



**Ahsanullah University of Science and Technology (AUST)  
Department of Mechanical and Production Engineering**

**LABORATORY MANUAL**  
For the students of  
Department of Mechanical and Production Engineering  
2<sup>nd</sup> Year, 1<sup>st</sup> Semester

Student Name :  
Student ID :

**Department of Mechanical and Production Engineering**  
**Ahsanullah University of Science and Technology (AUST)**  
**IPE 2112: Manufacturing Processes-I Sessional**  
**Credit Hour: 1.5**

**General Guidelines:**

1. Students shall not be allowed to perform any experiment without apron and shoes.
2. Students must be prepared for the experiment prior to the class.
3. Report of an experiment must be submitted in the next class.
4. Viva for each experiment will be taken on the next day with the report.
5. The report should include the following:
  - Top sheet with necessary information
  - Main objectives
  - Work material/machine/tool/equipment used (with their specifications)
  - Experimental procedures
  - Experimental results and discussions (Experimental setup, Experimental conditions, Data, Graph, calculation etc.)
  - Conclusions
  - Acknowledgements
  - References
6. A quiz will be taken on the experiments at the end of the semester.
7. Marks distribution:

Total Marks		
Report	Attendance and Viva	Quiz
30	30	40

## Experiment-1:

### Study of Lathe Machine and Its Various Operations

#### Objectives:

- Become familiar with basic lathe operations.
- Experiencing various types of turning operations in lathe machine.
- Learn to calculate cutting speed, material removal rate, and spindle horsepower.

Metal lathe or metalworking lathe are generic terms for any of a large class of lathes designed for precisely machining relatively hard materials. They were originally designed to machine metals; however, with the advent of plastics and other materials and with their inherent versatility, they are used in a wide range of applications, and a broad range of materials. In machining jargon, where the larger context is already understood, they are usually simply called lathes, or else referred to by more-specific subtype names (tool room lathe, turret lathe, etc.). These rigid machine tools remove material from a rotating work piece via the (typically linear) movements of various cutting tools, such as tool bits and drill bits. A typical lathe machine is shown in the following Fig.1.

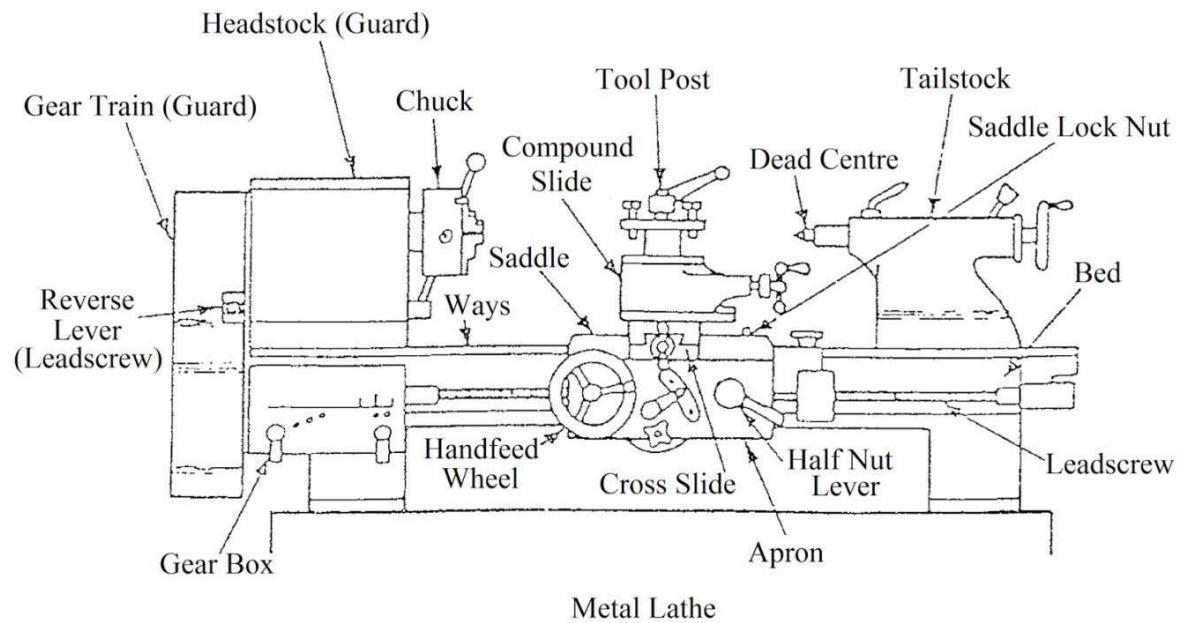


Fig.1 Schematic view of the lathe machine.

#### Different types of turning operations:

1. Straight turning
2. Taper turning
3. Facing
4. Grooving
5. Boring
6. Threading
7. Knurling
8. Drilling

9. Countersinking
10. Counterboring

**Bed:** The bed is the base or foundation of the parts of the lathe. The main feature of the bed is the ways,

which are formed on the bed's upper surface and run the full length on the bed. The ways keep the tailstock and the carriage, which slide on them, in alignment with the headstock.

**Headstock:** The headstock contains the headstock spindle and the mechanism for driving it.

**Tailstock:** The primary purpose of the tailstock is to hold the dead center to support one end of the work being machined. However, the tailstock can also be used to hold tapered shank drills, reamers and drill chucks.

**Carriage:** The carriage is the movable support for the cross feed slide and the compound rest. The compound rest carries the cutting tool in the tool post. The carriage has T-slot or tapped holes to use for clamping work for boring or milling.

**Feed Rod:** The feed rod transmits power to the apron to drive the longitudinal feed and cross feed mechanisms. The feed rod is driven by the spindle through a train of gears.

**Lead Screw:** The lead screw is used for thread cutting. It has accurately cut ACME threads along its length that engage the threads of half-nuts in the apron where the half-nuts are clamped over it. The lead screw is driven by the spindle through a gear train.

**Crossfeed Slide:** The crossfeed slide is mounted to the top of the carriage in a dovetail and moves on the carriage at a right angle to the axis of the lathe. A crossfeed screw allows the slide to be moved toward or away from the in accurate increments.

