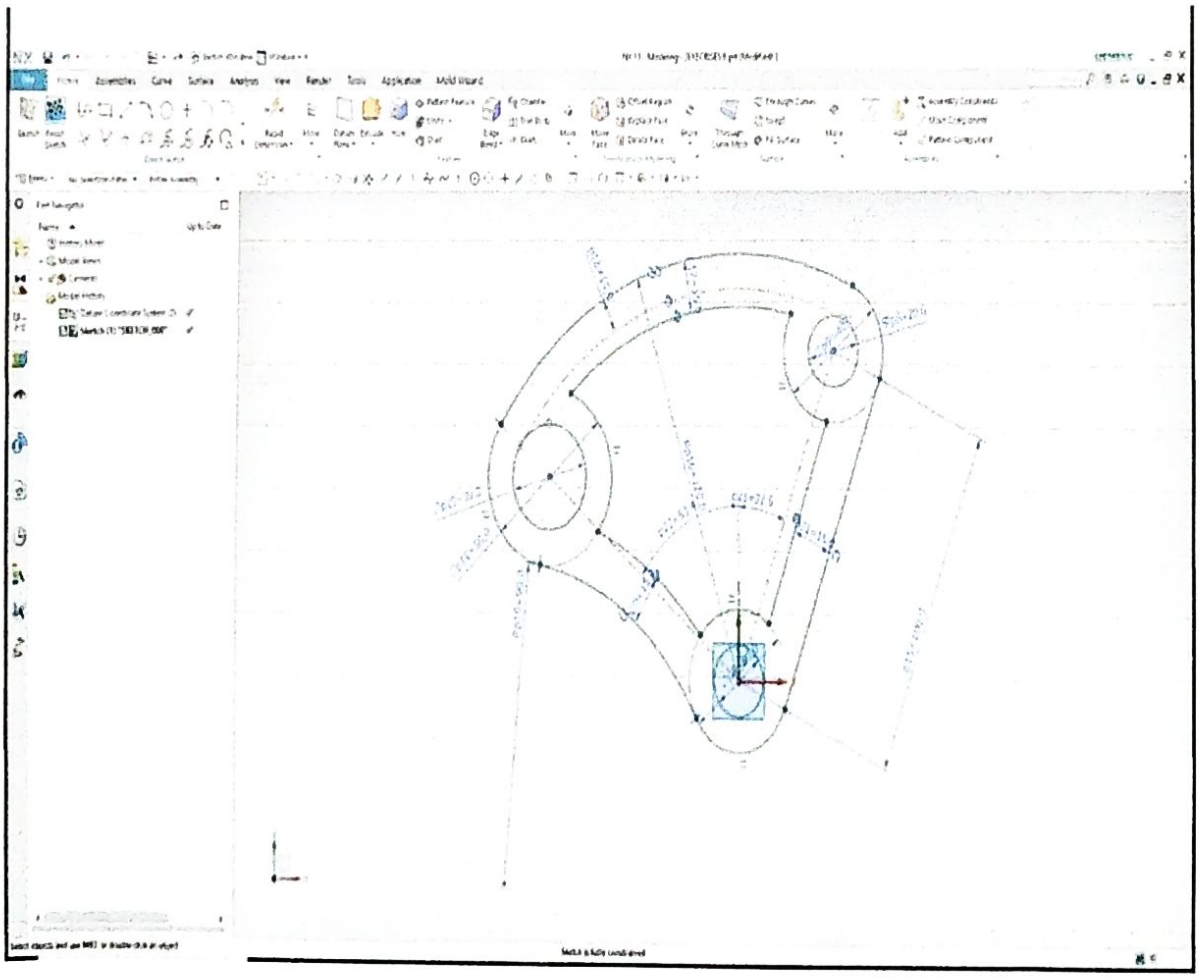


Fig. 3.1 2d model

3.2 3D Model

3D-modeling is a precise workflow often involving the painstaking placement of individual vertices to achieve the correct contours of the desired object. The exterior of the mesh is composed of polygons which can be subdivided into smaller shapes to create more detail. These subdivisions are especially necessary if the 3D model is to be animated.

