



TURNING MANUFACTURING PROCESS

VOLUME 1



NAZIHAH MOHD NOOR
NORHAYATI BINTI MOHD
AMIRTHAVALLI A/P GOVINDAN



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AUTHORS

NAZIHAH MOHD NOOR

Mechanical Engineering Department

NORHAYATI BINTI MOHD

Mechanical Engineering Department

AMIRTHAVALLI A/P GOVINDAN

Mechanical Engineering Department

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ABOUT AUTHOR'S

Nazriah Mohd Noor



Currently a Senior Lecturer in Mechanical Engineering Department, Politeknik Ungku Omar (PUO), Perak and has 15 years experienced in lecturing. I obtained my first degree in Bachelor of Engineering (Mechanical) and Master Degree in Master of Engineering (Mechanical) from University Tun Hussein Onn Malaysia (UTHM), Johor. I also had an experienced in teaching CAD/CAM and CNC Technology more than 10 years.

Norhayati binti Mohd

With over 30 years of service as a lecturer, I have honed my expertise in the field of Mechanical Engineering. Over the past decade, I have also been actively involved in assisting with AUTOCADD classes, leveraging my extensive knowledge to support the students in class. I hold a Master's degree in Mechanical Engineering from Universiti Tun Hussein Onn Malaysia (UTHM), which has further solidified my commitment to excellence in education and the continuous advancement of technical skills.



Amirthavalli a/p Govindan



Senior Lecturer in Mechanical Engineering Department, Politeknik Ungku Omar (PUO), Perak and has 21 years of experience in lecturing. She obtained her first degree in Bachelor of Mechanical Engineering from Kolej University Tun Hussein Onn Malaysia, Johor and Master Degree in Master of Engineering (Manufacturing) from University Kebangsaan Malaysia (UKM), Selangor. She is experienced in teaching CAD and Quality Management Processes for more than 10 years.

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Finally, million thanks go to all people who have supported us during the journey to completely the eBook directly and indirectly.

Thank You



PREFACE

This eBook is about turning manufacturing process. It is a fundamental machining technique used to produce cylindrical parts by removing material from a workpiece using a cutting tool on a lathe machine.

This process is essential for creating precise components used across various industries, including automotive, aerospace, and medical devices

Hopefully this eBook enhances your knowledge and understanding about turning manufacturing process.



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T O P I C

01

TURNING MANUFACTURING PROCESS OVERVIEW

Definition of Turning Process :

Turning is a machining process where a cutting tool removes material from a rotating workpiece to create a desired shape, often cylindrical in nature. It is a foundational to subtractive manufacturing techniques.

Significance in Manufacturing:

Turning plays a critical role in the machining sector, providing precision and efficiency in producing components with tight tolerance and high surface quality, vital for many industries.

TURNING MANUFACTURING PROCESS OVERVIEW

Industry Relevance:

The turning process is prevalent across various sectors, including automotive, aerospace and medical manufacturing, highlighting its versatility and necessity in modern production environments.



T O P I C

02

An illustration of a hand holding a megaphone, with sound waves emanating from it. The hand is orange, and the megaphone has a dark blue handle and a yellow cone. The background is white with some purple decorative elements.

UNDERSTANDING THE TURNING PROCESS

A yellow rectangular box with a thin black border, containing the text 'CORE DEFINITION:'.

CORE DEFINITION:

Turning specifically refers to the removal of material from a workpiece while it is rotating, achieved through various cutting tool configurations that engage with the surface

A pink rectangular box with a thin black border, containing the text 'KEY COMPONENTS:'.

KEY COMPONENTS:

Key elements of the turning process include the workpiece, spindle, cutting tool, and feed mechanism, each playing integral roles in achieving precise outcomes.

UNDERSTANDING THE TURNING PROCESS



MACHINE TOOL UTILIZED:

Turning is primarily conducted using lathe machines, which can be classified into manual, CNC and special-purpose lathes each offering different capabilities and control levels

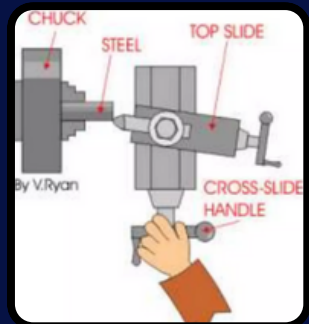
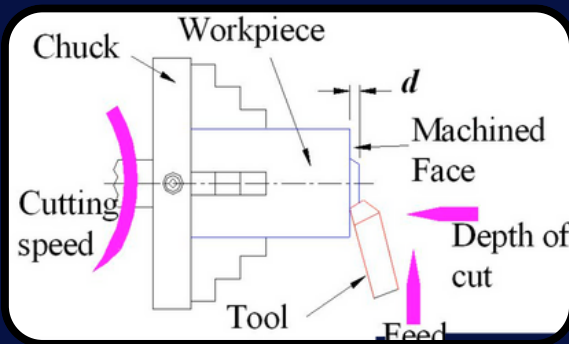
T O P I C

