Sanghita

MACHINE SHOP

The shop where machining operations are performed. Machining is a manufacturing process in which the raw material is processes by removing unwanted material with the help of machines. Different machine used in machine shop are:

1. Lathe machine
2. Shaper
3. Milling machine
4. Planning machine
5. Drilling machine
6. Grinding machine
7. Threading machine

LATHE

A lathe is a powered mechanical device in which the work is held and rotated against a suitable cutting tool fore producing cylindrical forms in the metal, wood or any other machinable material

TYPE OF LATHE

a) Precision lathe
b) Tool room lathe
c) Capstan and turret lathe
d) Automatic lathe
e) Speed lathe
f) Engine lathe
g) Bench lathe
h) Special purpose lathe

THE PRINCIPLE OF LATHE

1. BED: The IT is the base or foundation of lathe. It is casting made in one piece. It holds or support all other parts of lathe.

2. HEAD STOCK: It is a permanently fastened on the innerways at the left hand end of the bed. It supports spindle and driving arrangements. All lathe receive their power through head stock.

3. TAILSTOCK: It is the counter part of head stock of is situated at the right end of the bed. It is used fore supporting the work when turning on centers or when a long component is to be held in a chuck.

4. CARRIAGE: It is located between headstock. It can slide along bed guide ways and be locked at any position by tightening the carriage lock screws. It consist of following

Five main parts;

1. APRRON: It is fastened to saddle. It contains gears and clutches for transmitting motion from feed rod and hand wheel to the carriage. Also split nut which engages with the lead screw during threading. The Clutch mechanism is used for transmitting motion from feed rod whereas the split nut along with the lead screw moves the carriage during thread cutting

2. SADDLE: It is made up of H shaped casting. It aids saddle to slide on bed guideways by operating hand wheels.

3. COMPOUND REST: It supports the tool post and cutting tool in its various positions. It may be swiveled on the cross-side to any angle in the horizontal plane.

4. CROSS-SLIDE: It is provided with a female dovetail on one side and assembled on top of saddle having a mail dovetail.

5. TOOL POST: It is used to hold various tool holders and tools. Three types of tool post commonly used are;
   a) Ring and rocker tool post.
   b) Square head tool post.
   c) Quick change tool post

6. LEGS: The are supports which carry entire load of the machine. Legs are casted and it is placed on the floor of the shop on foundation by grouting. The left leg acts as a housing for the motor, the pulleys and the counter shaft at the same time the right leg acts as a housing or the coolant tank, pump and the connecting parts.

   SPECIFICATION OF LATHE: The size of the lathe is specified by one of the following ways:
   A) Length of the bed.
   B) Distance between centres
   C) Diameter of the work which can be turned between the ways
   D) Swing over carriage

SHAPER

Shaper is a versatile machine which is primarily intended for producing flat surfaces. The surfaces may be horizontal, vertical or inclined. This machine involves the used of single point tool held in a properly designed tool box mounted on a reciprocating ram.

CLASSIFICATION OF SHAPERS;

1. According to the ram driving mechanism

a) Crank shaper
b) Geared shaper
c) Hydraulic shaper

2. According to position and travel of ram
   a) Horizontal shaper
   b) vertical shaper

3. According to direction of cutting stroke
   a) Push cut shaper
   b) draw cut shaper

4. According to design of table
   a) Plain shaper
   b) Universal shaper

MILLING

It is a machine tool in which metal is removed by means of a Revolving cutter with many teeth, Each teeth has an edge which removes metal.

TYPE OF MILLING MACHINE

(1) COLUMN & KNEE TYPE MILLING;
   (a) Horizontal milling machine (b) vertical milling machine
   (c) Universal milling machine.

(2) PLANER MILLING MACHINE
(3) FIXED BED TYPE
(4) SPECIAL purpose milling machine.