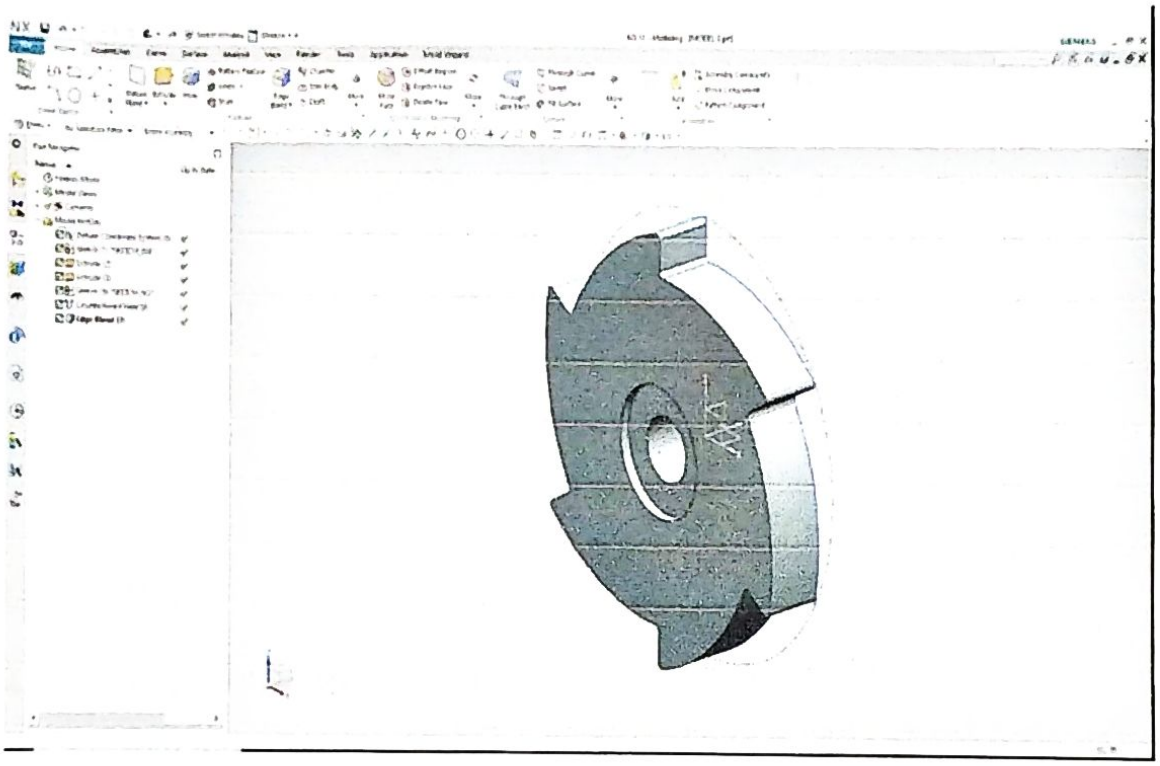


Fig. 3.2 3D model

3.3 Assembly Model

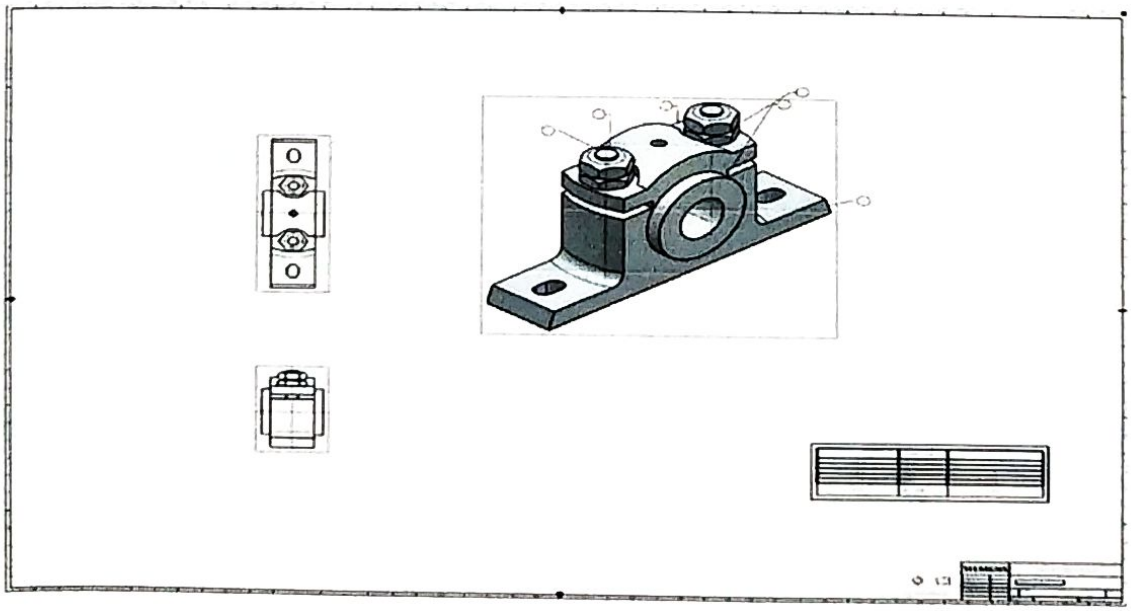


Fig. 3.3 Assembly model

Assembly modeling is a technology and process of using CAD (computer-aided design) and product visualization software to design components of a product. Each component within an assembly is represented as surface models.

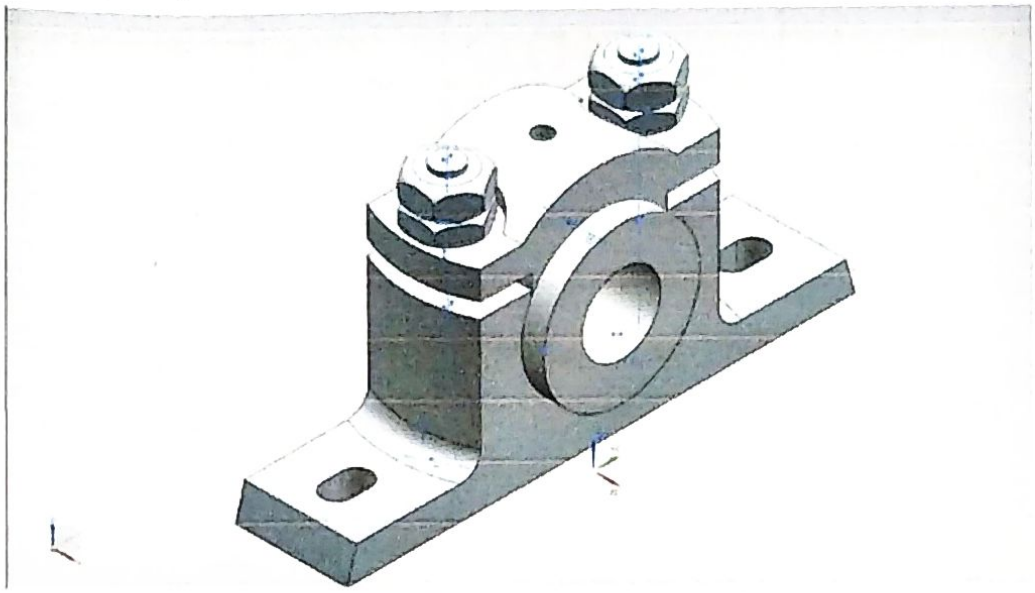


Fig 3.3.1 assembly model

CHAPTER 4

4.0NC AND CNC PROGRAMMING

4.1 NC PROGRAMMING

Numerical control (NC) systems are hardware controls in which most of functions are carried out by electronic hardware based upon digital circuit technology. Numerical Control is a technique for controlling machine tools or processes using coded command instructions. These coded command instructions are interpreted and converted by NC controller into two types of signals namely; motion control signals and miscellaneous control signals. Motion control signals are a series of electric pulse trains that are used to control the positions and the speed of the machine table and spindle, whereas miscellaneous control signals are set of ON/OFF signals to execute the spindle rotation and direction, control of coolant supply, selection of cutting tools, automatic clamping and unclamping, etc. In motion control signals, each pulse activates a motion of one basic length-unit (BLU).

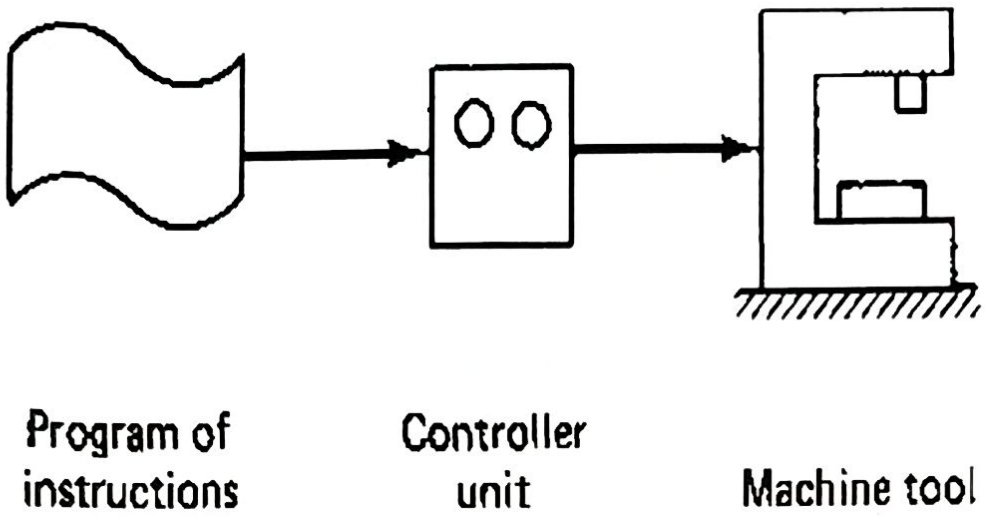


Fig. 4.1 basic elements of NC machine

4.2 Introduction to CNC Programming

A part program is a series of coded instructions required to produce a part. It controls the movement of the machine tool and the on/off control of auxiliary functions such as spindle rotation and coolant. The coded instructions are composed of letters, numbers and symbols and are arranged in a format of functional blocks as in the following example

