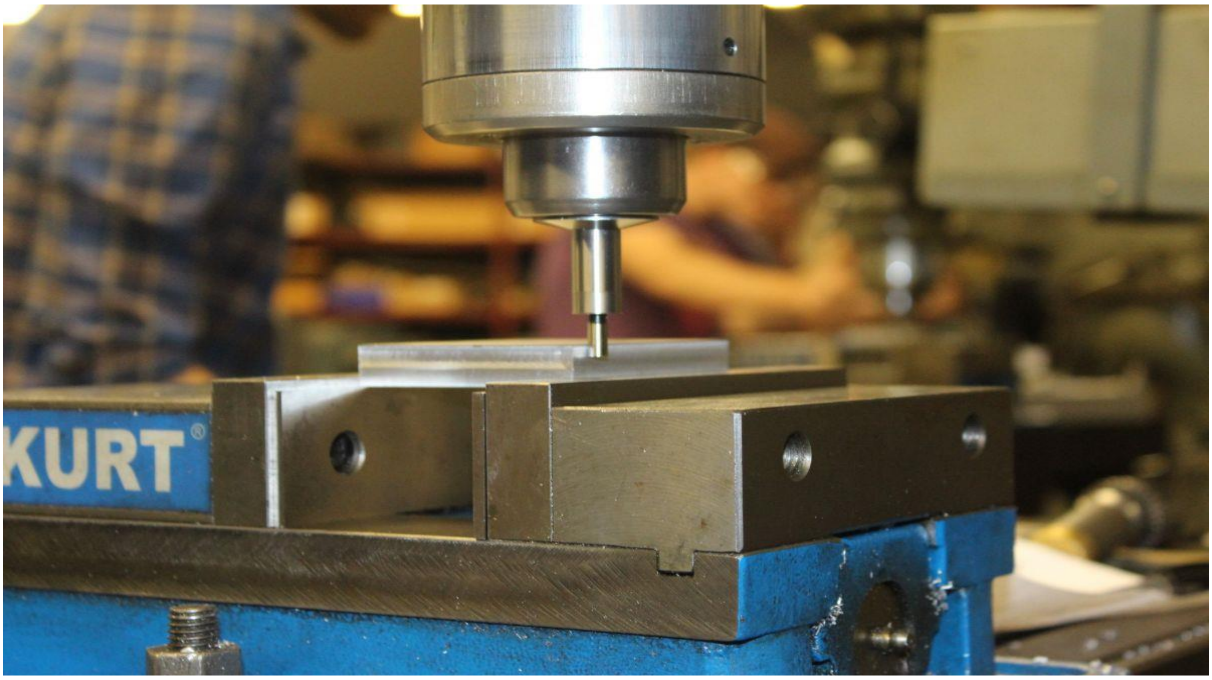
FOUNDRY WORKS

LEVEL – I

Based on March, 2022 Curriculum Version 1



Module Title: Operating Basic Workshop Machineries

Module Code: IND FDW1 M04 0322

Nominal duration: 90 hours

Prepared By: Ministry of Lobar and Skill

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Acronyms

SS- Stainless Steel

OD-Outside Diameter

ASTM-American Society for Testing and Materials

ANSI-American National Standards Institute

QC- Quality Control

LAP- Learning activity performance

Introduction to Operating Basic Workshop Machineries

In the field of Foundry, machine shop is both an engineer's laboratory and an artist's studio. Some operations require a lot of precision and planning and three dimensions, while others are more free form. Each material and each operation require different machines, but they all follow the same basic principles. By knowing the possibilities and limitations of the tools, you can better design the objects you create.

If you ever visit an industrial manufacturing plant, you might find that many of the machines are unfamiliar. They might look like something you've seen before, but with a different set-up or different tooling. The secret to a machine shop is that all of the tools operate on the same principles. A machine may have straight or rotating blades, a flat-edged or angled cutting tool, a moving tool or a moving workpiece. By understanding first, the basic concepts of the machine shop, you can figure out how to use a machine that might not be as familiar, or even create your own tools to solve a special machining problem.

A machine shop can contain some raw materials (such as bar stock for machining) and an inventory of finished parts. These items are often stored in a warehouse. The control and traceability of the materials usually depend on the company's management and the industries that are served, standard certification of the establishment, and stewardship.

Module units

- Work requirements
- Set-up machine
- Machine operations
- Finished components

Learning objectives of the Module

At the end of this session, the students will able to:

- Determine and plan job requirements
- Perform correct procedures of Set-up machine
- Perform machine operations
- Assure quality of finished component

Module Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Unit one: Work requirements

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

1. Work instruction and drawings
2. Mechanical properties of engineering materials
3. Machines and tools
4. 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:

1. Analyze and select Work instruction and drawing
2. Identify mechanical properties of engineering materials
3. Select appropriate machines and tools
4. Determine Sequence of operations for maximum efficiency

1.1 Work Instruction and drawing

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.

A. 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.

1.1.1 Safety Requirement in machine shop

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.

1.1.2 Causes of Accidents

The accidents may take place due to

A. 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.

B. 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.

C. 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.

1.1.3 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

1.1.4 Safety Rule

Safety rules are classified in to three categories. These are

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

B. 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.

C. Work shop safety

- Keep the floor around your machine clear of chips and wipe up spilled cutting fluid
- Oily rugs must be placed in approved safety containers

1.2. Mechanical properties of engineering materials

Common engineering materials are normally classified as metals and nonmetals. Metals and non-metals differ in their properties. The choice of materials for a given job depends very much on its properties, cost, availability and such other factors. Metals may conveniently be divided into ferrous and non-ferrous metals.

1.2.1 Ferrous metals

Ferrous metals may be defined as those metals whose main constituent is iron such as pig iron, wrought iron, cast iron, steel and their alloys. They are usually stronger and harder and are used in daily life products. They possess a special property that their characteristics can be altered by heat treatment processes or by addition of small quantity of alloying elements. Ferrous metals possess different physical properties according to their carbon content. **The most Ferrous metals are: -**

A. Cast iron It is primarily an alloy of iron and carbon. The carbon content in cast iron varies from 1.5 to 4 per cent. Small amounts of silicon, manganese, Sulphur and phosphorus are also present in it. Carbons in cast iron are present either in Free State like graphite or in combined state as commentate. Cast iron contains so much carbon or its equivalent that it is not malleable. One characteristic (except white cast iron) is that much of carbon Content is present in free form as graphite. Largely the properties of cast iron are determined by this fact. Melting point of cast iron is much lower than that of steel.

B. Wrought iron The meaning of "wrought" is that metal which possesses sufficient ductility in order to permit hot and/or cold deformation. Wrought iron is the purest iron with a small amount of slag forged out into fibers. The typical composition indicates 99 per cent of iron and traces of carbon, phosphorus, manganese, silicon, Sulphur and slag.

C. Steel is an alloy of iron and carbon with carbon content maximum up to 1.7%. The carbon occurs in the form of iron carbide, because of its ability to increase the hardness and strength of the steel. Other elements e.g., silicon, Sulphur, phosphorus and manganese are also present to greater or lesser amount to import certain desired properties to it. Most of the steel produced now-a-days is plain carbon steel.

1.2.2 Non-ferrous metals

Non-ferrous metals are those which do not contain significant quantity of iron or iron as base metal. These metals possess low strength at high temperatures, generally suffer from hot shortness and have more shrinkage than ferrous metals. **The most non-Ferrous metals are: -**

A. **Copper** is one of the most widely used non-ferrous metals in industry. It is extracted from ores of copper such as copper glance, copper pyrites, malachite and azurite. Copper is a corrosion resistant metal of an attractive reddish-brown color.

B. **Aluminum** is a white metal which is produced by electrical processes from clayey mineral known as bauxite. In its pure state, it is weak and soft but addition of small amounts of Cu, Mn, Si and Mg makes it hard and strong. It is also corrosion resistant, low weight and non-toxic.

C. **Nickel is** a silvery shining white metal having extremely good response to polish. The most important nickel's ore is iron sulphones which contain about 3% of nickel. About 90% of the total production of nickel is obtained by this source. Nickel is as hard as steel. It possesses good heat resistance. It is tough and having good corrosion resistance. Its melting point is 1452°C and specific gravity is 0.85. At normal temperature, nickel is paramagnetic. When it contains small amount of carbon, it is quite malleable. It is somewhat less ductile than soft steel, but small amount of magnesium improves ductility considerably.

D. **Lead** is a bluish grey metal with a high metallic luster when freshly cut. It is the softest and heaviest of all the common metals. It is very malleable and may be readily formed into foil. It can readily be scratched with fingernail when pure. Lead has properties of high density and easy workability. It has very good resistance to corrosion and many acids have no chemical action on it. Its melting point is 327°C and specific gravity is 11.35. Lead and its alloys as engineering material have limited but important uses. Lead alloys are used for soldering (Pb–Sn, Pb–Sn–Sb) and bearings (Pb–Sn–Sb, Cu–Pb, Cu–Sn–Pb).

1.3. Machines and tools

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. Some Types of machines are discussed below: -

1.3.1. 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, 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.

A. Types of Lathe machine

There are four 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 operations simultaneously
- Bench Lathe: a small lathe which can be mounted on the work bench for doing small precision and light jobs.

B. Major Parts of Lathe Machine

There are five major parts of lathe machine**: -**

- 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.

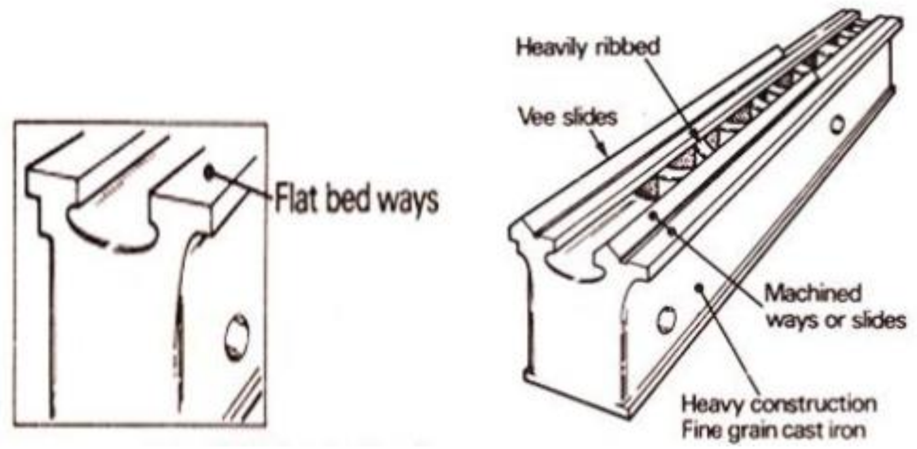


Figure. 1.1 Bed

❖ HEAD STOCK: The headstock is the lathe feature that provides the means of holding and rotating the work accurately.

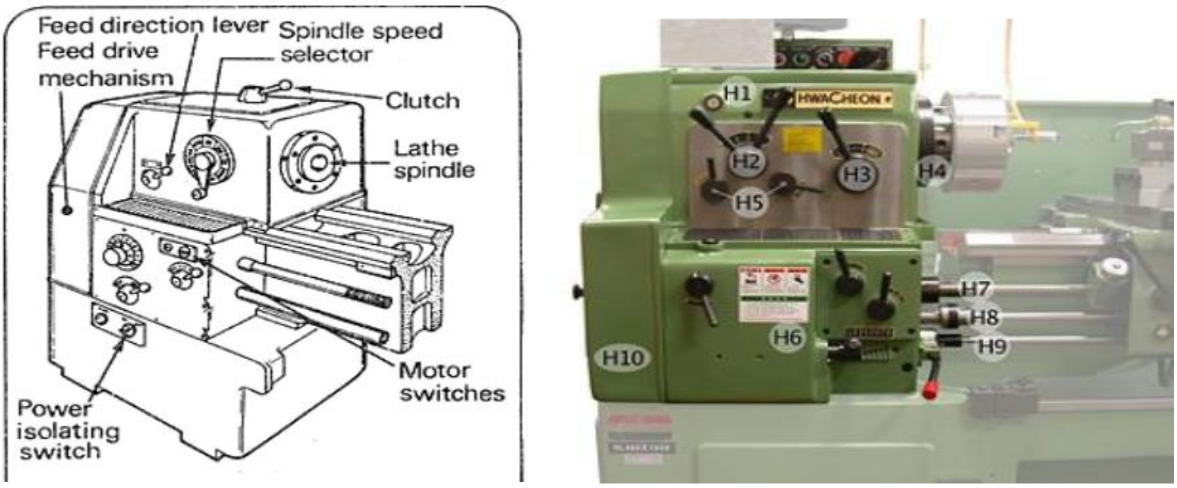


Figure. 1.2 Head stock

C. 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.

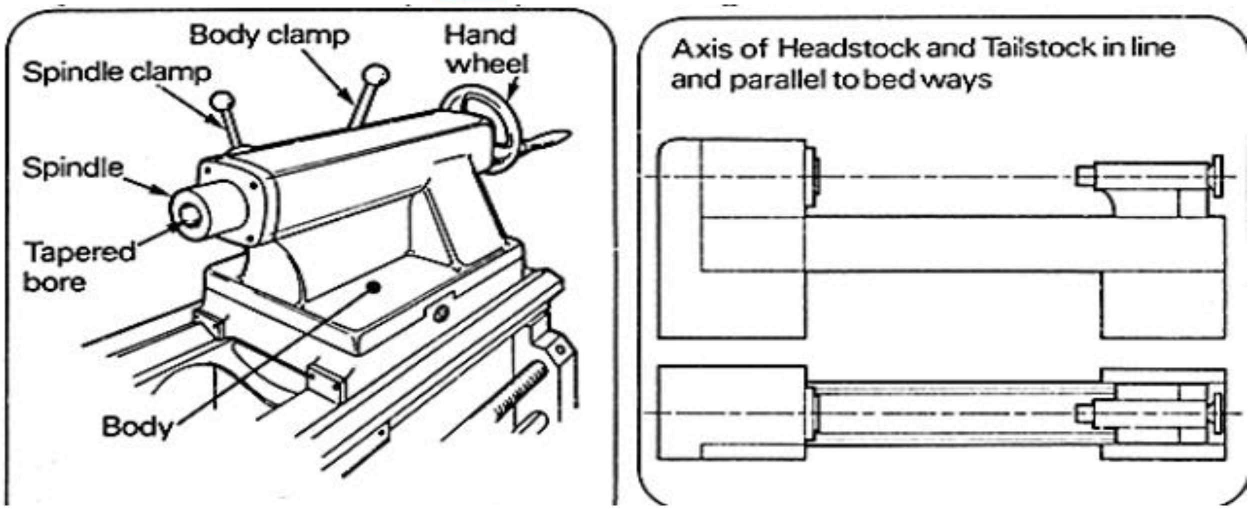


Figure. 1.3Tail stock

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

- ❖ 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 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.

