LATHE

INTRODUCTION

1) The lathe is one of the most important machines in any workshop.
2) Its main objective is to remove material from outside by rotating the work against a cutting tool.
3) Though a lathe is used to produce cylindrical work, yet it may also be used for many other purposes such as drilling, threading, grinding, milling, turning, boring, reaming, knurling, etc.
4) In addition to it, with help special attachments, operations like key-way cutting, cam & gear cutting, shaping, fluting can be carried out.

Q. What is working Principle of a Lathe?
The working principle of a lathe is shown in Fig.5.1

1) In a lathe, the workpiece is held in a chuck or between centres and rotated about its axis at a uniform speed.
2) The cutting tool held in the tool post is fed into the workpiece for a desired depth and in the desired direction (i.e., in the linear, transverse or lateral direction).
3) Since there exists a relative motion between the workpiece and the cutting tool therefore the material is removed in the form of chips and the desired shape is obtained.
Q. **Give classification of lathe.**

Lathes are classified according to

1) The design,
2) Type of drive,
3) Arrangement of gears and
4) Purpose.

The following are important types of lathe:

1. **Speed lathe.**
   a) It is one of the simplest types of all types all lathes.
   b) It is driven by power and consists of a bed, a headstock, a tailstock and an adjustable slide for supporting the tool.
   c) Since the tool is fed into the work by hands and cuts are very small, therefore this type of lathe is driven at high speeds usually from 1200 to 3600 r.p.m.
d) The work may be held between centres or attached to a face plate on the headstock.

e) The speed lathe is used mainly for wood working, centering, metal spinning, polishing etc.

2. Engine or centre lathe.

a) It is a general purpose lathe and is widely used in workshops.

b) It differs from a speed lathe that it has additional mechanism for controlling the spindle speed and for supporting and controlling the feed of the fixed cutting tool.

c) The cutting tool may be led both in cross and longitudinal direction with reference to the lathe axis with the help of a carriage.


a) The bench lathe is so small that it can be mounted on a bench.

b) All the types of operation can be performed on this lathe that may be done on an ordinary speed or engine lathe.

c) This is used for small work usually requiring considerable accuracy such as in the production of gauges, punches and beds for press tools.

4. Tool room lathe.

a) The tool room lathe is similar to an engine lathe and is equipped with all accessories needed for accurate tool work.

b) It has an individually driven geared headstock with a wide range of spindle speeds.

c) Since this lathe is used for precision work on tools, gauges, dies, jigs and other small parts, therefore greater skill is needed to operate the lathe.

5. Capstan and turret lathe.

a) The capstan and turret lathes are the modification of engine lathes and is particularly used for mass production of identical parts in the minimum time.

b) These lathes are semi-automatic and are fitted with multi tool holding devices, called capstan and turret heads.
c) The advantage of capstan and turret lathe is that several different types of operations can be performed on a workpiece without resetting of work or tools.

**6. Automatic lathes.**

a) The automatic lathe are so designed that the tools are automatically fed to the work and withdrawn after all the operations are complete to finish the work.

b) Since the entire operation is automatic, these lathes require little attention of the operator.

c) These lathes are used for mass production of identical parts.

**7. Special purpose lathes.**

a) The work which can not be conveniently accommodated or machined on a standard lathe, the special purpose lathes are used.

b) The **Gap bed lathe** which has a removable section in the bed in front of the headstock to provide a space or gap is used to swing extra large diameter jobs.

c) The **Wheel lathe** is made for finishing the journals and turning the tread on railroad car and locomotive wheels.

**Q. How lathe is specified? Or what is the size of the lathe?**

The size of a lathe is expressed or specified by the following items and illustrated in Fig. 5.3

1. The height of the centres measured from the lathe bed.

2. The swing diameter over bed. This is the largest diameter of work that will revolve without touching the bed and is twice the height of the centre measured from the bed of the lathe.

3. The length between centres. This is the maximum length of work that can be mounted between the lathe centres.

4. The swing diameter over carriage. This is the largest diameter of work that will revolve over the lathe saddle, and is always less than the swing diameter over bed.

5. The maximum bar diameter. This is the maximum diameter of bar stock that will pass through hole of the headstock spindle.
6. The length of bed. This indicates the approximate floor space occupied by the lathe.