**Lathe Chucks:** The lathe chuck is a device for holding lathe work. It is mounted on the nose of the spindle. The work is held by jaws which can be moved in radial slots toward the center of the chuck to clamp down on the sides of the work.

**The 4-jaw independent lathe chuck** (Fig.2A) is the most practical chuck for general work. The four jaws are adjusted one at a time, making it possible to hold work of various shapes and to adjust the center of the work to coincide the axis of the spindle. The 3-jaw **universal chuck** (Fig.2B) can be used only for holding round or hexagonal work. All three jaws move in and out together in one operation and bring the work on center automatically.

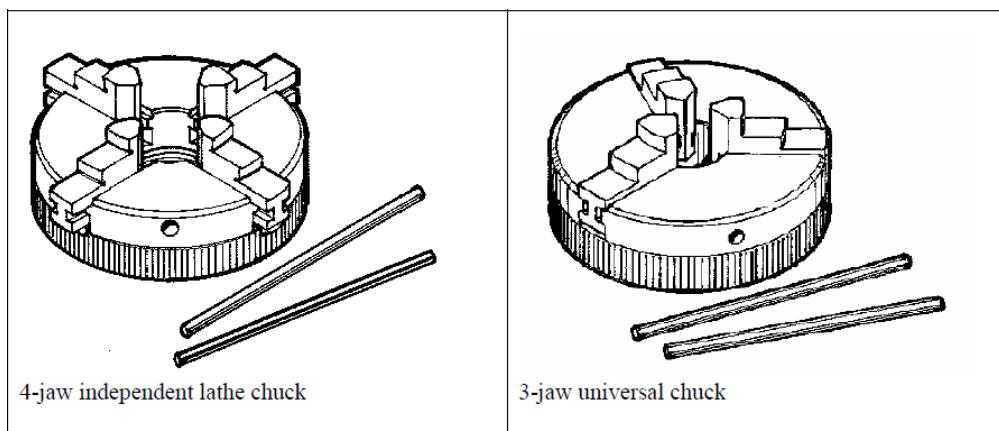


Fig.2 lathe chuck

**Cutting Speed** is defined as the Speed at which a point on the Surface of the work passes the cutting edge or point of the tool and is normally given in m/min. Cutting speed can be calculated by using the following formula:

$$V = \pi D N / 1000 \text{ m/min}$$

Where:

N = Spindle Speed (RPM)

D = Diameter of Work piece (mm)

V = Cutting Speed of metal (m/min)

**Feed rate:** Feed rate is used to describe the distance the tool moves per revolution of the work piece and depends largely on the surface finish required. For roughing out a soft material a feed of up to 0.25 mm/rev may be used.

**Cutting Tool for Lathe:** There are various kinds of the cutting tools for a lathe which depends on the type of work materials and shape of the parts. Fig. 4(a) shows the well-used cutting tool called a side tool. The cutting tool shown in Fig. 4(b) is used at parting and grooving processes. The cutting tool shown in Fig. 4(c) is called a boring bar. It is used to cut at an inside surface. It can make a big hole, which cannot be process by a drill and a high accurate hole.

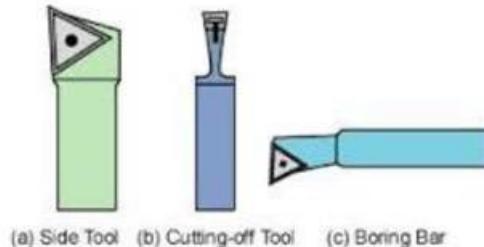
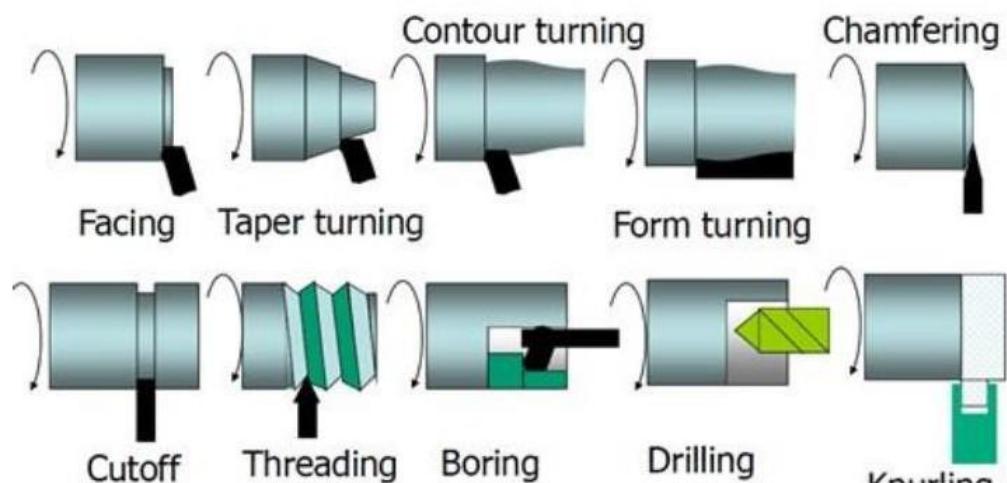


Fig.4 cutting tool used in lathe machine|

#### Various cutting operations that can be performed on a lathe



#### Assignment :

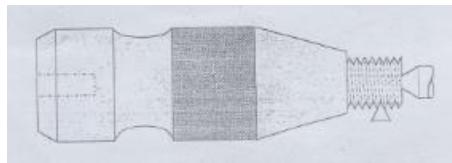
(a) Measure all dimensions on the specimen turned by your group. Make a neat sketch and

indicate all measured dimensions.

(b) Discuss briefly how tapered portion was turned.

**Exercise-1:** You will need to use the Engine Lathe to perform the following operations in order to make the following shaft.

- Facing
- Chamfering
- Straight turning
- Contour turning
- Taper turning
- Knurling
- Threading and
- Drilling



The equipments/tools you will use in this part include:

- Engine lathe
- Facing tool
- Turning tool
- Center drill
- Knurling tool
- Drill bit etc.

