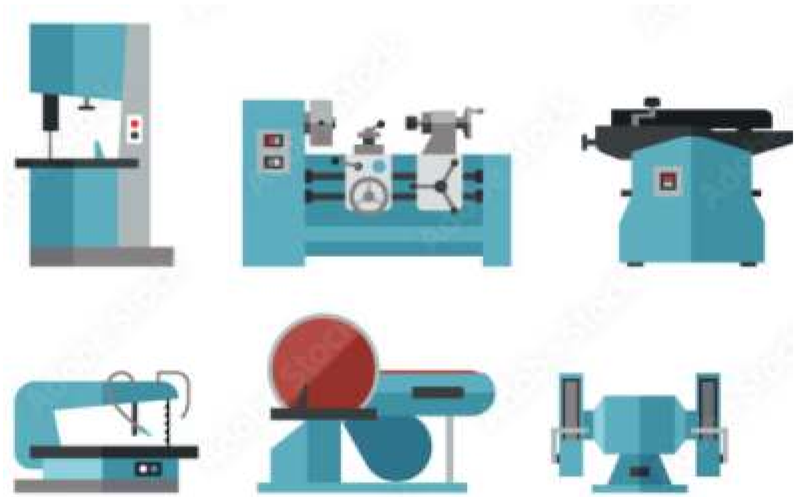
Mechanics

Level-I

Based on March 2022, Curriculum Version 1



Module Title: - Operating Basic Workshop Machinery

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Acknowledgment

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Acronym

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TTLM-Teaching, Training and Learning Material.

TVT – Teaching Vocational Training.

LAP**-** Learning Activity Performance.

HSS- High Speed Steels

Introduction to the Module

Basic Work Shop Machinery is an entry-level module on basic work shop machines in some forms of Technical Trainings in TVT Institutions. It is a short briefing on the basics of machine and tools selection, tools sharpening, tools mounting and positioning, machining speeds and feeds, work piece mounting and securing and clamping devices. This module is designed to meet the industry requirement under Mechanics Occupational Standard, particularly for the unit of competency: **Operate Basic Workshop Machinery.**

This module covers the units:-

- Machine Shop Occupational Health and Safety
- Job Requirements
- Machine Set-Up
- Machine Operations
- Quality assure for finished component

Learning Objective of the Module

- Apply machine shop occupational health and safety
- Identify job requirements

- Select machine and tools
- Perform machine set-up
- Select machining speeds and feeds
- Identify Sequence of operations
- Perform machine operations
- Assure quality for finished components

Module Instruction

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

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the "LAP test" giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit One: Machine Shop Occupational Health and Safety

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

- Personnel Protective Equipment (PPE)
- OHS Preventative Occupational Health and Safety (OHS)
- Machine shop standards and regulations

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:

- Identify personal protective equipment (PPE)
- Follow OHS preventive procedure
- Abide to machine shop standards and regulations

1.1 Personnel Protective Equipment (PPE)

Personal protective equipment used in a machine shop may include safety glasses, protective shoes, face shields, respirators, gloves, goggles, gowns, head covers, masks welding gear and disposable clothing.

PPE choices should be based on a PPE assessment that identifies the hazards of different machines that affect the operators. Many machinists commonly face hazards such as exposure to chemicals, liquids, oils, heat, sharp edges, moving parts, pinch points, punctures, welding sparks, noise, vibrations and flying debris – all of which should factor in the PPE assessment and selection process. Small injuries that occur frequently include lacerations from burrs or chips, bumping a sharp tool bit or insert while handling a part in the machine, dumping scrap in a bin, and unfolding a band saw blade. All of these injuries are preventable with the proper PPE.

Here are a few examples:

- Head protection – Bumping into objects/falling objects.
- Eye protection – Safety glasses/side shields (goggles for splashes and spatters)
- Face protection – Face shield with safety glasses and side shields (for splashes and spatters)
- Footwear – Steel toe boots or shoes
- Hearing protection – noise cancelling earmuffs (push to listen)

Figure 1.1 Personal protective equipment

1.2 Occupational Health and Safety (OHS)

1.2.1 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. **Causes of Accidents**

The accidents may take place due to:

- Human causes,
- Environmental causes and
- Mechanical causes

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.
- Accidents occur because of not using personal protective devices

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.
- May occur due to not using of safety devices such as helmets, goggles, gloves, masks etc.

2. Causes of accidents while working with machinery

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

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

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

4. Safety Rules

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

- Avoid horse play
- Keep the floor around your machine clear of chips and wipe up spilled cutting fluid

- Oily rugs must be placed in approved safety containers.

5. Safety when Machining Work Piece

- Do not operate any machine before understanding its mechanism.
- Always stop a machine before measuring, cleaning or making any adjustments. It is dangerous to do any type of work around moving parts of a machine.
- Never operate a machine unless all safety guards are in place.
- Keep hands away from moving parts. It is dangerous practice to "feel" the surface of the revolving work or to stop a machine by hand
- Never use a rag near the moving parts of a machine rag may be drawn into the machine, along with the hand that is holding it.
- Never have more than one person's operate a machine at the same time. Not knowing what the other person would or would not do has caused many accidents.

1.2.2 Machine Shop Standards and Regulations

- Student affected by drugs or alcohol **are not permitted** in the workshop.
- Students with any health problems that may affect workplace safety (e.g., medication, epileptic fits) must report these conditions to the workshop staff
- No food or drink in the workshop
- Wear the correct protective equipment for the tools you are using – ask if in doubt
- Immediately notify the workshop supervisor of any faulty or broken equipment
- Ask how to use the tools safely
- Make sure your work piece is fixed securely before work commences
- Keep clear of any person operating tools and machinery (bumping an operator or get tangled in the lead could cause serious injury to you or the operator)
- Do not talk to anyone operating electrical equipment and machinery
- Clean up any spills immediately
- Wash hands after using equipment and materials

1.2.3 Emergency in Workplaces

A) First Aid Box

A First Aid Box, though it can differ from workplace to workplace, should include: wrapped sterile adhesive dressings in assorted sizes, sterile eye pads, individually wrapped bandages, safety pins, individually wrapped sterile unmedicated wound dressings and disposable gloves.

Figure 1.2 First Aid Box

B) Fire Extinguisher

If your workshop involves the risk of a Class B fire, you should equip your workshop with an **AFFF (aqueous film-forming foam) foam fire extinguisher**. These extinguishers are not affected by the alcohol content of inflammable liquids, and therefore are much more effective on fuel-based fires.

Figure 1.3 Fire extinguisher

1.2.4 House Keepings

To some people, the word "housekeeping" calls to mind cleaning floors and surfaces, removing dust, and organizing clutter. But in a work setting, it means much more. Housekeeping is crucial to safe workplaces. It can help prevent injuries and improve productivity and morale, as well as make a good first impression on visitors. The practice extends from traditional offices to industrial workplaces, including factories, warehouses and manufacturing plants that present special challenges such as hazardous materials, combustible dust and other flammables. Experts agree that

all workplace safety programs should incorporate housekeeping, and every worker should play a part.

Figure 1.4 House keeping at workplace

Self check-1

Directions: Answer all the questions listed below. Use the Answer sheet provided by your trainers.

A) Fill in the blank space for the following Questions

1. _________ commonly occurs due to use of unguarded or improper guarded machines or equipment.

2. Student affected by drugs or alcohol ______________ in the workshop.

3. __________ choices should be based on a PPE assessment that identifies the hazards of different machines that affect the operators.

4. The accidents may take place due to ________._________ and__________.

5. Accidents generally occur while _______ or________ at unsafe speed.

B) Write True if the statement is correct and False if the statement is no correct.

______1. Student affected by drugs or alcohol are permitted in the workshop.

______2. Continued use of old, poor maintained or unsafe equipment may result in accidents.

______3. Improper ventilation in the plant may also leads to industrial accidents.

______4. Rotating machine parts do not give rise to damages or injuries.

______5. All of these injuries are preventable without the use proper PPE.

C) Answer the following Questions

1. Write the three classifications of safety rules.
2. Mention the three causes of accident.
3. List the hazard parts of rotating machines,
4. What safety is required for work shop?
5. What are the importance of PPE?

Unit Two: Job Instruction and Requirements

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

- Work Requirements
- Machine and Tools Selection
- Machining Sequence of operations

This guide 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:

- Determine work requirement
- Select machine and tools
- Determine machining sequence of operation

2.1 Work Instruction and Requirements

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

Working drawings/Diagrams

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

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

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

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

It helps streamline the manufacturing process. The precise details of the technical drawing helps machinists to create parts 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.

2.2 Machine and Tools Selection

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 a term used to describe a variety of material removal processes in which a cutting tool removes unwanted material from a work piece to produce the desired shape. Machining Process Machining can be used to create a variety of features including Holes, Slots, Flat surfaces, and Complex surface contours. 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.

While machined parts are typically metal, almost all materials can be machined, including: Metals, Plastics, Composites, and Wood.

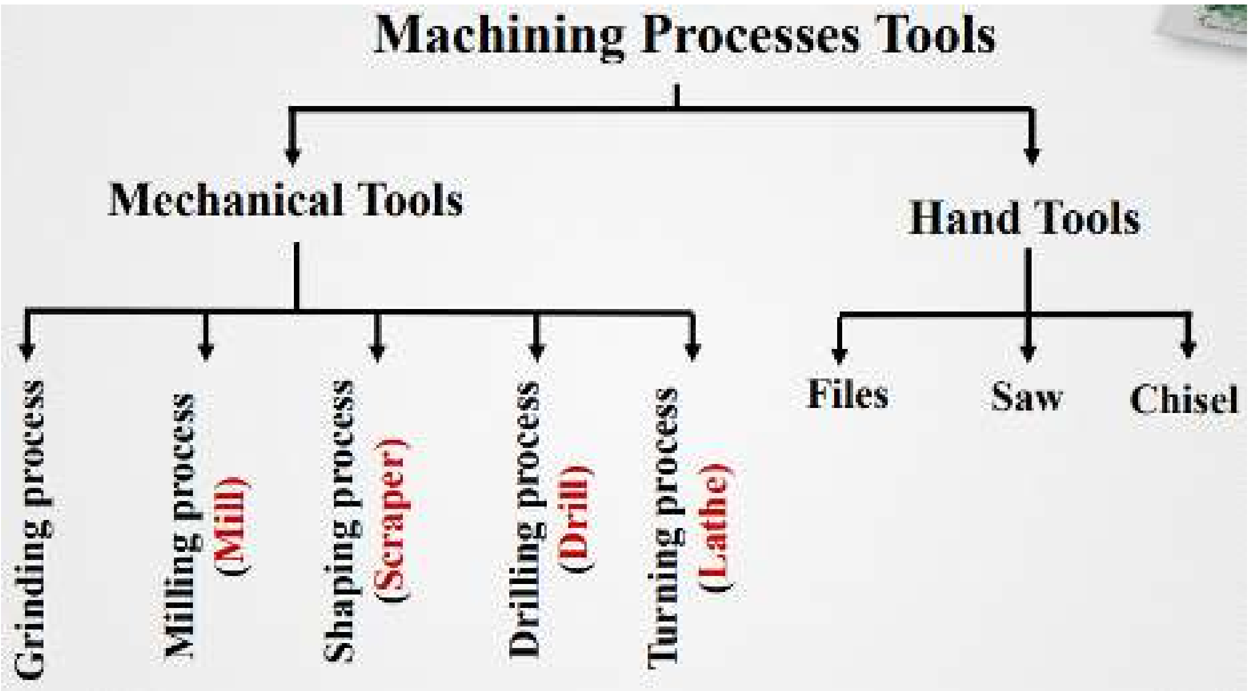

Figure 2.1 Machining process

2.2.1 Grinding Machines

A grinding machine, often shortened to grinder, is a machine tool used for grinding, which is a type of machining using an abrasive wheel as the cutting tool. Each grain of abrasive on the wheel's surface cuts a small chip from the work piece via shear deformation. This produces a smooth finish on the flat surface. The grinding wheel is used in grinding machines for cutting.

Types of Grinding Machines

1. Bench grinding machine
2. Portable or Hand grinding machine
3. Pedestal grinding machine

1. Bench Grinding Machine

These types of grinding machines are fixed on a workbench or table. Gear or pulley is fitted in it. For rotating the big-size gears or pulley a handle is also fixed. It contains one or two grinding wheels. Edges of cutting tools can be made with this grinder. Provision can be made to operate these with power also.

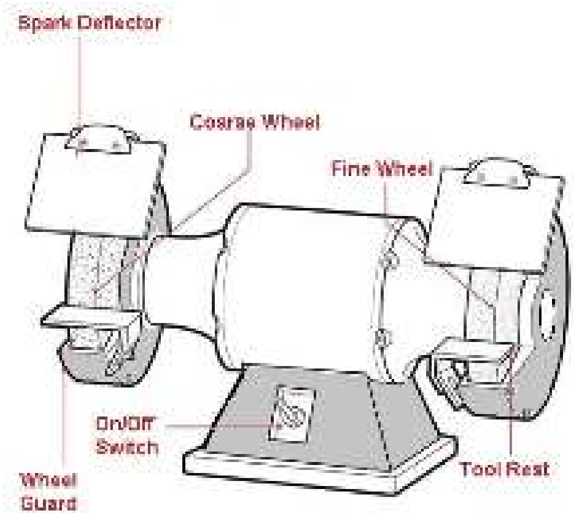

Figure 2.2 Bench grinding machine

2. Portable or Hand grinding machine

This type of grinding machine also known as a side or disc grinder, is a handheld power tool used for cutting, grinding and polishing. 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 2.3 Portable or hand grinding machine

4. Pedestal grinding machine

These types of grinding machines are operated with electric power. This is fitted on a pedestal frame separately on the ground. A grinder wheel is fitted each on both sides of the shaft of the electric motor. Tools rests are also provided with them. These are the most widely used in the workshops. Edges of all types of cutting tools are made with these grinders. Apart from this, molded articles can also be cleaned with it.