03

Type of _____ Turning Operations

FACING

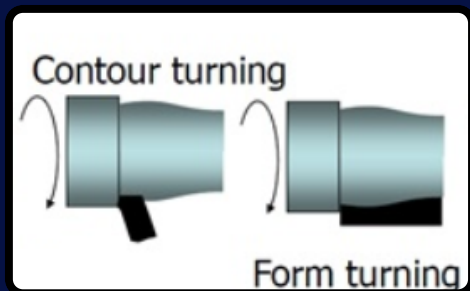
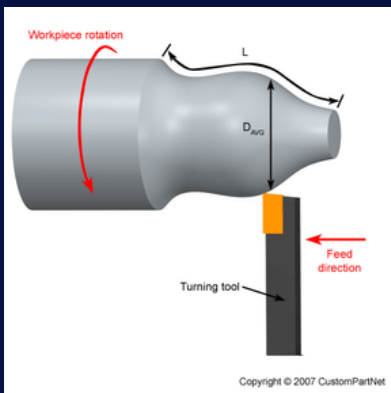
A turning operation that involves machining the surface of the workpiece to create a flat, smooth surface perpendicular to the axis of rotation, typically at the beginning of the machining



Type of _____ Turning Operations

CONTOURING

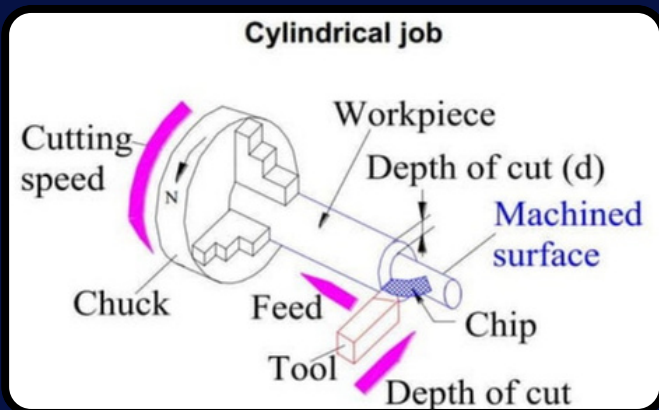
This operation is used to create complex shapes and profiles on the workpiece by continuously varying the position of the cutting tool in relation to the workpiece surface.



Type of _____ Turning Operations

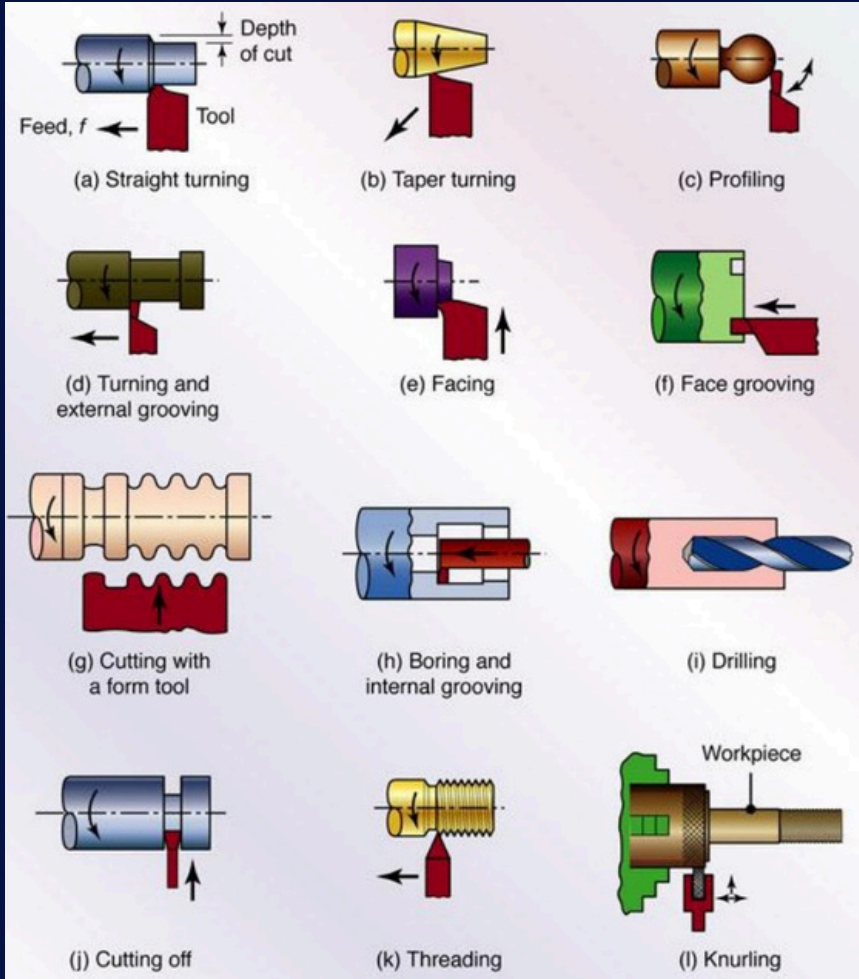
TAPER TURNING & THREAD CUTTING

Taper turning creates conical shapes, whereas thread cutting produces helical ridges around a cylindrical surface, both enhancing the functionality of turned component



