VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JNANA SANGAMA, BELAGAVI-590 018, KARNATAKA

An Internship Report on

"CNC Milling Programming and Operation "

Submitted in partial fulfillment of the requirements for awarding the degree of**Bachelor of Engineering in Mechanical Engineering** of Visvesvaraya Technological University, Belagavi.

Submitted by

ARUN KUMAR K

(1RN19ME403)

Under the Guidance of

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Department of Mechanical Engineering

RNS INSTITUTE OF TECHNOLOGY

(AICTE Approved, VTU Affiliated & NAAC 'A' Grade Accredited)
Dr. Vishnuvardhan Road, Rajarajeshwari Nagar, Channasandra, Bengaluru-560098
2021-2022

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DEPARTMENT OF MECHANICAL ENGINEERING

CERTIFICATE

This is to certify that the internship on **"CNC Milling Programming & Operation"** has been successfully completed by **ARUN KUMAR K (1RN19ME403)** bonafide student of **RNSInstitute of Technology** in partial fulfilment of the requirements for the award of degree in **Bachelor of Engineering in Mechanical Engineering of Visvesvaraya Technological University, Belagavi**, during academic year **2021-2022**. It is certified that all corrections/ suggestions indicated for Internal Assessment have been incorporated in the report and deposited in the department library. The internship report has been approved as it satisfies the academic requirements in respect of seminar for the said degree.

Mr. NIRANJAN M K	**Dr. Mukesh Patil**	**Dr. M K Venkatesha**
Internal Guide	Professor and H0D	Principal
Assistant Professor		

Examiners

	Name	**Signature**	**Date**
1.			
2.			

DECLARATION

I, **ARUN KUMAR (1RN19ME403)** student of VIII semester B.E. Mechanical Engineering, **RNS Institute of Technology, Bengaluru**, hereby declare that the internship on **"CNC Milling Programming & Operation**" has been carried out by me and the report has been submitted in partial fulfillment of the requirement for the VIII semester degree of ***Bachelor of Engineering in Mechanical Engineering*** of **Visvesvaraya Technological University, Belagavi,** during academic year **2021-2022.**

Date:

Place:

ARUN KUMAR K

ಸರ್ಕಾರಿ ಉಪಕರಣಾಗಾರ ಮತ್ತು ತರಬೇತಿ ಕೇಂದ್ರ
GTTC
Govt. Tool Room & Training Centre
(A Govt. of Karnataka Society) (An Indo – Danish Project)
Rajajinagar Industrial Estate, Bengaluru – 560 010, INDIA

Date: 23.09.2021

Internship Letter

Certificate of Competency is awarded for successful Completion of Course in CNC Milling programming & operation to Mr. Arun kumar K (1RN19ME403) for the period of 02.09.2021 to 23.09.2021 at Govt. Tool Room & Training Centre, Bangalore.

Principal

Principal
Govt. Tool Room & Training Centre
Rajajinagar Indl
Bangalore - 560 010

ACKNOWLEDGEMENT

It is my privilege and duty to acknowledge the kind help and guidance received from several people in preparation of this report. It would not have been possible to prepare this report in this form without their valuable help, co-operation and guidance.

First and foremost, I wish to express my sincere gratitude to the Management of R.N.S. Institute of Technology for providing a conducive environment to carry out this internship.

I would like to express my thanks to the Principal **Dr. M K Venkatesha** for his encouragement that motivated me for the successful completion of this internship report.

It gives me immense pleasure to thank **Dr.Mukesh Patil**, Professor and Head of Department of Mechanical Engineering, for his valuable suggestions and guidance throughout.

I would like to thank my internship guide Prof. **Mr. Niranjan M K**, Assistant Professor, Department of Mechanical Engineering for his consistent guidance and support throughout the internship.

I would like to thank Govt. Tool Room & Training Centre for accepting me as an intern and guiding me throughout the same.

I would also like to thank all other teaching and non-teaching staff of Mechanical Department who have directly or indirectly helped me in the completion of this internship.

