1 APRIL Unit-2 - Machine Tool Operations

LATHE MACHINE

Lathe is considered as one of the oldest machine tools and is widely used in industries. It is called as mother of machine tools.
The primary task of a lathe is generation of cylindrical workpieces. In this process, excess unwanted metal is removed.
The machine tool useful in performing plain turning, taper turning, thread cutting, chamfering and knurling by adopting is called lathe.

Main Parts of a Lathe Machine

1. Bed
2. Headstock
3. Spindle
4. Tailstock
5. Carriage
   a) Saddle
   b) Apron
   c) Cross-Slide
   d) Compound-rest
   e) Compound-slide
   f) Tool post
6. Feed Mechanism
7. Lead screw
8. Feed Rod

① Bed

Bed is mounted on the legs of the lathe which are bolted to the floor. It forms the base of the machine. It is made of cast iron and its top surface is machined accurately and precisely.

② Headstock

Headstock is mounted permanently on the inner guide ways at the left hand side of the bed. The headstock houses a hollow spindle and the mechanism for driving the spindle at multiple speeds.

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③ Spindle

The spindle rotates on two large bearings housed on the headstock casting. A hole extends through the spindle so that a long bar stock maybe passed through the hole. The front end of the spindle is threaded on which chucks, faceplate, driving plate and catch plate are screwed. The front end hole is tapered to receive live centre which supports the work.

④ Tailstock

Tailstock is located on the inner guide ways at the right side of the bed opposite to the headstock. The spindle has a taper hole to receive the dead centre or shanks of tools like drill or reamer.

⑤ Carriage

Carriage is located between the headstock and tailstock on the lathe bed guide ways. It has several parts to support, move and control the cutting tool

- Saddle : It is an H-shaped casting which connects the pair of bed guide ways like a bridge.
- Cross-Saddle :- Cross saddle is situated on the saddle and slides on the dovetail guide ways at right angle to the bed guide ways.
- Compound rest :- A part which connects cross slide and compound slide. Compound slide is attached to the compound rest by dove tail joint.
- Tool Post :- Located on top of compound slide used to hold the tools rigidly.

⑥ Lead screw :-

The leadscrew is a long threaded shaft used as master screw. It is brought into operation during thread cutting to move the carriage to a calculated distance.

⑦ Feed Rod :-

Feed Rod is placed parallel to the leadscrew on the frontside of the bed. It is useful in providing feed movement to the carriage except for thread cutting and to move cross-slide

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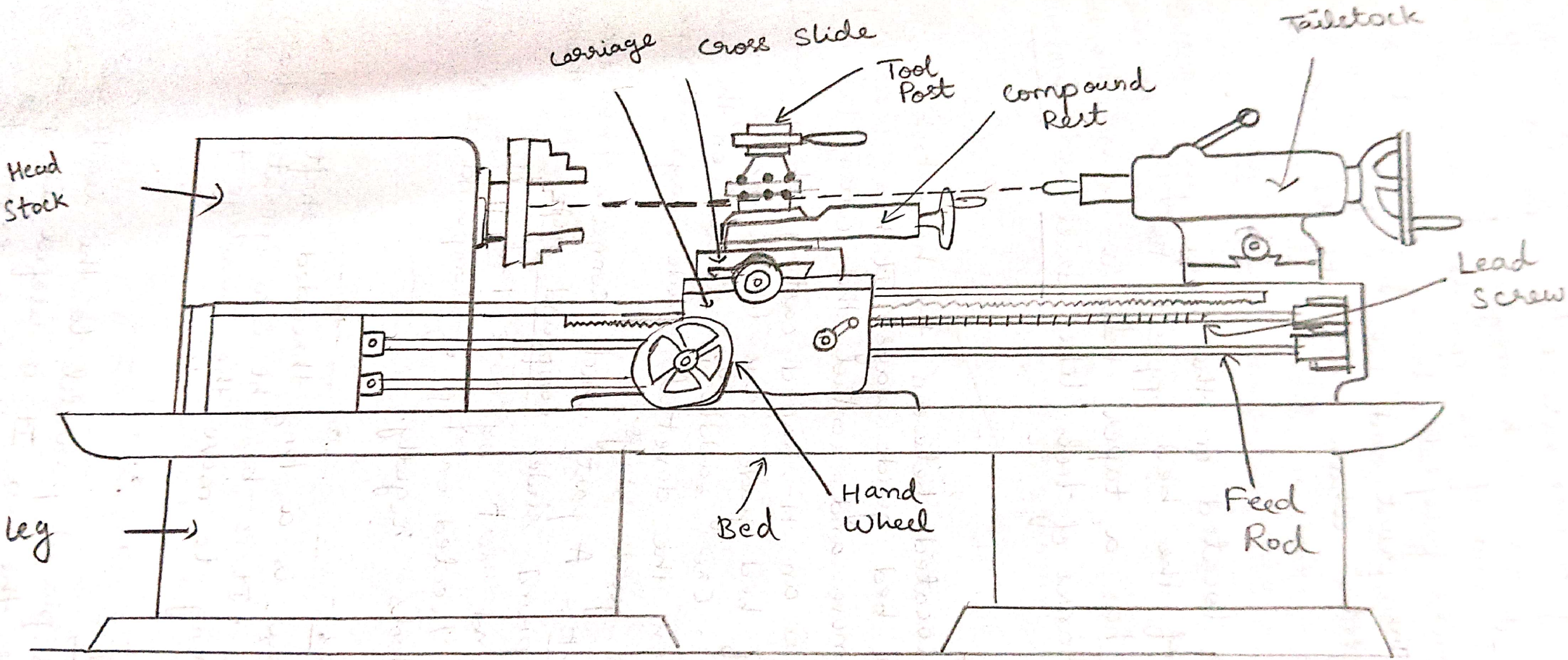

