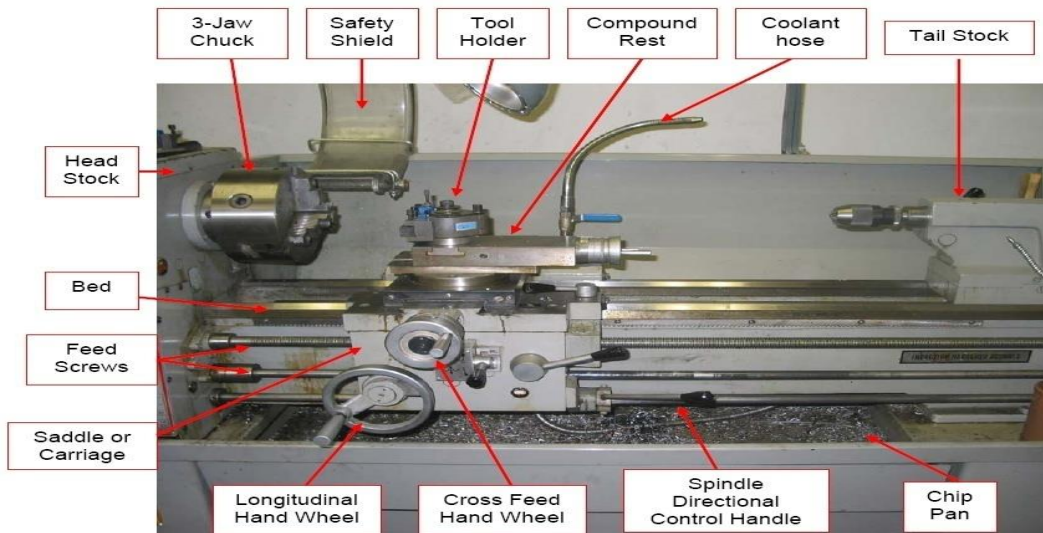


# Machining

## Level – I

Based on March ,2022 Curriculum Version 1



Module Title: - Perform General Workshop Machining

Module code: **IND MAC1 M 05 0322**

Nominal duration: 80 Hours

Prepared by: Ministry of Labour and Skill

August , 2022

Addis Ababa, Ethiopia

Page 1 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

## Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Page 2 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

## Contents

Acknowledgment .....	2
Contents .....	3
Introduction to the Module .....	4
Unit one: plan job requirements.....	6
1.1 Work Requirements .....	6
1.2 .Machine And Tools.....	8
1.2.1 Drilling Machine .....	8
1.2.2. Lathe Machine .....	13
1.2.3 Power Hacksaw Machine.....	17
1.2.4 Milling Machine.....	18
1.2.5 Planning And Shaping .....	21
1.3 Sequence of operations .....	25
Self check-1 .....	<b>Error! Bookmark not defined.</b>
Unit two : Set-up machine .....	30
2.1 Inspect and sharpen tools .....	31
2.2 Mount and position tools .....	37
2.3 guards and accessories .....	41
2.4 Cutting Speeds, RPM, Feeds and Depth of cuts .....	50
2.5 Setup Operations .....	52
Self check-2 .....	<b>Error! Bookmark not defined.</b>
Unit Three : Perform machine operations.....	57
3.1 Work holding devices .....	58

3.2 Operate machine .....	75
3.3 Machine Parameters.....	95
3.3.1 Feed:.....	95
3.3.2 Cutting speed .....	95
3.3.3 Depth of cut.....	95
3.4 Safety Procedures.....	98
Self-Check -3 .....	103
Operation sheet 3.1. Perform machine operations .....	107
Lap Test .....	109
Unit Four : Quality assure finished component .....	111
4.1 Check Components .....	111
4.2 Measuring Tools And Equipment.....	113
4.3 Handle deviations.....	122
4.4 Routine Maintenance And Adjustments .....	126
Self check-4 .....	<b>Error! Bookmark not defined.</b>
Operation sheet 4.1: Quality assure finished component.....	<b>Error! Bookmark not defined.</b>
Operation sheet 4.1: Quality assure finished component.....	<b>Error! Bookmark not defined.</b>
Lap Test .....	<b>Error! Bookmark not defined.</b>

## Introduction To The Module

In machining filed:- Machining is a manufacturing process in which a sharp cutting tool is used to cut away material to leave the desired part shape. Machining is one of the most important manufacturing processes. To perform the operation, relative motion is required between the tool and work. This relative motion is achieved in most machining operations by means of a primary motion, called the cutting speed, and a secondary motion, called the feed. The shape of the tool and its penetration into the work surface, combined with these motions, produces the desired geometry of the resulting work surface.

This module is designed to meet the industry requirement under the machining occupational standard, particularly for the unit of competency: Perform General Workshop Machining.

### **This module covers the units :**

plan job requirements

Set-up machine

machine operations

Assure Quality

### **Learning Objective of the Module**

Determine plan job requirements

Set-up machine

machine operations

Assure Quality for finished component

### **Module Instruction**

For effective use this modules trainees are expected to follow the following module instruction:

Read the information written in each unit

Accomplish the Self-checks at the end of each unit

Perform Operation Sheets which were provided at the end of units

Do the “LAP test” giver at the end of each unit and

Read the identified reference book for Examples and exercise

Page 5 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

## Unit one: plan job requirements

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Work requirements
- Machine And Tools
  - Drilling Machine
  - Lathe Machine
  - Milling Machine
- Sequence Of Operations

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- ✓ Analyze and select Work requirements
- ✓ Select Appropriate machine and tools
  - Drilling Machine
  - Lathe Machine
  - Milling Machine
- ✓ Determining sequence of operations

### 1.1 Work Requirements

Work instructions and drawings/diagrams

Page 6 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

A work instruction is a tool provided to help someone to do a job correctly. A Work Instruction is the most detailed description of a task. Its purpose is to explain step by step how to do a specific task or work. Work instructions are key to reducing variation, allowing manufacturers to improve quality and meet demand.

### **Working drawings/Diagrams**

The term working drawing is used to describe the complete set of drawing information needed for the machining and assembly of a product based on its design. An essential element of a working drawing is the parts list, or bill of materials (abbreviated BOM).

A working drawing is a drawing or set of drawings produced by the designer, manufacturer, or fabricator. Shop drawings are typically required for prefabricated components. The working drawing normally shows more detail.

The primary role or function of working drawings is to convert design data into finished part information and to clearly communicate that information to building industry, code officials, product manufacturers, suppliers and fabricators.

Assembly drawings can be used to represent items that consist of more than one component. ... Assembly drawings may include instructions, lists of the component parts, reference numbers, and references to detail drawings or shop drawings, and specification information.

It helps streamline the manufacturing process. The precise details of the technical drawing helps builders create objects without errors, delays or other costly issues. This alone is the most important duty of the drawings.

Working drawings will develop in detail from block and massing drawings and sketches to very detailed technical drawings describing every component in a way that will enable them to be constructed and operated.

### **1.4 FACTORS DETERMINING JOB REQUIREMENTS**

1. Materials to be used
2. Surface finished required
3. Tolerance to be allowed
4. Quantity of units
5. Scale of drawing

Page 7 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

6. Name of the object and how it is used
7. Types of drawings

## 1.2 .Machine And Tools

### Introduction

Machining is a manufacturing process in which a sharp cutting tool is used to cut away material to leave the desired part shape. Machining is one of the most important manufacturing processes. To perform the operation, relative motion is required between the tool and work. This relative motion is achieved in most machining operations by means of a primary motion, called the cutting speed, and a secondary motion, called the feed. The shape of the tool and its penetration into the work surface, combined with these motions, produces the desired geometry of the resulting work surface.

### 1.2.1 Drilling Machine

Drilling is a process of producing round holes in a solid material or enlarging existing holes with the use of multi tooth cutting tools called *drills* or *drill bits*. Various cutting tools are available for drilling, but the most common is the *twist drill*.

Drilling machines, also called drill presses, cut holes in metal with a twist drill. They also use a variety of other cutting tools to perform the following basic hole-machining operations: (1) reaming, (2) boring, (3) counter boring, (4) countersinking, and (5) tapping internal threads with the use of a tapping attachment.

Drilling is an operation of producing circular hole by using drill bits. The drilling operation accomplished by Drilling machine, lathe in which the drill is held in tailstock and the work is held by the chuck. The most common drill used is the twist drill.

Page 8 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022



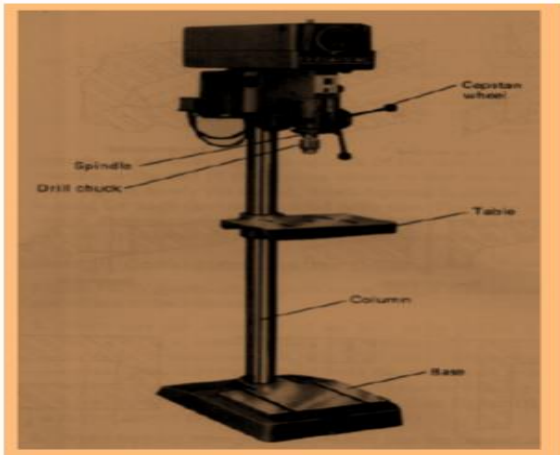


Fig 1.3. Drilling machine

#### Figure 1:0:1 Drilling Machine

##### 1.4.1 Parts of drilling machine

**Spindle:** the spindle holds the drill or cutting tools and revolves in a fixed position in a sleeve.

**Column:** the column is cylindrical in shape and built strong and solid. The column supports the head and the sleeve or quill assembly.

**Head:** The head of the drilling machine is composed of the sleeve, a spindle, an electric motor and feed mechanism. The head is bolted to the column.

**Worktable:** The worktable is supported on an arm mounted to the column. The worktable can be adjusted vertically to accommodate different heights of work or it can be swung completely out of the way. It may be tilted up to 90 degree in either direction, to allow long pieces to be end or angle drilled.

**Base:** The base of the drilling machine supports the entire machine and when bolted to the floor, provides for vibration-free operation and best machining accuracy. The top of the base is similar to the worktable and may be equipped with T- slot for mounting work too large for the table.

##### Cutting conditions in drilling

The twist drill is a cutting tool with two symmetrical opposite cutting edges, each removing part of the material in the form of chip.

Page 9 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

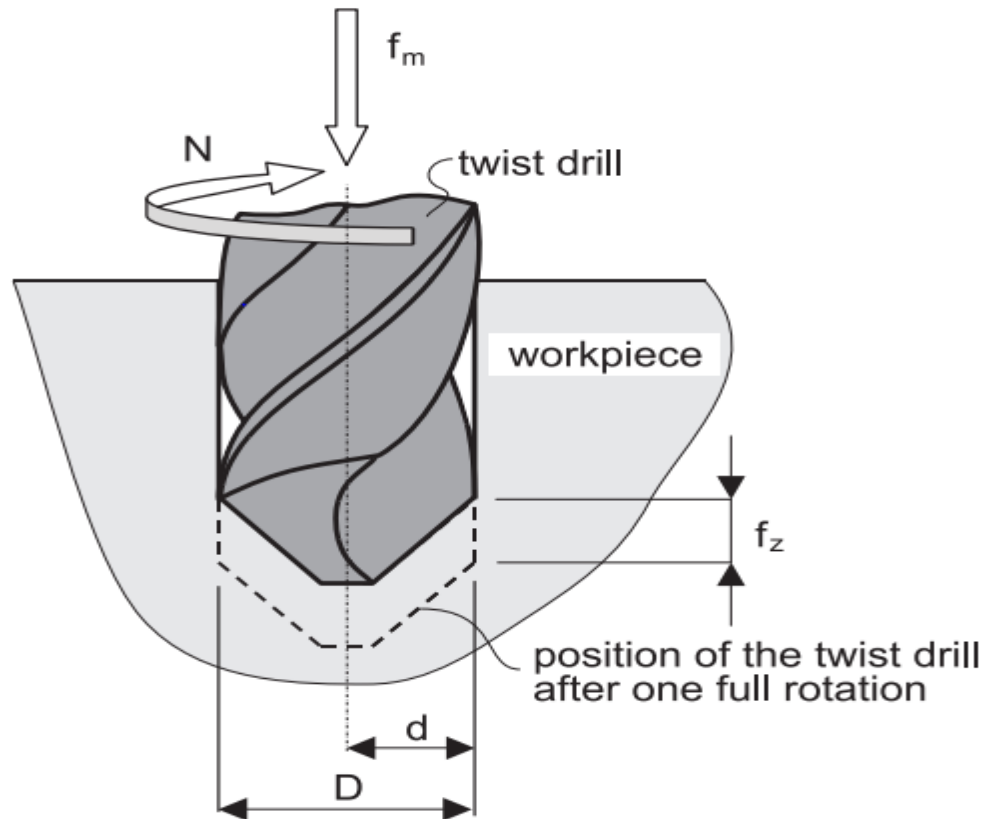


Figure 1:0:2 Basics of a drilling operation

2.3.2 Cutting velocity  $V$  in drilling is not a constant along the major cutting edge as opposed to the other Machining operations. It is zero at the center of the twist drill, and has a maximum value at the drill Corner. The maximum cutting speed is given by

$$V = \pi DN$$

Where  $D$  is the drill diameter, and  $N$  is the rotational speed of the drill.

### 2.3.3 Types of drilling machine

Portable drilling machine

Bench drilling machine

Up-Right Drilling Machine

Radial drilling machine

Pillar drilling machine

Gang drilling machine

Multiple drilling machine

Page 10 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

## Drill press

Although a hand drill is commonly used for drilling of small holes, a drill press is preferable when the location and orientation of the hole must be controlled accurately. A drill press is composed of a base that supports a column; the column in turn supports a table. Work can be supported on the table with a vise or hold down clamps, or the table can be swiveled out of the way to allow tall work to be supported directly on the base. Height of the table can be adjusted with a table lift crank then locked in place with a table lock. The column also supports a power head containing a motor. The motor turns the spindle at a speed controlled by a variable speed control dial. The spindle holds a

Drill chuck to hold the cutting tools (drill bits, center drills, reamers, etc.). The machine tool described is a typical upright drill press. The smaller modifications, mounted on a table rather than the floor are known as bench drills.



Figure 1:0:3 Bench Type Drilling Machine

Page 11 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022



Figure 1:0:4 Upright Drill



Figure 1.0:5 Pillar Drill Machine

This is the largest drill press designed to drill up to 100-mm diameter holes in large work parts. It has a radial arm along which the drilling head can be moved and clamped.

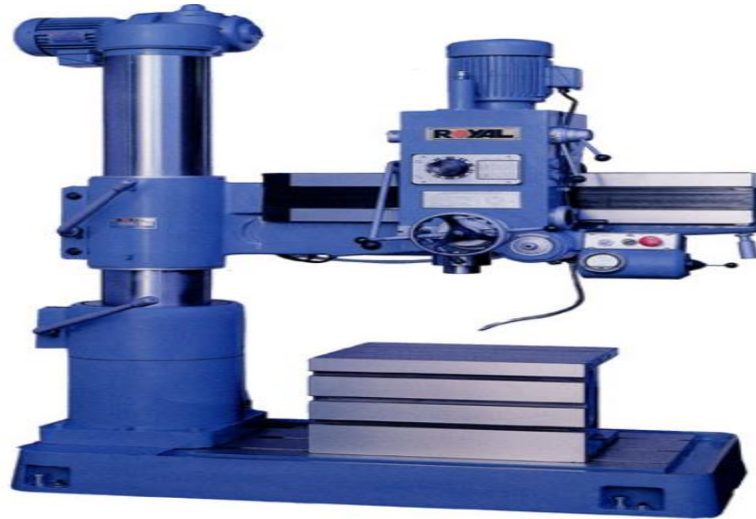


Figure 1:0:6 Basics of a drilling operation

Figure 0:7 Radial Drill Machine

#### CARE OF DRILLING MACHINES

Lubrication is important because of the heat and friction generated by the moving parts. Follow the manufacturer's manual for proper lubrication methods. Clean each machine after use. Clean T-slots. Grooves. And dirt from belts and pulleys. Remove chips to avoid damage to moving parts. Wipe all spindles and sleeves free of grit to avoid damaging the precision fit. Put a light coat of oil on all unpainted surfaces to prevent rust. Operate all machines with care to avoid overworking the electric motor.

#### 1.2.2. Lathe Machine

The lathe removes undesired material from a rotating work piece in the form of chips with the help of a cutting tool which is traversed across the work and can be feed deep in work. The lathe is a versatile machine tool in which the work is held and rotated. A cutting tool is moved along the work to produce cylindrical shapes (turning) or across the work to form flat surfaces (facing). The lathe machine is used principally for shaping of metal (and sometimes wood or other materials). The basic lathe that was designed to cut cylindrical part, to produce screw threads,

Page 13 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

tapered work, drill holes, knurled surfaces, and crankshafts and etc. Various designs and constructions of lathe have been developed to suit different Machining conditions and usage.

#### TYPES OF LATHE MACHINE

Speed Lathe: it is so named because of the very high speed of the headstock spindle

Engine Lathe: the most important machine tool in the lathe machines and by far most widely used.

Turret Lathe: it is a production used to perform a large number of operation simultaneously

Bench Lathe: a small lathe which can be mounted on the work bench for doing small precision and light jobs.

The five Major Parts of Lathe Machine

The Bed

The Headstock

The Tailstock

The Carriage

The Feed Mechanism

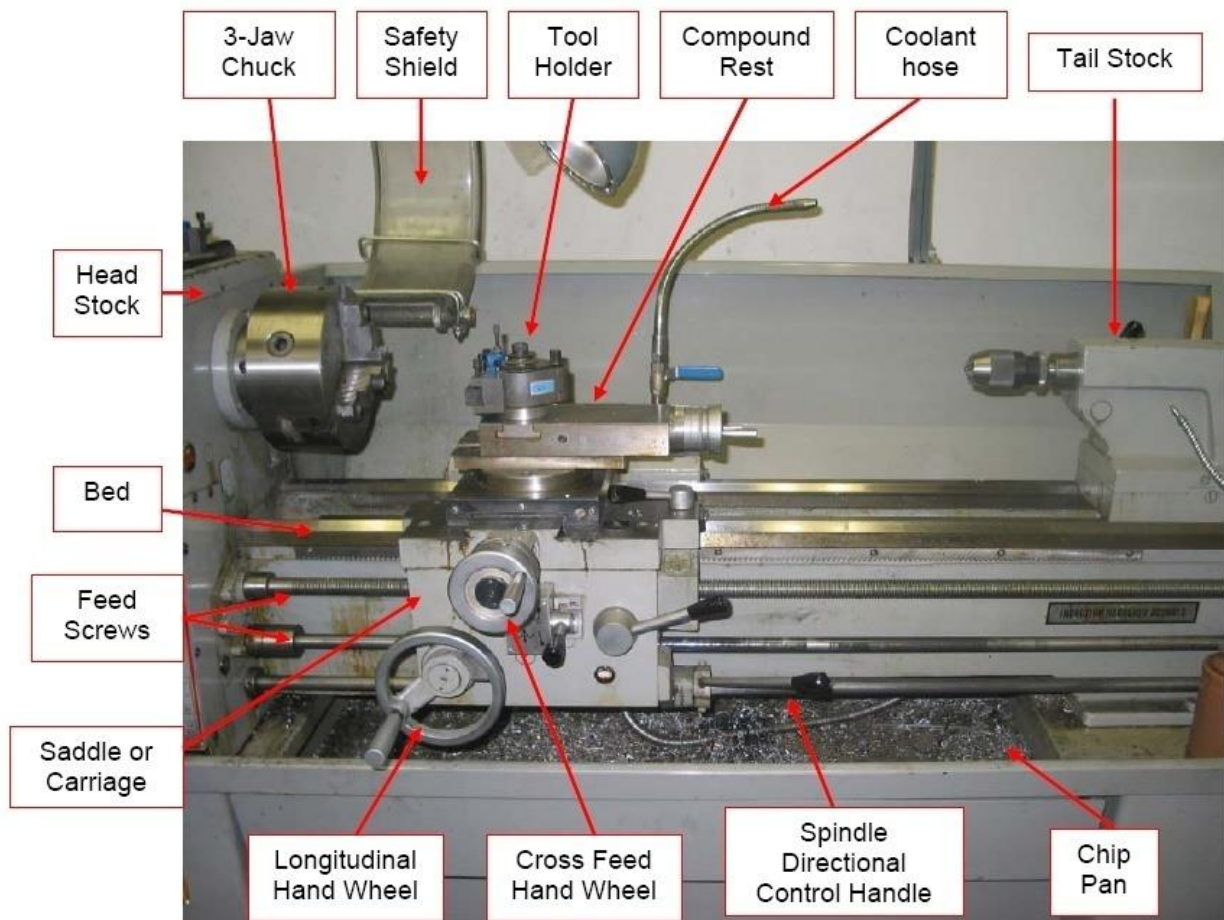


Figure 1:0:8 Lathe Machine and Parts

**BED:** The bed is the part of the lathe that provides support for the other components. It is the foundation on which all the other parts are fitted.

**HEADSTOCK:** The headstock is the lathe feature that provides the means of holding and rotating the work accurately.

**TAILSTOCK:** The tailstock is used mainly to support the right hand end of the work. It may be moved and clamped in position along the bed.

**CARRIAGE:** The carriage is the lathe that provides the method of holding and moving the cutting tool accurately. It consists of two major parts:

Apron

Saddle

Page 15 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

Saddle is the part of the carriage that fits across and moves along the bed, between the head and tailstock. The cross slide is mounted on top of the saddle and provides a cross movement for the cutting tool. The slide is at right angles to the bed and is moved by means of a screwed spindle fitted with a handle.

The compound rest is fitted on top and to the front of the cross slide. The compound rest may be swiveled horizontally through 360°. The top slide is fitted on top of the compound rest. It provides a means of supporting the tool post, which holds the cutting tool. The top slide provides a limited horizontal movement for the cutting tool. By swiveling the compound rest, the top slide may be set at an angle to the cross slide. Normally the compound rest is set so that the top slide is at the right angles to the cross slide.

Apron is bolted to the front of the saddle. It contains the mechanism for moving and controlling the carriage.

#### FEED MECHANISM

Most center lathes have some form of power feed mechanism to provide automatic movement to the cutting tool. Power feed can be applied to both the saddle and cross slide.

##### Quick Change Box

This box provides a means of changing the speed of the feed shaft. The rate of feed can be varied in relation to the revolutions of the work to suit different materials and operations.

**Feed Shaft:** Power is transmitted from the rear end of the headstock spindle through the quick change gear box to the feed shaft located at the front of the lathe bed.

**LEAD SCREW:** Center lathes equipped with power feed also have provision for screw cutting. A special threaded spindle is mounted on the front of the lathe bed adjacent to the feed shaft. It is driven through the quick change gear box. Both the lead screw and the feed shaft pass through the apron of the carriage. Controls on the apron enable the feed shaft or the lead screw to be connected to the carriage.

##### Feed engagement Lever

When the feed lever is engaged, power is connected from the feed shaft to the saddle and cross slide. This provides automatic feeding for facing and turning.

##### Lead Screw Engagement Lever

Page 16 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022



The lead screw is connected and released from the carriage by means of half nuts. The lead screw engagement lever on the apron operates the half nuts. These nuts are halved to enable the lead screw to be engaged or disengaged easily.

An interlocking mechanism between the levers prevents the lead screw and the feed shaft from being engaged at the same time. The arrangement of gears in the feed drive mechanism provides a means of reversing the direction of rotation of the feed shaft and the lead screw.

### 1.2.3 Power Hacksaw Machine

All power hacksaw machines are basically similar in design. Figure 6-1 shows a typical power hacksaw and identifies its main parts, which are discussed below.

#### Base

The base of the saw usually contains a coolant reservoir and a pump for conveying the coolant to the work. The reservoir contains baffles which cause the chips to settle to the bottom of the tank. A table which supports the vise and the metal being sawed is located on top of the base and is usually referred to as part of the base.

#### Vise

The vise is adjustable so that various sizes and shapes of metal may be held. On some machines the vise may be swiveled so that stock may be sawed at an angle. The size of a power hacksaw is determined by the largest piece of metal that can be held in the vise and sawed.

#### Frame

The frame of the saw supports and carries the hacksaw blade. The machine is designed so that the saw blade contacts the work only on the cutting stroke. This action prevents unnecessary wear on the saw blade. The cutting stroke is on the draw or back stroke.

Page 17 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022



Figure 1:0:9 Power Hacksaw Machine

### 1.2.4 Milling Machine

Milling machine is one of the most versatile conventional machine tools with a wide range of metal cutting capability. Milling machines are machine tools used to rotate single or multiple cutting edges and remove metal when work is fed against a rotating cutter. Functions of Milling machine capable of machining flat or contoured surfaces, slots, grooves, recesses, threads, gears, spirals and other configurations.

Milling machines are available in a variety of designs that can be classified as the following: (1) standard knee-and-column machines, including the horizontal and the vertical types; (2) bed-type or manufacturing machines; and (3) machines designed for special milling jobs.

#### Types of Milling Machine

Milling machine may be grouped into two large families:-

Fixed bed type milling machine:-are characterized by very rigid work table construction and support. The work moves only longitudinal direction.

It is sub grouped in two:-

Horizontal ,

Vertical and

Planer type

B. Column and knee type milling machine:-the parts that provide movements to the work consists of a column that support and guides the knee in vertical movements. But both groups are made with horizontal and vertical spindle.

There are three basic types of Knee and column type MM

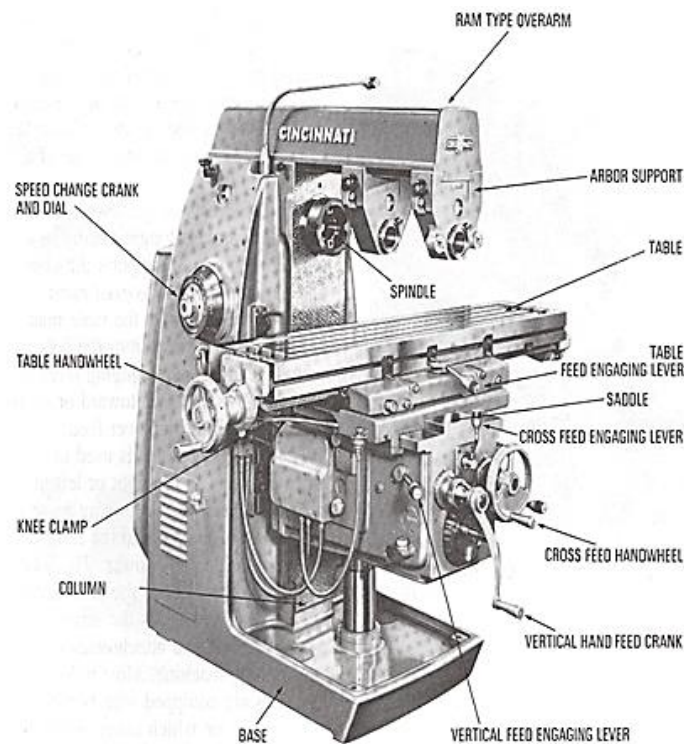
Page 18 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

Plane (horizontal spindle) MM:-

Contains the drive motor and gearing and a fixed position HMM spindle.

The work table on this machine has three movements vertical ,cross and longitudinal or (z ,y & x axis)

The plain horizontal milling machine's column contains the drive motor and gearing and a fixed position horizontal milling machine spindle. An adjustable overhead arm containing one or more arbor supports projects forward from the top of the column. The arm and arbor supports are used to stabilize long arbors. Supports can be moved along the overhead arm to support the arbor where support is desired depending on the position of the milling cutter or cutters.