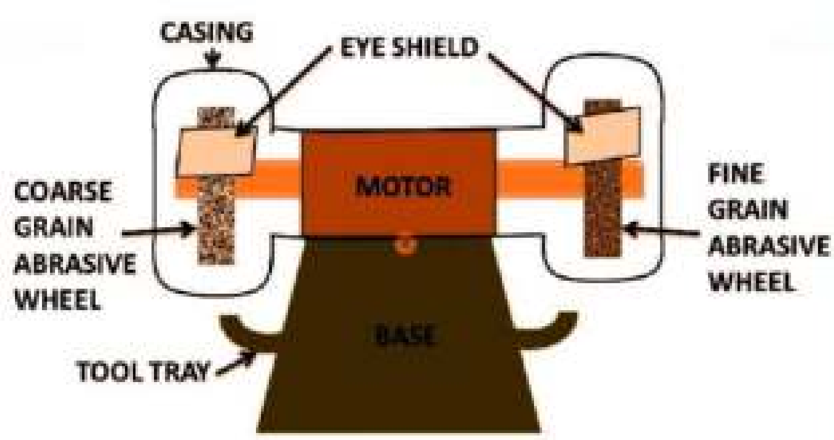

Figure 2.4 Pedestal grinding machine

2.2.2 Drilling Machines

Drilling machine, also called drill press, is a powerful tool used to cut a round hole in to or through metal, plastic, wood or other solid materials through turning and advancing rotary drill bits into a work piece. This drilling cutting tool is held in the drill press by a chuck and fed into the work at variable speeds. The speed and feed should be set properly and coolant needs to be provided for the desired finished part. The drilling machine can not only be applied in the drilling process, but aldso useful for many other machining operations. There are various operations can be performed on a drilling machine, such as plane drilling, step drilling. core drilling, boring, counter boring, reaming, countersinking, spot facing, tapping and trepanning. Although there are many different types of drilling machines, the components of a drilling machine are more-or-less similar. In order to understand the working mechanism of drilling machines, we must first take a look at the various components that make up a drilling machine: Base, column, swivel table, power system, hand wheel and chuck.

Types of Drilling Machines

Portable Drilling Machines

Bench Drilling Machines

Pedestal Drilling Machines

Radial Drilling Machines

1. Portable Drilling Machines

A portable drilling machine is a smaller, hand-operated power drill that is primarily used for producing small holes up to 12 millimeters in any place in an object. It has the ability to drill a hole through plastic, wood, concrete, and metal. Portable drill machines are utilized by woodworkers, homeowners, plumbers, electricians, and industrial employees because of their small size and portability.

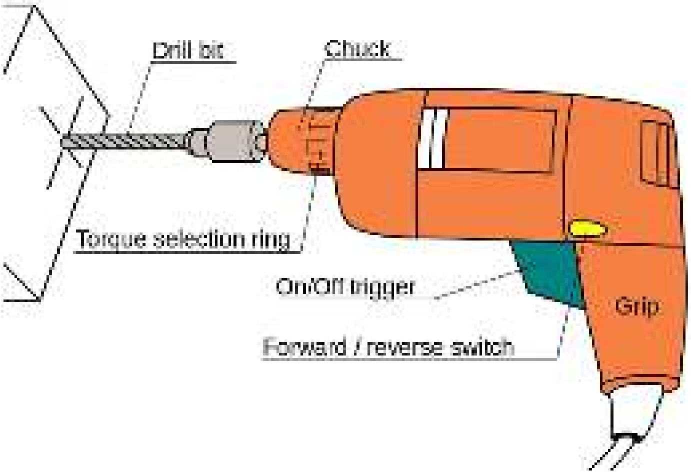

Figure 2.5 Portable drilling machines

2. Bench Drilling Machines

If a project requires drilling holes on either wood or metal, the bench drilling machine will be a perfect choice!

This is a bench drill machine for drilling holes in wood or metal. Boring, reaming, and taping are also available as cutting processes. This drilling machine can drill holes up to 12.5mm in diameter in steel. It is also commonly utilized by crafters and manufacturers.

Because of the advantages that this equipment provides, it is also known as a sensitive drilling machine.

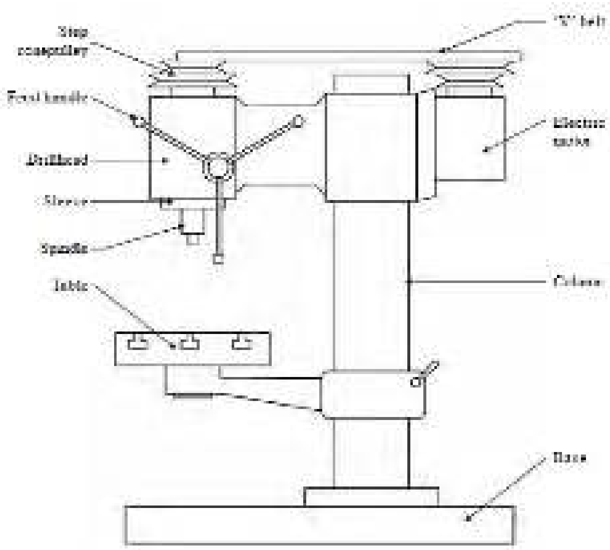

Figure 2.6 Bench drilling machines

3. Pedestal Drilling Machines

A pedestal drill is a fixed style of power tool that is very versatile and used to cut holes into ceramic, glass, plastic, metal or wood. It’s commonly used in product manufacturing and woodworking. It requires training and skill in order to operate correctly. Pulling down on the lever engages the drill, allowing the bit to bore its way into various materials at a rapid rate.

Its parts are Base, Vertical Column, Swivel Table, Chuck, Table Clamp, Spindle and power head.

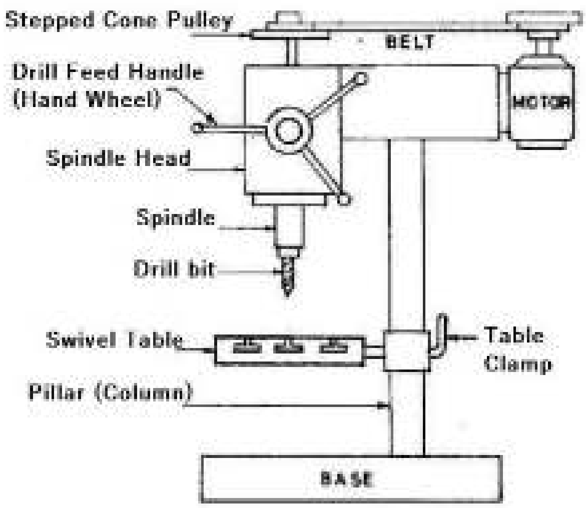

Figure 2.7 Pedestal drilling machines

4. Radial Drilling Machine:

A radial drilling machine is used to drill holes in the components but it is quite different from the general drilling machine. The radial drilling machine has an arm that can rotate in the given radius.

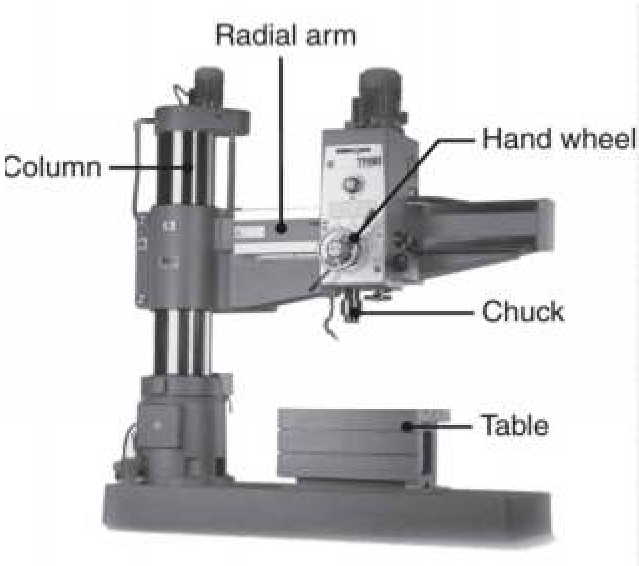

Figure 2.8 Radial drilling machines

2.2.3 Power Hacksaw Machines

All power hacksaw machines are basically similar in design.

Base

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

Vise

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

Frame

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

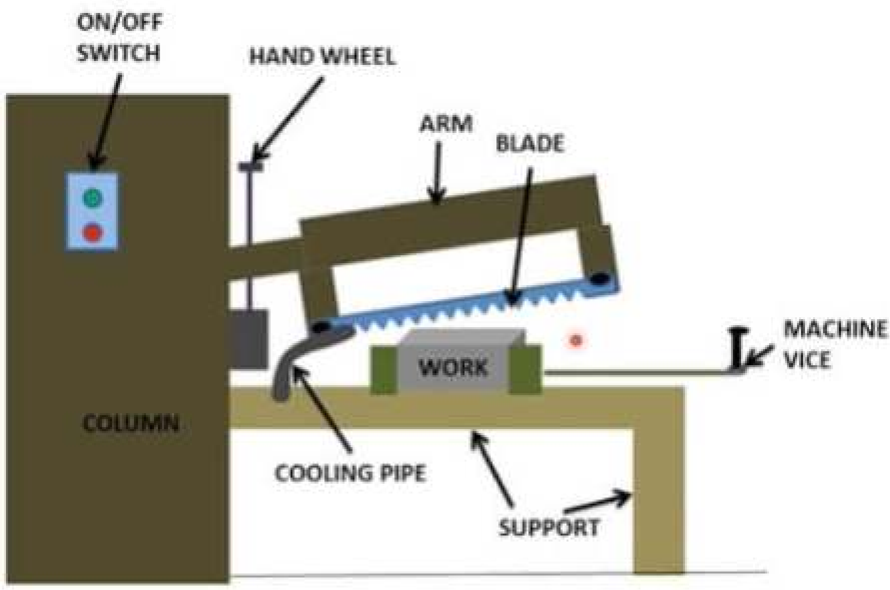

Figure 2.9 Power hacksaw machines

2.2.4 Planer Machine

A planer is a machine tool primarily designed to produce planes and flat surfaces by a single-point cutting tool

A planer machine is just like a shaper machine but, it is very large and massive and it is capable of machining heavy jobs which can't be done by the shaper.

The main difference between planer and shaper is that In a planer, the work is loaded over the table and reciprocates past the stationary cutting tool and the feed is given by the lateral movement of the tool but In shaper, the ram holding the tool reciprocates over the stationary work loaded over the table and feed is given by the crosswise movement of the table.

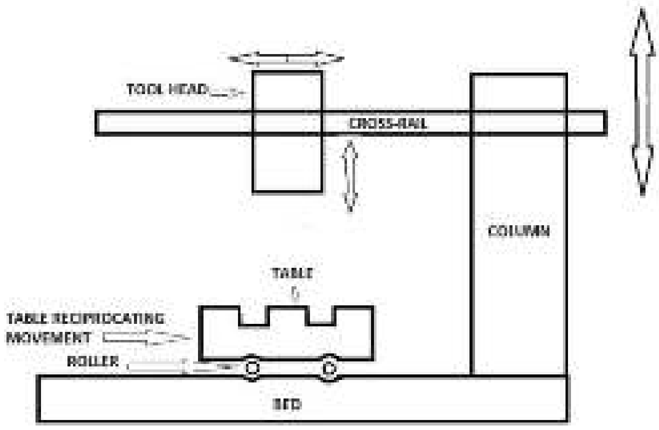

Figure 2.10 planer machines

2.2.5 Shaper Machine

Shaper is commonly used to produce flat surfaces can be horizontal, vertical or inclined by machining with the help of a reciprocating tool. Due to its limited length of its ram stroke, shaper is conveniently adapted to smaller jobs. However it's a slow machine and is only considered suitable only for unit or batch production rather than mass production. It is even preferred to other quick metal cutting machines with even multiple teeth cutters because it can give all kinds of surface finish on this single machine along with ease of machining varieties of surfaces with minimum change over time since the set up time for a shaper is much less for most of the jobs.