PARTS OF MILLING

(1) BASE; It is a heavy casting on which column and other parts are mounted .
(2) COLUMN; There are guide ways on the front face of the column on which knee slides.
(3) KNEE; It supports the saddle table, work piece and other damping device.
(4) SADDLE; It is mounted on the knee and can be moved by a hand wheel.
(5) TABLE; It is mounted on the saddle and can be moved by hand or automatic power feed.
(6) ARBOR; It holds and drives different types of milling cutters.
(7) SPINDLE; It gets power from gears, belt drivers to drive the moter . It has the power to add or remove milling cutter on the arbor.

OTHER TOOLS IN MACHINE SHOP

Measuring Tools

1. Steel Rule
2. Vernier Caliper (L.C.-0.02mm)

3. Out Side Micro Meter (0.01mm)
4. In side caliper / out side caliper
5. Threading gauge
6. Vernier height gauge
7. Dial indicator
8. Surface gauge
9. Radius gauge
10. Feeler gauge
11. Surface plate

CUTTING TOOLS

1. Single point cutting tool
2. Internal / external threading tool
3. Parting off tool
4. Boring tool
5. Knurling tool
6. Round split die / spring die
7. Tap set
8. Twist drill
9. Taper shank drill
10. Smooth file

MISCELLANEOUS TOOLS

1. Double ended spanner
2. Ring spanner
3. Allen key set
4. (l) shape socket wrench

LATHE MACHINE ACCESSORIES & ATTACHMENT

1. Live Centre / dead center or revolving center.
2. Job or dog carrier
3. Mandrel
4. Collet chuck
5. Drill chuck
6. Steady rest
7. Face plate
8. Angle plate
9. Three jaw chuck or four jaw chuck

- **Cutting Speed:** The cutting speed (v) of a tool is the speed at which the metal is removed by the tool from the workpiece. In a lathe it is the peripheral speed of the work past the cutting tool expressed in meters per minute.

Cutting Speed = m/min.

Where, 'd' is the diameter of the work in mm. and 'n' is the r.p.m of the job.

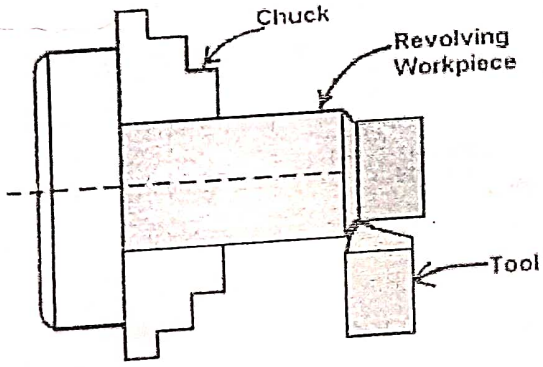
- **Feed:** The feeds of a cutting tool in a lathe work is the distance the tool advances for each revolution of the work.Feed is expressed in mm/revolution. Increased feed reduces the cutting time. But increased feed greatly reduces the tool life. The feed depends on factors such as size, shape, strength, and method of holding the component.
- **Depth Of Cut:** The depth of cut (t) is the perpendicular distance measured from the machined surface to the uncut surface of the work piece.In a lathe the depth of cut is expressed as follows:

Depth of cut= $(d_1-d_2)/2$

Where d_1= dia. of the work surface before machining, and d_2= dia of the machined surface.

Turning:

It is the most common type of operation in all lathe machine operations. Turning is the operation of removing the excess material from the workpiece to produce a cylindrical surface to the desired length.



Turning Operation

The job held between the centre or a chuck and rotating at a required speed. The tool moves in a longitudinal direction to give the feed towards the headstock with proper depth of cut. The surface finish is very good.

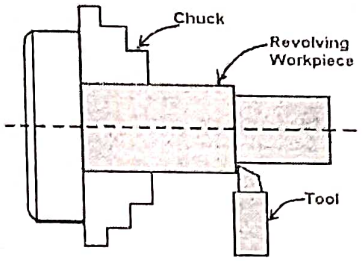
1. Straight Turning:

The workpiece is held on the chuck and it is made to rotate about the axis, and the tool is fed parallel to the lathe axis. The straight turning produces a cylindrical surface by removing excess metal from the workpiece.

2. Rough Turning:

It is the process of removal of excess material from the workpiece in a minimum time by applying high rate feed and heavy depth of cut. in rough turning the average depth of cut 2mm to 4mm can be given and feed is from 0.3 to 1.5mm per revolution of the work.