**Fig 2.1. Horizontal milling machine**

**Figure 1:0:10 Milling Machine And parts**

Column: the column houses the spindle, the bearings, the gear box, the clutches, the shafts, the pumps, and the shifting mechanisms for transmitting power from the electric motor to the spindle at a selected speed.

Page 19 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

Knee is mounted in front of the column is for supporting the table and to provide an up or down motion along the Z axis.

Saddle is consists of two sideways, one on the top and one at the bottom located at 90° to each other, for providing motions in the X or Y axes by means of lead screws.

Table is mounted on top of the saddle and can be moved along the X axis. On top of the table are some T-slots for the mounting of work piece or clamping fixtures.

Arbor is an extension of the spindle for mounting cutters. Usually, the thread end of an arbor is of left hand helix.

Swivel table housing - is fastened to saddle on a universal milling machine, enables the table to be swiveled 45° to either side of the center line.

Feed dial- is used to regulate the table feeds.

The spindle - provides the drive for arbors, cutters and attachments used on a milling machine.

Over arm - provides correct alignment and support of the arbor and various attachments.

Arbor support - is fitted to the over arm and can be clamped at any location on the over arm.

Spindle speed dial - is set by a crank that is turned to regulate the spindle speed

Universal (horizontal spindle) MM:- It is similar to the Plane (horizontal spindle) MM but have table to swing up to 45° in either direction for angular and helical milling operations

Universal milling machine is a milling machine having a table fitted with all motions and a dividing head with change gears so that it can perform any type of milling operation.

The basic difference between a universal horizontal milling machine and a plain horizontal milling machine is the addition of table swivel housing between the table and the saddle of the universal machine. This permits the table to swing up to 45° in either direction for angular and helical milling operations. The universal machine can be fitted with various attachments such as the indexing fixture, rotary table, slotting and rack cutting attachments, and various special fixtures.

c) Vertical spindle MM: - differ from other type of MM by having the cutter spindle in a vertical position or at right angle to the work .It also include

A swivel head MM:-Spindle can be swiveled for angular cut

Sliding head MM:-The head can be moved in vertical position

Page 20 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

The rotary head MM:- Spindle can move vertically in a circular line

A vertical milling machine which is of similar construction to a horizontal milling machine except that the spindle is mounted in the vertical position.

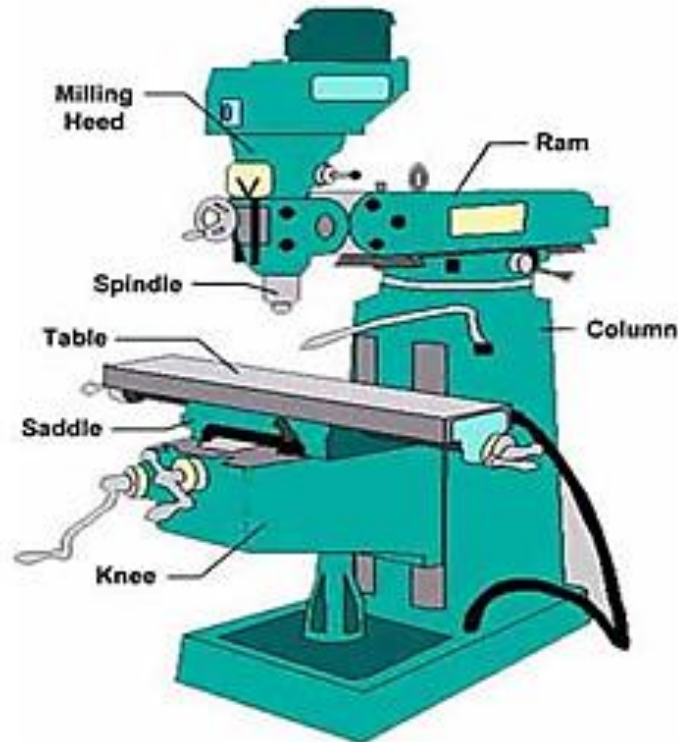


Fig 2.2. Vertical Milling machine

.Methods of controlling MM

Manual:- All movement are made hand lever control

Semi-automatic :- movements are controlled by hand and /or by power feed

Fully Automatic :- A complex hydraulic feed arrangements follow two or three dimensional templates to guide the cutter automatic

### 1.2.5 Planning And Shaping

Planning and *shaping* are similar operations, which differ in the kinematics of the process. Planning is a machining operation in which the primary cutting motion is performed by the work piece and feed motion is imparted to the cutting tool. In shaping, the primary motion is performed by the tool, and feed by the work piece:

Page 21 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

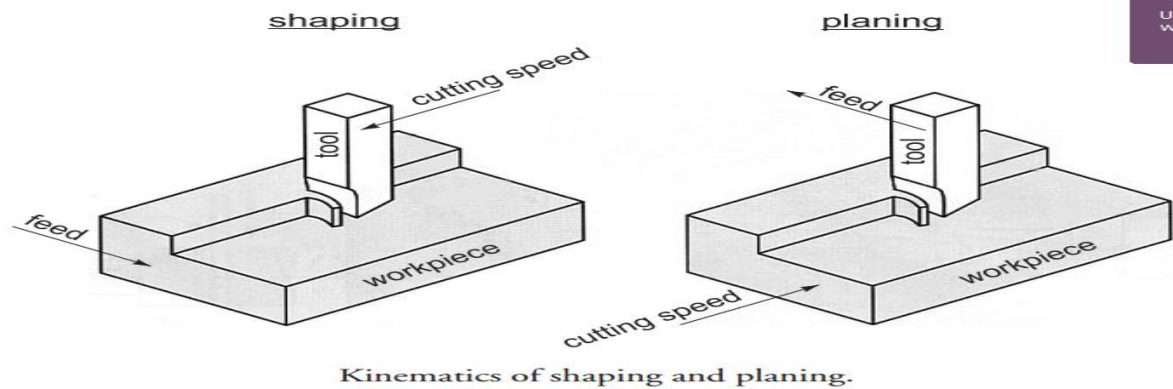
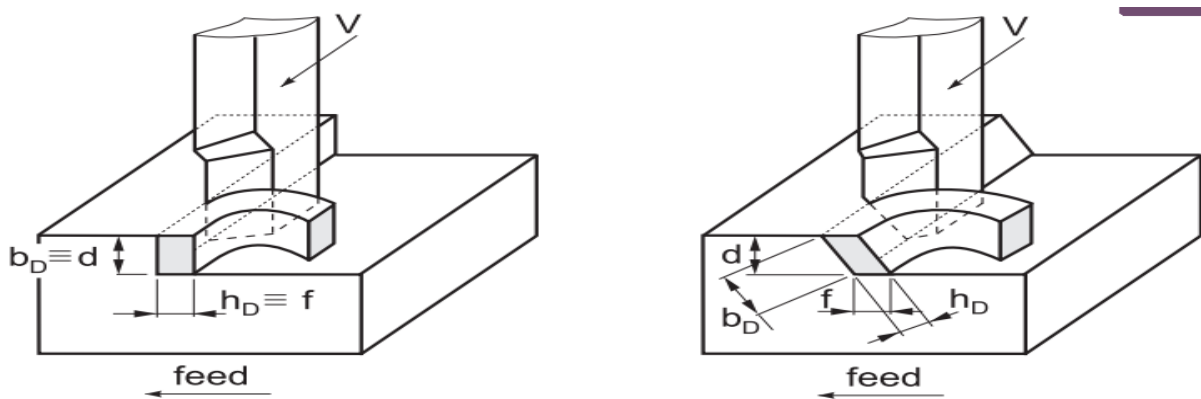


Figure 1:0:11 kinematics of shaping and planing

The *cutting conditions* in planing and shaping are illustrated in the figure. Only the shaping operation is portrayed but the cutting conditions are essentially the same and for planing:



Cutting conditions in orthogonal (*Left*) and oblique (*Right*) shaping.

Figure 1:0:12 cutting conditions

Cutting velocity  $V$  in planing is linear and constant along the cutting path. In shaping, the picture is more complicated. The cutting tool is held in the tool post mounted in the ram, which reciprocates over the work with a forward stroke, cutting at velocity  $V$  and a quick return stroke at higher velocity. The cutting velocity is therefore not constant along the cutting path. It increases from zero to maximum in the beginning of the stroke and gradually decreases to zero at the end of the stroke. The cutting speed  $V$  is assumed to be twice the average forward ram velocity.

Page 22 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

Feed  $f$  in planning and shaping is in mm per stroke and is at right angles to the cutting direction.

Depth of cut  $d$  is defined as usual as the distance between the work and machined surfaces.

Shapers

Shapers are used to produce primarily flat surfaces by means of single or multiple cutting tools.

Shapers use a reciprocating motion

For ward stroke (cutting motion)

Backward stroke (non cutting stroke)

The size of the shaper is determined by the largest cube which it can machine. For example, a 300mm shaper can machine 300mm x 300mm x 300mm.

Use of Shaper operations

flat surfaces,

a block square and parallel,

angular surfaces,

Serrating - operation performed on a surface to form a series of equally spaced grooves, which are often used on wide jaws, plates, washers and other parts that are intended to provide a good grip

Main parts of shaper

Frame.

Ram moves in adjustable slide rails. The stroke length and position can be adjusted.

Cross-rail- It is itself adjustable side rails and carries the table on horizontal slide rails.

Table has T-slots and holes to clamp works piece. The setting motion is vertical and the feed motion is horizontal.

Main gear box - The rotary movement of the motor is transmitted the crank gear by change-over gear box (3 to 8 r.p.m). The direction of motion is changed by a crank and rocker

2.3 Types of shapers

The most common type of shaper is horizontal shaper they can be:

Mechanically driven (crank and rocker)

Hydraulically driving (cylinder and piston)

Principle of the crank-type shaper

Page 23 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

There are several mechanical methods of driving the reciprocating shaper ram, the crank-type being the most commonly used

The quick return of the ram of the back or non-cutting stroke is obtained when the crank pin is traveling through 140 degree of the cycle.

The crank pin will pass through 220 degree of the cycle during the cutting stroke or forward stroke.

The direction of motion is changed by a crank and rocker

The motor drives the crank wheel (driving wheel) over the main gear box. The crank is seated in the drilling wheel and can be shifted radially. This carries with it the sliding block which guides in the rocker arm and sets its' reciprocating motion.

. The crank pin runs in its circular path at uniform speed.

It must travel a longer distance in its working stroke  $\alpha$  (longer time), and a shorter distance in the return stroke  $\beta$  (less time), the speed is alternately higher and lower. The longer the stroke the greater is the difference in speeds

#### *Changing the stroke length*

If the crank pin is drawn away from the center of the wheel, it describes a crank circle of greater radius, and the rocker arm swings through a greater distance, the stroke becomes longer

Analogously, if it is drawn towards the center of the wheel, a shorter stroke results.

*Changing the stroke position must be set to match the position of the work piece.*

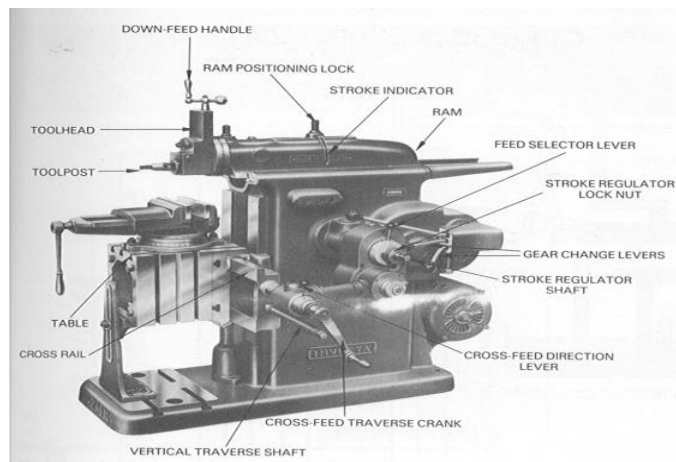
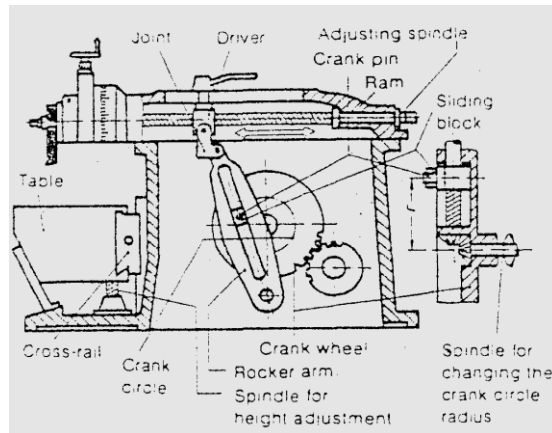


Figure 1:0:13 parts of shaper

Page 24 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022





**Figure 1:0:14 principle of the crank type shaper**

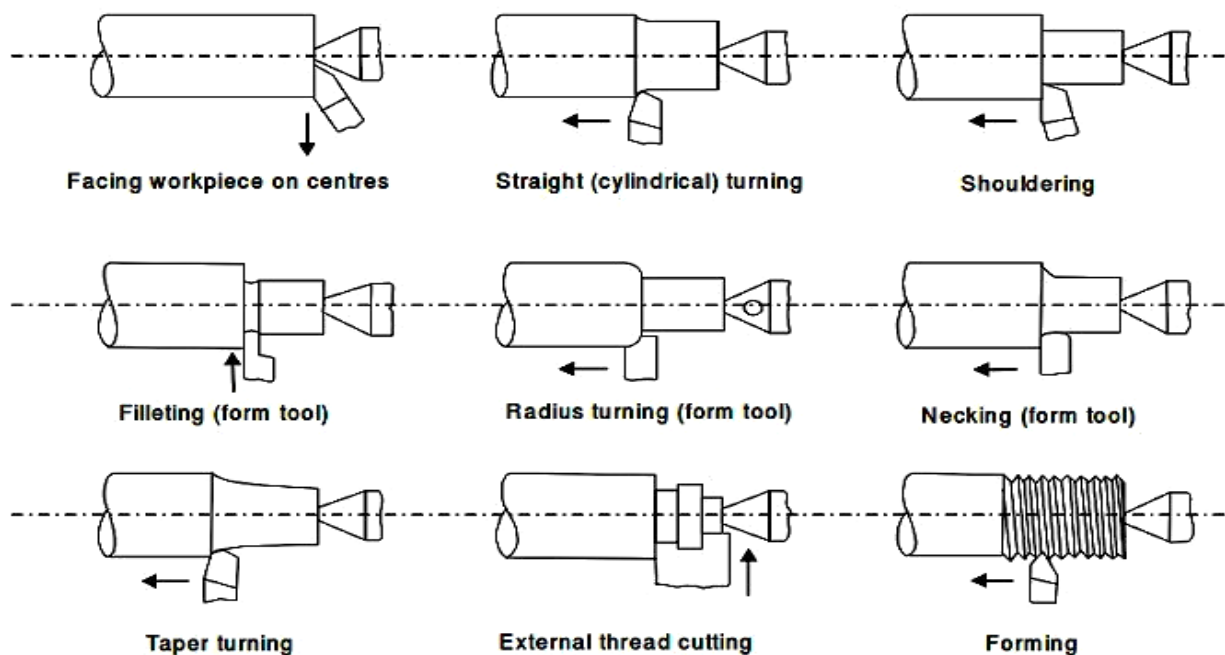
### 1.3 Sequence of operations

Introduction to sequence of operations

Sequencing refers to the order in which activities occur in the operations process. But there are a lot of operations are performed by different machines such as;

Operation on lathe machine Facing, Turning, Chamfering, Grooving, Forming, Knurling, Undercutting, Eccentric turning, Taper turning, Thread cutting, Drilling, Reaming, Boring, Tapping and etc. these operation are depend on one another.

Page 25 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------



**Fig. Lathe operation**

[www.mechengg.net](http://www.mechengg.net)

Figure 1:0:15 Lathe operation

Common lathe operations:

- |                              |                   |                 |
|------------------------------|-------------------|-----------------|
| 1. Facing                    | 2. Plain turning  | 3. Step turning |
| 4. Drilling                  | 5. Boring         | 6. Reaming      |
| 7. Under cutting or grooving | 8. Threading      | 9. Knurling     |
| 10. Forming                  | 11. Taper turning |                 |

Drilling operation

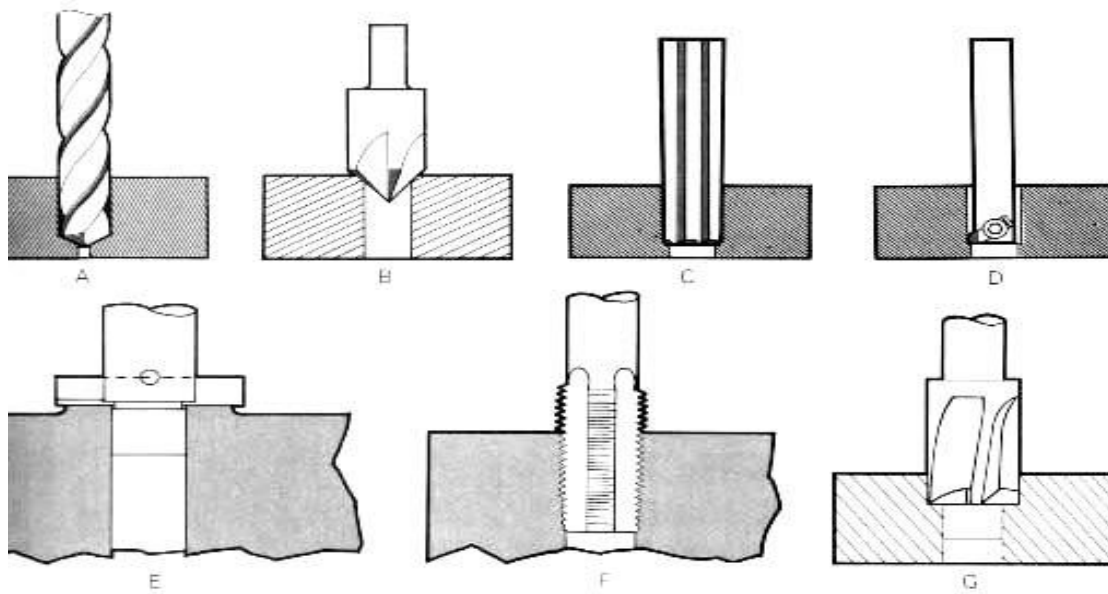


Figure 1:0:16 Drill Operations

## Self-check-1

Direction I choose the best answer

1. The assembly which consists of saddle, cross-slide, compound slide and tool post is  
A. headstock B. tailstock C. bed D. carriage
2. In a milling machine, cutters are mounted on  
A. column B. spindle C. overhanging arm D. arbor
3. One part of the milling machine it is fitted to the over arm and can be clamped at any location on the over arm  
A. Arbor support B. Spindle C. cross- slide D. Column
4. One is not parts of engine lathe  
A. Headstock, a tailstock,  
B. A carriage  
C. A bed upon which the tailstock and carriage move.  
D. Tool post  
E. Grinding wheel
5. One of the following is not properties of tail Stock  
A. The tail stock consists of the upper and lower tail stock castings can be adjusted for taper or parallel turning by two screws set in the base.  
B. The tail stock can be locked in any position along the bed of the lathe  
C. The tail stock spindle has an internal taper to receive the dead center, or live center  
D. The tail stock provides support for the right hand end of the work  
E. All of the above
6. One is not the main parts of carriage  
A. Compound rest  
B. The saddle  
C. Cross-slide,  
D. Apron  
E. Headstock
7. One properties of lead screw.  
A. The lead screw is used for thread cutting

Page 28 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

- B. Along its length are accurately cut acme (highest) threads which engage the threads of the half-nuts in the apron when the half-nuts are clamped over it.
- C. When the lead screw turns inside the closed half-nuts, the carriage moves along the ways a distance equal to the lead of the thread
- D. All of the above

Directions 2: Match the term in column A with the term in column B

- | A  | B                              |
|--|--------------------------------|
| 1. used to of producing holes and enlarging existing holes           | A. The lathe machine           |
| 2. removes material from a rotating work piece in the form of chips. | B. Milling machines            |
| 3. rotate single or multiple cutting edges and removes metal         | C. Planning and <i>shaping</i> |
| 4. Process are differ in the kinematics operation.                   | D. Drilling a machine          |

## Unit two: Set-up machine

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- ✓ Inspect and sharpen tools
- ✓ Mount and position tools
- ✓ guards and accessories
- ✓ cutting speeds, RPM, feeds and depth of cuts
- ✓ setup operations

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Inspect and sharpen tools
- Mount and position tools
- Set and adjust guards and accessories
- Calculate cutting speeds, RPM, feeds and depth of cuts
- Perform setup operations

## 2.1 Inspect and sharpen tools

### Cutting tools Terminology and Tool Geometry

- For cutting tools, geometry depends mainly on the properties of the tool material and the work material.
- The standard terminology is shown in the following figure. For single point tools, the most important angles are the rake angles and the end and side relief angles

#### RAKE ANGLE

Rake angle is the angle between the top face of the tool and the normal to the work surface at the cutting edge

- A large rake angle will improve cutting action, but would lead to early tool failure, since the tool wedge angle is relatively weak
- . The back rake angle affects the ability of the tool to shear the work material and form the chip. It can be positive, negative or neutral
- Positive rake angles reduce the cutting forces resulting in smaller deflections of the work piece, tool holder, and machine.
- If the back rake angle is too large, then strength of the tool is reduced as well as its capacity to conduct heat.
- In machining hard work materials, the back rake angle must be small, even negative for carbide and diamond tools.
- The higher the hardness, the smaller the back rake angle.
- For high-speed steels, back rake angle is normally chosen in the positive range.
- . *Side rake* must be given to the tool point, to provide the correct cutting *angle* for the material being machined
- . Negative *rake* is when the top surface of the tool is inclined at an angle above the center-line of the work. It employed with success when machining the harder bronze alloys.

Table 2..2 Typical value for top rake angle

Page 31 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

Material	Side Relief	Front Relief	Side Rake	Back Rake
Aluminum	12°	8°	15°	35°
Brass	10°	8°	5° to -4°	0°
Bronze	10°	8°	5° to -4°	0°
Cast iron	10°	8°	12°	5°
Copper	12°	10°	20°	16°
Machine Steel	10° to 12°	8°	12° to 18°	8° to 15°
Tool Steel	10°	8°	12°	8°
Stainless Steel	10°	8°	15° to 20°	8°

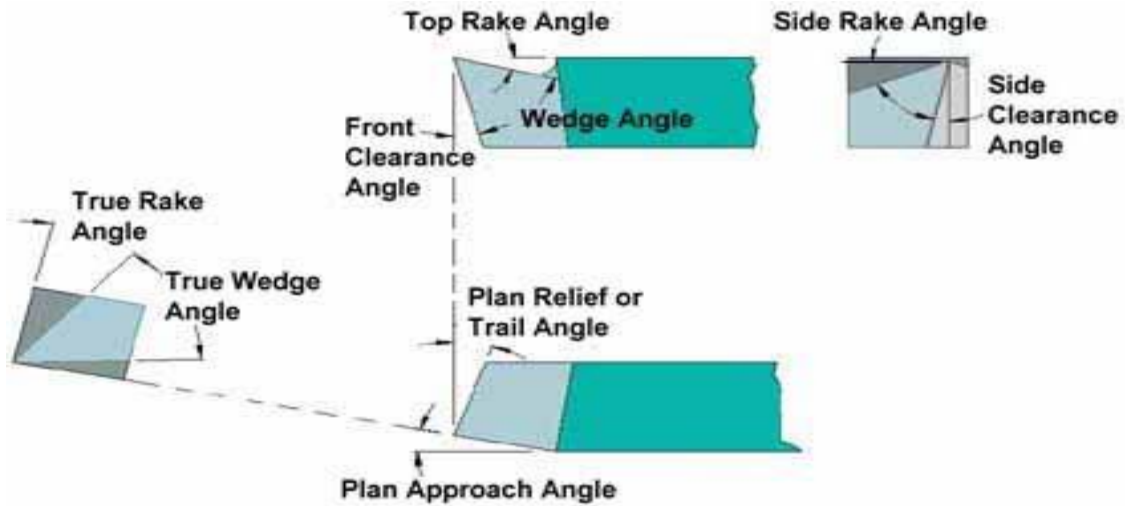


Figure 2.1 Main Features of a Single Point Cutting Tool



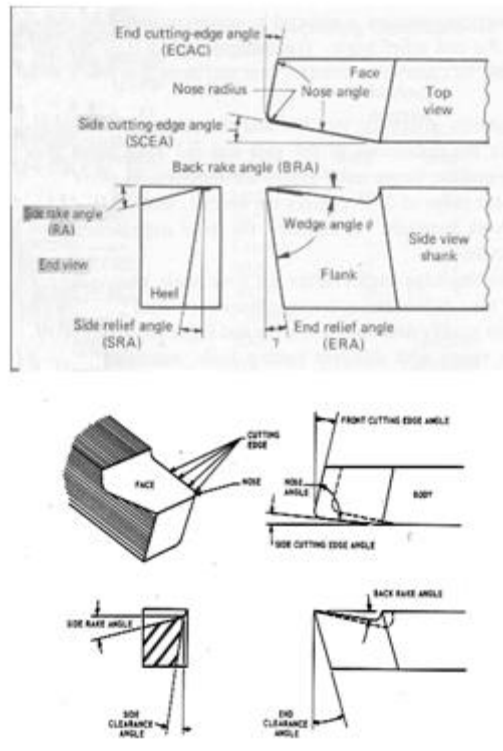


Figure 2.2 single point cutting tool terminology and tool geometry

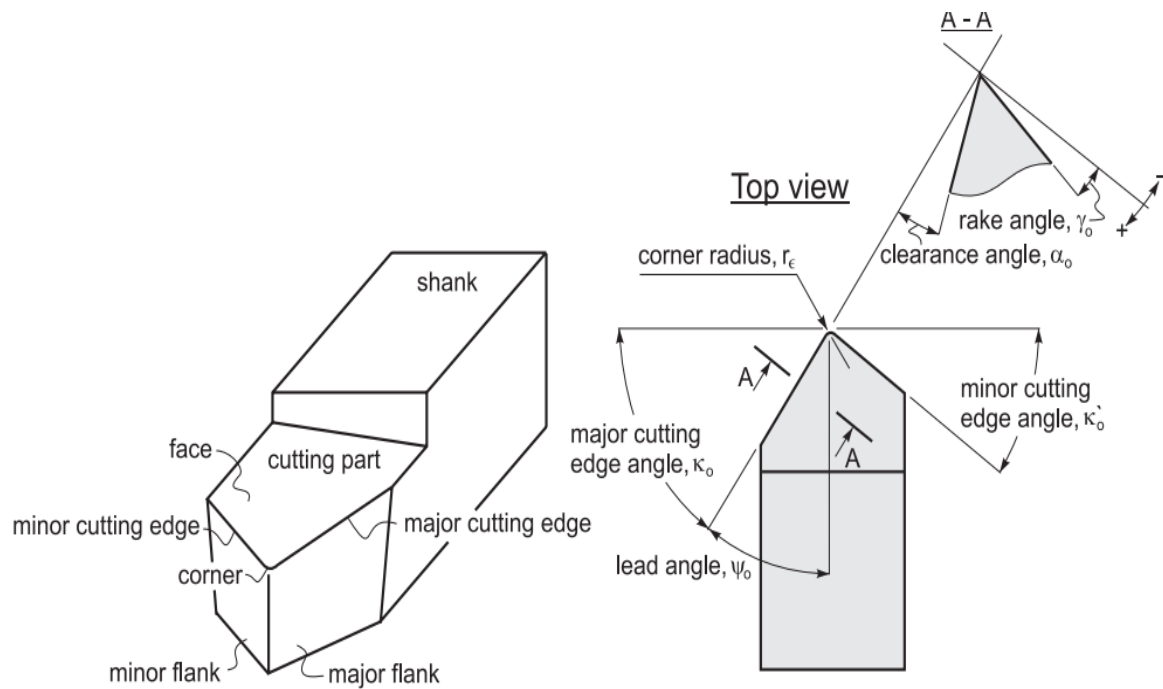
### Clearance Angle

- Clearance angle is the angle between the flank or front face of the tool and a tangent to the work surface originating at the cutting edge.
- All cutting tools must have clearance to allow cutting to take place.
- Clearance should be kept to a minimum, as excessive clearance angle will not improve cutting efficiency and will merely weaken then tool.
- Typical value for front clearance angle is  $6^\circ$  in external turning
- . *Side clearance* must be given to allow the tool to cut or the tool will rub on the work.
- . *Front clearance* must also be given to the tool in order to provide a satisfactory cutting angle.

