DRONACHARYA
College of Engineering

LABORATORY MANUAL

B.Tech. Semester- VI

WORKSHOP LAB-I
Subject code: LC-ME-310G

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DEPARTMENT OF ROBOTICS AND AUTOMATION
DRONACHARYA COLLEGE OF ENGINEERING
KHENTAWAS, FARRUKH NAGAR, GURUGRAM (HARYANA)

Table of Contents

Vision and Mission of the Institute

Vision:

To impart Quality Education, to give an enviable growth to seekers of learning, to groom them as World Class Engineers and Managers competent to match the expanding expectations of the Corporate World has been our ever enlarging vision extending to new horizons since the inception of Dronacharya College of Engineering.

Mission:

M1: To serve the society and improve the mode of life by imparting high quality education in the field of Engineering and Management catering to the explicit and implicit needs of the students, society, humanity and industry.

M2: To create an inspiring ambience that raises the motivation level for conducting quality research

M3: To provide an environment for acquiring ethical values and positive attitude.

Vision and Mission of the Department

Vision:

To be a globally recognized leader in robotics and automation education, research, and innovation, empowering students to excel in a technologically advanced world.

Mission:

M1: To provide high quality education and training in robotics and automation, equipping students with the knowledge, skills, and attitudes necessary for successful careers in the field.

M2: To foster a culture of innovation and entrepreneurship, encouraging student and faculty to develop and apply cutting-edge technologies in robotics and automation

M3: To conduct impactful research and development activities, addressing real-world challenges and advancing the field of robotics and automation

M4: To promote ethical practices, environmental sustainability and social responsibility in the deployment of technologies

M5. To collaborate with industry, academia and research organizations to create opportunities for industry-driven projects, internships, and placements ensuring the relevance of our programs and enhancing industry readiness or our graduates

Programme Educational Objectives (PEOs)

PEO1: To provide innovative and state-of-the-art solutions solve complex problems in automation, robotics and allied fields, and design high quality systems for diverse applications.

PEO2: To develop research oriented analytical ability among students and to prepare them for making technical contribution to the society.

PEO3: To ccontinue life-long learning and pursue professional development opportunities like graduate degrees or professional studies to adapt to the evolving technological changes..

PEO4: To prepare the students work in diverse, multi-disciplinary teams and possess leadership skills, ethical standards, environmental concerns and social awareness.

PEO5: To Re-learn and innovate in ever-changing global economic and technological environments on the 21st century

Programme Outcomes (POs)

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and software tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes (PSOs)

PSO1: Identify the needs, analyze, design and develop simple robotic systems and programs for diverse applications in real time.

PSO2: Design, select and integrate appropriate automation and robotic subsystems for multi-domain engineering and integrate software applications tools.

PSO3: Develop impactful engineering solutions by using research-based knowledge and research methods in the fields of advanced robotics and other relevant fields.

PSO4: Evaluate existing engineering elements and processes, identifying areas for improvement. Propose innovative robotic and automation solutions to enhance the performance and efficiency of conventional systems.

PSO5: Identify suitable sensing, interfacing, control, actuation, and communication technologies to integrate various subsystems. Develop robots capable of analyzing data and implementing automated solutions through seamless connectivity between different components.

University Syllabus

1. Study and Practice of Orthogonal & Oblique Cutting on a Lathe.
2. Machining time calculation and comparison with actual machining time while cylindrical turning on a Lathe and finding out cutting efficiency.
3. Study of Tool Life while Milling a component on the Milling Machine.
4. Study of Tool Wear of a cutting tool while Drilling on a Drilling Machine.
5. Study of Speed, Feed, Tool, Preparatory (Geometric) and miscellaneous functions for N. C part programming.
6. Part Programming and proving on a NC lathe for:- a. Outside Turning b. Facing and Step Turning c. Taper Turning d. Drilling e. Outside Threading
7. Part Programming and Proving on a NC Milling Machine:-
    a. Point to Point Programming
    b. Absolute Programming
    c. Incremental Programming
8. Part Programming and Proving for Milling a Rectangular Slot

Course Outcomes (COs)

Upon successful completion of the course, the students will be able to:

C310.1: vapour power cycles and find and compare different cycles based on their performance parameters and efficiencies

C310.2: steam boilers, their types and components

C310.3: fundamentals of flow of steam through a nozzle

C310.4: steam turbines and can calculate their work done and efficiencies.

