

LABORATORY MANUAL

CNC Lab

(B .E. 6th Semester)



DEPARTMENT OF MECHANICAL ENGINEERING

Jorhat Engineering College

Jorhat – 785007 (Assam)

COLLEGE VISION AND MISSION

Vision:

To develop human resources for sustainable industrial and societal growth through excellence in technical education and research.

Mission:

1. To impart quality technical education at UG, PG and PhD levels through good academic support facilities.
2. To provide an environment conducive to innovation and creativity, group work and entrepreneurial leadership.
3. To develop a system for effective interactions among industries, academia, alumni and other stakeholders.
4. To provide a platform for need-based research with special focus on regional development.

DEPARTMENT VISION AND MISSION

Vision:

To emerge as a centre of excellence in mechanical engineering and maintain it through continuous effective teaching-learning process and need-based research.

Mission:

- M1:** To adopt effective teaching-learning processes to build students capacity and enhance their skills.
- M2:** To nurture the students to adapt to the changing needs in academic and industrial aspirations.
- M3:** To develop professionals to meet industrial and societal challenges.
- M4:** To motivate students for entrepreneurial ventures for nation-building.

STUDENT PROFILE	
NAME :	
ROLL NUMBER :	
COURSE :	B.E. in Mechanical Engineering
SEMESTER :	6 th Semester
YEAR :	

PERFORMANCE RECORD		
EXP. NO.	TITLE OF EXPERIMENT	REMARKS / GRADE
1	CNC Programming and Simulation.	
2	Setting up of workpiece zero position and machining in Modular Vertical 3 Axis CNC Milling machine.	
3	Machining in Semi production Vertical 3 Axis CNC machine (MTab XLMill)	
4	Setting up of workpiece zero position and machining in Modular CNC Turning machine.	

OFFICE USE	
Checked By :	
Overall Grade / Marks :	
Signature of Lab In charge :	

Introduction

NC: Numerical Control is a technology where machine tool is controlled by a coded program to machine a part.

CNC: It is the NC technology where a dedicated PC is there to interface with Machine Control Unit for writing CNC program and Run it to machine the desired part in the machine of the CNC system.

Part Program: It is a program written block by block with alpha-numeric codes. Codes or words are written in a format of sequence.

Sequence of Codes or Words in a single line/block of Part programming:

N, G, X, Y, Z, A, B, C, I, J, K, F, S, T, R, M

N : Sequence number

G-Codes: Preparatory Codes.

- G00:** Rapid Travel
- G01:** Linear interpolation
- G02:** Circular interpolation CW
- G03:** Circular interpolation CCW
- G04:** Dwell for a specific time
- G17:** XY plane
- G18:** XZ Plane
- G19:** YZ plane
- G20:** Inch data input
- G21:** mm data input
- G28:** Go Home
- G32:** Thread cutting in Turning
- G40:** Cancel cutter Offset
- G41:** Offset cutter Left
- G42:** Offset cutter Right
- G80:** Cancel canned cycle
- G81:** Drilling cycle
- G82:** Counter boring cycle
- G83:** Deep hole drilling cycle
- G90:** Program in absolute Coordinate
- G91:** Program in incremental Coordinate
- G92:** Specify Tool Origin
- G94:** Feed mm/min in milling and Drilling
- G95:** Feed mm/rev in milling and Drilling
- G98:** Feed mm/min in turning
- G99:** Feed mm/rev in Turning

X,Y,Z: Coordinate data for three linear axes

A,B,C: Coordinate data for three rotational axes

I,J,K: Coordinate values of arc center corresponding to X, Y and Z axes

F : Feed rate per minute or per revolution in either inches or mm as specified by G code

S : Spindle speed in rpm

T : Tool selection (used for machine with automatic tool changers)

R : Radius of arc; used in circular interpolation

M-Code: Miscellaneous Code

M00: Program stop; used in middle of program. The machine must be restarted.

M02: Machine Stop

M03: Spindle start CW

M04: Spindle start ACW

M05: Spindle Stop

M06: Tool Change

M07: Coolant on (Flood)

M08: Coolant on (Mist)

M09: Coolant off

M13: Spindle start and coolant on

M17: Spindle Stop and Coolant Off

M30: End of program

M98: Call Milling Cycle Subprogram

M99: End of Milling Subprogram

Experiment No. 1

Title: CNC Programming and Simulation.