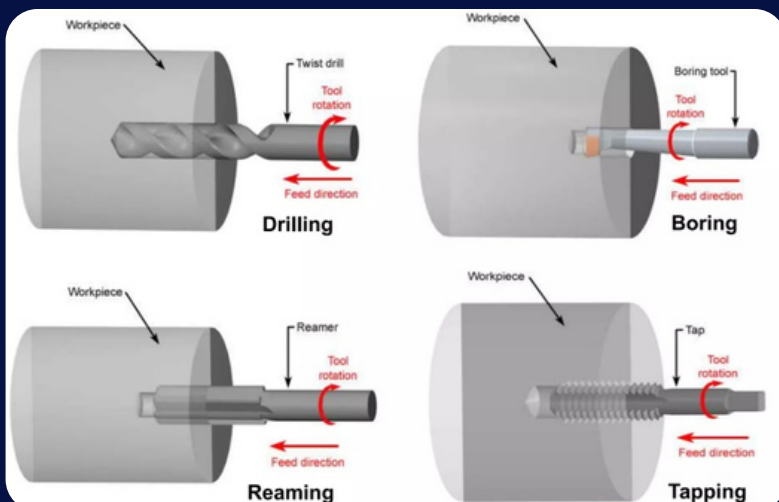
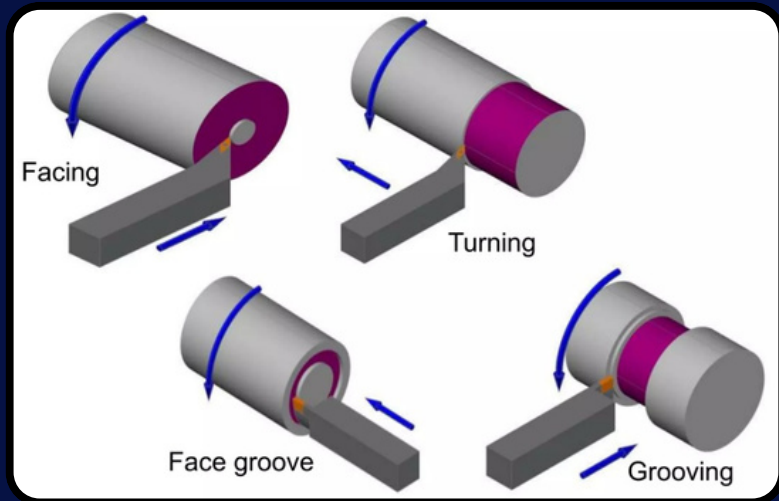
Lathe

