DRONACHARYA
College of Engineering

LABORATORY MANUAL

B.Tech. Semester- VI

MANUFACTURING TECHNOLOGY -II
Subject code: LC-ME-310G

Prepared by:

Mrs. Neha Chauhan

Sign.: ……………………..

Checked by:

Mrs. Neha Chauhan

Sign.: ………………….

Approved by:

Name : Prof. (Dr.) Isha Malhotra

Sign.: ………………….

DEPARTMENT OF MECHANICAL ENGINEERING
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:

1. To prepare students for full and ethical participation in a diverse society and encourage lifelong learning by following the principle of 'Shiksha evam Sahayata' i.e. Education & Help.

2. To impart high-quality education, knowledge and technology through rigorous academic programs, cutting-edge research, & Industry collaborations, with a focus on producing engineers& managers who are socially responsible, globally aware, & equipped to address complex challenges.

3. Educate students in the best practices of the field as well as integrate the latest research into the academics.
4. Provide quality learning experiences through effective classroom practices, innovative teaching practices and opportunities for meaningful interactions between students and faculty.
5. To devise and implement programmes of education in technology that are relevant to the changing needs of society, in terms of breadth of diversity and depth of specialization.

Vision and Mission of the Mechanical Department

Vision:

"To become a Centre of Excellence in teaching and research in the field of Mechanical Engineering for producing skilled professionals having a zeal to serve society."

Mission:

M1: To create an environment where students can be equipped with strong fundamental concepts, various experiments and problem solving skills.

M2: To provide an exposure to emerging technologies by providing hands on experience for generating competent professionals.

M3: To promote Research and Development in the frontier areas of Mechanical Engineering and encourage students for pursuing higher education.
M4: To inculcate in students ethics, professional values, team work and leadership skills.

Programme Educational Objectives (PEOs)

PEO 1: Engineers will practice the profession of engineering using a systems perspective and analyze, design, develop, optimize & implement engineering solutions and work productively as engineers, including supportive and leadership roles on multidisciplinary teams.

PEO 2: Continue their education in leading graduate programs in engineering & interdisciplinary areas to emerge as researchers, experts, educators & entrepreneurs and recognize the need for, and an ability to engage in continuing professional development and life-long learning.

PEO 3: Engineers, guided by the principles of sustainable development and global interconnectedness, will understand how engineering projects affect society and the environment.

PEO 4: Promote Design, Research, and implementation of products and services in the field of Engineering through Strong Communication and Entrepreneurial Skills.

PEO 5: Re-learn and innovate in ever-changing global economic and technological environments of the 21st century.

Programme Outcomes (POs)

1. Apply knowledge of computing, mathematical foundations, algorithmic principles, and engineering theory in the modeling and design of systems to real-world problems (fundamental engineering analysis skills).
2. Apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline.
3. Design and conduct experiments, as well as to analyze and interpret data (information retrieval skills). Practical application of engineering skills, combining theory and experience, and use of other relevant knowledge and skills.
4. Analyze a problem, identify, formulate and use the appropriate computing and engineering requirements for obtaining its solution(engineering problem solving skills).
5. Understand the appropriate codes of practice and industry standards.
6. Identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques.
7. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues.
8. Communicate effectively, both in writing and orally (speaking / writing skills).
9. Understand professional, ethical, legal, security and social issues and responsibilities (professional integrity).
10. Understand customer and user needs and the importance of considerations such as Aesthetics.
11. Use creativity to establish innovative solutions.
12. Adapt to a rapidly changing environment by having learned and applied new skills and new technologies.
13. To Significantly contribute to delivery of desired component, product, or process.
14. Formulate and solve moderately complex engineering problems, accounting for hardware/software/human interactions.
15. Recognize the importance of professional development by pursuing postgraduate studies or face competitive examinations that offer challenging and rewarding careers in computing.
16. Apply the Knowledge of management techniques which may be used to achieve engineering Objectives within that context

Program Specific Outcomes (PSOs)

On successful completion of the Mechanical Engineering Degree programme, the Graduates shall exhibit the following:

PSO1: Apply the knowledge gained in Mechanical Engineering for design and development and manufacture of engineering systems.

PSO2: Apply the knowledge acquired to investigate research-oriented problems in mechanical engineering with due consideration for environmental and social impacts

PSO3: Use the engineering analysis and data management tools for effective management of multidisciplinary projects.

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 NC 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.