## Experiment-2:

### Study of Milling Machine and Its Various Operations

Milling machine is one of the most versatile conventional machine tools with a wide range of metal cutting capability. Many complicated operations such as indexing, gang milling, and straddle milling etc. can be carried out on a milling machine. Milling machines are among the most versatile and useful machine tools due to their capabilities to perform a variety of operations. Milling machines can be classified as horizontal and vertical.

#### (A) Horizontal Milling Machine

**Column:** The column houses the spindle, the bearings, the gearbox, the clutches, the shafts, the pumps and the shifting mechanisms for transmitting power from the electric motor to the spindle at a selected speed.

**Knee:** The knee mounted in front of the column is for up or down motion supporting the table and to provide up and down motion along the Z axis.

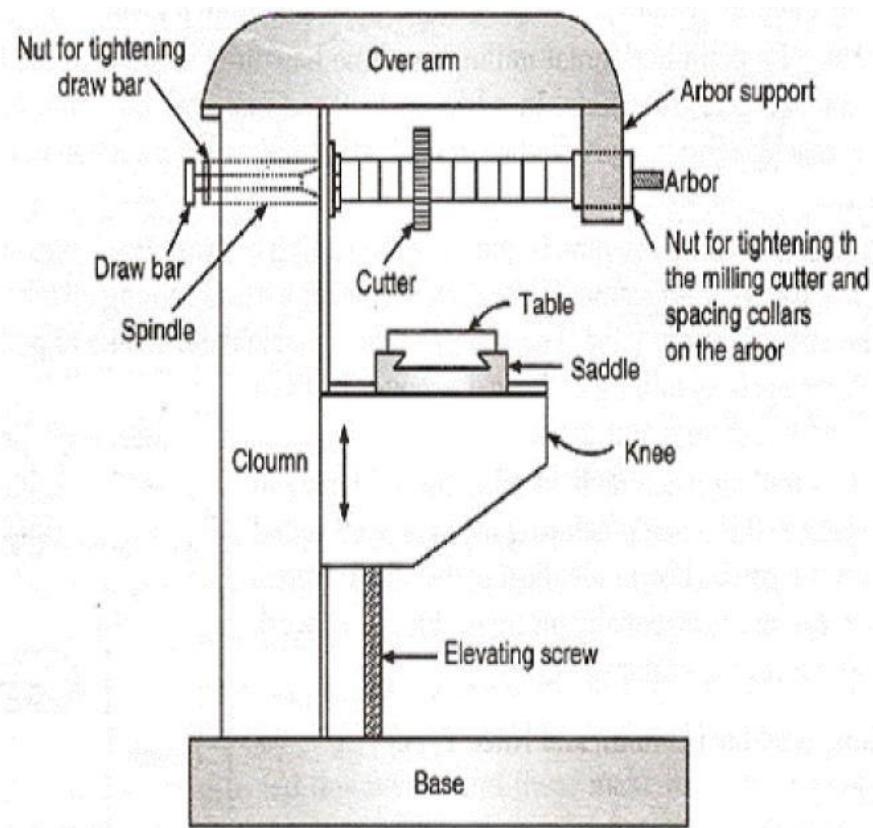


Fig : Horizontal milling machine

**Saddle** : The saddle consists of two slide ways , one on the top and one at the bottom located at  $90^{\circ}$  to each other for providing motions in the X or Y axes by means of lead screws.

**Table**: The table is mounted on top of the saddle and can be moved along the X axis. On top of the table are some T-slots for the mounting of workpiece or clamping fixtures.

**Arbor**: The arbor is an extension of the spindle for mounting cutters. Usually, the thread end of an arbor is of left hand helix.

### (B) Vertical Milling Machine

**Column** : The column houses the spindle, the bearings, the gearbox, the clutches, the shafts, the pumps and the shifting mechanisms for transmitting power from the electric motor to the spindle at a selected speed.

**Knee**: the knee mounted in front of the column is for supporting the table and to provide an up or down motion along the Z axis.

**Saddle**: The saddle consists of two slide ways, one on the top and one at the bottom located at  $90^{\circ}$  to each other, for providing motions in the X or Y axes by means of lead screws.

**Table**: The table is mounted on top of the saddle and can be moved along the X axis. On top of the table are some T-slots for the mounting of workpiece or clamping fixtures.

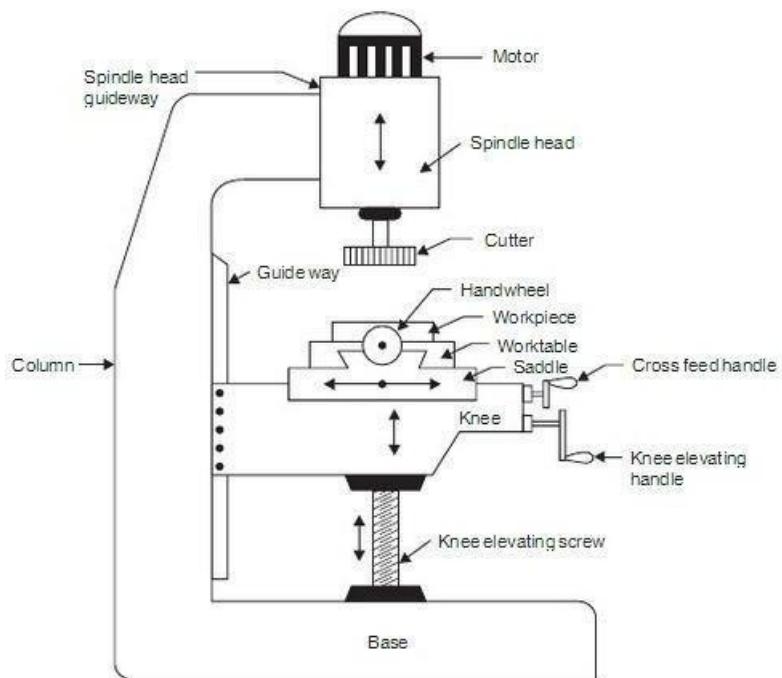
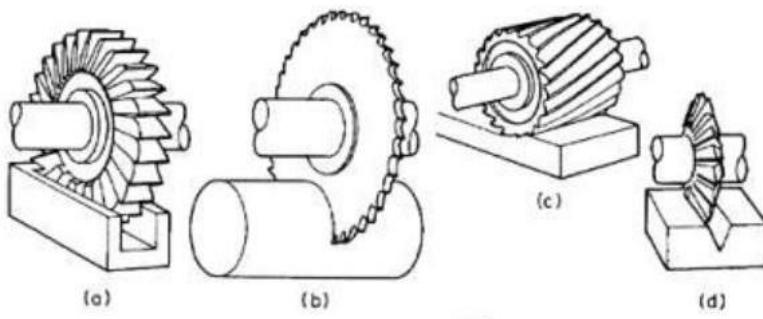


Fig. 4.10 Vertical milling machine

**Milling head** : The milling head consisting the spindle, the motor and the feed control unit is mounted on a swivel base such that it can be set at any angle to the table.