Cutting Operations



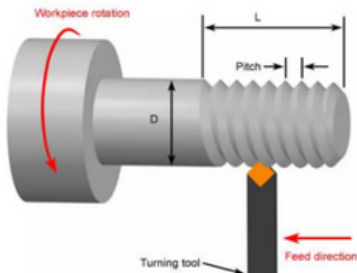
Lathe

Cutting Operations

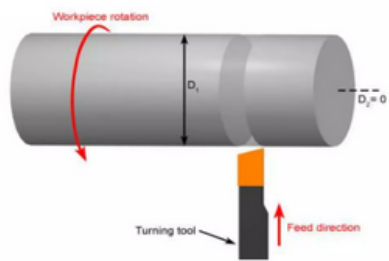


Lathe

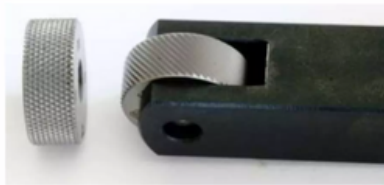
Cutting Operations



Threading



Parting off

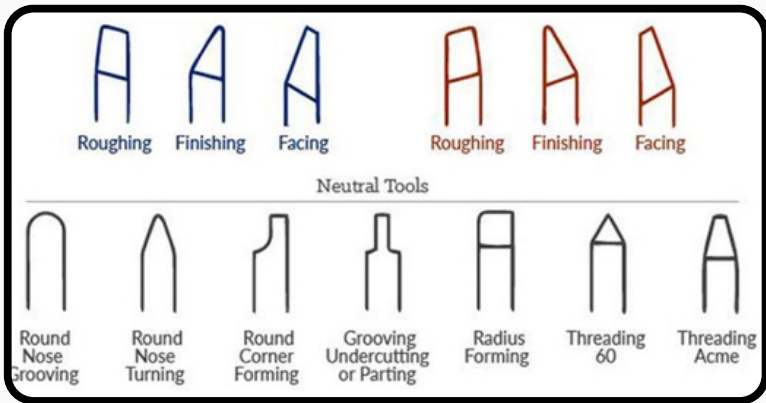


Knurling

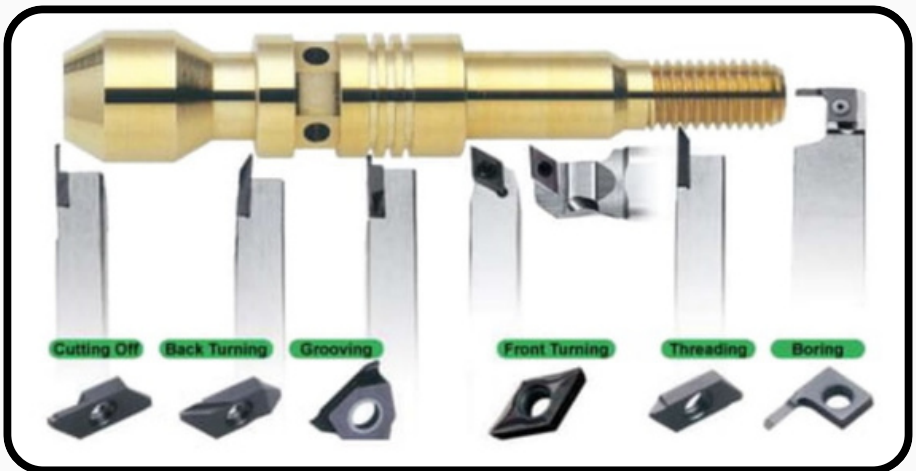
T O P I C

04

TOOL SELECTION



TOOL SELECTION



ALL LATHE-CUTTING INSTRUMENTS ARE SINGLE-POINT ONES AND ARE HELD BY TOOL HOLDERS. THE SHAPING OUTCOMES DEPEND ON THE ANGLE THEY FEED TO A WORKPIECE, CUTTING SPEED, FEED RATE, AND DEPTH

T O P I C

05

MACHINING CODE

M CODES

Miscellaneous codes, M is mainly used to designate movement of the components of the machine

- M00 : Program Stop - - -
- M01 : Optional Stop - - -
- M02 : Program End - - -
- M03 : Spindle Clockwise - - -
- M04 : Spindle Anti-Clockwise - - -
- M05 : Spindle Stop - - -
- M08 : Coolant Pump 'ON' - - -
- M09 : Coolant Pump 'OFF' - - -
- M22 : Machining Start - - -
- M30 : Program End - - -

MACHINING CODE

G CODES

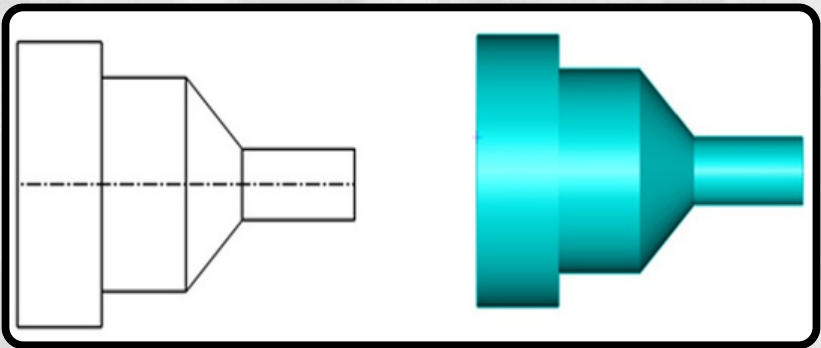
Preparatory codes G is used more on the machining movement such as cutting in a straight line, taper, curves, making rough cuts and finishing, threading, grooving, etc.

G00: Rapid Traverse

The carriage moves at high speed to the coordinates that has been specified in the program. The rate of movement depends on the amount choosen in percentage of 25%, 50%, 75% Or 100% of 10000 – 23000 mm/min that has been set by the machine supplier

G01 : Linear Interpolation (Machining in a straight line)

The cutting tool moves in a straight line between two points that has been stated in the program. The rate of movement will depend on the Feedrate, F that has been specified in the program according to the type of cut and material being machined.



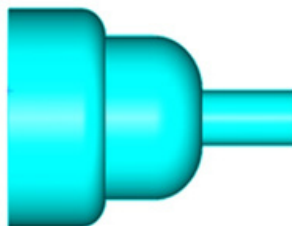
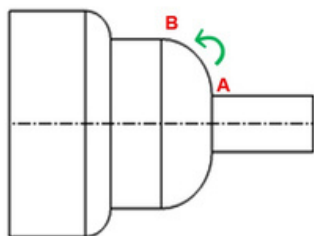
G02 :Circular Interpolation Clockwise (Curve or Radius)

The cutting tool moves in a straight line between two points that has been stated in the program. The rate of movement will depend on the Feedrate, F that has been specified in the program according to the type of cut and material being machined.



G03: Circular Interpolation Anti-Clockwise (Curve or Radius)

This code has the same meaning as G02 but the curve movement is in the anti-clockwise direction as shown below..



G04 : Dwell

G20 : Imperial Unit

G21 : Metric Unit

**G94 : Feedrate in metre/minute
or feet/minute**

**G95 : Feedrate in mm/revolution
or inch/revolution.**

T O P I C

06

PROGRAM CONFIGURATION

BLOCK




- A program is composed of several blocks.
- One block is separated from another block with an “end of block code” (;)

WORD (ADDRESS & NUMBER)



- Elements which make up blocks are called words.
- Words consists of addresses and numbers of several digits that follow the addresses. (+ or - symbols may precede the numbers if necessary.)