NOTE: . At least Six experiments are to be performed in the Semester.

Course Outcomes (COs)

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

CO310.1- Acquire knowledge about mechanics of chip formation and to identify the factors related to tool wear and machinability.

CO310.2- Learn about different gear manufacturing and gear finishing operations.

CO310.3- Select the proper cutting tool material and components of jigs and fixtures.

CO310.4- Understand the basics principles of non-conventional machining processes and their applications.

CO310.5- Identify and select different measuring instruments for the inspection of different components.

CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PO16
CO310.1	3	3	3	-	2	-	3	3	3	2	-	3	3	-	-	3
CO310.2	-	3	-	-	2	3	-	-		2	-	3	-	-	2	3
CO310.3	-	-	3	3		3	-	-	3	-	3	-	3	3	-	
CO310.4	3	-	3	-	2	-	3	3	-	2	-	3	-	3	2	3
CO310.5	3	3	-	3	-	3	-	-	3	2	3	-	3	3	-	3

CO-PSO Mapping

	PSO1	PSO2	PSO3
CO310.1	3	2	-
CO310.2	2	3	-
CO310.3	3	2	-
CO310.4	3	2	3
CO310.5	2	3	3

Course Overview

Course provide knowledge on machines and related tools for manufacturing various components. It help students to understand the relationship between process and system in manufacturing domain and to identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

List of Experiments

S. No.	NAME OF EXPERIMENTS	Course Outcomes
1	Study and Practice of Orthogonal & Oblique Cutting onLathe.	CO310.1, CO310.3, CO310.5
2	Machining time calculation and comparison with actual machining time while cylindrical turning on a Lathe andfinding out cutting efficiency.	CO310.1, CO310.2, CO310.5
3	Study of Tool Life while Milling a component on the Milling Machine.	CO310.1, CO310.3
4	Study of Tool Wear of a cutting tool while Drilling on aDrilling Machine.	CO310.1, CO310.3
5	Study of Speed, Feed, Tool, Preparatory (Geometric)and Miscellaneous functions for N. C part programming.	CO310.2
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	CO310.3, CO310.4
7	Part Programming and Proving on a NC MillingMachine:- a. Point to Point Programming b. Absolute Programming c. Incremental Programming	CO310.3, CO310.4
8	Part Programming and Proving for Milling a Rectangular Slot.	CO310.3, CO310.4

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.

Emergency: Reception

Security: Main Gate

Lab assessment criteria

Grading Criteria	Exemplary (4)	Competent (3)	Needs Improvement (2)	Poor (1)
AC1: Pre-Lab written work (this may be assessed through viva)	Complete procedure with underlined concept is properly written	Underlined conceptis written but procedure is incomplete	Not able to write concept and procedure	Underlined conceptis not clearly understood
AC2: Program Writing/ Modeling	Assigned problem is properly analyzed, correct solution designed, appropriate language constructs/tools are applied.	Assigned problem is properly analyzed, correct solution designed, appropriate language constructs/ tools are applied	Assigned problem is properly analyzed & correct solution designed	Assigned problem isproperly analyzed
AC3: Identification & Removal of errors/ bugs	Program/solution written is readable Able to identify errors/ bugs and remove them	Able to identify errors/ bugs and remove them with little bit of guidance	Is dependent totallyon someone for identification of errors/ bugs and their removal	Unable to understand the reason for errors/ bugs even after they are explicitly pointed out Solution is not well demonstrated and implemented concept is not clearly explained
AC4:Execution & demonstration	All variants of input /output are tested, Solution is well demonstrated and implemented concept is clearly explained	All variants of input /output are not tested, However, solution is well demonstrated and implemented concept is clearly explained	Only few variants of input /output are tested, Solution is well demonstrated but implemented concept is not clearly explained	Less than 40 % of the assigned problems are well recorded with objective, design contracts and solution along with
AC5:Lab Record Assessment	All assigned problems are well recorded with objective, design constructs and solution along with Performance analysis using all variants of input and output	More than 70 % of the assigned problems are well recorded with objective, design contracts and solution along with Performance analysis is done with all variants ofinput and output	Less than 70 % of the assigned problems are well recorded with objective, design contracts and solution along Performance analysis is done with all variants ofinput and output	Performance analysis is done with all variants of input and output

