



# Manufacturing Machining

## Module-4 Notes

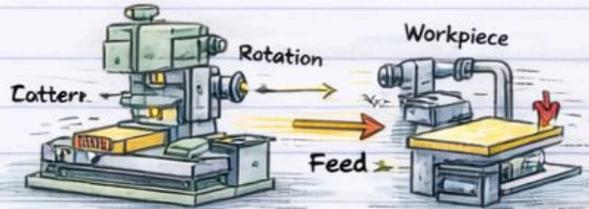
by [pyqfort.com](http://pyqfort.com)

Grinding Wheel

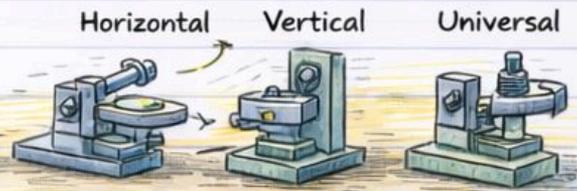


### Contents Covered:

• Milling and it's Principle



• Milling Machines

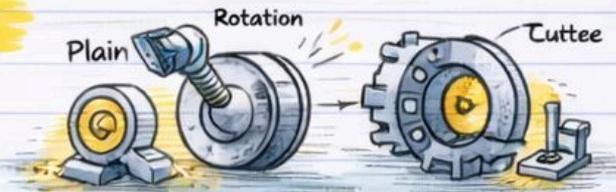


• Milling Operations

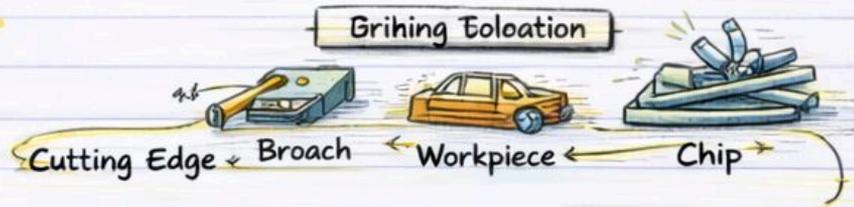
• Types of Milling Cutters



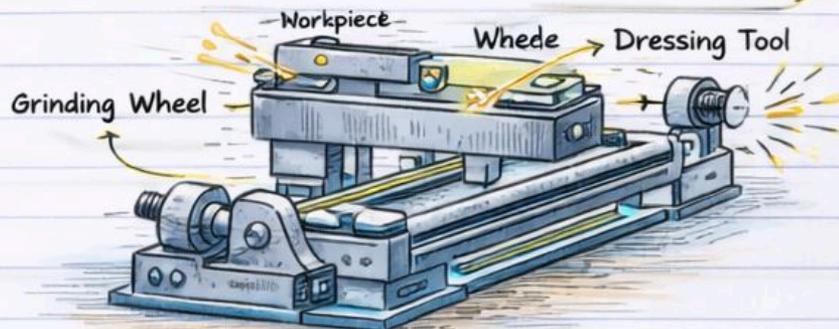
• Grinding and it's Principle



• Chip formation



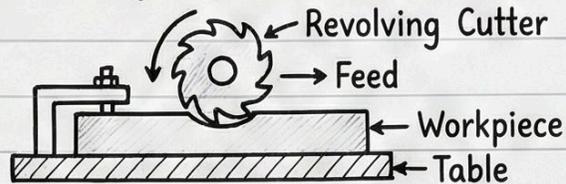
• Redressing



# Milling and its Principle

## 1. What is Milling?

- Milling is a machining process in which metal is removed by means of a revolving cutter with many teeth.
- The workpiece is supported on a table and may be fed to the cutter, longitudinally, transversally or vertically.
- It is very useful for producing cylindrical surfaces and especially plane surfaces.



## 2. Importance & Versatility:

- The milling machine is the most versatile machine tool, used for nearly all operations with high accuracy and surface finish.
- Can produce a wide variety of flat and formed surface.
- Use of indexing head and possibility of mounting several cutters on the machine arbor can increase metal removal rate.