C310.5: types and working of condensers and compressors and define their different types of efficiencies

CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PO16
CO1	3	2	3	-	3	-	3	3	3	2	-	3	3	-	-	3
CO2	-	3	-	-	2	3	-	-		2	-	3	-	-	3	3
CO3	-	-	3	3		3	-	-	2	-	2	-	2	3	-	
CO4	3	-	3	-	3	-	3	3	-	2	-	3	-	3	2	3
CO5	3	3	-	3	-	3	-	-	3	2	3	-	3	3	-	3

CO-PSO Mapping

	PSO1	PSO2	PSO3
CO1	3	2	-
CO2	2	3	-
CO3	3	2	-
CO4	3	2	3
CO5	2	3	3

Course Overview

Heat transfer occurs in many unit operations in variety of processes in chemical, petrochemical, power and pharmaceutical industries. Understanding the fundamentals governing heat transfer is key to designing equipment that involves heat exchange. This course for undergraduate students covers the fundamental aspects and quantitation of different modes of heat transport. This course deals with both the fundamental and applied aspects, starting with the basic concepts and governing equations and evolving into the design of relevant industrial units. The students will be made aware of the core scientific issues and will be encouraged to solve problems on their own.

List of Experiments

S.No.	NAME OF EXPERIMENTS	CO Covered
1.	Study and Practice of Orthogonal & Oblique Cutting on a Lathe.	CO1, CO2
2.	Machining time calculation and comparison with actual machining time while cylindrical turning on a Lathe and finding out cutting efficiency.	CO1
3.	Study of Tool Life while Milling a component on the Milling Machine.	CO1
4.	Study of Tool Wear of a cutting tool while Drilling on a Drilling Machine.	CO1, CO3
5.	Study of Speed, Feed, Tool, Preparatory (Geometric)and Miscellaneous functions for N. C part programming.	CO1, CO3
6.	Part Programming and proving on a NC lathe for:- a. Outside Turning b. Facing and Step Turning c. Taper Turning d. Drilling e. Outside Threading	CO1, CO4
7.	Part Programming and Proving on a NC Milling Machine:- a. Point to Point Programming b. Absolute Programming c. Incremental Programming	CO1, CO4
8.	Part Programming and Proving for Milling a Rectangular Slot.	CO2, CO5

DOs and DON'Ts

DOs

1. Work deliberately and carefully.
2. Keep your work area clean.
3. Students must wear college uniform and carry their college ID.
4. Students should have separate note book for practical.
5. Students should have their own pencil, eraser, scale, along with pen and lab note book.
6. Handle the equipment /models carefully.

DON'Ts

1. Do not wander around the room, distract other students, startle other students or interfere with the laboratory experiments of others.
2. Do not eat food, drink beverages or chew gum in the laboratory.
3. Do not open any irrelevant internet sites on lab computer.

General Safety Precautions

Precautions (In case of Injury or Electric Shock)

1. To break the victim with live electric source, use an insulator such as fire wood or plastic to break the contact. Do not touch the victim with bare hands to avoid the risk of electrifying yourself.
2. Unplug the risk of faulty equipment. If main circuit breaker is accessible, turn the circuit off.
3. If the victim is unconscious, start resuscitation immediately, use your hands to press the chest in and out to continue breathing function. Use mouth-to-mouth resuscitation if necessary.
4. Immediately call medical emergency and security. Remember! Time is critical; be best.

Precautions (In case of Fire)

1. Turn the equipment off. If power switch is not immediately accessible, take plug off.
2. If fire continues, try to curb the fire, if possible, by using the fire extinguisher or by covering it with a heavy cloth, if possible, isolate the burning equipment from the other surrounding equipment.
3. Sound the fire alarm by activating the nearest alarm switch located in the hallway.

Guidelines to students for report preparation

All students are required to maintain a record of the experiments conducted by them. Guidelines for its preparation are as follows:

1) All files must contain a title page followed by an index page. The files will not be signed by the faculty without an entry in the index page.

2) Student's Name, Roll number and date of conduction of experiment must be written on all pages.

3) For each experiment, the record must contain the following

(i) Aim/Objective of the experiment

(ii) Pre-experiment work (as given by the faculty)

(iii) Lab assignment questions and their solutions

(iv) Test Cases (if applicable to the course)

(v) Results/ output

Note:

1. Students must bring their lab record along with them whenever they come for the lab.
2. Students must ensure that their lab record is regularly evaluated.