PROGRAM CONFIGURATION



O - Program Number
N - Sequence Number
G - Preparatory Function
X,U,Z,W,R,C - Dimension word
F- Feed
S - Spindle Revolution
Cutting Speed
T - Tool
M - Miscellaneous function
P,Q - Designations of sequence
number

Fundamental Principles

Coordinate System

- Longitudinal Motion
- Transverse Motion

Dimensioning System

- Absolute
- Incremental
- Mixed

Reference System

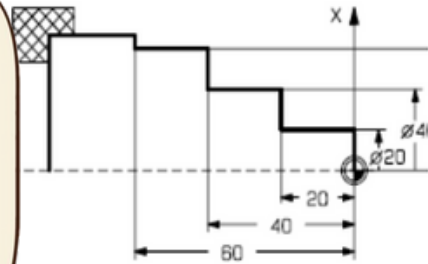
- Machine Reference
- Work Reference



DIMENSIONING

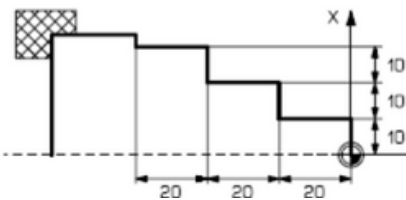
ABSOLUTE DIMENSIONING

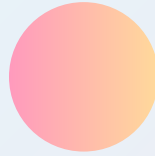
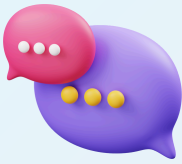
In the drawings for CNC turning absolute system considers the value of X as the diameter value not the radius.



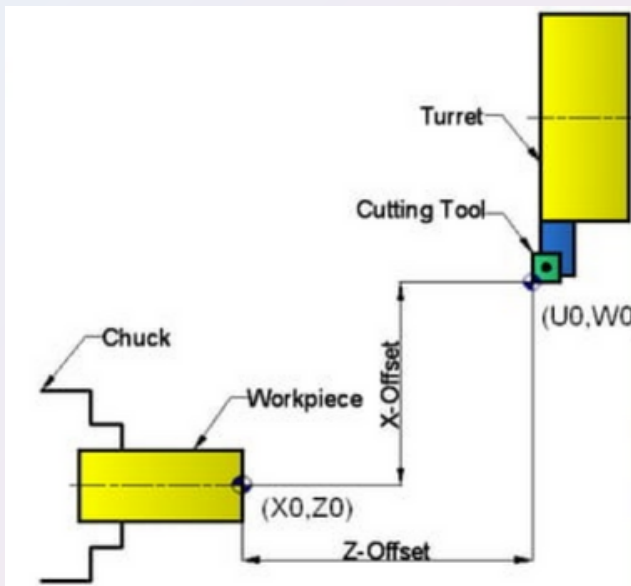
INCREMENTAL DIMENSIONING

Uses incremental values that are always measured from the current point to the next point





The distance traveled by the tool cutting edge from the machine reference point to the work reference point in a particular axis is termed as "Tool Offset". For turning tool offset is measured in both the direction i.e. 'X' & 'Z'



TOOL OFFSET

INSTRUCTION OF PROGRAM

01

INTRODUCTION

N10 G00 X50.0 30.0 ; BLOCK



Block No


End of Block

Words

G 00

Address

Data



LAYOUT OF CNC PROGRAM

BILLET X 25.0 Z 60.0;

| | |
|--------------------------|-----------------------------------|
| G99 G21 S500 M13; | [Setting Cutting Condition |
| G28 U0 W0; | [Ref. Point Return |
| M06 T0101 | [Tool Call |
| G00 X 25.0 Z2.0; | [Positioning |

| | |
|-----|------------------------------|
| ... | [Path Definition |
| ... | or Cycle Utility |
| | or Subroutine Utility |

| | |
|-------------------|---------------------------|
| G28 U0 W0; | [Ref. Point Return |
| M30.0; | [End of Program |