## 3. Principle of Milling Machine:

- Flat as well as curved surfaces are generated by rotating multi-edged cutting tool called milling cutters.
- The milling cutter is rotated and the feed is given to the workpiece.
- Main milling processes: slab milling, face milling, slot milling, form milling, angular milling.

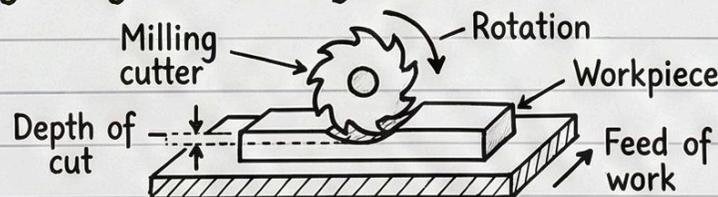


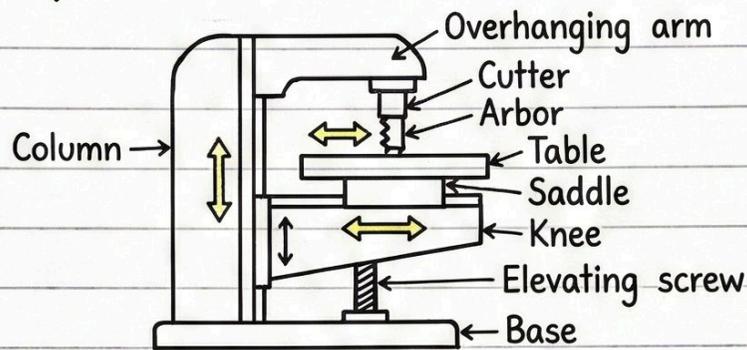
Fig. 4.36



# Column and Knee Type Milling Machines

## 1. General Description:

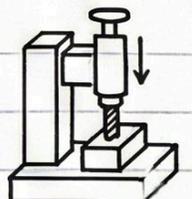
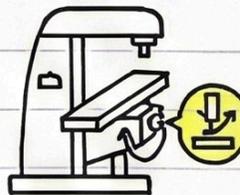
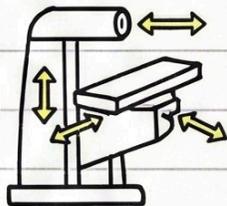
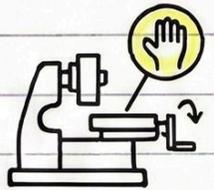
- This type is the most commonly used in production shop.
- The work table is mounted on a knee casting which can slide up and down on a hollow column.
- These machines are further classified as per method of power supply to the table, different axis of rotation, and different movements of the table.



(Based on Fig. 4.37)

## 2. Types :

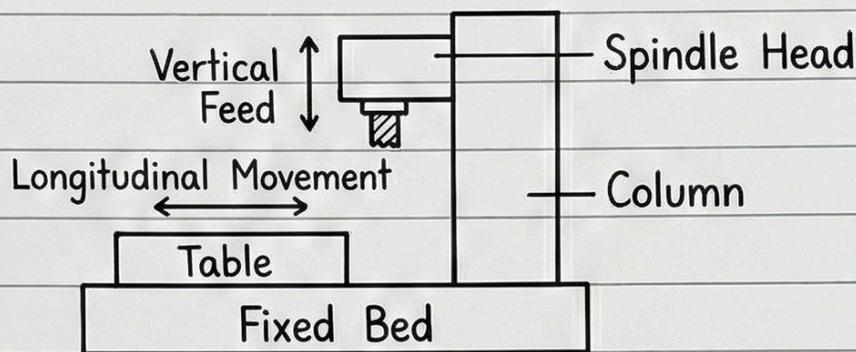
- Hand Milling Machine**: Simple and small for light milling operation (keyways, grooves, slots). Manual feeding of workpiece.
- Plain Milling Machine**: Rigid and sturdy for heavy jobwork. Horizontal spindle, table fed manually or by power in vertical, cross or longitudinal direction.
- Universal Milling Machine**: Tool room machine for very accurate jobs. Table mounted on a circular swivelling base. Can produce gears, drills, reamers, etc.
- Omniversal Milling Machine**: Tool room machine with all universal features plus a special knee assembly for longitudinal direction horizontally. Can machine taper spiral grooves.
- Vertical Milling Machine**: Cutter is mounted on a vertical spindle. Can be plain or universal type. End mills and face milling cutters used for grooves, slots, flat surfaces.