Experiment 1

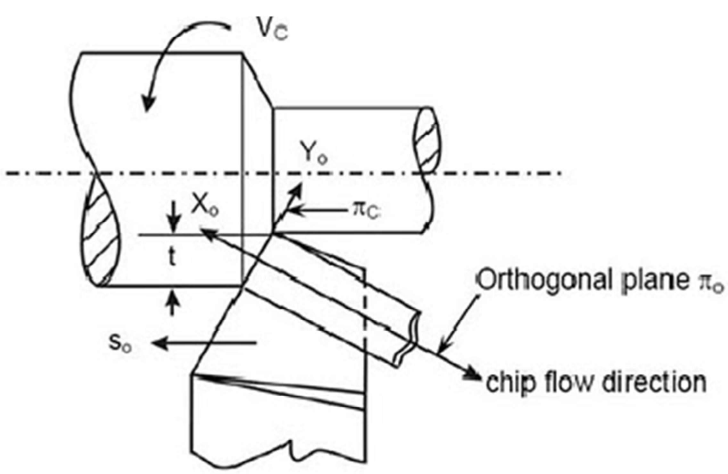
Aim: Study and Practice of Orthogonal & Oblique Cutting on a Lathe.

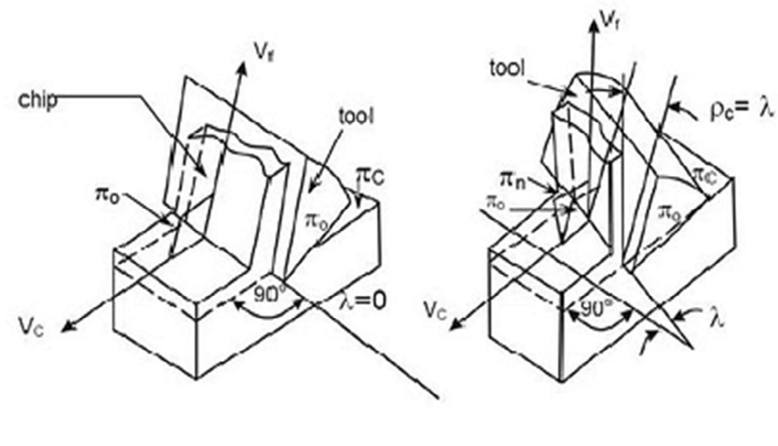
Apparatus: Lathe Machine

Theory:

It appears from the diagram in the following figure that while turning ductile material by a sharp tool, the continuous chip would flow over the tool's rake surface and in the direction apparently perpendicular to the principal cutting edge, i.e., along orthogonal plane which is normal to the cutting plane containing the principal cutting edge. But practically, the chip may not flow along the orthogonal plane for several factors like presence of inclination angle, etc. The role of inclination angle λ on the direction of chip flow is schematically shown in figure which visualizes that,

- when λ=0, the chip flows along orthogonal plane, i.e., ρ = 0
- when λ≠0, the chip flow is deviated from π and ρ = λ where ρ is chip flowdeviation (from π) angle





(a) $\lambda = 0$ (b) $\lambda \neq 0$

Orthogonal cutting: when chip flows along orthogonal plane, π , i.e., ρ = 0

Oblique cutting: when chip flow deviates from orthogonal plane, i.e. ρ ≠0 But practically ρ may be zero even if λ= 0 and ρ may not be exactly equal to λ even if λ≠0. Because there are some other (than λ) factors also which may cause chip flow deviation.

Result: Hence the study of Orthogonal & Oblique Cutting on a Lathe is completed.

Experiment 2

Aim: Machining time calculation and comparison with actual machining timewhile cylindrical turning on a Lathe and finding out cutting efficiency.

Apparatus: Lathe Machine

Theory:

The major aim and objectives in machining industries generally are;

• reduction of total manufacturing time, T
• increase in MRR, i.e., productivity
• reduction in machining cost without sacrificing product quality
• Increase in profit or profit rate, i.e., profitability.

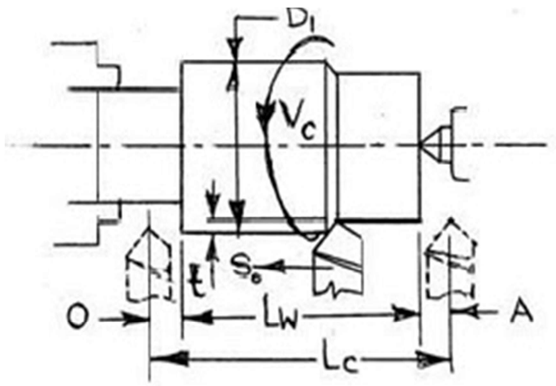
Hence, it becomes extremely necessary to determine the actual machining time TC required to produce a job mainly for,

• assessment of productivity
• evaluation of machining cost
• Measurement of labour cost component assessment of relative performance or capability of any machine tool, cutting tool, cutting fluid or any special or new techniques in terms of saving in machining time. The machining time, TC required for a particular operation can be determined roughly by calculation i.e., estimation or precisely, if required, by measurement. Measurement definitely gives more accurate result and in detail but is tedious and expensive. Whereas, estimation by simple calculations though may not be that accurate, is simple, quick and inexpensive. Hence, determination of machining time, especially by simple calculations using suitable equations is essentially done regularly for various purposes.