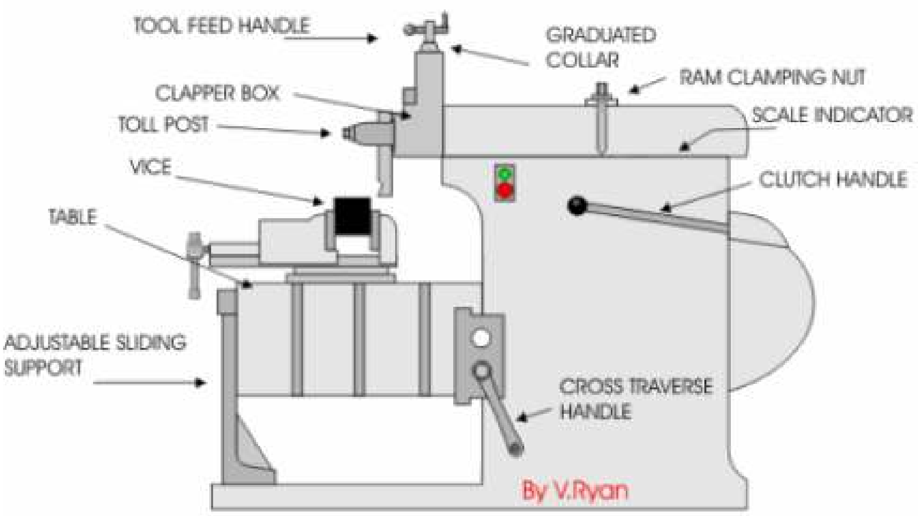

Figure 2.11 Shaper machines

2.2.6 Slotter Machine

It is a reciprocating type of machine tool in which the ram that holds the tool moves in the vertical axis. It is almost similar to the shaper machine. In the shaper machine, the ram reciprocates in the horizontal direction, and in the slotter machine the ram reciprocates in the vertical direction. The cutting action in the slotter takes place during the downward stroke of the ram, and there is no cutting in the return stroke and called an idle stroke.

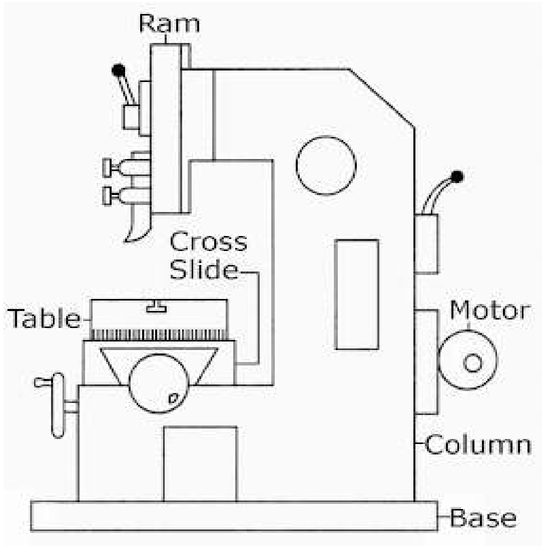

Figure 2.12 Slotter machine

2.2.6 Lathe Machines

A lathe machine is a machine that holds the work piece on a chuck and tool on a tool post, the lathe machine rotates the work piece about an axis to perform different operations such as turning, facing, chamfering, thread cutting, knurling, drilling, and more with tools that are applied to the work piece to design an object with symmetry about that axis.

The main function of a lathe is to remove the metal from a work piece to give a required size and shape. In a lathe machine, the tool is held and a work piece is rotating about an axis rotation to perform various operations with different tools.

The lathe machine is primarily used to produce cylindrical surfaces and plane surfaces at a right angle to the axis of rotation. It can also produce tapers and bellows etc. Most suitable lathes can also be still used to produce most solids of revolutions, plane surfaces & screw threads, etc.

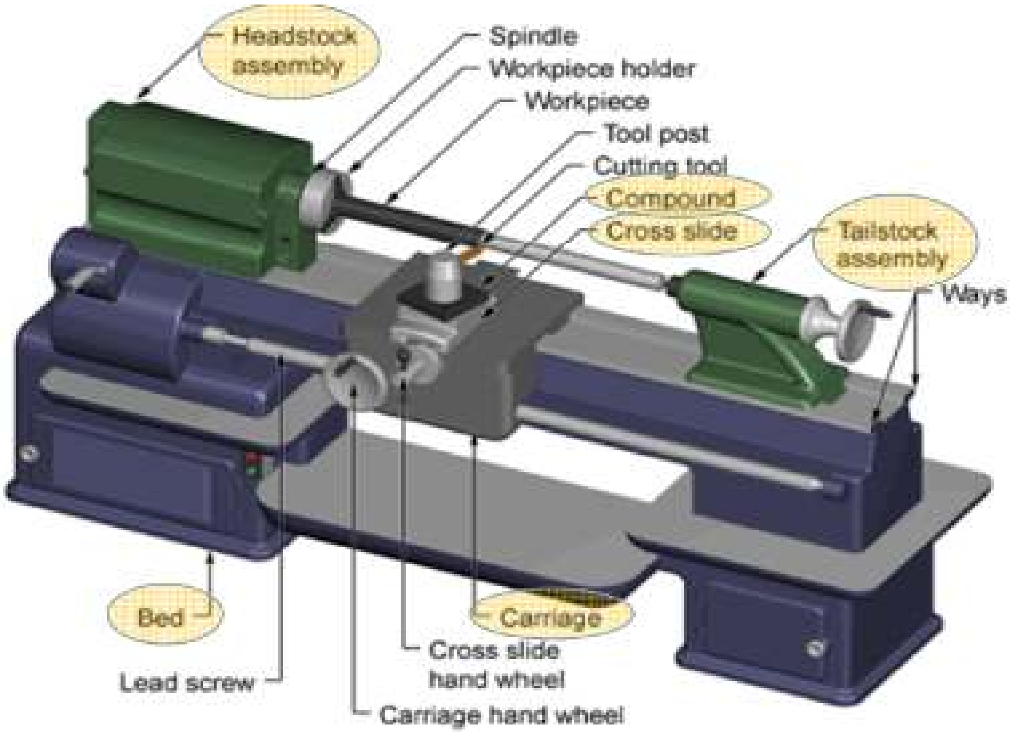

Figure 2.13 Lathe machine

Parts of Lathe Machine

The following are the main parts of lathe machine:

1. Bed

The lathe bed is the base of the machine, which is a solid structure. It should be provided strictly under heavy pressure. On top of the bed, has the V-type of guide ways include the angle of 90°.

2. Headstock

It is located on the left-hand side of the lathe bed. It has a hollow spindle and the different types of mechanism for driving and changing the speed of the spindle.

In this case, the speed increases when the belt is shifted from larger to smaller diameter pulleys. The spindle is made up of nickel, chrome steel and carbon steel. The front end of the spindle hole is taper for holding the centers perfectly.

The speed changing is based on the following conditions,

The type of material to be cut

The type of finish-finishing cut-small depth-high speed

The diameter of the work piece

Type of operation

3. Tailstock

The tailstock is located on the right-hand side of the lathe bed. The tailstock supports the other end of the work piece when it is machining between two centers.

It holds the tool rigidly and perfectly for performing operations such as drilling, reaming, tapping, and boring. It can move along the guide ways and can clamp in any position on the bed.

4. Carriage

The carriage is one of the most important parts of the lathe tool and it will serve as a supporting, moving, and controlling part of the cutting tool.

a) Saddle

It is 'H' shaped. The saddle fits over the bed and slides along the guide ways by carrying the cross slide and tool post. It can lock in any position in its movement.

b) Cross Slide

It is an attachment to the saddle and to the compound rest. The cross slide move by the turning hand wheel. Transverse movement is obtained when the nut mounted on the feed screw is engaged with the binder screw of the cross slide.

c) Compound rest

It is a circular base, graduated in degrees and it is used to obtain angular cuts and tapers of the variable cross-section. It consists of a compound slide hand wheel; compound slide feed screw, compound slide nut. The compound slide hand wheel is mainly used in taper turning operations to give the feed.

d) Tool post

The tool post is placed above the compound rest and it holds the tool firmly. There are different types of tool post,

Single screw tool post

Four-way tool post

Eight-way tool post

5. Feed mechanism

The amount of the tools relative to the work piece is called 'Feed'.

A lathe tool has 3 types of feed

Longitudinal feed: Here the tool moves parallel to the lathe axis. It is affected by means of the carriage movement.

Cross feed: Here the tool moves at right angles to the lathe axis.

Angular feed: By adjusting the compound slide and swiveling it to the required angle to the lathe axis. Cross and longitudinal feeds are both hand and power operated, but angular is only hand operated.

6. Screw or Thread Cutting Mechanism

The lathe is important to the machine tool, which is used to cut the required type of threads on a given work. The rotation of the screw is used to move the tool along the work piece to produce the screw threads. The half-nut mechanism is used in the lathe.

7. Feed Rod

It is a long shaft having a keyway extends from the feed box across and in front of the bed. The power is transmitted from the lathe spindle to the apron gears through the feed rod.

The feed rod is mainly using to move the carriage or cross slide for the operations such as turning, boring, facing and all other considering the thread cutting operation.

8. Lead screw

It is a long threaded shaft used for only thread cutting operation. The lead screw is in an arranged position in all operations from the gearbox. It may also be used to give the motion for turning, boring, etc., in the lathes which are equipped with a feed rod.

2.2.6.1 Types of Lathe Machine

1) **Speed Lathe:** it is so named because of the very high speed of the headstock spindle
2) **Engine Lathe:** the most important machine tool in the lathe machines and by far most widely used.
3) **Turret Lathe:** it is a production used to perform a large number of operation simultaneously
4) **Bench Lathe**: a small lathe which can be mounted on the work bench for doing small precision and light jobs.

2.2.6.2 Lathe Machine Operations

Lathe machine operations done either by holding the work piece between centers or by a chuck are:

1. Turning
    - Plain or Straight Turning
    - Rough Turning

- Shoulder Turning
- Taper Turning
- Eccentric Turning

2. Facing
3. Chamfering
4. Knurling
5. Thread cutting
6. Boring
7. Forming
8. Grooving
9. Contour turning
10. Drilling
11. Cut off

2.2.6.3 Lathe Machine Accessories

The lathe machine accessories are used either for holding and supporting the workpiece or for holding the tool. The important lathe accessories are

1. Centers
2. Chucks
3. Collets
4. Angle Plates
5. Face Plates
6. Mandrels
7. Catch Plates and Carriers

2.2.6.4 Lathe Attachments

The lathe machine attachments are additional types of equipment used for some special and specific purposes. The important lathe attachments are:

1. Stops
2. Rests
3. Taper turning attachments
4. Milling attachments
5. Grinding attachments
6. Gear attachments
7. Boring attachments

2.2.7 Milling Machines

Milling is the machining process in which the removal of metal takes place due to the cutting action of a rotating milling cutter. In a milling machine, the cutter is rotating due to work piece is fed against it. This machine can hold more than one tool at a time. The cutter rotates at high speed, and because of the many cutting edges, it removes metal at a very fast rate.

The machine can also hold one or a number of cutters at a time. Thus, the milling machine is one of the most important machines in the workshop. In this machine, all the operations can perform with high accuracy.

The metal removal rate is high as compared to a lathe machine, planner machine, and shaper machine. It has good accuracy and a better surface finish. This is why a milling machine finds wide application in production work.

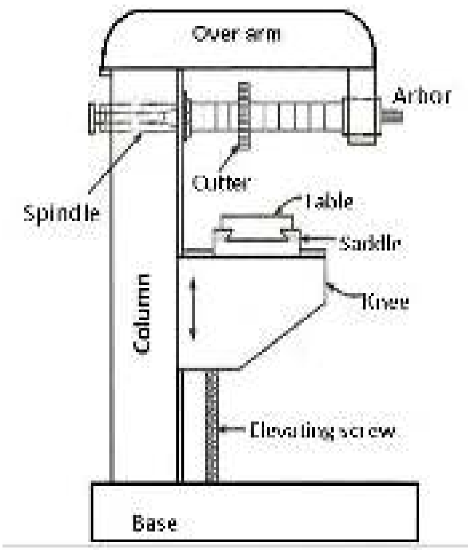

Figure 2.14 Milling machine

2.2.7.1 Parts of Milling Machine

Following are the different parts of milling machine:

1. Base
2. Column
3. Saddle
4. Table
5. Overhanging arm
6. Spindle
7. Arbor

Base

- The base of the machine is grey iron casting and serves as a foundation member for all other parts which rests on it.

- The base carries the column at its one end. In some other machines, the base is hollow and works as a reservoir for cutting fluid.

Column

- The column is the main supporting frame mounted on the base.
- It is box-shaped and houses all the driving mechanism for the spindle and feed table.
- The front vertical face of the column is precisely machined and is equipped with dovetail guide ways for supporting the knee.
- The top of the column is finished to hold an overarm that extends beyond the front of the machine.

Knee

- The knee is a fixed grey iron casting that slides up and down on the vertical ways of the column face.
- The adjustment of height is affected by an elevating screw mounted on the base that also supports the knee.
- The knee houses the feed mechanism of the table and controls to operate it.
- The top face of the knee forms a slide way for the saddle that gives cross travel to the table.

Saddle

- On the top of the knee is placed the saddle, which slides on guide ways set exactly at 90 degrees to the column face.
- A cross-feed screw near the top of the knee engages a nut on the bottom of the saddle to move it horizontally, by hand or power, to apply cross-feed.
- The top of the saddle is precisely machined to provide guide ways for the table.

Table

- It rests on guide ways on the saddle and travels longitudinally.
- The top of the table is finished accurately and T-slots are provided for clamping the work and other fixtures.
- A lead-screw is provided under the table that engages with a nut on the saddle, it helps to move the table horizontally by hand or power.
- The longitudinal travel of the table possibly limited by fixing trip dogs on the side of the table.
- In universal machines, the table may also be swiveled horizontally. For this purpose, the table is mounted on a circular base, which in its turn is mounted on the saddle.

- The circular base is graduated in degrees.

Overhanging arm

- Overhanging arm act as a support for the arbor.
- It is mounted on the top of the column extends outwards the column face and works as bearing support for the other end of the arbor.
- The Overhanging arm is adjustable so that the bearing support may be provided nearest to the cutter.
- More than one bearing support can be provided for the arbor.