# Fixed Bed Type Milling Machine

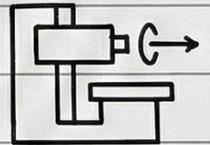
## 1. General Description:

- These are **high production** milling machines.
- The work table is mounted on a **fixed bed** and has **only longitudinal movement**.
- The **adjustable spindle head** is attached to a **vertical column** and can be fed **vertically**.

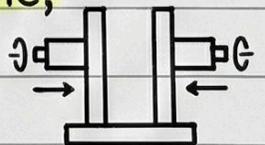


## 2. Special Features/Types:

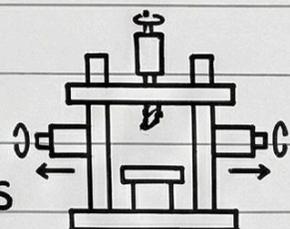
(i) Simplex Milling Machine: Has **single adjustable, horizontal spindle head**.



(ii) Duplex Milling Machine: Has **two adjustable, horizontal spindle heads** attached to two separate vertical columns, one on each side of fixed bed.



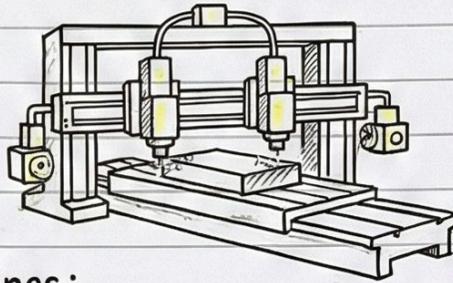
(iii) Triplex Milling Machining: Has **two adjustable, horizontal spindle heads** attached to two separate vertical columns and **additional vertical spindle head** mounted on a cross rail.



# Planer and Special Milling Machines

## 1. Planer Milling Machine:

- It is a heavy duty production machine which is similar to double housing planer.
- Spindle carriers are mounted in place of planer tool posts and are operated by individual motors.
- Two additional vertical milling heads are fitted on a cross rail and can travel along it.

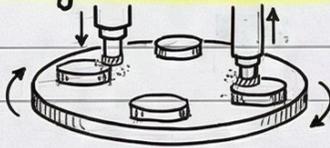


## 2. Special Milling Machines:

- Designed for specific jobs, having unique spindle and workpiece/cutter movement arrangements.

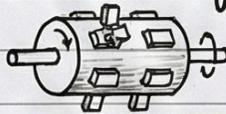
### (i) Rotary table machine:

- A mass production machine with a heavy, rotating, circular work table.
- Has two vertical spindles with facing mill cutters set at different heights for roughing and finishing.
- Allows continuous loading and unloading of workpieces.



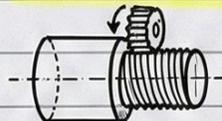
### (ii) Drum milling machine:

- Workpieces are mounted on the periphery of a rotating drum fixture against rotating cutters (up to four).
- Operation is continuous and suitable for mass products.



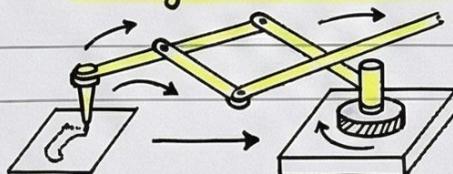
### (iii) Planetary milling machine:

- Revolving cutters move in a planetary path to finish a stationary cylindrical surface (internal/external).
- Specially used for cutting internal or external threads of different pitches.



### (iv) Pantograph milling machine:

- Used for duplicating and profiling work like die and mould cutting, grooving.
- Tool position is guided by a templet of the model.
- Pantograph helps to enlarge, reduce or copy the same size.