**Ram**: The ram on which the milling head is attached can be positioned forward and backward along the slide ways on the top of the columns.

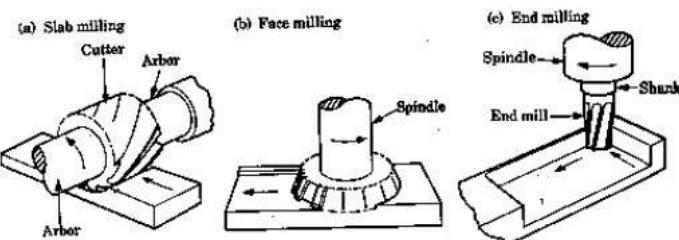
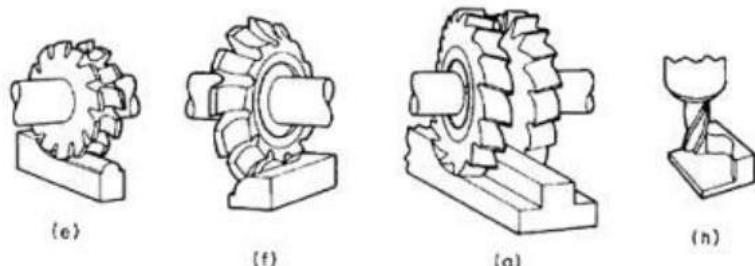
**Various cutting operations that can be performed on milling machine**



### Peripheral Milling

- a)slotting
- b)slitting
- c)slab milling
- d)slitting
- e)form milling
- f)side milling
- g)straddle milling
- h)end milling

### Face milling

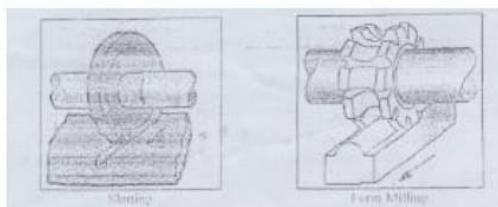


### Assignment :

1. Explain the differences between peripheral and face milling.
2. List four types of knee and column type milling machines.
3. Differentiate between up milling and down milling. Which method do you think is more efficient?
4. What are the functions of arbor and ram of a horizontal milling machine?

**Exercise-2:** You will need to use the milling machine and perform the following milling operations in in order to make the following product.

- Slotting
- Form Milling
- Pocket Milling
- End Milling



**Formulae Necessary for Calculations:**

$$\text{Spindle Speed, } N = \frac{1000 V}{\pi D}$$

Where

N = R.P.M. of the cutter

V = Linear cutting speed of the material in m/min. (as shown in Table-1 )

D = Diameter of cutter in mm

**Table feed rate,  $f = f_t \cdot N \cdot n$**

**Material removal rate, MRR = w. d. f**

Where,

f = Table feed

d in mm/min

$f_t$  = Movement per tooth of cutter in mm or chip load in mm/tooth

n = No. of teeth of cutter end

N = R.P.M. of the cutter

w = Width of cut

d = Depth of cut

Table-1: Cutting speed and Feed rate for some common material

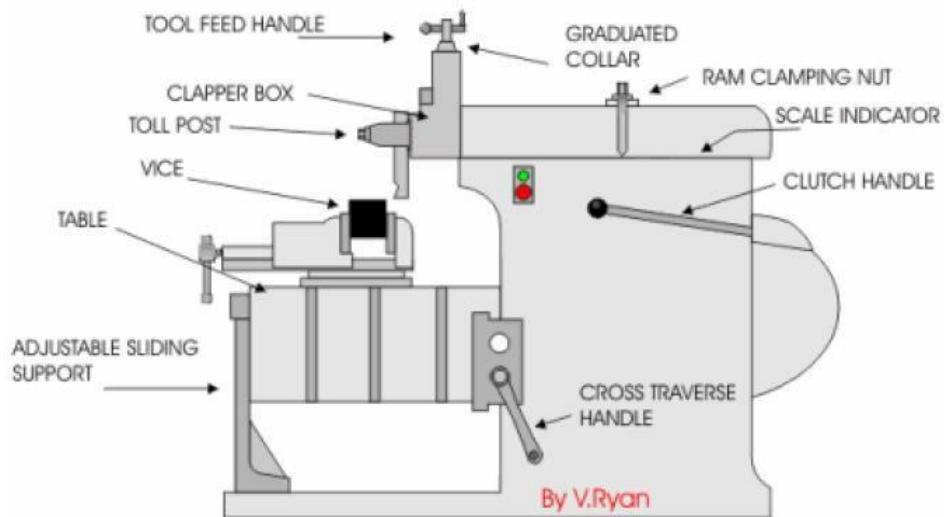
Tool Material	High Speed Steel		Carbide
Material	Cutting speed (v)	Feed (f)	Cutting speed (v)
Mild Steel	25	0.08	100
Aluminium	100	0.15	500
Hardened Steel	---	---	50

## Experiment-3: Study of Shaping Machine and Its Various Operations

The shaper is a relatively simple machine. It is used fairly often in the tool room or for machining one or two pieces for prototype work. Tooling is simple and shapers do not always require operator attention while cutting. The horizontal shaper is the most common type and its principal components are shown below and described as follows:

**Ram:** The ram slides back and forth in dovetail or square ways to transmit power to the cutter. The starting point and the length of the stroke can be adjusted.

