

MANUFACTURING PRACTICES BETP 1303 MILLING

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Lesson Outcomes

At the end of this topic, students be able to:

1. Explain basic structure of milling
2. Differentiate types of cutting tools, milling operations etc.
3. Understand how to operate milling machine.
4. Identify cutting speeds and feed for milling work.
5. Understand cutting tools geometry.

Contents

- Introductions
- Milling nomenclature
 - Main structure of milling
 - Types of cutting tools and tool holders
 - Milling operations
 - Milling parameters
 - Examples of products by milling
 - Advance milling/ CNC milling machine

Introductions

- Milling is a machine tool for **cutting by moving back and forth and up and down**. Rotating the milling, normally affects the workpiece mounted on the table.
- Milling has **vertical and horizontal direction**. The main spindle is calling the vertical and horizontal with respect to the table surface.
- Milling can be divided into **two types which clockwise or counter-clockwise operation**.
 - 1) Conventional milling/up milling
 - 2) Climb milling/down milling

Milling nomenclature

- Main structure of milling -



Column

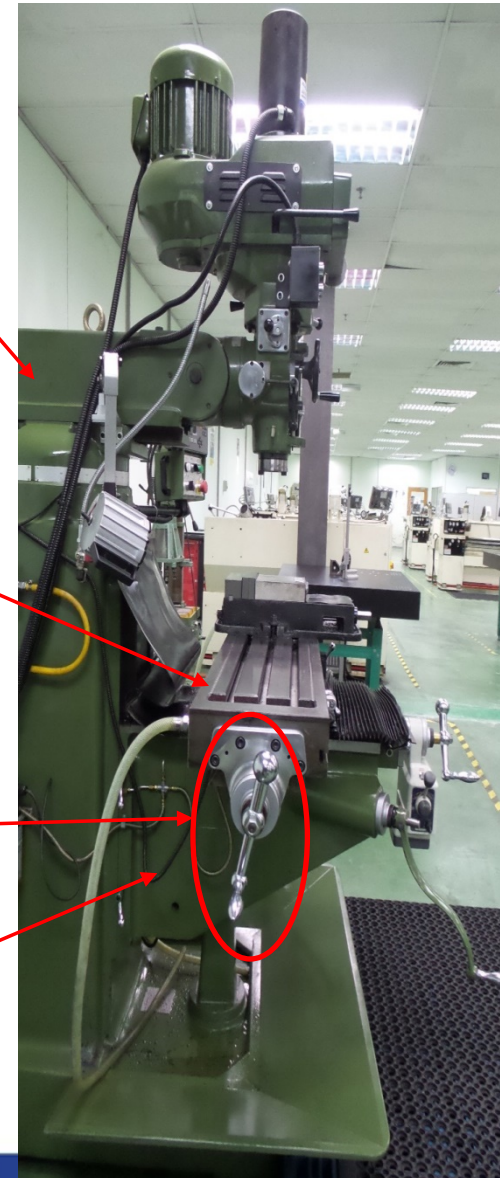
Spindle head

Worktable

Base

Spindle

Knee



Milling nomenclature

- Main structure of milling -



Spindle head

Spindle head – Contains cutter holders and the spindle. The head can be adjusted vertically or may be fixed in vertical machines. For cutting tapered surfaces it can be spinned in a vertical plane.