Objective: To write and simulate CNC Part program for three axes Milling machine.

CNC Part programme examples:

Example 1: Write a CNC part programme to cut the part as shown in Fig.1 from an aluminium slab of 19 mm thickness and size 90 mm x 90 mm.

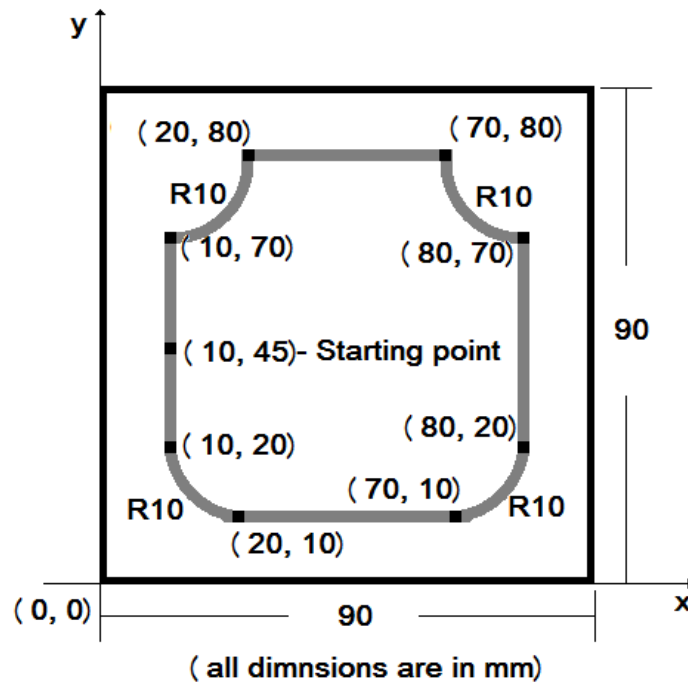


Fig.1

Program code	Comments
N01 G21 G94;	Metric mode, Feed in mm/min
N02 G28 G91 Z0;	Go to axis reference, Incremental mode
N03 G28 X0 Y0;	(Machine zero position)
N04 M03 S1800;	Spindle start CW at 1800 rpm
N05 G00 G90 X0 Y0 F100;	Rapid travel in Abs mode with Feed 100 mm/min
N06 G00 Z10 F50;	Rapid travel in Z dir (10 mm) ,Feed 50 mm/min
N07 G00 X10 Y45;	Rapid travel in X dir (10 mm), Y dir (45 mm)
N08 G01 Z-0.5 F50;	Linear interpolation, go to given coordinates
N09 G01 Y70;	
N10 G03 X20 Y80 R10;	Circular interpolation CCW ending at X20 Y80 with radius 10 mm

N11 G01 X70;	Linear interpolation , go to given coordinates
N12 G03 X80 Y70 R10;	Circular interpolation CCW ending at X80 Y70 with radius 10 mm
N13 G01 Y20;	Linear interpolation, go to given coordinates
N14 G02 X70 Y10 R10;	Circular interpolation CW ending at X70 Y10 with radius 10 mm
N15 G01 X20;	Linear interpolation, go to given coordinates
N16 G02 X10 Y20 R10;	Circular interpolation CW ending at X10 Y20 with radius 10 mm
N17 G01 Y45;	Linear interpolation, go to given coordinates
N18 G00 Z10;	Pull out the cutter to safe height (rapid travel)
N19 G28 G91 Z0;	Go to axis reference, Incremental mode (Machine zero position)
N20 G28 X0 Y0;	
N21 M05;	Stop spindle
N22 M30;	End of programme

Example 2: Write a CNC part programme to cut the part as shown in Fig.2 using milling cycle subprogram from an aluminium slab of 19 mm thickness and size 90 mm x 90 mm.