 Header

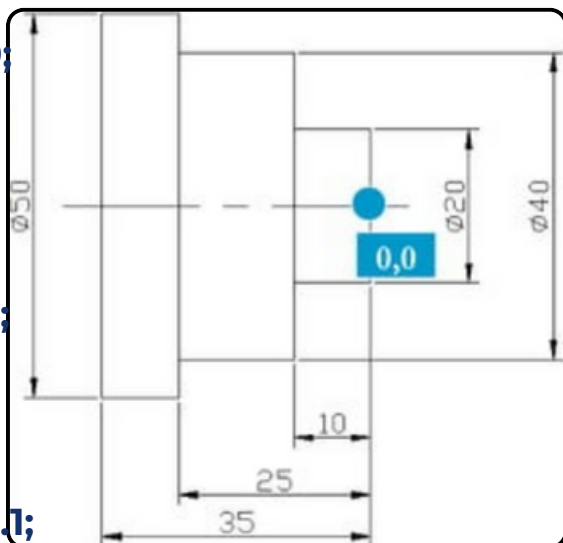
 Body

 End



Example Program

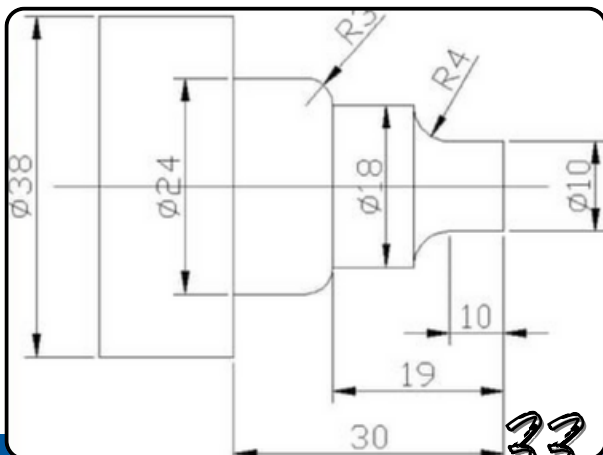
```
[BILLET X 55.0 Z 40.0;  
G99 G21 G40;  
S1000 M13;  
M06 T0101;  
G00 X55.0 Z2.0;  
G01 X55.0 Z0.0 F0.2;  
G01 X-1.0 Z0.0 F0.1;  
G00 X55.0 Z2.0;  
G00 X20.0;  
G01 X20.0 Z-10.0 F0.1;  
G01 X40.0 Z-10.0;  
G01 X40.0 Z-25.0;  
G01 X50.0 Z-25.0;  
G01 X50.0 Z-35.0;  
G01 X55.0 Z-35.0;  
G00 X55.0 Z2.0;  
G28 U0 W0;  
M30.0;
```





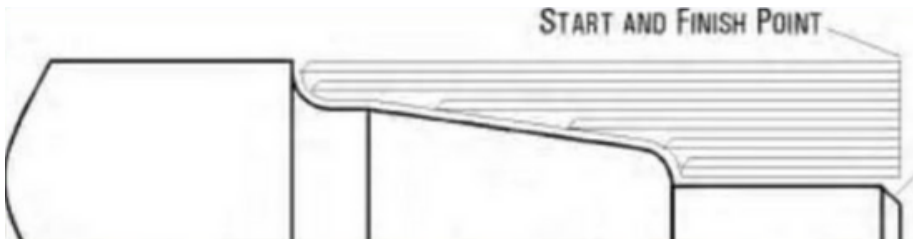
Example Program

```
[BILLET X 55.0 Z 40.0;  
G99 G21 G40 S1000 M13;  
M06 T0101;  
G00 X38.0 Z2.0;  
G01 X38.0 Z0.0 F0.2;  
G01 X-1.0 Z0.0 F0.1;  
G00 X38.0 Z2.0;  
G00 X10.0;  
G01 X10.0 Z-10.0 F0.1;  
G02 X18.0 Z-14.0 R4.0;  
G01 X18.0 Z-19.0;  
G03 X24.0 Z-22.0 R3.0;  
G01 X24.0 Z-30.0;  
G01 X38.0 Z-30.0;  
G01 X38.0 Z-30.0;  
G00 X38.0 Z2.0;  
G28 U0 W0;  
M30.0;
```



G71

TURNING CYCLE



Writing Format

G71 U1.0 R1.0;

G71 P10 Q20 U0.5 W0.5 F0.25;

N10 G00 X...;

.....

.....

.....

N20;

G70 P10 Q20 F01.5;

1st Line G71:

U - Specifies the depth of cut in each pass

R - Retract amount after every pass

2nd Line G71:

P - Specifies the start block number

Q - Specifies the end block number

U - Specifies the finishing allowance in X

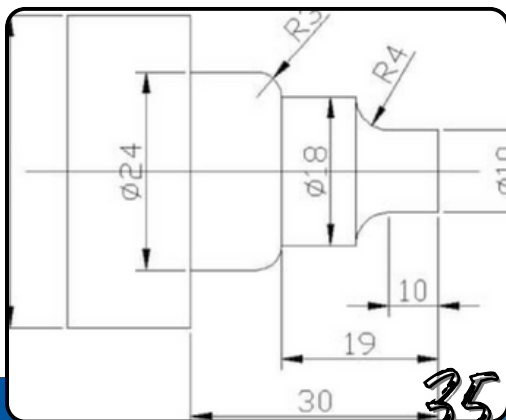
W - Specifies the finishing allowance in Z

