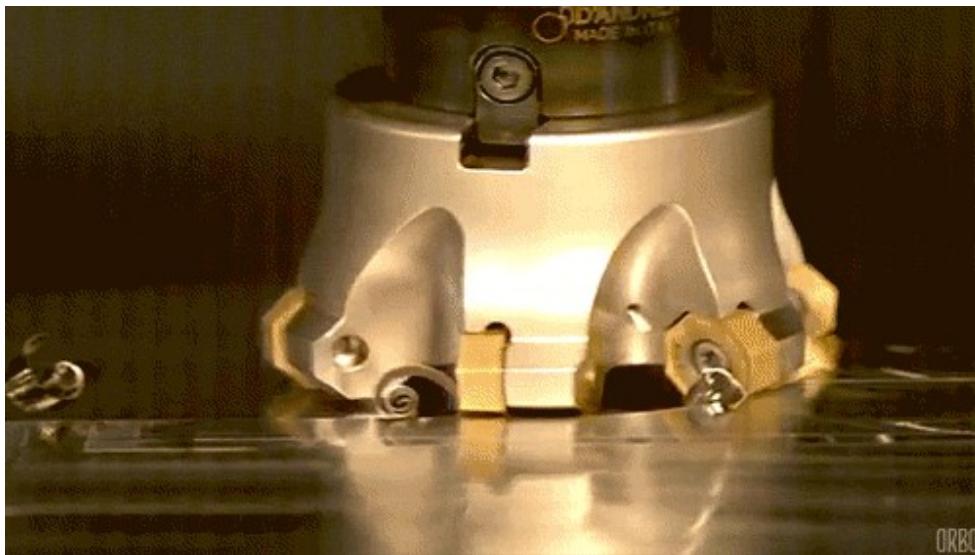


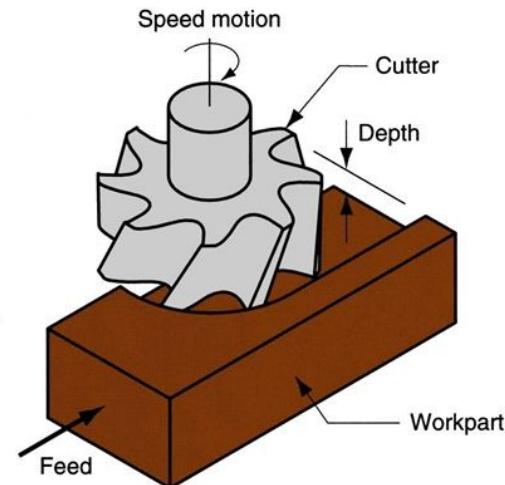
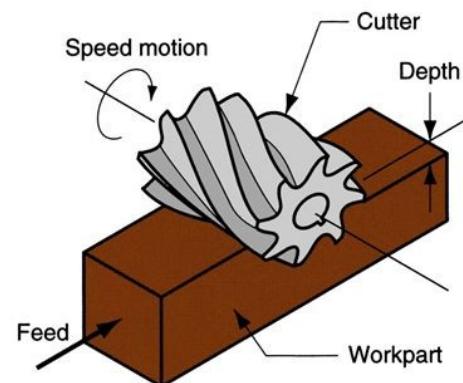
### MILLING

- In milling, the work piece is fed into a rotating milling cutter, which is a multi-point tool as shown.
- It is unlike a lathe, which uses a single point cutting tool. The tool used is called milling cutter.