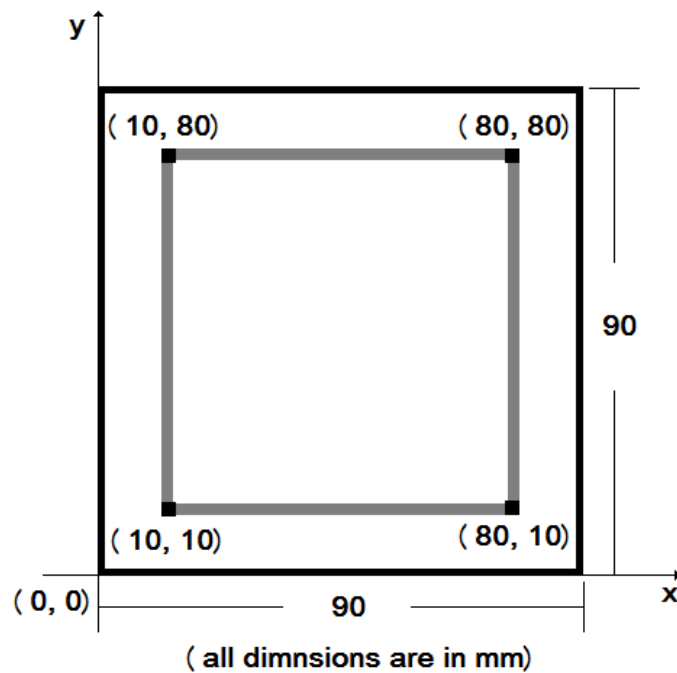


Fig.2

Program code	Comments
N01 G21 G94;	Metric mode, Feed in mm/min
N02 G28 G91 Z0;	Go to axis reference, Incremental mode (Machine zero position)
N03 G28 X0 Y0;	
N04 M03 S1800;	Spindle start CW at 1800 rpm
N05 G00 G90 X0 Y0 F100;	Rapid travel in Abs mode with Feed 100 mm/min
N06 G00 Z5 F50;	Rapid travel in Z dir (5 mm) ,Feed 50 mm/min

N07 G00 X10 Y10;	Rapid travel
N08 G01 Z0 F50;	Touch work piece with Feed 50 mm/min
N09 M98 P1111 L3;	Call subprogram 1111 three times
N10 G00 G90 Z15;	Pull out the cutter to safe height (rapid travel)-Abs mode
N11 G28 G91 Z0;	Go to axis reference, Incremental mode
N12 G28 X0 Y0;	(Machine zero position)
N13 M05;	Stop spindle
N14 M30;	End of programme
Sub program	
O1111	Subprogram name
G01 G91 Z-0.5 F50	In incremental mode cut 0.5 mm in Z dir, feed 50 mm/min
G01 G90 Y80 F100	In Abs mode trace the coordinates (cutting material in the path)
G01 X80	
G01 Y10	
G01 X10	
M99	End of sub program

Example 3: Write a CNC part programme to cut a full circle(R 15 mm) as shown in Fig.3 from an aluminium slab of 19 mm thickness and size 90 mm x 90 mm.

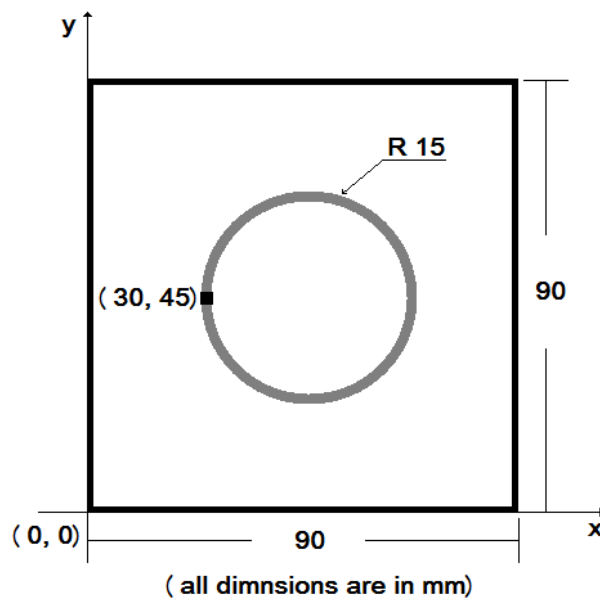


Fig. 3

Program code	Comments
N01 G21 G94;	Metric mode, Feed in mm/min
N02 G28 G91 Z0;	Go to axis reference, Incremental mode (Machine zero position)
N03 G28 X0 Y0;	
N04 M3 S1800;	Spindle start CW at 1800 rpm
N05 G00 G90 X0 Y0 F100;	Rapid travel in Abs mode with Feed 100 mm/min
N06 G00 Z10 F50;	Rapid travel in Z dir (10 mm) ,Feed 50 mm/min