Lathe Machine

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Lathe Specifications

1. Length of the bed
2. Maximum distance between live and dead centres
3. Height of centres from the bed
4. Swing Diameter
   - Over Bed - Largest Diameter of work piece which is rotated without touching bed.
   - Over Carriage - Largest Diameter of the work that will revolve over saddle.
5. Bore Diameter of spindle
6. Width of the bed
7. Type of the bed
8. Pitch value of the lead screw
9. Horse power of the motor
10. Number and range of spindle speeds
11. Number of feeds
12. Spindle Nose Diameter
13. Floor space required
14. Type of machine.

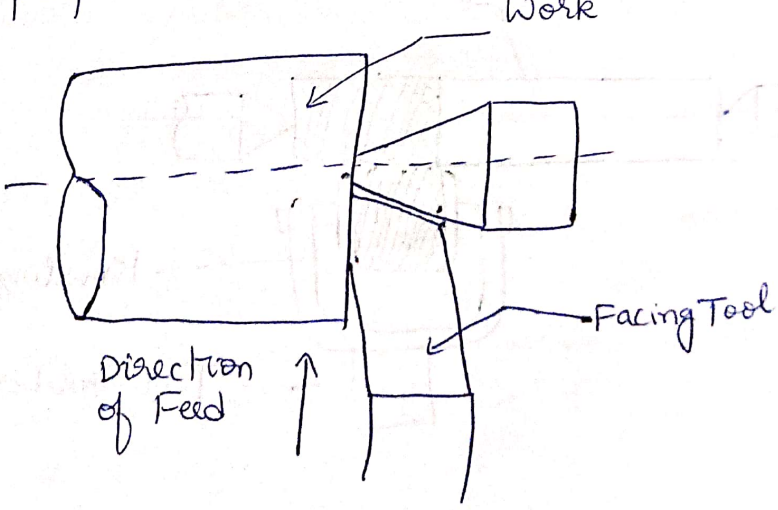
Lathe Work holding devices

1. Chucks
2. Face Plate
3. Driving Plate
4. Catch Plate
5. Carriers
6. Mandrels
7. Centres
8. Rests.

Lathe Operations (Turning, Facing, Knurling)

1. Facing

It is the operation of machining the ends of a piece of work to produce flat surface which is square with the axis. The operation involves feeding the tool perpendicular to the axis of rotation of the work.



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Turning — ②

Turning in a lathe is to remove excess material from the workpiece to produce a cylindrical surface of required shape and size

Straight Turning

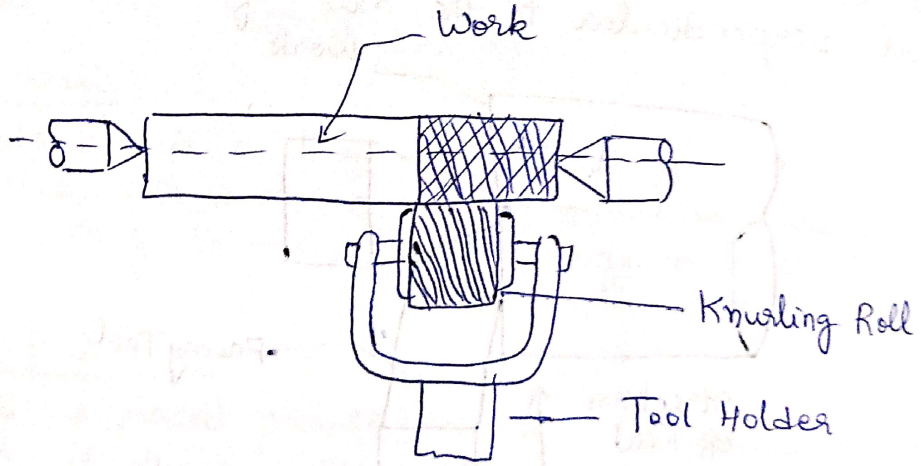
The work is turned straight when it is made to rotate about the lathe axis and the tool is fed parallel to the lathe axis The straight turning produces a cylindrical surface by removing excess metal from workpieces.

Step Turning

The process of turning different surfaces having different diameters. The work is held between centres and the tool is moved parallel to the axis of the lathe. It is also called shoulder turning.

③ — Knurling

Knurling is the process of embossing a diamond-shaped pattern on the surface of the workpiece.
The knurling tool holder has one or two hardened steel rollers with edges of required pattern. The tool holder is pressed against rotating work.
The rollers emboss the required pattern.
The tool holder is fed automatically to the required length.
Knurls are available in coarse, medium and fine pitches
The patterns may be straight, inclined or diamond shaped.



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MACHINE

Drilling machine is one of the most important machine tools in a workshop. It was designed to produce a cylindrical hole of required diameter and depth on metal workpieces.
A mark of indentation is made at the required location with a centre punch. The rotating drill is pressed at the bottom of location and fed into the work. The hole can be made upto a required depth.