Milling nomenclature

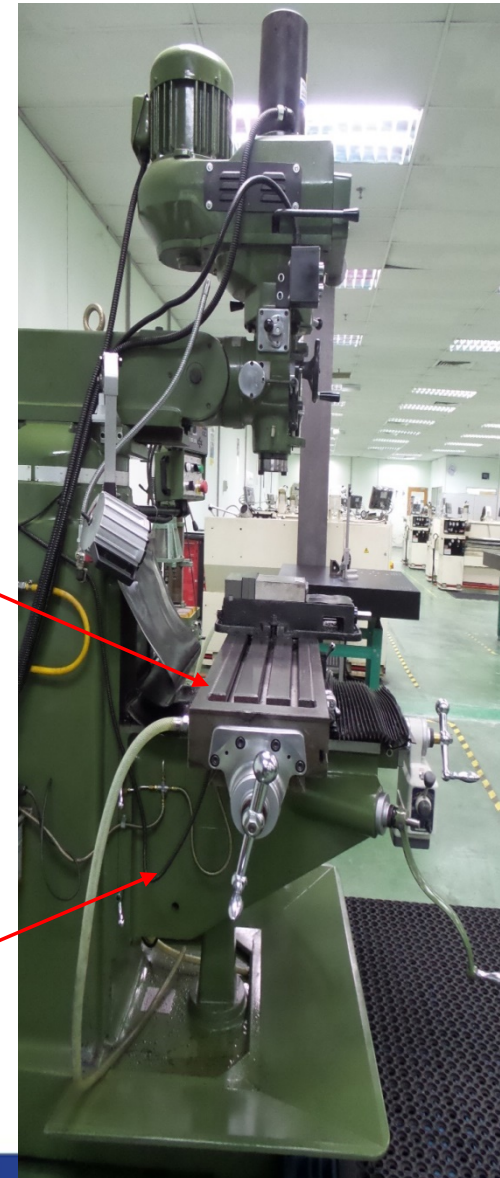
- Main structure of milling -

Worktable – The table moves longitudinally relative to the saddle on which the materials is clamping using T-slots.

Worktable

Knee – Gives the table vertical movement and supports the saddle so that the depth of cut can be adjustable.

Knee



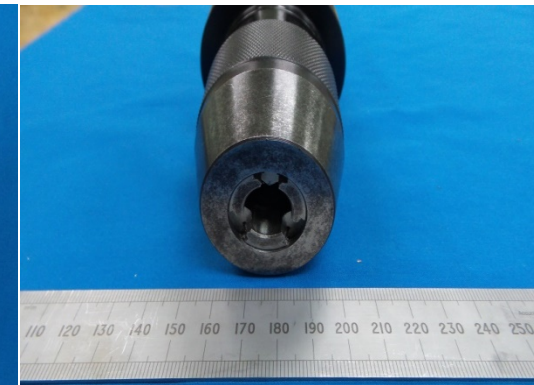
Milling nomenclature

-Types of cutting tools and tool holders -

Tool bits - types of tool bits include end milling tools, facing tools and drilling.



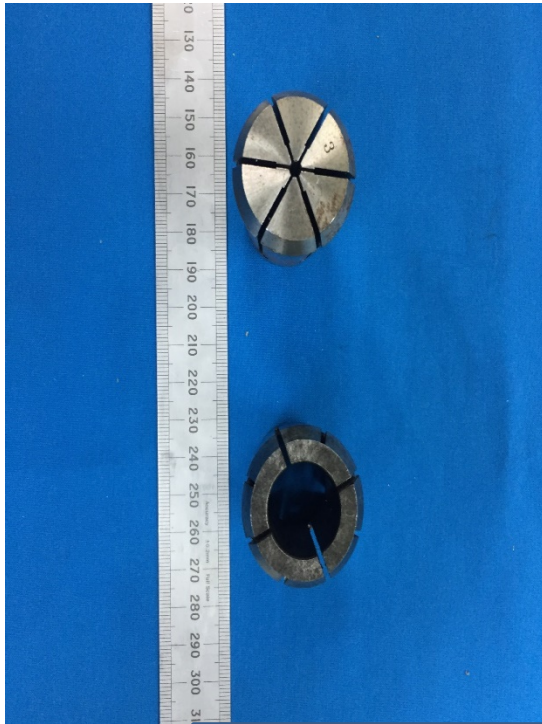
Facing tools



End milling tools

Milling nomenclature

-Types of cutting tools and tool holders -



Drilling tool holder



Drilling tool

Milling nomenclature

- Milling operations -

INSTALLING A CUTTING TOOL – Make sure to clean the holder, then secure the bolts. Milling cutting tools are held by tool holders. Using a quick release lever to set the tool holder to the tool post. While, the tool post is set to the compound with a T-bolt.