# Milling Operations



## 1. Introduction:

- The **main operations** which are carried out on a **milling machine** are listed below

## 2. Common Milling Operations:

(i) **Plan or Slab Milling**: Produces **flat surface parallel** to the axis of the cutter.

(ii) **Face Milling**: Produces **flat surface perpendicular** to the axis of the cutter.

(iii) **End Milling**: Used for producing **flat surfaces, slots, grooves, and keyways**.

(iv) **Side Milling**: Produces **flat surfaces on the sides** of the workpiece.

(v) **Slot Milling**: Used for cutting **slots, grooves, and keyways** (e.g., T-slot, Woodruff key-seat).

(vi) **Angular Milling**: Produces **flat surfaces at an angle** to the axis of the cutter.

(vii) **Form Milling**: Used for producing **irregular or curved surfaces** using a **formed cutter**.

(viii) **Straddle Milling**: **Two or more side milling cutters** are used to machine **two parallel vertical surfaces simultaneously**.

(ix) **Gang Milling**: **Several milling cutters** are mounted on the **same arbor** to machine **several surfaces simultaneously**.

(x) **Stripping or Saw Milling**: Used for **cutting off workpieces** or producing **narrow slots**.



## 3. Other Operations:

- Other important operations include: **keyways, grooves and slots, profile milling, Cam milling, Thread milling, Gear cutting, metal milling**

# Types of Milling Cutters

## Introduction:

- There are many **different types of milling cutters**.  
Some are



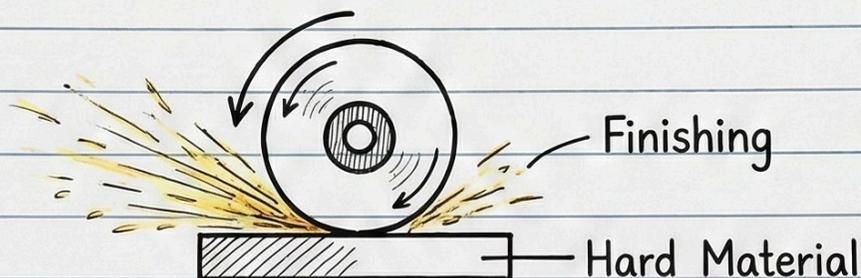
## Classification of Cutters:

- Plain milling cutter**: Used for flat surfaces.  
Types: (i) Light duty, (ii) Heavy duty, (iii) **metal plain milling cutter**. 
- Side milling cutter**: Cuts on periphery and sides.  
Types: (i) Plain, (ii) Staggered teeth, (iii) Half side, (iv) Interlocking. 
- Metal cutting saw**: For cutting off or narrow slots.  
Types: (i) Plain, (ii) Staggered teeth. 
- Angle milling cutter**: For angular surfaces.  
Types: (i) Single angle, (ii) Double angle. 
- End mill**: Cuts on end and periphery.  
Types: (i) Taper shank, (ii) Straight shank, (iii) Shell end mill. 
- T-slot milling cutter**: For cutting T-slots. 
- Woodruff key slot milling cutter**: For woodruff keyways. 
- Fly cutter**: Single-point tool on a bar. 
- Formed cutter**: For irregular shapes.  
Types: (i) Convex, (ii) Concave, (iii) Corner rounding, (iv) Gear, (v) Thread.  
- Tap and reamer cutter**: For making threads and finishing holes. 
- Inserted tooth cutter**: Teeth are separate inserts. 

