Machining may be defined as the operation or process of removing the excess metal by means of a cutting tool, in the **machine tool;** to obtain the desired shape, size and surface finish.

A machine, which performs the material removal operation with tools, to produce desired shape and size of the work-piece, is known as **machine tool**.

Purpose of Machine tools:

a) To improve production rates
b) To reduce cost of production
c) To reduce fatigue of workers
d) To achieve better quality
e) To reduce wastage.

Basic Conditions for machining (Machining Principle)

a) The material of tool should be harder than metal to be machined
b) Tool should be strong and held rigidly
c) Shape of tool is designed properly
d) There must be a relative movement between the tool and work piece

Basic relative movements/ motions the tool and work-piece must a have relative movement against each other for the machining to take place and these movements/ motions may be Circular (Rotary) or Reciprocating (Straight line).

Lathe machine

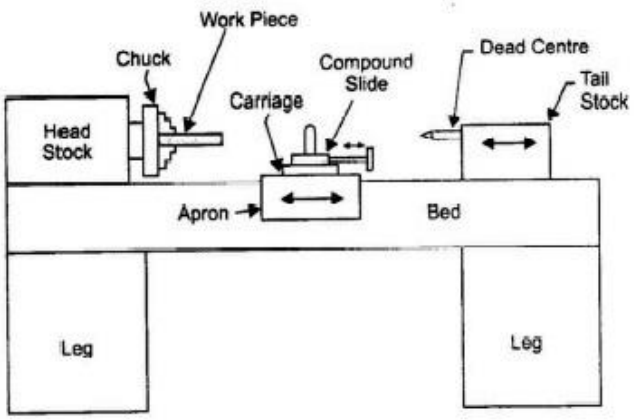
The lathe machine is one of the earliest machine tools and one of the most versatile and widely used as machine tool for performing the machining operations.

Principle: The job to be machined is held and rotated in a lathe chuck; a single point cutting tool is advanced which is stationary against the rotating job. Since the cutting tool material is harder than the work-piece, so metal is easily removed from the job.

The principal parts of lathe are:

a) Bed b) Head stock c) Tail stock d) Carriage e) Feed mechanism f) Legs

1) Bed



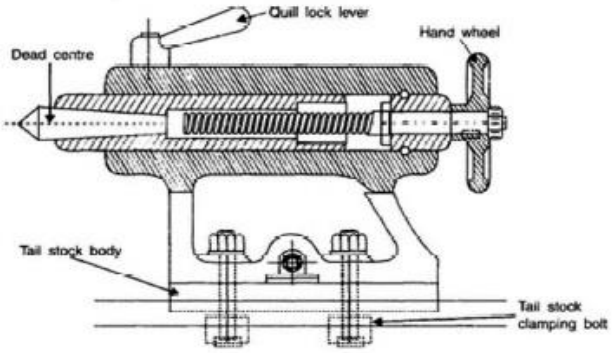
It is the base or foundation of the lathe. It is heavy, rugged and single piece casting made to support the working parts of the lathe. On the top of the bed, there are two sets of guide ways—outer ways and inner ways. Outer ways is for the carriage and the inner ways for the tailstock. The guide ways are of two types wide flat guide ways and inverted V-guide ways. With flat guide ways, chip accumulation is a problem but life is more but for V-guide ways combination of both the flat and inverted V-guide ways are used.

2) Headstock

The headstock is permanently fastened on the inner ways at the left side of the bed. The headstock spindle, a hollow cylindrical shaft supported by bearings, provides a drive from the motor to the work holding device. A live centre and sleeve, a face plate, or a chuck can be fitted to the spindle nose to hold and drive the work. All lathes receive their power with the help of a head stock. The power transmission device may be step cone pulleys or a geared head drive.

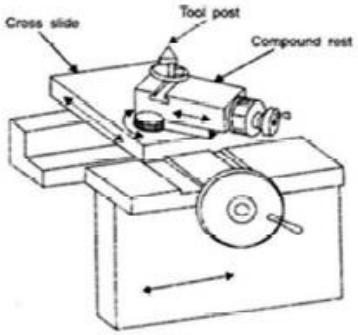
3) Tailstock

It is situated at the right hand end of the bed and is mounted on the inner guide ways. It can be moved towards or away from the operator. Tailstock can be locked in any position along the bed of the lathe by tightening the clamp lever or nut. The tailstock spindle is a hollow tapered shaft (left side end). It can be used to hold the dead centre or other tools having the same tapers such as drills and reamers. The tailstock hand wheel is used to move the tail stock spindle in or out of the tailstock casting and a spindle binding (clamping) lever or lock handle is used to hold the tailstock spindle in a fixed position.