N07 G00 X30 Y45;	Rapid travel
N08 G01 Z-0.5 F50;	Cut 0.5 mm in Z direction
N09 G02 I15;	Cut a circle in CW with R 15 mm
N10 G00 Z15;	Pull out cutter to safe height
N11 G28 G91 Z0;	Go to axis reference, Incremental mode (Machine zero position)
N12 G28 X0 Y0;	
N13 M05;	Spindle stop
N14 M30;	End of Program

Example 3: Write a CNC part programme to drill 5 holes (R 3 mm) as shown in Fig.4 at an aluminium slab of 19 mm thickness and size 90 mm x 90 mm.

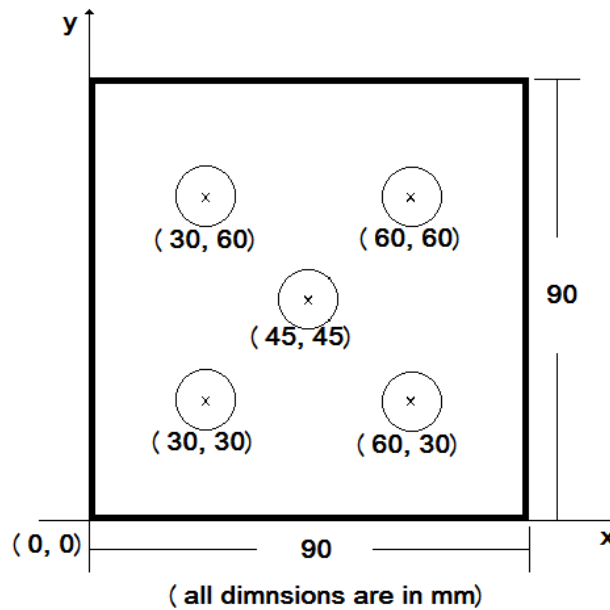


Fig. 4

Program code	Comments
N01 G21 G94;	Metric mode, Feed in mm/min
N02 G28 G91 Z0;	Go to axis reference, Incremental mode (Machine zero position)
N03 G28 X0 Y0;	
N04 M03 S1800;	Spindle start CW at 1800 rpm
N05 G00 G90 X0 Y0 F100;	Rapid travel in Abs mode with Feed 100 mm/min
N06 G00 Z10 F50;	Rapid travel in Z dir (10 mm) ,Feed 50 mm/min
N07 G83 X45 Y45 Z-3 Q0.5 R1 F50;	Start dip hole drilling cycle, XY coordinates, Z=total depth in mm, Q=Depth of cut in mm, R= retract value in mm (in general R=2Q), F=Feed rate
N08 X30 Y60;	
N09 X60 Y60;	
N10 X60 Y30;	
N11 X30 Y30;	
N12 G80;	End of Drilling (Canned) cycle

N13 G00 Z15;	Pull out cutter to safe height
N14 G28 G91 Z0;	Go to axis reference, Incremental mode (Machine zero position)
N15 G28 X0 Y0;	
N16 M05;	Spindle stop
N17 M30;	End of Program

Steps to Simulate CNC programme in CNCTrain Software:

- 1) Put the USB Hardware Lock in place
- 2) Switch on the PC
- 3) Double click the CNC TRAIN
- 4) Enter the Password
- 5) Load or write a program
- 6) Select Job / Tool and set the slab dimensions
- 7) Simulate by AUTO – RESET – CYCLE Start
- 8) Correct the program if required
- 9) Stop the software
- 10) Switch off the PC
- 11) Remove the Hardware Key and Store

Exercise: Write a CNC part programme to cut the part as shown in Fig.5 from an _____ slab of ___ mm thickness and size ___ mm x ___ mm.

Fig.5:

Program code:

Exp. No. 1	Title: CNC Programming and Simulation.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	
Signature of Lab Incharge with Date of Check	
SEAL	

Experiment No. 2

Title: Setting up of workpiece zero position and machining in Modular Vertical 3 Axis CNC Milling machine.