Drilling Machine Specifications

1. Maximum diameter of the drill that it can handle.
2. Size of the largest workpiece that can be centred under the spindle.
3. Distance between the face of the column and the axis of the spindle.
4. Diameter of the table
5. Maximum travel of the spindle
6. Numbers and range of spindle speeds and feeds
7. Morse taper number of drill spindle
8. Floor space required
9. Weight of the Machine
10. Power input is also needed to specify the machine completely.

Working of Drilling Machine — Tools

1. Drill : A drill is a tool used to originate a hole in a solid material. A helical groove known as 'flute' is cut along the length of the drill.
2. Reamer :- The tool used for enlarging and finishing a previously drilled hole is known as reamer. It is a multi-tooth cutter and removes smaller amount of material.
3. Counter Bore : It is a multi tooth cutting tool used for enlarging the top of the previously machined hole. It has three or four cutting teeth.

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④ Countersink :-

A countersink has cutting edges on its conical surfaces. This is used for enlarging the top of the holes conically.

⑤ Tap :-

A tap has threads like a bolt which acts as a multi-cutting tool.

Drilling Machine Parts

① Axis : It is the longitudinal centre line of the drill running through the centres of the tang and the chisel edge.

② Body : It is the part of the drill from its extreme point to the commencement of the neck Helical grooves are cut on the body of the drill.

③ Shank : It is the part of the drill by which it is held and driven. The shank of the drill can be fitted directly into the spindles or tool holding device.

④ Tang : The flattened end of the shank is known as tang. It ensures a positive drive of the drill.

⑤ Neck :- This is diametrically undercut between the body and shank of the drill.

⑥ Point : It is the sharpened end of the drill.

⑦ Lip : It is the edge formed by the intersection of flank and face

⑧ Land : Cylindrically ground surface on the leading edges of the drill flutes adjacent to the body clearance surface.

⑨ Flutes :- The grooves in the body of drill. This permits the cutting fluid to reach the cutting edges.

Drilling Machine Operations.

Drilling is the operation of producing a cylindrical hole of required diameter and depth by removing metal by the rotating edge of a cutting tool called drill. Drilling is one of the simplest methods of producing a hole. Drilling does not produce an accurate hole in work place.

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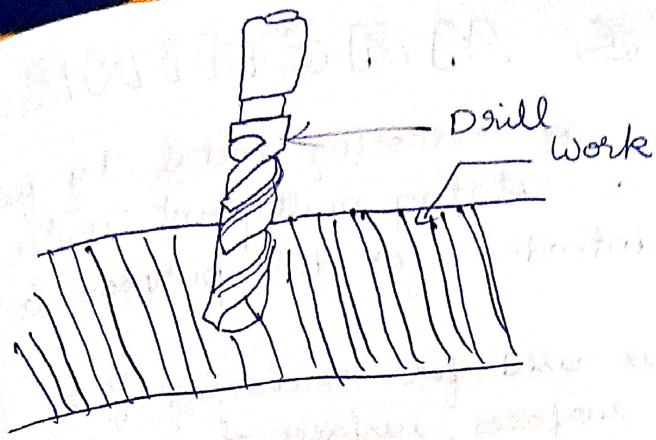
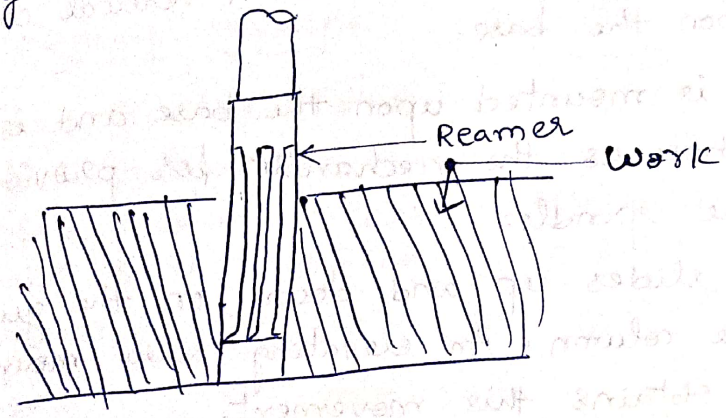
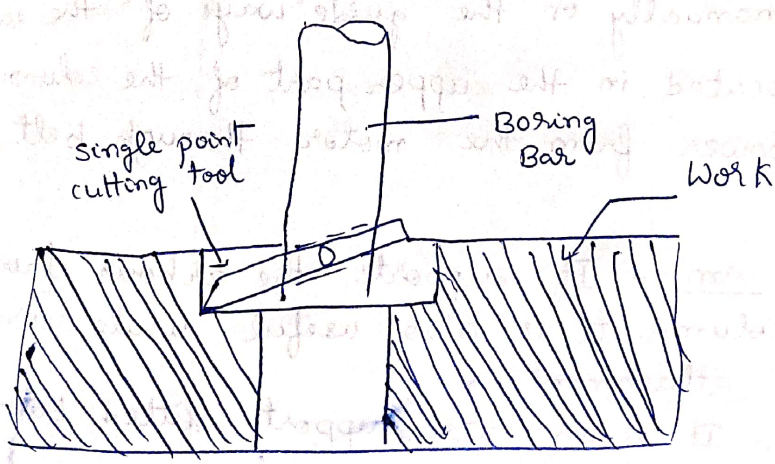


② Reaming
The size of hole made by drilling may not be accurate and the internal surface will not be smooth. Reaming is an accurate way of sizing and finishing a hole which has been previously drilled by a multi-point cutting tool known as reamer.