### Angle of relief

This is needed to prevent “chatter” or vibration of the tool, the frontal area of the tool in contact with the work being reduced to the minimum consistent with obtaining a good finish to the work surface.

Page 33 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------



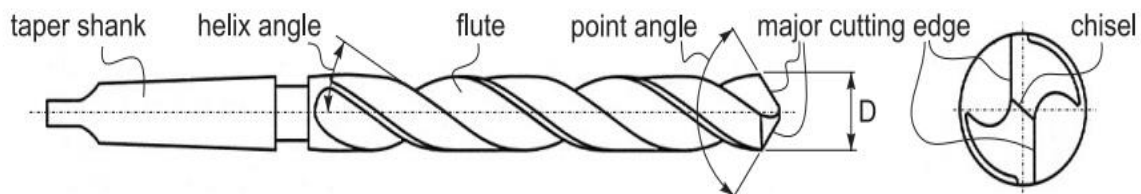
Cutting edges, surfaces and angles on the cutting part of a turning tool

Figure 2.3

### Twist drill Drills

The twist drill does most of the cutting with the tip of the bit. It has two flutes to carry the chips up from the cutting edges to the top of the hole where they are cast off. The standard drill geometry

Is shown in the figure:



Standard geometry of a twist drill.

Figure 2.4

The typical helix angle of a general purpose twist drill is 18~30° while the point angle (which equals two times the major cutting edge angle, see page 101) for the same drill is 118°. Some standard drill types are,

straight shank: this type has a cylindrical shank and is held in a chuck;

Taper shank: this type is held directly in the drilling machine spindle.

Drills are normally made of HSS but carbide-tipped drills, and drills with mechanically attached carbide inserts are commonly used in many operations, especially on CNC drilling machines:



Coated HSS twist drills.

Carbide-tipped twist drills.

Indexable inserts twist drills.

**Figure 2:5 Drill bit**

**Twist Drill Parts:** A drill may be divided into 3 main parts: shank, body, point.

#### Shank

Generally, drills up to ½ “ or 13mm in diameter have straight shanks, while those over this diameter usually have tapered shanks. Straight shank drills are held in a drill chuck; tapered shank drills fit into the internal taper of the drill press spindle. A tang is provided on the end of the tapered-shank drills to prevent the drill from slipping while it is cutting and allow the drill to be removed from the spindle or socket without the shank being damaged.

#### Body

Page 35 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

The body is the portion of the drill between the shank and the point.

## Point

The point of the twist drill consists of the chisel edge, lips, lip clearance, and heel. The chisel edge is the chisel-shaped portion of the drill point. The lips or the cutting edges are formed by the intersection of the flutes. The lips must be of equal length and have the same angle so that the drill will run true and will not cut a hole larger than the size of the drill.

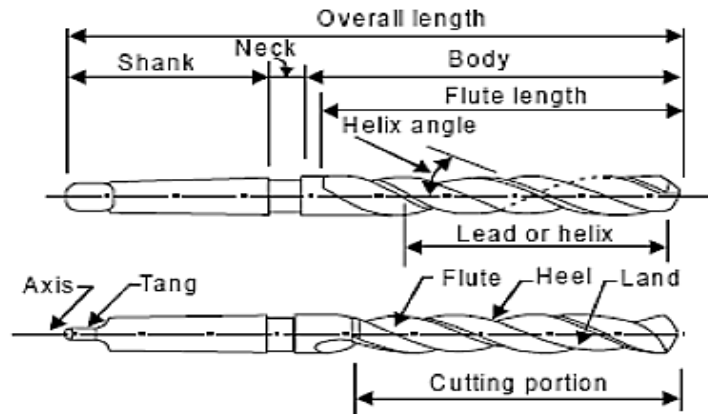
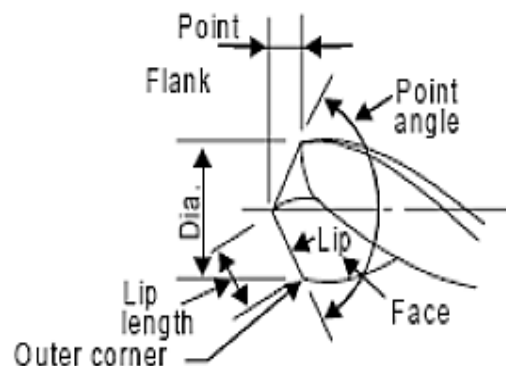


Figure 2.6 Drill bit parts



**Straight shank drill bit**



**Taper shank drill bit**

Figure 2.7 Drill Bit Types

Page 36 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

## 2.2 Mount and position tools

### 1 Mounting the cutting tools in machine tools

1. Appropriate selection of tool holder and the method of mounting
2. Proper positioning and orientation of the tool depending upon its type

size and shape

geometry and it should also;

Proper alignment in respect of coaxially, concentricity and machine tool configuration

Accurate and quick locating, strong support and rigid clamping

Minimization of run out and deflection during cutting operation easy and quick mounting and change

Unobstructed (free) chip flow and cutting fluid action.

### 3.2 Mounting of tools in lathes

Different types of tools which are used in lathes are usually mounted in the following ways.

HSS tools (Shank type) in the tool post.

HSS form tools and threading tools in tool post

Carbide and ceramic inserts in standard tool-holders

Drills and reamers, if required, in the tailstock

Boring tools in tool post

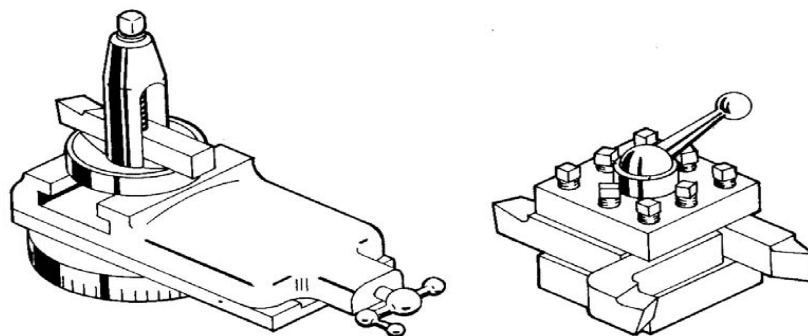


Figure 2.8 Lathe tool fix

### 3.5. Tool holding devices

The drill press spindle provides the means for holding and driving the cutting tool. It may have tapered hole to accommodate tapered shank tools or its end may be tapered or threaded for mounting a drill chuck. Although there is a variety of tool holding devices and accessories, the most commonly found in a machine shop are drill chucks, drill sleeves and drill sockets.

Drill chucks are the most common devices used on a drill press for holding straight –shank cutting tools.

*Drill sleeves* are used to adapt the cutting tool shank to the machine spindle and if the taper on the cutting tool is smaller than the tapered hole in the spindle.

A *drill sockets* used when the hole in the spindle of the drill press is too small for the taper shank of the drill.

#### Mounting of tools in Drilling machines

Small straight shank type solid HSS and carbide drill are held in a drill chuck which is fitted in the drill spindle at its taper bore.

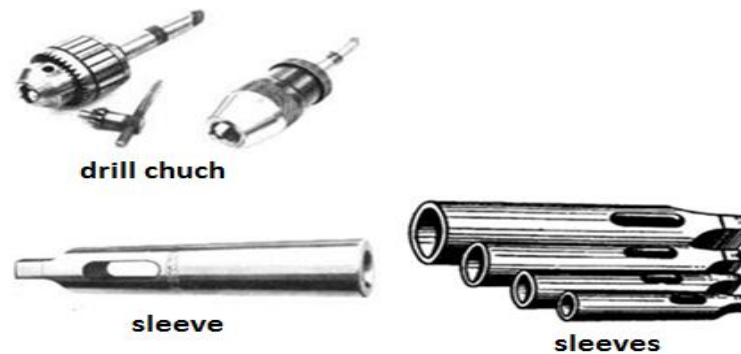


Figure 2.9 Drill sleeve

Cutter holding devices in milling machines are:

Arbors - used for mounting the milling cutter, are inserted and held in the main spindle by a draw bolter a special quick - change adapter.

Shell-end mill arbors - It may fit in to the main spindle or the spindle of the vertical attachment which permit face milling to be done either horizontally or vertically.

Collet adapters - are used for mounting drills or other tapered - shank tools in the main spindle of the machine or the vertical milling attachment.

Page 38 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022



Figure 2.10 Arber, Adapter, Shell end mill Arber, Sleeve

A quick-change adapter - mounted in the spindle, & permits drilling, boring, and milling operations without a change in the setup of the work piece.

Drill Chuck.

The drill chuck is a small universal-type chuck which can be used in either the headstock spindle or in the tailstock for holding

Straight-shank drills,

reamers,

taps, or

Small-diameter work-pieces.

The drill chuck has three or four hardened steel jaws which are moved together or apart by adjusting a tapered sleeve within which they are contained.

The drill chuck is capable of centering tools and small-diameter work-pieces to within 0.002 or 0.003 of an inch when firmly tightened.



Figure 2.11 Drill chuck

## CUTTING TOOL HOLDING DEVICE

Page 39 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

### 1. Straight tool holders

The straight tool holder is generally purpose type. It can be used for taking cuts in either direction and for general machine operation

### 2. Left tool holder

The left hand offset tool holder is designed for machining work close the chuck or face plate for cutting from right to left.

### 3. Right tool holder

The right hand offset holder is designed for machining work close to the tail stock, for cutting from left to right and for facing operations.

4. A threading tool holder    threading tool holder is designed to hold a special form-relieved thread cutting tool

### 5. The carbide tool holder

The carbide tool holder: has a square hole parallel. To the base of the tool holder, to accommodate carbide tipped tools.

### 6. Cutting-off /parting tools holder

Cutting-off /parting tools: is used to hold the long, thin cutting off blade that can be locked securely in the tool holder by means of either a cam lock or locking nut.

### 7 Boring tool holder

Boring tool holder: are made in several styles. A light duty tool holder, medium boring tool holder and a heavy-duty boring bar holder.





Left hand tool holder



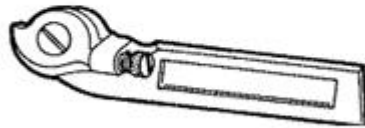
Straight tool holders



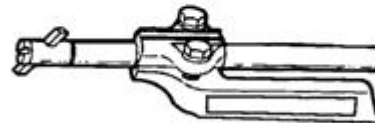
Right hand tool holder



carbide tool holder



Thread cutting tool holder



Boring tool holder

Figure 2.12 Tool Holder

## 2.3 guards and accessories

The lathe accessories are used for holding and supporting the work or for holding the cutting the various lathe accessories are discussed as follows

A general purpose machine tool is basically comprised of power drive and kinematic system for the essential formative and auxiliary tool – work motions and a rigid body or structure to accommodate all of the above. But several additional elements or devices called accessories are also essentially required for that machines' general functioning, mainly for properly holding and supporting the work piece and the cutting tool depending upon the type and size of the tool – work and the machining requirements.

### 1. Adjusting Centers.

a) There are two types of centers i.e.,

live center and dead center.

b) A center which fits into the headstock spindle and revolves with the work is called live center.

Page 41 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

c) The center which is used in a tailstock spindle and does not revolve is called dead center.



Figure 2.13 Center

## 2. Adjusting Chucks.

- a) It is an important device used for holding and rotating the work piece in lathes.
- b) The work pieces which are too short to be held between centers are clamped in a chuck.
- c) It is attached to the lathe spindle by means of two bolts with the back plate screwed on to the spindle nose.
- d) There are many types of the chuck, but the following two are commonly used.
  - i) Three jaw universal chuck.

The three jaw universal chuck, as shown in Fig. is also called self-centering chuck or scroll chuck. Thus chuck is used for holding round and hexagonal work.

### ii) Four jaw independent chuck.

- 1. The four jaw independent chuck, as shown in Fig. has four reversible jaws, each of which may be independently adjusted to accommodate the work it supports.
- 2. This type of chuck can hold square, round and irregular shape of work in either a concentric or eccentric position.

a. The other types of the chucks are

iii) combination chucks, IV) magnetic chuck, v) collect chuck, vi) drill chuck, and vii) air or hydraulic chuck

## 3. Adjusting Lathe dog or carrier

Page 42 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

- a) The work placed on a mandrel or held between centers is rotated positively by clamping the dog or carrier to the end of the work.
- b) This is engaged with a pin attached to the drive plate or face plate.
- c) The lathe dog or carrier may be of straight type or bent type as shown in Fig.



Figure 2.14 Lathe Dog

#### 4. Adjusting Drive plate

- a) The drive plate, as shown in Fig. is a circular plate which is bored out and threaded so that it can be attached to the spindle nose.

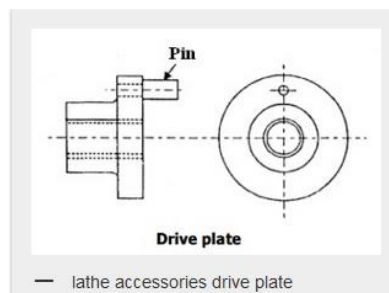


Figure 2.15 Driven Plate

- b) It also carries a hole for the pin which is used only when the work is held in a lathe dog having straight tail. When bent-tail dog is used, this pin is taken out and the bent portion of the tail is inserted into the hole.

#### 5) Adjusting Face plate.



**Figure 2.16 Face Plate**

- a) The face plate, as shown in Fig. is similar to drive plate except that it is larger in diameter.
- b) It contains more open slots or T-slots so that bolts may be used to clamp the work piece to the face of the plate.
- c) The face plate is used for holding work pieces which cannot be conveniently held in a chuck.

#### 6. Adjusting Angle plate

- a) An angle plate is simply a cast iron plate with two faces planed at right angles to each other and having slots in various positions for the clamping bolts.
- b) It is always used with the face plate for holding such parts which cannot be clamped against the vertical surface of the face plate.



**Figure: Angle Plates**

**Figure 2.17 Angle Plate**

#### 7. Adjusting Mandrels

- a) The lathe mandrel is a cylindrical bar with center hole at each end. It is used to hold hollow work pieces to machine their external surface.
- b) The work revolves with the mandrel which is mounted between the centers of the lathe. The various types of mandrels used for different classes of work are shown in Fig.

Page 44 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

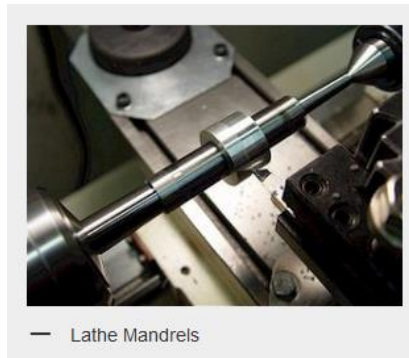


Figure 2.18 Mandrel

#### 8. Adjusting Steady, follower and other rests

Long work pieces often need to be supported in the middle, as cutting tools can push (bend) the work piece away from where the centers can support them, because cutting metal produces tremendous forces that tend to vibrate or even bend the work piece. This extra support can be provided by a steady rest (also called a steady, a fixed steady, a center rest, or sometimes, confusingly, a center). It stands stationary from a rigid mounting on the bed, and it supports the work piece at the rest's center, typically with three contact points 120° apart.



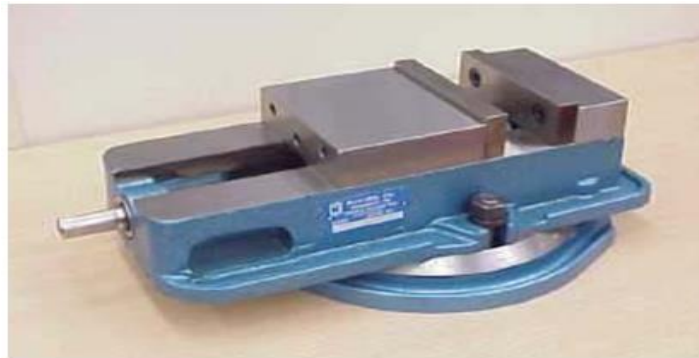
Figure 2.19 Steady Rest

A follower rest (also called a follower or a travelling steady) is similar, but it is mounted to the carriage rather than the bed, which means that as the tool bit moves, the follower rest “follows along” (because they are both rigidly connected to the same moving carriage)

Adjusting Machine vices

Page 45 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

The machine vise is used on several machines such as, the milling and drilling machines and it is the most common type of work holding device used on the machines.



**Machine Vise**

**Figure 2.20 Machine Vice**

#### 4.3 Types of spindle noses

There are four types of headstock spindle noses to which accessories are fitted. They are:

Threaded spindle

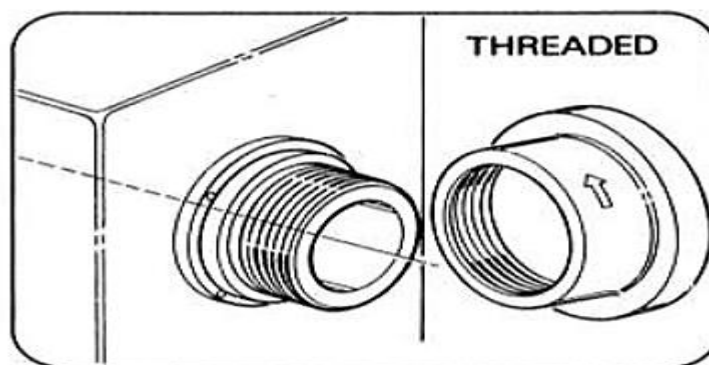
Taper and locking ring

Cam lock

Bolted

Threaded spindle

Accessories are screwed directly on to the spindle. The fit of the threaded holds the accessory true to the axis of the spindle. A shoulder bears against the necessary to hold it square to the spindle.



**Figure 2.21 Threaded Spindle**

### Taper and locking ring

When a threaded locking ring is tightened the accessory is firmly held on the taper.

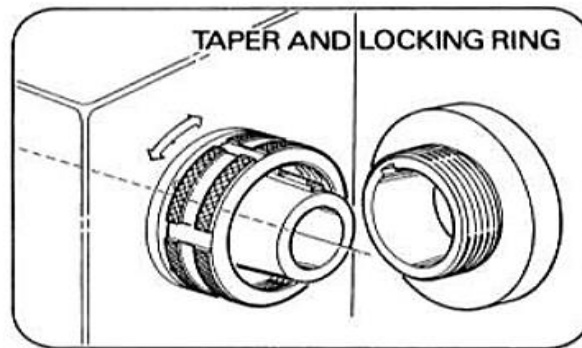


Figure 2.22 Taper and locking ring

### Cam lock

When the cam locks are tightened, the accessory is drawn firmly on to a short taper and against a flange.

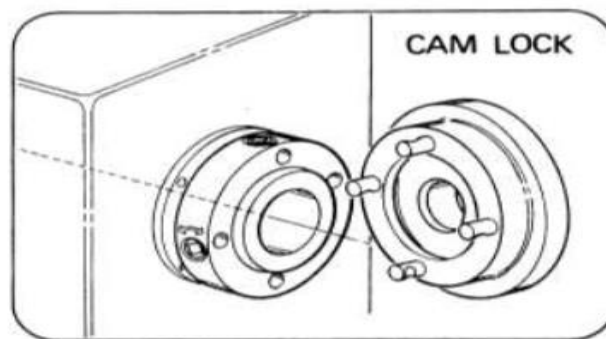


Figure 2.23 Cam lock

### Bolted

The accessory is bolted to a flange on the spindle by a number of studs that protrude from the rear face of the accessory. A short taper locates the accessory centrally. Drive is provided by a locating key.

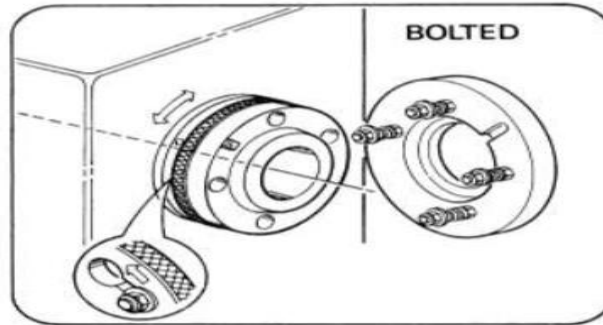


Figure 2.24 Bolted

#### 4.4 Machine Guarding

Any machine part which can cause injury must be guarded. Machine guards help to eliminate personnel hazards created by points of operation, ingoing nip points, rotating parts and flying chips.

Types of guards commonly used machine guards are:-

Fixed guard-is kept in place permanently by fasteners that can only be released by the use of a tool.

Interlocked guard-shuts off or disengages power to the machine and prevents it from starting when the guard is removed/ opened.

Adjustable guard-provides a barrier which can be adjusted to suit the varying sizes of the input stock.

Self-adjusting guard-provides a barrier which moves according to the size of the stock entering the danger area.

Two hand controls -concurrent use of both hands is required to operate the machine, preventing the operator from reaching the danger area.

Pull back -the device is attached to the wrist of the operator which pulls the operator's hands away from the point of operation or other hazardous areas when the machine operates.

Machine guards are surface grinding wheels main protective barrier against a deadly result of a broken grinding wheel.

Page 48 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------



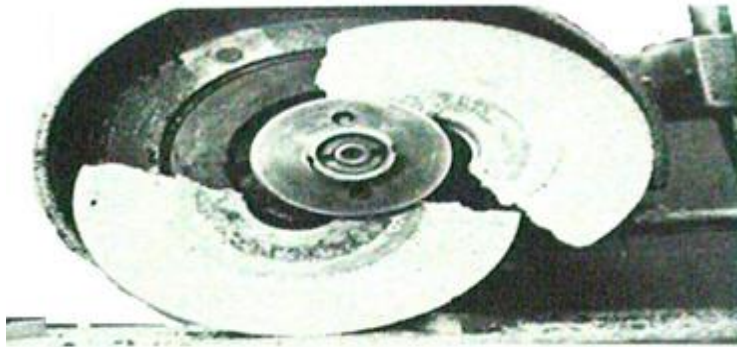


Figure 2.25 Machine guard

#### 4.4 Miscellaneous safeguarding aids

Shields can be used to provide protection from flying particles, splashing metal working fluids or coolants. Holding tools can be used to place and remove stock. Example, reaching into the danger area of a power press. Holding tools must not be used as a replacement of machine guards.

#### 4.5 Safety precautions while working with machinery

Ensure that the guards are in position and in good working condition before operating.

Know the location of emergency stop switch.

Do not wear loose clothing or jewelry that can be caught in the rotating parts.

Confine long hair.

Page 49 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

## 2.4 Cutting Speeds, RPM, Feeds and Depth of cuts

### 2 Cutting speed, feed and depth of cut

#### Cutting Speed/Surface Velocity

- Cutting speed is defined as the speed at which the work moves with respect to the tool
- It is the peripheral speed of the work past the cutting tool, or the speed at which the metal is removed by the tool from the work.

It is expressed in meters / min or measured in feet per minute

Cutting speed,  $V = \pi dn / 1000 \text{ m / min.} = \pi dn / \text{ft/min}$

Where;  $n = \text{r.p.m.}$ , and  $d = \text{diameter of w/p in mm or in feet}$

$$r / \text{min} = \frac{CS(\text{ft})}{\text{circumference(in)}} \quad (\text{for inch calculation})$$

$$r / \text{min} = \frac{12 \times CS}{\pi D}$$

$D$  – diameter of the cutter

$CS$  – cutting speed

$$r / \text{min} = \frac{CS(\text{m}) \times 1000}{\pi \times D(\text{mm})} = \frac{CS \times 1000}{3.1416 \times D} \quad (\text{for metric calculation})$$

$D$  – diameter of the cutter

N.B during calculate lathe RPM take diameters work piece

Feed:

Feed is the distance the tool advances for each revolution of the work piece

Expressed in mm / revolution or inch/revolution

- Feed rate is defined as the distance the tool travels during one revolution of the part.

Tool Material	High Speed Steel		Carbide	
Material	Cutting Speed	Feed (f)	Cutting Speed	Feed (f)

Mild Steel	25	0.08	100	0.15
Aluminum	100	0.15	500	0.3
Hardened Steel	---	---	50	0.1

#### e. Depth of Cut

- The perpendicular distance measured from the machined surface to the uncut surface of work

Or the distance the tool is plunged into the surface

expressed in mm or in inch

If  $d_1$  = diameter of work before machining, and

$d_2$  = diameter of work after machining,

Then, Depth of cut =  $d_1 - d_2 / 2$

#### METAL REMOVAL RATE

- For turning, MRR values range from 0.1 to 600 in<sup>3</sup> per minute.
- Most processes have MRR's that can be expressed as the volume of metal removed divided by the time needed to remove it:

$MRR = (\text{volume of cut})/(\text{cutting time})$

- MRR can be used to estimate the power required to sustain the cutting operation.

For most Aluminum alloys,

On a roughing cut (.010 to .020 inches depth of cut) run at 600 fpm.