3. Shoulder Turning:



Shoulder Turning

When a workpiece has different diameters and is to be turned, the surface forming steps from one diameter to the other is called the shoulder, and machining this part of the workpiece is called shoulder turning.

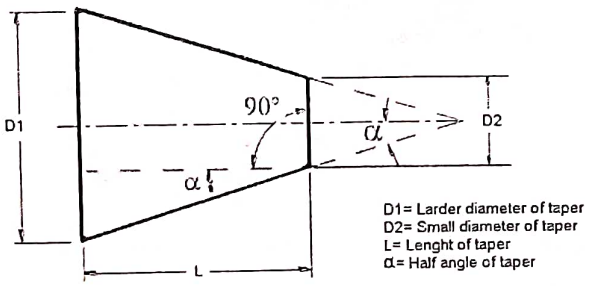
Eccentric turning

When a cylindrical surface two separate axis of rotation, with the first axis, is offset to the other axis then such a workpiece is machined by the operation called eccentric turning. Here three sets of centre holes are drilled.

By holding the workpiece at these three centres the machining operation for each of the surface can be completed.

Taper Turning:

- A "taper" is the uniform increase or decrease in the diameter of the workpiece and measured along with its length.
- Taper turning means to produce a conical shape by a gradual reduction in diameter from a cylindrical workpiece.



The amount of taper in the workpiece is usually specified on the basis of the difference in diameter of the taper to its length. It is known as a cone and it is indicated by the letter K.

It has the formula K = D-d / 1 to produce the taper on the workpiece.

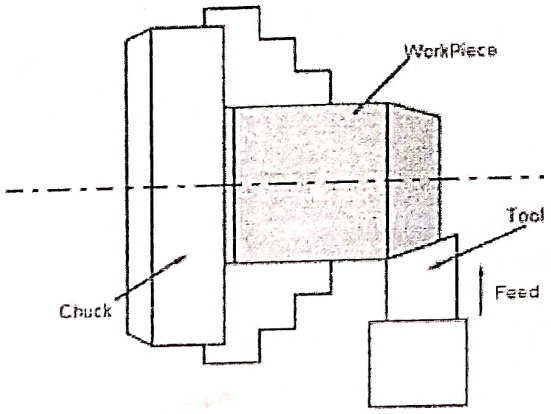
- D = Larger diameter of taper.
- d = Small diameter of taper.

In case of lathe, the taper on a given workpiece is obtained by tuning the job and feeding the tool at an angle to produce a gradual increase or decrease in the diameter of the workpiece.

- The two important types of tapers are,
  - "More taper" here, the angle is very small and varies from 1.4 to 1.5°.
  - "Metric taper" is available in seven standard sizes with standard taper angles.
- Methods of taper turning,
  - Form tool method
  - Combined feeds method
  - Compound rest method or swivelling compound rest method
  - Tailstock set over method
  - Taper turning attachment method

1. Form tool method

Here the taper length obtain is equal to the width of the form tool. To obtain the required size of the taper the form tool is fed slowly straight into the workpiece by operating the cross slide perpendicular to the lathe axis.



Taper Turning Using Form Tools.

This is the simplest method of taper turning. It is limited to obtain small taper length such as chamfering the side of the workpiece. The method is done at a faster rate.

Disadvantages of taper turning attachment:

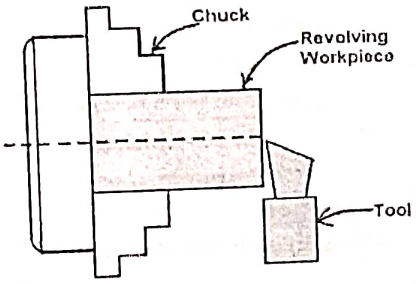
- It requires additional mounting facilities.
- Fitting and removing attachment consume more time.
- The attachment has to take large forces.

Tailstock set over method

Here the workpiece on the job is tilted at the required taper angle. The tool is fed parallel to the axis.