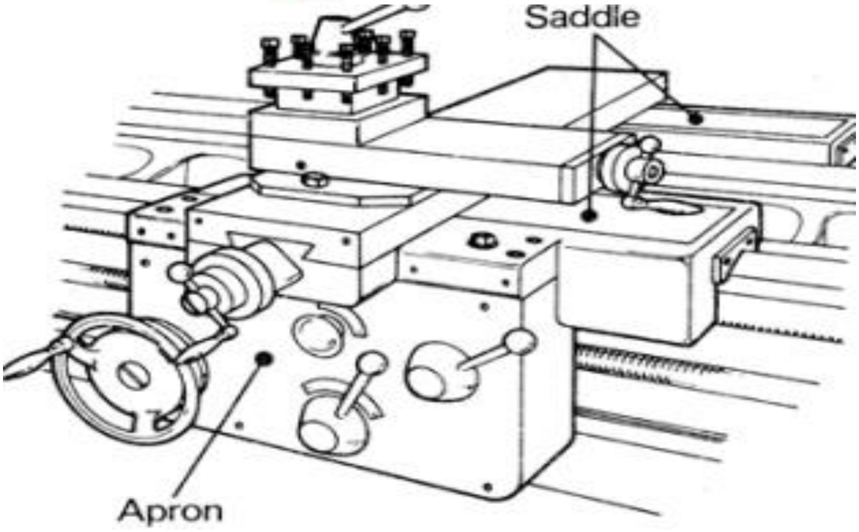


Figure. 1.4 Carriage

E. 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 slid.

- Quick Change Box is providing 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.

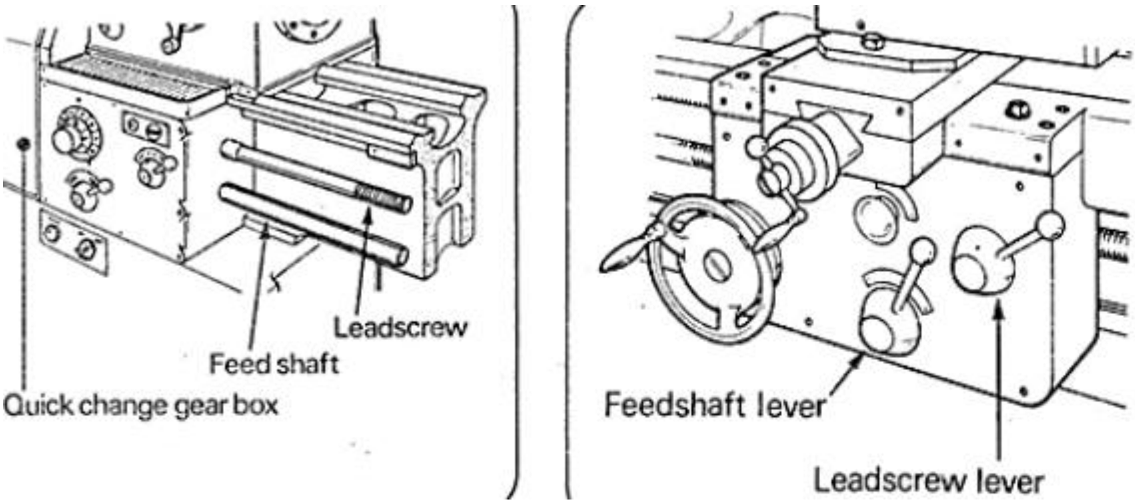


Figure. 1.5 Feed mechanism

1.3.2 Milling machine

Milling machines are machine tools used to rotate single or multiple cutting edges and removes metal when work is feed against a rotating cutter Functions of Milling machine are capable of machining flat or contoured surfaces, slots, grooves, recesses threads, gears, spirals and other configurations.

Milling machine is one of the most versatile conventional machine tools with a wide range of metal cutting capability. The number of operations which may be carried out on a given machine depends on the type of machine, type of cutter, and the accessories or attachments available for use with the machine. A large number of accessories are available for expanding the variety of operations which can be performed on these machines.

In a milling machine operation, the work piece is fed against a rotating cutting tool called a milling cutter. Cutters of many shapes and sizes are available for a wide variety of milling operations. Milling machines cut flat surfaces, grooves, shoulders, inclined surfaces, dovetails, and T-slots. Various form-tooth cutters are used for cutting concave forms and convex grooves, for rounding corners, and for cutting gear teeth.

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.

A. 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 spindle milling machine: - the 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. work table on this machine has three movements vertical, cross and longitudinal or (z, y & x axis)

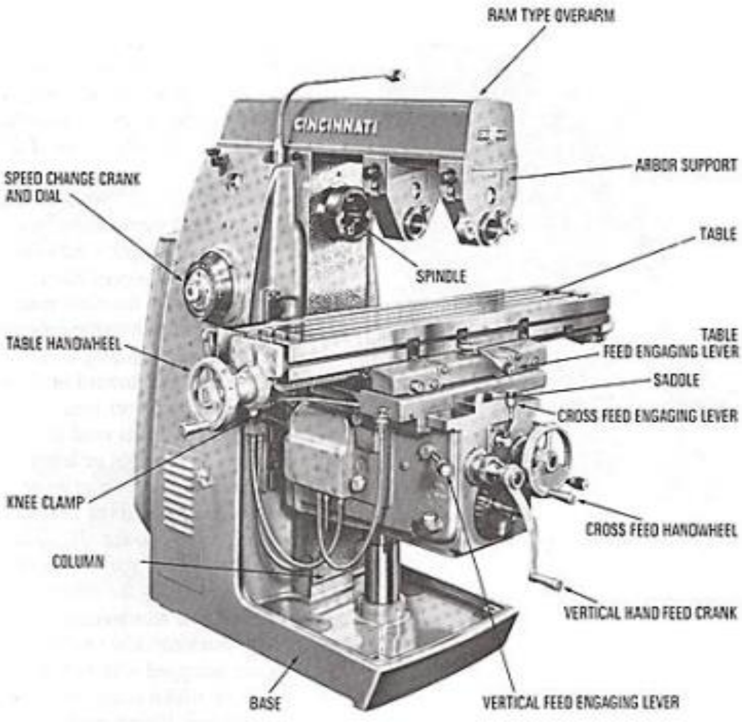


Figure. 1.6 horizontal milling Machine

- Vertical Milling Machine: - differ from other type of Milling machine by having the cutter spindle in a vertical position or at right angle to the work. It also includes A swivel head, Sliding head and the rotary head. vertical milling machine which is of similar construction to a horizontal milling machine except that the spindle is mounted in the vertical position.

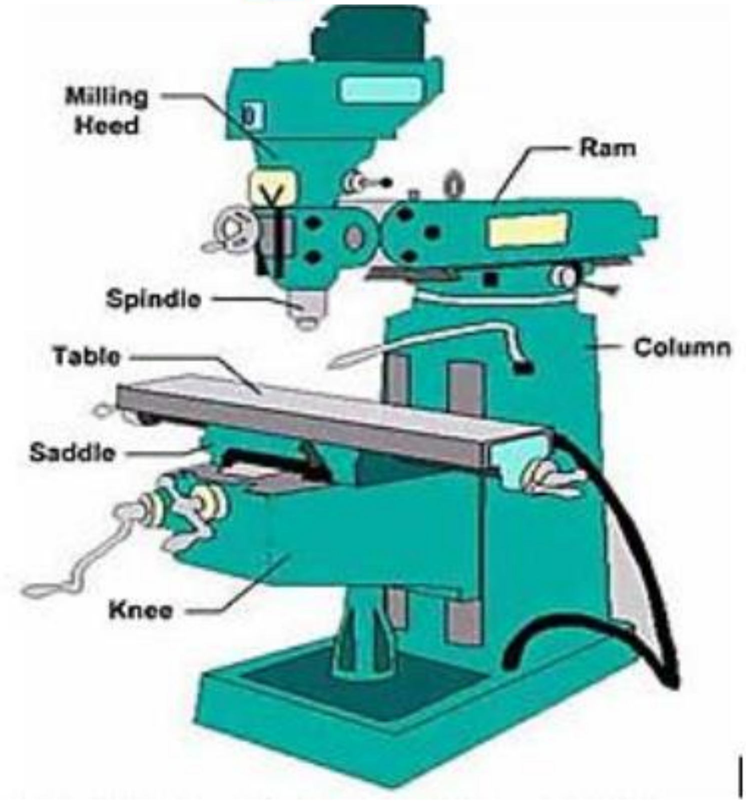


Figure. 1.7 Vertical milling Machine

B. MAJOR PARTS OF MILLING MACHINE

- ❖ Column: - is a hollow casting with thick walls and supports other parts of the machine such as spindle, sliding k nee and over arm.
- ❖ Base is made of ribbed cast iron and it may contain a coolant reservoir.
- ❖ Knee moves up and down the face of the column and supports the saddle and table.
- ❖ Over arm**:** the over arm may round or of the more common ram type. It may be adjusted to ward or away from the column to increase the capacity of the machine.

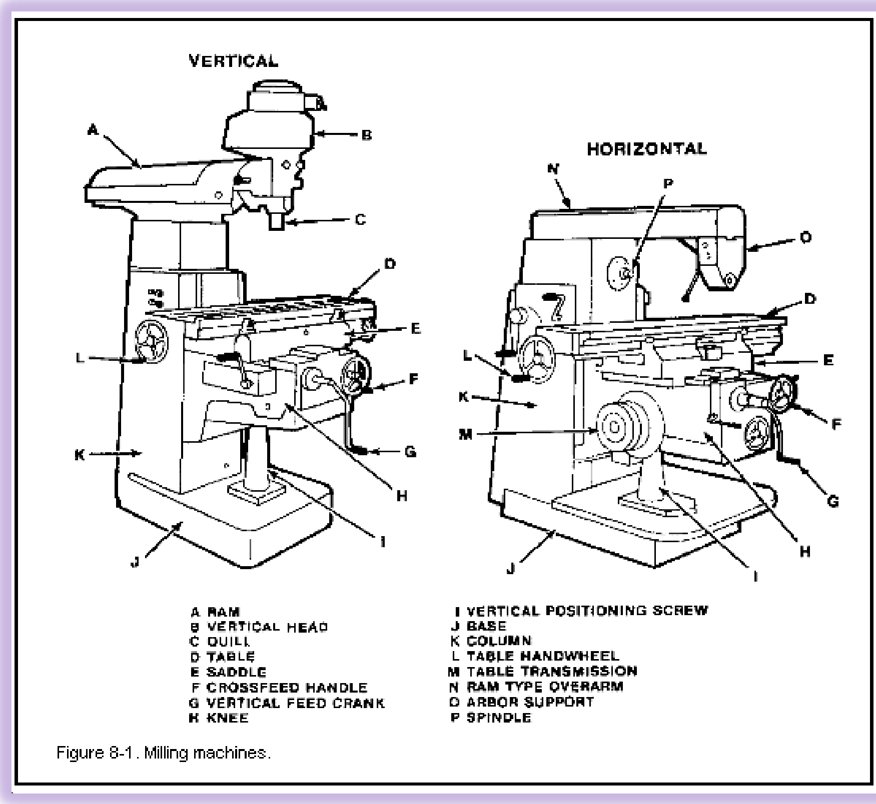


Figure. 1.8 parts of milling Machine

1.3.3. 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.

PORTABLE DRILLS

The portable drill is a hand-supported, power-driven machine tool that rotates twist drills, reamers, counter bores, and similar cutting tools. The portable drill may be electrically
powered by means of an internal electric motor.

Portable drills are rated by the maximum size hole that can be drilled in steel without overtaxing the motor or drill.

Therefore, a 1/4-inch-capacity drill is capable of drilling a 1/4-inch diameter hole or smaller in steel. Portable electric and pneumatic drills rated at 1/4 to 1/2-inch maximum capacities are usually equipped with geared drill chucks for mounting straight, round shank twist drills or other similar tools by using a chuck key.