Finally, I would hereby acknowledge and thank my parents who have been a source of inspiration and also instrumental in the successful completion of internship report.

ARUN KUMAR K
(1RN19ME403)

COMPANY PROFILE

Govt. Tool Room and Training Centre

GTTC is an autonomous society, and a recognized Scientific and Research Organization by the Government of India. Govt. Tool Room and Training Centre (GTTC), is serving industry by way of precision tooling and providing in well trained craftsmen the area of tool and die making.

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.

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CHAPTER 1

INTRODUCTION

Computer Numerical Control (CNC) programming instructs the machining tools to cut the material into any desired shape. However, these machining tools are intricate and exhibit varying reactions to different programs, making mastering CNC programming tedious.

CNC programming helps build the code that directs the operation and working of a CNC machine. A CNC machine employs a subtractive manufacturing process that cuts away portions of the base material to give any desired shape.

CNC machines typically use G-codes and M-codes for the CNC machining process. G-codes oversee the positioning of the tools and have the part prepared for the cutting or milling process. M-codes control the rotations of tools and other functions. For parameters including speed, tool number, cutter diameter offset, and feed, the system employs other alphanumeric codes that begin with S, T, D, and F respectively.

Types of CNC Programming

CNC programming comprises three main programming types, namely –

1. Manual
2. Computer-Aided Manufacturing (CAM)
3. Conversational

1. Manual CNC Programming

Manual CNC programming is a traditional and the most tedious approach which requires the programmer to be aware of the machine's responses by anticipating the program's outcome. This programming type is ideal for performing basic tasks or when creating a specific design.

2. CAM CNC Programming

CAM CNC programming is a suitable approach for those with minimal experience in advanced math skills.

The software converts CAD design into the CNC programming language and helps bypass most mathematical steps required during the manual programming approach.

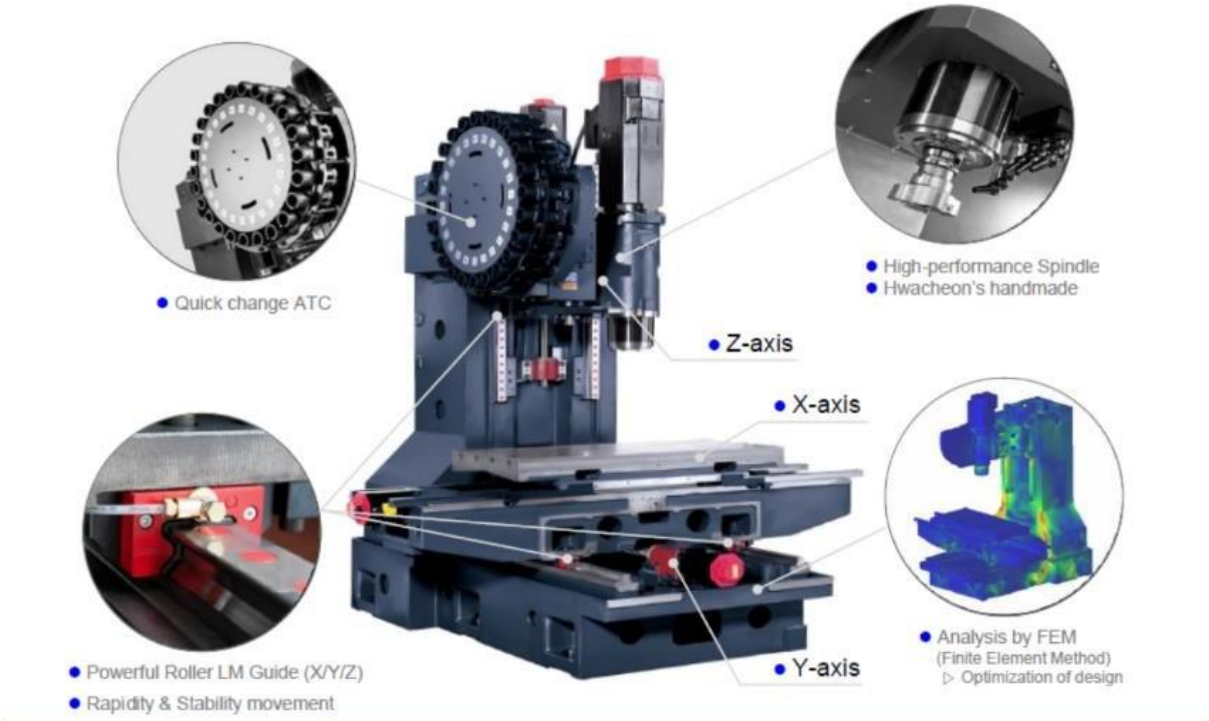
Some popular CNC software ideal for all skill levels include Linux CNC, Easel, GRBL, Planet CNC, and more.