Q. List the parts of the lathe. And explain any one of them.

Fig. illustrates the basic parts of a geared head lathe. Following are the principal parts:
Bed, Headstock, Tailstock, Carriage, Feed mechanism and Screw cutting mechanism.

**THE BED**
The lathe bed forms the base of the machine. The headstock and the tailstock are located at either end of the bed and the carriage rests over the lathe bed and slides on it.
The lathe bed being the main guiding member of the tool, for accurate machining work, must satisfy the following conditions:

1. It should be sufficiently rigid to prevent deflection under tremendous cutting pressure transmitted through the tool-post and carriage to the lathe bed.
2. It must be massive with sufficient depth and width to absorb vibration.

**THE HEADSTOCK**

The headstock is secured permanently on the inner ways at the left hand end of the lathe bed, and it provides mechanical means of rotating the work at multiple speeds. It comprises essentially a hollow spindle and mechanism for driving and altering the spindle speed. All the parts are housed within the headstock casting. The spindle of the headstock, illustrated in Fig.5.5, is made of carbon or nickel-chrome steel.

This is usually of a large diameter to resist bending and it should be perfectly aligned with the lathe axis and accurately machined for producing true work surface.

**TAILSTOCK OR LOOSE HEADSTOCK**

The tailstock is located on the inner ways at the right hand end of the bed. This has two main uses: (1) it supports the other end of the work when it is being machined between centres, and (2) it holds a tool for performing operations such as drilling, reaming, tapping, etc. To accommodate different lengths of work, the body of the tailstock can be adjusted along the ways chiefly by sliding it to the desired position where it can be clamped by bolts and plates.

**CARRIAGE**

The carriage of a lathe has several parts that serve to support, move and control the cutting tool.

It consists of the following parts: (1) saddle, (2) cross-slide, (3) compound slide or compound rest, (4) tool post, and (5) apron.

**Saddle:** The saddle is an H-shaped casting that fits over the bed and slides along the ways. It carries the cross slide and tool post.

**The cross-slide:** The cross-slide comprises a casting, machined on the underside for attachment to the saddle and carries locations on the upper face for the tool post or compound rest: The compound rest or compound slide is mounted on the top of the cross-slide and has a circular base graduated in degrees. It is used for obtaining angular cuts and short tapers as well as convenient positioning of the tool to the work.

**The tool post:** This is located on the top of the compound rest to hold the tool and to enable it to be adjusted to a convenient working position. The type and mounting of the tool post depends upon the class of work for which it is to be used.

**The apron:** the apron is fastened to the saddle and hangs over the front of the bed. It contains gears, clutches and levers for operating the carriage by hand and power feeds.
FEED MECHANISM
The movement of the tool relative to the work is termed as feed. A lathe tool has three types of feed – longitudinal, cross and angular. When the tool moves parallel to the lathe axis, the movement is a longitudinal feed. When the tool moves to the right angle to the lathe axis is a cross feed. When compound slide is swiveled at an angle to the lathe axis is termed as angular feed.

THREAD CUTTING MECHANISM
The rotation of the lead screw is used to transverse the tool along the work to produce screw thread. The half-nut mechanism makes the carriage to engage or disengage with the lead screw. It comprises a pair of half nuts capable of moving in or out of mesh with the lead screw. The two halves of the nut are connected in the cam slots in a circular disc by two pins. When the disc is rotated by a hand lever attached to it, the pins being guided in the cam slots serve to open or close the split nuts and thus engages or disengages with the lead screw.

Q. Explain with sketches the lathe accessories.
The lathe accessories are used for holding and supporting the work or for holding the cutting the various lathe accessories are discussed as follows

1. Centres.
   a) There are two types of centres i.e., live centre and dead centre.
   b) A centre which fits into the headstock spindle and revolves with the work is called live centre.
   c) The centre which is used in a tailstock spindle and does not revolve is called dead centre.

(a) Standard centre                     (b) Half centre
2. Chucks.

a) It is an important device used for holding and rotating the workpiece in laths.

b) The work pieces which are too short to be held between centres 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.5.7 (a) is also called self centering chuck or scroll chuck. Thus chuck is used for holding round and hexagonal work.