**Toolhead:** The toolhead is fastened to the ram on a circular plate so that it can be rotated for making angular cuts. The toolhead can also be moved up or down by its hand crank for precise depth adjustments.



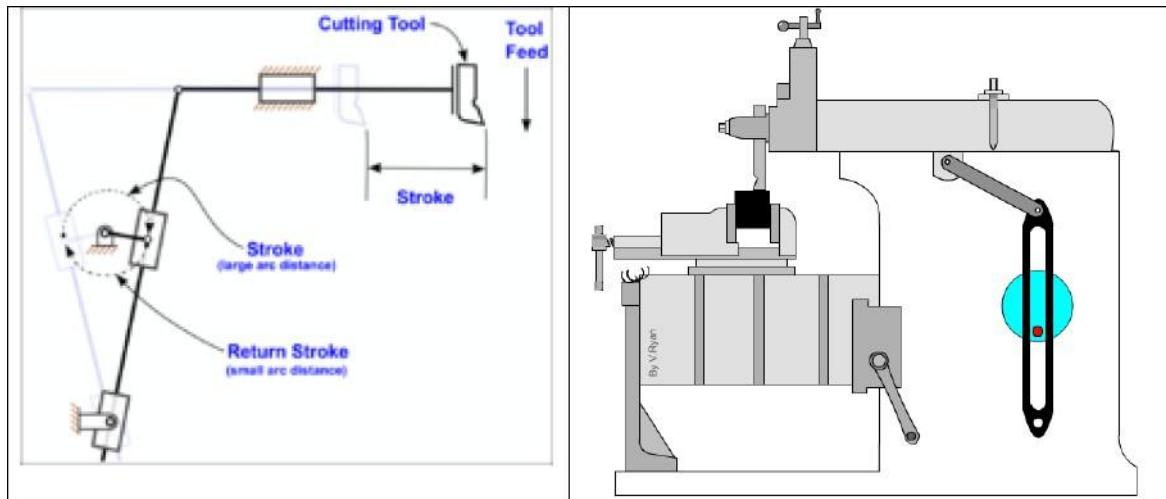
Shaping machine

**Clapper Box:** The clapper box is needed because the cutter drags over the work on the return stroke. The clapper box is hinged so that the cutting tool will not dig in. Often this clapper box is automatically raised by mechanical, air or hydraulic action.

**Table:** the table is moved left and right, usually by hand, to position the work under the cutter when setting up. Then either by hand or more often automatically the table is moved sideways to feed the work under the cutter at the end or beginning of each stroke.

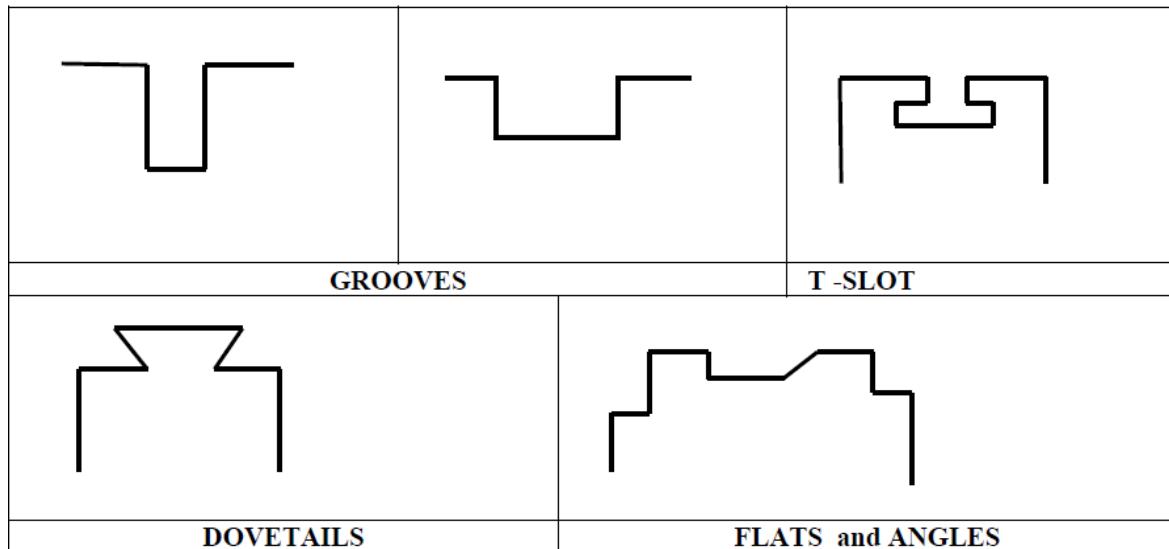
### Quick Return Mechanism

The shaping machine is used to machine flat metal surfaces especially where a large amount of metal has to be removed. Other machines such as milling machines are much more expensive and are more suited to removing smaller amounts of metal very accurately. The reciprocating motion of the mechanism inside the shaping machine can be seen in the diagram. As the disc rotates the top of the machine moves forwards and backwards pushing a cutting tool. The cutting tool removes the metal from work which is carefully bolted down.