Procedure:

The factors that govern machining time will be understood from a simple case of machining. A steel rod has to be reduced in diameter from D1 to D2 over a length L by straight turning in

A centre lathe as indicated in Fig.



Calculations:

Sl No	L	A	O	L_C	V_C	D	N	S_O	D1	D2	T	n_p	T_c

Where,

L= length of the work piece in mm;A= approach run in mm;
O= over run in mm;
Lc=actual length of cut in mm; Vc= cutting velocity in mm/min;
D= diameter of the job before cut in mm;
N=spindle speed in rpm;
So= tool feed in mm/rev;
D1= initial diameter before passes in mm;
D2=final diameter after passes in mm; t=depth of cut in one pass in mm;
np=no of passes; Tc=machining time in min;

Result: The machining time of the turning operation is done and compar

Experiment 3

Aim: To study the Tool Life while Milling a component on the Milling Machine.

Apparatus: Milling Machine

Theory:

Tool life: Time of cutting during two successive milling or indexing of the tool. Tool life is thelength of cutting time that a tool can be used or a certain flank wearvalue has occurred(0.02”).
Taylor’s tool life equation:
$vT^n = C$
v = cutting speed
n = cutting exponent C
= cutting constant T =
tool life
n and C depend on speed, work material, tool material, etc.Cutting
Speed can be obtained by the formula as shown: N= (v*1000) /
(π*d)
Where :
N=spindle speed in rpm;
v=cutting speed in m/min;
d=diameter of cutter in mm;

Procedure:

1. Determine the cutting speed by using given d and N values.
2. Apply Taylor’s equation and the n and C values, we can solve for tool life.

Calculations:

Sl No	n	C	d	N	V	T

Result: Thus the tool life of milling cutter is found out.

Experiment 4

Aim: To study Tool wear of a cutting tool while Drilling on a Drilling Machine.
Apparatus: Drilling Machine

Theory ; Tool wears are classified as shown below

1. Gradual wear → Crater wear, Flank wear
2. Catastrophic wear → Breaking, chipping

Three basic wear mechanisms involved in tool wear:

1. Adhesive wear
2. Abrasive wear → Two body, Three body
3. Diffusion wear

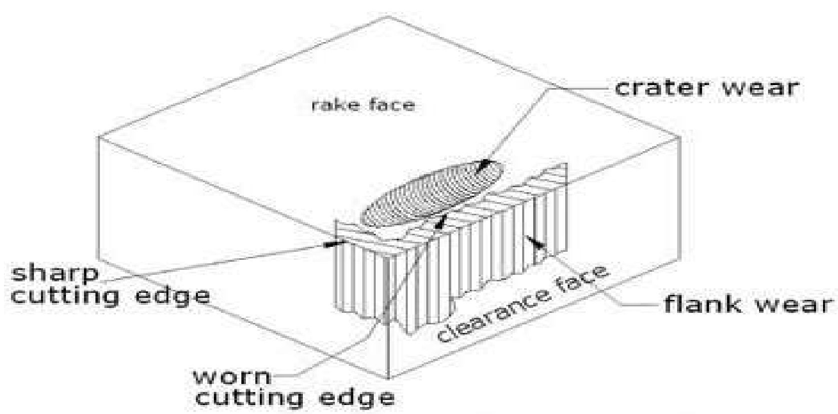


Figure 2. Flank and crater wear on the faces of cutting tool.

Crater wears:

Consists of a concave section on the tool face formed by the action of the chip sliding on the surface. Crater wear affects the mechanics of the process increasing the actual rake angle of the cutting tool and consequently, making cutting easier. At the same time, the crater wear weakens the tool wedge and increases the possibility for tool breakage. In general, crater wear is of a relatively small concern.

Flank wear:

Occurs on the tool flank as a result of friction between the machined surface of the work piece and the tool flank. Flank wear appears in the form of so-called wear land and is measured by the width of this wear land, VB, Flank wear affects to the great extend the mechanics of cutting. Cutting forces increase significantly with flank wear. If the amount of flank wear exceeds some critical value (VB > 0.5~0.6 mm), the excessive cutting force may cause tool failure.

Catastrophic wear (Built up Edge):

In single point cutting of metals, a built up edge (BUE) is an accumulation of material against the rake face that seizes to the tool tip, separating it from the chip. The built up edge effectively changes tool geometry and rake steepness. It also reduces the contact area between the chip and thecutting tool, leading to:

- A reduction in the power demand of the cutting operation.
- Slight increase in tool life, since the cutting is partly being done by the built up edge rather than the tool itself.