Spindle

- The spindle of the machine is located in the upper part of the column and receives power from the motor through belts, gears, and clutches and transmit it to the arbor.
- The front end of the spindle just projects from the column face and is provided with a tapered hole into which various cutting tools and arbor may be inserted.
- The accuracy in metal machining by the cutter depends on the strength, accuracy and rigidity of the spindle.

Arbor

- Arbor is an extension of the machine spindle on which milling cutters are securely mounted and rotated.
- These are made with taper shanks for proper alignment with the machine spindles having taper holes at their nose.
- The arbor may be supported at the farthest end from the overhanging arm or maybe of cantilever type which is called stub arbor.

2.2.7.2 Working Principle of Milling Machine

The working principle of the milling machine, applied in the metal removing operation on a milling machine. The work is rigidly clamped on the table of the machine and revolving multi teeth cutter mounted either on a spindle.

The cutter revolves at a normal speed and the work fed slowly past the cutter. The work can be fed in a longitudinal, vertical or cross direction. As the work progress further, the cutter teeth remove the metal from the work surface to produce the desired shape.

The two methods of milling

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

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

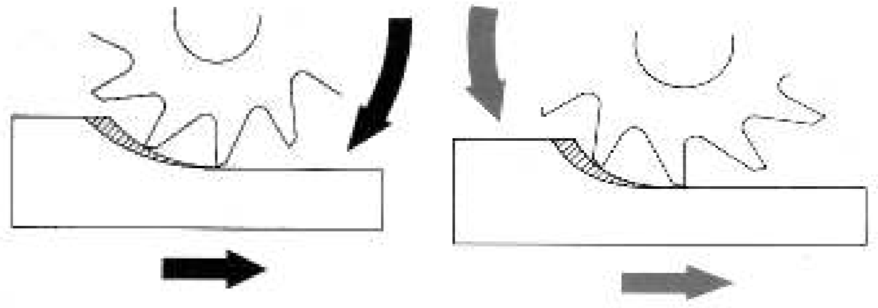

Figure 2.15 a) Conventional (Up) milling b) Climb (Down) milling

2.2.7.3 Types of Milling Machines

Following are the different types of milling machines:

1. Column and knee type
    - Hand milling machine
    - Plain or horizontal milling machine
    - Vertical milling machine
    - Universal milling machine
    - Omniversal milling machine
2. Manufacturing type or fixed bed type
    - Simplex milling machine
    - Duplex milling machine
    - Triplex milling machine
3. Planer type milling machine
4. Special Type
    - Rotary table milling machine
    - Drum milling machine
    - Profile milling machine
    - Planetary milling machine
    - Tracer controlled milling machine
    - Pantograph milling machine
    - NC/CNC milling machine

2.3 Machining Sequence of operations

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

1. 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.

A. 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.
B. Countersinking – is the operation of producing a tapered or cone shaped enlargement to the end of the hole.
C. 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.
D. 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.
E. 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.
F. 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.
G. 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

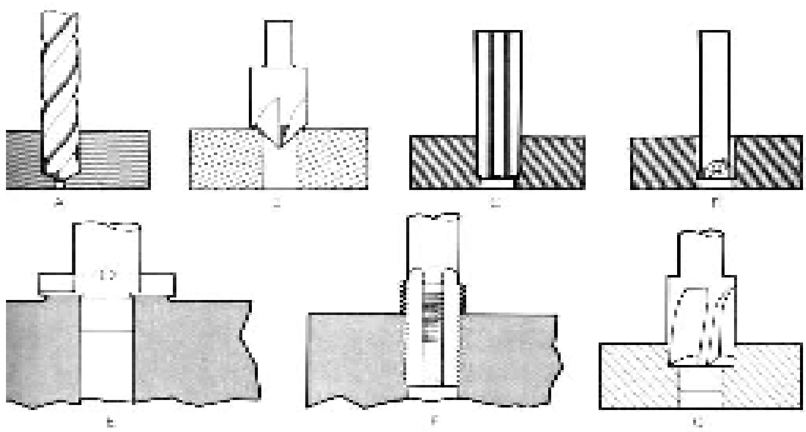

Figure 2.16 Drilling machines operation

2. Operation on lathe machine: facing, turning, chamfering, grooving, forming, knurling, undercutting, taper turning, thread cutting, drilling, reaming, boring, tapping and etc. these operation are depend on one another

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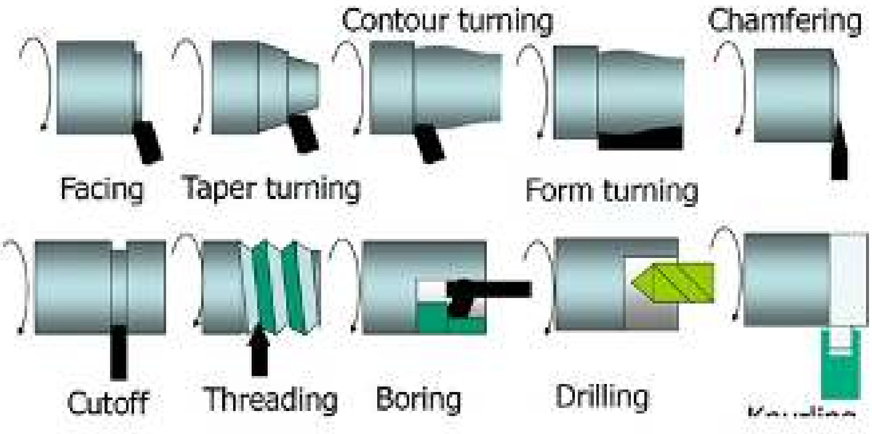


Figure 2.17 Lathe machine operations

Operation on milling machine:

Following are the different types of operations performed on milling machine:

- Plain Milling Operation
- Face Milling Operation
- Side Milling Operation
- Straddle Milling Operation
- Angular Milling Operation
- Gang Milling Operation

1. Form Milling Operation
2. Profile Milling Operation
3. End Milling Operation
4. Saw Milling Operation
5. Milling Keyways, Grooves, and Slot
6. Gear Milling
7. Helical Milling
8. Cam Milling
9. Thread Milling

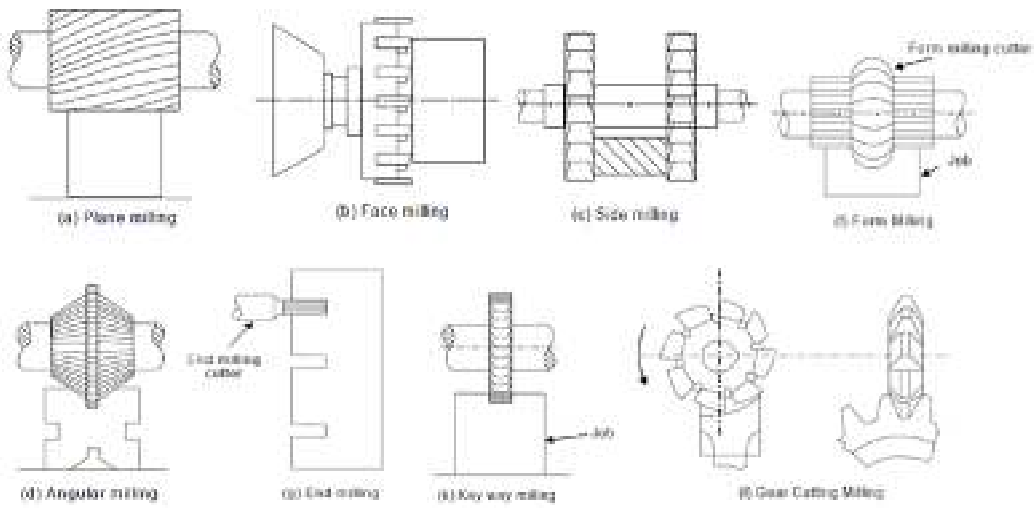


Figure 2.18 Milling machine operations

Self-check-1

Directions: Answer all the questions listed below. Use the Answer sheet provided by your trainers:

A) Choose the correct answer from the following Questions

1. The tool used in a lathe is a

A. multipoint cutting tool B. Single point cutting tool

C. End cutting tool D. Twist Drill tool

2. The assembly which consists of saddle, cross-slide, compound slide and tool post is

A. Headstock B. Tailstock C. Bed D. Carriage

3. In a milling machine, cutters are mounted on

A. Column B. Spindle C. Overhanging arm D. Arbor

4. One is not parts of engine lathe

A. Headstock B. A carriage
C. Tool post D. Column

5. One of the following is not properties of tail Stock

A. The tail stock can be locked in any position along the bed of the lathe
B. The tail stock spindle has an internal taper to receive the dead center, or live center
C. The tail stock provides support for the right hand end of the work
D. All of the above

6. The main 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

7. One of the following is not lathe cutting tool materials
   A. HSS
   B. Carbide steel
   C. Tungsten Carbide
   D. None of the above

B) Match the term in column B with the term in column A.

A	B
______ 1. Work holding device	A) Arbor
______ 2. Tool holding part in drilling machine	B) Duplex
______ 3. Cutter securing part on milling machine	C) Shaper
______ 4. Type of milling machine	D) Chuck
______ 5. Use reciprocating cutting tools	E) Vise

C) Answer the following questions

1. List parts of milling machine and explain each.
2. Mention type of grinding machine and explain the differences.
3. List type of cutting tools in milling machines.
4. List type of Lathe operation and explain each.
5. List types of drilling machine and explain each.
6. List type of conventional milling machine and explain.
7. List parts of Lathe machine and explain their uses.
8. List types of Lathe cutting tools.
9. List types of milling cutting tools.
10. Write the difference between shaper and slotter machines.

Operation sheet-1

Operation title: Drilling operations

Purpose: To perform and practice drilling of different diameter hole on a sheet metal.

Instruction: Use the drilling machine and required drill bits, perform the tasks given below. For this operation you have required to apply every PPE and machine shop safety to perform the task

Tools and requirement:

- Drilling machines
- Drill bits
- Work holder
- Scribers
- Hand hammer
- Punches

Precautions: For every practice applying every PPE and machine shop safety to perform the task is mandatory.

Procedures

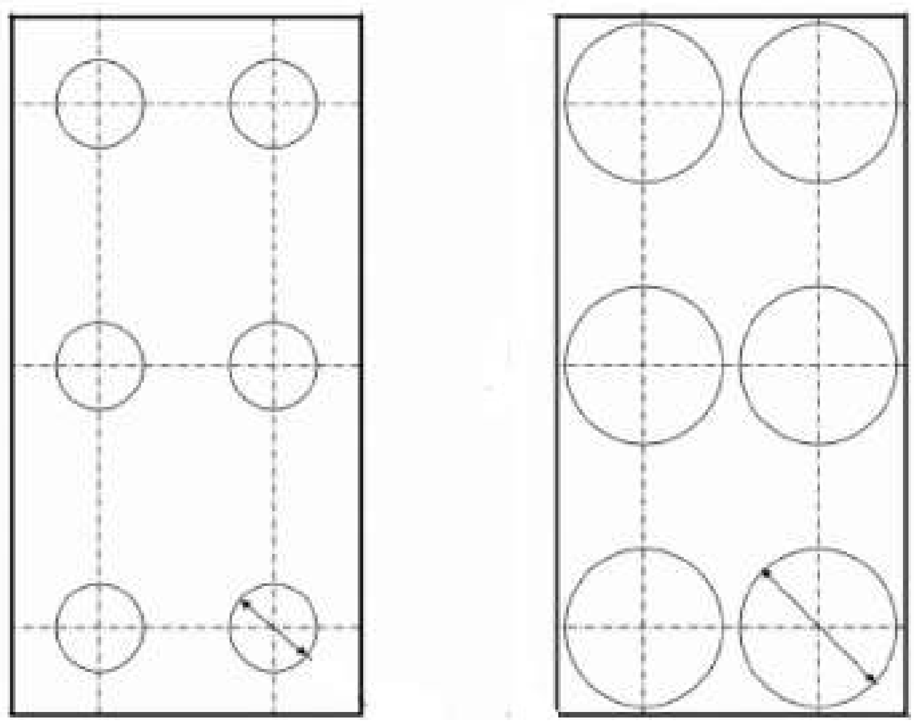
The steps to perform the drilling are as follows:

1. Prepare the work piece as required dimension
2. Laying out the work piece using scribers.
3. Punch/mark each hole positions using punchers.
4. Mount the work in to drill vise
5. Adjust drill bits to the spindle or drill chuck
6. ‘ON’ the machine and adjust the required rpm

7. Drill the hole.

LAP Test-1

Task 1: Perform drilling operation on the given plates.



Required specification of plate

- Plate size: 100mm x 50mm.
- Plate thickness: 4mm
- Drill bit size recommended: Ø8mm,Ø10mm, Ø12mm and Ø15mm.

Unit Three: Machine Set-Up

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

- Safety rules in machine shop
- Machine cutting tools
- Cutting Tools Sharpening and inspecting
- Tools Mounting and positioning
- Machine Guards and Accessories Set up
- Calculating cutting speeds, RPM, feeds and depth of cuts

This guide 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:

- Follow Safety rules in machine shop
- Identify machine cutting tools
- Inspect Tools Sharpening
- Mounting and Positioning Tools within machine specifications.
- Setting and adjusting Machine Guards and Accessories Set up
- Calculating Machining Speeds, RPM and Feeds

3.1 Safety Rules in Machine Shop

- Keep floors free of oil, grease, or any other liquid. Clean up spilled liquids immediately. They are slipping hazards.
- Aisles should be clear at all times to avoid tripping or other accidents.
- Store materials in such a way that they cannot become tripping hazards.
- Do not leave tools or work on the table of machine even if the machine is not running. Tools or work may fall off and cause toe or foot injury.
- Put tools away when not in use.
- Place all scrap in scrap boxes.