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 No. 1

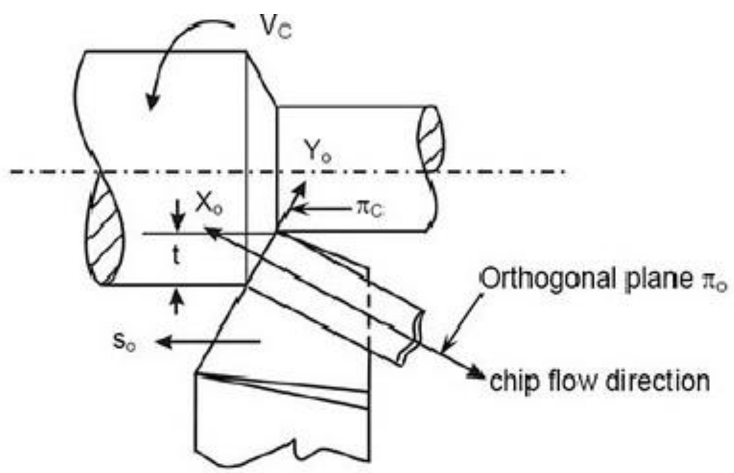
Aim: Study and Practice of Orthogonal & Oblique Cutting on a Lathe.

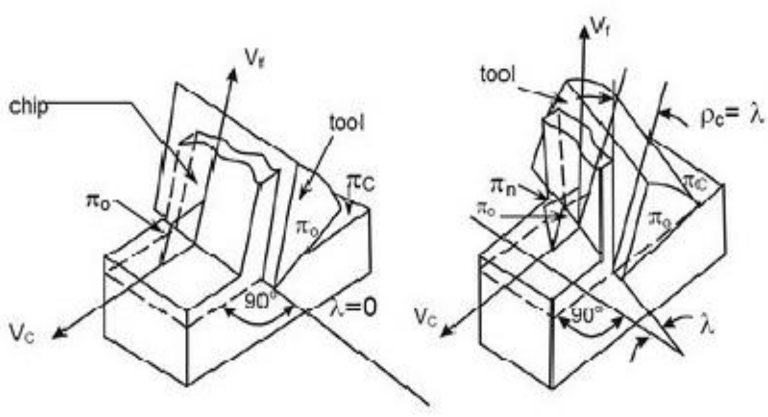
Apparatus: Lathe Machine

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 flow deviation (from π) angle





(a) λ = 0 (b) λ ≠ 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 No. 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;

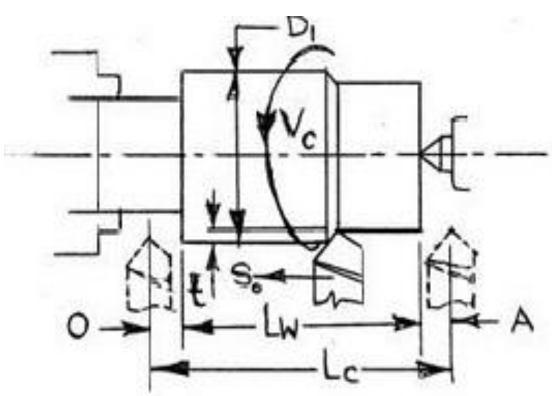
• reduction of total manufacturing time, T
• increase in MRR, i.e., productivity
• reduction in machining cost without sacrificing product quality
• Increase in profit or profit rate, i.e., profitability.

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 ina 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 compared.

Experiment No. 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 No. 4

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

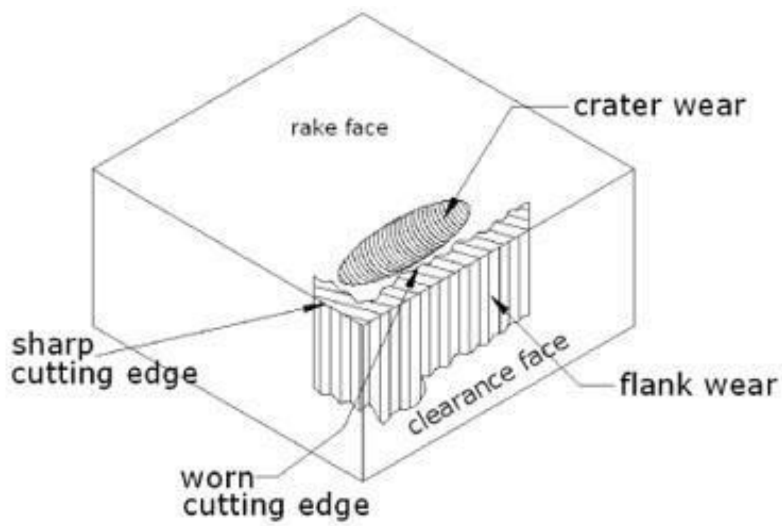
Apparatus: Drilling Machine

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



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.