The tilting of the workpiece or the job to the required taper angle is achieved by the movement of tailstock with the help of tailstock set over the screw. This method is useful for small tapers.

Facing:

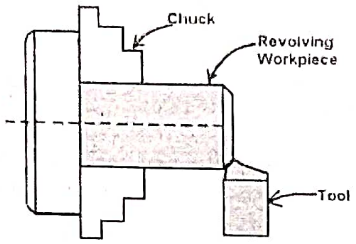


Facing Operation

It is an operation of reducing the length of the workpiece by feeding the perpendicular to the lathe axis. This operation of reducing a flat surface on the end of the workpiece. For this operation, regular turning tool or facing tool may use. The cutting edge of the tool should set to the same height as the centre of the workpiece.

- Facing consist of 2 operations
    - Roughing: Here the depth of cut is 1.3mm
    - Finishing: Here the depth of cut is 0.2-0.1mm.

Chamfering operation

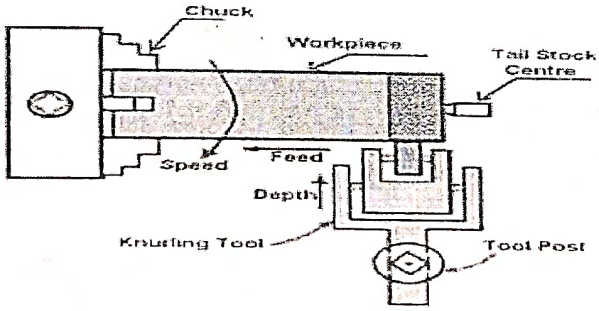


Chamfering

It is the operation of getting a bevelled surface at the edge of a cylindrical workpiece. This operation is done in case of bolt ends and shaft ends. Chamfering helps to avoid damage to the sharp edges and protect the operation getting hurt during other operations. Chamfering on bolt helps to screw the nut easily.

Knurling operation

It is an operation of obtaining a diamond shape on the workpiece for the gripping purpose. This is done to provide a better gripping surface when operated by hands. It is done using a knurling tool. The tool consists of a set of hardened steel roller, and it is held rigidly on the toolpost.

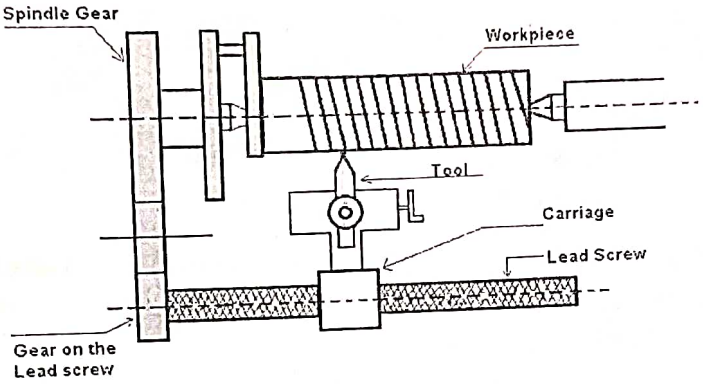


Knurling

Knurling is done at the lowest speed available on a lathe. It is done on the handles and also in case of ends of gauges. The feed varies from 1 to 2 mm per revolution. Two or three cut may be necessary to give the full impression.

Thread cutting

It is the important operation in the lathe to obtain the continuous "helical grooves" or " threads''. When the threads or helical grooves are formed on the out surface of the workpiece is called external thread cutting. When the threads or helical grooves are formed on the inner surface of the workpiece is called internal thread cutting. The workpiece is rotating between the two centres i.e., live centre and dead centre os the lathe.



Thread Cutting

Here the tool is moved longitudinally to obtain the required type of the thread. When the tool is moved from right to the left we get the left-hand thread. Similarly, when the tool is moved from left to the right we get the right-hand thread.

Here the motion of the carriage is provided by the lead screw. A pair of change gears drives the lead screw and by rotating the handle the depth of cut can be controlled.