Abrasion wear: this is a mechanical wearing action due to hard particles in the work material gouging and removing small portions of the tool.
Location: both on rake and flank faces.

Adhesion wear: as the cutting chip flows across the tool under high temperature and high pressure, small particles of the tool are "welded" to the chip surface and taken away.

Location: mostly on the rake face.
Diffusion wear: is a process in which an exchange of atoms takes place across a close contact atthe tool-chip boundary between two materials.
Location: on the rake face.

Experiment 5

Aim: To study the Speed, Feed, Tool, Preparatory (Geometric) and miscellaneous functions forNC part programming

Apparatus: NC Milling Machine

Theory:

Part program: A computer program to specify

- Which tool should be loaded on the machine spindle?
- What are the cutting conditions (speed, feed, coolant ON/OFF etc?)
- The start point and end point of a motion segment
- How to move the tool with respect to the machine.

CNC G-codes: Preparatory Functions– involve actual tool moves.G00 - Positioning at rapid speed; Mill and Lathe
G01 - Linear interpolation (machining a straight line); Mill and Lathe
G02 - Circular interpolation clockwise (machining arcs); Mill and Lathe G03 - Circular interpolation, counter clockwise; Mill and Lathe
G04 - Mill and Lathe, Dwell
G09 - Mill and Lathe, Exact stop
G10 - Setting offsets in the program; Mill and Lathe G12 - Circular pocket milling, clockwise; Mill
G13 - Circular pocket milling, counterclockwise; Mill
G17 - X-Y plane for arc machining; Mill and Lathe with live tooling G18 - Z-X plane for arc machining; Mill and Lathe with live tooling G19 - Z-Y plane for arc machining; Mill and Lathe with live tooling G20 - Inch units; Mill and Lathe
G21 - Metric units; Mill and Lathe
G27 - Reference return check; Mill and Lathe
G28 - Automatic return through reference point; Mill and Lathe

G29 - Move to location through reference point; Mill and Lathe (slightly different for eachmachine)
G31 - Skip function; Mill and
Lathe G32 - Thread cutting;
Lathe
G33 - Thread cutting; Mill
G40 - Cancel diameter offset; Mill. Cancel tool nose offset; Lathe
G41 - Cutter compensation left; Mill. Tool nose radius compensation left;
Lathe G42 - Cutter compensation right; Mill. Tool nose radius compensation
right; LatheG43 - Tool length compensation; Mill
G44 - Tool length compensation cancel; Mill (sometimes
G49)G50 - Set coordinate system and maximum RPM;
Lathe
G52 - Local coordinate system setting; Mill and
Lathe G53 - Machine coordinate system setting; Mill
and Lathe
G54~G59 - Work piece coordinate system settings #1 t0 #6; Mill and Lathe
G61 - Exact stop check; Mill and
Lathe G65 - Custom macro call; Mill
and LatheG70 - Finish cycle; Lathe
G71 - Rough turning cycle;
LatheG72 - Rough facing
cycle; Lathe
G73 - Irregular rough turning cycle;
LatheG73 - Chip break drilling cycle;
Mill
G74 - Left hand tapping; Mill
G74 - Face grooving or chip break drilling;
LatheG75 - OD groove pecking; Lathe
G76 - Fine boring cycle;
MillG76 - Threading
cycle; Lathe
G80 - Cancel cycles; Mill and
LatheG81 - Drill cycle; Mill and

Lathe G82 - Drill cycle with
dwell; Mill G83 - Peck drilling
cycle; Mill
G84 - Tapping cycle; Mill and
Lathe G85 - Bore in, bore out; Mill
and Lathe G86 - Bore in, rapid out;
Mill and LatheG87 - Back boring
cycle; Mill
G90 - Absolute
programming G91 -
Incremental programming
G92 - Reposition origin point;
MillG92 - Thread cutting
cycle; Lathe G94 - Per minute
feed; Mill
G95 - Per revolution feed; Mill
G96 - Constant surface speed control;
LatheG97 - Constant surface speed
cancel
G98 - Per minute feed;
Lathe G99 - Per revolution
feed; **Lathe**

CNC M Codes: Miscellaneous Functions – involve actions necessary for machining (i.e. spindleon/off, coolant on/off).