On a finishing cut (.002 to .010 depth of cut) run at 1000 fpm

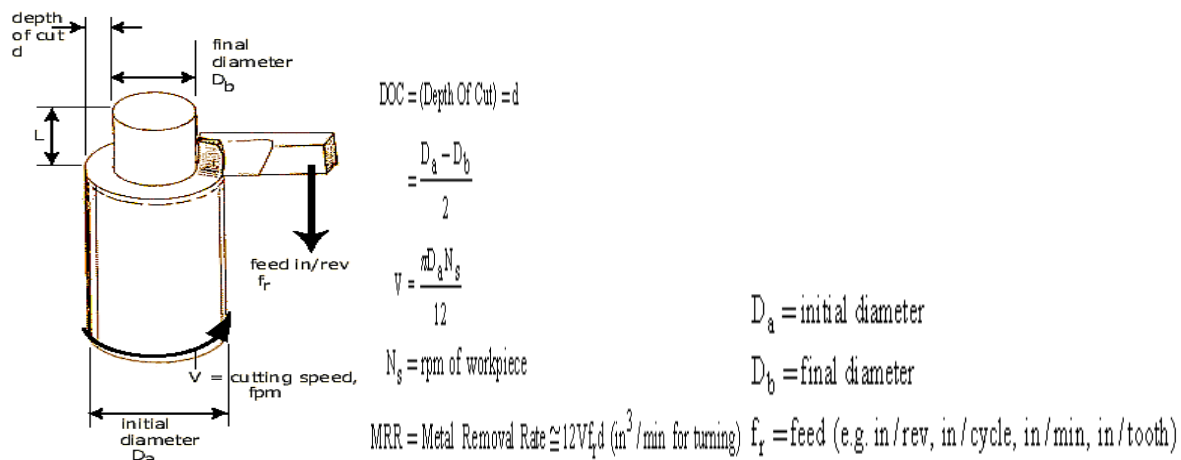


Fig4.26 metal removal rate

#### Cutting time

- With turning, the cutting time can be expressed as the following:
- The allowance is an estimation factor which is added to the L term to allow for the tool to enter and exit the cut.

$$\text{CUTTING TIME} = \frac{L + \text{Allowance}}{f_r N_s}$$

#### 6.6 Recommended feed per tooth (for high speed steel cutters)

Material	Face mills		Helical Mills		Slotting and side Mills		End mills		Form relived Cutters	
	In	Mm	In	Mm	In	Mm	In	Mm	In	mm
Aluminum	0.022	0.55	0.018	0.45	0.013	0.33	0.011	0.28	0.007	0.18
Brass & Bronze	0.014	0.35	0.011	0.28	0.008	0.20	0.007	0.18	0.004	0.10
Machine steel	0.012	0.30	0.010	0.25	0.007	0.18	0.006	0.15	0.004	0.10
Tool steel (medium)	0.010	0.25	0.008	0.20	0.006	0.15	0.005	0.13	0.003	0.08
Stainless steel	0.006	0.15	0.005	0.13	0.004	0.10	0.003	0.08	0.002	0.05
Cast iron	0.013	0.33	0.010	0.25	0.007	0.18	0.007	0.18	0.004	0.10

## 2.5 Setup Operations

Before starting a lathe machining operation, always ensure that the machine is set up for the job that is to be accomplished. After selecting and preparing proper cutting tool you have to

adjust the center distance The cutting edge of the tool bit should be set to the center height of the lathe spindle. There are several methods for checking the height of the tool bit. Perhaps the simplest way is to place a thin strip of metal, such as a steel rule or feeler gage, between the work piece and the point of the tool bit. If the height is correct, the strip of metal will be held vertical. If the top is leaning toward you, the tool bit is too low. If the top is leaning away from you, the tool bit is too high. Using the standard tool post, you adjust the tool bit height using shims under the tool bit. You can get an economical set of shims, about the right size, at any auto parts store. Purchase a set of feeler gages and remove the pivot pin. The easy way to adjust the tool bit height is to get a quick change tool post. Virtually all quick change tool posts incorporate a mechanism for easily adjusting the tool bit height.

## Lathe Machine Operation

### Standard Operating Procedure (SOP) - Lathe

All stock must be properly secured in the lathe chuck or mounted prior to the machining process taking place. Use the correct sized clamp or vise for the stock being machined.

Turn the chuck or faceplate by hand to ensure there is no binding or danger of the work striking any part of the lathe.

Check to ensure the cutting tool will not run into the chuck or lathe dog. If possible, feed away from the chuck or dogs.

Before starting the lathe, ensure the spindle work has the cup center imbedded; tail, stock and tool rests are securely clamped; and there is proper clearance for the rotating stock.

Prior to starting the lathe, ensure that small diameter stock does not project too far from the chuck without support from the tail stock center.

When using wood, do not mount a split work piece or one containing knots.

When roughing stock, do not force the tool in the work piece or take too big a cut.

The operator must always be aware of the direction and speed of the carriage or cross-feed prior to engaging the automatic feed.

Never leave the key in the chuck. Do not let go of the key until it is free of the chuck and secured in its proper holding place.

Select turning speed carefully. Large diameter stock must be turned at a very low speed. Always use the lowest speed to rough out the stock prior to final machining.

Page 53 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

The correct speed and feed for the specific material and cutting tool must be used. Stop the machine before making adjustments or measurements.

Do not remove metal or wood chips from the table or stock by hand. Use a brush or other tool to properly remove chips or shavings from the table or stock.

Never attempt to run the chuck on or off the spindle head by engaging the power.

Do not stop the rotation of the chuck by reversing the power to the lathe unless tapping holes.

Do not leave tools, bits or excess pieces of stock on the lathe bed.

All belts and pulleys must be guarded. If frayed belts or pulleys are observed, the lathe must be taken out of service and the belts or pulleys replaced.

Stop the machine immediately if odd noise or excessive vibration occurs.

Only properly sharpened drill bits and cutting tools in good condition should be used. Dull drill bits and chipped or broken cutting tools must be removed from service.

Disconnect the lathe from power source and follow OSEH Guideline IHS011, Lock-out/Tag-out - Control of Hazardous Energy Sources if making repairs or servicing.

When an operator has finished working on the lathe, and before leaving the lathe for any reason, the power must be shut off and the machine must come to a complete stop.

When an operator observes an unsafe condition with the lathe or stock being worked, the operator must report it immediately to the designated MSSA and the lathe shall be taken out of service until the problem has been corrected.

#### Steps In Facing Operation

1. Prepare the tools and materials.
2. Observe safety precautions while operating the lathe.
3. Mount the work piece to the chuck.
4. Center the work piece.
5. Set the facing tool used right cut facing tool.
6. Feed the cutting tool into the work with the compound rest.
7. Repeat procedure no. 5 until work piece meet the specified measurement

#### Knurling Operation

The knurling tool must be set up correctly. Otherwise, the knurls will not track properly and will dull rapidly. Use this procedure:

Page 54 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

1. Mark off the section to be knurled.
2. Adjust the lathe to a slow back gear speed and a fairly rapid feed.
3. Place the knurling tool in the tool post and set it up to the work. Both wheels must bear evenly with the wheel faces parallel with the work surface.
4. Start the lathe and force the knurls slowly into the work surface until a pattern begins to form. Engage the automatic feed and let the tool move across the work. When it reaches the proper position, stop the machine but do not disengage the feed. Reverse spindle rotation and permit the tool to move back to the starting point. Repeat the operation until a satisfactory knurl has been formed. Flood the surface with cutting fluid during the operation.

## Self-check-2

### Test-I Choose

1. Which operation always performed first?  
A. Tapering   B. Facing   C. Turning   D. forming
2. \_\_\_\_\_ is defined as the operation of producing a hole by removing a metal from a solid mass using a cutting tool called a twist drill.  
A. Boring   B. Drilling   C. Countersinking   D. Reaming
3. Reaming is used for \_\_\_\_\_  
A. Drilling work   B. Smoothing work   C. Tapping work   D. Countersinking
4. A large nose radius produces better for \_\_\_\_\_? (1 point)  
A. Cutting large amount   B. Good surface finish   C. Rough cutting   D. All
5. A 60° angle cutting tool used for \_\_\_\_\_? (1 point)  
A. Parting   B. Threading   C. Grooving   D. Turning

### Directions II: Calculate

1. List the six angles of turning tools? (6 points)

Page 55 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

2. Write the two cutting edges on the end of the tool bit? (2 Points)

**Directions 2:** Match the term in column A with the term in column B.

A	B
1. is generally purpose type. It can be used for taking cuts in either direction and for general machine operation	A. dead center.
2. concurrent use of both hands is required to operate the machine, preventing the operator from reaching the danger area	B. B. live center
3. offset tool holder is designed for machining work close the chuck or face plate for cutting from right to left	C. Interlocked guard-.
4. center which fits into the headstock spindle and revolves with the work is called	D. Straight tool holders
5. shuts off or disengages power to the machine and prevents it from starting when the guard is removed/ opened	E. Left tool holder
6. The center which is used in a tailstock spindle and does not revolve is called	F. straight tool holder

-



### Unit Three : Perform machine operations

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Work holding devices
- Operate machine
- machine parameters
  - Speeds
  - Feeds
  - Depth
- safety procedures.

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- ✓ Mount materials to be machined and secured using clamping devices.
- ✓ Operate machine correctly
- ✓ Set machining parameters for job requirements and maximum tool life.
  - Speeds
  - Feeds
  - Depth
- ✓ Perform operations applying safety procedures.

### 3.1 Work holding devices

#### 3.3 Mounting of work in lathes

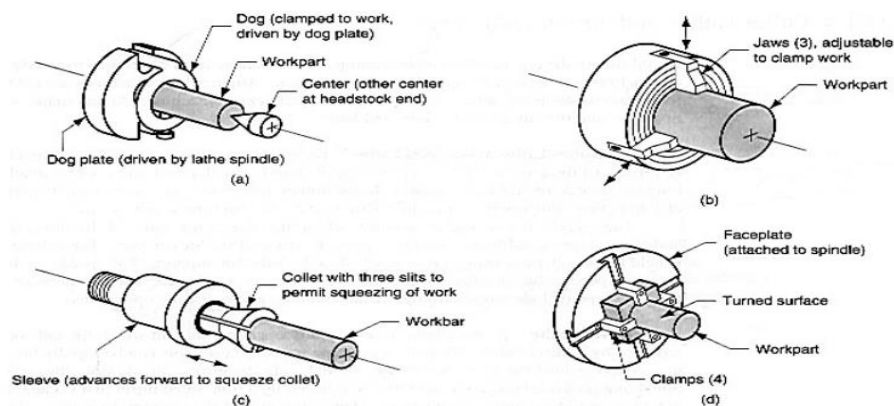
Work is held or mounted in the lathe with a number of methods,

Between two *centers*. The work piece is driven by a device called a *dog*; the method is suitable for parts with high *length-to-diameter ratio*.

A *3 jaw self-centering chuck* is used for most operations on cylindrical work parts. For parts with high *length-to-diameter ratio* the part is supported by center on the other end.

*Collet* consists of tubular bushing with longitudinal slits. Collets are used to grasp and hold bar stock. A collet of exact diameter is required to match any bar stock diameter.

A *face plate* is a device used to grasp parts with irregular shapes:



Four work holding methods used in lathes: (a) mounting the work between centers using a dog, (b) three-jaw chuck, (c) collet, and (d) face plate for noncylindrical workparts.

Figure 3.1 Four work holding methods used in lathe

#### 3.4 Mounting a Work on milling machine

A. General.

Page 58 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

An efficient and positive method of holding work pieces to the milling machine table is essential if the machine tool is to be used to advantage. Regardless of the method used in holding, there are certain factors that should be observed in every case. The work piece must not be sprung in clamping; it must be secured to prevent it from springing or moving away from the cutter; and it must be so aligned that it may be correctly machined.

Milling machine worktables are provided with several T-slots, used either for clamping and locating the work piece itself or for mounting various holding devices and attachments. These T-slots extend the length of the table and are parallel to its line of travel. Most milling machine attachments, such as vises and index fixtures, have keys or tongues on the underside of their bases so that they may be located correctly in relation to the T-slots.

Methods of Mounting Work pieces.

- (1) Clamping a Work piece To the Table.
- (2) Clasping a Work piece to the Angle Plate.
- (3) Clamping Work pieces in Fixtures.
- (4) Holding Work pieces Between Centers.
- (5) Holding Work pieces in a Chuck.
- (6) Holding Work pieces in the Vise.

## MOUNTING AND CENTERING OF WORKPIECE ON THE LATHE

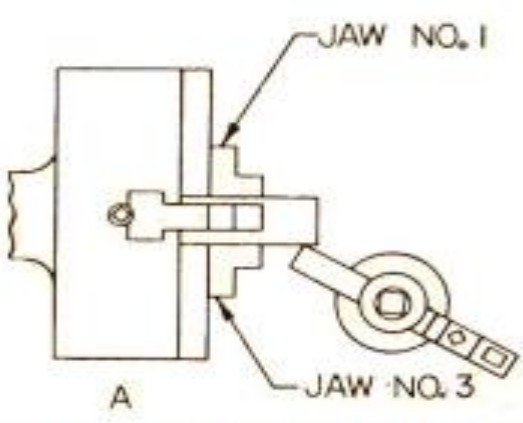
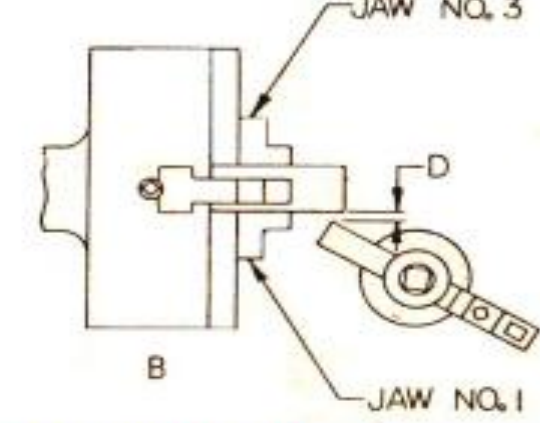
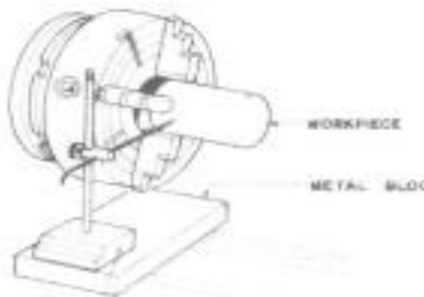
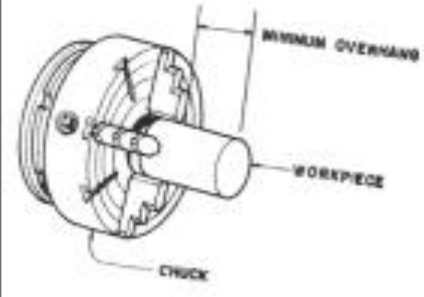
Mounting Work in a Four Jaw Independent Chuck Visual Inspection Approach Using High Spot – Low Spot Technique		
  <p> <b>(A)</b> High Spot is the highest point that touches the point of any centering devices.  <b>(B)</b> Low Spot is the gap created as it moves away from the workpiece                      Illustration show the back of a loose tool holder as a means to determine equidistance                 </p>		
<b>Visual Estimate Inspection Method</b> 1. Chalk method /Surface gage /wiggler method/Alignment of Chuck's jaw		
<b>NOTE: Do visual inspection by;</b> <ol style="list-style-type: none"> <li>Loosen up the jaw opposite of the high spot and screw tight the high spot's jaw to push the workpiece</li> <li>Having plenty of light while using scratch white paper as background distinguisher between workpiece gap and the point of a centering devices</li> <li>Repeating the procedures until an equal gap was visible in four front of the chuck's jaw. Tighten the high spot area if gap in the low spot equal 0.5mm.</li> <li>Checking for wobble spin and remedied it by light tapping</li> </ol>		

Figure 3.2 Mounting and centering work in lathe

Cutter holding devices in milling machines are:

**Arbors** - used for mounting the milling cutter, are inserted and held in the main spindle by a draw bolter a special quick - change adapter.

**Shell-end mill arbors** - It may fit in to the main spindle or the spindle of the vertical attachment which permit face milling to be done either horizontally or vertically.

**Collet adapters** - are used for mounting drills or other tapered - shank tools in the main spindle of the machine or the vertical milling attachment.

### 3.6 WORK HOLDING DEVICES

Many different devices, such as chucks, collets, faceplates, drive plates, mandrels, and lathe centers, are used to hold and drive the work while it is being machined on a lathe. The size and type of work to be machined and the particular operation that needs to be done will determine which work holding device is best for any particular job. Another consideration is how much accuracy is needed for a job, since some work holding devices are more accurate than others. Operational details for some of the more common work holding devices the universal scroll chuck, Figure 7-19, usually has three jaws which move in unison as an adjusting pinion is rotated. The advantage of the universal scroll chuck is its ease of operation in centering work for concentric turning. This chuck is not as accurate as the independent chuck, but when in good condition it will center the jaws are moved simultaneously within the chuck by a scroll or spiral-threaded plate. The jaws are threaded to the scroll and move an equal distance inward or outward as the scroll is rotated by the adjusting pinion. Since the jaws are individually aligned on the scroll, the jaws cannot usually be reversed. Some manufactures supply two sets of jaws, one for internal work and one for external work. Other manufactures make the jaws in two pieces so the outside or gripping surface may be reversed. Which can be interchanged? r work within 0.002 The universal scroll chuck can be used to hold and automatically center round or hexagonal workplaces. Having only three jaws, the chuck cannot be used effectively to hold square, octagonal, or irregular shapes. to The independent chuck, Figure 7-19, generally has four jaws which are adjusted individually on the chuck face by means of adjusting screws. The chuck face

is scribed with concentric circles which are used for rough alignment of the jaws when chucking round workpieces. The final adjustment is made by turning the work piece slowly by hand and using a dial indicator to determine its concentricity. The jaws are then readjusted. The jaws of the independent chuck may be used as illustrated or may be reversed so that the steps face in the Opposite direction; thus workpieces can be gripped either externally or internally. The independent chuck can be used to hold square, round, octagonal, or irregularly shaped workpieces in either a concentric or eccentric position due to the independent operation of each jaw. Because of its versatility and capacity for fine adjustment, the independent chuck is commonly used for mounting odd shaped workpieces which must be held with extreme accuracy.

The drill chuck, Figure 7-19, is a small universal chuck which can be used in either the headstock spindle or the Tail stock for holding straight-shank drills, reamers, taps, or small diameter workpieces. The drill chuck has three or four hardened steel jaws which are moved together or apart by adjusting a tapered sleeve within which they are contained. The drill chuck is capable of centering tools and small diameter workpieces to within 0.002 or 0.003 inch when firmly tightened.

### 3.7 the collet chuck

The most accurate means of holding small work pieces in the lathe . The collet chuck is the most accurate means of holding small workpieces in the lathe. The collet chuck consists of a spring machine collet (Figure 7-20) and a collet attachment which secures and regulates the collet on the headstock spindle of the lathe.

The spring machine collet is a thin metal bushing with an accurately machined bore and a tapered exterior. The collet has three lengthwise slots to permit its sides being sprung slightly inward to grip the work piece. To grip the work piece accurately, the collet must be no more than 0.005 inch larger or smaller than the diameter of the piece to be chucked. For this reason, spring machine collets are available in increments of 1/64 inch. For general purposes, the spring machine collets are limited in capacity to 1 1/8 inch in diameter.

Page 62 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

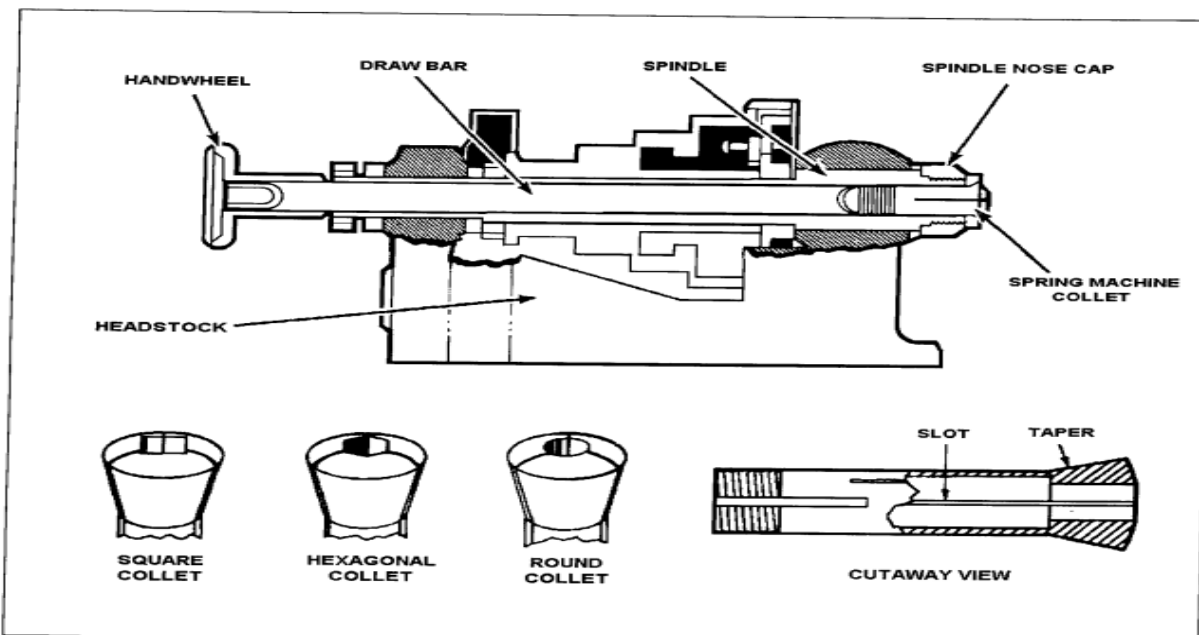


Figure 7-20. Spring machine collet chucks and installation method.

Figure 3.0:1 spring machine collet

### 3.8 LAYING OUT AND MOUNTING WORK

There is relatively little layout work to be done for most lathe work because of the lathe's ability to guide the cutting tool accurately to the work piece. If center holes must be located and drilled into the end of a work piece for turning lay out and center-punch the work piece using other methods. Some suggested methods are to use a bell-type center punch between centers and this cannot be accomplished on the lathe, (Figure 7-32), use hermaphrodite calipers to scribe intersecting arcs, use the centering head of the combination square, or use dividers (Figure 7-33).



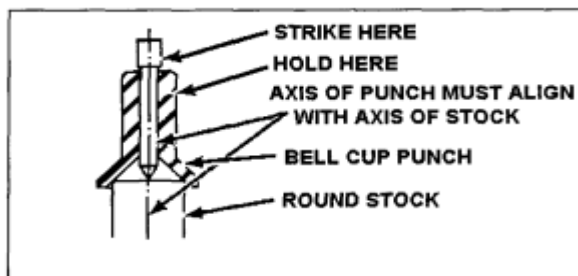


Figure 7-32. Bell-type center punch.

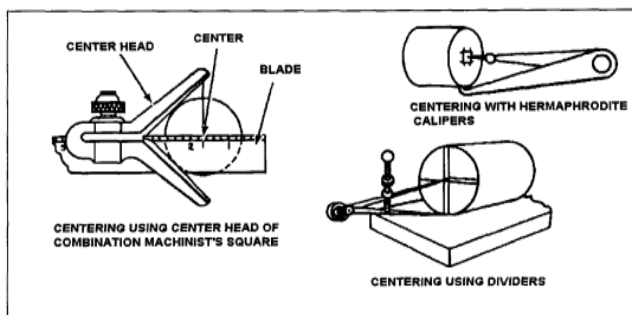


Figure 7-33. Laying out center holes.

Figure 3:0:2 lay outing on work piece

### 3.9 METHODS OF MOUNTING WORK

**Mounting Work pieces in Chucks** When installing the chuck or any attachment that screws onto the lathe headstock spindle, the threads and bearing surfaces of both spindle and chuck must be cleaned and oiled. In cleaning the internal threads of the chuck, a spring thread cleaner is very useful (Figure 7-34).

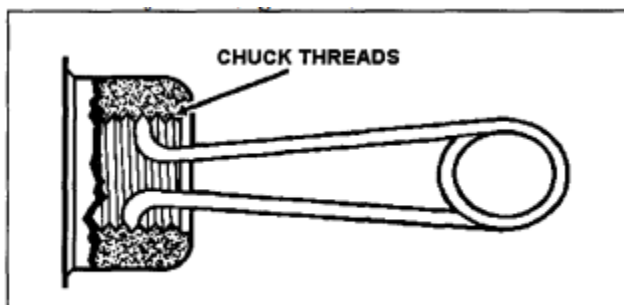


Figure 7-34. Spring thread cleaner.

Figure 3:0:3 spring thread cleaner

Page 64 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------



Turn the spindle so that the key is facing up and lock the spindle in position. Make sure that the spindle and chuck taper are free of grit and chips. Place the chuck in position on the spindle. Engage the draw nut thread and tighten by applying four or five hammer blows on the spanner wrench engaged with the draw nut. Rotate the spindle 180°, engage the spanner wrench, and give four or five solid hammer blows to the spanner wrench handle. The work piece is now ready for mounting. Work automatically centers itself in the universal (3 jaw) scroll chuck, drill chuck, collet chucks, and step chuck, but must be manually centered in the independent (4 jaw) chuck. To center work in the independent chuck, line the four jaws up to the concentric rings on the face of the chuck, as close to the required diameter as possible. Mount the work piece and tighten the jaws loosely onto the work piece (Figure 7-35). Spin the work piece by hand and make approximate centering adjustments as needed, then firmly tighten the jaws.

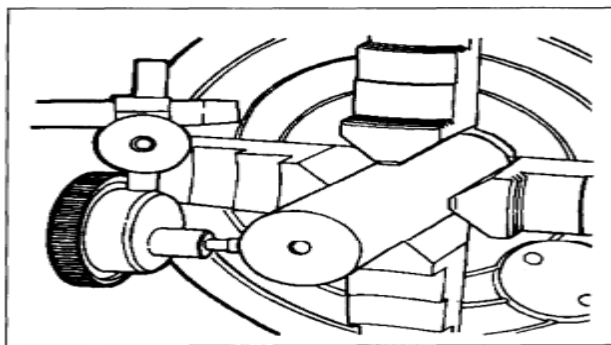


Figure 7-35. Mounting work in a 4-jaw independent chuck.

Figure 3:0:4 mounting work piece on 4 jaw

To center a work piece having a smooth surface such as round stock, the best method is to use a dial test indicator. Place the point of the indicator against the outside or inside diameter of the work piece. Revolve the work piece slowly by hand and notice any deviations on the dial. This method will indicate any inaccuracy of the centering in thousandths of an inch.

#### Mounting Work to Faceplates

Mount faceplates in the same manner as chucks. Check the accuracy of the faceplate surface using a dial indicator, and true the-faceplate surface by taking a light cut if necessary. Do not use faceplates on different lathes, since this will cause excessive wear of the faceplate due to

repeated truing cuts having to be taken. Mount the work piece using T-bolts and clamps of the correct sizes (Figure 7-36). Ensure all surfaces are wiped clean of burrs, chips, and dirt. When a heavy piece of work is mounted off center, such as when using an angle Plate, use a counterweight to offset the throw of the work and to minimize vibration and chatter. Use paper or brass shims between the work and the faceplate to protect the delicate surface of the faceplate. After mounting the work to an approximate center location, use a dial indicator to finish accurate alignment

### 3.9.2 Mounting Work between Centers

Before mounting a work- piece between centers, the work piece ends must be center-drilled and countersunk. This can be done using a small twist drill followed by a 60° center countersink or, more commonly, using a countersink and drill (also commonly called a center drill). It is very important that the center holes are drilled and countersunk so that they will fit the lathe centers exactly. Incorrectly drilled holes will subject the lathe centers to unnecessary wear and the work piece will not run true because of poor bearing surfaces. A correctly drilled and countersunk hole has a uniform 60° taper and has clearance at the bottom for the point of the lathe center. Figure 7-37 illustrates correctly and incorrectly drilled center holes.

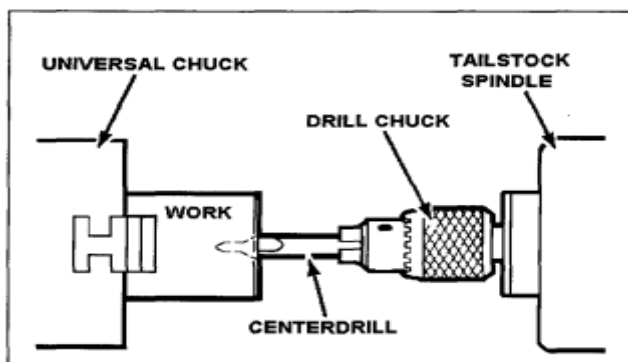


Figure 7-38. Center drilling.