G70 - Finishing Pass



Example Program

```
[BILLET X38.0 Z 40.0;  
G99 G21 G40 S1000 M13;  
M06 T0101;  
G00 X39.0 Z2.0;  
G01 X38.0 Z0.0 F0.2;  
G01 X-1.0 Z0.0 F0.1;  
G00 X38.0 Z2.0;  
G71 U1.0 R0.5;  
G71 P10 Q20 U0.5 W0.1 F0.35;  
N10 G00 X10.0;  
G01 X10.0 Z-10.0 F0.1;  
G02 X18.0 Z-14.0 R4.0;  
G01 X18.0 Z-19.0;  
G03 X24.0 Z-22.0 R3.0;  
G01 X24.0 Z-30.0;  
N20 G01 X39.0 Z-30.0;  
G70 P10 Q20;  
G00 X39.0 Z2.0;  
G28 U0 W0;  
M30.0;
```



T O P I C

07

A 3D CAD model of a mechanical assembly. The assembly consists of a large grey cylindrical component with a central hole, a smaller grey rectangular component mounted on top, and a yellow cylindrical component with a threaded section. Three numbered callouts (1, 2, 3) point to specific features: 1 points to a small black dot on the top grey component, 2 points to a small black dot on the side of the top grey component, and 3 points to the yellow component. Two coordinate axes are shown: X+ (vertical) and Z+ (diagonal).