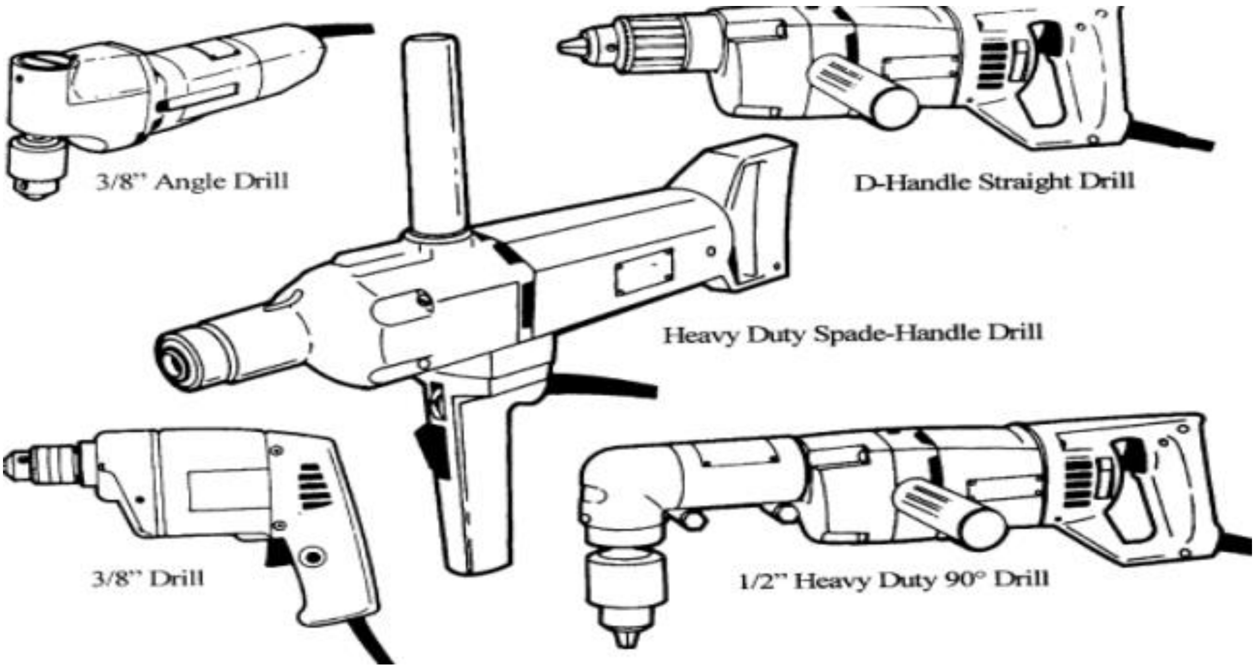


Figure. 1.9 portable drill Machine

A. 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 degrees 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 larger for the table.

B. Types of drill Machine

- Drill press 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 than 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. 1.10 Press drill Machine

- Radial drill: 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. 1.11 Radial drill Machine

1.3.4 Grinding Machine

Grinding is the process of removing metal by the application of abrasive which are bonding to form a rotating wheel. When the moving abrasive particle contacts the work piece, they act as tiny cutting tools, each particle cutting a tiny chip from the work piece. The grinding machine is used for roughing and finishing flat, cylindrical and sharpening cutting tools.

Grinding machines remove small chips from metal parts that are brought into contact with a rotating abrasive wheel called a grinding wheel or an abrasive belt. Grinding is the most accurate of all of the basic machining processes. Modern grinding machines grind hard or soft parts to tolerances of plus or minus 0.0001 inch (0.0025 millimeter).

A. PORTABLE GRINDERS

The portable grinder is a lightweight, hand-operated machine tool. It can be powered electrically or pneumatically, depending on the model selected. The portable grinder is used in the field or maintenance shop to grind excess metal from welds, remove rust, and for special finishing operations around the work area. Since this tool is hand operated, the quality of the work depends upon the ability and experience of the operator.

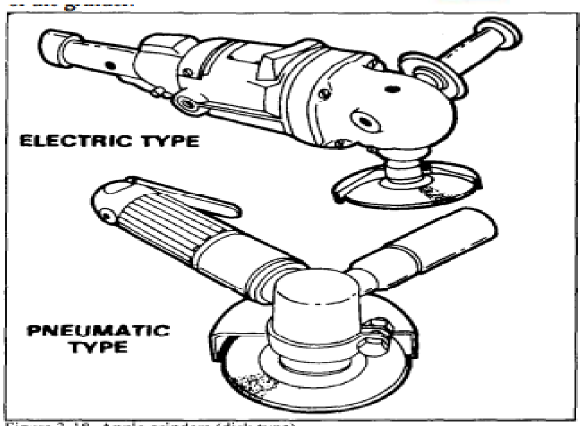


Figure 3-18. Angle grinders (disk type).

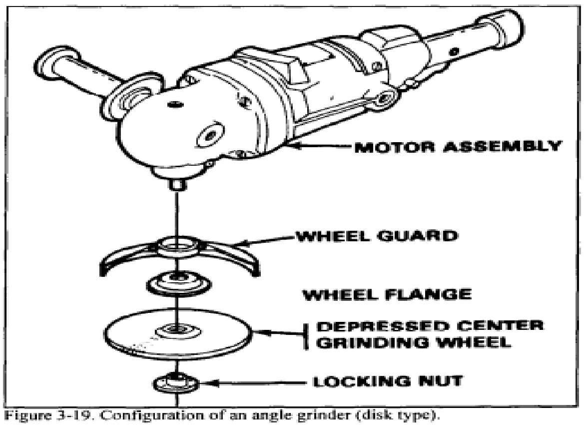


Figure 3-19. Configuration of an angle grinder (disk type).

Figure. 1.12 Portable Grinder Machine

B. Surface grinding

it is used for grinding flat surfaces. The work piece is supported on rectangular table which moves back forth and reciprocating beneath the grinding wheel.

Figure. 1.13 Surface Grinder Machine

C. Cylindrical grinding

This process used for grinding external and internal cylindrical surface.

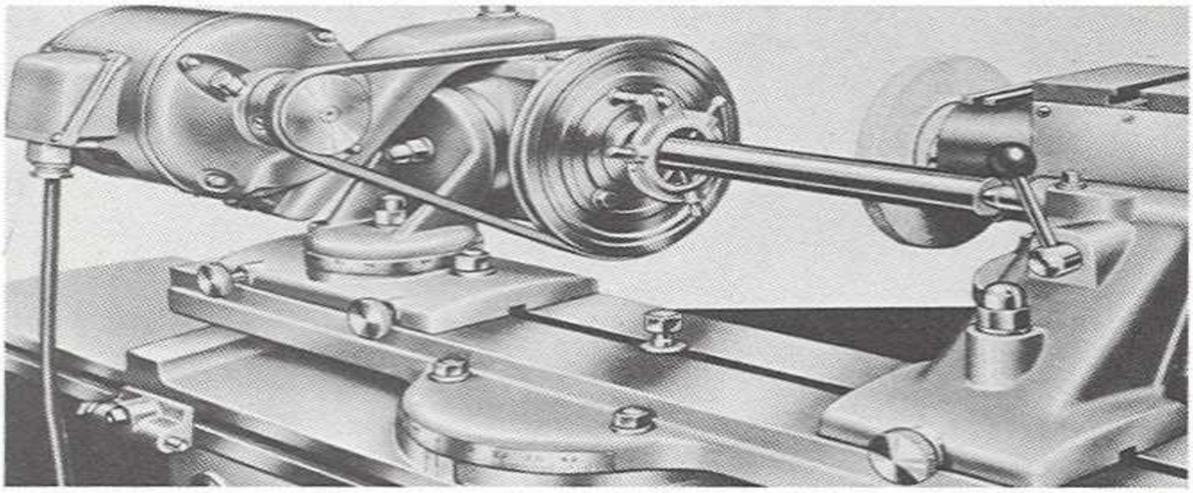


Figure. 1.14 cylindrical Grinder Machine

1.4 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;

A. 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.

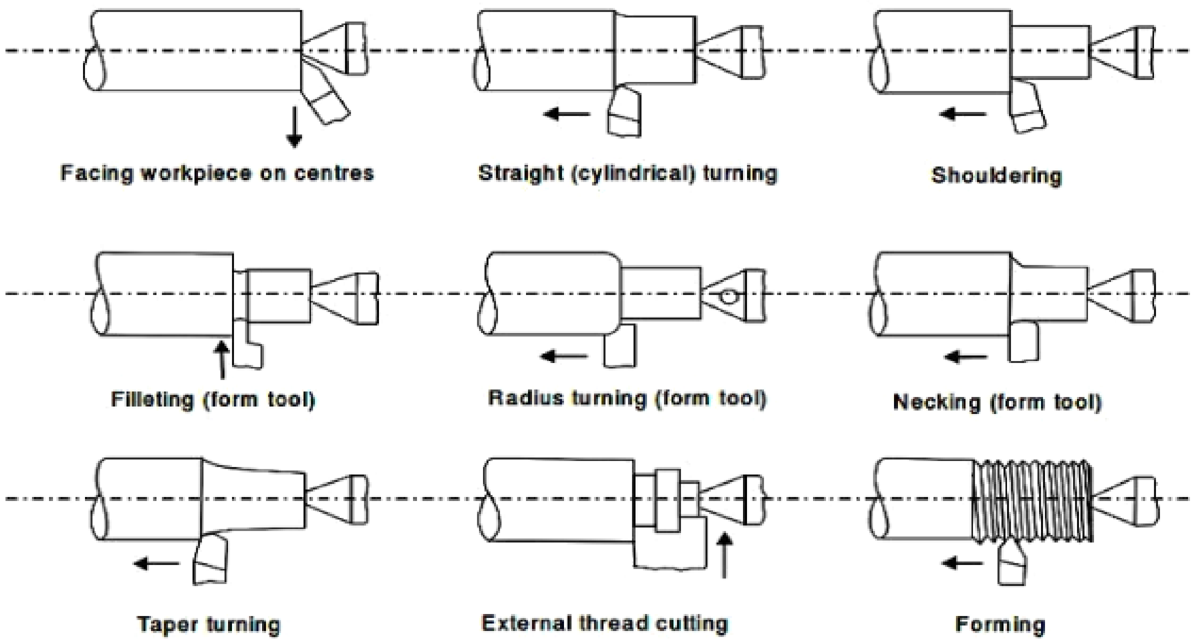


Figure. 1.15 Lathe operations

B. Sequence of operations on lathe machine

- Prepare the tools and materials Secure the tools and materials from the tool keeper Check and clean them before using
- Mount the work piece to the chuck.
- Open the chuck jaws to the approximate size of the work piece diameter.
- Position the work piece in the chuck and slightly tighten the chuck jaws.
- Set the compound most at 90 degrees.
- Position the tool holder, used right cut facing tool.
- The point of the tool permits a slight clearance between the work faces the center.
- Bring the cutting tool up until it touches the surface to be machined.
- Observed safety precaution while performing facing operation used eye goggles to protect eyes from the chips.
- Feed the center into the work with the compound rest.

C. Operations on Drill machine

Operation on Drilling machines may be used for performing a variety of operations besides drilling a round hole. A few of the more standard operations, cutting tools and work set-ups will be briefly discussed.

- Drilling – may be defined as the operation of producing a hole by removing a metal from a solid mass using a cutting tool called a twist drill.
- Countersinking – is the operation of producing a tapered or cone shaped enlargement to the end of the hole.
- Reaming – is the operation of sizing and producing a smooth round hole from a previously drilled or bored hole with the use of a cutting tool having several cutting edges.
- Boring – is the operation of enlarging and truing a hole by means of a single-point cutting tool which is usually held in a boring bar.
- Spot-facing – is the operation of smoothing and squaring the surface around a hole to provide a seat for the head of a cap screw or a nut. A boring bar with a pilot section on the end to fit into the existing hole is generally fitted with a double-edged cutting tool. The pilot on the bar provides rigidity for the cutting tool and keeps it concentric with the hole.

For the spot facing operation, the work being machined should be securely clamped and the machine set approximately ¼ of the drilling speed.

- ❖ Tapping – is the operation of cutting internal threads in a hole with a cutting tool called a tap. Special machine or gun taps are used with a tapping attachment when this operation is performed by power in a machine.
- ❖ Counter boring – is the operation of enlarging the top of a previously drilled hole to a given depth to provide a square shoulder for the head of a bolt or a cap screw.

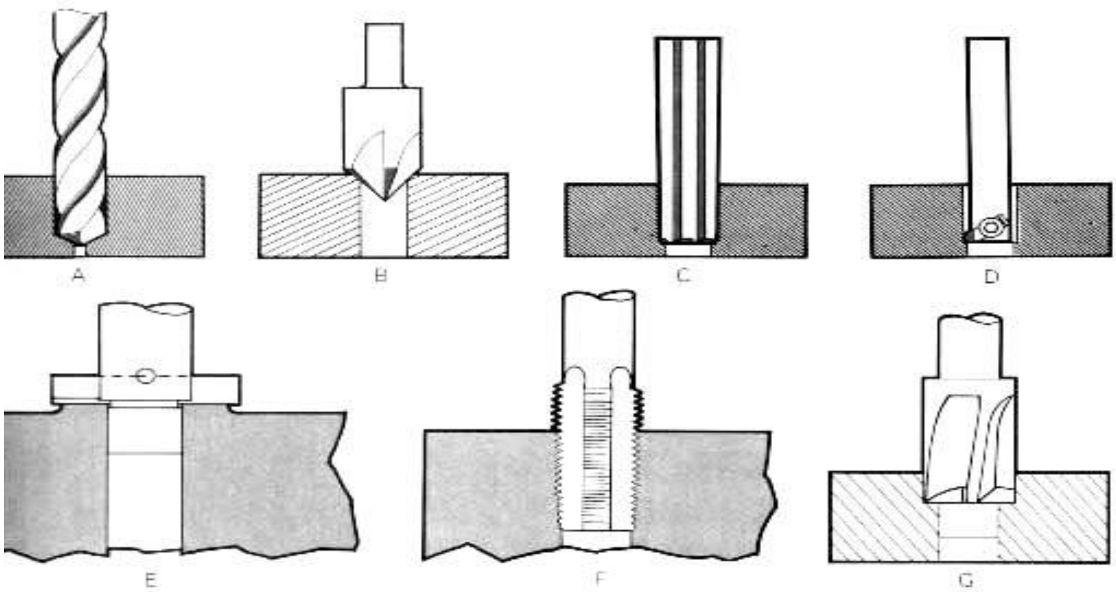


Figure. 1.16 drill machine operations

SELF CHECK 1.1

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

1. The tool used in a lathe is a
   A. multipoint cutting tool B. Single point cutting tool
   C. saw tooth cutting tool D. drill
2. Knurling tool (knurl) is a
   A. single point cutting tool B. saw tooth cutting tool
   C. embossing tool D. parting tool
3. The assembly which consists of saddle, cross-slide, compound slide and tool post is
   A. headstock B. tailstock C. bed D. carriage
4. In a milling machine, cutters are mounted on
   A. column B. spindle C. overhanging arm D. arbor
5. 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
6. 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
7. 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
8. One is not the main parts of carriage
   A. Compound rest