N10 G01 X5.0 Y2.5 F15.0

| | | | |

| | | | Feed rate (15 in/min)

| | | Y-coordinate (2.5")

| | X-coordinate (5.0")

| Linear interpolation mode

Sequence number

4.3 Important things to know:

- Axis Codes: X,Y,Z - Used to specify motion of the slide along X, Y, Z direction.
- Feed and Speed Codes: F and S- Specify feed and spindle speed.
- Tool codes: T – specify tool number
- Units, incremental or absolute positioning
- Coolant Control: On/Off, Flood, Mist

4.4 A CNC system consists of the following 6 major elements:

- Input Device
- Machine Control Units
- Machine Tool
- Driving System
- Feedback Devices
- Display Unit

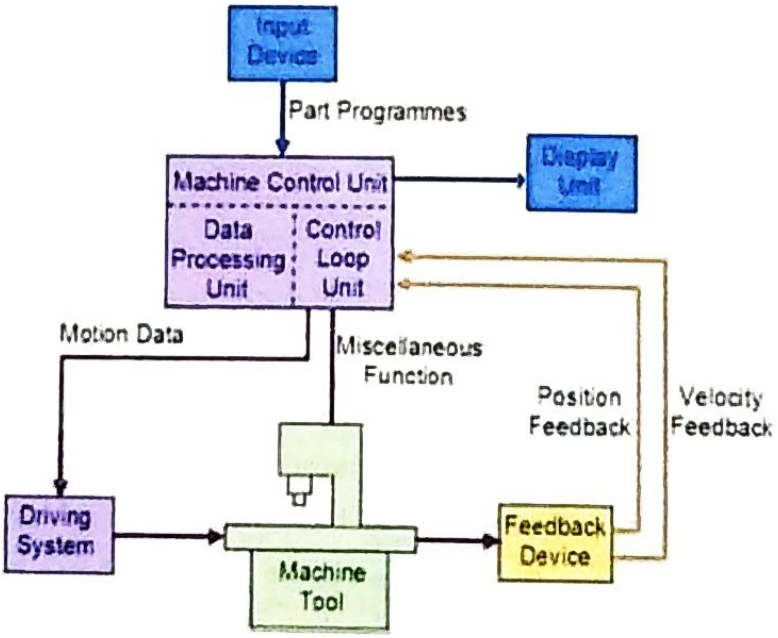


Fig. 4.2 components of CNC

4.4.1 PROGRAMME INPUT DEVICE

- The program input device is the means for part program to be entered into the CNC control

- Three commonly used program input devices are punch tape reader, magnetic tape reader.

4.4.2 Machine Control Unit

The machine control unit (MCU) is the heart of a CNC system. It is used to perform the following functions:

It read the coded instructions, decode the coded instructions. Implement interpolations (linear, circular, and helical) to generate axis motion commands. and feed the axis motion commands to the amplifier circuits for driving the axis mechanisms. And it receives the feedback signals of position and speed for each drive axis. To implement auxiliary control functions such as coolant or spindle on/off and tool change.

4.4.3 Machine Tool

CNC controls are used to control various types of machine tools. Regardless of which type of machine tool is controlled, it always has a slide table and a spindle to control position and speed. The machine table is controlled in the X and Y axes, while the spindle runs along the Z axis.

4.4.4 Feedback System

The feedback system is also referred to as the measuring system It uses position and speed transducers to continuously monitor the position at which the cutting tool is located at any particular instant. The MCU uses the difference between reference signals and feedback signals to generate the control signals for correcting position and speed errors.

4.4.5 Drive System

Drives are used to provide controlled motion to CNC elements drive system consists of amplifier circuits, drive motors, and ball lead-screws. The MCU feeds the control signals (position and speed) of each axis to the amplifier circuits.

4.5 How to write CNC Programming

- Programming consists of a series of instructions in form of letter codes
- Preparatory Codes
- G codes- Initial machining setup and establishing operating conditions
- N codes- specify program line number to executed by the MCU
- M codes- specify for miscellaneous function or machining function
- Each letter address relates to a specific machine function. "G" and "M" letter addresses are two of the most common. A "G" letter specifies certain machine preparations such as inch or metric modes, or absolutes versus incremental modes.
- A "M" letter specifies miscellaneous machine functions and work like on/off switches for coolant flow, tool changing, or spindle rotation. Other letter addresses are used to direct a wide variety of other machine commands.

4.6 ISO MACHINE TOOL AXIS DEFINATION

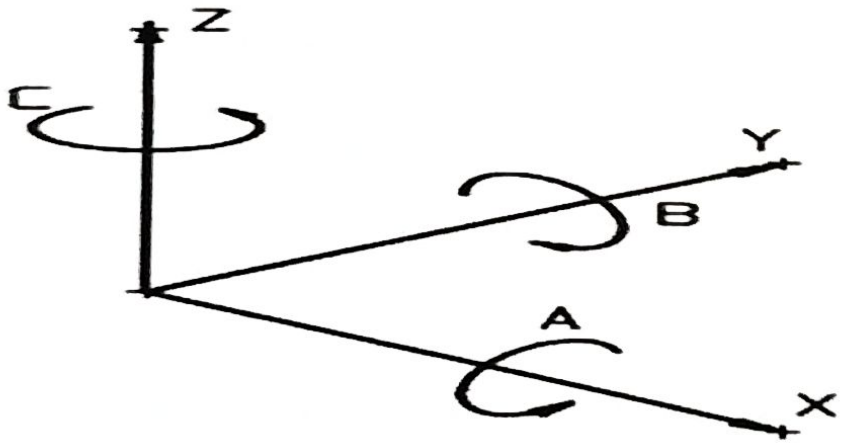


Fig. 4.3 machine tool axis

- ISO machine tools mainly having 3 axes for machining conditions.
- X axes which is called as Longitudinal axes.
- Y axes which is called as cross axes.
- Z axes which takes the Tool & Work piece in contact for machining.
- In addition of the above linear movement along the X, Y and Z axes it is possible to control rotation around each axes. This controllable axes are marked as A, B and C