Objective: To learn to setup a CNC Milling machine and executing a part programme.

Procedure: To setup the workpiece zero point refer to Fig.1 and the following steps should be followed

1. Start the spindle
2. Manually move the tool to a safe distance from the workpiece
3. Gradually adjust its position near to that face of the workpiece which is facing you.
4. Now turn on the jog mode and set the travel speed to 0.1mm/min.
5. Now slowly touch that face by jogging the tool in Y direction.
6. Upon touchup, Set Y zero at minus tool radius distance.
7. In the same method set X direction to zero.
8. For setting Z direction to zero, touch the upper surface of the workpiece by the tool in jogging mode and set to zero.

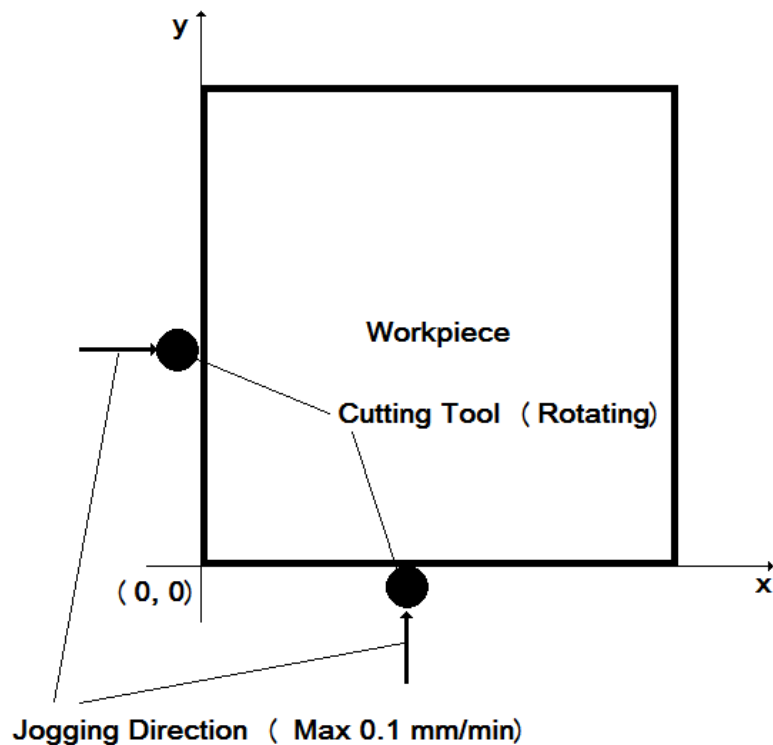


Fig.1

Exercise: Write a CNC part programme to cut the part as shown in Fig.2 from an wPVC slab of ___ mm thickness and size 40 mm x 100 mm and execute it in Modular Vertical 3 Axis CNC Milling machine.

Fig.2:

Program code:

Exp. No.2	Title: : Setting up of workpiece zero position and machining in Modular Vertical 3 Axis CNC Milling machine.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	
<p>Signature of Lab Incharge with Date of Check</p> <p style="text-align: right;">SEAL</p>	

Experiment No. 3

Title: Machining in Semi production Vertical 3 Axis CNC machine (MTab XLMill)

Objective: To learn to setup a Semi production CNC Milling machine and executing a part programme.

Procedure:

1. Put the Hardware-Key in place.
2. Switch on the PC
3. Power on the M/C
4. Check the lubrication level and crank the hand pump 5 times to remove air bubbles in the lubrication system
5. Switch on the controller box.
6. Double click the CNC TRAINER.
7. Select metric programming.
8. Write Password – master
9. Link up the machine to the PC using Machine link
10. Run warm-up cycle by following steps.
11. Machine link – Machine On M03, S500.
12. Gradually increase spindle speed to 1000, 1500, 1800, 2000, 2200, 2500 rpm.
13. Stop Spindle as warm up cycle ends.
14. Set RAPID mode and move the spindle in X, Y, Z mode manually
15. HOME Z, X, Y.
16. Spindle Start – 1000.
17. Execute Job zero setting procedure as described in Exp 2.
18. Open file from samples or type a program.
19. Click Auto – Reset --- Cycle start
20. After executing the machining, delink the machine.
21. Close CNC Train
22. Switch off Control panel.
23. Shut down the.
24. Remove the Hardware Key– store safe.