![Three jaw chuck](image)

(a) Three jaw chuck

![Four jaw chuck](image)

(b) Four jaw chuck

ii) Four jaw independent chuck.

1. The four jaw independent chuck, as shown in Fig.5.7 (b) 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.

The other types of the chucks are

iii) combination chucks, iv) magnetic chuck, v) collect chuck, vi) drill chuck, and vii) air or hydraulic chuck
3. Lathe dog or carrier

a) The work placed on a mandrel or held between centres 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.5.8 (a) and (b) respectively.

![Lathe dog or carrier](image)

(a) Straight tail pipe  (b) Bent tail pipe

4. Drive plate

a) The drive plate, as shown in Fig.5.9 is a circular plate which is bored out and threaded so that it can be attached to the spindle nose.
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.

![Drive plate](image)

5. Faceplate.

c) The face plate, as shown in Fig.5.10 is similar to drive plate except that it is larger in diameter.
d) It contains more open slots or T-slots so that bolts may be used to clamp the workpiece to the face of the plate.

e) The face plate is used for holding work pieces which can not be conveniently held in a chuck.

6. **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 can not be clamped against the vertical surface of the face plate.

7. **Mandrels.**

   a) The lathe mandrel is a cylindrical bar with centre hole at each end. It is used to hold hollow work pieces to machine their external surface.

   b) The work revolves with the mandrel which is mounted between the centres of the lathe. The various types of mandrels used for different classes of work are shown in Fig.5.11

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Plain mandrel, Step mandrel and Collar mandrel
Q. **Describe the tools used for various machining operations.**

   a) The tool used in a lathe, for general purpose work, is a single point tool, but for special operations multi-point tools may be used.

   b) The material used for lathe tools should have hardness, toughness, heat resistance and low wear.

   c) The commonly used materials are high carbon steel; high speed steel, cemented carbides, diamond tips and ceramics.

![Diagram showing various lathe tools](image)

(a) **Turning Tool**     (b) **Facing Tool**     (c) **Chamfering Tool**

(d) **Form or Profile Tools**     (e) **Parting or necking Tool**     (f) **External Threading Tool**

(g) **Internal Threading Tool**     (h) **Boring Tool**     (i) **Knurling Tool**

The lathe tools, depending upon the nature of operation done by the tool, are classified as follows:

1) Turning tool (left hand or right hand),
2) Facing tool (left hand or right hand),
3) Chamfering tool (left hand or right hand),
4) Form or profile tool,
5) Parting or necking tool,
6) External threading tool,
7) Internal threading tool,
8) Boring tool, and
9) Knurling tool.

**Different kinds of tools used for external surfaces**

- Parting tool
- Turning tool
- Right hand turning tool
- Left hand turning tool
- Radius turning form tool
- Thread cutting tool
- Chamfering form tool

**Different kinds of tools used for internal surfaces**

- Internal turning
- Internal facing
- Recess or groove making
- Internal threading

**Q. Which are the operations that are performed on the lathe?**

The most common operations which can be carried out on a lathe are

1) Facing,
2) Plain turning,
3) Step turning,
4) Taper turning,
5) Drilling,
6) Reaming,
7) Boring,
8) Undercutting,
9) Threading,
10) Knurling.

These operations are discussed as follows;

1) **Facing**
   This operation is almost essential for all works. In this operation, as shown in Fig. the workpiece is held in the chuck and the facing tool is fed from the centre of the workpiece towards the outer surface or from the outer surface to the centre, with the help of a cross-slide.

2) **Plain turning**
   It is an operation of removing excess amount of material from the surface of the cylindrical workpiece. In this operation, as shown in Fig. the work is held either in (lie chuck or between centres and the longitudinal feed is given to the tool either by hand or power.

3) **Step turning**
   It is an operation of producing various steps of different diameters in the workpiece, as shown in Fig. This operation is carried out in the similar way as plain turning.

4) **Taper turning**
   It is an operation of producing an external conical surface on a workpiece. A small taper may be produced with the help of a forming tool or chamfering.
tool, but the larger tapers are produced by swiveling the compound rest, as shown in Fig. 5.17 at the required angle or by offsetting the tailstock or by taper turning attachment.