4.7 RIGHT HAND THUMB RULE

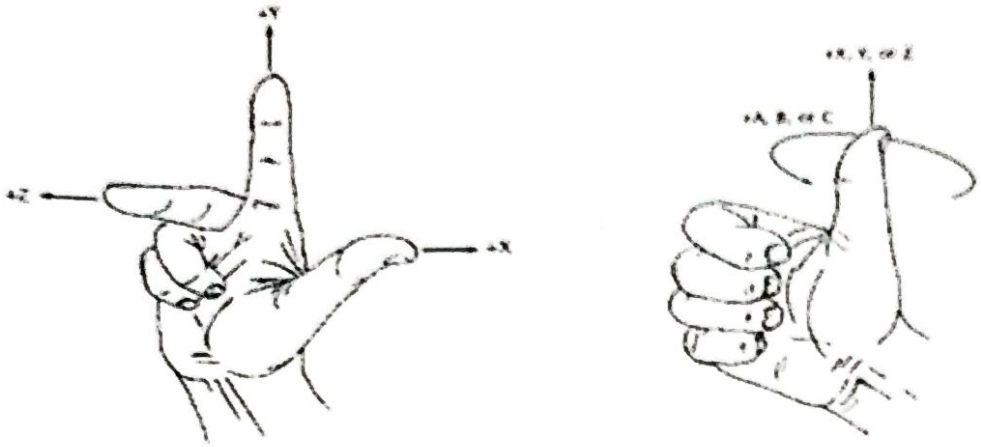


Fig. 4.4 Right hand thumb rule

- As per right hand rule The Thumb defines +X Direction.
- The middle finger shows +Z Direction.
- The Index finger defines +Y Axes Direction.
- To determine the positive, or clockwise, direction about an axis, close your hand with the thumb pointing out.
- The thumb may represent the X, Y, or Z direction and the curl of the fingers may represent the clockwise, or positive, rotation about each axis.
- These are known as A, B, and C and represent the rotary motions about X, Y, and Z, respectively

CHAPTER 5

5.0 COORDINATE SYSTEMS IN NC PROGRAM

5.1 Types of coordinate system:

Coordinate system enables the exact description of all points on a work plane or room.

Basically there are two types of coordinate system.

1. Cartesian Coordinate system
2. Polar Coordinate system

We are having 2 types of dimensioning methods to describe the Points in both above Coordinate systems which are:

1. Absolute Dimensioning
2. Incremental Dimensioning

5.1.1 CARTESIAN COORDINATE SYSTEM

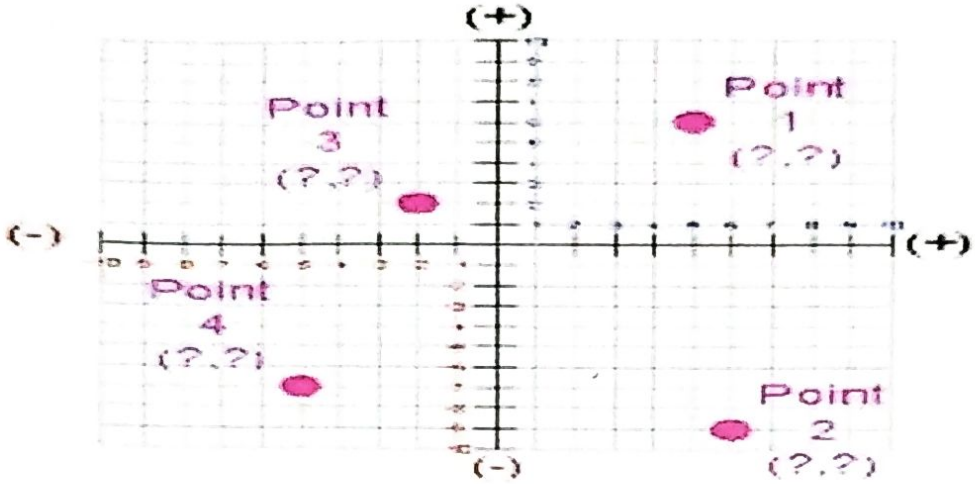


Fig. 5.1 Cartesian co-ordinate system.

We have already learned this type of coordinate system in primary class. A Cartesian coordinate system, also called rectangular coordinate system includes for the exact description of the points.

1. 2D coordinate system
2. 3D coordinate system

5.2 2D-COORDINATE SYSTEM

In the two-dimensional coordinate system e.g. in the X, Y coordinate system, each point on the plane is explicitly defined. The distance from the y axis is called the x coordinate and the distance from the X axis is called Y coordinate. These coordinate have a positive or a negative sign.

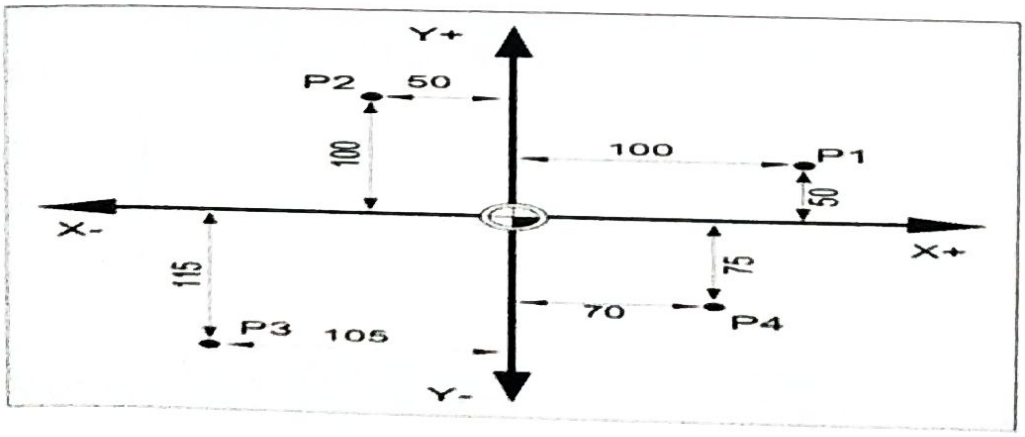


Fig. 5.2 2D coordination system

Position of points

5.3 3D-COORDINATE SYSTEM

In the Three-dimensional coordinate system e.g. in the X, Y & Z coordinate system, each point on the plane is explicitly defined with its height or depth the distance from the y axis is called the x coordinate and the distance from the X axis is called Y coordinate. Distance from the top to depth is defined as Z axis. These coordinate have a positive or a negative sign.

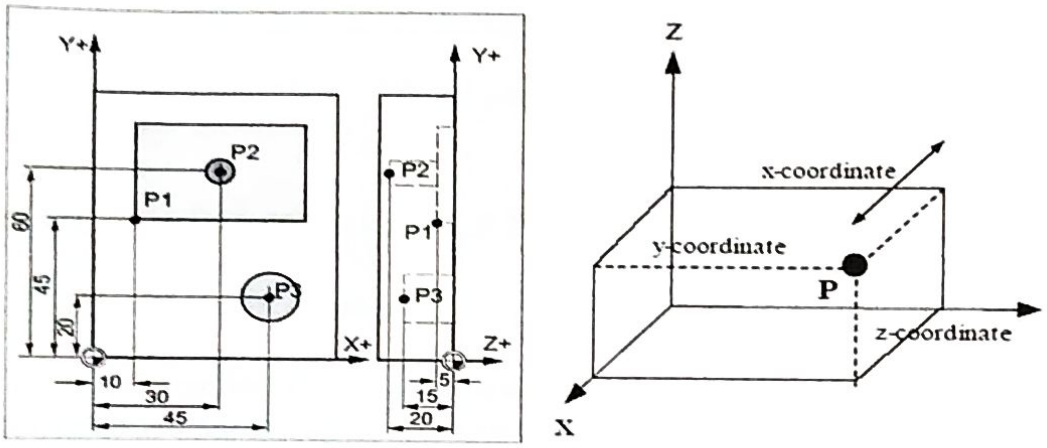


Fig 5.3 3D co-ordinate system.