③ Boring : It is the operation enlarging the diameter of the previously made hole. Boring tool is a tool with only one cutting edge. The tool is held in a boring bar which has a taper shank to fit into the spindle or a socket.



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Radial Drilling Machine

① Radial arm :- Allows the drill head to be positioned at various heights and angles above the workpiece.

② Drill Head :- Houses the spindle, which Rotates the drill bit and is mounted on the drill arm.

③ Spindle :- Rotates the drill bit, driven by the motor.

④ Motor :- Provides the power to rotate the spindle and in some cases, the radial arm.

⑤ Column :- A vertical pillar that supports the radial arm and allows for vertical adjustment of the arm.

⑥ Base :- Provides stability for the entire machine.

⑦ Chuck :- Holds the drill bit securely.

⑧ Pulleys :- Used to transmit power from the motor to the spindle and adjust the speed of rotation.

⑨ Feed Mechanism :- Allows the operator to control the downward movement of the spindle and drill bit.

Bench Drilling Machine

- Base :- It is the foundation of the drilling machine, providing a stable platform for the entire machine.
- Column :- A vertical post that supports the head and table, ensuring precise alignment and movement.
- Head :- This houses the motor, drive mechanism and quill. Its responsible for rotating the drill bit and controlling the feed.
- Spindle :- A hollow shaft that holds the drill chuck and allows the drill bit to rotate.
- Worktable : A platform that supports the workpiece being drilled.
- Chuck :- A mechanism that securely grips the drill bit preventing it from slipping during drilling.

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* Feed Mechanism:

The mechanism that allows the drill bit to move downwards into the workpiece at a controlled rate, ensuring efficient and accurate drilling.

* Motor:

The motor provides the power to rotate the spindle and drive the drill bit. It is typically attached to the head or the base of the machine.