B. The saddle

C. Cross-slide,

D. Apron

E. Headstock

9. Popular types of tool posts are

A. the standard tool posts

B. castle tool posts

C. The quick-change tool posts

D. All of the above

10. The sole purpose of the tool post is

A. To provide a rigid support for the tool holder

B. To provide cutting fluid

C. To provide cutting action

D. All of the above

11. One properties of lead screw**.**

A. The lead screw is used for thread cutting

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

12. 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

13. One not Purpose of drill Chuck

A. Used for holding straight-shank drills

B. Used for holding reamers

C. Used for holding taps

D. Used for holding Small-diameter work-pieces

E. Used for holding lathe check

14. 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
15. One of the following is not common types of centers
    A. Male Center
    B. Pipe Center
    C. Female Center
    D. Half-Male Center
    E. None
16. One of the following is not lathe cutting tool materials
    A. HSS
    B. Carbide steel
    C. Tungsten Carbide
    D. Tantalum Carbide and Titanium Carbide.
    E. None of the above
17. One of the following is used to support long work pieces
    A. Tailstock
    B. steady rest
    C. follower rest
    D. All of the above
18. Types of lathe cutting tools
    A. Right-Hand Turning Cutter Bit.
    B. Left-Hand Turning Cutter Bit.
    C. Round-Nose Turning Cutter Bit.
    D. All of the above

1. Write three examples of Hazards parts of machines? (3points)
2. Loose clothing, using jewelry while operating machine which has moving parts not so much causes of accidents. (1point)

A. True B. False

3. 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 requirement

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

Term A	Term B
_____ 1. Faceplate	a) chuck key
_____ 2. Four Jaw Chuck	b) lathe dog
_____ 3. Universal Lathe Chuck	c) collet chuck
_____ 4. Chuck partner	d) three (3) jaw chuck
_____ 5. Drill press type of lathe chuck	e) independent chuck
	f) Three jaws

***Note:* Satisfactory rating - 3 points Unsatisfactory - below 3 points**

Answer Sheet

Score = ____________

Name: ____________________________ Date: ________________

Unit Two: Set-up machine

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

1. Cutting Tools
2. Appropriate machines tools
3. Accessors and machine guards
4. Speed and Feed
5. Set up operation

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:

1. Sharp and inspect cutting tools
2. Mount and position appropriate Tools
3. Select and Set Accessors and machine guards
4. Calculate Speeds and feeds
5. Perform Setup operations

2.1 Cutting Tool

When you purchase a new lathe tool bit, it might have an angle on the end, but it is not properly sharpened for turning. Grinding lathe tool bits is a bit of an art. It takes some practice to get good at it. You need to create a cutting edge that is sharp, extends out so that the cutting edge and not the side of the tool contacts the work, but that still has enough support to maintain sufficient strength to cut metal. Before diving in, there are some terms you need to understand. The illustration below shows these terms.

First, notice that there are two cutting edges on the tool bit. There is a cutting edge on the end of the tool bit called the front cutting edge. There is also a cutting edge on the side of the tool. There are typical rake and clearance (relief) angles for HSS tool bits.

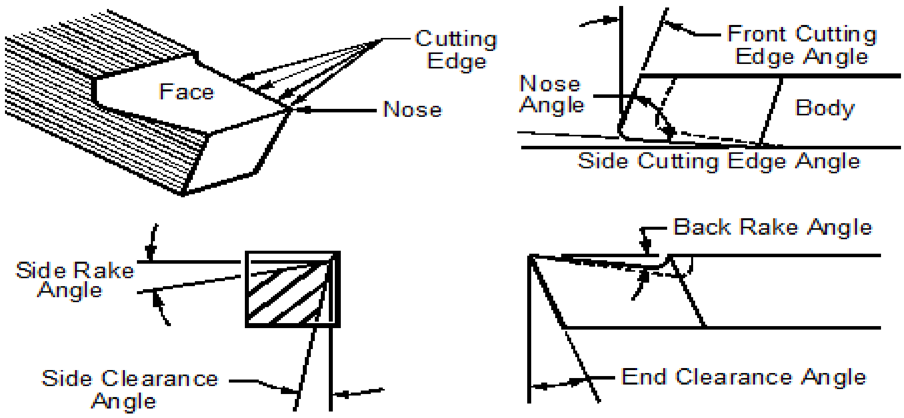


Figure. 2.1 Tool bit nomenclature

Cutting tool is a wedge shaped and sharp-edged device that is used to remove excess layer of material from the work piece by shearing during machining in order to obtain desired shape, size and accuracy. It is rigidly mounted on the machine tool. A relative velocity between work piece and cutting tool is also provided by various mechanical and other arrangements for cutting action. Cutting tool is basically the cutter used in machining operation. Various machining operations utilize different cutters and thus various names are available for these cutters based on the application. A list of commonly used cutting tools is provided below.

- ❖ **Single point turning tool**: -cutter for turning operation performed in lathe
- ❖ **Drill**: -cutter for drilling operation performed on drilling machine or lathe or milling machine
- ❖ **Milling cutter (or mill)**: -cutter for milling operations performed on milling machine

- **Fly cutter**: -cutter for fly milling operation performed in milling machine
- **Shaper**: -cutter for shaping operation performed in shaping machine
- **Planer**: -cutter for planning operation performed in planning machine
- **Boring bar**: -cutter for boring operation performed in drilling or boring machine
- **Reamer**: -cutter for reaming operation performed in drilling machine
- **Broach**: -cutter for broaching operation performed in broaching machine
- **Hob**: -cutter for hobbling operation performed in hobbling machine
- **Grinding wheel**: -abrasive cutter for grinding operation performed in grinding machine.

2.1.1 Classification of cutter

Cutting tools can be classified in various ways; however, the most common way is based on the number of main cutting edges that participates in cutting action at a time. On this basis, cutting tools can be classified into three groups as given below.

- **Single point cutting tool**: - such cutters have only one main cutting edge that participate in cutting action at a time. Examples include turning tool, boring tool, fly cutter, slotting tool, etc.
- **Double point cutting tool**: - such as the name implies, these tools contain two cutting edges that simultaneously participate in cutting action at a pass. Example includes drill (common metal cutting drill that has only two flutes).
- **Multi-point cutting tool**: - These tools contain more than two main cutting edges that can simultaneously remove material in a single pass. Examples include milling cutter, broach, gear hobbling cutter, grinding wheel, etc.

2.1.2. Sharpening cutting tools

Almost all milling cutters including straight and helical teeth are able to Be reconditioned using tool and cutter grinding machine.

A. Procedures for grinding a plain milling cutter

- selects the correct wheel for the job. True it with a diamond tool.
- mounts the cutter on a suitable arbor and places the unit between centers.
- mounts the tooth rest to the wheel head. Position the edge about 6 mm above the center line of the grinding wheel, this will produce a 5-to-6-degree clearance angle on the cutting edge of a 1.5 mm diameter cutter. Adjust to suit the cutter being ground.

2.1.3 Grinding Tool Bits

Bench grinder is used to sharpen your tool bits. Even an inexpensive bench grinder can do a good job grinding lathe tool bits. In some cases, you might want to purchase a higher quality fine grit wheel.

Keep a small cup of water near your grinder. Grinding generates heat, which can cause two problems. The tool bit will become too hot to hold. Overheating can also affect the heat treatment of the tool bit, leaving the cutting edge soft. Use a protractor to measure the angles. They are not super-critical, but you should try to stay within one degree of the recommendations.

❖ **Grind the Front Relief**

The first step in creating a tool bit is to grind the front relief. For most work, a relief angle of 10° works well. While you are grinding the front relief, you are also creating the front cutting-edge angle. Make this angle about 10° also, so that the corner formed by the front cutting edge and the side cutting edge is less than 90°.

❖ **Grind the Left Side Relief**

Form the left side relief next. Again, create about a 10° angle. You don't need to form a side cutting angle. The side cutting edge can be parallel to the side of the tool blank.

❖ **Grind the Top Rake**

The top of the tool bit is ground at an angle that combines the back rake and the side rake. The side rake is most important, because the side cutting edge does most of the work. For cutting steel and aluminum, the side rake should be about 12° and the back rake should be about 8°. For cutting brass, the rake angles should be much less, or even 0°.

❖ **Round the Nose**

A small nose radius allows you to turn into tight corners. A large nose radius produces better surface finishes. Create a nose radius that is appropriate for the tool bit you are creating.

2.2. Appropriate machines tools

Appropriate selection of tool holder and the method of mounting 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 chip flow and cutting fluid

A. 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

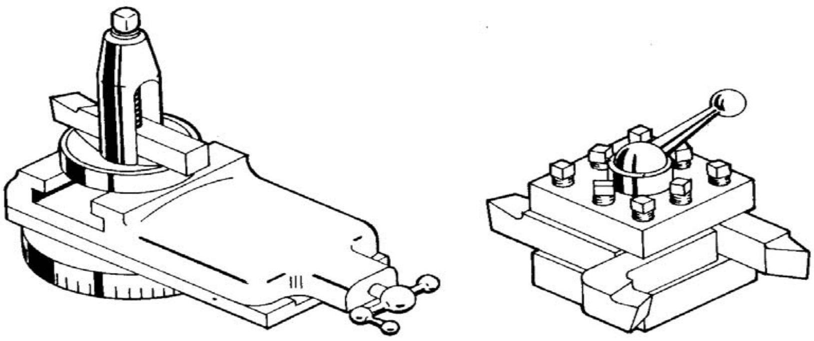
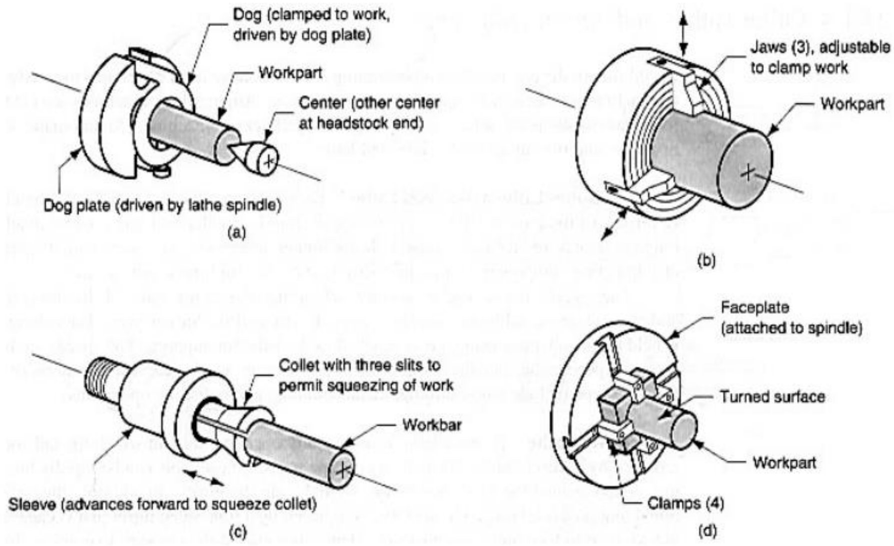


Figure. 2.2 Tool post

B. 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.
- **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 c**onsists 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.
- **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. 2.2 chuck

C. Mounting a Work on milling machine

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.

2.2.1 Tool holding device

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.
- **drill socket**s used when the hole in the spindle of the drill press is too small for the taper shank of the drill.

2.2.2. 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.

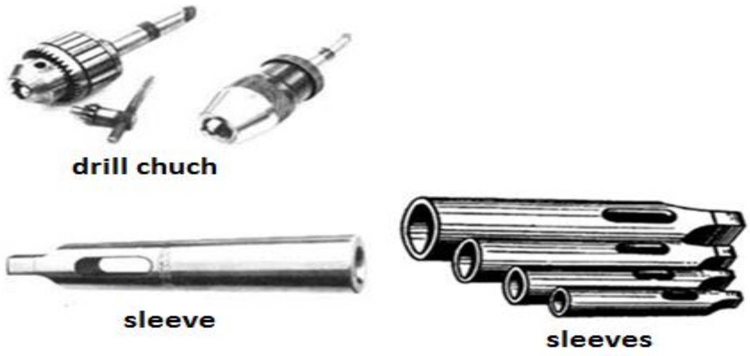


Figure. 2.3 Sleeve

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.

Arbor, Adapter,shell end mill arbor, sleeve

Figure. 2.4 Arbor

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

2.2.3 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. Having only three jaws, the chuck cannot be used effectively to hold square, octagonal, or irregular shapes. to the independent chuck 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 workplaces. 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, workplaces can be gripped either externally or internally. The independent chuck can be used to hold square, round, octagonal, or irregularly shaped workplaces 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 workplaces which must be held with extreme accuracy.

The drill chuck 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 workplaces. 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 workplaces to within 0.002 or 0.003 inch when firmly tightened.

2.2.4 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

A. 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

B. 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.

C. 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.

D. 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

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.

2.3. Accessors and machine guards

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.

A. Adjusting Centers.

- ❖ There are two types of centers i.e., live center and dead center**.**
- ❖ A center which fits into the headstock spindle and revolves with the work is called live center.
- ❖ The center which is used in a tailstock spindle and does not revolve is called dead center.

Figure. 2.5 Live center and dead center

B. Adjusting Chucks.

- ❖ It is an important device used for holding and rotating the work piece in lathes.
- ❖ The work pieces which are too short to be held between centers are clamped in a chuck.

- It is attached to the lathe spindle by means of two bolts with the back plate screwed on to the spindle nose.
- There are many types of the chuck, but the following two are commonly used.

C. 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.

Figure. 2.5 3 jaw chuck lathe machine accessories

D. Four jaw independent chuck.

Figure. 2.5 4 jaw chuck lathe machine accessories

E. Adjusting Lathe dog or carrier

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**.** This is engaged with a pin attached to the drive plate or face plate.

Figure. 2.6 lathe dog

F. Adjusting Drive plate

- ❖ 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.
- ❖ 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.