4) Carriage

The carriage controls and supports the cutting tool. By the help of this, tool moves away or towards the headstock. It has five major parts



Carriage

a. **Saddle**: It is an H-shaped casting mounted on the top of the lathe ways so it slides along the ways between the headstock and tailstock. On the top it supports the cross slide.
b. **Cross Slide**: It is mounted on the saddle. The cross slide has a dovetail that fits over the saddle
c. **Dovetail**. It provides the cross movement (towards or away from the operator) to the cutting tool. It supports the compound rest.
d. **Compound Rest**: It is mounted on the top of the cross-slide and is used to support the cutting tool. It can be swiveled to any angle for taper turning operations.
e. **Tool Post**: It is mounted above the compound rest. A T-slot is machined in the compound rest to accommodate the tool post. It clamps the cutting tool or cutting tool holder in a desired position.
f. **Apron**: It is fastened to the saddle and contains the feeding mechanism. The apron hand wheel can be turned by hand to move the carriage along the bed of the lathe. The automatic feed lever is used to engage power feeds to the carriage and the cross slide.

5) Feed Mechanism

The movement of the tool relative to the work is termed as **feed**. The combination of different parts to ensure the feed is known as feed mechanism. A lathe tool may have three types of feed.

a) **Longitudinal Feed**: When the tool moves parallel to the work i.e. towards or away from the headstock.
b) **Cross Feed**: When the tool moves perpendicular to the work i.e. towards or away from the operator.
c) **Angular Feed**: When the tool moves at an angle to the work. It is obtained by swiveling the compound slide.

Cross and longitudinal feed are both hand and power operated but angular feed is only hand operated.

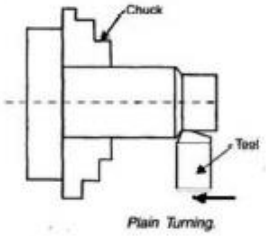
a) **Lead screw** is used for cutting of the threads in combination with the split nut. Split nut **(Half nut)** ensures that carriage moves without any slippage.
b) **Feed Rod** is used for powered longitudinal movement of the carriage and cross slide.

6) Legs

Legs support the entire weight of the machine. These are made of cast iron and may be with the lathe bed. These are firmly secured to the foundation by bolts.

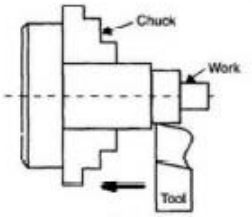
Lathe machine operations

The most common operations which can be performed on a lathe machine are described below:



Plain Turning.

a. **Plain Turning**: It is an operation of removing excess amount of material from the surface (cylindrical surface or circumference) of the cylindrical workpiece. This operation is done to reduce the diameter of the workpiece.



Step Turning.

b. **Step Turning**: It is an operation of producing various steps of different diameters in the workpiece.

c. **Taper Turning**: It is an operation of producing an external conical surface on a work-piece. Taper turning can be performed by the tail stock set over method, by swiveling the compound rest, or using the taper turning attachment. Most commonly used is by swiveling the compound rest.

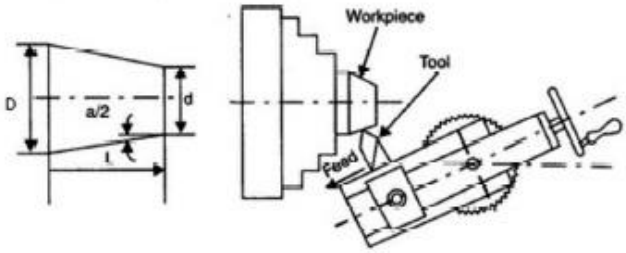
$$tan \propto = \frac{(D-d)}{2L}$$

Where, $\propto$ = angle of swiveling of compound slide

D= Larger diameter
d= small diameter
L= Length of the bar

Steps Involved In the Taper Turning of a bar (How taper turning is done?)