Tool holder



Lever

Milling nomenclature

- Milling operations -

POSITIONING THE TOOL

Release the bolts and tighten the cutting tool to the saddle. Use a dial indicator to position the saddle accurately. After that, referencing the dial indicator at the base of the compound, rotate the cutting tool to the desired angle. The cutting tool can be manually hand fed along the desired angle. Use a micrometer dial to allow accurate positioning of the compound and cross slide.

Milling nomenclature

- Milling operations -

Face milling

The cutter is inserted on a spindle having an axis of rotation perpendicular to the materials surface.



Milling nomenclature

- Milling operations -

End milling

- End milling is an important machining operation because its capability and versatility to produce various curved surfaces and profiles.
- The cutter, named an end mill has either a tapered shank (for larger cutter sizes) or a straight shank (for small sizes) and is inserted into the spindle of the milling machine.



Milling nomenclature

- Milling parameters -

- The **cutting speed, V**
in peripheral milling is the surface speed of
the cutter, or

$$V = \pi D N$$

where

D : the cutter diameter

N : the rotational speed of the cutter

Milling nomenclature

- Milling parameters -

- **For a straight-tooth cutter**, the approximate undeformed chip thickness (chip depth-of-cut), can be calculated from the equation

$$t_c = 2f \sqrt{\frac{d}{D}}$$

- **Feed-per-tooth** is determined from the equation

$$f = \frac{v}{Nn}$$

where

v : the linear speed (*feed rate*) of the workpiece

n : the number of teeth on the cutter periphery.

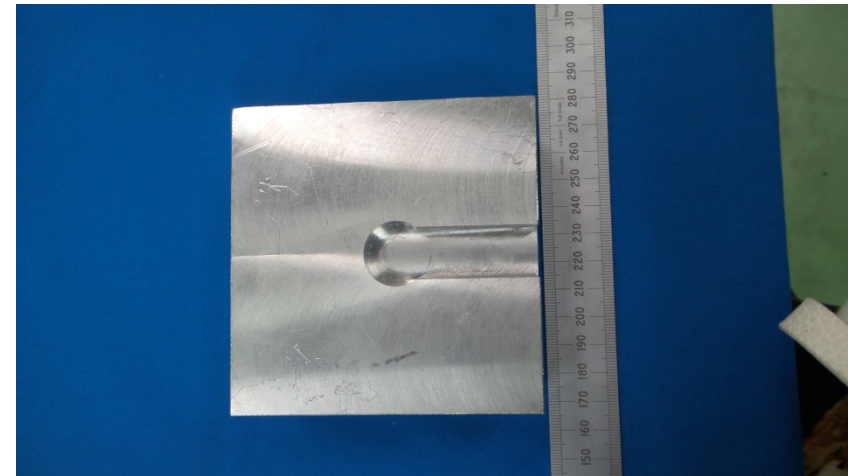
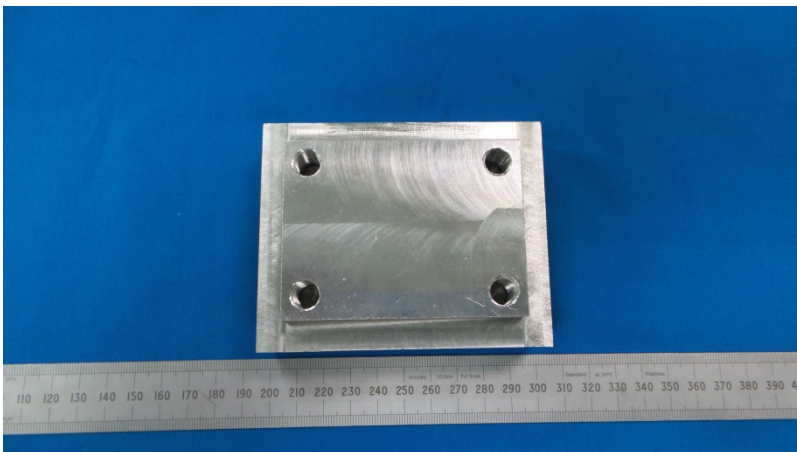
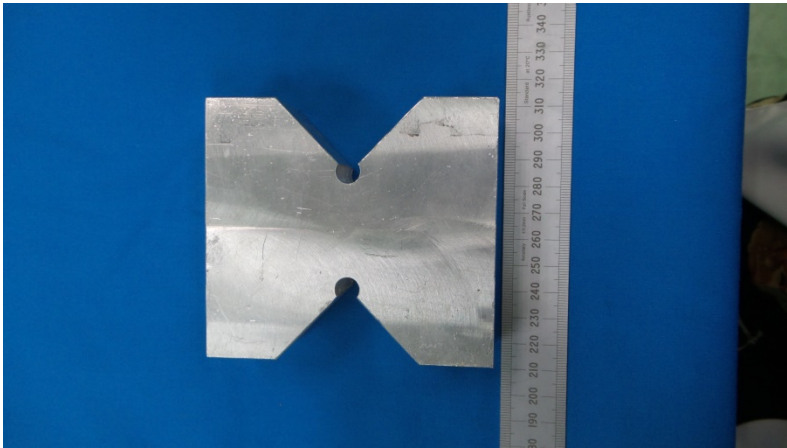
Milling nomenclature