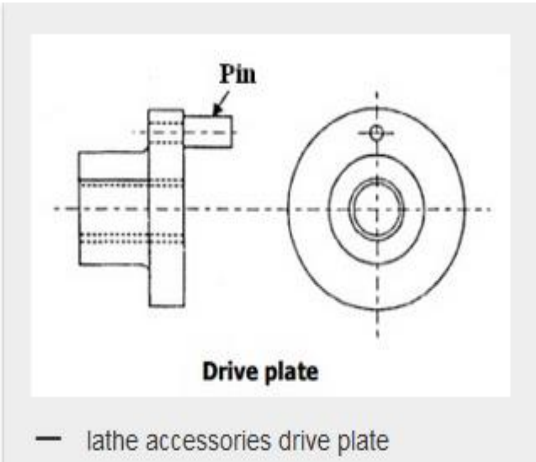


Figure. 2.6 Drive plate

G. Adjusting Face plate.

- ❖ The face plate, as shown in Fig. is similar to drive plate except that it is larger in diameter.
- ❖ 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.
- ❖ The face plate is used for holding work pieces which cannot be conveniently held in a chuck.

Figure. 2.6 Face plate

H. Adjusting Angle plate

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

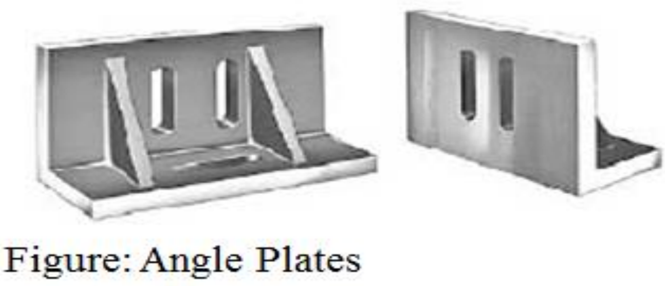


Figure. 2.7 Angle plate

Adjusting Mandrels

- 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.
- 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.

— Lathe Mandrels

Figure. 2.7 Lathe mandrels

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 s**teady rest (also called a steady, a fixed steady, a center rest, or sometimes, confusingly, a center)**.

— a steady rest

Figure. 2.8 steady rest

I. Adjusting Machine vices

- 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 devise used on the machines.

Machine Vise

Figure. 2.9 Machine vise

2.3.1 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.

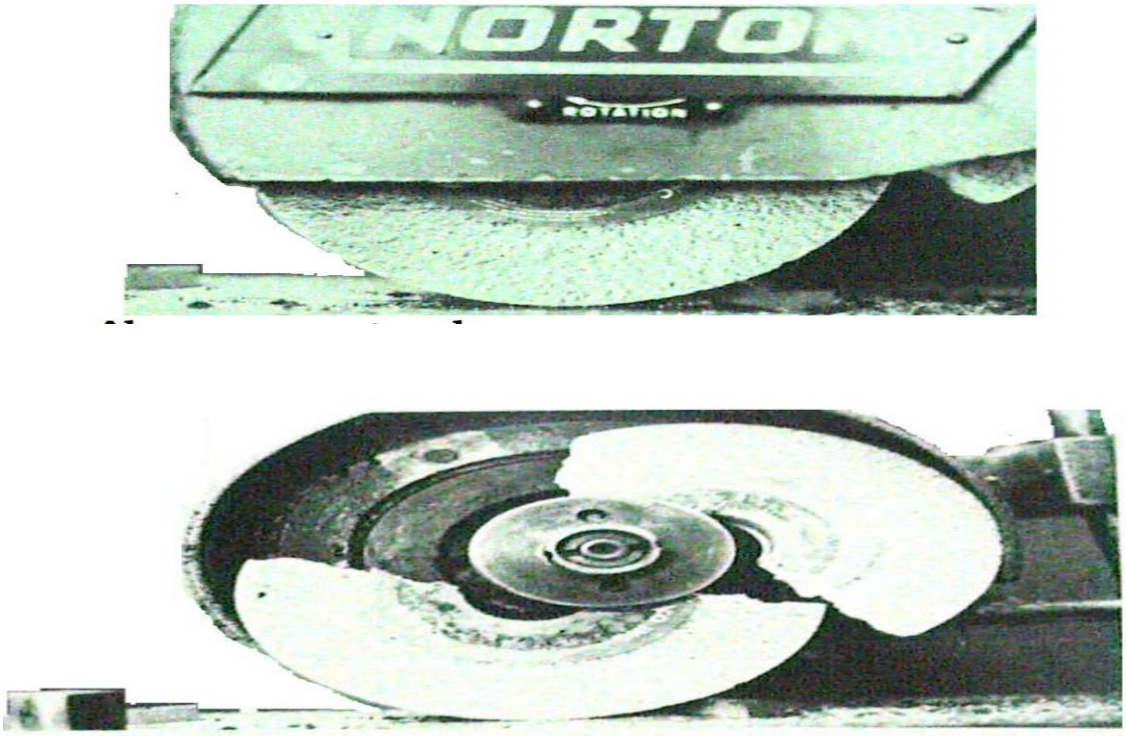


Figure. 2.10 Machine guard

2.4 Speed and Feed

When a cutting tool is applied to a work piece, its motion relative to the work piece has two components: -

- The motion resulting from the primary motion of the machine tool, which is called the cutting speed.
- The motion resulting from the feed motion of the machine tool, which is called, feed speed. The resultant of these two motions is called the resulting cutting motion.

Cutting speed (V)

The cutting speed is the distance traveled by the work surface in a unit of time in relation to the cutting edge of the tool. In other words, it is the speed at which the circumference of the work passes the tool bit.

Feed

Feed refers the ratio of the distance that the cutting tool is distanced in the direction of feed motion to full rotation of the work. Generally, feed is the distance the cutter moves during one revolution of the work. The cutting tool may be feed manually or automatically along the work while machining.

A longitudinal feed is when the tool travels in a direction parallel to the work axis. A cross feed is when the tool travels in a direction perpendicular to the work axis.

Depth of cut (t)

The depth of cut is the thickness of the layout of metal removed in one cut, or pass, measured in a direction perpendicular to the direction of the feed motion. In turning with axial (longitudinal) feed, depth of cut is measured the decrease in diameter. In radial (facing) feed, depth of cut is measured the decrease in length.

In turning cylindrical surfaces depth of cut (t) can be found by: - $t = \frac{D-d}{2}$

Where D- diameter of the work piece

d- Diameter of machined surface.

The cutting speed (V) can be found by: -

$$V = \frac{\pi DN}{1000} \text{ m/min}$$

Where: - D-work diameter in mm for lathe machine and diameter of cutting tools for drilling and milling machines.

N- Rotational frequency of the work in rev/min

Example: -

1. Calculate the speed of rotation of the machine if the diameter of the work piece is 50 mm and the cutting speed of the tool is 45 m/min

   $N = \pi D$

   3.14x50mm

   N= 286 r / min

2. As the above speed of rotation of the machine and cutting speed of the tool the Diameter of the work decrease in to 46mm. Calculate the depth of cut.

   $$t = \frac{D-d}{2} \longrightarrow \frac{50mm - 46mm}{2} \longrightarrow \frac{4mm}{2} = 2mm$$

   t=2mm

3. According to question number two the final diameter of the work piece is 44mm and r/min of the machine is the same, calculate the cutting speed of the tool.

$$V = \frac{\pi DN \text{ m/min}}{1000} \qquad \frac{3.13 \times 44\text{mm} \times 286 \text{ r/min}}{1000\text{mm}} \qquad \frac{39515}{1000}$$

V= 39.50 m/min

For milling machine

Spindle Speed

Spindle speed in revolution per minute (R.P.M.) for the cutter can be calculated from the equation: -

$$N = \frac{CS \times 1000}{\pi d}$$

Feed Rate calculation

Feed rate (F) is defined as the rate of travel of the workpiece in mm/min. But most tool suppliers recommend it as the movement per tooth of the cutter (f). Thus,

F = f. u. N

Where---- F = table feed in mm/min

Table: 2.1 Cutting speed and feed rate for some common material

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

2.5 Set-up Operation

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.

2.5.1 LATHE MACHINE OPERATION

General operations on the lathe include straight and shoulder turning, facing, grooving, parting, turning tapers, Boring and cutting various screw threads

- Facing: -Reducing the length of a shaft by lathe cutting tool.
- Turning; It`s reducing the diameter of a shaft. It is two kinds: -
  - ✓ Straight turn or cylindrical and
  - ✓ Tapper turns: - when it increases or decreases in diameter at a uniform rate.

There are four kinds of tapper making

- By using form tool: -This technique is limited to the production of short tapers
- Taper turning with compound rest:

This is given by: -

$$\tan\Theta = \frac{D - d}{2l}$$

where. D= large diameter
d= small diameter
l = tapper length

A. To face a work piece:

- Put a tool bit in the tool holder and adjust the cutting edge to center height.
- Angle the tool so that the side cutting edge forms an acute angle with the face of the work piece.

- Move the carriage to the right so that the tool bit is past the right end of the work piece.
- Ensure that the power feed forward/neutral/reverse lever is in the neutral position.
- Push down on the power feed lever until the half nuts engage. You might have to move the carriage slightly so the half nuts will engage.
- Turn the lathe on. Adjust the speed to an appropriate speed for the

B. STEPS IN FACING OPERATION

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

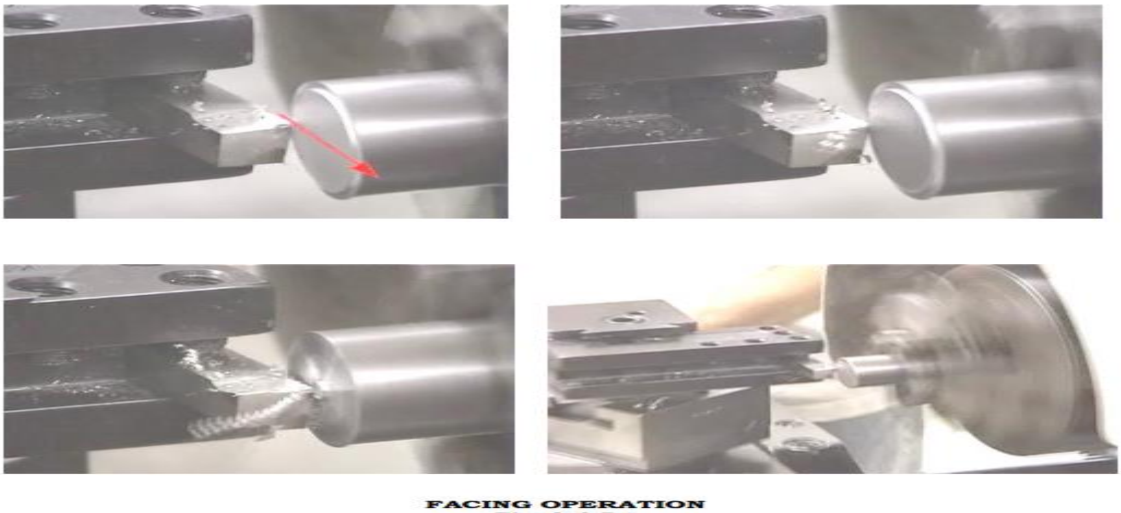


Figure. 2.11 steps in facing operation

Turning

Turning is a form of machining, a material removal process, which is used to create rotational parts by cutting away unwanted material. The turning process requires a turning machine or lathe, work piece, fixture, and cutting tool. The work piece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to the turning machine, and allowed to rotate at high speeds. The cutter is typically a single-point cutting tool that is also secured in the machine, although some operations make use of multi-point tools. The cutting tool feeds into the rotating work piece and cuts away material in the form of small chips to create the desired shape

There are several methods of turning angles or tapers.

For large angles of short length, such as a chamfer, turn the compound rest to the angle you want. Advance the tool across the work with the compound rest, and advance the tool into the work with the cross slide or the carriage. you can use the same method for small angles (usually called tapers) of a length less than the compound rest travel. For longer tapers, the work is usually placed between centers with the tail center offset from the centerline of the lathe. Choose a tool bit with a slightly rounded tip, this type of tool should produce a nice smooth finish. For more aggressive cutting, if you need to remove a lot of metal, you might choose a tool with a sharper tip. Make sure that the tool is tightly clamped in the tool holder.

Adjust the angle of the tool holder so the tool is approximately perpendicular to the side of the work piece. Because the front edge of the tool is ground at an angle, the left side of the tip should engage the work, but not the entire front edge of the tool. The angle of the compound is not critical; I usually keep mine at 90 degrees**.**

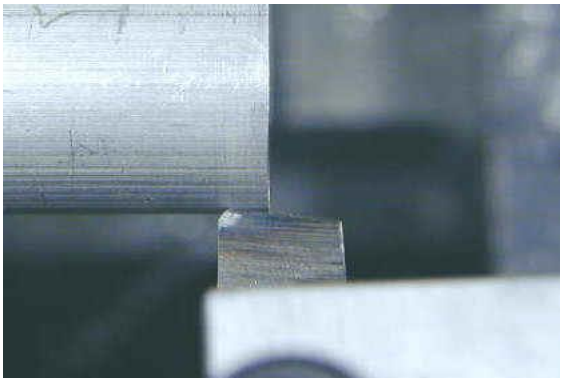


Figure. 2.12 turning operation

PARTING OPERATIONS

Parting is the operation of cutting off material after machining. This is one of the most difficult jobs performed on a lathe. The cutting tool must be ground with the correct clearance (front, side, and end).

KNURLING OPERATION

It is the process that forms horizontal or diamond shaped serrations on the circumference of the work to provide a gripping surface. It is done with knurling tool that is mounted in the lathe tool post. The Knurl pattern is raised by rolling the Knurl pattern against the metal to raise the surface STRAIGHT and DIAMOND PATTERN KNURLS.

How to Use a Knurling Tool

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

- ❖ Mark off the section to be knurled.
- ❖ Adjust the lathe to a slow back gear speed and a fairly rapid feed.
- ❖ 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.
- ❖ 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.