Figure 3:0:5 Center drill

To mount work between centers, the operator must know how to insert and remove lathe centers. The quality of workmanship depends as much on the condition of the lathe centers as on the proper drilling of the center holes. Install the lathe center in the tailstock spindle with a

light twisting motion to ensure a clean fit. Install the center sleeve into the headstock spindle and install the lathe center into the center sleeve with a light twisting motion. To remove the center from the headstock spindle, hold the pointed end with a cloth or rag in one hand and give the center a sharp tap with a rod or knockout bar inserted through the hollow headstock spindle. To remove the center from the tailstock, turn the tailstock hand wheel to draw the tailstock spindle into the tailstock. The center will contact the tailstock screw and will be bumped loose from its socket

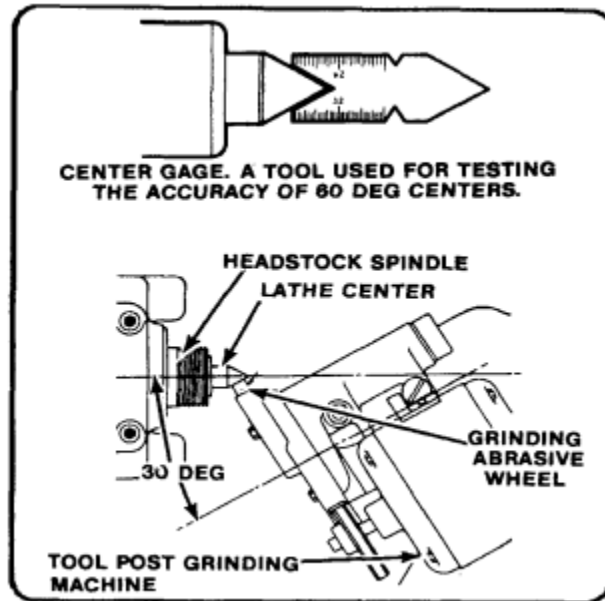


Figure 7-40. Checking and truing a 60 degree lathe center.

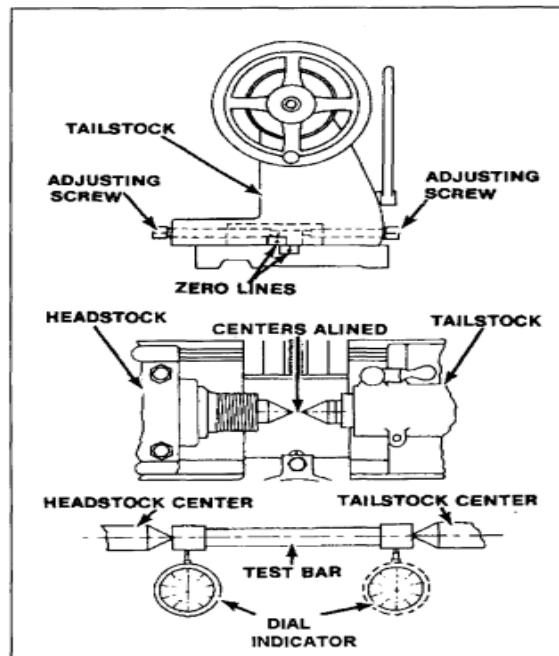


Figure 7-42. Checking the alignment of centers.

Figure 3:0:6 Checking the alignment of centering

Lathe centers must be parallel with the ways of the lathe in order to turn workpieces straight and true. Before beginning each turning operation, the center alignment should be checked. The tailstock may be moved laterally to accomplish this alignment by means of adjusting screws after it has been released from the ways. Two zero lines are located at the rear of the tailstock and the centers are approximately aligned when these lines coincide (Figure 7-42). This alignment may be checked by moving the tailstock up close to the headstock so that the centers almost touch, and observing their relative positions (Figure 7-42).

After mounting the headstock and tailstock centers, the accuracy of the 60° point should be checked using a center gage or a dial indicator. If the center in the headstock is not at 60°, or is scarred and burred, it must be trued while inserted in the lathe headstock spindle. If the headstock center is a soft center (a center that is not heat-treated and hardened), it can be turned true with the lathe tool bit. If the center in the headstock is hardened, it must be ground with a tool post grinding machine to get a true surface (Figure 7-40).

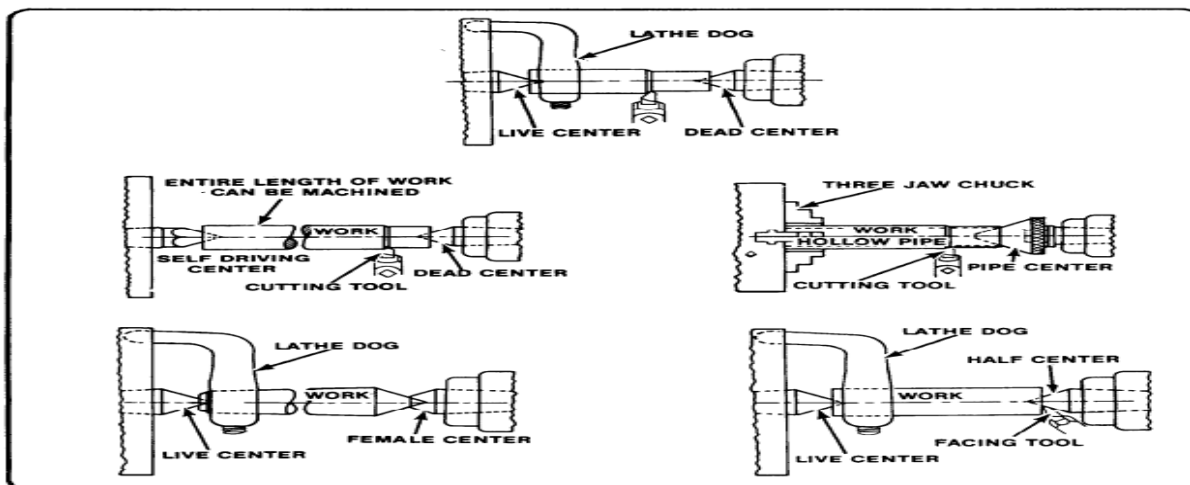


Figure 7-43. Holding work between centers.

Figure 3:0:7 holding work between center

### 3.9.4 Mounting Work on Mandrels

To machine a work piece of an odd shape, such as a wheel pulley, a tapered mandrel is used to hold and turn the work. The mandrel must be mounted between centers and a drive plate and lathe dog must be used. The centers must be aligned and the mandrel must be free of burrs.

Page 69 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

Mount the work piece onto a lubricated mandrel of the proper size by using an arbor press. Ensure that the lathe dog is secured to the machined flat on the end of the mandrel and not on the smooth surface of the mandrel taper (Figure 7-44). If expansion bushings are to be used with a mandrel, clean and care for the expansion bushings in the same manner as a normal mandrel.

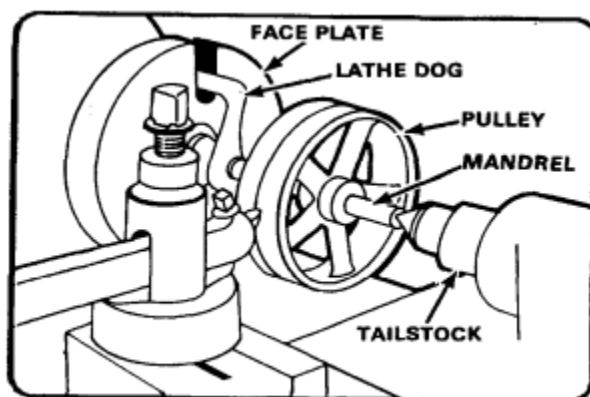


Figure 7-44. Pulley mounted on a mandrel.

Figure 3:0:8 pulley mounted on mandrel

Always feed the tool bit in the direction of the large end of the mandrel, which is usually toward the headstock end, to avoid pulling the work out of the mandrel. If facing on a mandrel, avoid cutting into the mandrel with the tool bit.

## MOUNTING AND INDEXING WORK

An efficient and positive method of holding workpieces to the milling machine table is important if the machine tool is to be used to its fullest advantage. The most common methods of holding are clamping a work piece to the table, clamping a work piece to the angle plate, clamping the work piece in fixtures, holding a work piece between centers, holding the work piece in a chuck, and holding the work piece in a vise.

Regardless of the method used in holding, there are certain factors that should be observed in every case. The work piece must not be sprung in clamping, it must be secured to prevent it from springing or moving away from the cutter, and it must be so aligned that it may be correctly machined T-slots, Milling machine worktables are provided with several T-slots which are used either for clamping and locating the work piece itself or for mounting the various holding devices and attachments. These T-slots extend the length of the table and are parallel to its line of

travel. Most milling machine attachments, such as vises and index fixtures, have keys or tongues on the underside of their bases so that they may be located correctly in relation to the T-slots.

#### 4.1 Clamping Work pieces to the Table

When clamping a work piece to the worktable of the milling machine, the table and the work piece should be free from dirt and burrs. Work pieces having smooth machined surfaces may be camped directly to the table, provided the cutter does not come in contact with the table surface during milling. When clamping workplaces with unfinished surfaces in this way, the table face should be protected from damage by using a shim under the work piece. Paper, plywood, and sheet metal are shim materials. Clamps should be located on both sides of the work piece if possible to give a full bearing surface. These clamps are held by T-slot bolts inserted in the T-slots of the table. Clamp supports must be the same height as the work piece. Never use clamp supports that are lower than the work piece. Adjustable step blocks are extremely useful to raise the clamps, as the height of the clamp bar may be adjusted to ensure maximum clamping pressure. Clamping bolts should be placed as near to the work piece as possible so that the full advantage of the fulcrum principle may be obtained. When it is necessary to place a clamp on an overhanging part, a support should be provided between the overhang and the table to prevent springing or possible breakage. A stop should be placed at the end of the work piece where it will receive the thrust of the cutter when heavy cuts are being taken.

#### 4.2 Clamping a Work piece to the Angle Plate

Work pieces clamped to the angle plate may be machined with surfaces parallel, perpendicular, or at an angle to a given surface. When using this method of holding a work piece, precautions should be taken similar to those mentioned for clamping work directly to the table. Angle plates are either adjustable or nonadjustable and are generally held in alignment by keys or tongues that fit into the table T-slots

#### 4.3 Clamping Work pieces in Fixtures

Fixtures are generally used in production work where a number of identical pieces are to be machined. The design of the fixture depends upon the shape of the piece and the operations to be performed. Fixtures are always constructed to secure maximum clamping surfaces and are

built to use a minimum number of clamps or bolts in order to reduce the setup time required.

Fixtures should always be provided with

Keys to assure positive alignment with the table T-slots.

#### 4.4 Holding Work pieces in a Chuck

Before screwing the chuck to the index head spindle, it should be cleaned and any burrs on the spindle or chuck removed. Burrs may be removed with a smooth-cut, three cornered file or scraper, while cleaning should be accomplished with a piece of spring steel wire bent and formed to fit the angle of the threads. The chuck should not be tightened on the spindle so tightly that a wrench or bar is required to remove it. Cylindrical workplaces held in the universal chuck may be checked for trueness by using a test indicator mounted upon a base resting upon the milling machine table. The indicator point should contact the

Circumference of small diameter work pieces or the circumference and exposed face of large diameter pieces. While checking, the work piece should be resolved by rotating the index head spindle.

#### 4.5 Holding Work pieces in the Vise

AS previously mentioned, five types of vises are manufactured in various sizes for holding milling machine workplaces. These vises have locating keys or tongues on the underside of their bases so they may be located correctly in relation to the T-slots on the milling machine table (Figure 8-22).

The plain vise similar to the machine table vise is fastened to the milling machine table. Alignment with the milling machine table is provided by two slots at right angles to each other on the underside of the vise. These slots are fitted with removable keys that align the vise with the table T-slots either parallel to the machine arbor or perpendicular to the arbor. The swivel vise can be rotated and contains a scale graduated in degrees at its base which is fastened to the milling machine table and located by means of keys placed in the T-slots. By loosening the bolts which clamp the vise to its graduated base, the vise may be moved to hold the work piece at any angle in a horizontal plane. To set a swivel vise accurately with the machine spindle, a test indicator should be clamped to the machine arbor and a check made to determine the setting by



moving either the transverse or the longitudinal feeds, depending upon the position of the vise jaws. Any deviation as shown by the test indicator should be corrected by swiveling the vise on its base.

The universal vise is used for work involving compound angles, either horizontally or vertically. The base of the vise contains a scale graduated in degrees and can rotate  $360^\circ$  in the horizontal plane and  $90^\circ$  in the vertical plane. Due to the flexibility of this vise, it is not adaptable for heavy milling.

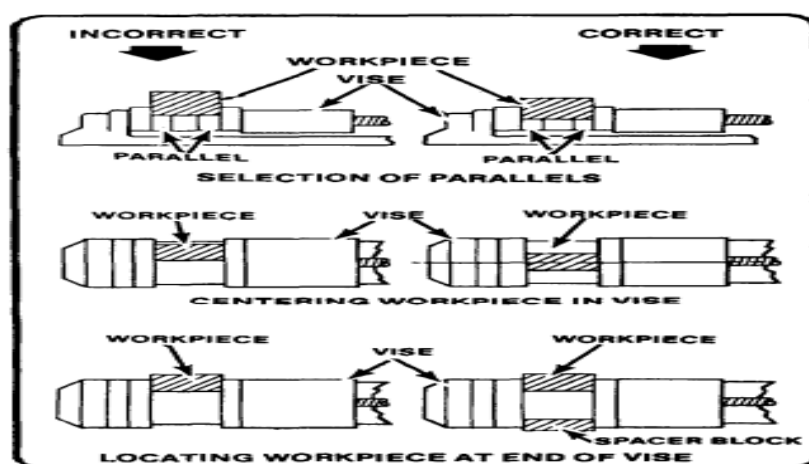


Figure 8-23. Mounting workpiece in the vise.

Figure 3:0:9 mount work in the vise

#### 4.6 Mounting the Work piece

When face milling, the work piece may be clamped to the table or angle plate or supported in a vise, fixture, or jig. Large surfaces are generally face milled on a vertical milling machine with the work piece clamped directly to the milling machine table to simplify handling and clamping operations.

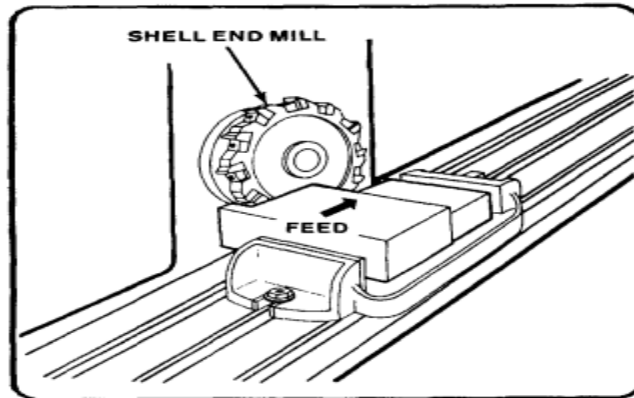


Figure 8-30. Face milling.

Figure 3:0:10 Face milling

## 3.2 Operate machine

### Lathe machine Operations

#### 3.1.1 Facing

Facing is the operation of machining the ends of a piece of work to produce flat Surface Square with the axis. The operation involves feeding the tool perpendicular to the axis of rotation of the work. *Facing operation*

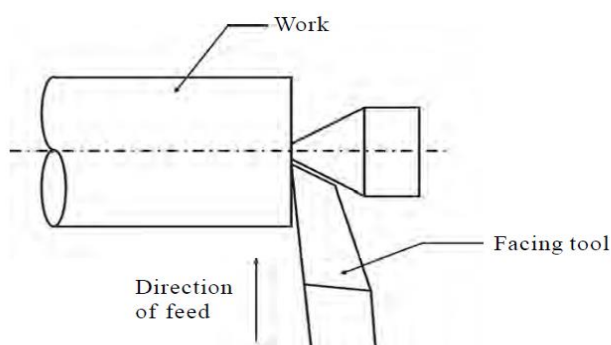


Figure 3:0:11 Facing

### FACING

Facing is the square finishing of the ends of the work-piece and is often used to bring the piece to a specified length.

In facing operations, the cutter bit does not traverse laterally (left or right) but cuts inward or outward from the axis of the piece.

Facing of the ends is usually performed before turning operations.

#### Facing Work in a Chuck

Facing is usually performed with the work held in a chuck or collets.

Allow the work piece to extend a distance no more than 1 1/2 times the work diameter from the chuck jaws.

And use finishing speeds and feeds calculated using the largest diameter of the work piece.

The tool bit may be fed from the outer edge to the center or from the center to the outer edge.

Page 75 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

Normal facing is done from the outer edge to the center since this method permits the operator to observe the tool bit and layout line while starting the cut. This method also eliminates the problem of feeding the tool bit into the solid center portion of the work piece to get a cut started.

Use a left-hand finishing tool bit and a right-hand tool holder when facing from the outer edge toward the center.

Work that has a drilled or bored hole in the center may be faced from the center out to the outer edge if a right-hand finishing tool bit is used.

Avoid excessive tool holder and tool bit overhang when setting up the facing operation. Set the tool bit exactly on center to avoid leaving a center nub on the work piece.

Use the tailstock center point as a reference point when setting the tool bit exactly on center.

If no tailstock center is available, take a trial cut and readjust as needed. If using the cross slide power feed to move the tool bit (into the center), disengage power when the tool bit is within 1/16 inch of the center and finish the facing cut using hand feed.

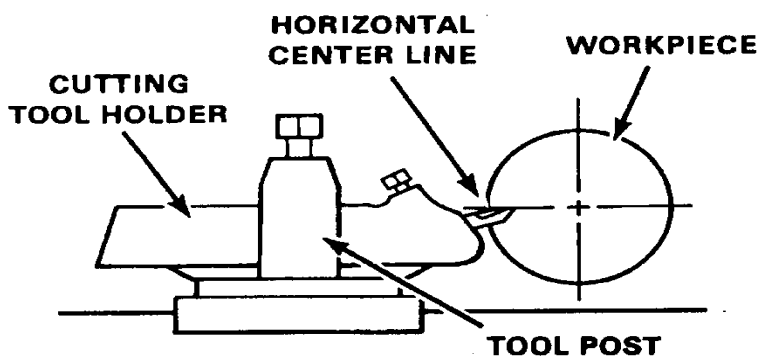


Figure 3:0:12 Facing Work between Centers

Sometimes the work piece will not fit into a chuck or collets, so facing must be done between centers. To properly accomplish facing between centers, the work piece must be center-drilled before mounting into the lathe.

A half male center (with the tip well lubricated with a white lead and oil mixture) must be used in the lathe tailstock to provide adequate clearance for the tool bit.

The tool bit must be ground with a sharp angle to permit facing to the very edge of the center drilled hole. Start the facing cut at the edge of the center-drilled hole after checking for tool bit clearance, and feed the cutting tool out to the edge.

Use light cuts and finishing feeds, which will reduce the tension, put on the half male center.

Replace the half male center with a standard center after the facing operation, since the half male center will not provide adequate support for general turning operations.

Only a small amount of material can be removed while facing between centers.

If too much material is removed, the center-drilled hole will become too small to support the work piece.

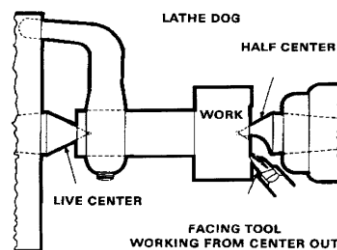


Figure 3:0:13 Facing tool working from center to out

## Turning

Turning in a lathe is to remove excess material from the work piece to produce cylindrical surface of required shape and size

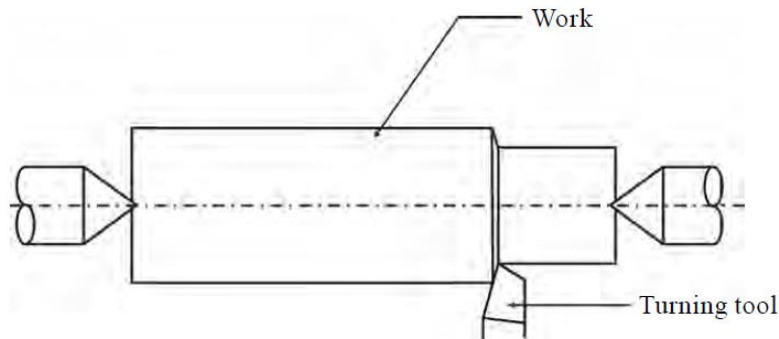


Figure 3:0:14 Turning

Straight turning may be performed upon a work-piece supported in a chuck, but the majority of work pieces turned on an engine lathe are turned between centers.

Turning is the removal of metal from the external or internal surface of cylindrical work pieces using various types of cutter tool bits.

### 3.1.2 ECCENTRIC TURNING

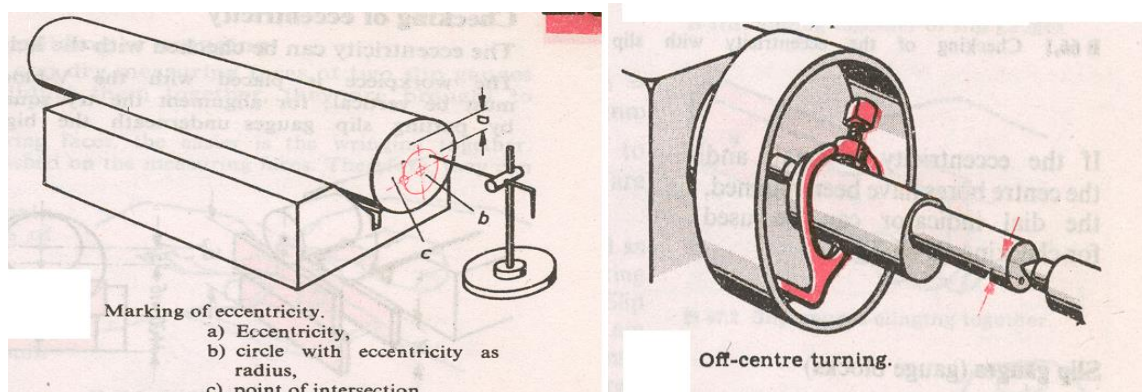
If the off-center size is big enough both the required centers can be drilled.

First the big diameter and then the off-center journal have to be turned. If the off-center size is small then the bigger diameter finished first.

Eccentric turning is done

Using lathe dogs and face plates by drilling the two centers.

On four jaws chuck by off-setting the independent jaw equal to the off-set center.



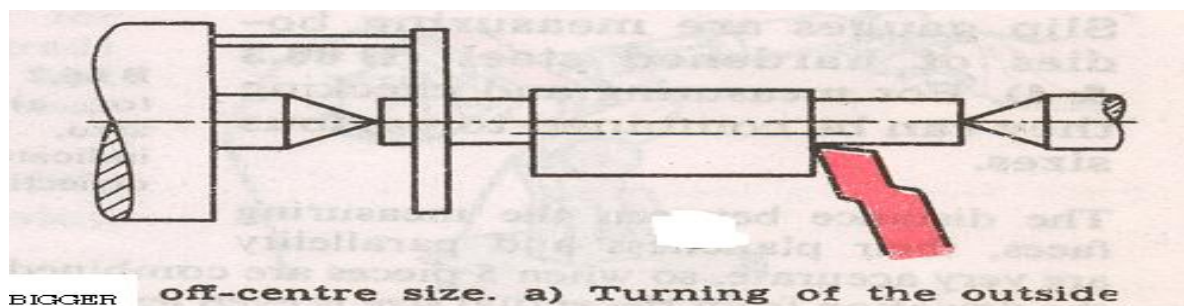


Figure 3:0:15 Off-centre turning

### 3.1.3 Cylindrical turning

The objectives of cylindrical turning are to produce a circular cylindrical surface in longitudinal cylinder turning the feed is parallel to the rotational axis of the work piece.

Taper may be defined as a uniform increase or decrease in diameter of a piece of work measured along its length.

Taper turning methods

1. Form tool method
2. Compound rest method
3. Tailstock set over method
4. Taper turning attachment method

### 3.1.4 Taper turning

A section of material is considered to be tapered when it increases or decreases in diameter at a uniform rate.

#### 3.1.4 Taper turning with compound rest:

The compound rest is generally used for turning or boring short steep tapers, but it can also be used for longer, gradual tapers, providing the length of the taper does not exceed the distance the compound rest will move upon its slide.

This method can be used with a high degree of accuracy, but is somewhat limited due to the lack of an automatic feed and the length of the taper being restricted to the movement of the slide.

Page 79 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

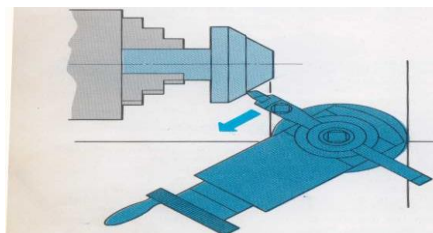


Figure 3:0:16 taper turning

When turning a taper using compound rest, note cut is made from small diameter to large diameter.

### 3.1.5 Taper turning by offset tailstock method:

This method also known as the tail stock set-over method is employed for taper turning jobs that can be turned between centers.

Only external tapers can be machined by using this method. calculating tail stock set over(S). Offset(S) must calculate for each job because the length of the piece plays an important part in the calculation.

When the length of the piece vary, different will be produced with the same tail stock offset.

Formula used ; Offset,  $S = \frac{LX(D-d)}{2L_o}$

Where

D= diameter of large end

d= diameter of small end

$L_o$ = length of taper

L= total length of piece

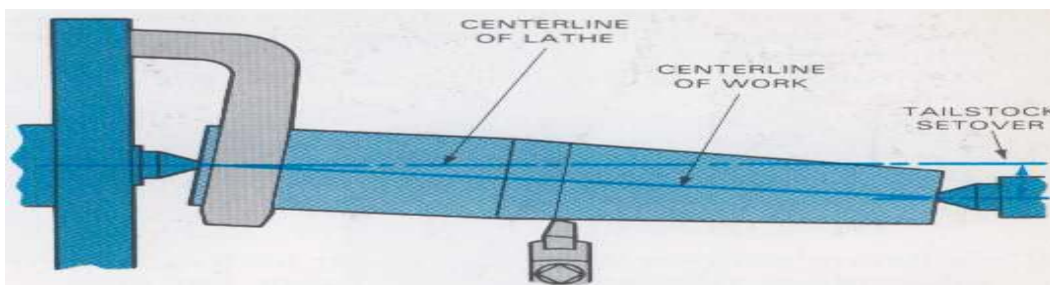


Figure 3:0:17 a taper by offset tailstock



Study how to machine a taper by offset tailstock technique.

### 3.1.6 Turning a taper with taper turning attachment:

It is an accurate way to cut tapers and offers advantages over other methods of machining tapers.

Internal and external tapers can be cut and accurate fit is assured for mating parts.

Work can be held by any conventional means.

The lathe does not have to be altered. The machine can be used for straight turning by locking the taper attachment out. No realignment of the lathe is necessary.

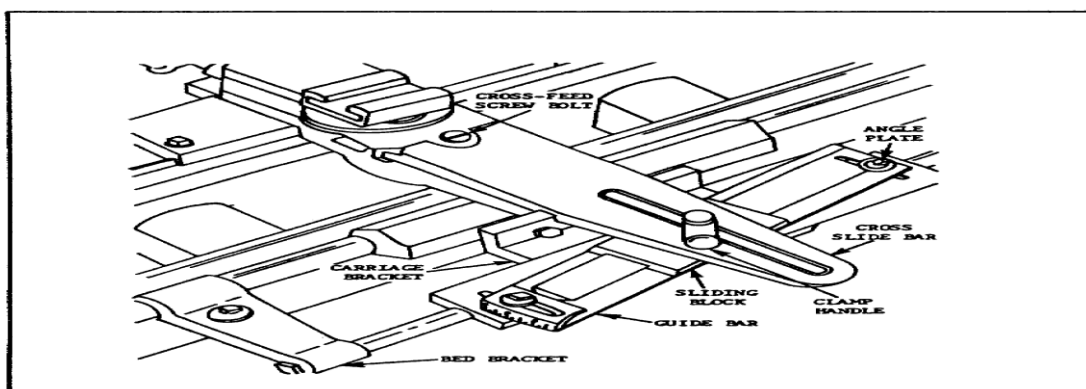


Figure 3:0:18 lathe fitted with telescopic taper attachment.