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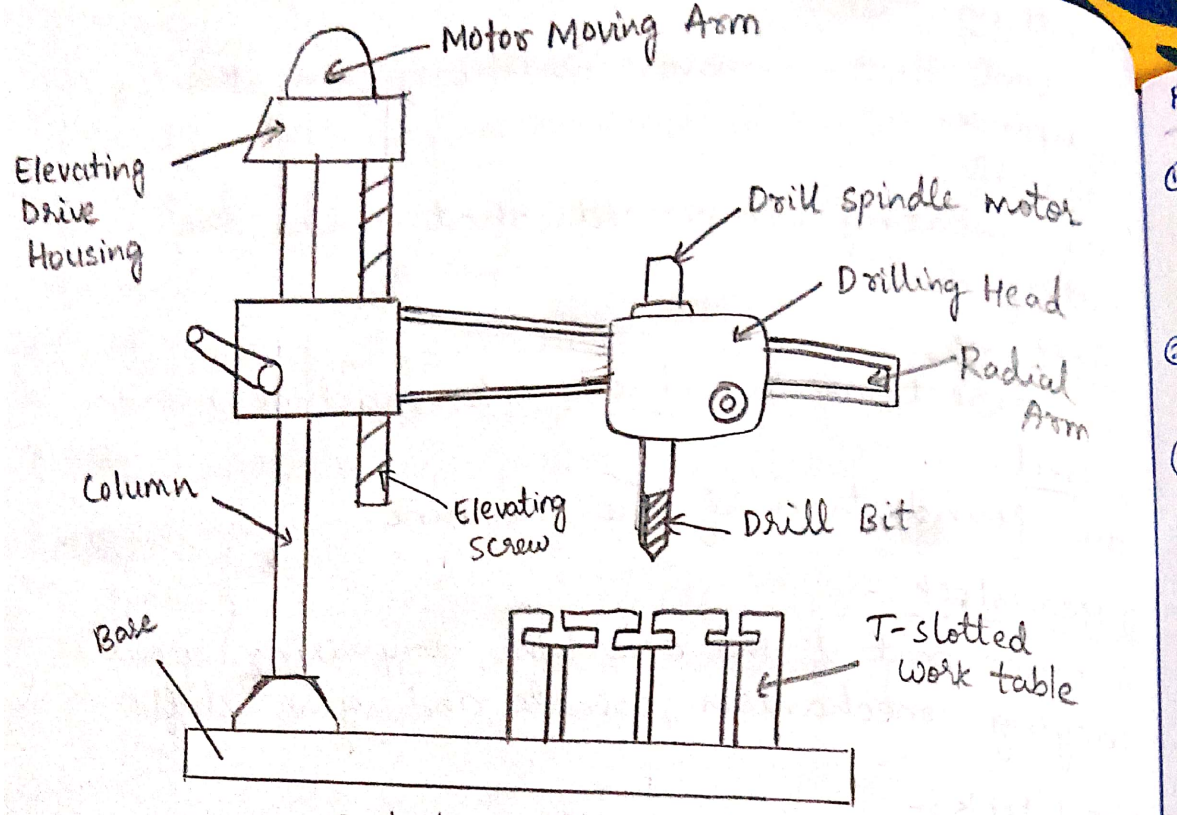
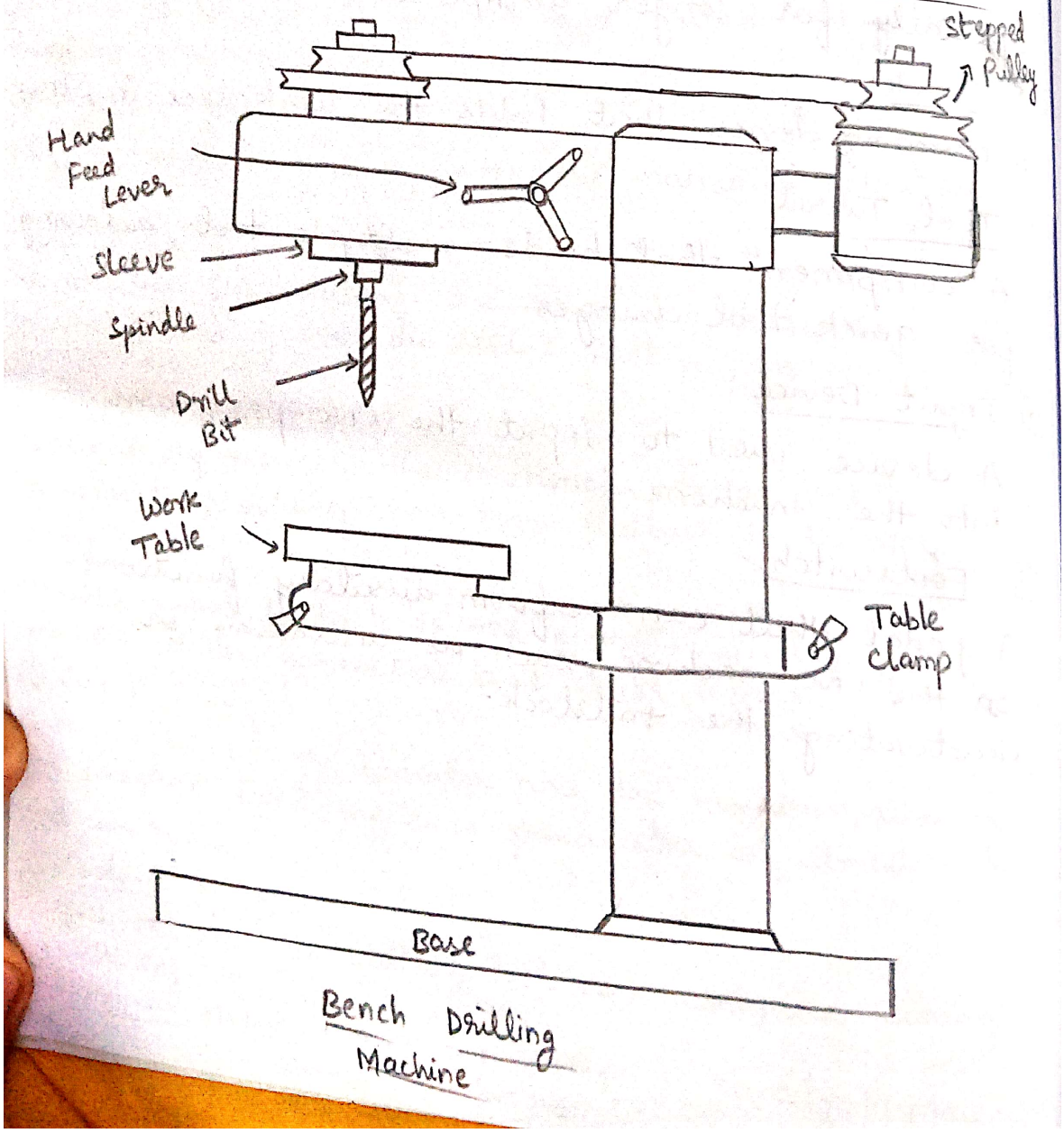


Radial Drilling Machine



Bench Drilling Machine

MILLING MACHINE

Milling is a process of removing metal by feeding the work against a rotating multipoint center. The machine tool intended for this purpose is a milling machine.

Milling machine is used for machining flat surfaces, contoured surfaces, surfaces of revolution, external and internal threads and helical surfaces of various-cross sections.

Horizontal Milling Machine

① Base: It is made of cast iron and supports all the other parts of the machine tool. A vertical column is mounted upon the base.

② Column: It is mounted upon the base and is box shaped. It houses the mechanism for providing drive for the spindle.

③ Knee: It slides up and down on the guide ways of the column. An elevating screw mounted on the base obtains this movement.

④ Saddle:- It is mounted on the guide ways of the knee and moves towards or away from the face of the column. The top of the saddle has guide ways for the table movement.

⑤ Table:- The table is moved longitudinally either by power or manually on the guide ways of the saddle.

⑥ Spindle:- Located in the upper part of the column. It receives power from the motor through belt, gears and clutches.

⑦ Overhanging arm:- It supports the arbour from the top of the column. It is also useful while using some special attachments.

⑧ Front Brace:- It is an extra support fitted between the knee and the overhanging arm.

⑨ Arbour:- It supports the different types of cutters used in the machine.