M00 - Program stop; Mill and Lathe
M01 - Optional program stop; Lathe and
MillM02 - Program end; Lathe and Mill
M03 - Spindle on clockwise; Lathe and Mill
M04 - Spindle on counterclockwise; Lathe and
MillM05 - Spindle off; Lathe and Mill
M06 - Tool change; Mill
M08 - Coolant on; Lathe and

Mill M09 - Coolant off; Lathe
and Mill
M10 - Chuck or rotary table clamp; Lathe and Mill
M11 - Chuck or rotary table clamp off; Lathe and
MillM19 - Orient spindle; Lathe and Mill
M30 - Program end, return to start; Lathe and
Mill M97 - Local sub-routine call; Lathe and
Mill
M98 - Sub-program call; Lathe and
Mill M99 - End of sub program; Lathe
and Mill

CNC N Codes: Gives an identifying number for each block of information.

X, Y, and Z codes are used to specify the coordinate axis.

• Number following the code defines the coordinate at the end of the move relative to anincremental or absolute reference point.
• The number may require that a specific format be used (i.e. 3.4 means three numbers before thedecimal and four numbers after the decimal).
I, J, and K codes are used to specify the coordinate axis when defining the center of a circle.
• Number following the code defines the respective coordinate for the center of the circle.
The number may require that a specific format be used (i.e. 3.4 means three numbers before the decimal and four numbers after the decimal).

F-code: used to specify the feed rate
S-code: used to specify the spindle speed
T-code: used to specify the tool identification number associated with the tool to be used insubsequent operations.

R-code:

•Retract distance when used with G81, 82, and 83.
•Radius when used with G02 and G03.

P-code: Used to specify the dwell time associated WI

Experiment 6

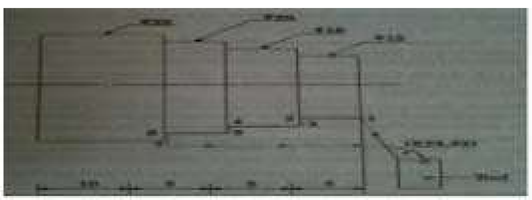
Aim: To study Part Programming and proving on a NC lathe for:-

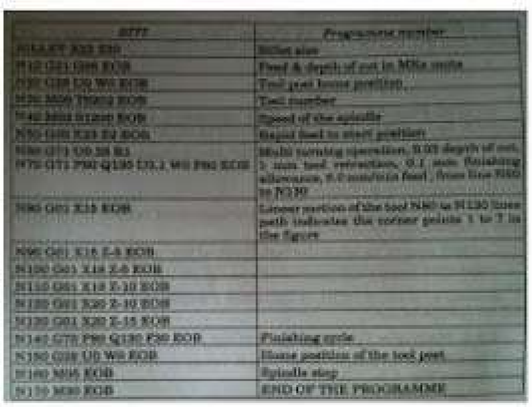
a. Outside Turning
b. Facing and Step Turning
c. Taper Turning
d. Drilling
e. Outside Threading

Apparatus: NC Lathe Machine

Procedure:

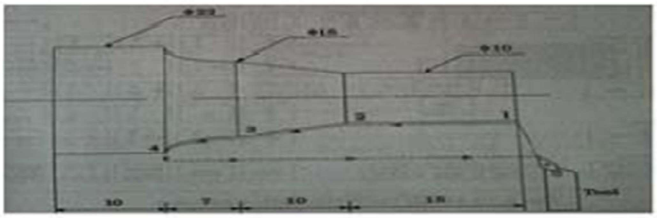
Example for step turning.





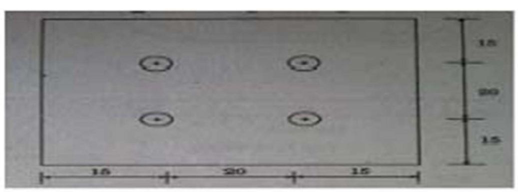
[illegible]	Programme number
N[illegible] X22 Z[illegible]	Billet size
N10 G21 G98 EOB	Feed & depth of cut in MM units
N20 G28 U0 W0 EOB	Tool post home position.
N30 M06 T0202 EOB	Tool number
N40 M03 S1200 EOB	Speed of the spindle
N50 G00 X23 Z2 EOB	Rapid feed to start position
N60 G71 U0.25 R1 N70 G71 P80 Q130 U0.1 W0 F80 EOB	Multi turning operation, 0.25 depth of cut, 1 mm tool retraction, 0.1 mm finishing allowance, [illegible] mm/min feed, from line N80 to N130
N80 G01 X15 EOB	Linear motion of the tool N80 to N130 lines path indicates the corner points 1 to 7 in the figure
N90 G01 X15 Z-5 EOB	
N100 G01 X18 Z-5 EOB	
N110 G01 X18 Z-10 EOB	
N120 G01 X20 Z-10 EOB	
N130 G01 X20 Z-15 EOB	
N140 G70 P80 Q130 F30 EOB	Finishing cycle
N150 G28 U0 W0 EOB	Home position of the tool post
N160 M05 EOB	Spindle stop
N170 M30 EOB	END OF THE PROGRAMME

Example for taper turning.