5) Drilling

It is an operation of making a hole in a workpiece with the help of a drill. In this operation, as shown in Fig. 5.18 the workpiece is held in a chuck and the drill is held in the tailstock. The drill is fed manually, into the rotating workpiece, by rotating the tailstock hand wheel.

6) Reaming

It is an operation of finishing the previously drilled hole. In this operation, as shown in Fig. 5.19 a reamer is held in the tailstock and it is fed into the hole in the similar way as for drilling.
7) **Boring**

It is an operation of enlarging of a hole already made in a workpiece. In this operation, as shown in Fig. 5.20 a boring tool or a bit mounted on a rigid bar is held in the tool post and fed into the work by hand or power in the similar way as for turning.

![Boring Diagram](image)

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**5.20 Boring**

8) **Undercutting or Grooving**

It is an operation of reducing the diameter of a workpiece over a very narrow surface. In this operation, as shown in Fig. 5.21 a tool of appropriate shape is fed into the revolving work up to the desired depth at right angles to the centre line of the workpiece.

9) **Threading**

It is an operation of cutting helical grooves on the external cylindrical surface of workpiece. In this operation, as shown in Fig. 5.22 the work is held in a chuck or between centres and the threading is fed longitudinally to the revolving work. The longitudinal feed is equal to the pitch of the thread be cut.
10) **Knurling**

It is an operation of providing knurled surface on the workpiece. In this operation, as shown in Fig. 5.23 a knurled tool is moved longitudinally to a revolving workpiece surface. The projections on the knurled tool reproduce depressions on the work surface.

**Q. Define cutting speed, feed and depth of cut for lathe**

The following terms are commonly used while machining a workpiece on lathe.

1. **Cutting speed.**

   It is defined as the speed at which the metal is removed by the tool from the workpiece. In other words, it is the peripheral speed of the work past the cutting tool. It is usually expressed in meters per minute.

2. **Feed.**

   It is defined as the distance which the tool advances for each revolution of the work. It is usually expressed in millimeters.

3. **Depth of cut.**

   It is defined as the depth of penetration of the tool into the workpiece during machining. In other words, it is the perpendicular distance measured from the machined surface to the unmachined surface of the workpiece. It is usually expressed in millimeters.
Q. Describe various attachments used on lathe.

(i) Taper attachment.
It is a device which is attached to the back of the carriage and is used to turn and bore tapers. An important part of the attachment is guide bar which is graduated in degrees at the end and in taper at the other. If the taper attachment is used consistently on one job, it would be advisable to shift the sliding bar occasionally to distribute equally any wear on the swiveling bar. For taper attachment to work satisfactorily, the compound rest and taper-attachment slide should move freely, but there should be no looseness or play.

(ii) Milling attachment.
It can be used for, face milling, dovetail milling, squaring of shafts, cutting slots etc. It may be fastened to the lathe compound in place of tool holder or may be mounted directly on the bottom slide in place of the compound. It has a graduated vise swivel at the base and has vertical hand feed screw also.

(iii) Steady Rest.
It is a device for supporting long shafts of small diameter while turning them, and also when boring or threading long spindles. It is used to prevent the work from yielding to the pressure of the cutting tool. For high speed work, a steady rest with rollers in jaws is used.

(iv) Follower Rest.
It is similar in purpose to a steady rest but differs in that it is attached to the saddle of the lathe. The adjustable jaws of the follower rest bear directly on the finished diameter of the work, following the cutting edge of the cutting tool on the opposite side of the work. As the tool feeds along the work, the follower rest, being attached to the saddle, travels with it.
Q. SOLVE THE PROBLEMS.

5.1 The pitch of a lead screw is 6mm, and the pitch of the thread to be cut is 1mm. Find change gears.

Sol:

\[
\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{\text{Pitch of the work}}{\text{Pitch of the leadscrew}}
\]

\[
= \frac{1}{6} = \frac{1 \times 20}{6 \times 20} = \frac{20}{120}
\]

or

\[
\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{1}{6} = \frac{120}{20}
\]

The driver will have 20 T and driven gear on lead screw will have 120 T.