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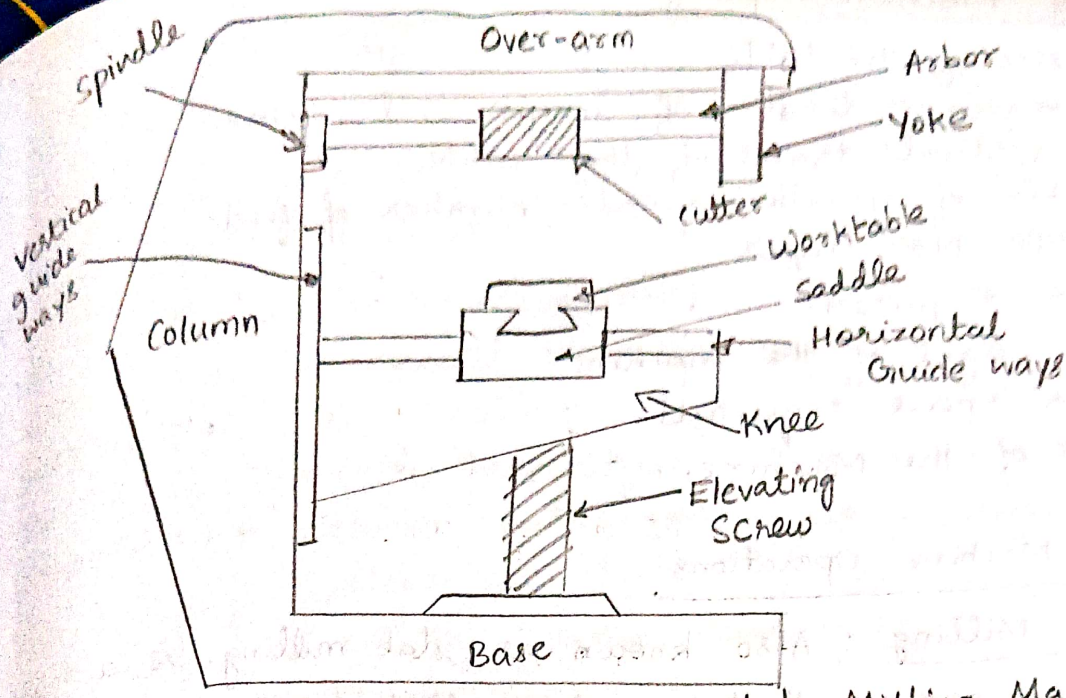
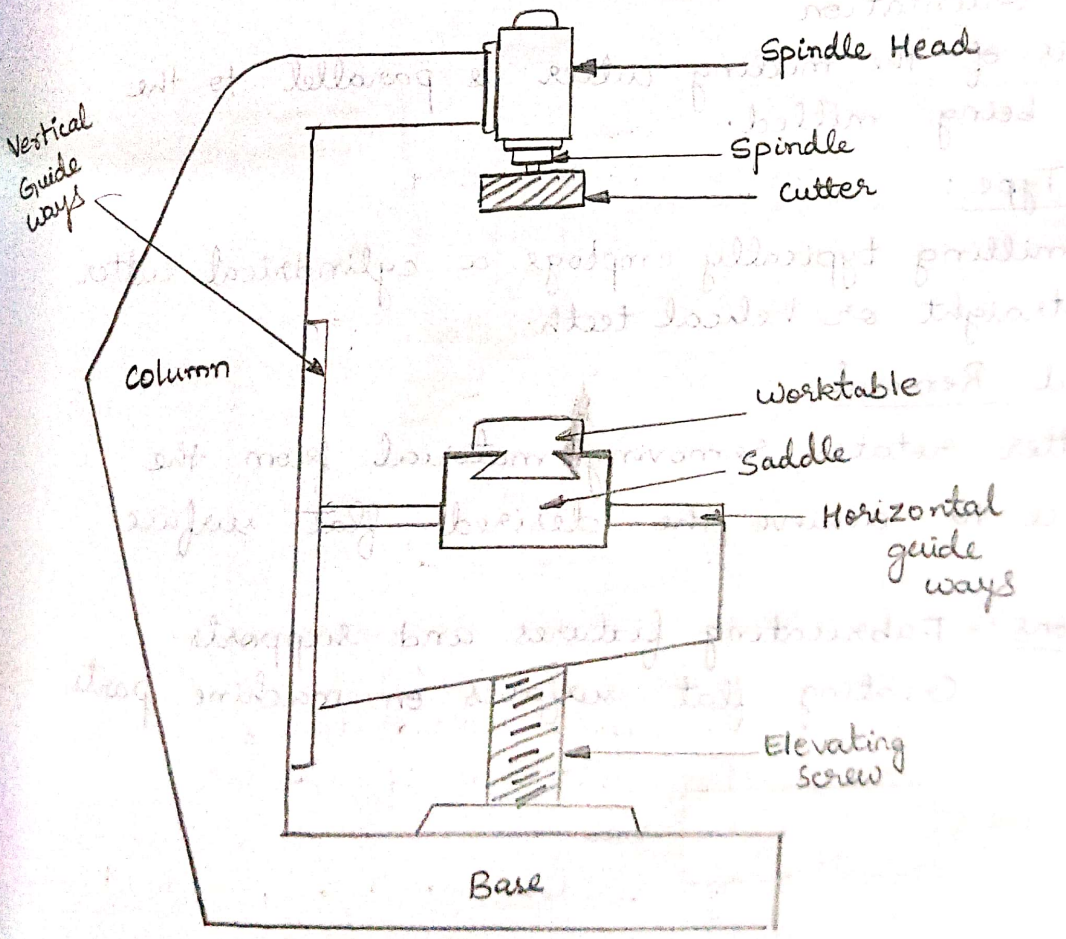


Horizontal Milling Machine

Vertical Milling Machine

It is very similar to a horizontal milling machine in construction as it has the same parts of base, column, knee, saddle and table. The spindle of the machine is positioned vertically. The cutters are mounted on the spindle.