Position of points

- P1 X+10 Y+45 Z-5
- P2 X+30 Y+60 Z-20
- P3 X+45 Y+20 Z-15

5.4 POLAR COORDINATE SYSTEM

The polar coordinate can be used instead of Cartesian coordinate to describe the work piece point positions. This is useful when points of work piece are going to be dimensioned with radius or angle. The point from which dimension starts is called "Pole".

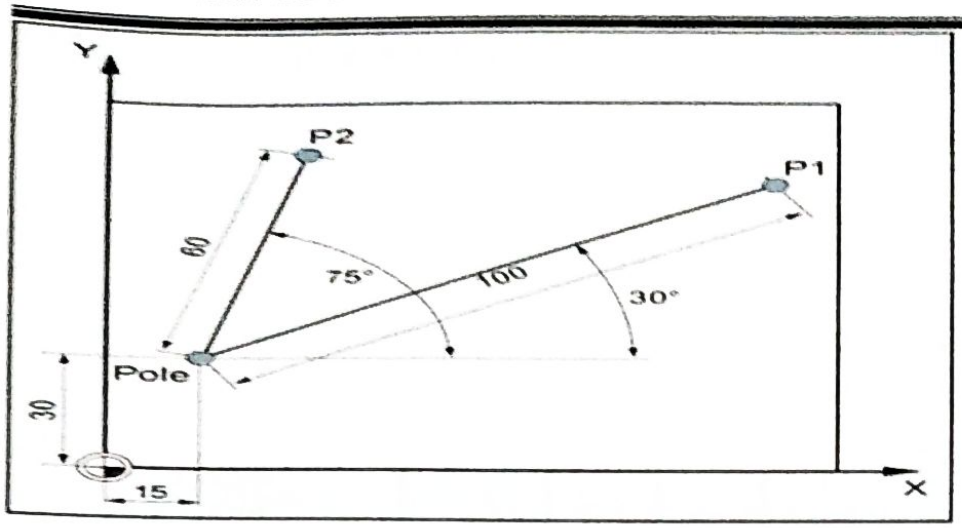


Fig. 5.4 polar co-ordinate system.

5.5 ABSOLUTE WORKPIECE DIMENSIONING

5.5.1 Absolute programming:

In this mode, the desired target position of the tool for a particular move is given relative to the origin point of the program.

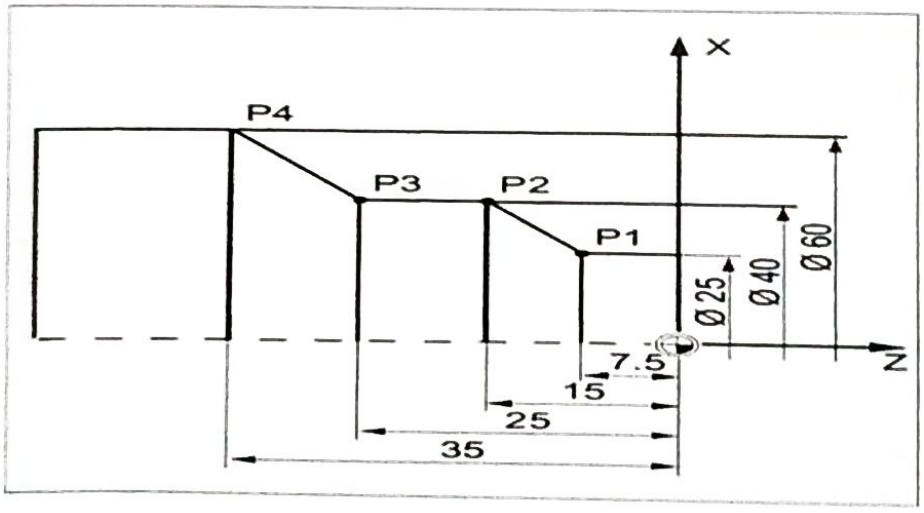


Fig. 5.5 absolute programming

5.5.2 Incremental programming:

In this mode, the next target position for the tool is given relative to the current tool position

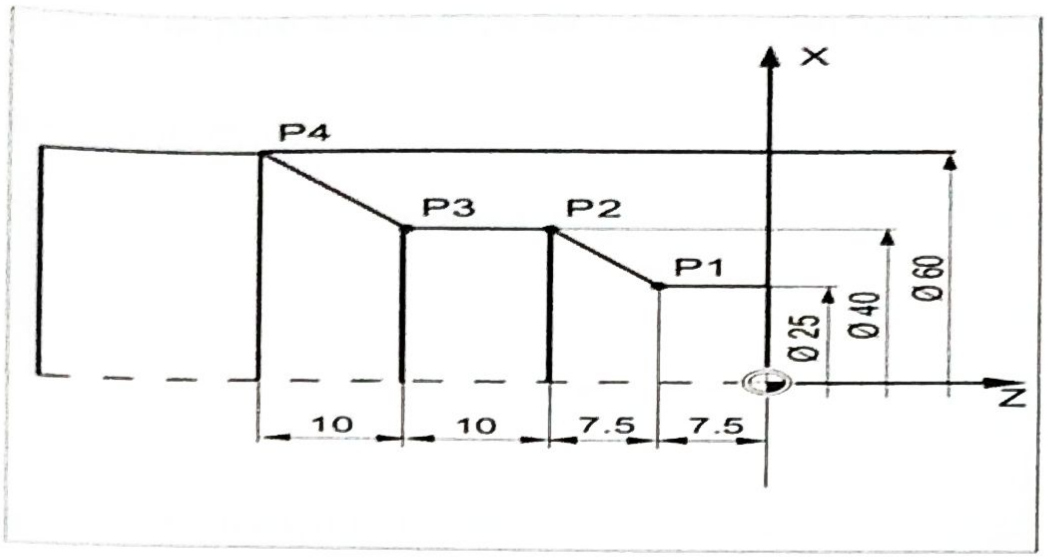


Fig. 5.6 Incremental programming.

5.6 AUTOMATIC TOOL CHANGER (ATC)

An Automatic tool changer or ATC is used in computerized numerical control (CNC) machine tools to improve the production and tool carrying capacity of the machine. ATC changes the tool very quickly, reducing the non-productive time. Generally, it is used to improve the capacity of the machine to work with a number of tools. It is also used to change worn out or broken tools. It is one more step towards complete automation.