Quick return mechanism

#### Various cutting operations that can be performed on a Shaping Machine



#### Calculation of MRR (Material Removal Rate):

$$MRR = d \cdot w \cdot t / \text{total machining time}$$

where,  $d$  = length of job

$w$  = width of job

$t$  = depth of cut

**Assignment :**

- a) Explain quick return mechanism with neat sketch
- b) Difference between shaper and planer machine
- c) Discuss how rotary motion transforms into linear motion in housing (body)

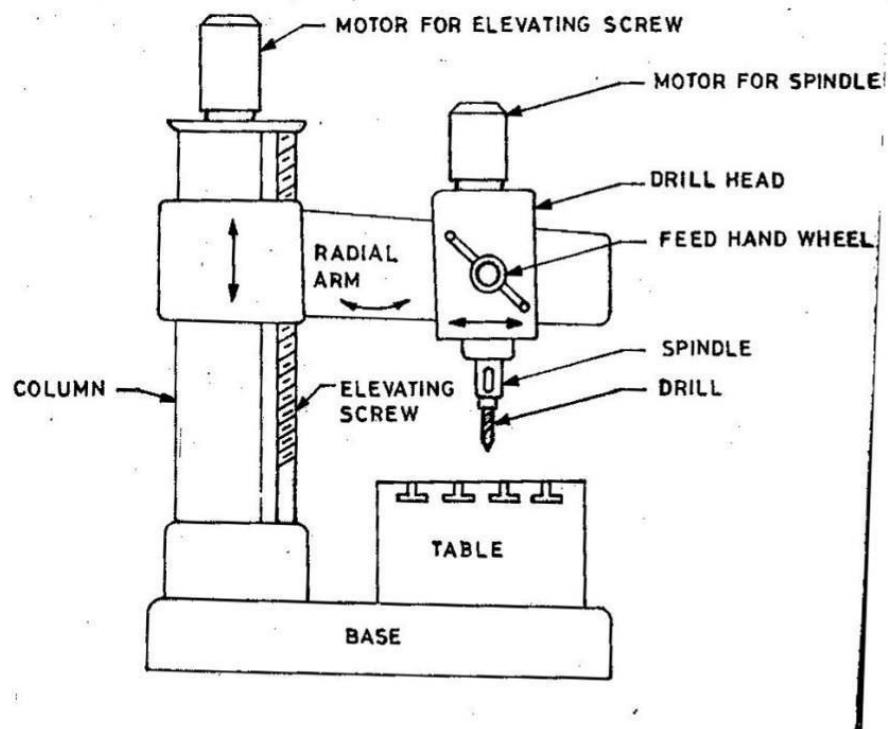
**Exercise-3:** You will need to use the shaping machine and perform the following shaping operations in order to make the following product.

- Side cutting
- Plain shaping
- V-grooving
- Slotting



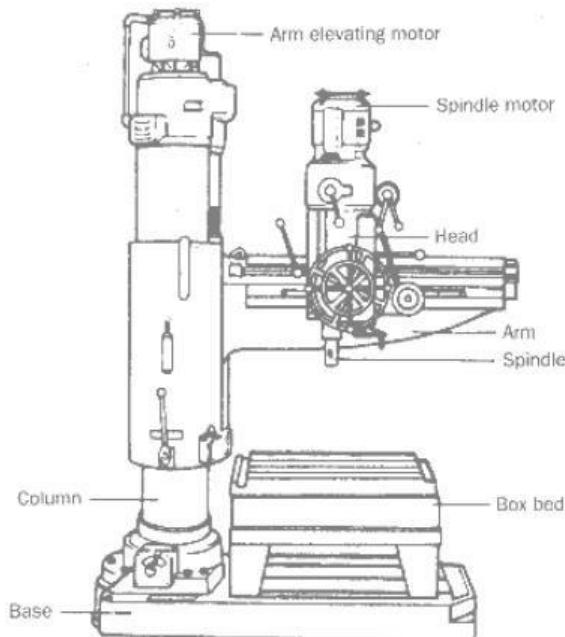
## Experiment-4: Study of Drilling Machine and Its Various Operations

A drill press is preferable to a hand drill when the location and orientation of the hole must be controlled accurately. A drill press is composed of a base that supports a column, the column in turn supports a table. Work can be supported on the table with a vise or hold down clamps or the table can be swiveled out of the way to allow tall work to be supported directly on the base. Height of the table can be adjusted with a table lift crank than locked I place with a table lock. The column also supports a head containing a motor. The motor turns the spindle at a speed controlled by a variable speed control dial. The spindle holds a drill chuck to hold the cutting tools (drill bits, center drills, deburring tools etc.)



**Radial drilling machines:** used on large workpieces, spindle mounts on radial arm allowing drilling operations anywhere along the arm length.

**Gang-drilling machines:** independent columns each with different drilling operation work piece slide from one column to next

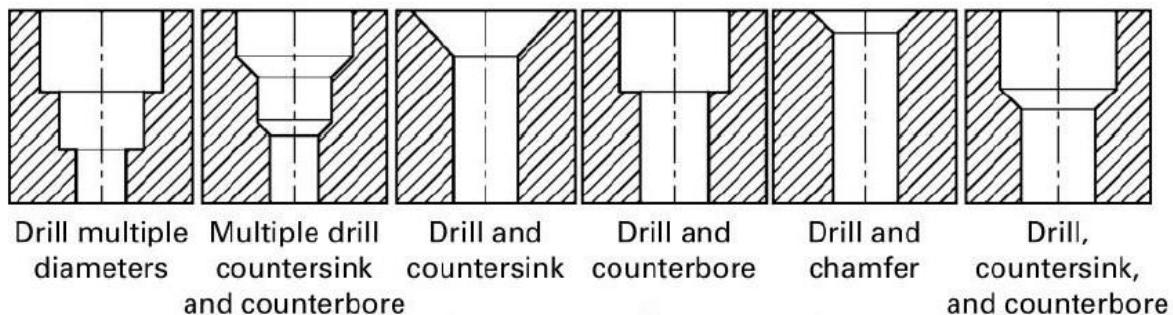


Radial drill machine



Gang drill machine

#### Various operations that can be performed on a Drilling Machine



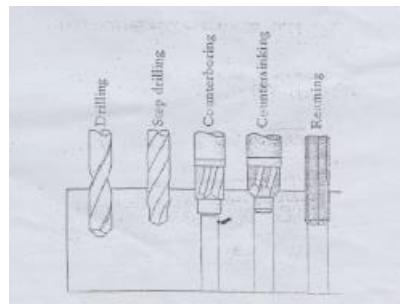
#### Assignment:

- Drill bit is a single point cutting tool or multi point cutting tool?
- Difference between counter boring and counter sinking

**Exercise-4:** You will need to use the drill press and perform the following drilling operations in order to make the following product.