3.2 Machine Cutting Tools

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.
- **Double point cutting tool**:- 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.

3.2.1. Drilling Tools (Twist Drill)

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

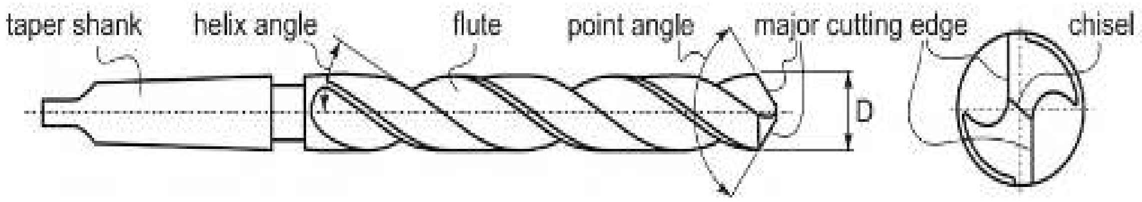


Figure 3.1 Twist drill

3.2.2. Lathe Cutting Tools

A lathe is a machine that rotates the work piece about an axis of rotation to perform various operations such as turning, undercutting, knurling, drilling, facing, boring, and cutting, with lathe cutting tools that are applied to the work piece to create an object with symmetry about that axis.

For general purpose work, the tool used in is a single point tool, but for special operations, multipoint tools may use.

In a lathe machine work, different operations require different types of lathe cutting tools, according to the process of using the lathe cutting tools.

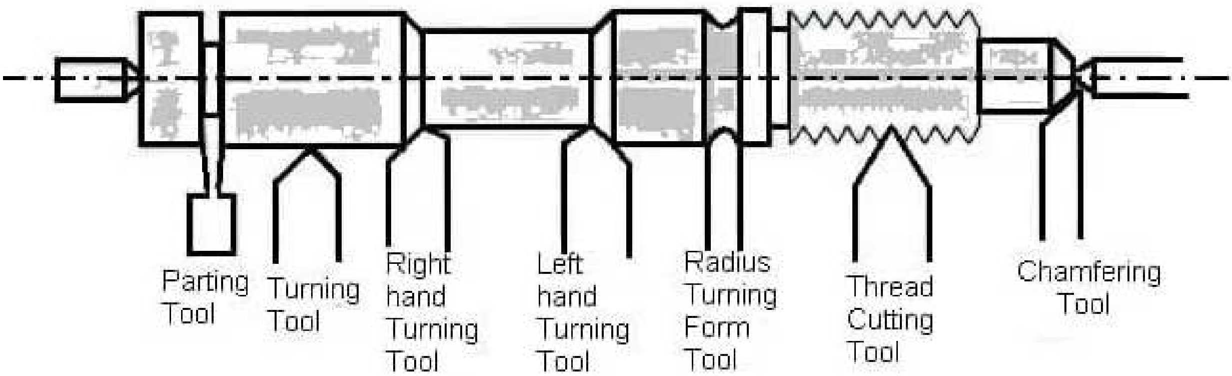


Figure 3.2 Lathe cutting tools

3.2.3 Milling Cutting Tools

Milling cutting tools are an important component of a milling machine. The milling cutter is the cutting tool used for scraping the excess material present outside the work-piece. All the milling machines contain a cutter.

The cutter in a milling machine during a typical milling operation moves perpendicular to its own axis, thus allowing it to remove excess material from the work-piece at the perimeter of the cutter. The milling machine is a very versatile machine on which multiple machining operations can be performed. The milling machine is used to machine and manufacture parts of various shapes & sizes. Milling cutters are an essential tool for performing these tasks.

Figure 3.3 Milling cutting tools

3.3 Cutting Tools Sharpening and Inspecting

3.3.1 Sharpening HSS Lathe 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. Between these cutting edges is a rounded section of cutting edge called the nose?

There are typical rake and clearance (relief) angles for HSS tool bits.

Recommended angles	
Side relief angle	12°-14°
Front relief angle	14°
Back rake angle	0°
Side rake angle	8°-15°

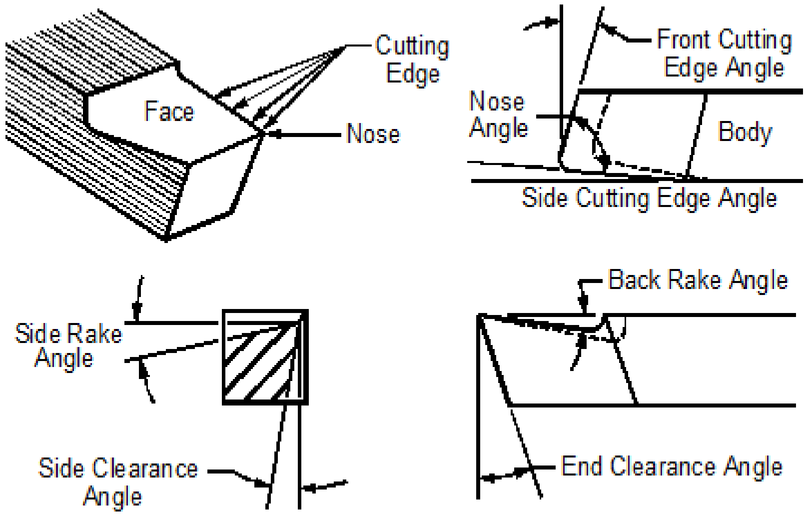


Figure 3.4 Typical rake and clearance (relief) angles for HSS tool bits

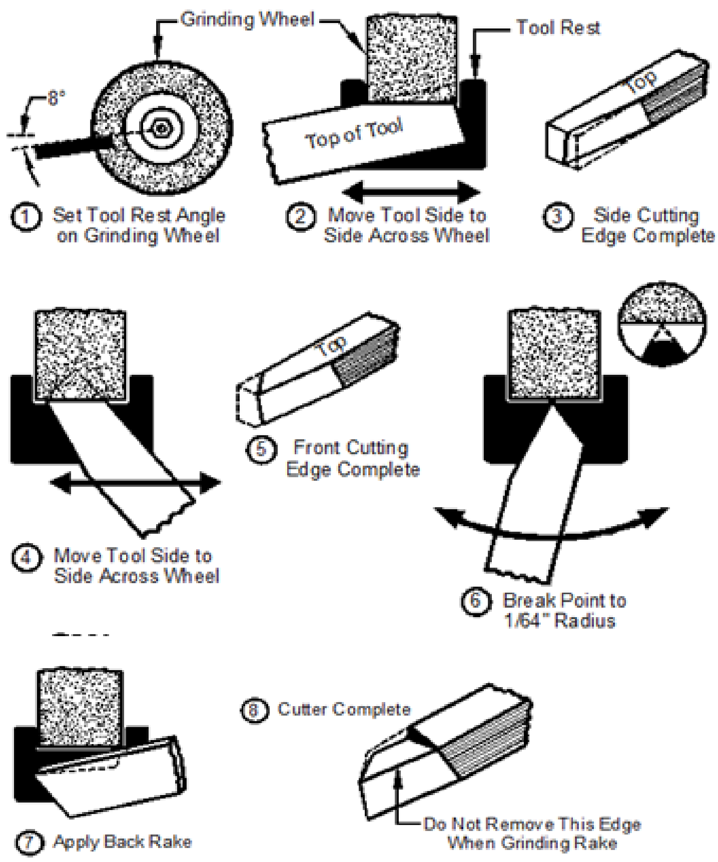


Figure 3.5 Steps for sharpening HSS tool bits.

3.3.2 Sharpening HSS Milling Cutting Tool

For sharpening cutters use specially-grinding and universal grinding. To get the right angles on the cutting edges of the tool can only be correctly selecting the appropriate grinding wheel and sharpening. As a result, the cutting properties will be high, and the surface — quality. Cutters of steel, containing cobalt, and vanadium, in contrast to similar steel R18, shown in the process of sharpening is not very good sanding behavior and the formation of burn marks.

3.3.3 Drill bit Sharpening

Correctly sharpening the drill bit requires the grinder to be at a slow speed. Placing he bit against the base of the wheel allows the sloped side to touch the cutter. This should be near a 60-degree angle for most bits. The tip of the bit should not touch grinder.

Figure 3.6 Drill bits sharpening.

3.4 Tools Mounting and Positioning

- 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

- Unobstructed (free) chip flow and cutting fluid action.

3.4.1 Mounting the cutting tools and work on Lathe machine

1. Mounting the cutting tools on lathe

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

1. HSS tools (Shank type) in the tool post.
2. HSS form tools and threading tools in tool post
3. Carbide and ceramic inserts in standard tool-holders
4. Drills and reamers, if required, in the tailstock
5. Boring tools in tool post

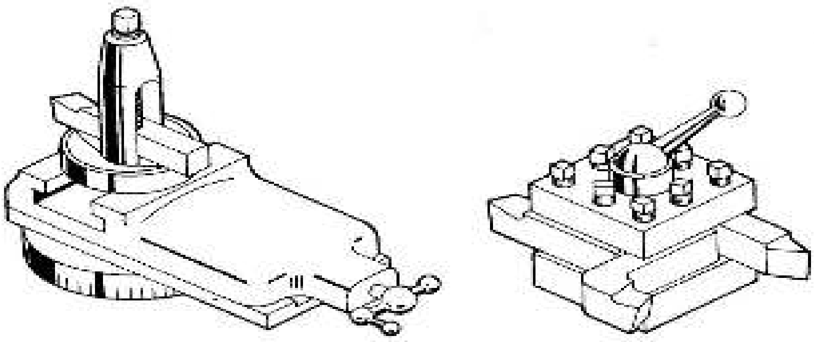


Figure 3.7 Mounting tools on lathe

2. Mounting work on lathe

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

- **Between two centers**. The work piece is driven by a device called a dog; the method is suitable for parts with high length-to-diameter ratio.
- **A 3 jaw self-centering chuck** is used for most operations on cylindrical work parts. For parts with high length-to-diameter ratio the part is supported by center on the other end.
- **Collet 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.
- **A face plate** is a device used to grasp parts with irregular shapes:

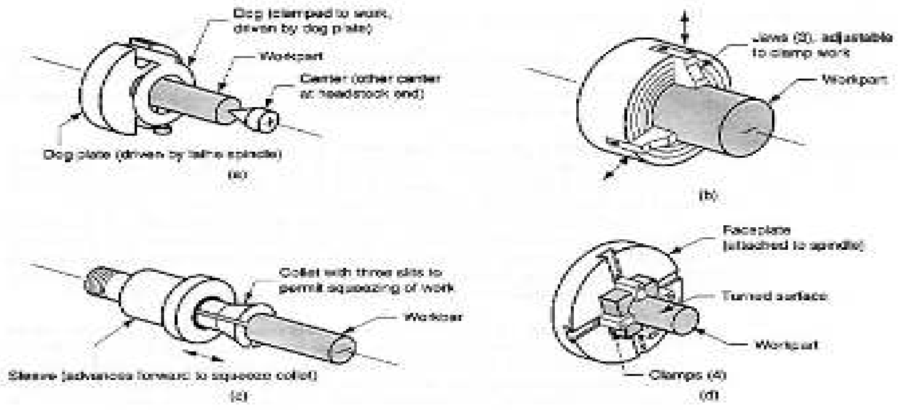


Figure 3.8 Mounting works on lathe

3.4.1 Mounting the cutting tools and work on milling machine

1. Mounting cutter on milling machines

The nose of milling machine spindles has been standardized. It is provided with a locating flange ф H7/h6 and a steep taper socket of 7:24 corresponding to an angle of 16° 35.6' to ensure better location of the arbor and end mill shanks. Rotation is transmitted to the cutter through the driving key secured to the end face of the spindle. Large face milling cutters are mounted directly on the spindle flange and are secured to the flange by four screws, whereas rotation is transmitted to the cutter through the driving keys on the spindle

2. Mounting work on milling machine

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

Methods of Mounting Work pieces**:**

(1) Clamping a work piece to the table.

(2) Clasping a work piece to the angle plate.

(3) Clamping work pieces in fixtures.

(4) Holding work pieces between centers.

(5) Holding work pieces in a chuck.

(6) Holding work pieces in the vise.

3.5 Machine and Accessories Guards Set up

3.5.1 Accessories with their functions used for lathe machine

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

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

1. Adjusting Centers.

a) There are two types of centers i.e., live center and dead center.

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

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

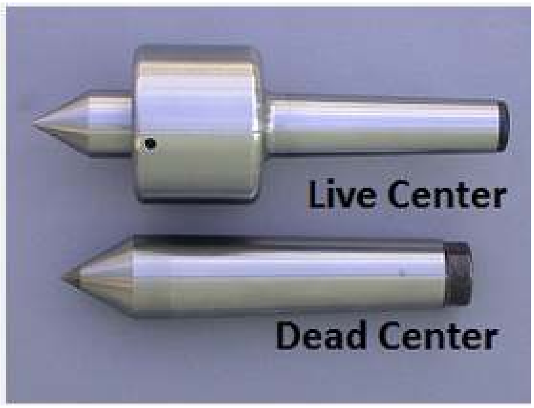


Figure 3.9 Centers adjusting

2. Adjusting Chucks.

a) It is an important device used for holding and rotating the work piece in lathes.

b) The work pieces which are too short to be held between centers are clamped in a chuck.

c) It is attached to the lathe spindle by means of two bolts with the back plate screwed on to the spindle nose.

d) There are many types of the chuck, but the following two are commonly used.

i) Three jaw universal chuck.