3. Conversational CNC Programming

Conversational CNC programming is easiest for beginners since it does not require the users to know G-code to create the intended cuts. The user only needs to type in the essential details in simple language.

This programming approach also lets the operator verify tool movements before executing the program to maintain the design's accuracy. However, this method is not practical for complex paths.

Parts of a CNC Milling Machine:



Some of main components in C-Type Structure

1. **Frame**

The frame is the main structure that supports the milling machine and helps to give it stability and rigidity. It usually comes with a base and detachable column/s.

2. **Spindle**

The spindle can be considered as the "heart" of a CNC milling machine. It normally comprises a rotating assembly, and a tapered section where tool holders may be positioned. The shaft of the spindle is normally where the tool is attached to, usually via a tool holder.

A motor with different levels of transmission is used to rotate the spindle.

3. Axes

In general, CNC milling machines have X / Y / Z as well as additional rotational axis or C / A or B (subject to configuration). These can be programmed using g-code in the CNC controller.

4. Columns

The columns of the CNC machining centre can be single (e.g., travelling column HiRex 4000 or also C-Frame like HiT 400 / 360; VESTA line including "B"; SIRIUS-650 / 850 / 1050) or double (SIRIUS 1250 / 2500 / L1 / L2). This depends on the level of complexity needed in the machining task.

5. CNC Control Panel

This is the main "nervous system" of the machine tool. It contains the electronics that helps to control the different cutting actions through programming functions. The control panel has a CNC monitor and programming buttons where data and codes can be punched in. It usually also offers a manual function

6. Tool / Tool Changers (Automatic Tool Changer or ATC)

These are either mounted at the column or separately mounted to the machine. The latter is preferred if larger tool changers are needed with 40 up to 300 different tools. Doing so not only helps to save time and effort – it also helps your operators to avoid unnecessary vibrations during operation.

7. Tool Holders

These come in many different sizes, systems and for various applications. The standard sizes for tool holders are BT 30 to BT 40 and BT 50 (BT refers to the taper angle of the cone on the holder). For higher rigidity and balanced fast rotations, BBT versions are recommended or the HSK System.

8. Table

The table provides a solid base to clamp the work piece directly on, and can be used to mount fixtures or vice to hold the piece in place. Most of the tables use T-slots for easy clamping of vice, fixture or part.

On Horizontal CNC milling machines, pallets are also available with Tap-holes. These allow greater flexibility in moving different work pieces to be machined. Increasingly, magnets are also being used for easy, fast and secured clamping.

9. Coolant Tank

Most CNC machining centres have a coolant tank to help supply coolant to the cutting surface or the spindle with tool during machining action. This helps to lengthen the life-span of the machine and its parts. Beyond this, the coolant will also remove heat generated by the machining action, and hence keep temperatures under control.

Types of Tools used in CNC Mill:

- End Mills, Flat or Ball nose, Straight or Form Tools.
- Face Mills
- Drills, U-Drills, Spiral Borer.
- Taps
- Reamers
- Tool Holders and Hydraulic Tool Holders, Shrink-Fit or Press-Fit holders.