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

Experiment No. 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 LatheG03 - 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 toolingG18 - Z-X plane for arc machining; Mill and Lathe with live toolingG19 - Z-Y plane for arc machining; Mill and Lathe with live toolingG20 - 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 LatheG32 - 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
MillM09 - 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
MillM97 - 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 No. 6

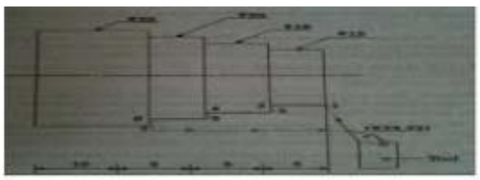
Aim: To study Part Programming and proving on a NC lathe for:-

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

Apparatus: NC Lathe Machine

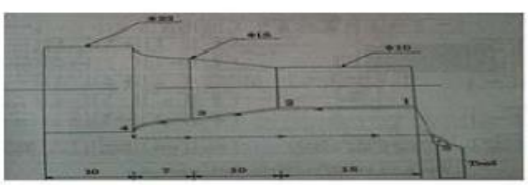
Procedure:

Example for step turning.



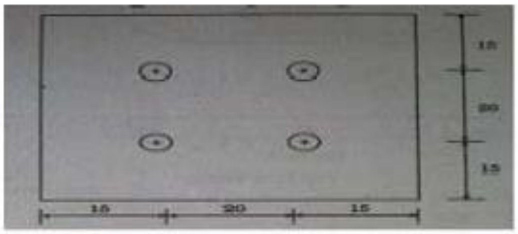
[illegible]	Programme number
BILLET X22 Z30	Billet size
N10 G21 G98 EOB	Feed & depth of cut in MKs units
N20 G28 U0 W0 EOB	Tool post home position
N30 M06 T0202 EOB	Tool number
N40 M03 S1200 EOB	Speed of the spindle
N50 G00 X22 Z2 EOB	Rapid feed to start position
N60 G71 U0.25 R1 N70 G71 P80 Q130 U0.1 W0 F60 EOB	Multi turning operation, 0.25 depth of cut, 1 mm tool retraction, 0.1 mm finishing allowance, 6.0 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



[illegible]	Programme number
BILLET X22 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, 0.25 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 position for the tool post
N150 M05	Spindle stop
N160 M30	END OF THE PROGRAMME

Example for taper Drilling.




```
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
```

Result: Hence, the study of NC programming is completed.

Results: Student will able to generate the milling programme.

Experiment No. 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 drilling machine is the best example of point to point system.

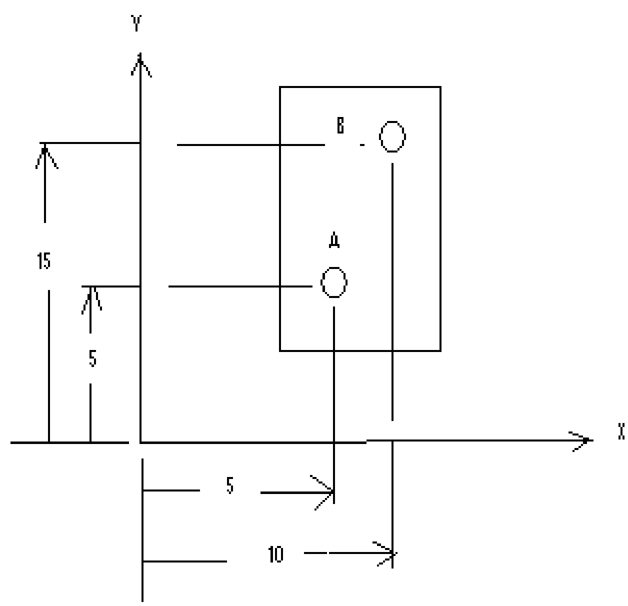
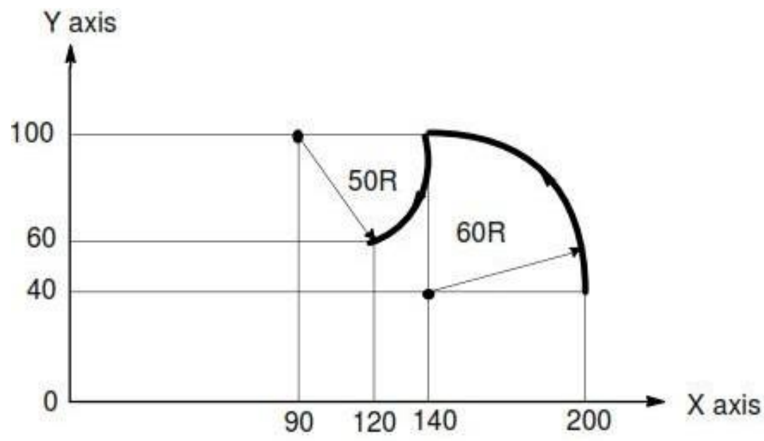