Filling

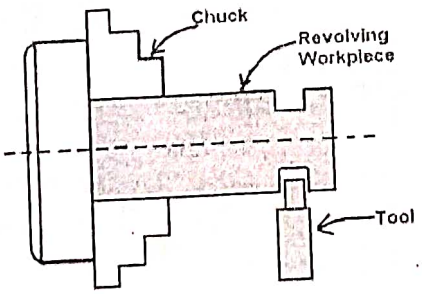
It is the finishing operation performed after turning. This is done on a lathe to remove burrs, sharp corners, and feed marks on a workpiece and also to bring it to the size by removing the very small amount of metal.

The operation consists of passing a flat single cut file over the workpiece which revolves at a high speed. The speed is usually twice that of turning.

Polishing

This operation is performed after filing to improve the surface quality of the workpiece. Polishing with successively finer grades of emery cloth after filing results in very smooth, bright surface. The lathe is run at high speeds from 1500 to 1800m per min, and oil is used on the emery cloth.

Grooving



Grooving

It is the process of reducing the diameter of a workpiece over a very narrow surface. It is done by groove tool. A grooving tool is similar to the parting-off tool. It is often done at the end of a thread or adjacent to a shoulder to leave a small margin.

Spinning

it is the process of forming a thin sheet of metal by revolving the job at high speed and pressing it against a headstock spindle. A support is also given from the tailstock end.

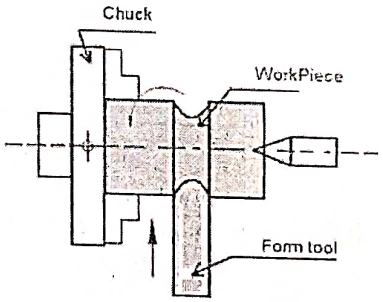
Spring Winding

Spring winding is the process of making a coiled spring by passing a wire around a mandrel which is revolved on a chuck or between centres. A small hole is provided on the steel bar, which is supported by Tool Post and the wire is allowed to pass through it.

Forming

It is the process of turning a convex, concave or of any irregular shape. Form-turning may be accomplished by the following method:

1. Using a forming tool.
2. Combining cross and longitudinal feed.
3. Tracing or copying a template.

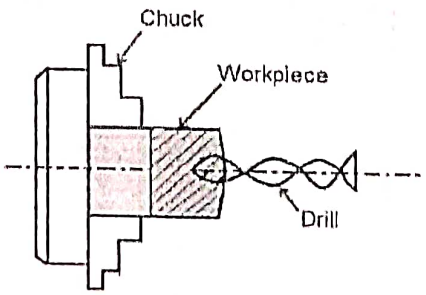


Forming Operation

2. Lathe machine operations (holding the work by a chuck)

Lathe machine operations performed by holding the work by a chuck or a faceplate or an angle plate are:

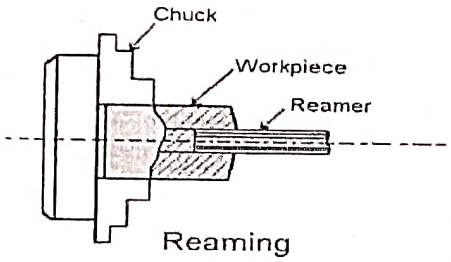
Drilling



Drilling

Drilling is the operation of producing a cylindrical hole in a workpiece. It is done by a rotating tool, the rotating side of the cutter, known as drilling drill.In this operation, The workpiece is revolving in a chuck or a faceplate and the drill is held in the tailstock drill holder or drill chuck.The feeding is adopted is affected by the movement of the tailstock spindle. This method is adopted for the drilling regular shaped workpiece.

Reaming

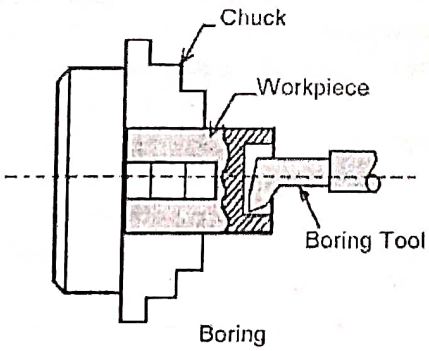


Reaming

Reaming is the operation of finishing and sizing a hole which has been already drilled or bored. The tool is used is called the reamer, which has multi-plate cutting edges.
The reamer is held on the tailstock spindle, either directly or through a drill chuck and is held stationary while the work is revolved at a very slow speed.