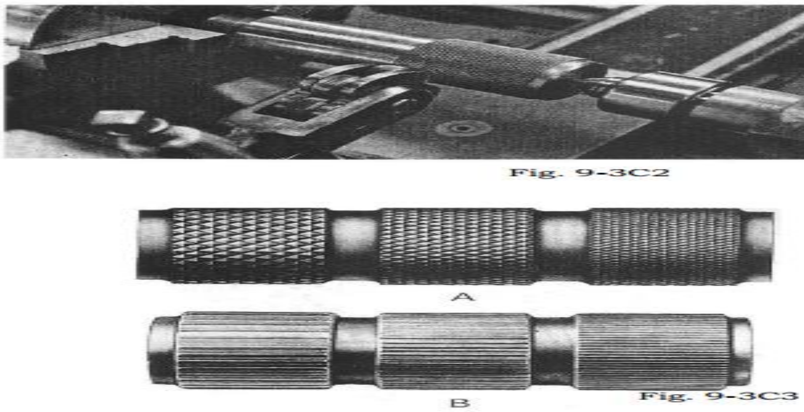


Figure. 2.13 Knurling operation

Screw Threads Operations

A screw thread is a spiral ridge formed on a straight cylinder or tapered cylindrical surface. The thread may be on an external on internal surface.

Parts of a Screw Tread

- ❖ **Major Diameter**. It is the largest diameter of a straight external or internal thread.
- ❖ **Pitch Diameter**. It is the distance between diametrically opposite points on straight thread; it is equal to the major diameter minus one fourth.

- **Minor Diameter**. It is the smallest diameter of straight external or internal threads.
- **Pitch.** It is the distance from a point on one thread to a corresponding point on the next thread measured parallel to the axes.
- **Flank**. It is the surface connecting crest and root.
- **Root**. It is the bottom surface joining the flanks of adjacent threads. The root diameter is the same as the minor diameter.
- **Crest**. It is the top surface of the thread bounded by the flanks.
- **Thread Angle**. It is the included angle between the flanks of adjacent turns of the thread.
- **Depth.** It is the perpendicular distance between the root and crest of the thread.
- **Lead Angle**. It is the angle which the spiral makes which its axis. The lead angle is determined by the lead and pitch diameter of the thread.
- **Lead**. It is the distance a thread surface moves parallel to the axis of the thread during one complete revolution.
- **Hand**. It is the direction in which the thread is turned to advance. A right hand is turned clockwise to advance. A left-hand thread is turned anticlockwise to advance.
- **Clearance**. It is a space left between the mating external and internal threads of facilitate easy rotation of threaded parts.

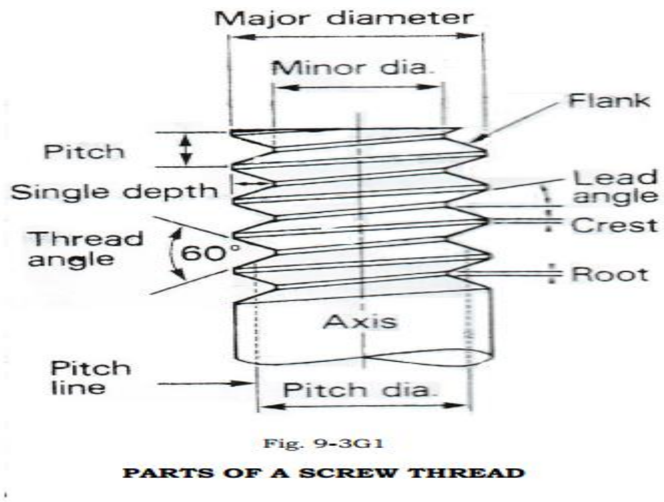


Figure. 2.13 Thread

MILLI NG MACHINE SETUP

Milling machine setups is necessary

- To prolong the life of a milling machine and its accessories and
- To produce accurat work,

This includes

- Prior to mounting any accessory , check that machine surface are free Of dirty and chips.
- Do not palce the tools cutters or parts on the milling machine table.
- When mounting cutters be sure to use keys on all but slitting saws.
- Check that the arbor spacers and bushings are clean and free of burrs.
- When tightening the arbor nut take care to make it only hand tight with a
- When work is mounted in a vise, tighten the vise securely by hand and tap it into place with a lead or soft faced hammer.

SELF CHECK 2

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

1. . In lathe machine boring tool is mounted on____?
   A. Cross slide B. Tool posts C. Box D. None
2. In drilling machine straight shank drill bit is mounted on?
   A. Drill chuck B. sleeve D. Arbor D. socket
3. It is used when the hole in the spindle of the drill press is too small for the taper shank of the drill.
   A. Drill chuck B. sleeve D. Arbor D. socket
4. It is used for mounting drills or other tapered - shank tools in the main spindle of the machine or the vertical milling attachment.
   A. Arbor B. Collet adapter C. Shell end mill arbor D. Chuck
5. Write the two cutting edges on the end of the tool bit? (2 Points)
6. A large nose radius produces better for _____? (1point)
   A. Cutting large amount B. Good surface finish C. Rough cutting D. All
7. List the six angles of turning tools? (6pints)
8. A 60° angle cutting tool used for___? (1point)
   A. Parting B. Threading C. Grooving D. Turning
9. One of the following is not holding work pieces in lathe machine
   A. Chucks B. Rests C. Mandrels D. Face plate E. None
10. ----------- Centre is fitted on the headstock spindle and rotates with the work
    A. Live B. Dead C. Rests D. Face plate
11. A cutting tool in a lathe work is the distance the tool advances for each revolution of the work is called-------.
    A. Feed B. cutting tool C. depth of cut D. all are correct
12. The distance travelled by a point on a milling cutter in one minute is known as
    A. cutting speed B. depth of cut C. spindle speed D. feed
13. The most important factors that affecting the efficiency of a milling operation are?
    A. cutting speed B. depth of cut C. Feed D. All of the above
14. ---------- The amount of tool advancement per revolution of the job parallel to the surface being machined.

A, Feed B, cutting speed C, depth of cut D, all

15. --------- The feed rate used on milling machine depends up on

a) The depth and width of cut b)The design or type of cutter

c) The sharpness of the cutter d) all

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

a) Cutting speed b) feed C) depth of cut d) none

17. -------- It is the distance in inches/ or (mm/min) that the work moves

a) Cutting speed b) feed C) depth of cut d) none

Directions: If the statement is correct say TRUE, if the statement is not correct say FALSE

1. In lathe machine boring tool is mounted on tool post
2. In drilling machine straight shank drill bit is mounted on drill chuck
3. Sleeve is used when the hole in the spindle of the drill press is too small for the taper shank of the drill.
4. Cutting speed is the most important factors that affecting the efficiency of a milling operation

Directions II Short Answer Questions

1. A shaft of diameter 85 mm is assumed to be turn on a lathe machine, The RPM of the spindle is adjusted to have 850rev/min for turning the project of the given specimen Calculate the cutting speed of the metal.

2. 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.

***Note:* Satisfactory rating - 25 points Unsatisfactory - below 25 points**

Answer Sheet

Score = ____________

Name: ___________________________ Date: ________________

Operation Sheet 2.1	Sharpening of HSS cutter for turning operation

Operation Title; Sharpening of HSS cutter for turning operation

Instruction: Sharpening HSS cutter by following the correct procedure

Purpose; the purpose is to understand the way to sharpening the HSS cutter

Required tools and equipment

HSS Cutter, Grinder machine, coolant

Precaution

Use personal protective equipment and follow the work shop safety rule

Procedures

Step 1- Dressing the grinding wheel

Step 2- Look up the typical angles for the work piece material

Step 3- Dip the tool in coolant frequently to keep it from overheating and annealing

Step 4- set tool rest angle on grinding wheel

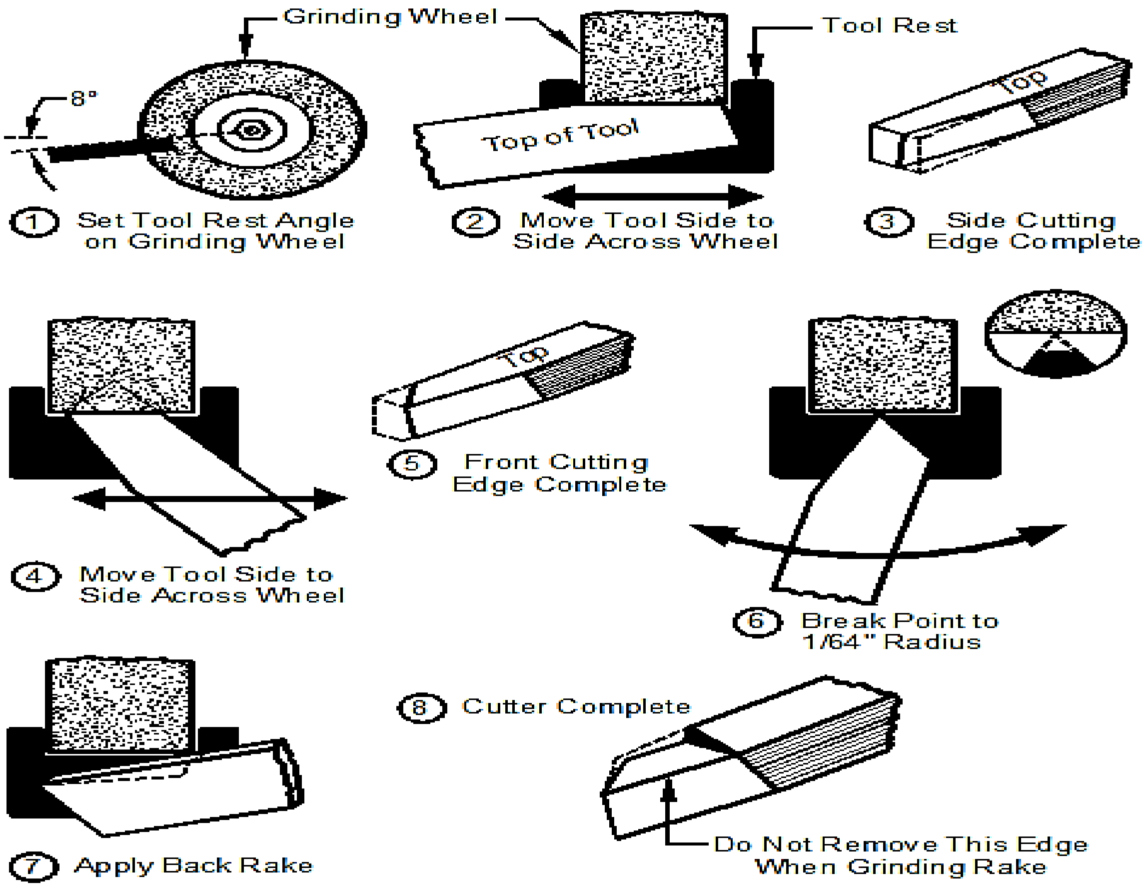
Step 5- Move tool size to side across wheel

Step 6- Complete grinding of side cutting edge

Step 7- Complete grinding of front cutting edge

Step 8- Grind or make rake angle

Quality criteria: follow the rule of HSS cutter sharpening



Grinding Wheel
Tool Rest
8°
Top of Tool
Top
1 Set Tool Rest Angle on Grinding Wheel
2 Move Tool Side to Side Across Wheel
3 Side Cutting Edge Complete
4 Move Tool Side to Side Across Wheel
5 Front Cutting Edge Complete
6 Break Point to 1/64" Radius
7 Apply Back Rake
8 Cutter Complete
Do Not Remove This Edge When Grinding Rake

Operation Sheet 2.2	Adjust the cutter and the work pieces on Milling machine

Operation Title; Adjust the cutter and the work pieces on Milling machine

Instruction: prepare the work piece and cutter and adjust according to standard

Purpose: the purpose is to understand the way adjust the tool and workpiece

Required tools and equipment;

cutter, workpieces milling machine, PPE

Precaution Use personal protective equipment and follow the work shop safety rule

Procedures

Step 1- check the functionally of the milling machine

Step 2- Mount the cutter in the center of arbor.

Step 3- Hold the work piece on universal vise than tighten

Step 4- Move the knee upward the cutter and to touch the work piece

Step 5- Than align the cutter and the work pieces

Step 6- Check the work pieces straight from the tip point of cutter

Quality criteria follow the rule of Adjusting the cutter and workpieces

Operation Sheet-2.3	Adjust the cutter and the work pieces on lathe machine

Operation Title; Adjust the cutter and the work pieces on lathe machine

Instruction: prepare the work piece and cutter and adjust according to standard

Purpose: the purpose is to understand the way adjust the tool and workpiece

Required tools and equipment;

cutter, workpieces, lathe machine, PPE

Procedure

Step 1- check all parameters found in lathe machine

Step 2- Insert the dead center into lathe tailstock of hollow spindle

Step 3- Mount the cutter in tool post

Step 4- Align the tip of cutter with the dead center

Step 5- Hold the work piece in the lathe machine chuck and check the alignment by centered cutter

Step 6- Check the work pieces out of center from the center by touching the tip of your cutter

Quality criteria follow the rule of Adjusting the cutter and workpieces

LAP Test	**Practical Demonstration**

Name: _______________________________ Date: _________________

Time started: __________________________ Time finished: _________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2:00 hours.

Task 1. Grind or sharpen HSS Cutting tools for turning and facing operation

Task 2. Center the cutter and the work pieces on lathe machine.

Task 3. Adjust the cutters and the work pieces on milling machines

Unit Three: Perform Machine operation

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

1. Clamp devices
2. Basic Machine

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:

1. Mount and secure clamp devices
2. Operate machine

3.1 Mount and secure clamp devices

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

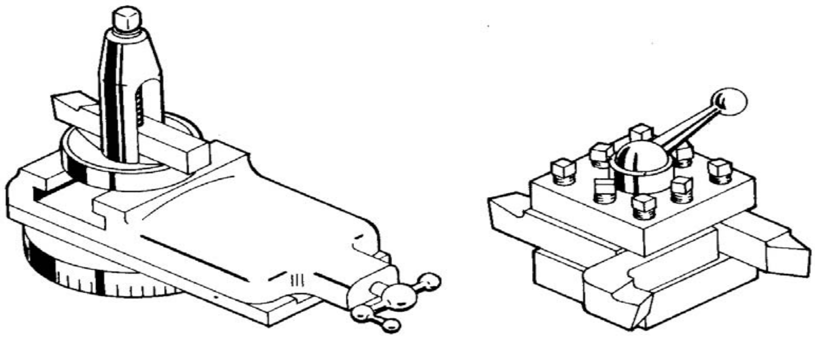


FIGURE 3.1 holding the cutting tool

3.1.1 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 socket.