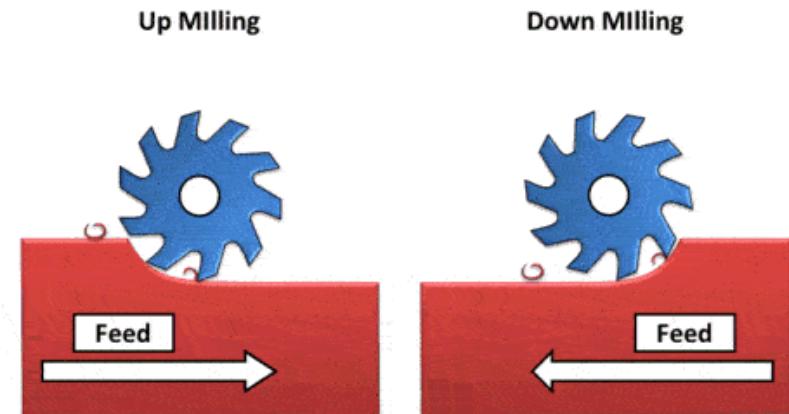
### MILLING

- Milling operation can be classified into two broad categories: **Peripheral Milling, Face Milling.**
- In peripheral milling the surface generated is **parallel** with the axis of rotation of cutter. This type of milling is carried out in Horizontal milling machine.
- In face milling surface generated is **at right angle** to the cutter axis. This type of milling is carried out in Vertical milling machine.



### UP AND DOWN MILLING

- Based on the directions of movement of the milling cutter and the feeding direction of the work piece, there are two possible types of milling:
  - **Up milling (conventional milling)**
  - **Down milling (Climb milling)**
- In up milling the cutting tool rotates in the **opposite direction** to the table movement. This tends to lift the work piece from the table.
- In down milling the cutting tool rotates in the **same direction** as that of the table movement. The cutting force will act downwards and as such would keep the work piece firmly in the work holding device.



### UP AND DOWN MILLING

#### UP MILLING

In up milling cutter rotates against the direction of feed

In this process, heat is diffused to the work piece which causes the change in metal properties

Progressive chip formation

#### DOWN MILLING

Cutter rotates with the direction of feed

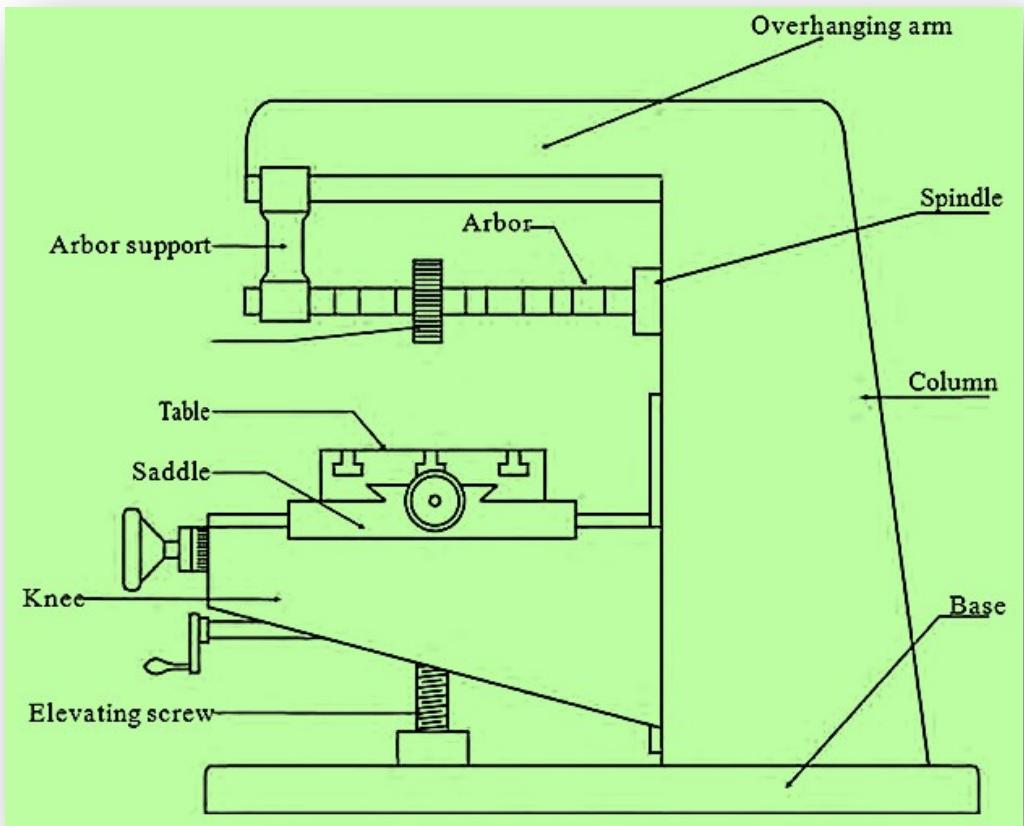
In down milling most of the heat diffuse to the chip without change the work piece properties