Boring

Boring is the operation of enlarging the hole which is already drilled, punched or forged. It cannot produce a hole. Boring is similar to the external turning operation and can be performed in a lathe. In this operation, the workpiece is revolved in a chuck or a faceplate and the tools which are fitted to the tool post is fed into the work.



Boring

It consists of a boring bar having a single point cutting tool which enlarges the hole. It also corrects out of roundness of a hole. This method adopted for boring small-sized works only. The speed for this process is slow.

Counterboring

Counterboring is the operation of enlarging the end of the hole through a certain distance. It is similar to a shoulder work in external turning.

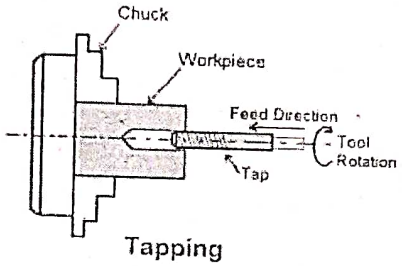
The operation is similar to boring and plain boring tools or a counterbore may be used. The tool is used called as a counterbore. The speed is slightly less than drilling.

Taper Boring

The principle of turning a tapered hole is similar to the external taper turning operation and is completed by rotating the work on a chuck or a faceplate. The feeding tool is at an angle to the axis of rotation of the workpiece.

A boring tool is mounted on the tool post and by swivelling the compound slide to the desired angle, a short taper hole is machined by hand feeding.

Tapping



Tapping

Tapping is the operation of cutting internal threads of small diameter using a multipoint cutting tool called the tap.In a lathe, the work is mounted on a chuck or on a faceplate and revolved at a very slow speed.

A tap of required size held on a special fixture is mounted on the tailstock spindle.

Undercutting

Undercutting is similar to grooving operation when performed inside a hole. It is the process of boring a groove or a large hole at a fixed distance from the end of a hole.

This is similar to the boring operation, except that a square nose parting is used. Undercutting is done at the end of an internal thread or a counterbore to provide clearance for the tool or any part.

Lathe machine operations (using special attachments)

Lathe machine operations are performed by using special attachments:

Milling

Milling is the operation of removing metal by feeding the work against a rotating cutter having multiple cutting edges.

For cutting keyways or grooves, the work is supported on the cross-slide by a special attachment and fed against a rotating milling cutter held by a chuck. The depth of cut is given by vertical adjustment of the work provided by the attachment.

The depth of cut is given by verticle adjustment of the work provided by the attachment. The feeding movement is provided by the carriage and the vertical movement of the cutter is arranged in the attachment.

Grinding

Grinding is the operation of removing metal in the form of minute chips by feeding the work against a rotating abrasive wheel known as the grinding wheel.

Both internal and external surface of a workpiece may be ground by using a special attachment mounted on the cross slide. For the grinding external surface, the work may be revolved between centres or on a chuck. For internal grinding, the work must be revolved on a chuck or faceplate. The feeding is done by the carriage and the depth of cut is provided by the cross slide. Grinding is performed in a lathe for finishing a job, sharpening a cutter, or sizing workpiece after it has been hardened.

Lathe Cutting Tools

A machine tool is no more efficient than its cutting tool. There is nothing in shop work that should be given more thoughtful consideration than cutting tools. Time is always wasted if an improperly shaped tool is used. The cutting action of the tool depends on its shape and its adjustment in the holding device. Lathe cutter bits may be considered as wedges which are forced into the material to cause compression, with a resulting rupture or plastic flow of the material. The rupture or plastic flow is called cutting. To machine metal efficiently and accurately, it is necessary that the cutter bits have keen, well-supported cutting edges, and that they be ground for the particular metal being machined and the type of cut desired. Cutter bits are made from several types of steel, the most common of which are described in the following subparagraphs.