Simple CNC machines work with a single tool. Turrets can work with a large number of tools. But if even more tools are required, then ATC is provided. The tools are stored on a magazine. It allows the machine to work with a large number of tools without an operator. The main parts of an automatic tool changer are the base, the gripper arm, the tool holder, the support arm and tool magazines. Although the ATC increases the reliability, speed and accuracy, it creates more challenges compared to manual tool change, for example the tooling used must be easy to center, be easy for the changer to grab and there should be a simple way to provide the tool's self-disengagement. Tools used in ATC are secured in toolholders specially designed for this purpose.

After receiving the tool change command, the tool to be changed will assume a fixed position known as the "tool change position". The ATC arm comes to this position and picks up the tool. The arm swivels between machine turret and magazine. It will have one gripper on each of the two sides. Each gripper can rotate 90°, to deliver tools to the front face of the turret. One will pick up the old tool from turret and the other will pick up the new tool from the magazine. It then rotates to 180° and places the tools into their due position.

The use of automatic changers increases the productive time and reduces the unproductive time to a large extent. It provides the storage of the tools which are returned automatically to the machine tool after carrying out the required operations, increases the flexibility of the machine tool. makes it easier to change heavy and large tools, and permits the automatic renewal of cutting edges.

5.7 CONTROL PANEL OF CNC

Fig. 5.7 Control panel.

A CNC machine is normally controlled by a computer and software. However, most CNC machines have a range of controls for manual use. It is rare for a CNC machine to be used manually as simple operations are best carried out on cheap/basic/manual machines. When a CNC machine is used manually it is being used well below its capability and specification.

5.7.1 Reset Button

The most important control button is usually the reset button. When the CNC machine is turned on, the reset button is pressed by the machine operator. This zero the cutter, moving the cutter to coordinates 0, 0, 0 on the X, And Z axis. In simple

terms, the reset button moves the cutter to the corner of the machine, above the work table.

5.7.2 Manual Control

The cutter can be controlled manually although this is rarely needed. The 'X' and 'Y' buttons control the movement of the cutter along the horizontal surfaces. The 'Z' buttons control depth and up / down movement.

5.7.3 STOP BUTTON: Most control panels have stop buttons. When pressed these stop the machine very quickly.

5.7.4 Speed and Feed

On some CNC machines it is possible to manually vary the speed and feed of the cutter.

CHAPTER 6

6.0 PROGRAME STRUCTURE

general, several commands are grouped together to accomplish a specific machining operation, hence the use of a block of information for each operation. Each command gives a specific element of control data, such as dimension or a feed rate. Each command within a block is also called a word. The way in which words are arranged within the block is called block format. Three different block formats are commonly used, (Fixed sequential format, Tab sequential format and Word address format) With this type of format, each type of word is assigned as address that is identified by a letter code within the part program. Thus, the letter code specifies the type of word that follows and then its associated numeric data is given. For example, the code T represents a tool number. Thus, a word of the form T01 would represent tool number 1. Theoretically, with this approach, the words in a given block can be entered in any sequence and the controller should be able to interpret them correctly. With the word address format only, the needed words for a given operation have to be included within the block. The command to which the particular numeric data applies is identified by the preceding address code. Word format has the advantage of having more than one particular command in one block something that would be impossible in the other two formats.

- N-CODE: Sequence number, used to identify each block with in an NC program and provides a means by which NC commands may be rapidly located. It is program line

number.It is a good practice to increment each block number by 5 to 10 to allow additional blocks to be inserted if future changes are required.

- G-CODE: Preparatory Word, used as a communication device to prepare the MCU. The G-code indicates that a given control function such as G01, linear interpolation, is to be requested.
- X,Y &Z co-ordinates. These give the coordinate position of the tool
- Commonly word addresses F-code: Feed rate. The F code specifies the feed in the machining operation
- S-CODE: Spindle speed. The S code specifies the cutting speed of the machining process.
- T-CODE: Tool selection. The T code specifies which tool is to be used in a specific operation.
- M-CODE: Miscellaneous function. The M code is used to designate a particular mode of operation for an NC machine tool.
- I, J & K-CODES: They specify the centre of arc coordinates from starting.

6.1 PREPERATORY (G) CODES

- G00 Rapid Positioning Motion
- G01 Linear Interpolation Motion
- G02 Circular Interpolation Motion CW
- G03 Circular Interpolation Motion CCW
- G04 Dwell (P) (P=Seconds"." Milliseconds)
- G09 Exact Stop, Non-Modal
- G17 Circular Motion XY Plane Selection (G02 or G03)
- G18 Circular Motion ZX Plane Selection (G02 or G03)
- G19 Circular Motion YZ Plane Selection (G02 or G03)
- G20 Inch Coordinate Positioning
- G21 Metric Coordinate Positioning
- G28 Machine Zero Return Thru Ref. Point
- G29 Move to Location Through G28 Ref. Point
- G40 Cutter Comp Cancel G41/G42/G141
- G41 2D Cutter Compensation, Left
- G42 2D Cutter Compensation, Right

- G43 Tool Length Compensation
- G49 Tool Length Compensation Cancel G43/G44/G43
- G52 Work Offset Positioning Coordinate
- G53 Machine Positioning Coordinate, Non-Modal
- G54 Work Offset Positioning Coordinate (Setting 56)
- G55 Work Offset Positioning Coordinate
- G56 Work Offset Positioning Coordinate
- G57 Work Offset Positioning Coordinate
- G58 Work Offset Positioning Coordinate
- G59 Work Offset Positioning Coordinate
- G73 HS Peck Drilling Canned Cycle
- G74 Reverse Tapping Canned Cycle
- G76 Fine Boring Canned Cycle
- G77 Black Bore Canned Cycle
- G80 Cancel Canned Cycle (Setting 56)
- G81 Drill Canned Cycle
- G82 Spot Drill / Counterbore Canned Cycle
- G83 Peck Drill Deep Hole Canned Cycle
- G84 Tapping Canned Cycle
- G85 Bore In ~ Bore Out Canned Cycle
- G86 Bore In ~ Stop ~ Rapid Out Canned Cycle
- G87 Bore In ~ Manual Retract Canned Cycle
- G88 Bore In ~ Dwell ~ Manual Retract Canned Cycle
- G89 Bore In ~ Dwell ~ Bore Out Canned Cycle
- G90 Absolute Positioning Command
- G91 Incremental Positioning Command
- G92 Global Work Coordinate System
- G93 Inverse Time Feed Mode ON
- G94 Inverse Time Feed OFF / Feed Per Minute ON
- G98 Canned Cycle Initial Point Return
- G99 Canned Cycle R Plane Return