- **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.
- **drill socket**s used when the hole in the spindle of the drill press is too small for the taper shank of the drill.

A. Methods of mounting and securing work on clamping devices

- Clamping a Work piece To the Table
- Clasping a Work piece to the Angle Plate.
- Clamping Work pieces in Fixtures.
- Holding Work pieces Between Centers.

❖ Holding Work pieces in a Chuck

3.2 Operate machine

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.

A. 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*

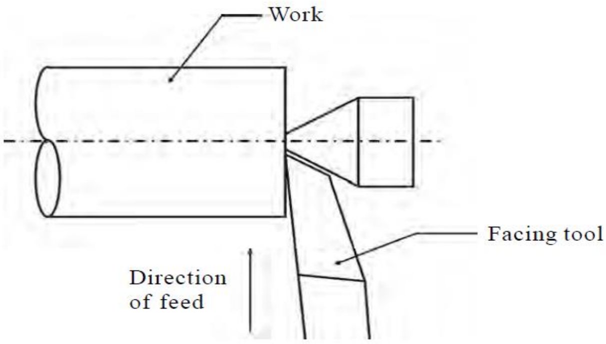


Figure 3.1 Facing

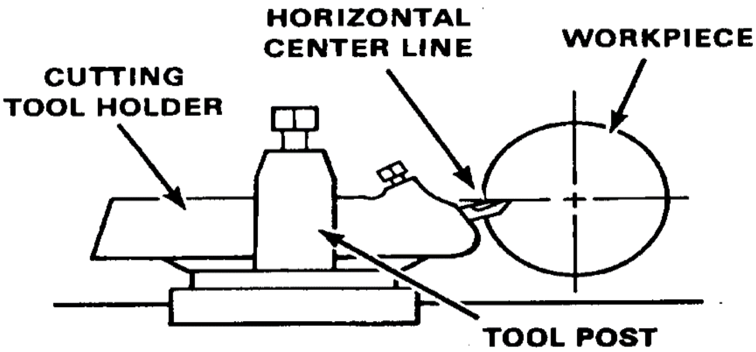


Figure 3.2 Facing Work between Centers

B. Turning

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

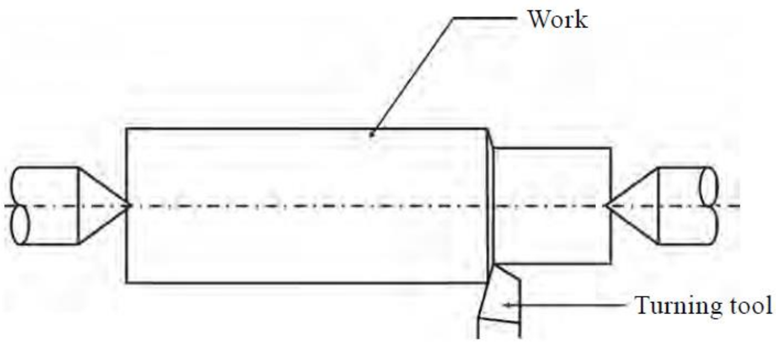


Figure 3.3 Turning

ECCENTRIC TURNING

- If the off-center size is begging 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.

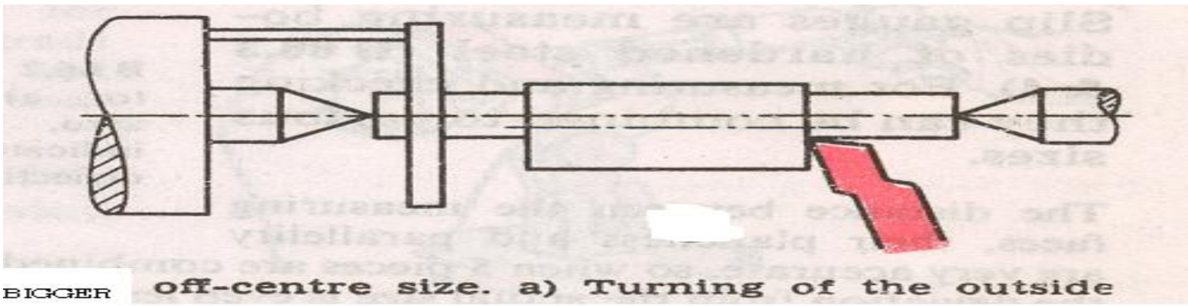
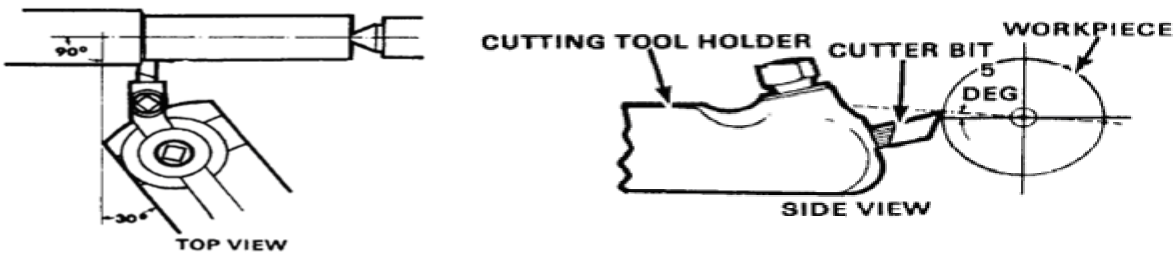


Figure 3.4 Ecentric Turning

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.



C. Taper

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

❖ **Taper turning methods**

- ✓ Form tool method
- ✓ Compound rest method
- ✓ Tailstock set over method
- ✓ Taper turning attachment method

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.

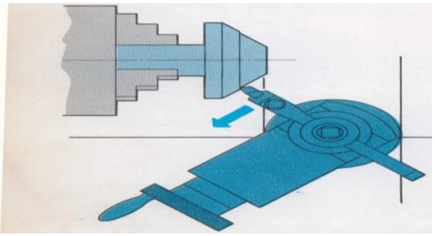


Figure 3.4 Taper Turning

Grooving and parting operations

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.

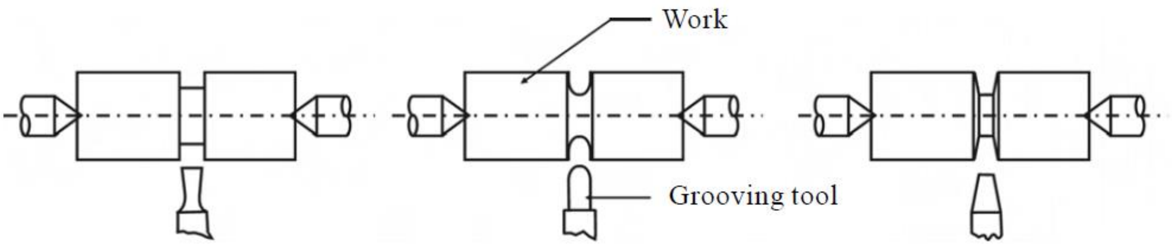


Figure 3.5 parting operation

D. KNURLING:

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.

E. 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.

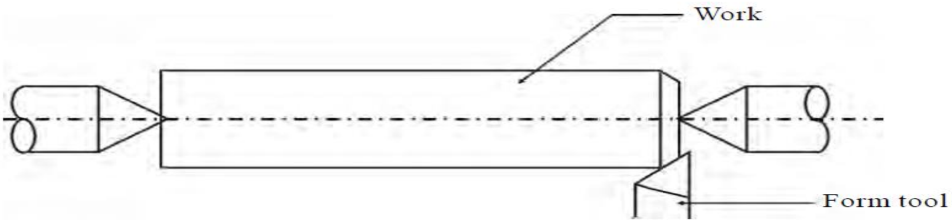


Figure 3.6 Chamfering

F. 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.

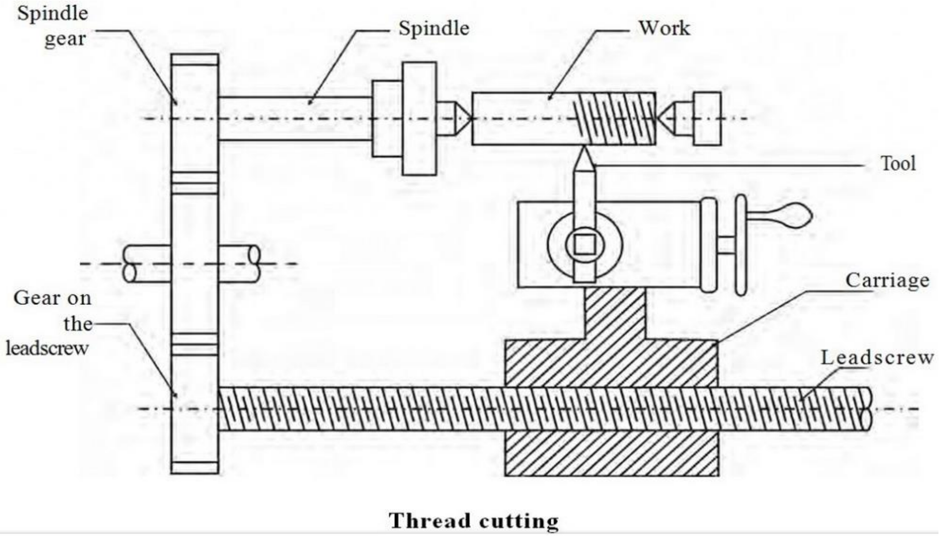


Fig 3.6 thread cutting

SELF CHECK 3

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

1. ----------------- is to remove excess material from the work piece to produce a cylindrical surface of required shape and size
   A. Tuning B. Facing C. Taper **D**. Knurling

2. Operations which is not on the lathe include
   A. straight and shoulder turning,
   B. facing,
   C. grooving,
   D. parting,
   E. turning tapers,
   F. None
3. which working condition of the lathe will determine
   A. speed,
   B. feed,
   C. Depth of cut
   D. All of the above
4. Depth of cut depends up on
   A. cutting speed,
   B. rigidity of machine and
   C. Tool material.
   D. All of the above
5. 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 tappers 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

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

1. Write the two common methods of aligning the vise with the machines?
2. Write in detail about work holding device

Directions: If the statement is correct say TRUE, if the statement isn't correct say FALSE

1. 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.
2. Thread cutting is one of the most important operations performed in a lathe.
3. Knurling is the process of embossing a diamond shaped pattern on the surface of the work piece.
4. Turning in a lathe is to remove excess material from the work piece to produce cylindrical surface of required shape and size

Note: **Satisfactory rating - 25 points Unsatisfactory - below 25 points**

Answer Sheet

Score = ___________

Name: ___________________________ Date: ________________

Unit Four: Assure quality of finished components

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

1. Conformance of component
2. Measuring tool and equipment.
3. Standard deviation
4. Maintenance and inspection plan

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:

1. Check conformance of component
2. Use technique of Measuring tool and equipment
3. Handle Standard deviation
4. Carry out Maintenance and inspection plan

4.1. Conformance of component specifications

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.

A. Consequences of incorrect sharpening

- Reduce tool life
- Complete failure of cutting edge
- Bend easily the cutting tool

B. 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 you 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.

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

4.1.1 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 tool and equipment

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 thermography 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 is the requirements are met for each characteristic. Common examples of 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.

4.2.1 Measuring tools and equipment in checking conformance.

A. 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.

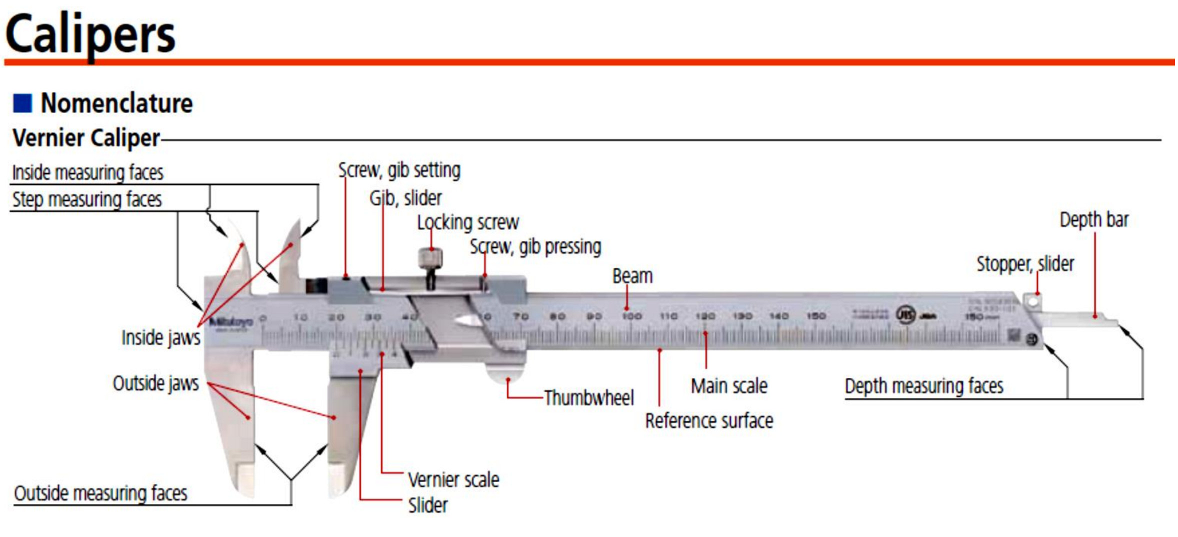


Figure. 4.1 outside caliper

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 X 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.