(1) Carbon Steel. Carbon steel, or tool steel is high in carbon content, hardens to a high degree of hardness when properly heated and quenched. The carbon-steel tool will give good results as long as constant care is taken to avoid overheating or "bluing," since the steel will lose its temper or hardness at a relatively low heat becoming ineffective as a cutting tool. For low-speed turning, high carbon steels give satisfactory results and are more economical than other materials.

1. (2) High-Speed Steel. High-speed steel is alloyed with tungsten and sometimes with chromium, vanadium, or molybdenum. Although not as hard as properly tempered carbon steel, the majority of lathe cutting tools are made of high-speed steel because it retains its hardness at extremely high temperatures. Cutter hits made of this material can be used without damage at speeds and feeds which heat the cutting edges to a dull red.

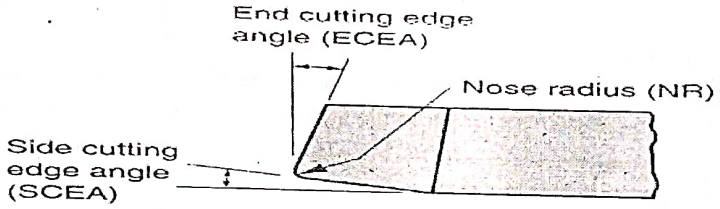
2. (3) Stellite. These cutter bits will withstand higher cutting speeds than high-speed steel cutter bits. Stellite is a nonmagnetic alloy which is harder than common high-speed steel. The tool will not lose its temper, even though heated red hot from the friction that is generated by taking a cut. Stellite is more brittle than high-speed steel. To prevent breaking or chipping, it requires just enough clearance to permit the tool to cut freely. Stellite is also used for machining hardened steel, cast iron, bronze, etc.

3. (4) Tungsten Carbide. Tungsten carbide is used to tip cutter bits when maximum speed and efficiency is required for materials which are difficult to machine. Although expensive, these cutter bits are highly efficient for machining cast iron, alloyed cast iron, copper, brass, bronze, aluminum, Babbitt metal, and such abrasive nonmetallic materials as fiber, hard rubber, and bakelite. Cutter bits of this type require very rigid support and are usually held in open-side toolposts. They require special grinding wheels for sharpening, since tungsten carbide is too hard to be redressed on ordinary grinding abrasive wheels.

4. (5) Tantalum Carbide and Titanium Carbide. These cutting tools are similar to tungsten carbide tools but are used mostly for machining steel where extreme heavy cuts are taken and heat and pressure tend to deform the cutting edge of the other types of cutting tools.

IMPORTANT TERMS OF SINGLE POINT CUTTING TOOL

- seven element defining the tool signature



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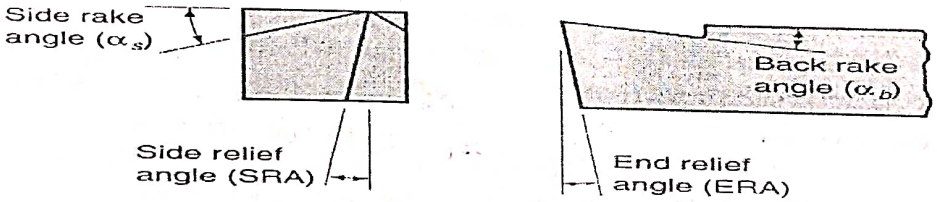


(b) Tool signature: α_b, α_s, ERA, SRA, ECEA, SCEA, NR

SINGLE POINT CUTTING TOOL SIGNATURE –

The signature isa sequenced of numbers listing the various angles, in degrees, and the size of a nose radius. This numerical method of identification has been standardized by the American Standard Association.

The seven elements that comprise the signature of a single point cutting tool are always stated in the following order: back rake angle, and nose radius. Thus a tool with a shape specified as

8-14-6-6-6-15-4

has 8° back rake, 14° side rake, 6° end relief, 6° end or side relief, 6° end cutting edge, and 15° side cutting edges angles, and 4 mm nose radius.

- **Back Rake Angle:** It indicates that the plane which forms the face or top of a tool has been ground back at an angle sloping from the nose.