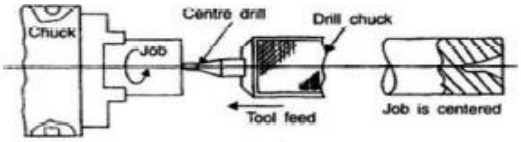
(i) Fix the bar in the chuck of head stock
(ii) Fix the single point cutting tool on the tool post
(iii) Adjust the taper angle on the compound rest by loosening the two nuts on the cross slide and tighten them



Taper Turning.

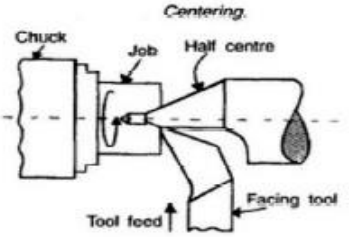
(iv) Now adjust the depth of cut and start the lathe machine
(v) Move the wheel on the compound rest to give the feed to the cutting tool
(vi) Repeat the procedure (iv and v)till the required taper is obtained

d. **Centering**: If the chuck is three jaws type, then centering is not required because it is self-centered chuck. But for four jaws chuck, centering is needed. Centre is located by means of using a combination set or using a bell centre punch. After locating the centre, centre holes are produced by using a countersunk tool or drill.



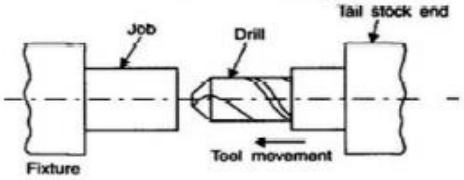
Centering.

e. **Facing**: Facing is the operation of machining the ends of a piece of work to produce the flat surface. 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.



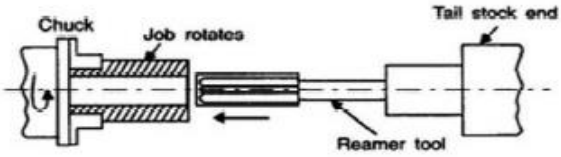
Facing.

f. **Drilling**: It is an operation of making a round hole in the workpiece with the help of a drill. 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.



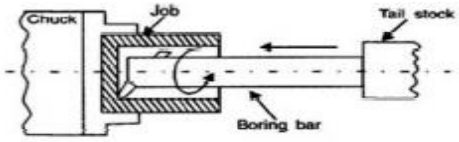
Drilling.

g. **Reaming**: It is an operation of finishing the previously drilled role. In this case, reamer is held in the tailstock and is fed into the hole by rotating the tailstock hand wheel.



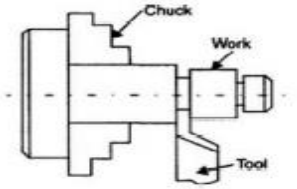
Reaming.

h. **Boring**: It is an operation of enlarging a hole already made in a workpiece. In this, boring tool is held in the tool post and is fed into the work similarly as in plain turning.



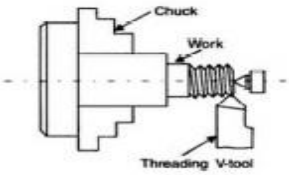
Boring.

i. **Undercutting or Grooving**: It is an operation of reducing the diameter of a workpiece over a very narrow surface. In this case, the proper cutting tool is fed into the revolving work upto the desired depth at right angle to the workpiece.



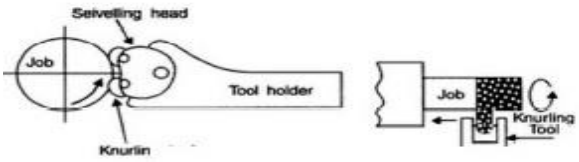
Undercutting or Grooving.