The three jaw universal chuck, as shown in Fig.3.10 is also called self-centering chuck or scroll chuck. Thus chuck is used for holding round and hexagonal work.

Figure 3.10 3 jaw chuck

ii) Four jaw independent chuck.

Figure 3.11 4 jaw chuck

1. The four jaw independent chuck, as shown in Fig.3.11 has four reversible jaws, each of which may be independently adjusted to accommodate the work it supports.
2. This type of chuck can hold square, round and irregular shape of work in either a concentric or eccentric position.

3. Adjusting Lathe dog or carrier

a) The work placed on a mandrel or held between centers is rotated positively by clamping the dog or carrier to the end of the work.

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

c) The lathe dog or carrier may be of straight type or bent type as shown in Fig. 3.12 below.

Figure 3.12 Lathe dog

4. Adjusting Drive plate

a) The drive plate, as shown in Fig. 3.13 is a circular plate which is bored out and threaded so that it can be attached to the spindle nose.

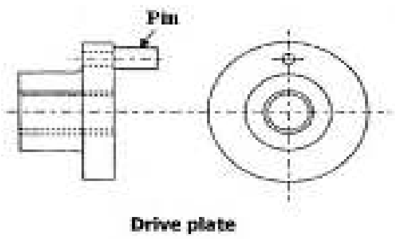


Figure 3.13 Drive plate

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

5) **Adjusting Face plate**.

Figure 3.14 Face plate

a) The face plate, as shown in Fig. is similar to drive plate except that it is larger in diameter.

b) It contains more open slots or T-slots so that bolts may be used to clamp the work piece to the face of the plate.

c) The face plate is used for holding work pieces which cannot be conveniently held in a chuck.

6. Adjusting Angle plate

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

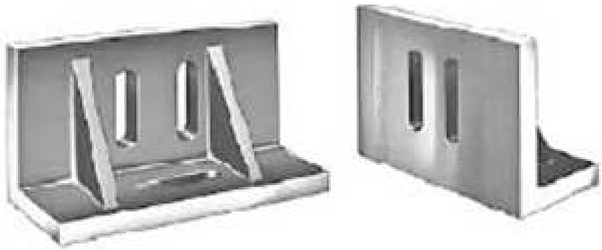


Figure 3.15 Angle plate

7. Adjusting Steady follower and other rests

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

Figure 3.16 Steady follower

3.5.2 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:-

1. **Fixed guard**-is kept in place permanently by fasteners that can only be released by the use of a tool.
2. **Interlocked guard**-shuts off or disengages power to the machine and prevents it from starting when the guard is removed/ opened.
3. **Adjustable guard-**provides a barrier which can be adjusted to suit the varying sizes of the input stock.
4. **Self-adjusting guard**-provides a barrier which moves according to the size of the stock entering the danger area.
5. **Two hand controls** -concurrent use of both hands is required to operate the machine, preventing the operator from reaching the danger area.
6. **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.

3.5.3 Miscellaneous safeguarding aids

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

3.6 Machining Speeds and Feeds

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

1. The motion resulting from the primary motion of the machine tool, which is called the cutting speed.
2. 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.

1. 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.

2. Feed (f)

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.

3. 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: - $\boldsymbol{t = \frac{D - d}{2}}$

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

$$Feed\ rate(f_r) = feed\ per\ rev\ x\ N(rpm)$$

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

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

where - N = R.P.M. of the cutter
CS = Linear Cutting Speed of the material in m/min. (see table 1)
d = Diameter of cutter in mm

The speed used on a milling machine depends:-

- The type of work material
- The cutter material
- The diameter of the cutter'
- The surface finish required
- The depth of cut being taken

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

$$Feed(f) = N\ x\ cpt\ x\ r/min$$

Where, N = number of teeth on the milling cutter
Cpt = chip per tooth for a particular cutter find from table
r/min = revolution per minute of milling cutter

Self-check-1

Directions: Answer all the questions listed below. Use the Answer sheet provided by your trainers:

A) Match column "B" with column "A".

A	B
__________1. Support long work piece in the middle	A) Collet
__________2. Independently adjusted chuck	B) 3 jaw
__________3. Grasp and hold bar stock	C) 4 jaw
__________4. Self-adjusting chuck	D) Lathe dog
__________5. Clamp to the end of work piece	E) Steady follower
	F) Machine guards

B) Say True if the statement is correct and False if the statement is not correct.

1. A longitudinal feed is when the tool travels in a direction parallel to the work axis.
2. Any machine part which can cause injury must be guarded.
3. Shields can be used to provide protection from flying particles, splashing metal working fluid
   or coolants.
4. The milling cutter is the cutting tool with single point cutting edges.
5. The Lathe cutter is the cutting tool with multiple point of cutting edges.

C) Answer the following questions.

1. What is the difference between 3 jaw and 4 jaw chucks?
2. What is the importance of steady follower in lathe machine operation?
3. Calculate the feed in mill meters per minute for a 75 mm diameter, six-tooth helical milling cutter (HSS) when machining a cast iron work piece (CS 60).
4. 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.
5. Calculater the r/min required for a 75 mm diameter high speed milling cutter when cutting machine steel (cs= 30 m/min).

Operation sheet-1

Operation title: Cutting tool sharpening

Purpose: To perform and practice tool sharpening for Lathe turning/facing operations.

Instruction: Use Bench/Pedestal grinding machine to perform the tasks given below. For this operation you have required to apply every PPE and machine shop safety to perform the task

Tools and equipment requirement:

- Grinding machines
- HSS cutter
- Coolants

Precautions: For every practice applying PPE and machine shop safety to perform the task is mandatory.

Procedures

The steps to perform the grinding operations are as follows:

- Prepare the work piece to be grind
- Laying out the work piece to locate each angles.
- Grip the work piece by your hand firmly or use any clamping devices
- Dip the tool in coolant frequently to keep it from overheating and annealing
- Look up the typical angles for the work piece material
- Set tool rest angle on grinding wheel
- Sharpen the cutter to the required profile.

Operation sheet-2

Operation title: Center the cutter and the work pieces on lathe machine.

Purpose: To perform and practice how to adjust the cutter and the work pieces on lathe machine.

Instruction: Adjust the cutter and the work pieces on lathe machine by applying information given above. For this operation you have required to apply every PPE and machine and machine shop safety to perform the task.

Tools and equipment requirement:

- Lathe machines
- HSS cutter
- Dial gauge

Precautions: For every practice applying PPE and machine shop safety to perform the task is mandatory.

Procedures

The steps to perform the grinding operations are as follows:

- Check all parameters found on lathe machine
- Insert the dead center into lathe tailstock of hollow spindle
- Mount the cutter in tool post
- Align the tip of cutter with the dead center
- Hold the work piece in the lathe machine chuck and check the alignment by centered cutter
- Check the work pieces out of center from the center by touching the tip of your cutter.

Operation sheet-3

Operation title: Adjusting the cutter and the work pieces on milling machine.

Purpose: To perform and practice how to adjust the cutter and the work pieces on milling machine.

Instruction: Adjust the cutter and the work pieces on milling machine by applying the above information. For this operation you have required to apply every PPE and machine and machine shop safety to perform the task.

Tools and equipment requirement:

- Milling machines
- Milling cutter

Precautions: For every practice applying PPE and machine and machine shop safety to perform the task is mandatory.

<u>Procedures</u>

The steps to perform the grinding operations are as follows:

- Check the functionally of the milling machine

- Mount the cutter in the center of arbor.
- Hold the work piece on universal vise then tighten
- Move the knee upward the cutter and to touch the work piece
- Then align the cutter and the work pieces
- Check the work pieces straight from the tip point of cutter

LAP Test-1

Task 1: Perform sharpening of tools for lathe turning, grooving and threading operation.

Required specification of HSS tools

HSS Tool size: 20mm x 20mm

20mm x 10mm

10mm x 10mm

8mm x 8mm and so on…

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

Unit Four: Machine Operations

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

- Safety rules in machine operation
- Work piece materials
- Clamping Devices
- Machining Operation

This guide 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:

- Follow Safety rules for machine operation
- Identify Work piece materials
- Identify Clamping Devices
- Perform machining operation

4.1 Safety Rules in Machining Operation

- Ensure that the guards are in position and in good working condition before operating.
- Know the location of emergency stop switch.
- Do not wear loose clothing or jewelry that can be caught in the rotating parts.
- Confine long hair.

4.1.1 Work Piece Materials for Machining

Understanding the work piece material is most important as it gives the idea of selecting the cutting tools and machining parameters. But before knowing about the materials is is important to understand the properties of raw materials. Some of the important properties are as below:

Ductility – It is the measure of the deformation of a material plastically without fracture. Materials with high ductility produces continuous chips whereas the low ductile materials produce segmented chips. Also high ductile materials needs higher cutting forces as compared to the low ductile materials

Hardness – It is the ability of the materials to withstand indentation or deformation. The cutting force required to plastically deform the work piece is very high and heat generation during cutting is high which decreases the tool life.

Toughness – It is the ability of a material to resist impact or absorb the energy of an impact. A higher toughness will lessen the risk of cracking.

Machinability – It is defined as the ease at which the material can be machined. The machinability of a material is affected by other properties like Hardness, Ductility, Thermal conductivity, Composition of the material.

Different types of work piece materials – There are different types of materials available as per the usage. The common materials are as below.

Steel – Most widely used material is steel. Steel contains less than 2% of Carbon and it can be shaped through Hot and Cold working method. There are 3 types of steel – low carbon steel or Mild steel which is having up to 0.3% Carbon, Medium carbon steel having 0.3-0.6% carbon and High carbon steel having more than 0.6% carbon. Steels are widely used in making I-Beams, Auto frames, Pins, Fixtures etc. Steels are soft and gummy in property and generates long chips while machining. High speed and high depth of cut is possible which cutting steel materials and positive rake geometries are used in the cutting tools.

Alloy Steel and Tool Steel – This material are used in making of Tools, Springs, Dies, Punches, Bearings, Shafts etc. It has got higher contents of C, Ni, Cr, Mo. This material provide better surface finish. Negative rake geometries are used in the cutting tools and moderate speed and depth of cut can be achieved in machining of this material.

Stainless Steel – Stainless steel is used mainly in those areas where oxidation or corrosion is a concern. This steel contains less than 1.2% Carbon and should have at least 10.5% Chromium. It provides high strength as compared to carbon and alloy steels.

Cast Iron – Cast iron contains more than 2% carbon. It has got excellent flow properties of molten iron which makes it ideal for making complex shapes such as engine blocks. It has very good property of wear resistance, compressive strength. Cast irons are of 2 different types-Gray cast iron and ductile cast iron. Gray cast iron is used in making Engine blocks, Pipe, Fittings, Castings and having less ductility than the other one. Ductile cast irons are used in making of Crankshafts, Brake disks, Springs, Gears, Housings etc. Gray cast iron provides better machinability and vibration damping properties.

Non Ferrous Materials – Non Ferrous materials are more corrosion resistant, lighter and better conductor of electricity but are expensive than ferrous materials. Aluminum and Al alloys are used extensively in Automotive, Aerospace, Wheels etc. and having very good machinability. Copper, Zinc, Brass.

4.1.2 Clamping Devices

Clamping device is used to minimize the distortion during the machining process. Once the work piece is located, it is necessary to hold it against the machining force. The mechanism used for this is known clamps. They are work holding devices usually positioned above the supporting surfaces.

Clamping force to hold a work piece against locator depends upon

1. Tool forces during operation
2. Positioning method of components

Basic requirement of clamping devices:

The following essential requirement should fulfill by clamping devices

- The clamps must hold the work piece rigidly while machining against all disturbing forces acting on the work piece. The clamping force should only enough to keep the work piece in correct position.
- The clamping should not damage work piece while holding them. The clamp should always contact at most rigid points of the component.
- The clamping should be applied only where the work piece has enough support of the fixture body. It helps to avoid the bending and damaging of the work piece due to clamping force.
- The clamping should not interfere the worker or the operation of machine or tool. It must enable worker to work efficiently and safely.
- Time for loading and unloading of the work piece should be short as possible. i.e. the clamping device must be quick acting.
- Clamping should not loosen during machining process due to vibration and distortion.

4.2 Machining Operation

4.2.1 Lathe machine Operations

1. Facing

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

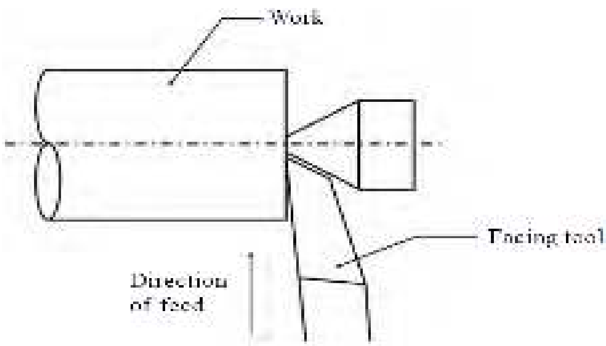


Figure 4.1 Facing

Facing

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

- In facing operations, the cutter bit does not traverse laterally (left or right) but cuts inward or outward from the axis of the piece.
- Facing of the ends is usually performed before turning operations

2. Turning

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

- Straight turning may he performed upon a work-piece supported in a chuck, but the majority of work pieces turned on an engine lathe are turned between centers.
- Turning is the removal of metal from the external or internal surface of cylindrical work pieces using various types of cutter tool bits.

