MECHANICAL ENGINEERING SCIENCE (UE25ME141A/B)

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Unit4

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Manufacturing operations,Robotics, and Smart Industry Practices

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MACHINE TOOL

- Machine Tool is a power driven machine to perform machining

- Machine Tool performs three major functions:
  -It rigidly supports the work piece and cutting tool
  -Provides relative motion between work piece and cutting tool
  -Provides range of speeds and feeds

INTRODUCTION

- Machine tools that give a shape to parts/products by removing metal chips from a workpiece include lathes, shapers and planers, drilling machines, boring machines, milling machines, grinders, etc.
- Before the Industrial Revolution of the 18th century, hand tools were used to cut and shape materials for the production of goods such as cooking utensils, wagons, ships, furniture, and other products.
- After the advent of the steam engine and material; goods were produced by power-driven machines that could only be manufactured by machine tools. Jigs and fixtures (for holding the work and guiding the tool) were the indispensable innovations that made interchangeable parts realities in the 19th century.

INTRODUCTION

Conventional Machining:

Definition: Involves physical contact between a harder cutting tool and the workpiece, removing material in the form of chips.

Examples: Turning, milling, drilling, grinding, shaping, and broaching.

Energy Source: Primarily mechanical energy.

Suitable for: Materials that are relatively soft and can be economically machined with standard tools.

Limitations: Can be challenging to machine hard materials, complex shapes, or those with intricate geometries.

INTRODUCTION

Non-Conventional Machining:

Definition:

- Utilizes various forms of energy (thermal, chemical, electrical, etc.) to remove material, often without direct contact between the tool and workpiece.

Examples:

- Electrochemical Machining (ECM): Uses electrochemical dissolution to remove material.
- Electro-Discharge Machining (EDM): Uses electrical discharges to erode material.
- Laser Beam Machining (LBM): Uses a focused laser beam to cut or ablate material.
- Ultrasonic Machining (USM): Uses ultrasonic vibrations and an abrasive slurry to remove material.
- Abrasive Jet Machining (AJM): Uses a high-velocity stream of abrasive particles to erode material.

INTRODUCTION

Non-Conventional Machining:

Energy Source:

- Thermal, chemical, and electrical energy.

Suitable for:

- Machining hard materials, complex shapes, and materials that are difficult to machine with conventional methods.

Advantages:

- Can achieve higher precision, intricate geometries, and work with materials that are otherwise difficult to machine.

Limitations:

- Generally more expensive than conventional methods and may require specialized equipment and skilled operators.

MECHANISM OF METAL CUTTING

- The removal of extra material from a metal surface by shearing or cutting action is known as machining or metal cutting. The cutting takes place along a plane, which is known as shear plane.
- There is a cutting zone; if it is examined carefully we find that the severe plastic deformation occurs in this zone due to compressive force applied by the sharp-edged cutting tool.
- The extra material due to this deformation flows over the tool surface, known as chip, and this shearing zone is known as primary shear zone.

MECHANISM OF METAL CUTTING

- During flow of chip on the rake surface of the cutting tool, the temperature of newly formed chip increases due to friction and it gets welded automatically on the rake surface.
- But, due to compressive force applied by newly formed chip (just after the welded chip) causes secondary shear of the welded chip, and this shear is known as secondary shear.
- In metal cutting the line generated by the cutting motion is called **generatrix** and the line formed by feed motion is called **directrix**.

Types of Chip Formation

Various types of chips, which are formed in various cutting conditions and type of machining, can be categorized as follows:

a) Continuous chip.

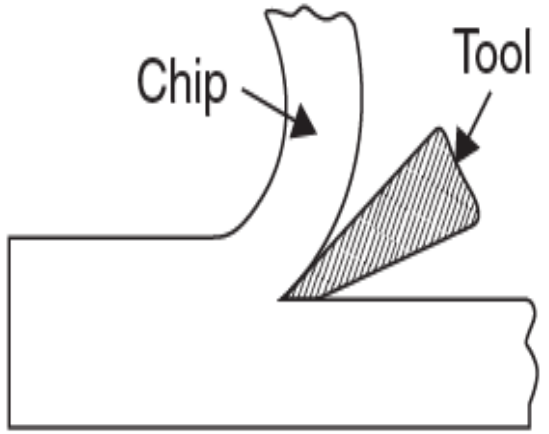
b) Discontinuous chip.

c) Continuous chip with built-up edge.

Types of Chip Formation

Continuous chip, as shown in Figure (a), is formed due to

- ❑ Machining of ductile materials.
- ❑ Small undercut thickness.
- ❑ High cutting speed.
- ❑ Large rake angle of the tool.
- ❑ Suitable cutting fluids.

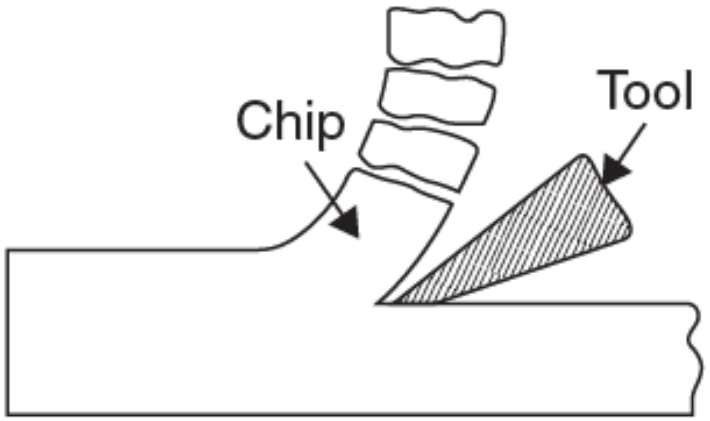


(a) Continuous chip

Types of Chip Formation

Discontinuous Chip: Discontinuous chip, as shown in Figure (b), is formed due to

- ❑ Machining of brittle work materials.
- ❑ Low cutting speed.
- ❑ Small rake angle.
- ❑ Large uncut chip thickness.

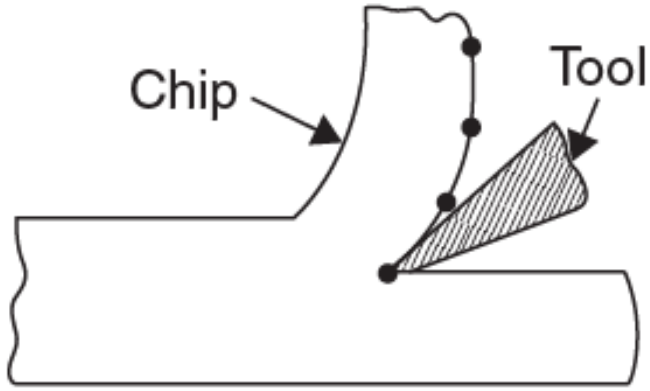


(b) Discontinuous chip

Types of Chip Formation

Continuous Chip with Built-up (BUP) Edge: Continuous chip with built-up edge, as shown in Figure (c), is formed due to

- Large friction or stronger adhesion between chips and
- tool face.
- Low rake angle.
- Large uncut chip thickness.



(c) Continuous chip with BUP