37

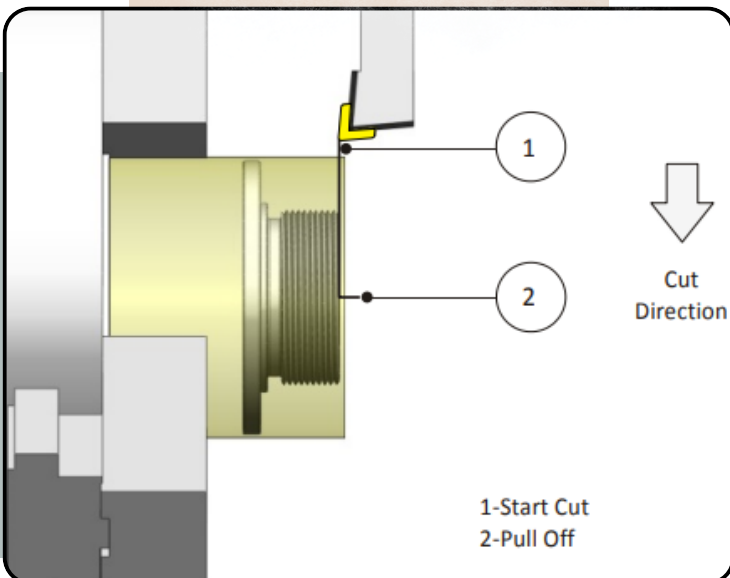
FACE



Scan Me

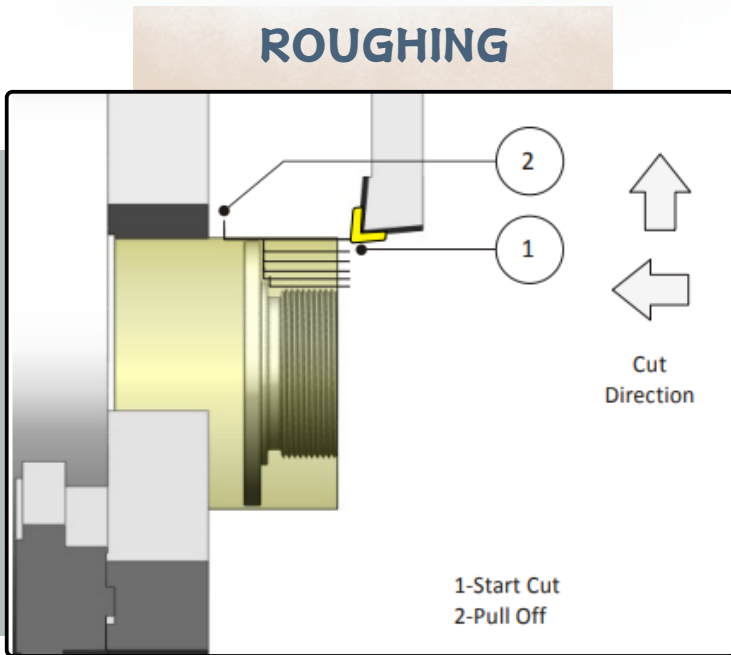
BY OLIVIA WILFACING IS
USUALLY THE FIRST OPERATION
OF ANY TURNING JOBSON

FACE TOOL PATH



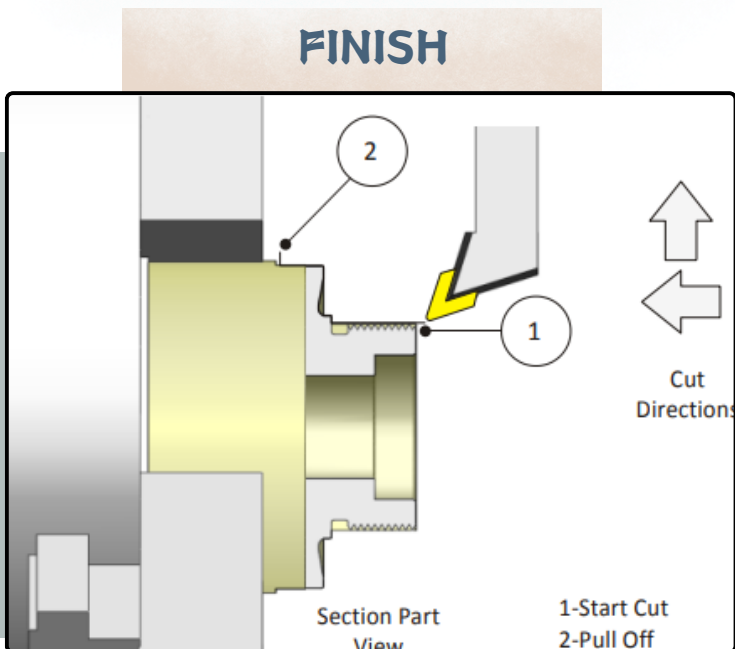
ROUGH

ROUGH THE PART LEAVING STOCK
IN Z AND X FOR FINISH PATHS



FINISH

FINISH THE PART. CHOOSE THE LARGEST AND MOST RIGID TOOL THAT WILL MAKE ALL THE FEATURES. WATCH THE BACK CLEARANCE OF THE TOOL TO ENSURE THE TOOL AND HOLDER DO NOT COLLIDE WITH THE PART



TURNING PROCESS

Rough - Finish - Thread



Scan Me

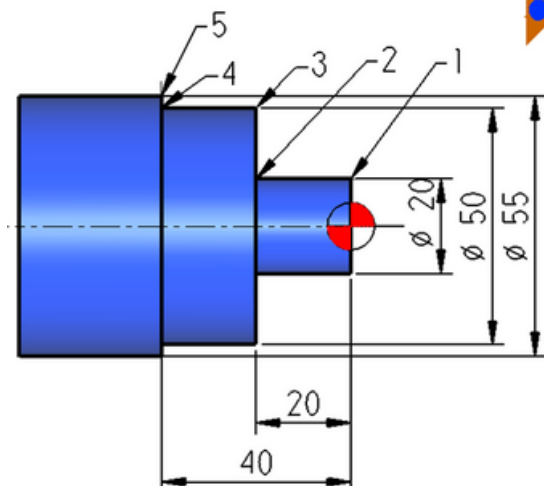


TUTORIAL



EXERCISE ON COORDINATE READINGS

1.



| POINT | G CODE | X | Z |
|-------|--------|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |

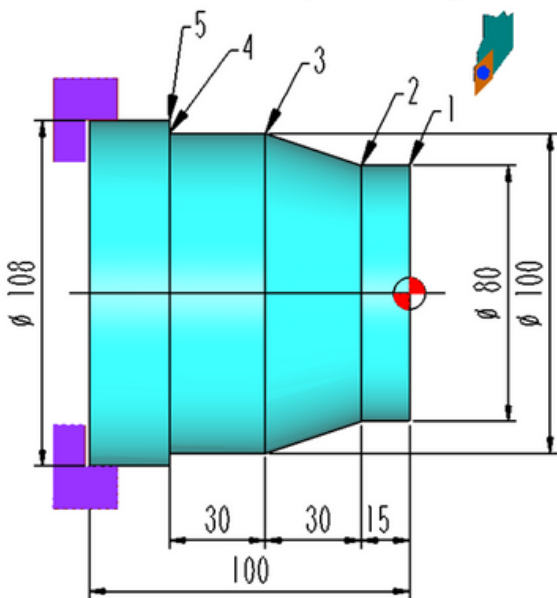
2.



| POINT | G CODE | X | Z | R |
|-------|--------|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |

EXERCISE ON COORDINATE READINGS

3.



| POINT | G CODE | X | Z |
|-------|--------|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |

ANSWER

EXERCISE ON COORDINATE READINGS

EXERCISE 1

| Point | G Code | X | Z |
|-------|--------|----|-----|
| 1 | G01 | 20 | 0 |
| 2 | G01 | 20 | -20 |
| 3 | G01 | 50 | -20 |
| 4 | G01 | 50 | -40 |
| 5 | G01 | 55 | -40 |

EXERCISE 2

| Point | G Code | X | Z | R |
|-------|--------|-----|-----|----|
| 1 | G01 | 36 | 0 | |
| 2 | G01 | 36 | -20 | |
| 3 | G02 | 36 | -36 | 16 |
| 4 | G03 | 100 | -52 | 16 |
| 5 | G01 | 100 | -82 | |

EXERCISE 3

| Point | G Code | X | Z |
|-------|--------|-----|-----|
| 1 | G01 | 80 | 0 |
| 2 | G01 | 80 | -15 |
| 3 | G01 | 100 | -45 |
| 4 | G01 | 100 | -75 |
| 5 | G01 | 108 | -75 |

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POLITEKNIK UNGKU OMAR

JABATAN KEJURUTERAAN MEKANIKAL

JALAN RAJA MUSA MAHADI

31400 IPOH, PERAK

Tel: 1-300-88-1969 / 05-5457622

Faks: 605-5471162

Laman web: <http://www.puo.edu.my>