Chip size is maximum at start and decreases with the feed

# MECHANICAL ENGINEERING SCIENCE

## MACHINE TOOL OPERATIONS

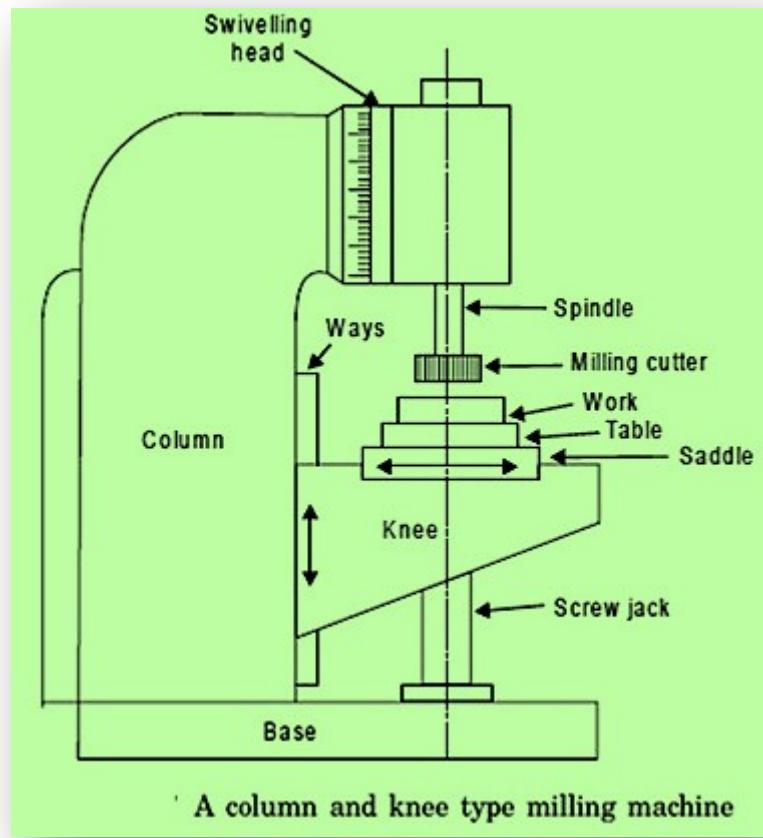
### HORIZONTAL MILLING MACHINE



# MECHANICAL ENGINEERING SCIENCE

## MACHINE TOOL OPERATIONS

### VERTICAL MILLING MACHINE



# MECHANICAL ENGINEERING SCIENCE

## MACHINE TOOL OPERATIONS



SI No.	HORIZONTAL MILLING MACHINE	VERTICAL MILLING MACHINE
1	Spindle is horizontal and parallel to the worktable	Spindle is vertical and perpendicular to the worktable
2	Cutter cannot be moved up and down	Cutter can be moved up and down
3	Cutter is mounted on the arbor	Cutter is directly mounted on the spindle
4	Spindle cannot be tilted	Spindle can be tilted for angular cutting
5	Operation such as plan milling, gear cutting, form milling, straddle, gang milling etc., can be performed	Operation such as slot milling, T- slots, flat milling and also different drilling operations can be performed