Vertical Milling Machine

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Milling machine Specifications

① The size of the table (length and width)
② The maximum lengths of longitudinal, cross and vertical travel of the table.
③ Number of spindle speeds, number of feeds.
④ Spindle Nose taper
⑤ Power required.
⑥ Net weight of the machine
⑦ Floor space required
⑧ Type of the Machine.

Milling Machine Operations

① Plain (Slab) Milling : Also known as slab milling, is a machining process that creates flat, horizontal surfa parallel to the cutter's axis, using a cylindrical cutter with straight or helical teeth.

Characteristics :-

• Flat Surface Creation

Primary purpose of plain milling is to produce flat, horizontal surfaces on a workpiece.

• Cutter Orientation

The axis of the milling cutter is parallel to the surface being milled.

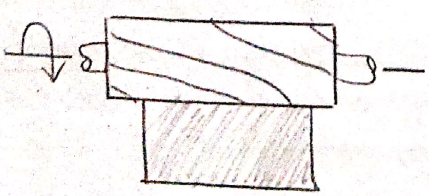
• Cutter Type :

Plain milling typically employs a cylindrical cutter with straight or helical teeth.

• Material Removal:

The cutter rotates, removing material from the workpiece to achieve the desired flat surface.

Applications :- Fabricating fixtures and supports
Creating flat surfaces on machine parts.



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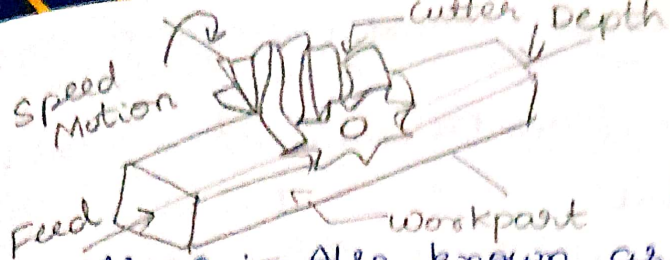


Plain Milling

(3) Slot Milling :- Also known as groove milling, is a machining process that uses a rotating cutting tool to create slots or grooves in a workpiece.

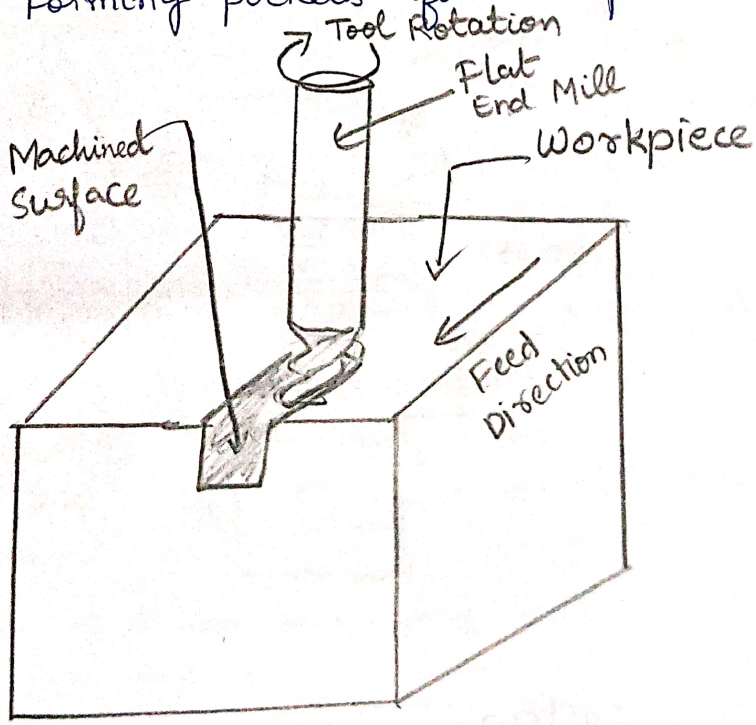
- It is a versatile technique used to produce precise and clean cuts for various applications.
- Slot milling cutters are typically cylindrical tools with teeth or flutes along their length, designed to remove material efficiently.

Applications :-

① Keyways: Creating slots for keys in shaft or other components.

② Slots :- Machining slots for fasteners, mounting hardware, or other functional purposes.

③ Pockets :- Forming pockets for components or features.