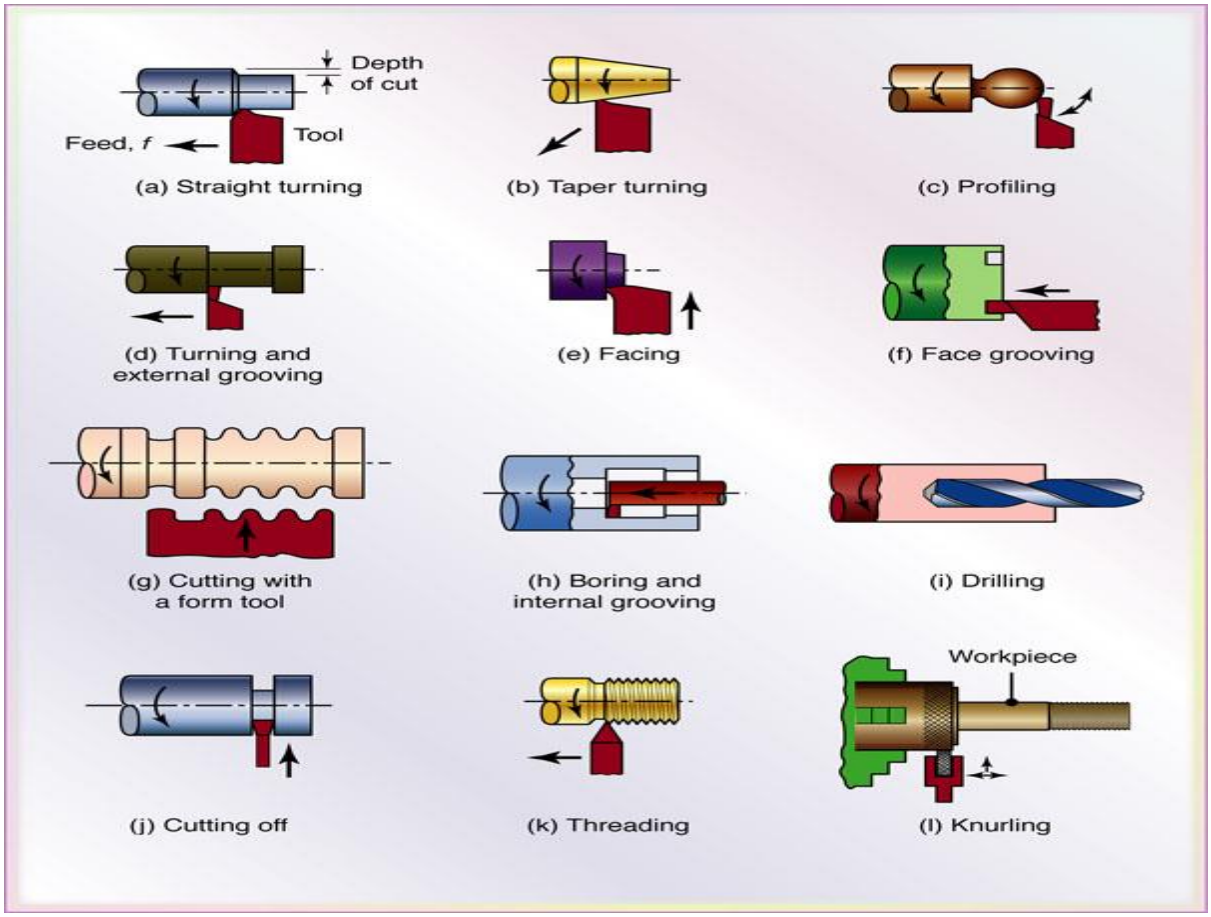
j. **Threading**: Both external and internal threads can be cut on lathe. For this operation some lathes are provided with quick change gear box, which enables the establishment of the required speed ratio very quickly. A chart is provided on the gearbox, which carries the complete information of speed and recommended feed. With the help of gear change lever, required speed and feed can be obtained.



Threading.

k. **Knurling**: Knurling produces a regularly shaped, roughened surface on a workpiece. The knurling tool is pressed against the workpiece, which causes the slight outward and lateral displacement of the metal so as to form the knurl, a raised diamond pattern.





Types of Lathes: (Refers reference books)

- Centre Lathe or Engine lathe
- Bench Lathe
- Tool room lathe
- Special purpose lathe
- Turret lathe
- Automatic lathe

Machining Calculations: Turning

Refers class notes

References:

1. **Text books:**

TB1: Manufacturing Technology (Volume-2) by P N Rao, Tata McGraw Hill, New Delhi
TB2: 'Production Technology' by R K Jain, Laxmi Publisher

2. **Reference Books:**

RB1: Workshop Technology by Hajara Choudhary
RB2: Ghosh A. and Mallik A. K., Manufacturing Science, EWP Pvt. Ltd.