6.2 MACHINE (M) CODES

Miscellaneous function

- M00 Program Stop
- M01 Program Optional Stop
- M03 Spindle in Clock-wise direction
- M04 Spindle in Counter Clock-wise
- M05 Spindle Stop
- M06 Tool Change at Home Position
- M08 Coolant On
- M09 Coolant Off
- M16 Tool Change at any position
- M17 Subprogram end
- M30 Program End & Reset
- M31 Chip Auger Forward
- M33 Chip Auger Stop
- M34 Coolant Spigot Position Down, Increment
- M35 Coolant Spigot Position Up, Decrement
- M36 Pallet Part Ready
- M41 Spindle Low Gear Override
- M42 Spindle High Gear Override
- M50 Execute Pallet Change
- M83 Auto Air Jet ON
- M84 Auto Air Jet OFF
- M88 Coolant Through Spindle ON
- M97 Local Sub-Program Call (P, L)
- M98 Sub-Program Call (P, L)
- M99 Sub-Program / Routine Return of Loop (P)

6.3 EXPLANATION OF LETTERS IN CNC PROGRAMMING

- F Feed as per G94 or G95
- G Preparatory Function

- DIAMON Diameter Input
- DIAMOF Radius Input
- I Interpolation Parameter related to X axis
- J Interpolation Parameter related to Y Axis
- K Interpolation Parameter related to Z axis
- L Subroutine name and Call
- N Block Number of auxiliary Block
- CR Radius for Circular Interpolation
- AR Aperture angle for Circular Interpolation
- P Number of sub-Routine Cycle repeats
- S Spindle Speed
- T Tool Number
- X Axis
- Y Axis
- Z Axis
- AC Absolute Co-ordinate
- IC Incremental Co-ordinate
- ANG Angle for Specification of a straight line in contour definition
- CHR Chamfer at corner side
- CHF Chamfer insert Chamfer Length
- RND Ram Dings
- D Tool Offset Number

6.4 EXPLANATION ORDER OF THE CNC PROGRAMME STATEMENT

In order to keep the block structure as clear as possible the statement must be programmed in this below manner:

- N.. G... X... Y... Z... F... S... T... D... M... H...;
- Here ";" means end of current block Note: All the codes are must be entered bfore the "end of block" for present block.

- CALCULATIONS IN CNC PROGRAMMING In CNC machine Programming Feed, Speed, machining times are calculated by some formulas, every calculation having some unit they are: CS Cutting Speed "meter/min".
- Speed Revolution/minute "rpm" Feed "mm/min" or "mm/rev". Machining Time minute.

6.5 CNC MACHINE START PROCEDURE

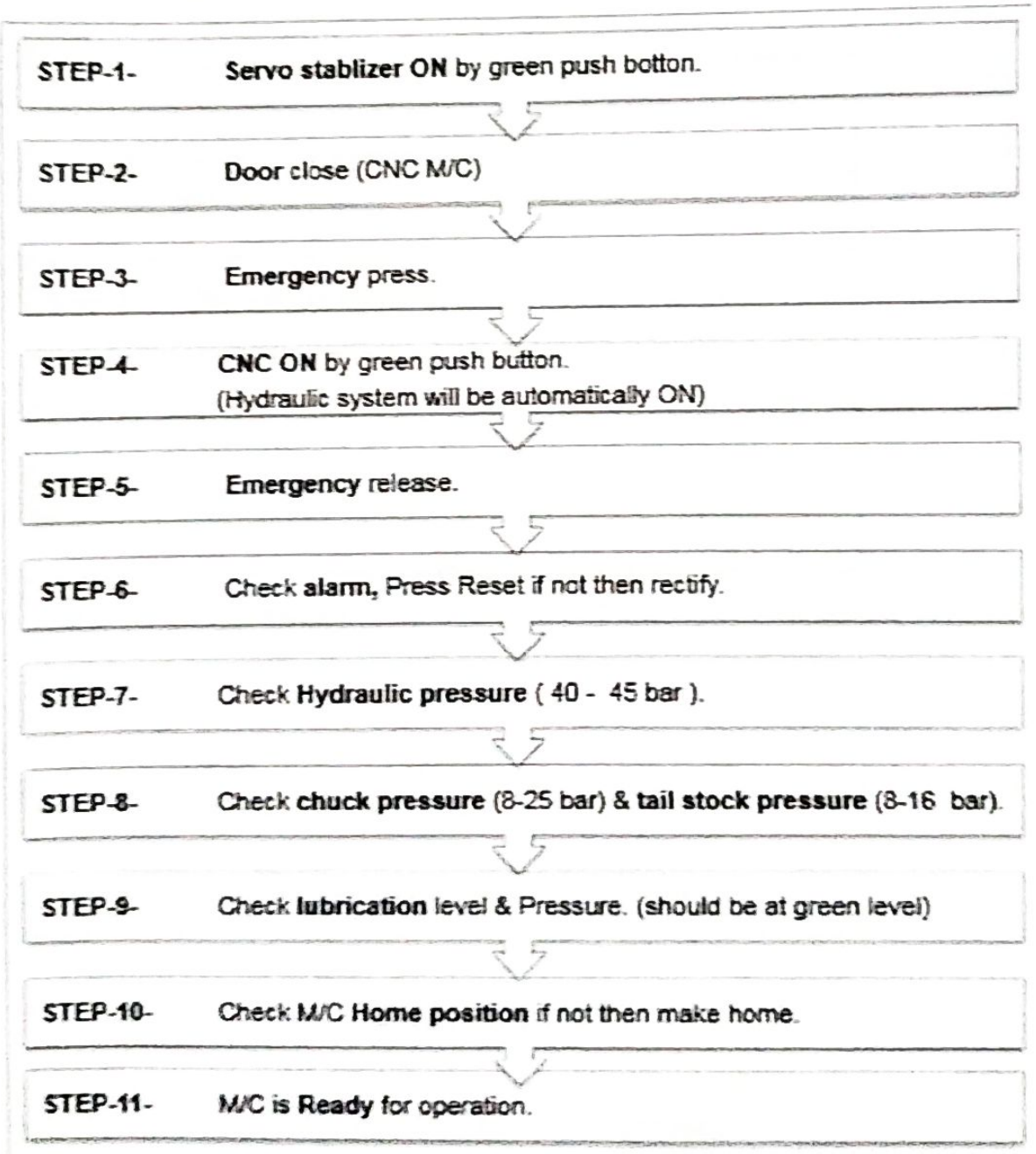


Fig. 6.1 CNC start procedure.