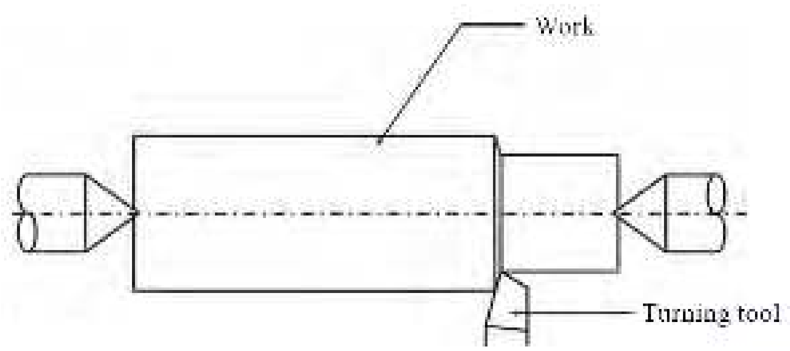


Figure 4.2 Turning

3. Taper turning

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

Taper turning methods

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

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.

Taper Angle is calculated by,

$$Tan\ \theta = \frac{D-d}{2l}$$

Where; D- Larger diameter of work piece

d- Smaller diameter of work piece

l- Taper length

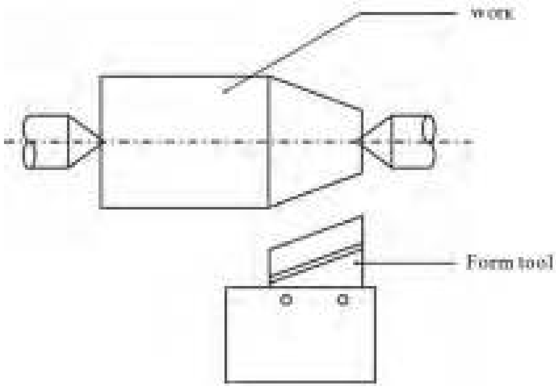


Figure 4.3 Taper Turning

3. Chamfering

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

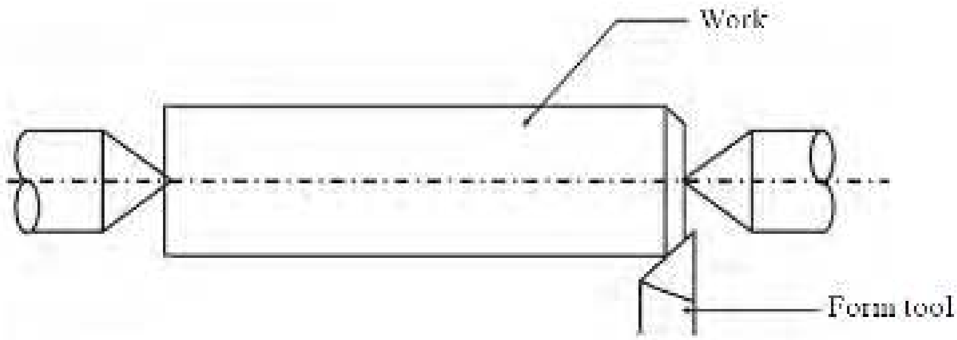


Figure 4.4 Chamfering

4. Grooving:

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

It is commonly called recessing, undercutting, or necking is often done at the end of thread to permit full travel of the nut up to a shoulder, or at the edge of a shoulder to ensure a proper fit of mating parts.

Grooves are generally square, round, or V-shaped.

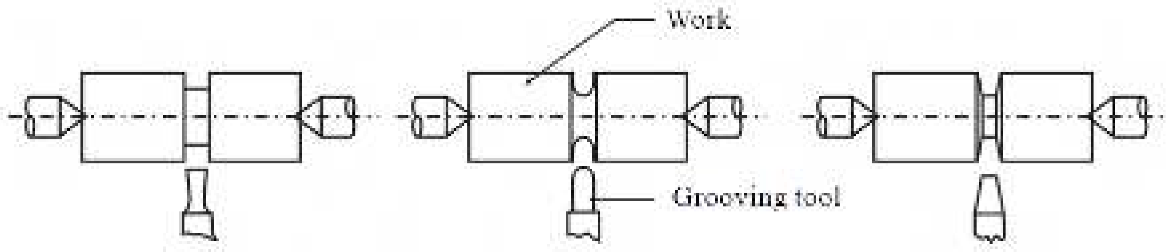


Figure 4.5 Grooving

5. Thread Cutting

A thread is a uniform helical groove cut on or in a cylinder or cone. Thread cutting on a lathe is one of the most exacting lathe operations. It requires a thorough knowledge of the principles and procedures of thread cutting. It ties together a number of operations and dimensions in such a way that accuracy must be maintained to achieve a proper working thread. Before attempting such operations, the operator should have knowledge of the fundamental principles of threads and the types in general use.

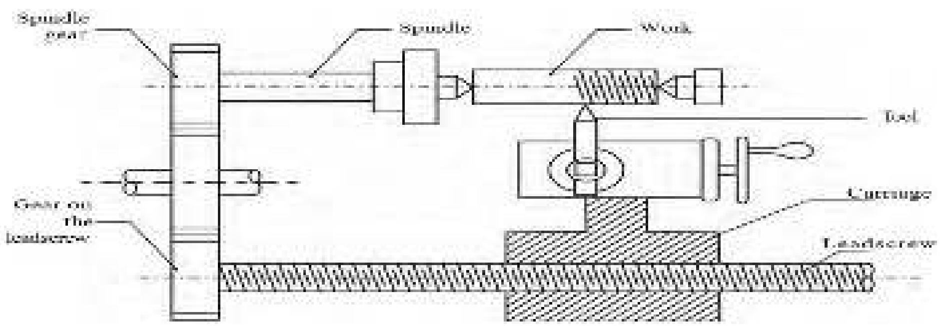


Figure 4.6 Threading

6. 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.

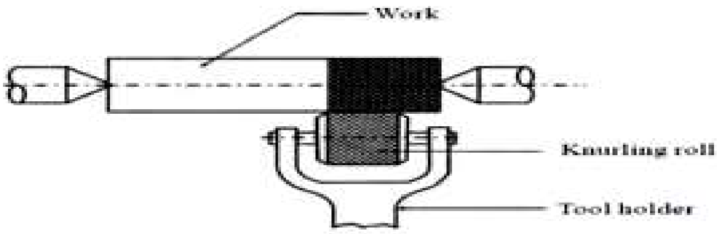


Figure 4.7 Knurling

Self-check-1

Directions: Answer all the questions listed below. Use the Answer sheet provided by your trainers:

A) Choose the correct answer from the give choice for each question

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 **no**t on the lathe include

A. Facing, B. Grooving, C. Slotting D. Parting,

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 C. Tool Material. D. All of the above

5. One of the following is not types of turning

A. Cylindrical turning B. Tapper turning C. Eccentric turning D. Shaping

6. One of the following is **not** types of tapper 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

B) Match column 'B' with column 'A'.

A	B
__________1. Ease of to be machined	A) Non ferrous metals
__________2. Produce continuous chip	B) Hardness
__________3. Withstand indentation	C) Machineability
__________4. Ability to resist impact	D) Ductility
__________5. Aluminum and its alloys	E) Toughness
	F) Stainless steel

C) Answer the following questions

1. Explain;
   i. Steel and stainless steel
   ii. Alloy steel and tool steel
2. Explain the difference between Ferrous and Non-ferrous metals. Give examples
3. Explain the difference between Turning Facing operation.

4. Explain the difference between Threading and Knurling operation
5. List and explain clamping devices for:
   i. Drilling
   ii. Turning
   iii. Milling

Operation sheet-1

Operation title: Facing work piece on lathe machine.

Purpose: To perform and practice how to face work piece on lathe machine.

Instruction: Perform facing operation of work piece on lathe machine by applying the above information. For this operation you have required to apply every PPE and machine and machine shop safety to perform the task.

Tools and equipment requirement:

- Lathe machines with accessories

- HSS cutter
- Vernier caliper

Precautions: For every practice applying PPE, machine and machine shop safety to perform the task is mandatory.

Procedures

The steps to perform facing operations are as follows:

- Mount a three jawed chuck onto the head stock
- Install a Drill chuck into your tailstock
- Secure your stock in the three jawed chuck with about 20mm – 50 mm extending out beyond the jaws.
- Using your "right handed cutting tool" square or face off the end of the stock.
- You want to take off just enough material to clean up the end so make sure that you are not taking too aggressive of a pass.
- Insert a #4 (stamped on to the drill) center drill into the drill chuck on your tailstock Center drill the end about 6mm deep.
- Take your part out of the three jawed chuck, flip it over, and secure it back in the chuck
- Face off the second end. Center drill the second end about 6mm, Take off the smallest amount of material possible.
- When done; remove the work piece and cutter from the machine.

Operation sheet-2

Operation title: Straight turning of work piece.

Purpose: To perform and practice how to straight turning a work piece on lathe machine.

Instruction: Perform straight turning operation on work piece on lathe machine by applying the above information. For this operation you have required to apply every PPE and machine and machine shop safety to perform the task.

Tools and equipment requirement:

- Lathe machines with accessories
- HSS cutters
- Vernier caliper

Precautions: For every practice applying PPE, machine and machine shop safety to perform the task is mandatory.

Procedures

The steps to perform facing operations are as follows:

- Mount a three jawed chuck onto the head stock
- Install a Drill chuck into your tailstock
- Secure your stock in the three jawed chuck
- Set up the tool on center and square to the part.
- When done; remove the work piece and cutter from the machine.

Operation sheet-3

Operation title: Tapering the work piece.

Purpose: To perform and practice how to taper turning a work piece on lathe machine.

Instruction: Perform taper turning operation on work piece on lathe machine by applying the above information. For this operation you have required to apply every PPE and machine and machine shop safety to perform the task.

Tools and equipment requirement:

- Lathe machines with accessories
- HSS cutters
- Vernier caliper

Precautions: For every practice applying PPE, machine and machine shop safety to perform the task is mandatory.

Procedures

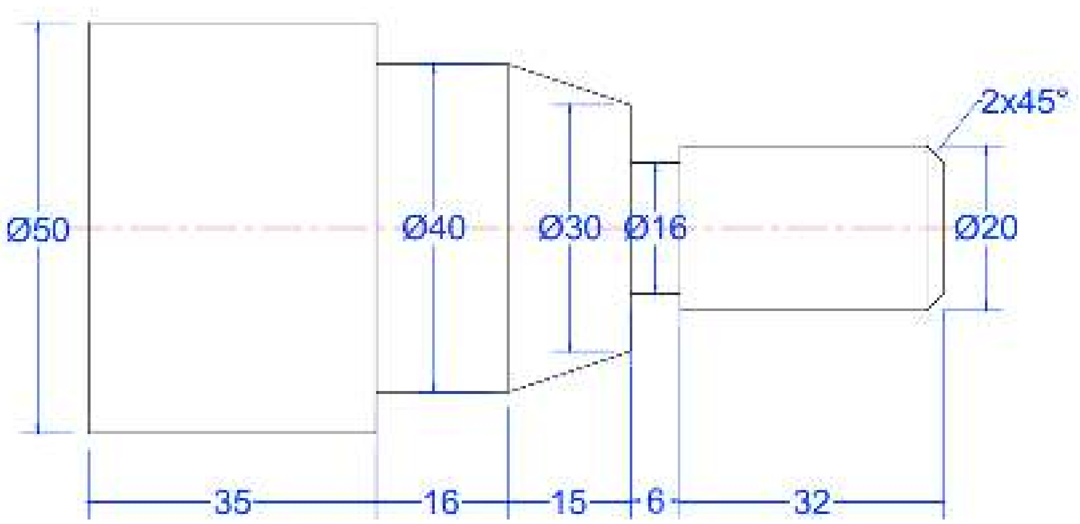
The steps to perform facing operations are as follows:

- Cutting the work piece by using power hacksaw
- Adjust the machine with proper parameters
- Mount the cutter and the work pieces in proper way
- Face the two ends
- Calculate taper angle
- Taper by using of Compound rest method
- Turn the work pieces according to drawing
- When done; remove the work piece and cutter from the machine
- Polishing the work pieces by using sand paper.

LAP Test-1

Task 1: Perform machining operation to fabricate the given Part,

.



Note:

- **Tolerance for dimensions: ±0.1mm**
- **Tolerance for angle: ±0.1°**
- **All dimensions in 'mm'**

Material required for work piece

- Aluminum ingot with 50mm diameter or
- Mild steel

Unit Five: Quality Assure Finished Component

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

- Quality for conformance
- Measuring tools and equipment
- Deviation handling
- Routine Maintenance and Adjustments

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

- Check quality for components
- Identify measuring tools for quality checking
- Handling Deviations
- Perform Routine Maintenance and Adjustments

5.1 Quality for Conformance

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.

5.1.1 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

5.1.2 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.

5.1.3 Techniques of checking conformance

Some common methods are visual; using measuring tools and equipment, industrial computed tomography scanning, microscopy, dye penetrant inspection, magnetic-particle inspection, X-ray or radiographic testing, ultrasonic testing, eddy-current testing, acoustic emission testing, and 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.