G-Codes used in CNC Mill

G00- Rapid Traverse
G01- Linear Traverse
G02- Circular Interpolation in Clockwise direction
G03- Circular Interpolation in Counter Clockwise direction
G04- Dwell
G05- Moves in the same direction as the last arc to be performed
G06- Tangential arc
G07- Single arc
G11- Circular Polar Clockwise
G13- Circular Polar Counter Clockwise
G15- Moves in the same direction as the last arc to be performed
G16- Tangential arc polar
G17- Selection of XY plane
G18- Selection of XZ plane
G19- Selection of YZ plane
G28- Mirror image
G30- Blank form (Bottom form of billet)
G31- Blank form (Tool form of billet)
G40- Tool radius compensation cancel
G41- Tool radius compensation left side
G42- Tool radius compensation right side
G43- Tool length offset
G54, 55, G56- Work offset
G64- Default cutting mode on
G74- Slot milling
G75- Rectangular pocket (CW)
G76- Rectangular pocket (CCW)
G77- Circular pocket (CW)
G78- Circular pocket (CCW)
G79- Cycle call
G80- Cancellation of Canned cycle
G81/G82- Spot Drilling/ Boring
G83- Peck Drilling
G90- Absolute Referencing
G91- Incremental Referencing
G98- Start to initial point/ Label
G99-Tool definition

M-Codes used in CNC Mill

M00- Program Stop
M01- Optional Stop
M02- Program End
M03- Spindle in CW
M04- Spindle in CCW
M05- Spindle stop
M06- Tool Change
M08- Coolant pump ON
M09- Coolant pump OFF
M10- Work clamp close
M13- Spindle forward + coolant ON

M14- Spindle forward + coolant OFF
M19- Spindle Orientation
M20- ATC Arm in
M21- ATC Arm out
M22- ATC Arm down
M23- ATC Arm up
M24- ATC Arc Clamping Activate
M25- ATC Arc Clamping Release
M30- Program End
M32- ATC CW rotation
M33- ATC CCW rotation
M38- Door Open
M39- Door Close
M98- Sub Program Call
M99- Sub Program repetition (Incremental Depth)

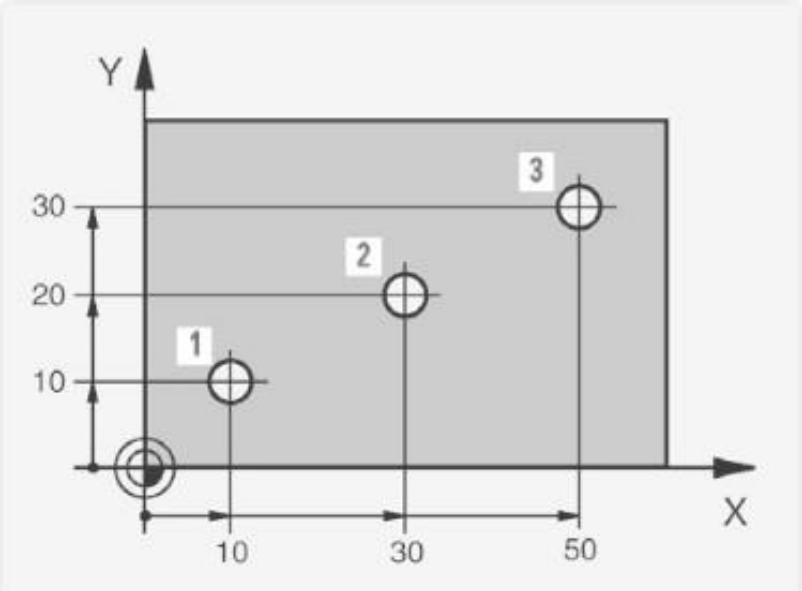
Dimensioning:

There are 2 types of dimensioning which are used in CNC programming. They are:

1. Absolute Referencing
2. Incremental Referencing

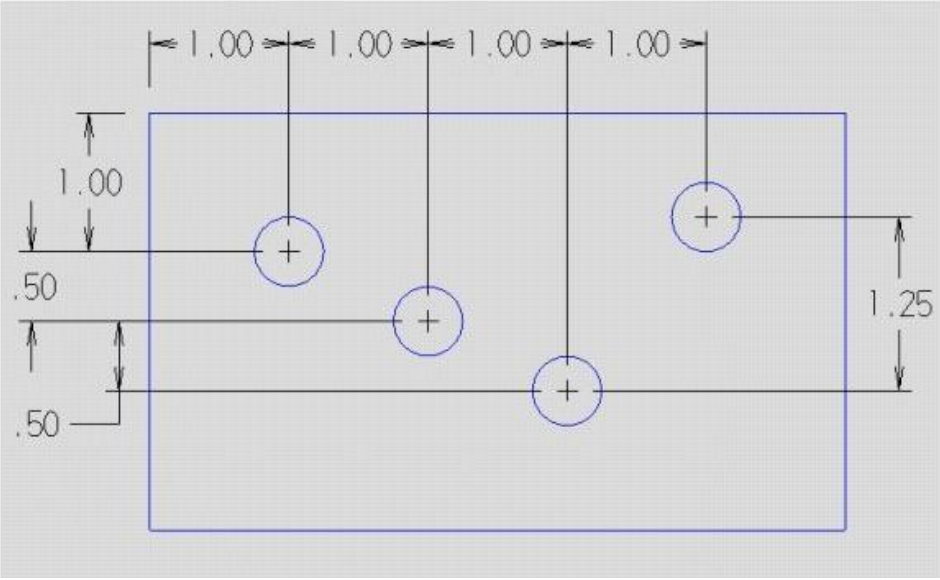
Absolute Referencing:

In absolute dimensioning, all the dimensions/ points are measured from common reference point or zero point. These zero points are called datum point.



Incremental Referencing:

In incremental dimensioning, all the dimensions/ points are measured from the previous point. This indicates the distance of the new point from the previous point.



Terms in Programming:

1. Program Number:- The program number functions as an addressing symbol for accessing a program. The program. The program number is expressed by putting the numericals of 4 digits after the alphabet "O", numericals from 0001 to 9999 can be used.

2. Sequence Number (N):- The sequence number is used to
    - Search
    - Callout the position being executed
    - The position you want to edit in the program easily.

    Sequence number is expressed by the numerals of 5 digits or less after alphabet "N" numerals from 1 to 99999 can be used.

3. Part Program:- Part Program is used to specify the machinery process for a single tool. That is a program for each process required.

ADVANTAGES, DISADVANTAGES AND APPLICATIONS OF CNC SYSTEMS

ADVANTAGES

- The manufacturing process can be simulated virtually and no need to make a prototype or a model. This saves time and money.
- Once programmed, these machines can be left and do not require any human intervention except for work loading and unloading.
- These machines can manufacture several components to the required accuracy without any fatigue as in the case of manually operated machines.
- Savings in time that could be achieved with the CNC machines are quite significant.

DISADVANTAGES

- CNC machines are generally more expensive than manually operated machines.
- The CNC machine operator only needs basic training and skills, enough to supervise several machines.
- Increase in electrical maintenance, high initial investment and high per hour operating costs than the traditional systems.
- Fewer workers are required to operate CNC machines compared to manually operated machines. Investment in CNC machines can lead to unemployment.

APPLICATIONS

- CNC was initially applied to metal working machinery: Mills, Drills, boring machines, punch presses etchant now expanded to robotics, grinders, welding machinery, EDM's flame cutters and also for inspection equipment etc.
- CNC electrical discharge machining (EDM).
- CNC fabrication machines (sheet metal punch press, bending machine, or press brake)

CONCLUSION

- We thank the Government tool room and training centre for providing us the opportunity to complete our internship course under the guidance of industrial professionals over a period of 4 weeks.
- This Program has proved that hands on experience with state-of-the-art equipment can set a student's knowledge base to a very high standard.
- It helped us to understand Industrial ways of work and in many ways guided us to gain work experience.
- It has effectively given us more insight into working of CNC machine technology, milling operation, designing and prototyping.