Exercise: Write a CNC part programme to cut the part as shown in Fig.1 from an wPVC slab of ___ mm thickness and size ____ mm x ____ mm and execute it in Semi production Vertical 3 Axis CNC machine.

Fig.1:

Program code:

Exp. No. 3	Title: Machining in Semi production Vertical 3 Axis CNC machine (MTab XLMill)
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	
<p>Signature of Lab Incharge with Date of Check</p> <p style="text-align: right;">SEAL</p>	

Experiment No. 4

Title: Setting up of workpiece zero position and machining in Modular CNC Turning machine.

Objective: To learn to setup a CNC Turning machine and executing a part programme.

Procedure: To setup the workpiece zero point refer to Fig.1 and the following steps should be followed

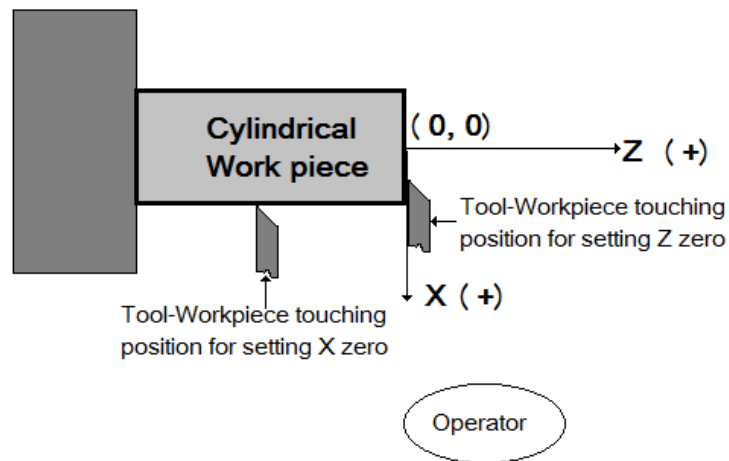


Fig.1

1. Start the spindle
2. Manually move the tool to a safe distance from the workpiece
3. Now in jogging mode touch the workpiece by the tool as shown in Fig. 1 and set respective axes to zero. For X axis, input the diameter of the workpiece in touchoff dialog box and the machine will automatically set X axis to zero position.
4. Move the tool to safe distance.

Example of a CNC program for turning: Refer to Fig.2

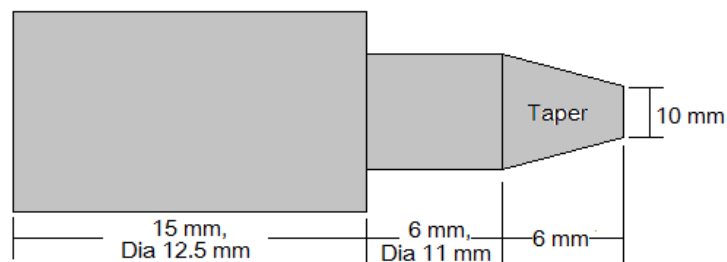


Fig.2

Program:	Comment
N01 G21;	
N02 G7;	
N03 G0 X20;	
N04 G0 Z1;	
N05 G0 X12;	
N06 G1 Z-12 F50	
N07 G0 X13 Z-10;	
N08 G0 Z1;	
N09 G0 X11.5;	
N10 G1 Z-12 F50;	
N11 G0 X12 Z-10;	
N12 G0 Z1;	
N13 G1 Z-12 F50;	
N14 G0 X12 Z-10;	
N15 G0 Z1;	
N16 G0 X10;	
N17 G1 Z0 F50;	
N18 G1 X11 Z-6 F50;	
N19 G1 X14;	
N20 G0 X20 Z2;	
N21 M02;	

Study the program and put comment against each code block.

Exercise: Write a CNC part programme to turn the part as shown in Fig.1 from an acrylic workpiece of ___ mm diameter and ____ mm length and execute it in Modular CNC Turning machine.

Fig.1:

Program code:

Exp. No. 4	Setting up of workpiece zero position and machining in Modular CNC Turning machine.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	
<p>Signature of Lab Incharge with Date of Check</p> <p style="text-align: right;">SEAL</p>	