- Drilling
- Step drilling
- Counterboring
- Countersinking

- Reaming



The equipment you will use in this part includes:

- Scribe
- Drill press
- Center drill
- 2drill bits
- Reamer
- Counter bore tool
- Countersink tool

## Experiment-5: Study of Grinding Machine and Its Various Operations

The grinding process consists of removing material from the workpiece by the use of a rotating wheel that has a surface composed of abrasive grains. Grinding is considered to be the most accurate of the existing machining processes. Grinding processes are used when high accuracies, close dimensional tolerances, and a fine surface finishes are required. Grinding processes also allow for high production rates. This allows for a lowered cost of production. Hard materials can also be machined.

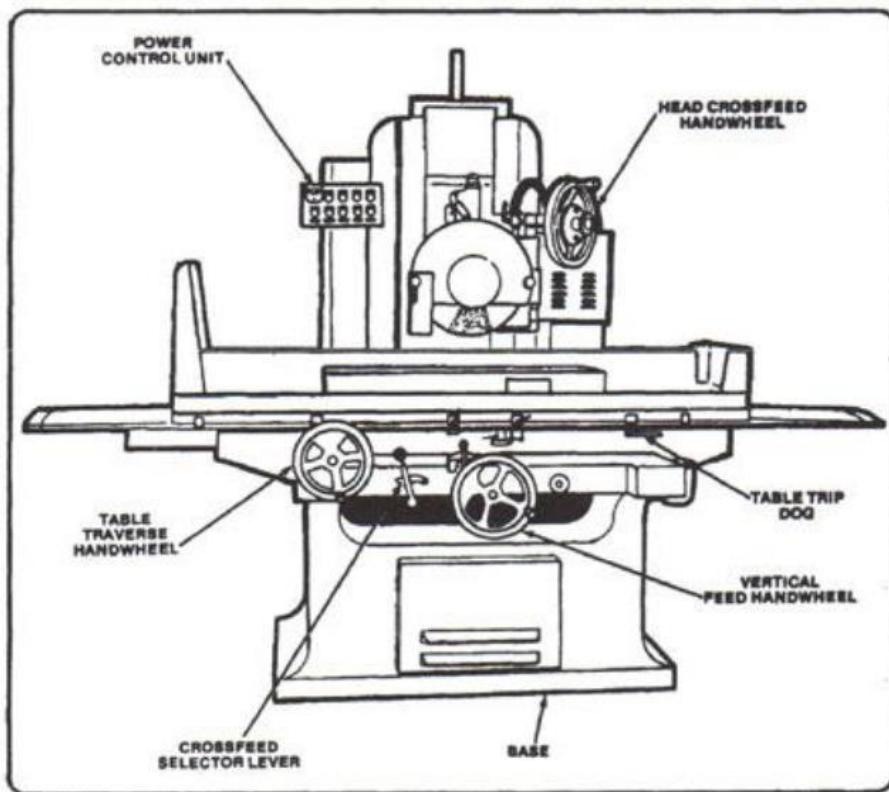


Figure 5-6. Reciprocating surface grinding machine.

Fig: Surface grinding machine

**Surface grinding** is most common of the grinding operations. A rotating wheel is used in the grinding of flat surfaces. Types of surface grinding are vertical spindle and rotary tables.

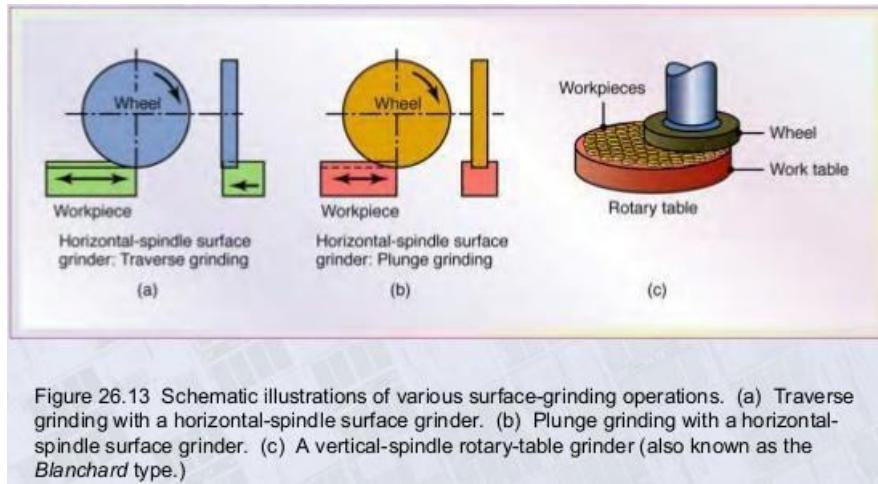


Figure 26.13 Schematic illustrations of various surface-grinding operations. (a) Traverse grinding with a horizontal-spindle surface grinder. (b) Plunge grinding with a horizontal-spindle surface grinder. (c) A vertical-spindle rotary-table grinder (also known as the *Blanchard* type.)

**Internal grinding** is used to grind the inside diameter of the workpiece. Tapered holes can be ground with the use of internal grinders that can swivel ion the horizontal.

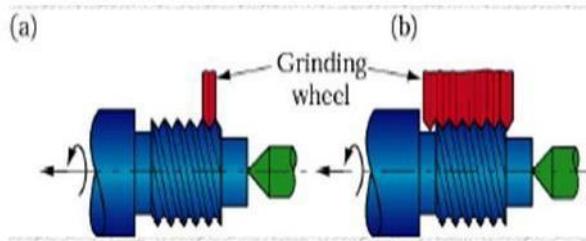


Fig: Thread grinding by (a) traverse, and (b) plunge grinding

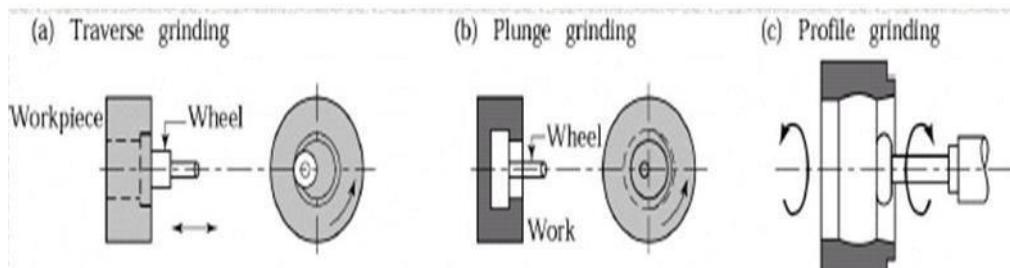


Fig: Internal grinding operations

**Cylindrical grinding** is also called center-type grinding and is used in the removing the cylindrical surfaces and shoulders of the workpiece. Both the tool and the workpiece are rotated by separate motors and at different speeds. The axes of rotation tool can be adjusted to produce a variety if shapes.