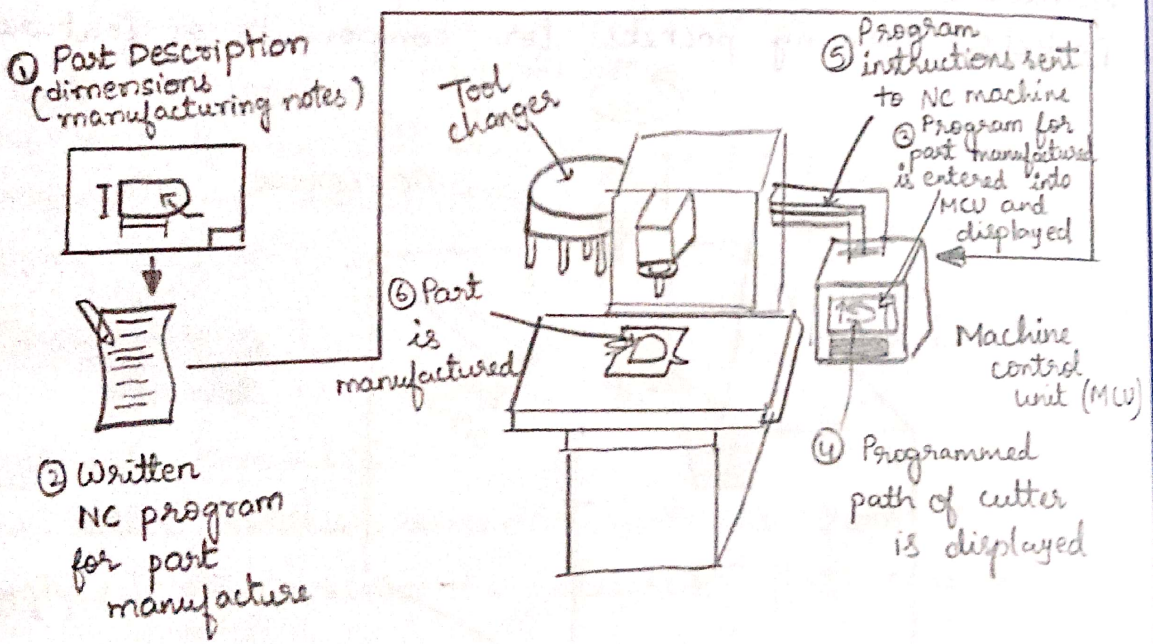
Slot Milling

Introduction to Advanced Manufacturing Systems:

Introduction to CNC (Computer Numerical Control)

- Computer numerical control is the numerical control system in which a dedicated computer is built into the control to perform basic and advanced numerical control functions.
- CNC controls are also referred to as soft-wired NC systems because most of their control systems functions are implemented by the control software programs.
- CNC is a computer assisted process to control general purpose machines from instructions generated by a processor and stored in a memory system

Components of CNC system Block diagram



Advantages of CNC system

★ CNC machines can be used continuously and only need to be switched off for occasional maintenance.

★ These machines require less skilled people to operate unlike manual lathes / milling machine.

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* These machines can be updated by improving the software used to drive the machines.
* Manufacturing process can be simulated virtually.
* CNC systems do not require any human intervention once programmed.
* Training for the use of CNC machines can be done through the use of virtual software.

Applications of CNC

. CNC was initially applied to metal working machinery:
* Mills, Drills, Boring Machines and Punch presses
. Now they are expanded to robotics, grinders, flame cutters, welding machinery, EDM's for inspection equipment etc.

* CNC mills and machining centers
* CNC fabrication machines
* CNC lathes and turning centers
* CNC cutting machines.

3D printing / Additive Manufacturing

It is a process that creates three-dimensional solid objects from digital files by layering material successively under computer control. Its a versatile technology used for rapid prototyping, custom manufacturing and many more.

Process

3D printing involves creating a digital model using CAD software or 3D scanning. This model is then sliced into layers and the 3D printer builds the object by depositing material layer by layer.

Materials

Various materials can be used, including plastics, metals, composites and even ceramics.

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Applications

3D printing is used across various industries, including engineering, aerospace, automotive, medicine and even fashion.

Advantages

It offers design flexibility, reduced waste compared to subtractive methods and the ability to create complex, custom-designed parts.

Accessibility:

3D printing has become more affordable and accessible, with desktop models available for individuals and small businesses.

Components of CNC machine

① Machine Control Unit (MCU)

Interprets G-code instructions and controls the machine's movements.

② Machine Tool

Physical machine that performs the machining operation.

③ Drive System

Responsible for moving the machine's axes and spindle according to the MCU's instructions.

④ Feedback Mechanisms

Continuously monitors the machine's position and movement, providing real-time feedback to the MCU.

⑤ Display Unit

Provides visual feedback to the operator, displaying machine status, parameters and error messages.

⑥ Control Panel

Interface between the operator and the machine, allowing for program input, machine parameter adjustments and monitoring.

⑦ Coolant System:

Used to cool the cutting tool and workpiece during machining.

⑧ Workpiece Holder: Holds the workpiece securely in place during machining.

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(9) Cutting Tool
The tool that removes material from the workpiece.

(10) Spindle:
The rotating component that holds the cutting tool.

(11) Axes:
The directions in which the machine moves.

(12) Bed:
The foundation of the machine.

(13) Headstock :-
A major part of the CNC lathe, comprising speed changing mechanism, spindle and gear shifts.

(14) Tailstock :-
A component used to support the workpiece, especially for longer workpieces.

(15) Chuck :-
A clamping device that holds the workpiece in place.

(16) Tool Turret
A component that holds multiple tools, allowing for quick tool changes.

(17) Input Device :
A device used to input the CNC program into the machine.

(18) Footswitch :-
A pedal that can perform auxilary functions on the CNC machine, such as activating or deactivating the tailstock.

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