### 3.1.7 Grooving and parting operations

Grooving:

Grooving is the process of cutting a narrow groove on the cylindrical surface of the work piece. It is often done at end of a thread or adjacent to a shoulder to leave a small margin. The groove may be square, radial or beveled in shape

It is commonly called

recessing,

undercutting, or

Necking is often done at the end of thread to permit full travel of the nut up to a shoulder, or at the edge of a shoulder to ensure a proper fit of mating parts.

Grooves are generally

square,  
 round, or  
 V-shaped.

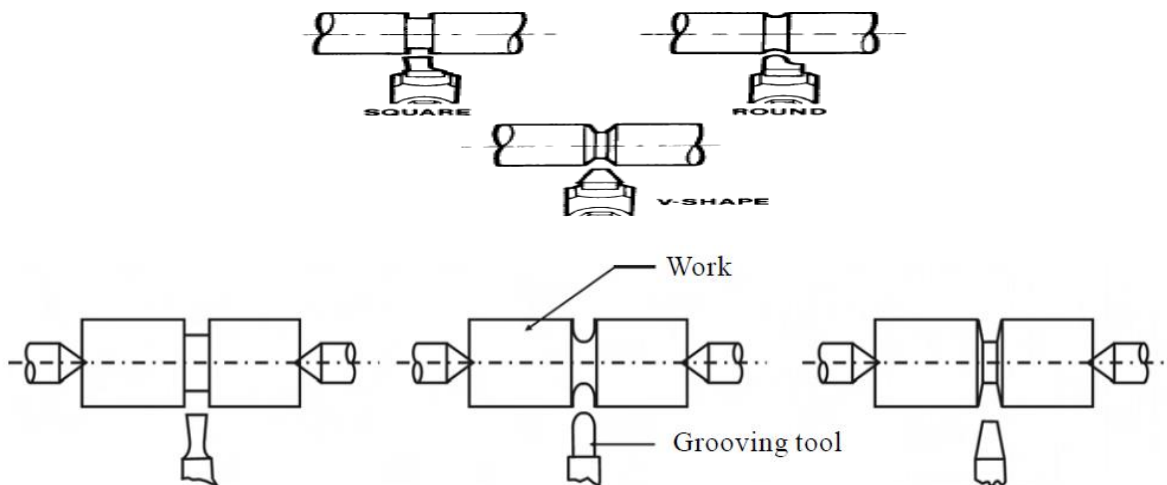


Figure 3:0:19 Lathe grooving operation

### 3.1.9 Parting operations:

Parting is the operation of cutting off material after it has been machined. This is one of the more difficult operations performed on a lathe.

The cutting tool must be ground with the correct clearance and held in straight or offset tool holder.

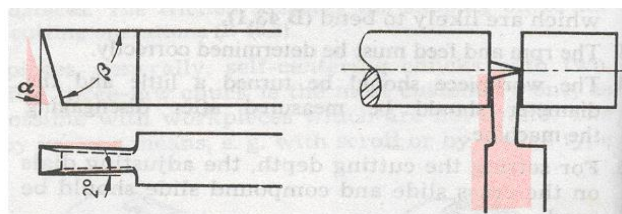


Figure 3:0:20 parting off

### 3.2 KNURLING:

Page 82 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

Knurling is the process of embossing a diamond shaped pattern on the surface of the work piece. The knurling tool holder has one or two hardened steel rollers with edges of required pattern. The tool holder is pressed against the rotating work. The rollers emboss the required pattern. The tool holder is fed automatically to the required length. Knurls are available in coarse, medium and fine pitches. The patterns may be straight, inclined or diamond shaped.

Knurls are available in coarse, medium and fine pitches. The patterns may be straight, inclined or diamond shaped.

Knurling is a process of impressing a diamond shaped or straight line pattern into the surface of the work piece to improve its appearance or to provide a better grip surface.

Straight knurling is often used to increase the work-piece diameter when a press fit is required.

Diamond and straight pattern rolls are available in three styles: fine, medium, and coarse. The knurling tool is a tool post type tool holder on which a pair of hardened steel rolls are mounted.



Diamond –point knurling of a cylindrical work piece

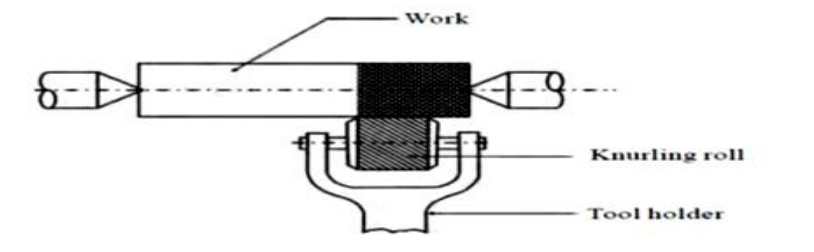


Fig Knurling

The purpose of knurling is:

Page 83 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

1. To provide an effective gripping surface
2. To provide better appearance to the work
3. To slightly increase the diameter of the work

### 3.3 Chamfering

Chamfering is the operation of beveling the extreme end of the work piece. The form tool used for taper turning may be used for this purpose. Chamfering is an essential operation after thread cutting so that the nut may pass freely on the threaded work piece.

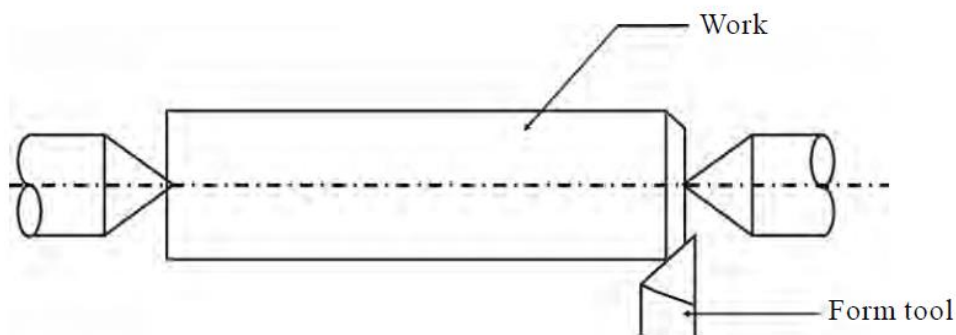


Figure 3:0:21 Chamfering

### Thread cutting

Thread cutting is one of the most important operations performed in a lathe. The process of thread cutting is to produce a helical groove on a cylindrical surface by feeding the tool longitudinally.

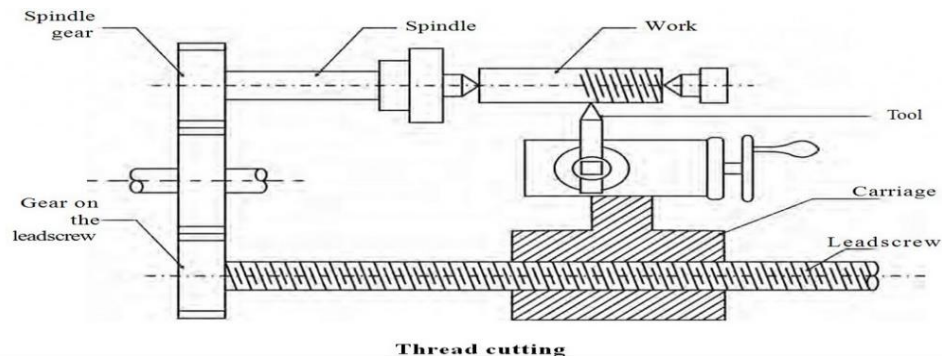


Figure 3:0:22 Threading

### 3.4 THREAD CUTTING

A thread is a uniform helical groove cut on or in a cylinder or cone. Thread cutting on a lathe is one of the most exacting lathe operations.

It requires a thorough knowledge of the principles and procedures of thread cutting.

It ties together a number of operations and dimensions in such a way that accuracy must be maintained to achieve a proper working thread.

Before attempting such operations, the operator should have knowledge of the fundamental principles of threads and the types in general use.

#### A. Screw Thread Terminology

1. *External or Male Thread*. A thread on the outside of a cylinder or cone.

2. *Internal or Female Thread*. A thread on the inside of a hollow cylinder or bore.

3. *Pitch (P)*. The distance from a given point on one thread to a similar point on a thread next to it, measured parallel to the axis of the cylinder. The pitch in inches is equal to one divided by the number of threads per inch.

#### *Lead*.

The distance a screw thread advances axially in one complete revolution. On a single-thread screw, the lead is equal to the pitch. On a double-thread screw, the lead is equal to twice the pitch, and on a triple thread screw, the lead is equal to three, times the pitch.

*Crest (also called "flat")*. The top or the outer surface of the thread joining the two sides.

*Root*. The bottom or inner surface joining the sides of two adjacent threads.

*Side*. The side of a thread is the surface which connects the crest and the Root.

*Thread Angle*. The angle between the sides of the adjacent threads, measured in an axial plane. For most V-threads, the angle is fixed at 60°.

*Depth*. The depth of the thread is the distance between the crest and the root of a thread, measured perpendicular to the axis.

*Major Diameter (D)*. The major diameter is the largest diameter of a screw thread.

*Minor Diameter (K)*. The minor diameter is the smallest diameter of a screw thread.

Page 85 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

*Pitch Diameter.* The pitch diameter is the diameter of an imaginary cylinder formed where the width of the groove is equal to one-half of the pitch. This is the critical dimension of threading as the fit of the thread is determined by the pitch diameter.

*Number of Threads per Inch/mm.* The number of threads per inch may be counted by placing a rule against the threaded parts and counting the number of pitches in 1 inch. A second method is to use the screw pitch gage. This method is especially suitable for checking the finer pitches of the screw threads.

*Screw Thread Forms.*

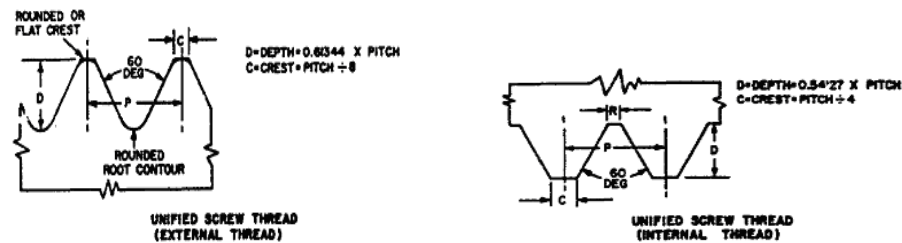
The most commonly used thread forms are discussed below.

The Acme,

Square, threads are the most common used for devices which function to transmit motion.

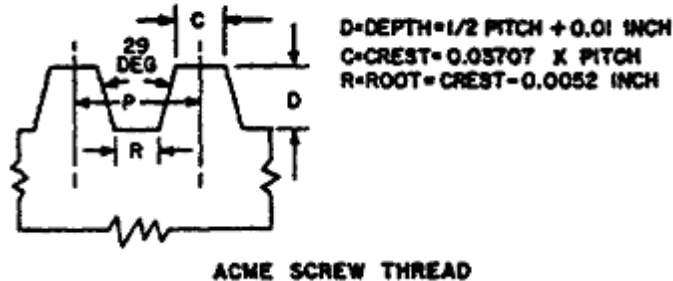
V- threads

V- Threads with a 60° thread angle. (National) Standard thread, a flat should be carefully ground at the point of the bit, perpendicular to the center line of the 60° thread angle.



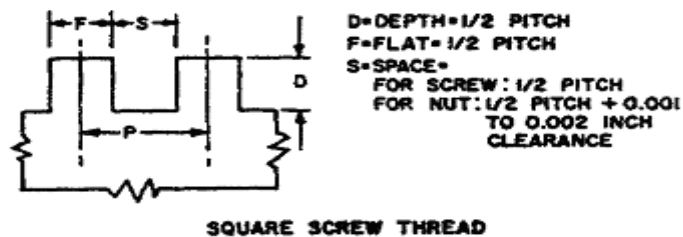
## 2. Acme Screw Thread.

The Acme screw thread form classified as a power-transmitting type of thread. This is because the 29° included threaded angle at which its sides are established reduces the amount of friction when matching parts are under load. Because the root and crest are wide, this thread form is strong and capable of carrying a heavy load. The Acme thread form is specially suitable



### *Square Screw Thread.*

Because of their design and strength, square screw threads are used for vise screws, jack screws, and other devices where maximum transmission of power is needed. All surfaces of the square thread are square with each other and the sides are perpendicular to the center axis of the threaded part. Because the contact areas are relatively small and do not wedge, friction between the matching threads is reduced to a minimum under heavy pressure.

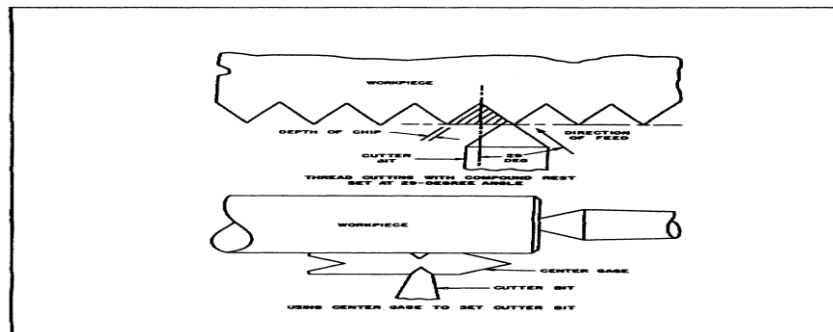


### 3.5 Setting Lathe for Thread Cutting

In cutting threads on a lathe, the pitch of the thread or the number of threads per inch obtained is determined by the speed ratio of the headstock spindle and the lead screw which drives the carriage.

Lathes that are equipped for thread cutting have gear arrangements for varying the speed of the lead screw.

Most modern lathes have a quick-change gearbox for varying the lead screw to the spindle ratio, but many older lathes, modern inexpensive lathes, and special lathes come equipped with standard change gears which must be arranged by computation to achieve the desired speed ratio. *Quick-Change Gearbox* for lathes equipped with quick-change gearboxes, the operator need only follow the instructions on the direction plates of the lathe to set the proper feed to produce the desired number of threads per inch. Once set to a specific number of threads per inch, the spindle speed can be varied depending upon the material being cut and the size of the work piece, without affecting the threads per inch.



SETTING UP CUTTER BIT FORTHREAD CUTTING OPERATIONS



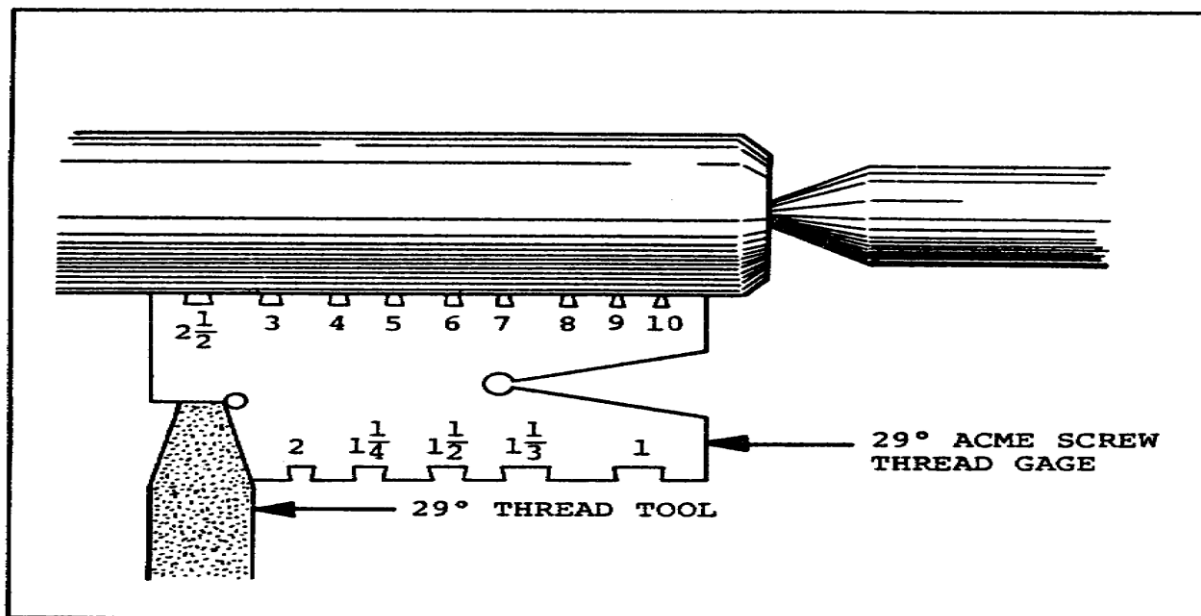


Figure 3:0:23 Acme screw thread gage

### 3.7 Drilling, Boring, Reaming, and counter boring

#### 3.7.1 DRILLING

Work held in a chuck can be drilled quickly and accurately in a lathe.

The drill held in a drill chuck or in the tailstock spindle, brought against the revolving work by turning the tailstock handle wheel. Various methods can be used to hold drills in a lathe depending on the size of the drill being used.

the most common methods are

Straight shank drills in a drill chuck.

Taper shank drills in the tailstock spindle taper.

Large taper shank drills in a drill holes.

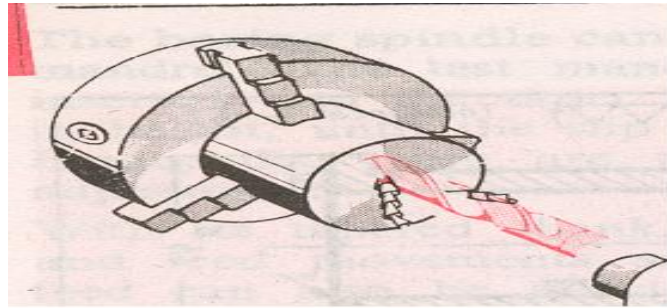


Figure 3:0:24 Drilling

### 3.7.2 Boring:

Boring is the operation of enlarging a drilled or bored hole by means of a single or double edge cutting tool held in a boring bar.

The hole produced should be concentric, parallel, and perpendicular to the work surface.

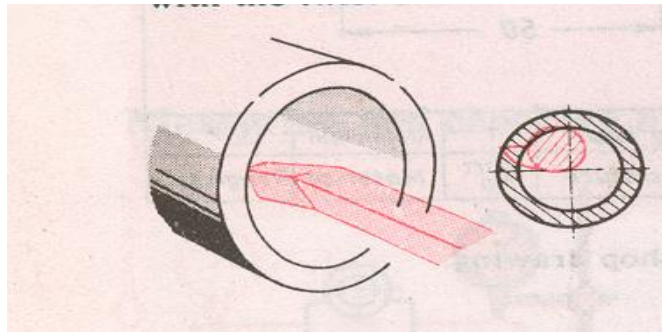


Figure 3:0:25 Boring

### 3.7.3 Reaming

It is the operation of sizing and producing a smooth hole from a previously drilled or bored hole with the use of a cutting tool having several cutting edges.

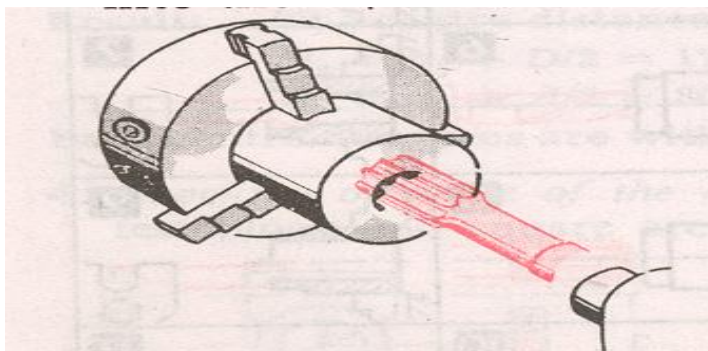


Figure 3:0:26 Reaming

#### 3.7.4 Counter boring:

It the operation of enlarging the end of a hole which has been drilled previously. A hole is generally counter bored to a depth slightly greater than the head of the blot, cap screw, or pin which it is to accommodate.

Counter bores are supplied in a variety of styles, each having a pilot in the end to keep the tool in line with the hole being counter bored.

#### 3.8 PROFILE TURNING

Radii and other shapes on a work piece are produced by profile turning. Generally, profile tools corresponding to the desired shape of the work-piece are used.

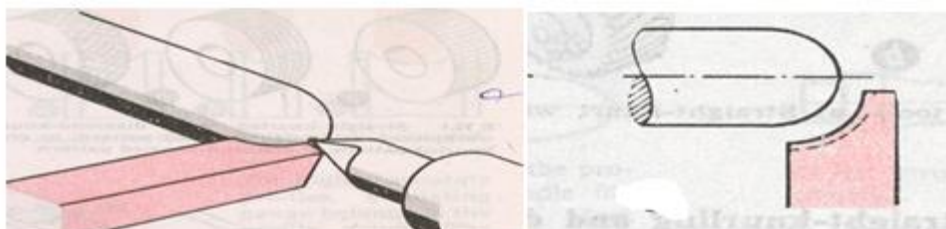


Figure 3:0:27 Profile turning

## Milling Machine operations

Although the majority of operations performed on a peripheral milling machine are either plain milling or side milling, several other operations or combinations of operations may be performed.

3.9.1 Plain or slab milling: the production of a horizontal flat surface parallel to the axis of the milling machine arbor. The work piece may held in a vise or fixture or fasten directly to the table and the cutter width extends beyond the work piece on both sides.

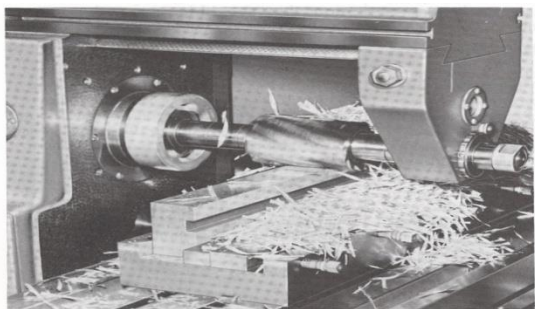


Figure 3:0:28 Milling the surface of a work piece held in a fixture.

3.9.2 *Side milling*: is the process of machining a vertical flat surface perpendicular to the axis of the milling machine arbor. This operation is performed by the combined action of the peripheral and side teeth on a side milling cutter.

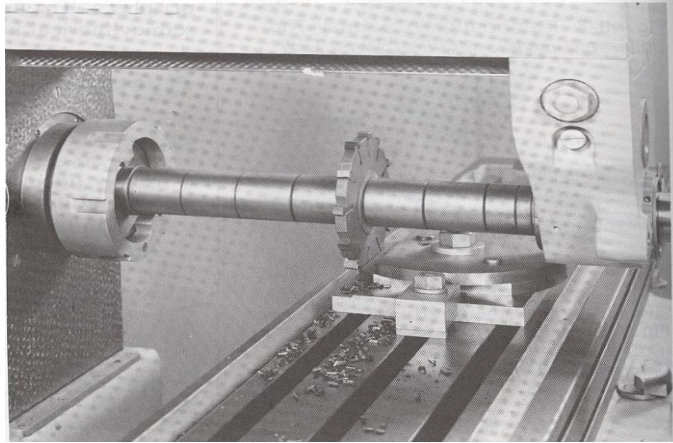


Figure 3:0:29 Side milling a vertical surface.

**3.9.3 Face milling:** is used to produce a flat surface parallel to the machine. This is done by means of a face milling cutter mounted in the milling-machine spindle. Face milling may also be done using a vertical milling attachment to produce horizontal flat surfaces. Both the periphery and the end of the teeth do the cutting.

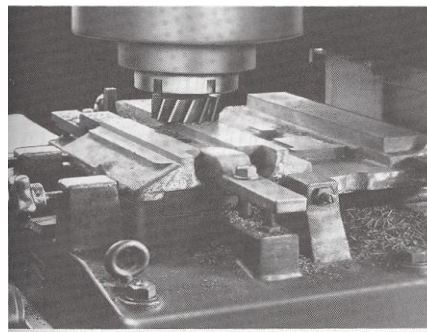


Figure 3:0:30 Face milling a flat surface with a shell end mill.

**3.9.4 Slotting:** is the process of cutting grooves or slots in the work piece. A staggered-tooth side milling cutter or an end mill can be used for this operation

The two methods of milling

*Conventional and Climb Milling:* The direction in which the work piece is fed into the cutter indicates whether conventional (up) milling or climb (down) milling is being used. In climb (down) milling method, work is fed in the same direction to the direction of rotation of the cutter.

*Conventional (Up) Milling:* In Conventional milling method, work is fed against (in opposite) the direction of rotation of the cutter. It is the most commonly used method of milling.

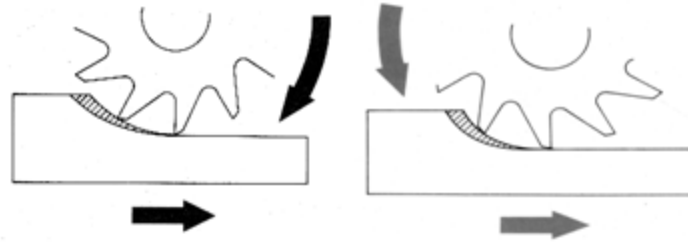


Figure 3:0:31. Conventional (Up) milling and Climb (Down) milling

Certain types of work can best be milled by climb milling, if the machine is equipped with a backlash eliminator. Although climb milling is not as widely used as conventional milling, it has certain advantages and disadvantages.

#### *Advantages*

It is particularly suited to the machining of thin and hard-to-hold parts, since the work piece is forced against the table or holding device by the cutter.

Work need not be clamped as tightly.

Consistent parallelism and size may be maintained particularly on thin parts.

It may be used where breakout at the edge of the work piece could not be tolerated.

It requires up to 20 percent less power to cut by this method.

It may be used when cutting off stock or when milling deep, thin slots.

#### *Disadvantages*

It cannot be used unless the machine has a backlash eliminator and the table gibs have been tightened.

It cannot be used for machining castings or hot rolled steel, since the hard outer scale will damage the cutter.

Page 94 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

### 3.3 Machine Parameters

#### 3.3.1 Feed:

The amount of tool advancement per revolution of the job parallel to the surface being machined.

it is given in mm/rev of the job that which the tool is feed

it depends upon :- finished required, depth of cut and the rigidity of the machine.

Mathematically, ( f ) = feed per rev. X rpm

#### 3.3.2 Cutting speed

It means the number of meters measured on the circumference of a job that passes the cutting edge of the tool in one minute.

mathematically,

$$\text{Cutting speed, (v)} = \frac{\pi DN}{1000} \text{ in m/min. Or } N = \frac{V \times 1000}{\pi D}$$

Where, D= is diameter of a job in m N= is spindle or job speed in rpm

For example: - calculate the rpm of a lathe machine spindle to turn a work having cutting speed 55 m/ min. Assume the diameter of the work is 80 mm.

#### 3.3.3 Depth of cut

It is the advancement of the tool in the job in a direction perpendicular to the surface being machined.

Depth of cut depends up on cutting speed, rigidity of machine and tool material.

$$\text{Depth of cut, (t)} = \frac{D-d}{2}$$

Where, D = is diameter of the work piece

d = is diameter of the work required

### Milling

Page 95 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

Cutting variables are the most important factors which affect the efficiency of the milling machine.

These are:-

1) Cutting speed: The speed, in surface feet per minute (sf/min) or meters per minute ( m /min) of which the metal may be machined efficiently.