0888	Programme number
BILLET X23 Z45	Billet size
N10 G21 G98	Feed & depth of cut in MKS units
N20 G28 U0 W0	Tool post home position
N30 M06 T0202	Tool number
N40 M03 S1200	Speed of the spindle
N50 G00 X21 Z2	Rapid feed to start position
N60 G71 U0.25 R1	Multi turning operation, 3.25 depth of cut, 1 mm tool retraction, 0.1 mm finishing allowance, 60 mm/min feed , from line N60 to N130
N70 G71 P80 Q120 U0.1 W0 F60	
N80 G01 X10	Linear motion of the tool
N90 G01 X10 Z-15	
N100 G01 X15 Z-25	
N110 G03 X22 Z-32 R7	Counter clockwise arc X22
N120 G01 X22 Z-42	
N130 G70 P80 Q120	Finishing cycle
N140 G28 U0 W0	Home positon for the tool post
N150 M05	Spindle stop
N160 M30	END OF THE PROGRAMME

Example for taper Drilling.

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N01 G90 EOB
N02 G17 EOB
N03 M06 EOB
N04 G01 X15 Y15 F60 EOB
N05 L701 EOB
N06 G01 X15 Y35 F60 EOB
N07 L701 EOB
N08 G01 X35 Y35 EOB
N09 L701 EOB
N10 G01 X35 Y15 F60 EOB
N11 L701 EOB
N12 G01 Z5 F10 EOB
N13 G00 X0 Y0 EOB
N14 M05 EOB
N15 M30 EOB
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Result: Hence, the study of NC programming is completed.

Experiment 7

AIM: To study the Part Programming and Proving on a NC Milling Machine:-

a. Point to Point Programming

b. Absolute Programming

C. Incremental Programming

Apparatus: NC Milling M/C

Procedure:

Point to Point Programming

In point to point system, the machining is done at specific positions. The working-piece remains unaffected as the tool moves from one position to the next. The system is the simplest. In fig.1, after drilling the hole at position A, the tool moves to position B, along the dotted line. A drillingmachine is the best example of point to point system.

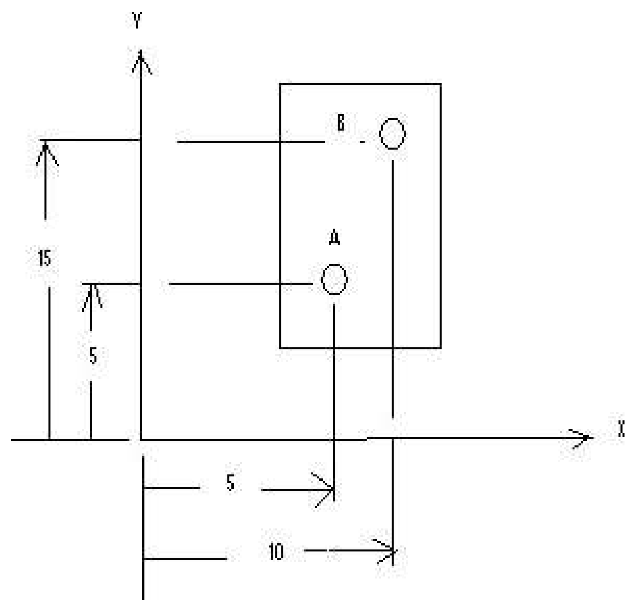
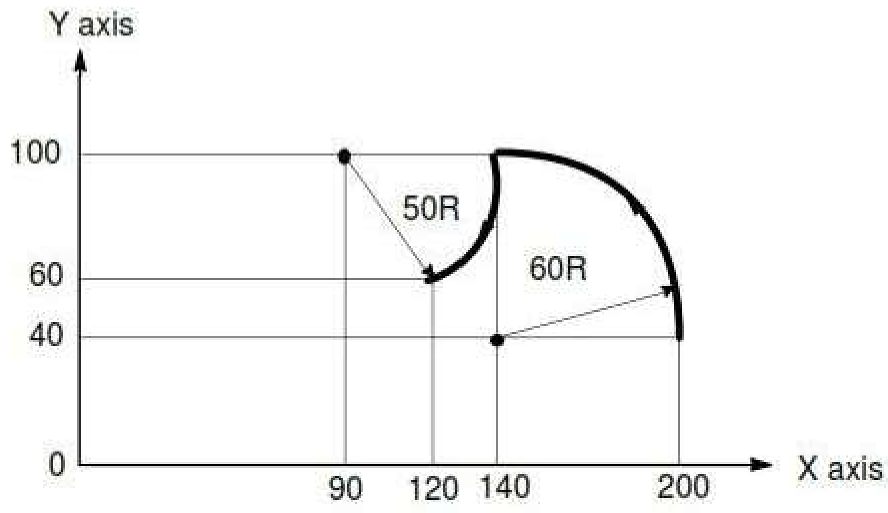


Figure-1

CNC Absolute Programming G90 Example Code

With absolute positioning, we tell the machine where to move based on a common point, called X0 Y0 and Z0. Every time we need to move to a certain position, the ending point of that moveis in direct relationship to this "common point".