- Milling parameters -

The power requirement in peripheral milling can be measured and calculated, **but** the forces acting on the cutter are difficult to calculate because of the many variables involved, particularly cutting- tool geometry.

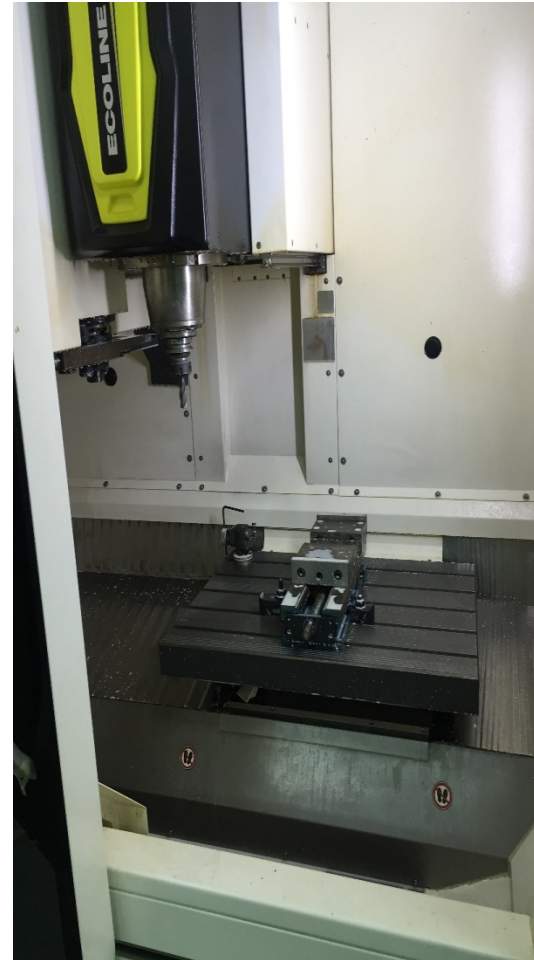
Milling nomenclature

Examples of products by milling



Milling nomenclature

Advance milling/CNC milling machine



Self-Test

1. Define what is milling?
2. Differentiate between conventional milling and climb milling.
3. Differentiate between end milling and facing process.
4. What is the formula to calculate cutting speeds?
5. What's the difference between conventional and advance milling machine?

Summary

- ✓ Introduction to milling machine which **cutting by moving back and forth and up and down.**
- ✓ Milling machine nomenclature which composed from **6 compounds; column, spindle head, worktable, base, spindle and knee.**
- ✓ Lathe operations included **facing, end milling, drilling etc.**