- **Side Rake Angle:** It indicates that the plane that form the face or top of a tool has been ground back at an angle sloping from the side cutting edge.
- **End Relief Angle:** It indicates that the nose or end of a tool has been ground back at an angle sloping down from he end cutting edge.
- **Side Relief Angle:** It indicates that the plane that forms the flank or side of a tool has been ground back at an angle slopping down from the side cutting edge.
- **End Cutting Edge Angle:** It indicates that the plane which forms the end of a tool has been ground back at an angle sloping from the nose to the side of the shank.
- **Side Cutting Edge Angle:** It indicates that the plane which forms the flank or side for a tool has been ground back at an angle to the side of the shank.

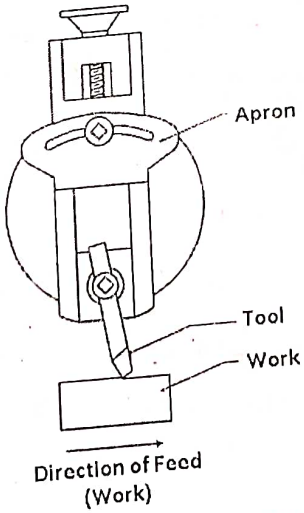
The following are the different shaper machine operations:

1. Machining horizontal surface
2. Vertical surfaces
3. Angular surfaces
4. Irregular surfaces
5. Cutting slots, grooves and keyways
6. Machining splines or cutting gears.

The various shapes of surfaces ate the result of either one or a combination of more than one of the above operations.

1. Machining Horizontal Surfaces

It is the most common shaper machine operations. In this, the work is fed in a horizontal direction under the reciprocating tool and the surface produced is horizontal and flat.



MACHINING OF HORIZONTAL SURFACE

The work is either held in a vice or clamped directly on the machine table, depending upon its size. The tool is held in a proper tool holder. It is set at a proper inclination and at the

For B.Tech (Workshop Practice Lab-ME192)

Shop Name: Machine Shop

Date:

Title: Various types of machining operations on a Mild Steel Rod (ϕ 32 mm × 110 mm) on Lathe.

Job Sketch:

Job Specification:

Schematic Diagram of Lathe:

Work Chart:

Holding tool

Sl. No.	Operations Involved	sketch	Measuring Tool	Marking Tool	Cutting Tool and tool material
1	Marking (110 mm length)				
2	Parting off the marked portion				
3	Centering				
4	Facing				
5	Straight Turning (ϕ __ mm to ϕ__mm) Length:				
6	Step Turning (ϕ__ mm to ϕ__mm) Length:				
7	Chamfering 2×45° (for 2 mm length and at an angle of 45°)				
8	Taper Turning (for __ mm length and with taper angle __°)				
9	Grooving				
10	Thread Cutting (for __ mm length with __ mm pitch)				

Safety Precautions:

Description of the Operations Involved:

~~Description of Tools used:~~

~~Description of Lathe:~~

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DEPARTMENT OF MECHANICAL ENGINEERING

Sample Questions (Workshop Practice)

LATHE

1. What is Machine? What are Machine Tools?
2. What is the difference between Machine and Machine Tool?
3. What are the different parts of Lathe? Draw the block diagram of Lathe and level its parts.
4. How is a Lathe specified?
5. Explain the terms: Cutting speed, Feed, Depth of cut in relation to turning.
6. Name and explain the different operations (Centering, Facing, Turning, Step Turning, Grooving, Chamfering, Drilling and Knurling) that can be performed on the lathe machine with suitable sketches.
7. Write functions of Lead Screw and Feed Rod of a Lathe.
8. Which materials are commonly used as cutting tool material? What are the good characteristics of cutting tool material?
9. What do you mean by taper? What are the different methods to cut taper on Lathe? Explain with neat sketch how to cut taper by swivelling the compound rest.
10. What is tool nomenclature? Draw a neat sketch of single point cutting tool and describe the functions of its angles.
11. What is coolant? What are the characteristics of a good coolant?
12. Describe thread cutting mechanism in Lathe with suitable sketch.

BASIC IDEA MATERIALS & MANUFACTURING PROCESSES