The formula used to find the work speed in mm

$$\text{Rpm} = \frac{\text{cs} \times 320}{D} \quad \text{Where, cs = meter per minute}$$

D = diameter of cutter in millimeter

The speed used on a milling machine depends:-

The type of work material

The cutter material

The diameter of the cutter

The surface finish required

The depth of cut being taken

Example:1. calculate the r/min required for a 75 mm diameter high speed milling cutter when cutting machine steel ( cs= 30 m/min)

$$\text{solution: } \text{rpm} = \frac{30 \text{ m/min} \times 320}{75 \text{ mm}} = \frac{9600}{75} = 128$$

2)Feed: it is the distance in inches/ or ( mm/min) that the work moves

The formula used to calculate the feed in mm/min. Is:-

$$\text{Feed (mm/min)} = N \times \text{cpt} \times \text{r/min}$$

Where, N = number of teeth on the milling cutter

Cpt = chip per tooth for a particular cutter find from table

r/min = revolution per minute of milling cutter

The feed rate used on milling machine depends up on a variety of factors, such as

- ✓ The depth and width of cut
- ✓ The design or type of cutter
- ✓ The sharpness of the cutter



- ✓ The work piece material
- ✓ The strength and the uniformity of the work piece
- ✓ The type of finish and accuracy required.

Example: Find the feed in millimeter per minute (mm/min) for a 75 mm diameter, six-tooth helical milling cutter when machining cast iron work piece.

Solution: first calculate the rpm of the cutter

$$\begin{aligned} \text{Rpm} &= \frac{cs \times 320}{D} \\ &= \frac{60 \times 320}{75} = 256 \text{ mm/rev} \end{aligned}$$

Thus, feed ( mm/ min) = N x cpt x rpm

$$\begin{aligned} &= 6 \times 0.18 \times 256 \\ &= \underline{276 \text{ mm/ min}} \end{aligned}$$

DEPTH OF CUT: it is the advancement of the tool in the job in a direction perpendicular to the surface being machined.

**Table 1 Recommended feed per tooth (for high speed steel cutters)**

Material	Face mills		Helical Mills		Slotting and side Mills		End mills		Form relived Cutters	
	In	Mm	In	Mm	In	Mm	In	Mm	In	mm
Aluminum	0.022	0.55	0.018	0.45	0.013	0.33	0.011	0.28	0.007	0.18
Brass & Bronze	0.014	0.35	0.011	0.28	0.008	0.20	0.007	0.18	0.004	0.10
Machine steel	0.012	0.30	0.010	0.25	0.007	0.18	0.006	0.15	0.004	0.10
Tool steel	0.010	0.25	0.008	0.20	0.006	0.15	0.005	0.13	0.003	0.08

(medium)							05			
Stainless steel	0.006	0.15	0.005	0.13	0.004	0.10	0.03	0.08	0.002	0.05
Cast iron	0.013	0.33	0.010	0.25	0.007	0.18	0.07	0.18	0.004	0.10

### 3.4 Safety Procedures.

#### 1.2 Safety Requirement in machine shop

##### Safety

The importance of safety was realized a century ago because of the occurrence of millions of industrial and other accidents, which resulted in death, or disablement of industrial employees every year.

##### 1.1 Causes of Accidents

The accidents may take place due to

- ☞ Human causes,
- ☞ Environmental causes and
- ☞ Mechanical causes.

##### *Human Causes*

- ☞ Accidents may occur while working on unsafe or dangerous equipment or machineries possessing rotating, reciprocating and moving parts.
- ☞ Accidents occur while operating machines without knowledge, without safety precautions, without authority, without safety devices
- ☞ Accidents generally occur while operating or working at unsafe speed
- ☞ Working for long duration of work, shift duty etc.
- ☞ Accidents commonly occur during use of improper tools

- ☞ Accidents may occur while working with mental worries, ignorance, carelessness, nervousness, dreaming etc.
- ☞ Accidents occur because of not using personal protective devices

### *Environmental Causes*

- ☞ Working at improper temperature and humidity (causes fatigue to the workers so a chance of accidents increases with workers having fatigue).
- ☞ The presence of dust fumes and smoke in the working
- ☞ Poor housekeeping, congestion, blocked exits; bad plant layout etc. may cause accidents.
- ☞ Accidents occur due to inadequate illumination.
- ☞ Improper ventilation in the plant may also leads to industrial accidents.

### *Mechanical Causes*

- ☞ Continued use of old, poor maintained or unsafe equipment may result in accidents.
- ☞ Accidents commonly occur due to use of unguarded or improper guarded machines or equipment
- ☞ Unsafe processes, unsafe design and unsafe construction of building structure may lead to accidents in the plant.
- ☞ It can occur due to improper material handling system and improper plant layout.
- ☞ May occur due to not using of safety devices such as helmets, goggles, gloves, masks etc.

#### *a. Other general causes of accidents in workshops*

Because of ignorance to work with

- ☞ -Equipment,
- ☞ Hand tools,
- ☞ -Cutting tools and
- ☞ -Machine tools.
- ☞ Operating machine and equipment's without knowledge

Page 99 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
----------------	--	---------------------------------------	---------------------------

- ☞ Extra curiosity to work without knowing
- ☞ Poor working conditions. Because of speedy work
- ☞ Improper method to work
- ☞ Due to use of improper tools
- ☞ Because of lack of discipline
- ☞ Uninterested in work
- ☞ Due to carelessness
- ☞ Due to over confidence
- ☞ Bad working environment
- ☞ Excessive over times duty by industrial workers
- ☞ Dangerous materials with which to work
- ☞ Lack of cleanliness
- ☞ Due to poor planning

As always we should be aware of safety requirements and attempt to observe safety rules in order to eliminate serious injury to ourselves or others.

Wear glasses, short sleeves, no tie, no rings, no trying to stop the work by hand. Stop the machine before trying to check the work. Don't know how it works? –“Don't run it.” Don't use rags when the machine is running.

Unguarded moving parts of machines/equipment and the sudden or uncontrolled release of their power systems can result in serious injuries.

Personnel working with machines must be aware of the risks involved and follow safe work practices.

Causes of accidents while working with machinery

- ☞ Loose clothing, hair, jewelry being caught in moving parts.

Page 100 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
-----------------	--	---------------------------------------	---------------------------

- ☞ Materials ejected from the machine when it is operational.
- ☞ Unplanned starting of the machine.
- ☞ Slipping and falling into an unguarded nip.
- ☞ Contact with sharp edges, e.g., cutting blade.
- ☞ Making adjustments while the machine is operational.
- ☞ Unauthorized operation of machines.
- ☞ Lack of preventive maintenance.

### Hazards parts of machines

- ☞ Rotating machine parts give rise to damages or injuries. Examples are
  - ☞ Rotating gears
  - ☞ Belt and its pulley
  - ☞ Chain and sprocket
  - ☞ Between grinding wheel and tool rest
  - ☞ Between rotating and fixed parts-Rotating parts operating alone
  - ☞ Shafts
  - ☞ Couplings-Reciprocating and sliding motions

### Safety Rules

#### Personal safety

- ✓ Dress appropriately remove necktie, necklace, wrist, watch & rings
- ✓ Wear apron or a properly shop fitted over coat and safety glasses
- ✓ place all guards before attempting to operate the machine
- ✓ To clean the lathe, do not remove chips with bare hands.
- ✓ Care must be taken when handling long sections of metal stock.

Page 101 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
-----------------	--	---------------------------------------	---------------------------

- ✓ Keep hand tools in good conditions and store them in such a way that peoples cannot be injured.

#### Machine safety

- ✓ No attempt should be made to operate a lathe until you know the proper procedure
- ✓ Don't use compressed air to remove chips and cutting oil from machine.
- ✓ Keep the machine clear of tools.
- ✓ Work shop safety
- ✓ Avoid horse play
- ✓ Keep the floor around your machine clear of chips and wipe up spilled cutting fluid
- ✓ Oily rugs must be placed in approved safety containers.
- ✓ Safety when Machining Work Piece
- ✓ Do not operate any machine before understanding its mechanism.
- ✓ Always stop a machine before measuring, cleaning or making any adjustments. It is dangerous to do any type of work around moving parts of a machine.
- ✓ Never operate a machine unless all safety guards are in place.
- ✓ Keep hands away from moving parts. It is dangerous practice to “feel” the surface of the revolving work or to stop a machine by hand
- ✓ Never use a rag near the moving parts of a machine rag may be drawn into the machine, along with the hand that is holding it.
- ✓ Never have more than one person's operate a machine at the same time. Not knowing what the other person would or would not do has caused many accidents
- ✓ Get first aid immediately for any injury, no matter how small

### Written Test

1. ----- is to remove excess material from the work piece to produce a cylindrical surface of required shape and size

2. Operations which is not on the lathe include

parting,

turning tapers,

None

A speed,

C Depth of cut

**D** All of the above

A cutting speed,

## C Tool material.

### B rigidity of machine and

D All of the above

\_\_\_\_\_1 Safety rules and procedures in lathe machine operation are

- ## A Personal safety

**B** Be sure all guards are in place before attempting to operate the machine

C Do not operate machines while taking medication(medicine)

**D** All of the above

\_\_\_\_\_6 One of the following is not types of turning

- A Cylindrical turning
- B Tapper turning
- C Eccentric turning
- D Decreasing the diameter of the work-pieces
- E Off-set turning
- F None of the above

----- 7. One of the following is not types of taper turning

- A Taper turning with compound rest
- B Taper turning by offset tailstock method
- C Turning a taper with taper turning attachment
- D Taper turning with forming tools
- E None

----- 8. Lathe chucks

- A Three-jaw universal chuck
- B Four- jaw independent chuck
- C Collect chuck
- D *Hollow Headstock Spindle Chuck*
- E *All of the above*

- ----- 9. *One is properties of faceplates*

- A A lathe faceplate is a flat, round plate that threads to the headstock spindle of the lathe.
- B The faceplate is used for clamping and machining irregularly-shaped work-pieces
- C The work-piece is either attached to the faceplate using angle plates or brackets, or is bolted directly to the plate.
- D All of the above

-----10. Lathe chucks

- A Three-jaw universal chuck
- B Four- jaw independent chuck



- C Collect chuck
- D *Hollow Headstock Spindle Chuck*
- E *All of the above*

**Directions II:** Match the term in column A with the term in column B.

- | A  | B                                      |
|--|--|
| 1. The direction in which the work piece is fed into the cutter indicates whether conventional (up) milling or climb (down) milling is being used. In climb (down) milling method, work is fed in the same direction to the direction of rotation of the cutter. | A. <i>face plate</i>                   |
| 2. is the process of cutting grooves or slots in the work piece. A staggered-tooth side milling cutter or an end mill can be used for this operation   | B. <i>Conventional (Up) Milling:</i>   |
| 3. is a device used to grasp parts with irregular shapes   | C. <i>Slotting</i>                     |
| 4. the production of a horizontal flat surface parallel to the axis of the milling machine arbor. The work piece may held in a vise or fixture or fasten directly to the table and the cutter width extends beyond the work piece on both sides                  | D. <i>Plain or slab milling</i>        |
| 5. In Conventional milling method, work is fed against (in opposite) the direction of rotation of the cutter. It is the most commonly used method of milling.  | E. <i>A 3 jaw self-centering chuck</i> |
| 6. have locating keys or tongues on the underside of their bases so they may be located correctly in relation to the T-slots on the milling machine  | F. <i>face plate</i>                   |
| 7. To machine a work piece of an odd shape, such as a wheel  | G. <i>Collet</i>                       |

pulley

8. consists of tubular bushing with longitudinal slits. Collets are used to grasp and hold bar stock. A collet of exact diameter is required to match any bar stock diameter.
9. is a device used to grasp parts with irregular shapes:
10. is used for most operations on cylindrical work parts. For parts with high *length-to-diameter ratio* the part is supported by center on the other end.

H. vises

I. Mandrels

J. *Conventional and Climb Milling*

**Directions III:** Answer all the questions listed below.

1. Write three examples of Hazards parts of machines? (3points)
2. Essential causes of accidents a. \_\_\_\_\_ ? (5point)
  - a. b. -----
  - b. -----
3. Write three types of *Human Causes* accidents? (5point)
4. Write the Good working habits of a skilled machinist (5point)
5. Name the seven (7) factors to be considered in determining the job requirements

Directions III: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Write three examples of Hazards parts of machines? (3points)

Essential causes of accidents a. \_\_\_\_\_ ? (5point)

b. -----

c. -----

4. Write three types of *Human Causes* accidents? (5point)
5. Write the Good working habits of a skilled machinist (5point)

6. Name the seven (7) factors to be considered in determining the job requirements

### **Operation sheet 3.1. Perform machine operations**

**Operation title:** Operate machine

**Purpose:** To perform facing operation

**Instruction:** Using the figure below and given equipments measure the length of each line

**Tools and requirement.**

Cylindrical stock

2. Chuck key

3. Tool holder

4. Tool bit

Page 107 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
-----------------	--	---------------------------------------	---------------------------

## 5. Lathe machine

### Steps in doing the task

Step 1- Mount a three jawed chuck onto the head stock

Step 2- Install a Drill chuck into your tailstock

Step 3- Secure your stock in the three jawed chuck with about 1 inch – 2 inch extending out beyond the jaws

Step 4- Using your “right handed cutting tool” square or face off the end of the stock. You

Step 5- want to take off just enough material to clean up the end so make sure that you are not taking too aggressive of a pass.

Step 6- Insert a #4 (stamped on to the drill) center drill into the drill chuck on your tailstock  
Center drill the end about  $\frac{1}{4}$  inches deep

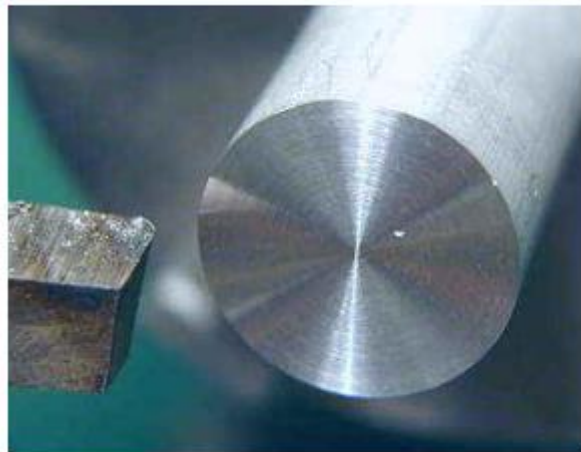
Step 7- Take your part out of the three jawed chuck, flip it over, and secure it back in the chuck

Step 8- Face off the second end. Take off the smallest amount of material possible Center drill the second end about  $\frac{1}{4}$  inches

Step 9- When done; remove the 3 jaw chuck from the headstock and the drill chuck from the tailstock.



Fig: Facing work on lathe machine



**Quality Criteria** :- the tolerance will be 0.05

Page 108 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
-----------------	--	---------------------------------------	---------------------------

**Precautions** :-All dimension in mm

## Lap Test

Task-1: Perform facing operation

Task-2: Perform Turning operation

Task-3: Chamfering

Task-4: square grooving

Task-5: Tapering

Task-3: Measure canal dimension

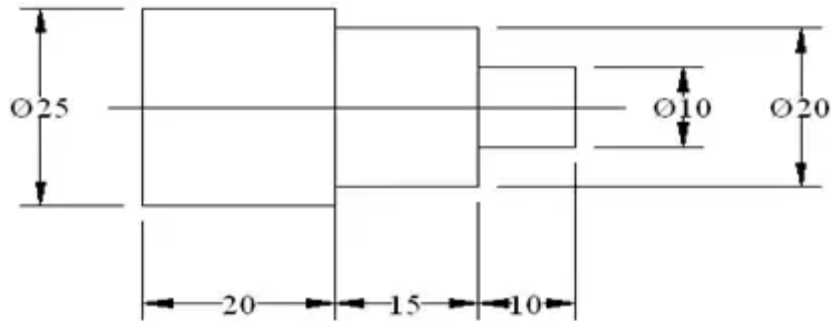
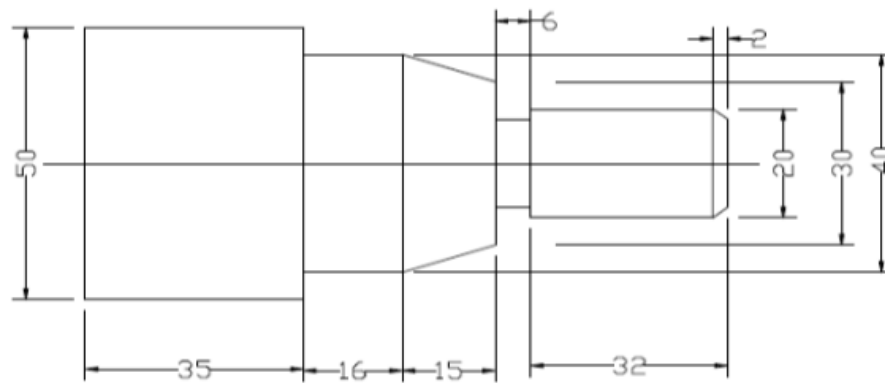


Figure 3:0:1 project 1



All dimensions are in millimeters

Figure 3:0:2 project 2

## Unit Four : Quality assure finished component

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

Check Components

measuring tools and equipment

Handle deviations

routine maintenance and adjustments

This unit will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

Check Components for conformance to specifications

Use appropriate measuring tools and equipment

Handle deviations

Carry out routine maintenance and adjustments

### 4.1 Check Components

Definitions of conformance

Page 111 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
-----------------	--	---------------------------------------	---------------------------

Conformance is usually defined as testing to see if an implementation successfully meets the requirements of a standard or specification. There are many types of testing including testing for performance, strength, surface finish, shape and dimensions. Although conformance testing may include some of these kinds of tests, it has one fundamental difference of the requirements or criteria for conformance must be specified in the standard or specification. This is usually in a conformance clause or conformance statement, but sometimes some of the criteria can be found in the body of the specification. Some standards have subsequent documentation for the test methodology and assertions to be tested. If the criteria or requirements for conformance are not specified, there can be no conformance testing.

Consequences of incorrect sharpening

Reduce tool life

Complete failure of cutting edge

Bend easily the cutting tool

Effects of incorrect speeds and feeds

Too Fast: Too much spindle speed will generate excess heat which softens the tool and dulls it faster. There are exceptions and mitigating circumstances we'll talk about in more advanced installments.

Best Tool Life: Slowing down the spindle a bit and feeding at slightly less than appropriate for maximum MRR gives the best tool life. We'll talk more below about Taylor's equations for tool life, but suffice it to say that reducing the spindle rpm is more important than reducing the federate, but both will help.

Surface Finish: Reducing your federates while keeping the spindle speed up lightens the chip load and leads to a nicer surface finish. There are limits, the biggest of which is that you'll eventually lighten the federate too much, your tools will start to rub, and tool life will go way down due to the excess heat generated by the rubbing.

Feeding Too Slow: As discussed, feeding too slow leads to rubbing instead of cutting, which can radically shorten your tool life and is to be avoided. Now that you know how the sweet spots break down, you'll have a better idea how to steer your feeds and speeds to the desired results.

Page 112 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
-----------------	--	---------------------------------------	---------------------------



## Non-Conformance Report Items

A non-conformance report must include at a minimum of the following information:

What is the main reason for the Non-Conformance Report or what went wrong

Why the work doesn't meet the requirement

What can be done to prevent the problem from happening again?

Explanation of corrective action taken/to be taken

## Product Inspection

Product Inspections conducted at various stages of the manufacturing process help you secure your production, safeguard the quality of your product and protect your brand image.

Product Inspections allow you to verify product quality on operation at different stages of the production process and prior to its dispatch. Inspecting your product before it leaves the working drawing requirement is an effective way of preventing quality problems.

An inspector checks your product against your chosen specifications to meet a range of requirements including passing the given standards of your destination market. With the use of inspection checklists that you can select online and tailor to your needs, your quality control process can be standardized and key quality concerns communicated to all parties involved in the inspection.

## 4.2 Measuring Tools And Equipment

### 2.1. Techniques of checking conformance

Some common **methods** are visual; using measuring tools and equipment, industrial computed tomography scanning, microscopy, dye penetrant **inspection**, magnetic-particle **inspection**, X-ray or radiographic testing, ultrasonic testing, eddy-current testing, acoustic emission testing, and thermograph **inspection**. For example, steel **ruler** is generally used by students for measuring length in few centimeters or millimeters.

Inspection in manufacturing includes measuring, examining, testing, or gauging one or more characteristics of a product or process and comparing the results with specified requirements to determine whether the requirements are met for each characteristic. Common examples of

Page 113 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

inspection by measurement or gauging include using a caliper or micrometer to determine if a dimension of a manufactured part is within the dimensional tolerance specified in a drawing for that part, and is thus acceptable for use. Measurement instruments used to certify manufacturing conformity should be considered early in the design of products.

## 2.2. Measuring tools and equipment in checking conformance.

### 1. Vernier caliper:-You can obtain better accuracy with the vernier caliper.

Vernier caliper consists principally of:-

A main scale (the fixed scale);

A fixed jaw (part of the rule scale);

A vernier scale (a moving scale);

A sliding jaw (attached to the moving scale).

The rule scale is graduated in millimeters. The moving scale moves on the rule scale, attached to the sliding jaw in a clamp. The vernier scale is graduated to read up to 49 mm. There are 50 divisions, which mean that there is a difference of 0.02 mm between the vernier scale and the main scale.

You need regular practice in using the vernier caliper to ensure that you understand its principle and use:

Move the sliding jaw to be in contact with the face being measured.

Tighten the locking screw on the clamp.

Make fine adjustment using the fine-setting screw.

Move the jaws so that they just touch the work; do not apply any force.

Tighten the head lock.

## Calipers

### ■ Nomenclature

#### Vernier Caliper

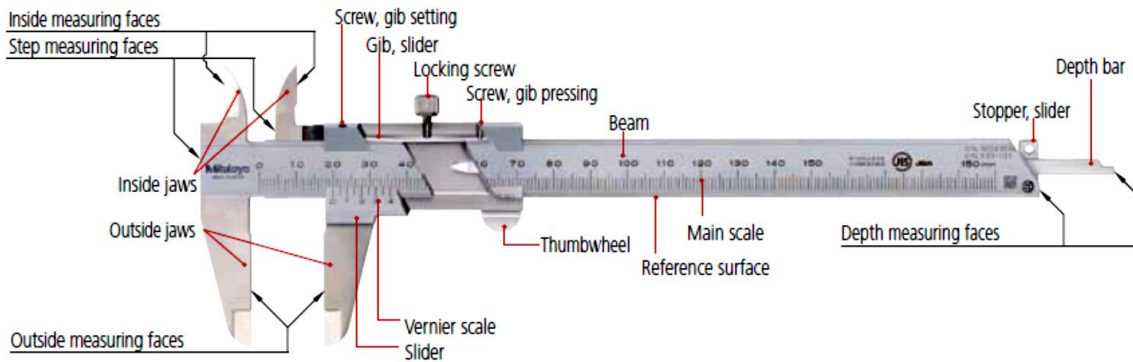


Figure 4:0:1 Vernier caliper

To read (for example) 25.44 mm from the caliper, look for the number of the millimeter division below the vernier zero: for example, it is 25. Next find the line on the vernier scale that coincides with a line on the main scale: in this case 22. To calculate the total measurement, multiply 20 by 0.02 and add to 25:

That is:

Main scale reading = 25.00 mm

Vernier scale reading =  $22 \times 0.02$  (0.44 mm) Final reading = 25.44 mm

The vernier caliper is a useful tool for taking external and internal measurements. Add the widths of the jaws (which are always stated on the caliper when taking internal measurements).

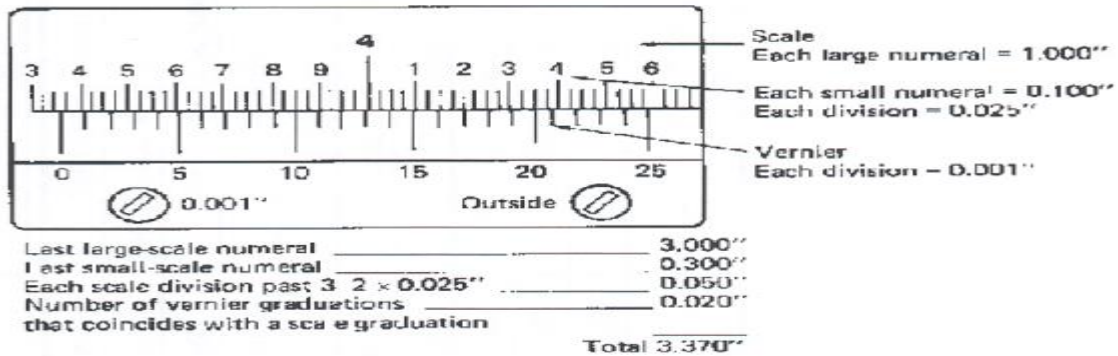


Fig. 6.1.7 Vernier Caliper

Figure 4:0:2

### Principle of Vernier Caliper

- Rule consists of the slide that fits over the rule. A distance on the slide of six-hundred thousandths (0.600) of an inch is graduated into 25 equal parts so that each division measures twenty four thousandths (0.024) of an in. Fig. 6.1.13. The graduations on the rule itself are twenty-five thousandth (0.025) of an inch, so in a distance of 600 there are 24 divisions on the rule. The difference in the size of the division on the rule and those on the vernier scale is one thousandth (.001) of an inch.

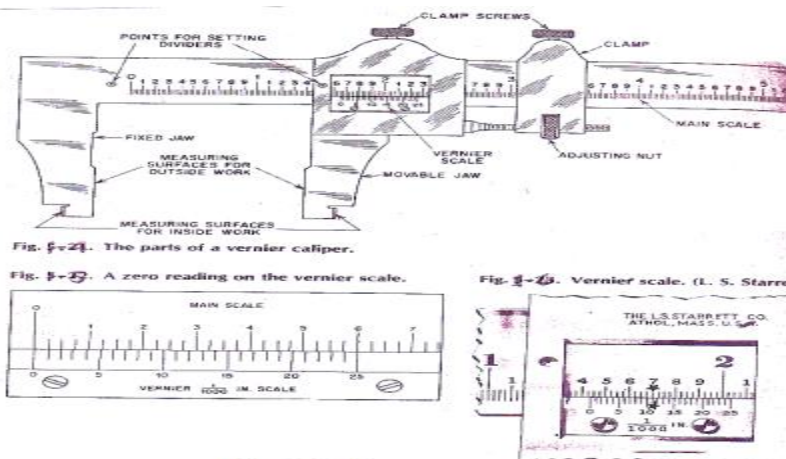


Fig. 6.1.13

Figure 4:0:3

## 2. Micro meter

A micrometer is a very useful instrument. It enables you to take measurements to within one hundredth of a millimeter (0.01 mm). The metric micrometer is able to measure ranges of 25 mm (that is, for 0-25 mm, 25-50 mm, and so on). A common type is shown in Figure 4.51.

The micrometer has a thread with pitch 0.5 mm.

This means that the spindle advances by 0.5 mm for each turn. However, there are 50 graduations on the thimble. So the movement advanced for each graduation of the thimble is  $0.5/50 = 0.01$  mm.

The procedure for using the micrometer is as follows.

1. Hold the plastic insert to prevent thermal expansion.
2. Keep the measuring faces square with the surfaces that you are measuring, to ensure an accurate measurement.
3. Turn the thimble until the faces touch the work.
4. Use the ratchet (if there is one) to obtain the correct pressure when turning the thimble, and prevent the jaw from moving further when it comes into contact with the work.