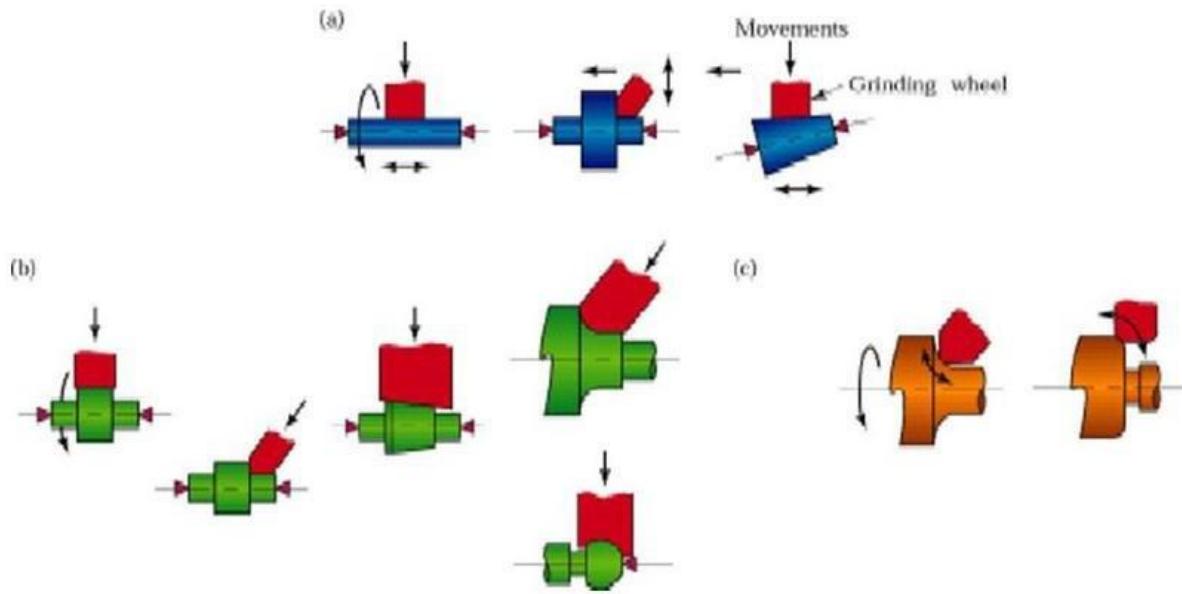
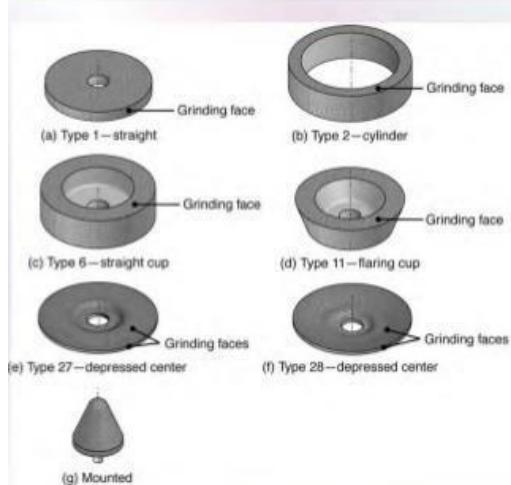


Fig: Examples of various cylindrical grinding operations. (a) Traverse grinding, (b) plunge grinding, and (c) profile grinding.

**Common Grinding Wheels:** A grinding wheel is made of abrasive grains held together by a bond. These grains cut like teeth when the wheel is revolved at high speed and is brought to bear against a work piece. The properties of a wheel that determine how it acts are the kind and size of abrasive how closely the grains are packed together and amount of the bonding material.



### Calculation of Grinding Ratio:

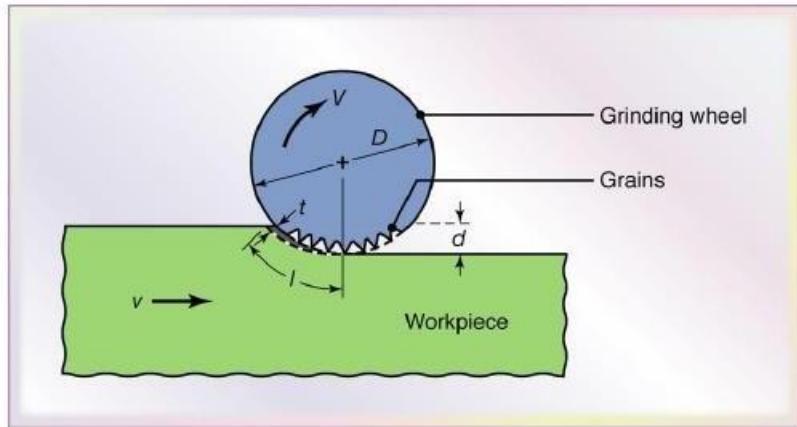


Figure 5.7

Where,

D=Grinding wheel diameter

d= Wheel depth of cut

V= Tangential velocity

v= Workpiece velocity

t= Undeformed thickness (grain depth of cut)

**Grinding ratio, G=Volume of material removed/Volume of wheel wear**

### Assignments:

- Why is grinding an abrasive machining process?
- Differentiate between rough and finish grinding process.
- Why is dressing of wheel necessary for grinding? Explain.
- What do you understand by fracture resistance and wear resistance?
- Calculate the MRR of your machining operation.

**Exercise-5:** You will need to use the surface grinding machine and perform the surface grinding operations in order to make the following part.