This CNC example code illustrates the usage of CNC Absolute Programming G90 G-Code andIncremental Programming G91 G-Code, as well as the usage of Circular Interpolation G-Code (G02/G03).



CNC Mill Programming Absolute Incremental G90 G91 Example Code

Mill Circular Interpolation G02 G03 with R

```
G92 X200 Y40 Z0

G90 G03 X140 Y100
R60 F300 G02 X120
Y60 R50
```

Mill Circular Interpolation G02 G03 with I

```
G92 X200 Y40 Z0

G90 G03 X140 Y100
I-60 F300 G02 X120
Y60 I-50
```

CNC Incremental Programming G91 Example Code

With incremental positioning, we are telling the machine where to go in relationship to where itcurrently is at. Basically like a set of directions given from where the machine stopped last.

Mill Circular Interpolation G02 G03 with R

```
G91 G03 X-60 Y60 R60
F300G02 X-20 Y-40
R50
```

Mill Circular Interpolation G02 G03 with I

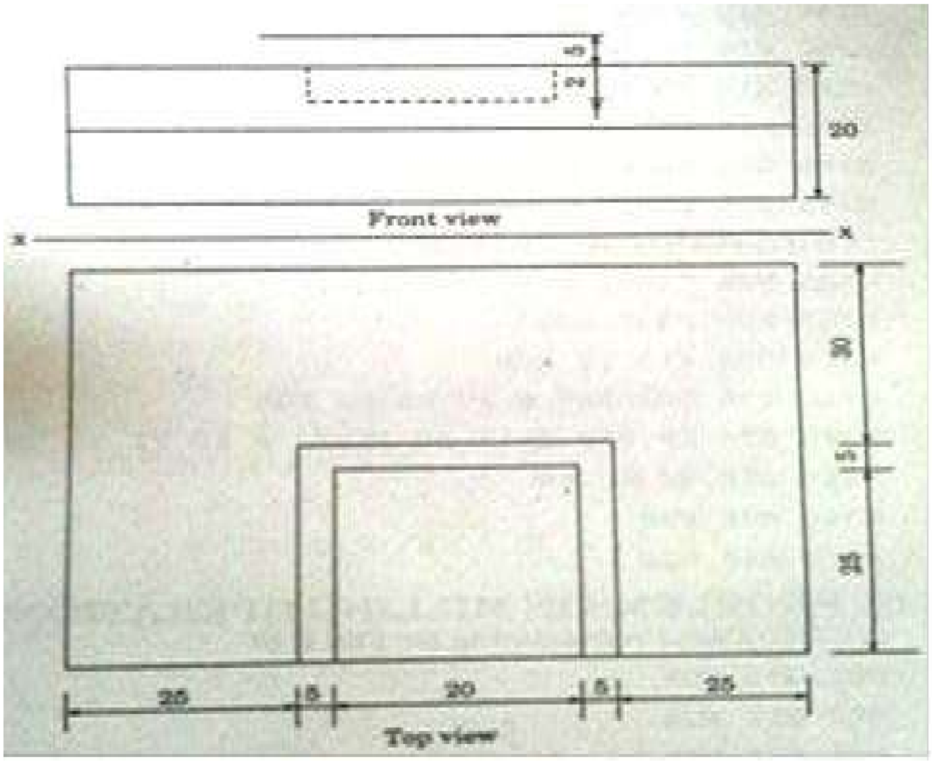
```
G91 G03 X-60 Y60 I-60
F300G02 X-20 Y-40I-50
```

Experiment 8

Aim: To study the part programming on a NC Milling Machine for a Rectangular Slot.

Apparatus: NC Milling Machine

Procedure:



N01 G90

EOB N02

G17 EOB

N03 M06

EOB N04

M04 S1200

N05 G01 X27.5 Y-7.5 F30

EOBN06 G01 Z-5.6 EOB

N07 L601

EOBN08

Z-6.3 EOB

N09 L601 EOB N140 M17

EOBN010 Z-7.0 EOB

N011 L601

EOBN012

Z5 EOB

N013 GO X0 Y0

EOBN014 M05

EOB

N015 M30 E

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