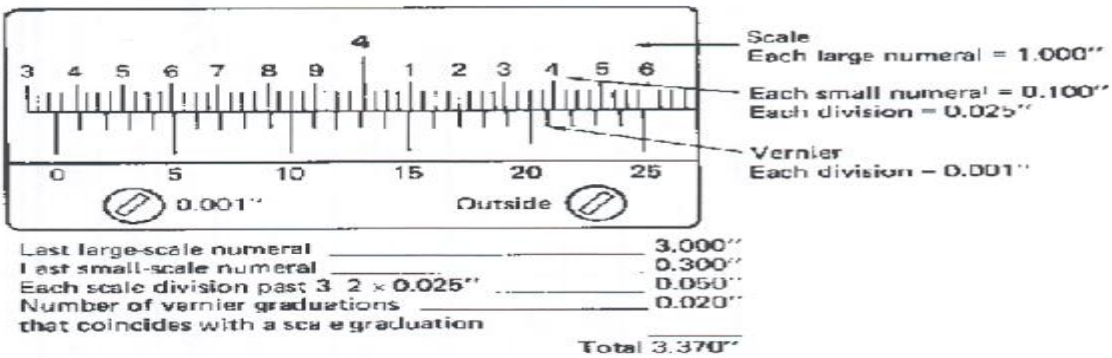


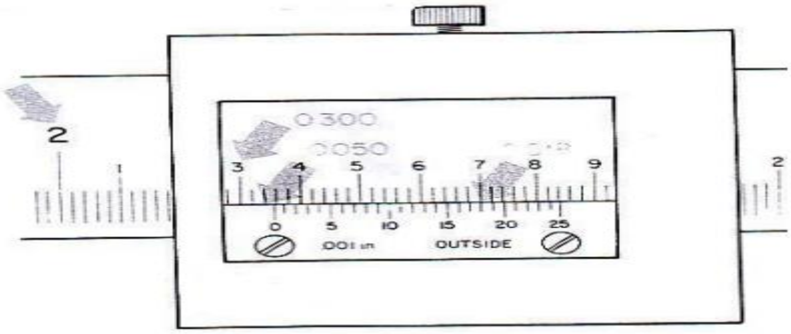
Fig. 6.1.7 Vernier Caliper

B. 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.

C. How to read Vernier Caliper

The zero mark on the vernier scale indicates the measurement to be read on the rule in Fig. 4.2.1. This is seen to be 1.425 in. and a little more. The exact amount over 1.425 is found by examining the division lines of the vernier scale to see which one exactly coincides with one of the lines on the rules. In this case it is line 11, so the full measurement is 10425 plus 0.011 which equals 1.436.



EXAMPLE the reading is composed of: The “0” line on the Vernier plate is between 2 and 3 on the beam = 2,000 Plus two 0.100 (1/10) Graduations = 0.200 Plus one 0.050 (1/20) Graduations = 0.050 Plus fifteen 0.001 (1/1000) Graduations = 0.015 Total reading = 2.368 in.

D. 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.

- ❖ Hold the plastic insert to prevent thermal expansion.
- ❖ Keep the measuring faces square with the surfaces that you are measuring, to ensure an accurate measurement.
- ❖ Turn the thimble until the faces touch the work.
- ❖ 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.

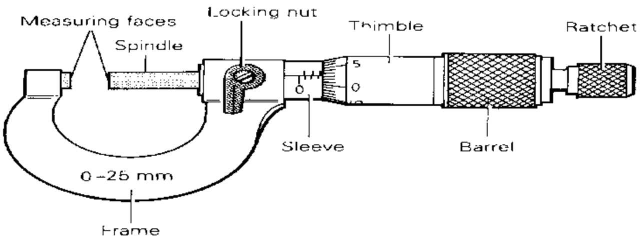


Figure 4.51 Outside micrometer.

Figure. 4.2 outside micrometer

The reading in Figure 4.52 is

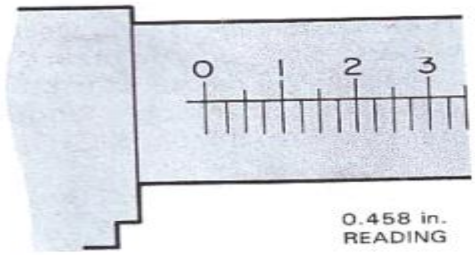
- ✓ Upper main scale 12.00 mm
- ✓ Lower main scale (no half mm) 0.00 mm
- ✓ Circular thimble scale 0.13 mm
- ✓ 13 X 0.01 mm = 0.13mm
- ✓ Total reading 12.13 mm

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

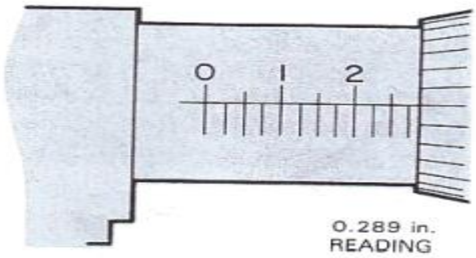
- ❖ Make sure that you store the micrometer away from dust.
- ❖ Always clean the measuring faces for good results.
- ❖ Oil the micrometer regularly to avoid rust.
- ❖ Pack the micrometer in its box when not in use.
- ❖ Do not use force on the thimble or ratchet.

How to read micrometer?

To read micrometer, we multiply the number of vertical position visible on the sleeve by 25 and add the number of divisions on the bevel of the thimble from 0 to the line that coincides with the horizontal line of the sleeve.



EXAMPLE 1
Reading is composed of:
4 large graduation of 4 X 0.100 = 0.400
2 small graduation or 2 X 0.025 = 0.050
and 8 graduation on the
thimble or 8 X 0.001 = 0.008
Total reading = 0.458 in.



EXAMPLE 2
Reading is composed of:
2 large graduation of 2 X 0.100 = 0.200
3 small graduation or 3 X 0.025 = 0.075
and 8 graduation on the
thimble or 8 X 0.001 = 0.014
Total reading = 0.289 in.

Fig. 6.1.12

E. 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

- ❖ 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°.
- ❖ 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).

- Add the two values together to give the reading: 12° 15' For accurate readings take care when setting and reading the vernier protractor.

F. 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.

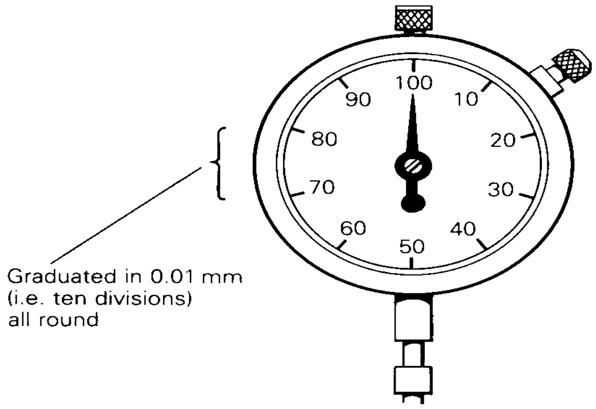


Figure 4.55 **The dial gauge.**

G. 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

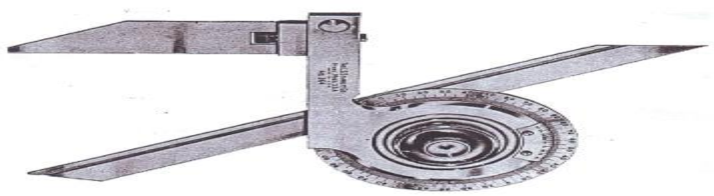


Fig. 6.1.8. Vernier Bevel Protractor

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

Fig. 4.4Vernier Bevel Protractor

4.3 Standard deviation

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

4.3.1 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

4.3.2 Errors in Measurement System

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 occur between both the measurements. Systematic Error / Random Error

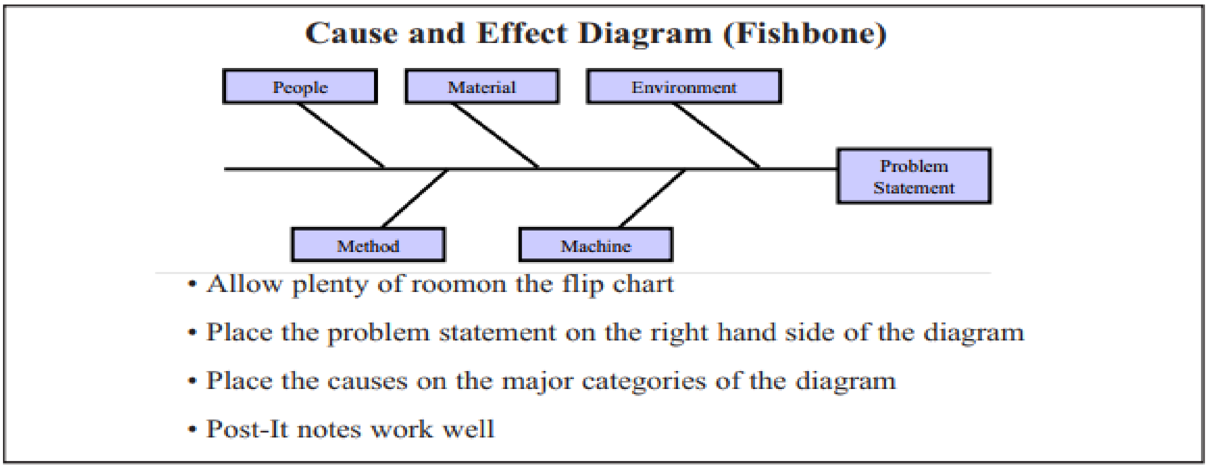
Examples

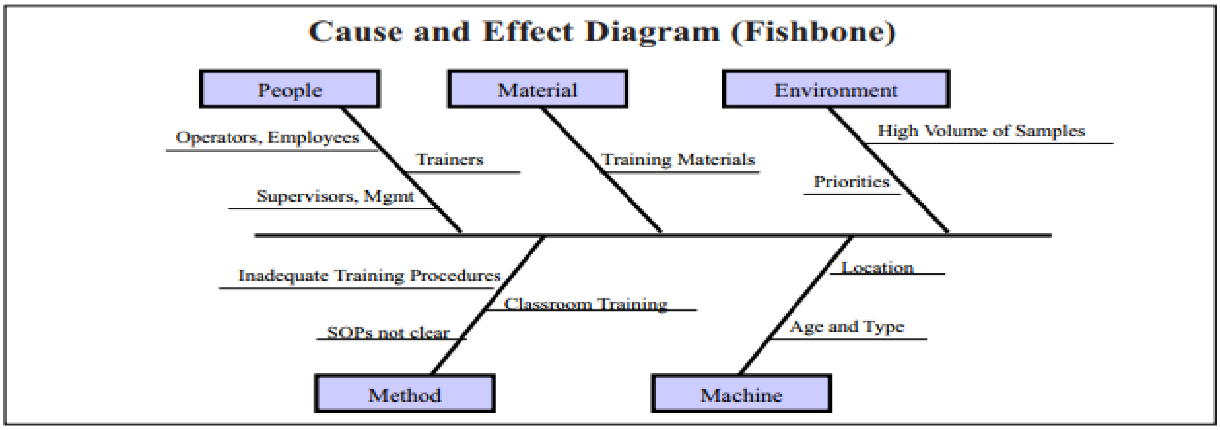
- ❖ A worn-out instrument: For example, a plastic tape measure becomes slightly stretched over the years, resulting in measurements that are slightly too high,
- ❖ An incorrectly calibrated or tarred instrument, like a scale that doesn't read zero when nothing is on it,
- ❖ A person consistently takes 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





4.4 Maintenance and inspection plan

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.

4.4.1 Purpose and objective of maintenance

The main purpose of maintenance in all industrial perspective is to reduce the business risks. In general, operation and maintenance are 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.

4.4.2 Routine maintenance

It 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. Routine maintenance is not necessarily need-based. In an 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”, i.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 railways 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.

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.

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

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

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

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

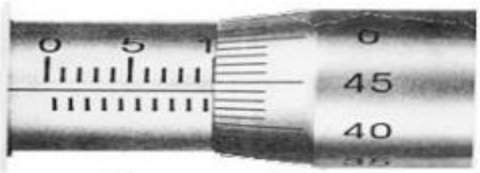
3. Component inspections allow on operation at final stages of the production process.

   A. True B. False

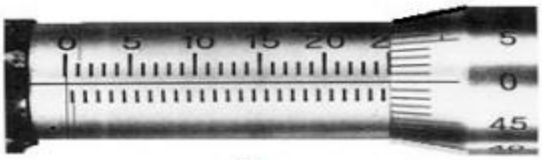
Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List the parts of Vernier caliper?
2. List the parts of Vernier Micrometer

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

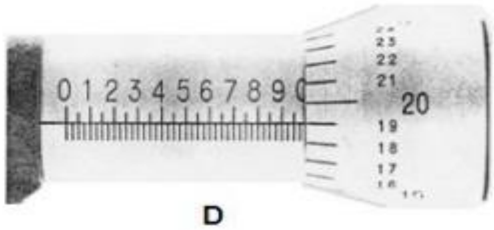


A



B

C



D

E

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

1. Write three examples for Errors in Measurement System?
2. Define deviations?

***Note:* Satisfactory rating - 5 points Unsatisfactory - below 5 points**

Answer Sheet

Score = ___________

Name: ____________________________ Date: _________________

Operation Sheet 4.1	Check for conformance of components

Operation Title: Check for conformance of components

Instruction: follow the rule and check the component

Purpose: the purpose is to understand the conformance of the components

Required tools and equipment

HSS cutter, Milling Cutter

Precautions: follow the workshop rule and use PPE

Procedures

Step 1- Establishing Standards and Methods for Measuring Performance

Step 2- Measuring the Performance

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

Step 4- Taking Corrective Action

Quality criteria; follow the standard quality of tool rule

Operation Sheet 4.2	Undertaking routine maintenance of the Machine

Operation Title: routine maintenance of the Machine

Instruction: follow the rule and check the machine

Purpose: the purpose is to understand the machine maintenance

Required tools and equipment

HSS cutter, Milling Cutter milling machine, lathe machine

Precautions: follow the workshop rule and use PPE

Procedure

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

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

Step 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

LAP Test	Practical Demonstration

Name: _________________________________ Date: __________________

Time started: ___________________________ Time finished: __________________

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

Task 1. Checking for conformance of the machined part

Task 2. Undertake routine maintenance of the machine

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