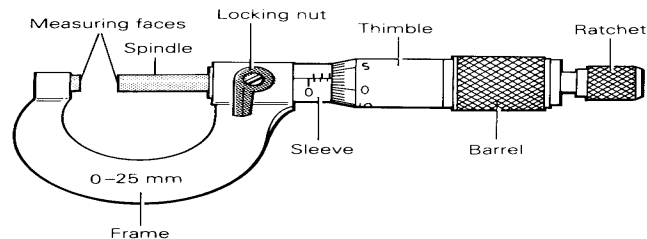


Figure 4.51 Outside micrometer.

Figure 4:0:4

The reading in Figure above is

Upper main scale 12.00 mm

Lower main scale (no half mm) 0.00 mm

Circular thimble scale 0.13 mm

$13 \times 0.01 \text{ mm} = 0.13 \text{ mm}$

Page 117 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
-----------------	--	---------------------------------------	---------------------------

Total reading 12.13 mm

The micrometer is an expensive tool, and you must take the utmost care when using it. The following points should help you.

- Make sure that you store the micrometer away from dust.
- Always clean the measuring faces for good results.
- Oil the micrometer regularly to avoid rust.
- Pack the micrometer in its box when not in use.
- Do not use force on the thimble or ratchet.

### Vernier Height Gauge

The vernier height gauge is used in conjunction with the surface plate, which has a smooth surface. The gauge has a heavy base. This supports the main scale, which is graduated in a similar way to the calipers. It has a means for of adjustment (Figure 4.53). It is used for accurate measurement of the depths of holes, slots, keyways and the like.

You can use the vernier protractor to measure angles to within 5 min of arc (Figure 4.54). The tool makes use of the vernier scale discussed above. It has the following parts: the main scale, with angular divisions; the vernier scale, divided into 12 divisions on each side of a zero mark; the rotating arm, which controls the movement of the vernier scale.

The procedure for using the vernier protractor is as follows

1. Observe the value of degrees on the main scale to each side of the zero mark on the vernier scale: for example, in Figure 4.54(b) it is 12°.
2. Find the mark on the vernier scale that coincides with a mark in the main scale. This gives the number of minutes (15 min in this case).
3. Add the two values together to give the reading: 12° 15'

For accurate readings take care when setting and reading the vernier protractor.

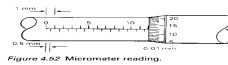


Figure 4.52 Micrometer reading.

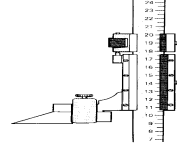


Figure 4.53 Vernier height gauge.

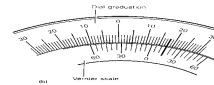
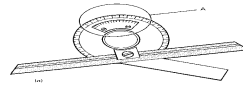


Figure 4.54 (a) The vernier protractor; (b) detail at A, showing reading of 12° 15'.

Figure 4:0:5 Height gage and vernier protractor

## Dial Gauge

The dial gauge, or dial test indicator (Figure 4.55), is a comparator. You use it to compare measurements. The tool magnifies minute movements for easy reading. It converts the linear movement of the plunger into rotary movement of an indicator, which moves over a circular scale. The scale is divided into equal parts, each representing 0.01 mm.

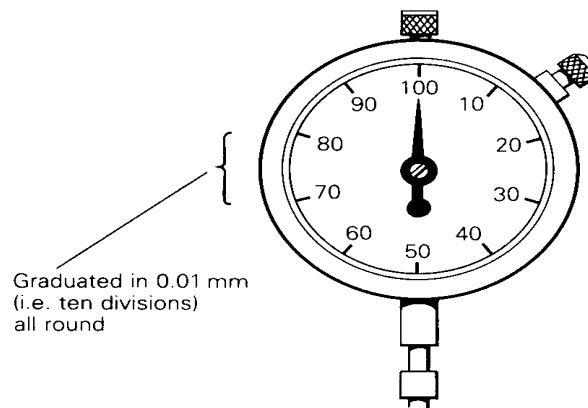
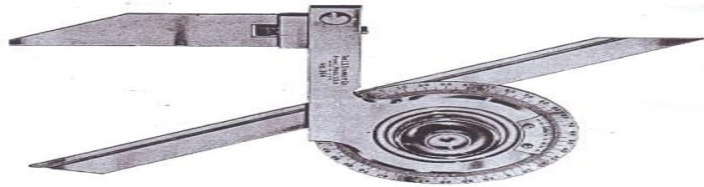


Figure 4.55 The dial gauge.

Bevel Protractor (Fig. 6.1.8). It is an instrument having a dial graduated in degree and sliding blade which is usually about 1/16 thick and it is used to measure angles and degree. Show fig. 6.1.9



**Fig. 6.1.8. Vernier Bevel Protractor**

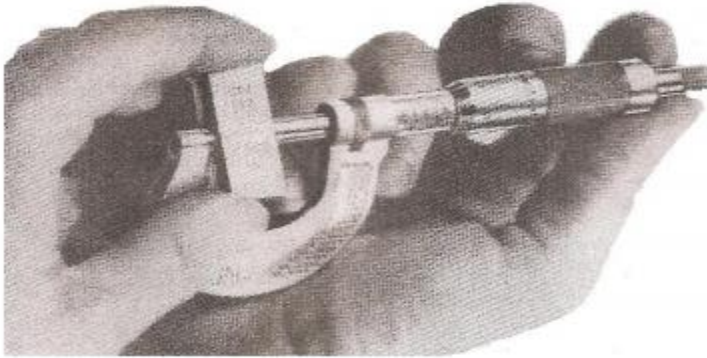


**Fig. 6.1.9 Reading the size of an angle of vernier bevel protractor**

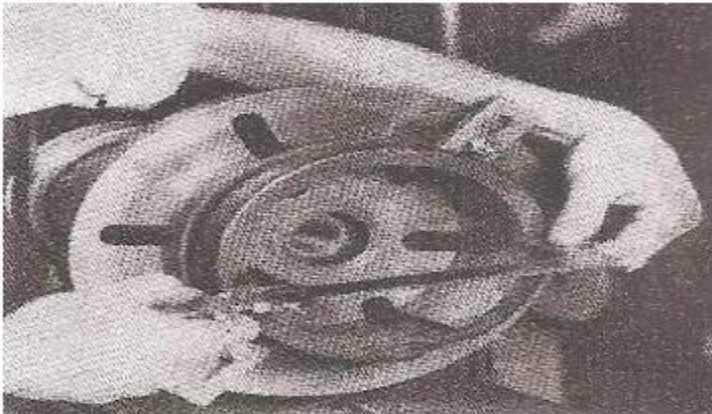
**Figure 4:0:6 Vernier Bevel Protractor**



Apply techniques Using Precision Measuring Tools



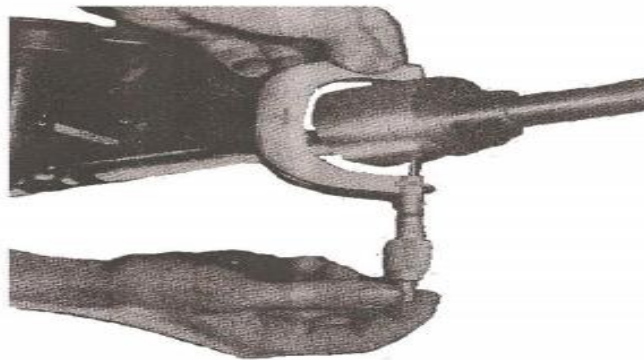
**Fig. 2.8 A micrometer being checked using a gage block**



**Fig. 2.9 An inside Vernier Caliper is used**



**Fig. 3.1 This is how to hold the micrometer correctly when piece is held in the hand.**



**Fig. 3.2 This is how to hold the micrometer correctly when piece is not held in the hand.**

**Figure 4:0:7 Measuring Techniques**

### 4.3 Handle deviations

#### Introduction

Quality Risk Management was mainly designed to be used prospectively when manufacturing operations are defined and validated. Therefore, potential deviations are identified and avoided by implementing risk control measures and preventive actions. QRM is based on the identification of product attributes and operational parameters which are critical to manufacturing operations in order to identify in advance their associated risks. This guidance document describes how this information may be used as criteria for the categorization and treatment of events, and eventually, deviations.

Under this approach, a sequence of steps may be identified when handling events and possible deviations:

- Event Detection

Page 122 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
-----------------	--	---------------------------------------	---------------------------

- Decision Making Process / Deviation Categorization
- Deviation Treatment
- Root cause investigation
- CAPA

#### Concept of deviations

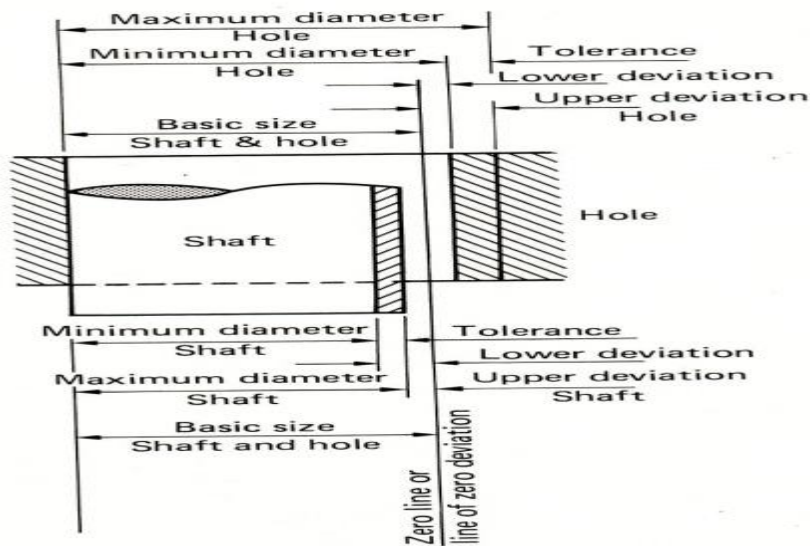
The differences of measurement from the given tolerances and the differences of measurement between each value in from working drawing's dimensions.

Actual deviation. This difference between a particular size and the basic. On the clearance fit diagram below the:-

Lower the deviation on the hole = the minimum diameter hole – basic size.

The upper deviation on the shaft = basic size – maximum

Diameter shaft.



**Clearance fit**

**Fig. 11-01A2 System of Limit and Fit**

**Figure 4:8**

### 3.2. Errors in Measurement System

Page 123 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
-----------------	--	---------------------------------------	---------------------------

An error may be defined as the difference between the measured value and the actual value. For example, if the two operators use the same device or instrument for finding the errors in measurement, it is not necessary that they may get similar results. There may be a difference between both measurements. The differences that occurs between both the measurements.

Systematic Error / Random Error

Examples

A worn out instrument: For example, a plastic tape measure becomes slightly stretched over the years, resulting in measurements that are slightly too high,

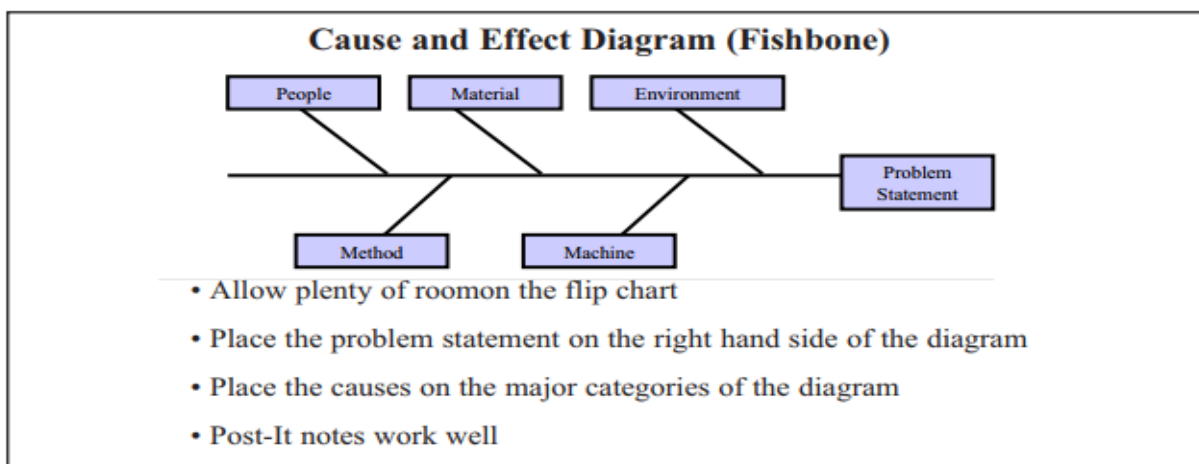
An incorrectly calibrated or tarred instrument, like a scale that doesn't read zero when nothing is on it,

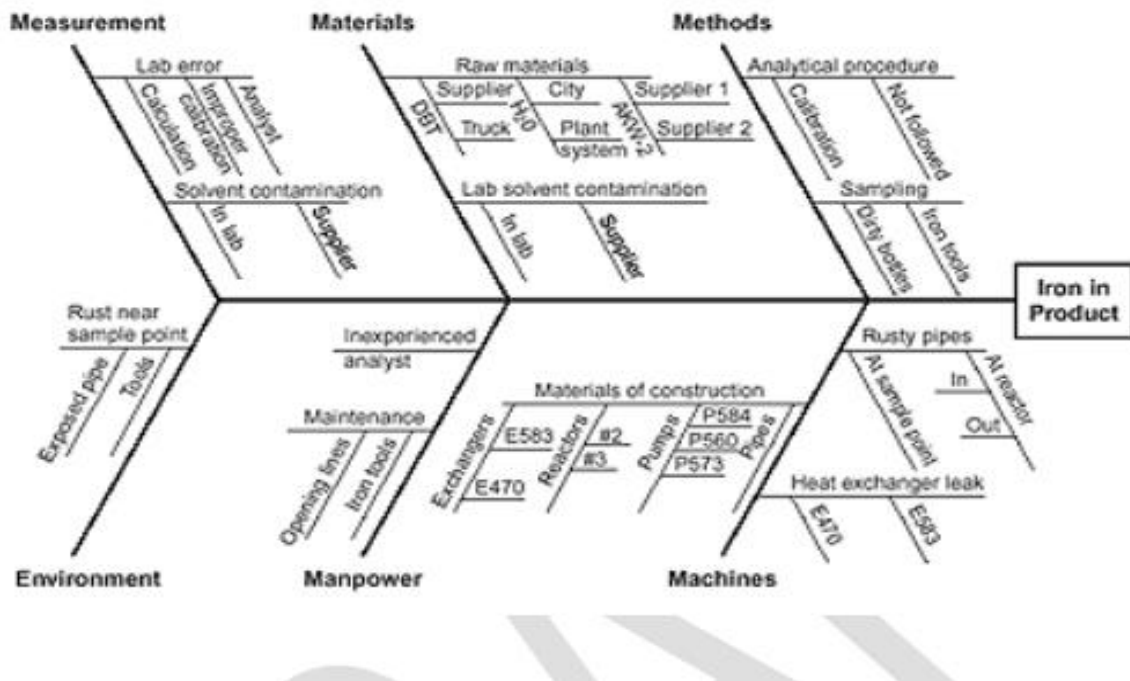
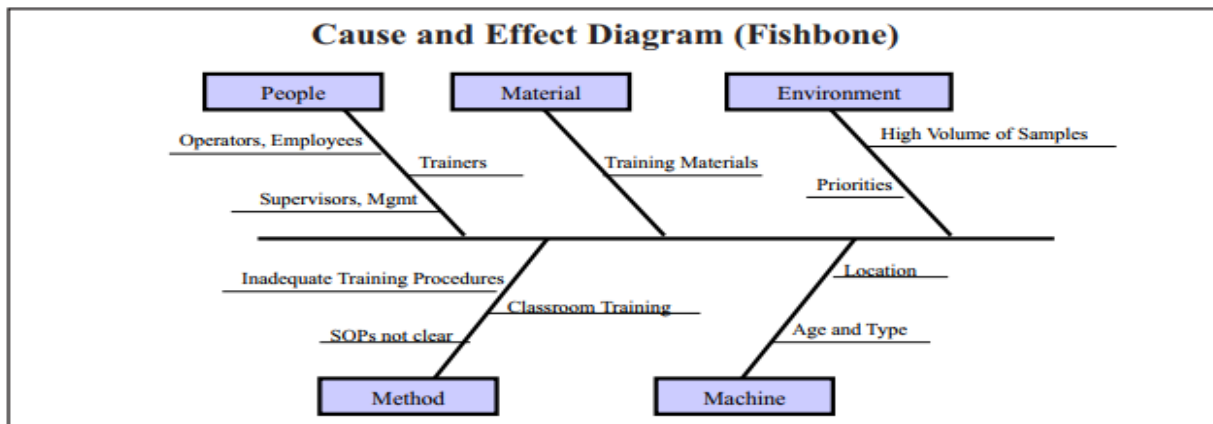
A person consistently takes an incorrect measurement.

Organization procedures and standard for handling deviations

Policies and procedures are designed to influence and determine all major decisions and actions, and all activities take place within the boundaries set by them. Procedures are the specific methods employed to express policies in action in day-to-day operations of the organization.

Causes of deviation





Using the wrong tool

In accurate taking care of operation

Lack of operator skill

Selecting wrong material

Corrective and Preventive Action

Corrective and Preventive Action (CAPA) focuses on the investigation of deviations. It does so in an attempt to either prevent their recurrence or their occurrence in the first place. To ensure the effectiveness of any corrective and preventive actions, organizations should continue monitoring them after the completion of the RCA and overall investigation. The most common CAPA-related audit observations include “inadequate—did not sufficiently address root cause;” “inappropriate, did not address root cause;” “corrective and preventive were not clearly defined;” and “not completed in the timeline identified.” One of the biggest pitfalls associated with CAPA occurs when someone assigns corrective and preventive actions without regard for resource requirement, capacity, ownership or timeline—in other words, without a plan. When it comes to CAPA, regulatory authorities expect organizations to ensure:

The identified CAPA addresses the root cause;

The solution can be implemented;

There is clear understanding of the overall impact of the CAPA;

Timelines and responsibilities (for implementation) have been reviewed and agreed to;

There is a plan; and

There is a monitoring phase.

If an organization makes it through the investigation and determines the root cause, that forms just part of the equation. In the case of an inappropriate CAPA, further problems may ensue. Thus, the appropriate CAPA should be applied and monitored to ensure its effectiveness.

## 4.4 Routine Maintenance And Adjustments

### 4.1 Introduction

Maintenance is all about preserving inherent reliability or built –in capacity of any asset. When we maintain an asset, the state which we wish to preserve must be one in which it continues to do whatever its users want it to do.

### 4.2 Purpose and objective of maintenance

Page 126 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
-----------------	--	---------------------------------------	---------------------------



The main purpose of maintenance in all industrial perspective is to reduce the business risks. In general, operation and maintenance is synonymous with high level of availability, reliability and assets operability linking directly with production capacity, productivity and business profit. The main objectives of maintenance are:-

To obtain plants and equipment at its maximum operating efficiency, reducing downtimes and ensuring operational safety.

To safeguard instruments by minimizing rate of deterioration and achieving this at optimum cost through budgeting and controls.

To help management in taking decisions on replacements or new investments and actively participate in specification preparation, equipment selection, its correction commissioning etc.

Help in implementation of suitable procedures for procurement, storage and consumption of spares, tools and consumables etc.

Standardization of spares and consumables, in conformity with plant, national and international standards and help in adoption of this standard by all users in the plant.

Running of centralized sciences like steam generation and distribution, water supply, air supply and fuel supply etc.

Running of captive workshops for repairs and conditioning and also for making some new spares.

#### Routine maintenance

**Routine maintenance** is the simplest but very essential form of maintenance system. Earlier the routine maintenance was considered about preventing failures. Today routine maintenance is being considered about avoiding, reducing or eliminating the consequences of failures. It involves jobs such as **cleaning, lubrication, inspection and minor adjustments pressure, flow, tightness** etc. and tightening of loose parts etc. It also includes **inspection of bearings, V-belts, couplings, jointing, foundation bolts, earthlings and protective covers** etc. The small and critical defects, observed during such inspection, are rectified immediately and bigger jobs are planned for rectification during next available shutdown. Such maintenance is essential for effective scheduled and preventive maintenance.

Page 127 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
-----------------	--	---------------------------------------	---------------------------

Routine maintenance is not necessarily need-based. In a equipment !plant some motors may be running for 4 hours a day and some others may be running 20 hours a day but, in routine as maintenance, all may be inspected at the same frequency. This may lead to some amount of over maintenance in some components, but the system pays up handsomely in the long run. “Regularity”,

.e. carrying out planned jobs regularly in simple cyclic schedule, is very essential in routine maintenance. Such schedules are simple (like check, clean, lubricate, tighten, adjust etc) and repetitive. Routine maintenance may also be considered as a small portion of preventive maintenance. Frequency of routine maintenance is generally once every shift or every day (normally at the start). Of course in sophisticated and automatic working equipment or in equipment having enough condition monitoring gadgets to indicate failures or deviations, the period of routine maintenance may change. Again, if such jobs are more and time availability is less, one group of job may be planned for Monday, another group of jobs for Tuesday and so on. Routine maintenance needs very little investment in time and money. The duration of routine maintenance is generally so small that it does not affect the output of machine appreciably. However, the cost of not-doing routine maintenance may be very high as a small defect may develop in big and catastrophic failure.

As one example of routine maintenance, in few railway suburban electric trains system, whenever the train stops at few bigger stations, a group of maintenance people immediately starts checking and doing minor jobs like identifying loose parts and tightening, cleaning moisture traps and checking brakes etc. The whole job may take 10 to 12 minutes by the time the train is due to start for onward journey. In industries, during shift change periods, a small group of maintenance personnel carry out necessary inspection, lubrication, adjustments and tightening etc., which may take about 15 minutes.

**4.3.1 Routine Maintenance, also known as preventive maintenance** and it is an essential part of the ongoing care and upkeep of any machine while on operations. For example, lubricating the machine parts, cleaning machine regularly, changing the coolant of the machine



Regular maintenance of equipment is an important and necessary activity. The term 'maintenance' covers many activities, including inspection, testing, measurement, replacement and adjustment, and is carried out in all sectors and workplaces.

**4.4 Corrective maintenance** where equipment is repaired or replaced after wear, malfunction or break down.

**4.5 Predictive maintenance**, which uses sensor data to monitor a system, then continuously evaluates it against historical trends to predict failure before it occurs.

## Self-check-4

### Test-I Matching

**Directions:** Choose the Best Answer

1. Which one types of testing or testing for conformance of the machined component?

A. conformance      B. Surface finish C. Shapes and dimensions      D. None

2. Which is one must be included in a non-conformance report?

A. Main reason error      B. The solution to prevent the problem

C. Explanation of corrective action to be taken      D. All

3. It is used to measure squareness of the edge of the work piece.

a. try square b. steel rule c. caliper d. micrometer

4. Is a precision tool used to measure diameter of round stock.

a. micrometer b. rule c. divider d. try square

5. Write three examples for Errors in Measurement System?

6. Define deviations?

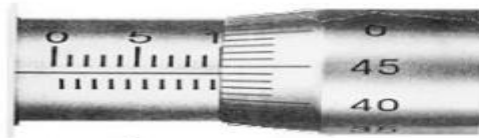
Component inspections allow on operation at final stages of the production process.

True      B. False

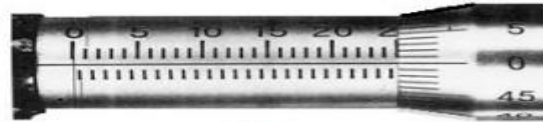
Directions: : Identify the different reading of micrometer and vernier caliper. Use separate sheets of paper.

List the parts of Vernier caliper?

List the parts of Vernier Micrometer



A



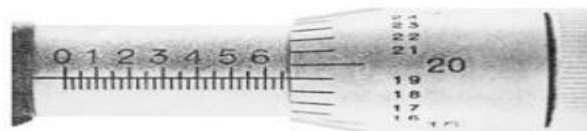
B



C



D



E

Reading

\_\_\_\_\_ MM

\_\_\_\_\_ MM

\_\_\_\_\_ MM

\_\_\_\_\_ MM

\_\_\_\_\_ MM

## Operation sheet 4.1: Quality assure finished component

**Operation title:** Check for conformance

**Purpose:** To Check for conformance of components

**Instruction:** Using the conformance standard measure equipments

### Tools and requirement

V. Caliper

Micrometer

### Steps in doing the task

Step 1- Establishing Standards and Methods for Measuring Performance

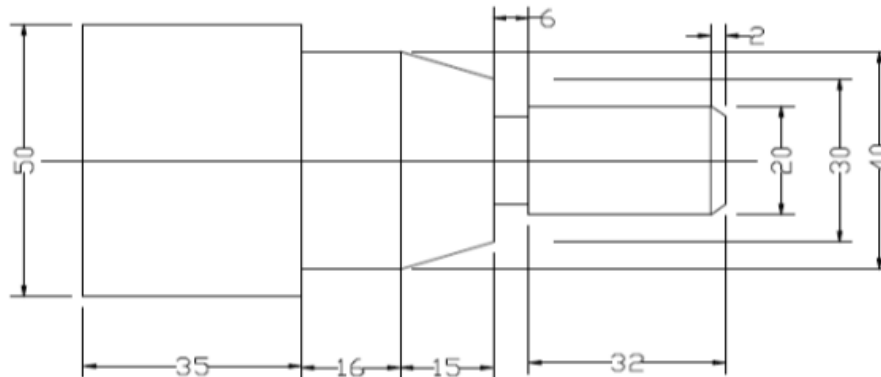
Step 2- Measuring the Performance

Sep 3- Determination of Whether the Performance Matches the Standard,

Step 4- Taking Corrective Action

Quality Criteria :- tolerance 0.02mm

Precautions



All dimensions are in millimeters

## Operation sheet 4.1: Quality assure finished component

**Operation title:** Routine Maintenance And Adjustment

Page 132 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
-----------------	--	---------------------------------------	---------------------------

**Purpose:** To prevent machine from damage and to increase efficiency

**Instruction:** Using the manual and see maintenance schedule

**Tools and requirement**

V. Caliper

Micrometer

**Steps in doing the task**

Step 1- check the oil, coolant and grease lubrication manuals

Step 2- check the performance of the machine based on the manuals

Sep 3-open the oil, coolant box and fill the oil or the coolant

Step 4- check the indicator and reclose the oil coolant boxes

Step 5- clean the machine the areas

**Quality Criteria**

Use standard oil

**Precautions**

See manual

**Lap Test**

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

Page 133 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1 August 2022
-----------------	--	---------------------------------------	---------------------------

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1hour.

Task 1. Checking for conformance of the machined part

Task 2.Undertake routine maintenance of the machine

### List of Reference Materials

Page 134 of 137	Ministry of Labor and Skills Author/Copyright	Perform General Workshop Machining	Version -1
			August 2022

Book: Machining and Machine Tools by A. B. Chattopadhyay.

Book: Metal Cutting: Theory And Practice by A. Bhattacharya.

Participants of this Module (training material) preparation

N o	Name	Qualifica tion (Level)	Field of Study	Organization/ Institution	Mobile number	E-mail
1	Meseret W/Mariam	A(MSC)	Manufacturing	Wolkite polytechnic college	0912117416	<a href="mailto:Bmesi2007@gmail.com">Bmesi2007@gmail.com</a>
2	Solomon Negtu	A(MSC)	Manufacturing	Harer polytechnic college	0912762152	<a href="mailto:solonnigatu@gmail.com">solonnigatu@gmail.com</a>
3	Kibru getahun	B(BSC)	Manufacturing	M.G.M.B. polytechnic college	0912370975	<a href="mailto:bmkibru@gmail.com">bmkibru@gmail.com</a>
4	Efrem Kebede	B(BSC)	MAT	BPTC	0910410054	<a href="mailto:efremkebede27@gmail.com">efremkebede27@gmail.com</a>
5						
6						
7						