6.6 METHOD OF INSERTING NEW PROGRAM

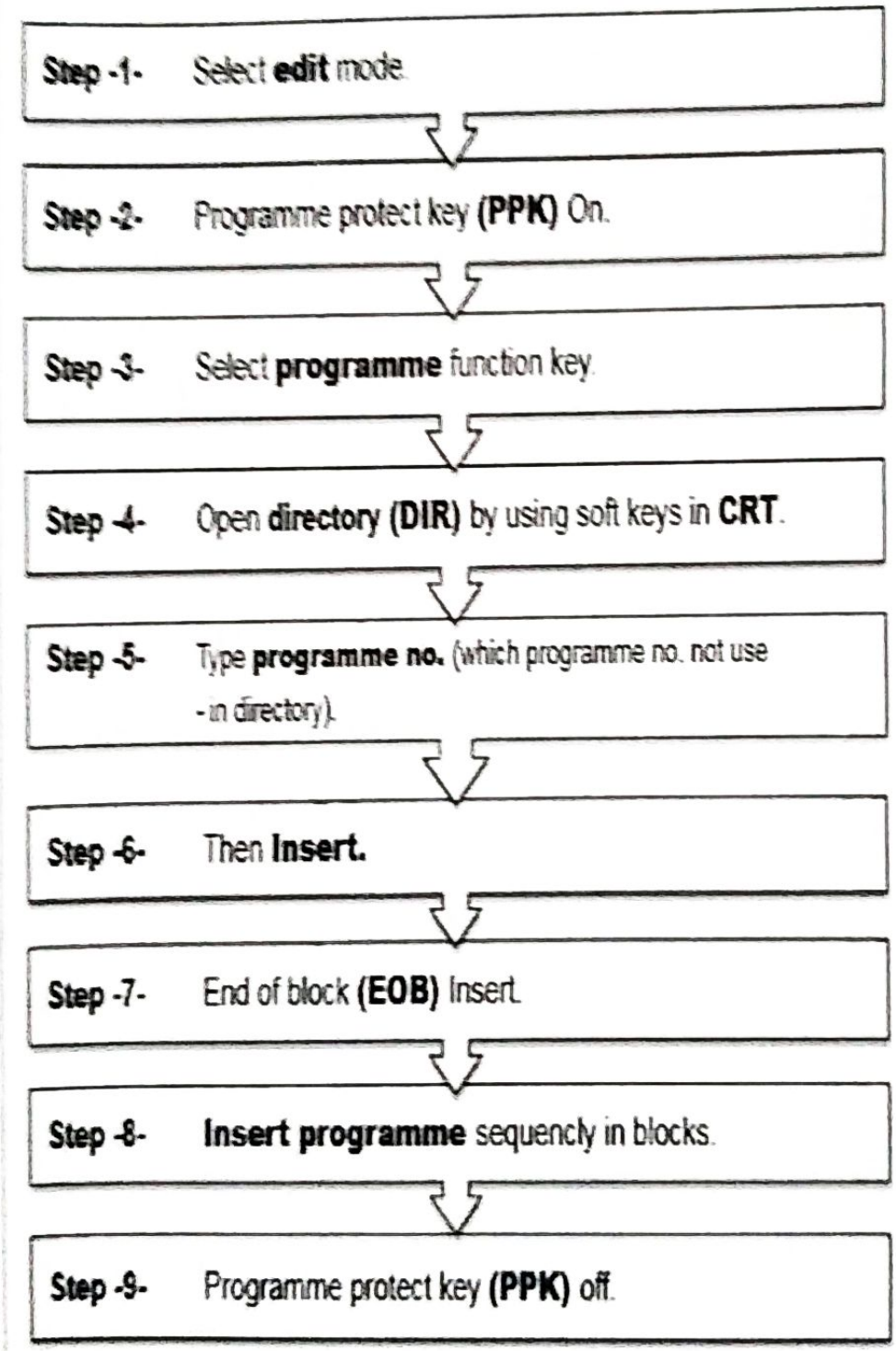


Fig. 6.2 methods of inserting new program

CHAPTER 7

7.1 SAMPLE PROGRAM OF TURNING MODEL

Write an ISO program for step turning operation of the component shown in figure using canned cycles. The diameter of the work piece = 30mm

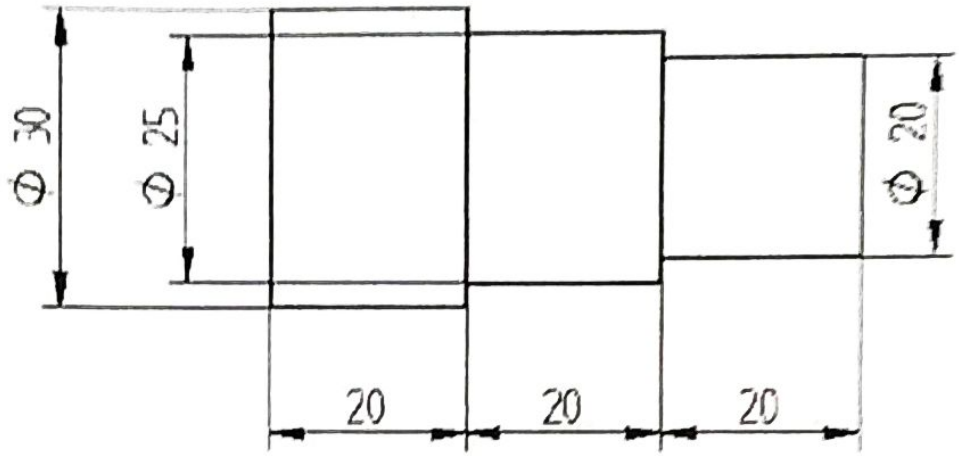


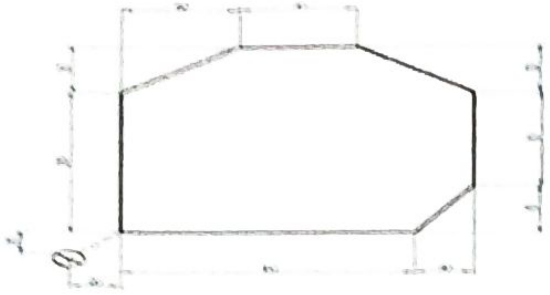
Fig. 7.1 Turning model

```
N0    G90   F0.5  S1200  T0101 M03
N10   G00   X30   Z2
N20   G71   U0.5   R0.5
N30   G71   P40   Q90   U0.05  W0.05
N40   G01   X20   Z0
N50   G01   X20   Z-20
N60   G01   X25   Z-20
N70   G01   X25   Z-40
N80   G01   X30   Z-40
N90   G01   X30   Z-60
N100  P40   Q90   G28   U0     W0
N110 M05
```

N120 M30

7.2 SAMPLE PROGRAM OF MILLING MODEL

Assume thickness = 20mm



SIMULATION MODEL:-

Fig. 7.2 milling model

N10 G90 G00 G54 G17

N20 G43 Z50 M08

N30 S1000 M03

N40 G00 X20 Y20

N50 G01 Z-20 F100

N60 G01 X120 Y60

N70 G01 X160 Y140

N80 G01 X160 Y190

N90 G01 X70 Y190

N100 G01 X20 Y140

N110 G01 X20 Y20

N120 G01 X0 Y0 Z50

N130 M09 M05 M30

CHAPTER 8

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- https://www.mechanicalbooster.com/2016/12/differen ce-between-nc-and-cnc-machine.html
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