Figure-1

CNC Absolute Programming G90 Example

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 move is in direct relationship to this “common point”.

This CNC example code illustrates the usage of CNC Absolute Programming G90 G-Code and Incremental 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
F300G02 X120 Y60 R50

Mill Circular Interpolation G02 G03 with I

G92 X200 Y40 Z0

G90 G03 X140 Y100 I-60
F00G02 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 it currently 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 F300
G02 X-20 Y-40 R50

Mill Circular Interpolation G02 G03 with I

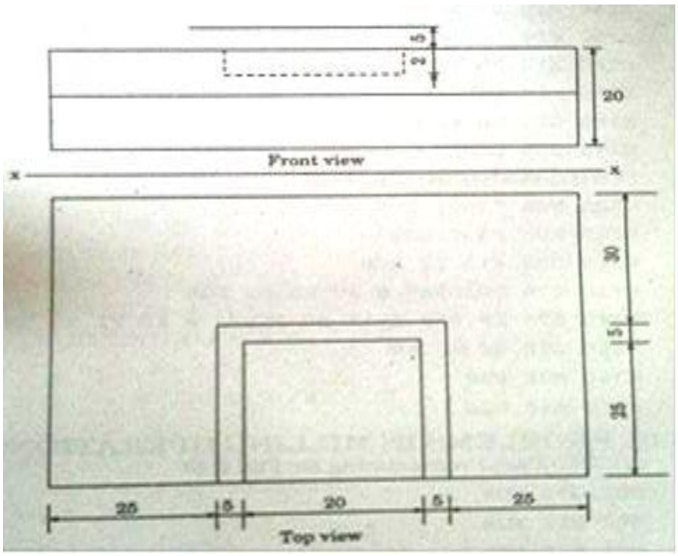
G91 G03 X-60 Y60 I-60 F300
G02 X-20 Y-40I-50

Results: Student will able to generate the milling programme.

Experiment No. 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 EOB

N06 G01 Z-5.6 EOB

N07 L601 EOB

N08 Z-6.3 EOB

N09 L601 EOB N140 M17 EOB

N010 Z-7.0 EOB

N011 L601 EOB

N012 Z5 EOB

N013 GO X0 Y0 EOB

N014 M05 EOB

N015 M30 EO

Results: Student will able to generate the Milling programme.

Viva Questions

1. What is the difference between orthogonal cutting and oblique cutting?
2. How does the cutting angle affect the chip formation in orthogonal cutting?
3. Explain the concept of shear angle in oblique cutting and its significance.
4. Discuss the advantages and limitations of using orthogonal cutting in lathe operations.
5. How do you calculate the machining time for cylindrical turning on a lathe?
6. How is the feed rate determined, and what factors should be considered when setting the feed rate for a specific machining operation?
7. Explain the factors that can affect the actual machining time in practice.
8. Define cutting efficiency and describe how it is calculated in lathe operations.
9. Discuss the importance of analyzing and improving cutting efficiency in machining processes.
10. what considerations should be taken into account when selecting the appropriate speed for a specific machining operation?
11. Define tool wear in drilling and discuss its causes.
12. Explain the different types of tool wear encountered during drilling operations.
13. Discuss the consequences of excessive tool wear on the quality of drilled holes.
14. Describe the preventive measures and strategies to minimize tool wear in drilling.
15. What is the purpose of the Speed function in NC part programming?
16. What factors influence the selection of the feed rate in NC part programming?
17. What information is typically included in the Tool function of NC part programming?
18. What are the main types of Preparatory (Geometric) and Miscellaneous functions used in NC part programming?
19. How is the tool selected and specified within the program, and what implications does it have on the machining operation?