# Grinding and its Principle

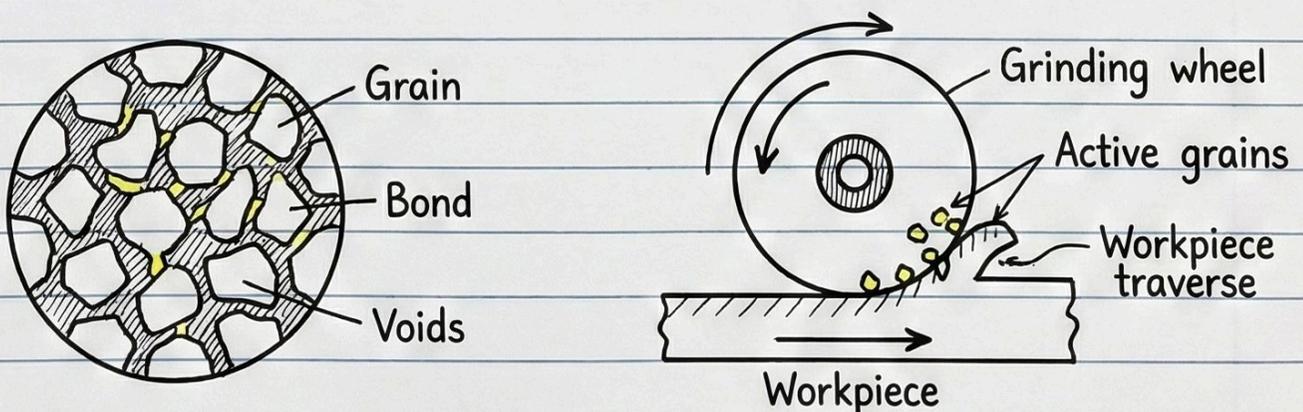
## 1. What is Grinding?

- Grinding is a metal cutting operation in which a rotating abrasive wheel is used as a tool.
- It is generally used as a finishing process to get high surface quality, correct size and accurate shape.
- Also used for machining hard materials which are difficult to cut by other tools.
- New processes like high speed grinding and creep feed grinding allow for bulk material removal.



## 2. Principle of Grinding:

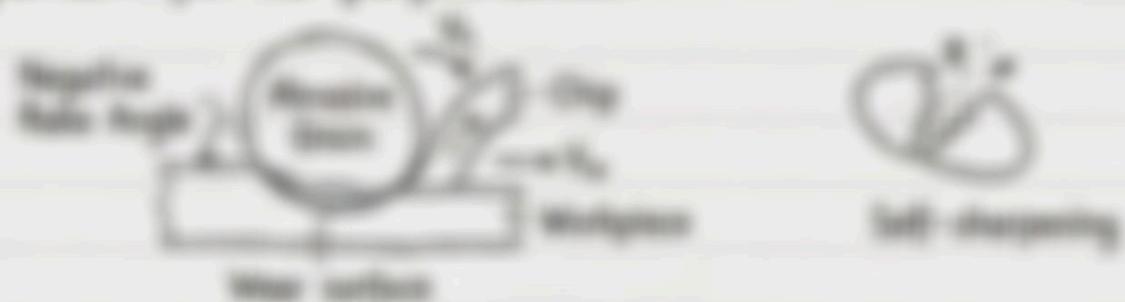
- A grinding wheel consists of abrasive particles called grains held together by a bond.
- The active grains on the wheel surface perform the cutting action like a multi-point tool (e.g., a milling cutter).
- Each irregularly shaped and randomly distributed active grain removes a short chip of gradually increasing thickness.



# Chip formation and Redressing

## 1. Chip formation:

- The active grain is a **small cutting tool** with a **large negative rake angle** ( $60^\circ$  or more).
- The **ploughing** action results in **progressive wear** and the formation of **worn areas** on the active grains.
- With the progress of grinding, the size and number of worn areas increase. This results in **increase of friction and force** acting on the grain.
- When the **force becomes very large**, the worn grain is **fractured** and a **new cutting edge** is exposed.
- This **self-sharpening property** of the grinding wheel is very important for its performance.



## 2. Redressing:

- If the wheel is made of **tough grains bonded together strongly**, the self-sharpening characteristic is **poor** and a **glazed appearance** is seen.
- The grinding wheel of this stage requires **dressing**.
- **Dressing with a diamond-tipped tool** removes the **worn grains** from the wheel periphery and a **new sharpened cutting surface** is generated.
- In case of **soft wheel**, the volume of wheel removed will be significant... Therefore, **more frequent dressing** will be required.





Full content is  
available at  
'[topmate.io/saumy1905](https://topmate.io/saumy1905)'  
or you can navigate  
to the specific section  
of the subject on  
'[pyqfort.com](https://pyqfort.com)'  
to access it