5.2 The pitch of a lead screw is 6mm, and the pitch of the thread to be cut is 1.25mm. Find the change gears.

Sol:

\[
\frac{\text{Driver teeth}}{\text{Driven teeth}} = \frac{\text{Pitch of the work}}{\text{Pitch of the leadscrew}}
\]

\[
= \frac{1.25}{6} = \frac{1.25 \times 4}{6 \times 4} = \frac{5}{24} = \frac{5}{4} \times \frac{1}{6}
\]

\[
= \frac{5 \times 10}{4 \times 10} = \frac{1 \times 20}{6 \times 20} = \frac{50}{40} \times \frac{20}{120}
\]

The driving gears will have 50 and 20 T and driven gears 40 and 120 T.

5.3 Find the time required for one complete cut on a piece of work 350 mm long and 50 mm in diameter. The cutting speed is 35 meters per minute and the feed is 0.5 mm per revolution.

Sol:

\[
\text{Cutting speed} = \frac{\pi dn}{1,000} = \frac{\pi \times 50 \times n}{1,000}
\]
or, 

\[ n = \frac{1000 \times 35}{\pi \times 50} = 222.5 \]

Number of revolutions required for complete cut

\[ = \frac{350}{0.5} = 700 \]

Time required for complete cut \[= \frac{700}{222.5} = 3.14 \text{ min.} \]
DRILLING

INTRODUCTION

The drilling machine is one of the most important machine tools in a workshop. It was primarily designed to originate a hole but it can perform a number of similar operations.

1. The basic purpose of a drilling machine is to drill cylindrical holes in Work pieces. (Metallic and non-metallic materials).
2. The holes are cut out of the material with a cutting tool, which is known as drill. The drill is fixed in a rotating spindle and can be fed towards the workpiece which may be fixed to the table or to the base of the machine.
3. The speed of the spindle and the feed can be adjusted according to the workpiece.

Some examples of drilling work are shown in Fig.

(a) Through hole (in a solid)  (b) Blind hole (in a solid)  (c) Finishing a cored hole (in a casting)
Q. What are the types of drilling machine?

1. Portable drilling machine
2. Sensitive drilling machine
3. Upright or column drilling machine
4. Radial drilling machine
5. Gang drilling machine
6. Multi-spindle drilling machine
7. Vertical drilling machine
8. Automatic drilling machine
9. Deep hole drilling machine

Q. Give specification of the drilling machine.

A heavy duty drilling machine is specified by following parameters.

1) Drilling capacity,
2) Taper in spindle (Morse no.),
3) Distance between spindle and column (maximum and minimum) in case of radial drilling machine,
4) Transverse of spindle,
5) Minimum distance between spindle and table,
6) Minimum distance between spindle and base plate,
7) Working surface of table (i.e., diameter),
8) Range of spindle speeds,
9) Range of power feed per revolution,
10) Motor speed, and
11) Motor power.

Q. Describe various drilling operations.

1) Drilling. It is an operation of producing a circular hole in a work piece by forcing a drill against it.
2) Boring. It is an operation of enlarging a hole that has already been drilled by a single point tool, so as to make it true to required size.
3) **Reaming.** It is an operation of slightly enlarging a machined hole to proper size with a smooth finish. The reamer is an accurate tool and is not designed to remove much metal. The reaming allowance is usually 0.2 mm only.

4) **Tapping.** It is an operation of producing internal threads in a hole by means of a tool called tap.

5) **Counter boring.** It is an operation of enlarging the mouth of a drilled hole to set bolt heads and nuts below the surface so that they may not project out from the surface level.

6) **Spot facing.** It is an operation to finish off a small portion of rough surface around a drilled hole to provide smooth seat for bolt head. Spot facing tool is a single blade; ground to give two cutting edges and is guided by a stem which runs in a pilot hole.

7) **Counter-sinking.** It is an operation to bevel the top of a drilled hole for making a conical seat for a flat head screw. Ordinary flat drill ground to correct angle is used for countersinking holes.
Q. Show the nomenclature of the drilling tool (Drill)

Q. Sketch the types of tools used on the drilling machine.
Q. **List the work holding devices on the drilling machine.**

1. T-bolts and clamps
2. Drill press vice
3. Step block
4. V-block
5. Angle plate
6. Drill jigs

**Q. List the tool holding devices on the drilling machine.**

The different methods used for holding tools in a drill spindle are:

1. By directly fitting in the spindle
2. By a sleeve
3. By a socket
4. By chucks