5.2 Measuring Tools and Equipment in Checking Conformance

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

Vernier caliper consists principally of:-

- A main scale (the fixed scale);
- A fixed jaw (part of the rule scale);
- A vernier scale (a moving scale);
- A sliding jaw (attached to the moving scale).

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

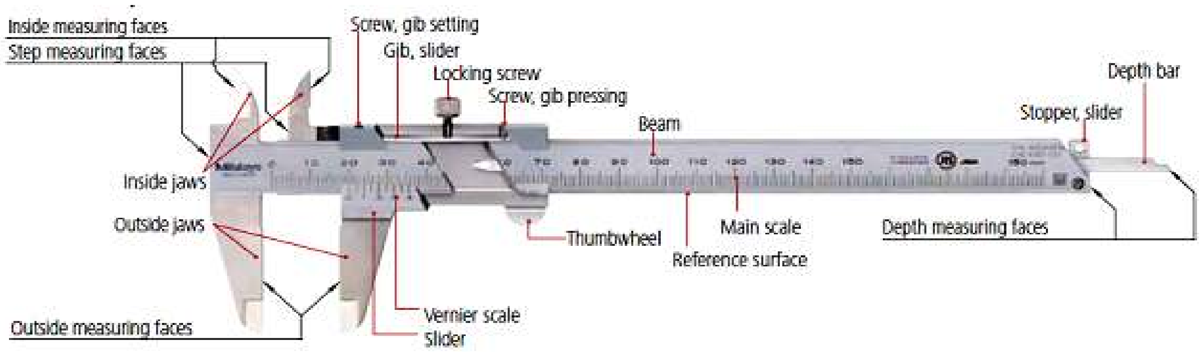


Figure 5.1 Vernier caliper nomenclatures

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.

2. Micro meter

A micrometer is a very useful instrument. It enables you to take measurements to within one hundredth of a millimeter (0.01 mm). The metric micrometer is able to measure ranges of 25 mm (that is, for 0-25 mm, 25-50 mm, and so on). A common type is shown in Figure 5.2.

The micrometer has a thread with pitch 0.5 mm.

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

The procedure for using the micrometer is as follows.

1. Hold the plastic insert to prevent thermal expansion.

2. Keep the measuring faces square with the surfaces that you are measuring, to ensure an accurate measurement.

3. Turn the thimble until the faces touch the work.

4. Use the ratchet (if there is one) to obtain the correct pressure when turning the thimble, and prevent the jaw from moving further when it comes into contact with the work.

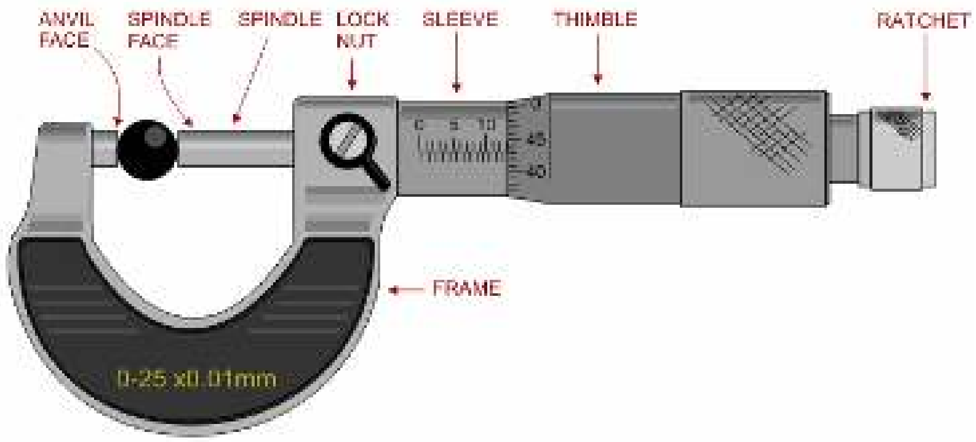


Figure 5.2 Micrometer nomenclatures

3. 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 5.3). It is used for accurate measurement of the depths of holes, slots, keyways and the like.

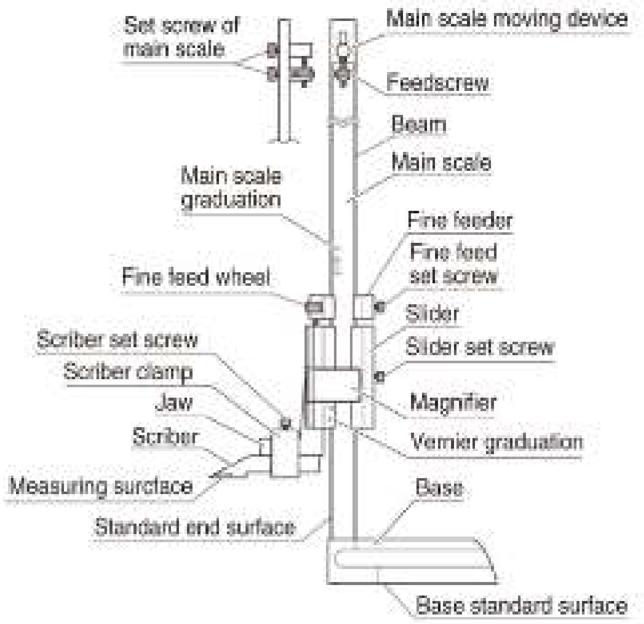


Figure 5.3 Vernier Height Gauge

4. Dial gauge

Dial gauges are used to measure the flatness and inclination of objects. It is used to check round bar roundness. It checks the flatness of an object as compared to the flatness of the standard object. In the mechanical field, dial gauges are used to check the flatness and alignment of various jobs and work pieces.

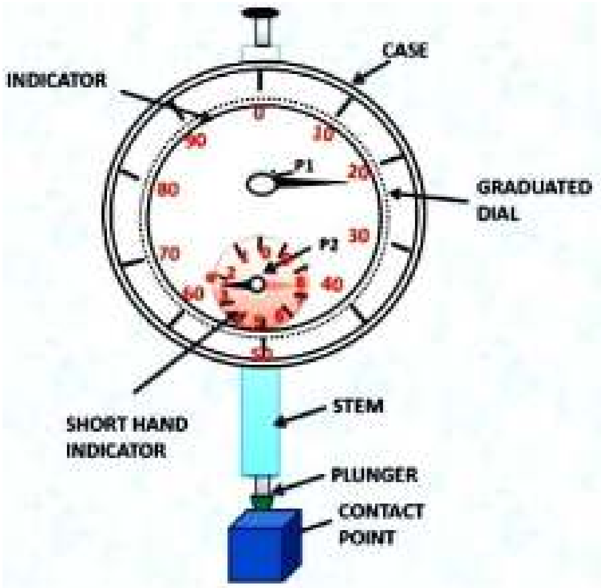


Figure 5.4 Dial gauge

4. Bevel protractor

In geometry, a protractor is a circular or semicircular instrument used for measuring an angle or a circle. The units of measurement used are normally degrees. Some protractors are half-discs that have existed since ancient times.

More advanced protractors, like Bevel Protractors, have one or two swinging arms, which help in measuring the angle. A bevel protractor is a graduated circular protractor it has a pivoted arm used for measuring or marking off angles.

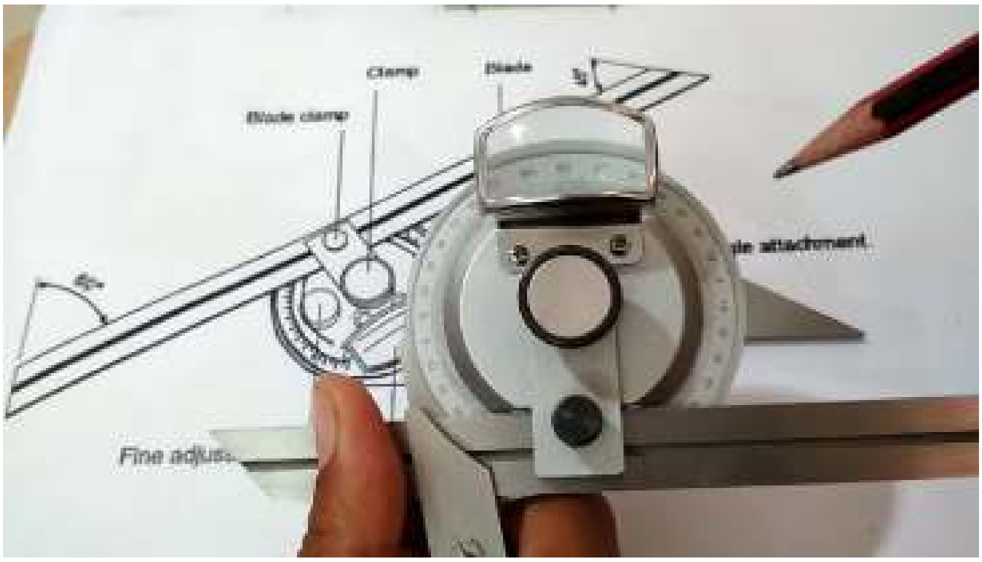


Figure 5.4 Bevel protractor

5.3 Deviations Handling

Deviations are measured differences between observed value and expected or normal value for a process or product condition, or a departure from a documented standard or procedure. A deviation may occur during sampling and testing, raw materials- and finished product acceptance and manufacturing.

5.3.1 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 occurs between both the measurements. Systematic Error / Random Error.

Examples

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

5.3.2 Corrective and Preventive Action

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

- The identified CAPA addresses the root cause;
- The solution can be implemented;
- There is clear understanding of the overall impact of the CAPA;
- Timelines and responsibilities (for implementation) have been reviewed and agreed to;
- There is a plan; and
- There is a monitoring phase.

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

5.4 Routine Maintenance and Adjustments

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

Self-check 1

Directions: Answer all the questions listed below. Use the Answer sheet provided by your trainers:

A) Write True if the statement is correct or False if the statement is incorrect.

1. Product Inspections allow you to verify product quality on operation at one stages of the
production process.
2. A deviation may occur during sampling and testing, raw materials- and finished product.
3. Measurement instruments used to certify manufacturing conformity should be considered early in the design of products.
4. Dial gauges are used to measure the angle and inclination of objects.
5. Today routine maintenance is being considered about avoiding, reducing or eliminating the consequences of failures.

B) Fill in the blank space for each question

1. ___________ is the simplest but very essential form of maintenance system.
2. ____________ is used in conjunction with the surface plate, which has a smooth surface.
3. ___________ are measured differences between observed value and expected or normal value for a process or product condition.
4. ____________ is usually defined as testing to see if an implementation successfully meets the requirements of a standard or specification.
5. The vernier scale is graduated to read up to ________ mm.
6. The differences that occurs between both the measurements is________/_______.

C) Answer the following question

1. Write the difference between preventive and corrective maintenance.
2. Mention the instruments used to check conformance and explain each.
3. What are the causes of error in measurements? List and explain.
4. What it mean by Non-Conformance?
5. Explain about routine maintenance in product quality checking.

Operation sheet-1

Operation title: Product conformance.

Purpose: To check whether the product meet the requirement of standard or specification.

Instruction: Perform product conformance checking using appropriate measuring and inspecting tools.

Tools and equipment requirement:

- Steel rule
- Vernier caliper
- Micrometer

Precautions: For every practice applying PPE, tool and equipment safety.

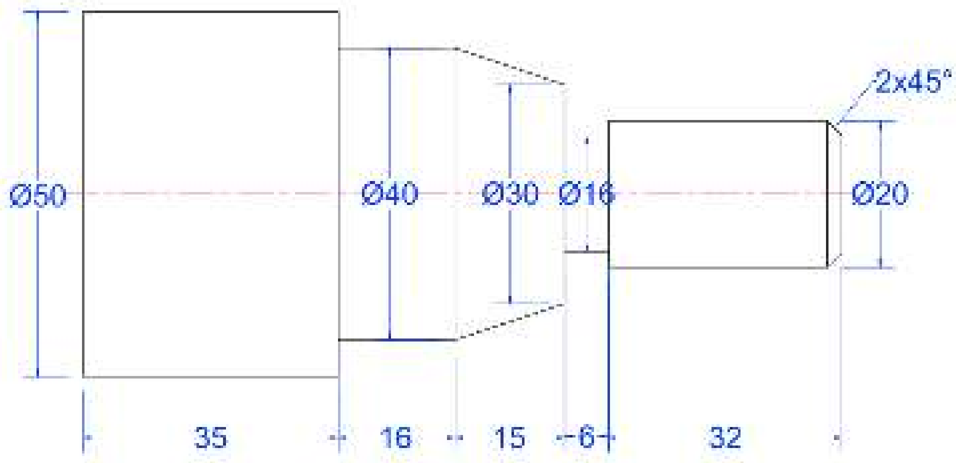
Procedures

The steps to perform facing operations are as follows:

- Prepare the product which is already machined
- Clean the product from burs or chip
- Measure/inspect each given size or dimension
- Record measured result in a given chart
- Calculate deviations
- Compare the deviation with the given Tolerances
- Make your decision whether the product meet specification or not.

LAP Test 1

Task 1: Perform conformance checking on the given product.



Tolerance for dimensions: ±0.1mm
Tolerance for angle: ±0.1°

Product Name:			**Drawing No.:**	
Sample Measured	**Actual(mm)**	**Measured(mm)**	**Deviation(mm)**	**Remark**
Diameters	50			
	40			
	30			
	20			
	16			
Length	35			
	32			
	16			
	15			
	6			
	2			
Taper angle	**Calculated**	**Measured**		
Is the product meet the Conformance?		□Yes		□ No
Checked by:			**Approved by:**	