MRCET CAMPUS

LIVE TO LEARN & LEARN TO SHARE

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(AUTONOMOUS INSTITUTION - UGC, GOVT. OF INDIA)

Affiliated to JNTUH; Approved by AICTE, NBA-Tier 1 & NAAC with A-GRADE | ISO 9001:2015

Maisammaguda, Dhulapally, Komaplly, Secunderabad - 500100, Telangana State, India

AIRCRAFT PRODUCTION TECHNOLOGY MANUAL

Name:...

Roll No:..............Branch:...

Year:.................Sem:...

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Certificate

Certified that this is the Bonafide Record of the work done by

Mr./Ms.. Roll No. .... of

B.Tech II Year .... Semester for the Academic Year 2025-26

in ....Manual.

Date: Faculty Incharge HOD

Internal Examiner External Examiner

INDEX

No	Date	Name of the Activity/Experiment	Grade/ Marks	Faculty Signature

MRCET VISION

To become a model institution in the field of Engineering, Technology and Management. To have a perfect synchronization of the ideologies of MRCET with challenging demands of international Pioneering Organizations.

MRCET MISSION

To establish a pedestal for the integral innovation, team spirit, originality and competence in the students, expose them to face the global challenges and become pioneers of Indian vision of modern society.

MRCET QUALITY POLICY

To pursue continual improvement of teaching learning process of Undergraduate and Postgraduate programs in Engineering & Management vigorously.

To provide state of art infrastructure and expertise to impart the equality education.

PROGRAM OUTCOMES (PO'S)

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM EDUCATIONAL OBJECTS: Aeronautical Engineering

1. PEO1 (PROFESSIONALISM & CITIZENSHIP): To create and sustain a community of learning in which students acquire knowledge and learn to apply it professionally with due consideration for ethical, ecological and economic issues.
2. PEO2 (TECHNICAL ACCOMPLISHMENTS): To provide knowledge-based services to satisfy the needs of society and the industry by providing hands on experience in various technologies in core field.
3. PEO3 (INVENTION, INNOVATION AND CREATIVITY): To make the students to design, experiment, analyse, and interpret in the core field with the help of other multidisciplinary concepts wherever applicable.
4. PEO4 (PROFESSIONAL DEVELOPMENT): To educate the students to disseminate research findings with good soft skills and become a successful entrepreneur.
5. PEO5 (HUMAN RESOURSE DEVELOPMENT): To graduate the students in building national capabilities in technology, education and research.

PROGRAM SPECIFIC OUTCOMES: Aeronautical Engineering

- To mould students to become a professional with all necessary skills, personality and sound knowledge in basic advance technological areas.
- To promote understanding of concepts and develop ability in design manufacture and maintenance of aircraft, aerospace vehicles and associate equipment and develop application capability of concepts sciences to engineering design and processes.
- Understanding the current scenario in the field of aeronautics and acquire ability to apply knowledge of engineering, science and mathematics to design and conduct experiments in the field of aeronautical Engineering.
- To develop leadership skills in our students necessary to shape the social, intellectual, business and technical worlds.

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

II Year B. TECH - I- SEM

AIRCRAFT PRODUCTION TECHNOLOGY (R24A2181) L/T/P/C 0/0/2/1

COURSE OBJECTIVES:

- The main objective of this course is to impart practical exposure on various aircraft production technologies used in industry.
- Impart the fundamental aspects of the metal cutting principles
- application in studying the behaviour of various machining processes
- train in knowing the fundamental parts of various machining operations and their kinematic schemes.
- Basic Exercises in Lathe, Shaper, Milling, Slotting, CNC and Grinding machines welding equipment comprising Microscopes polishing disc grinders as under.

LIST OF EXPERIMENTS

1. Plain turning, Taper Turning, Facing, Knurling, Thread cutting
2. Drilling, Boring, Counter boring, Counter sinking
3. Simple exercise on Shaping
4. Simple exercise on Planning
5. Plain Milling
6. Gear Milling (step milling & slot milling)
7. Sheet metal joining by soldering
8. Simple exercise on CNC machines and programme generation
9. Simple exercise on Gas Welding
10. Simple exercise on Arc Welding
11. Aircraft wood gluing practice
12. Study of properties of sandwich structures

Note: Any 10 experiments can be conducted

Reference Books:

1. "Aircraft production techniques" Keshu S.C, Ganapathy K.K., Interline Publishing House, Banglore- 1993.
2. "Manufacturing Engineering and Technology" by Kalpakajam - Addison Wesley

1. LATHE

A lathe machine is a versatile machine tool which shapes cylindrical workpieces by rotating them against a fixed cutting tool. A lathe machine is also known as “Centre Lathe” because of two centers between which the job can be held and rotated.

The main function of Lathe machine is to remove excess material in the form of chips by rotating the work piece against a stationary cutting tool. This is accomplished by holding the work securely and rigidly on the machine and then turning it against cutting tool which will remove metal from the work. To cut the material properly the tool should be harder than the material of the work piece. Some of operations of lathe machine are Plain turning, Taper Turning, Facing, Knurling, Thread cutting and boring etc.

Single Point Cutting Tool Definition:

A single point cutting tool is the type of cutting tool or cutter that removes material by means of one cutting edge during a single stroke of movement. for ex: turning, facing, slotting, planning, shaping, etc. This tool is used in Lathe, Shaper Machine.

Nomenclature of Single Point Cutting Tool:

Shank: It is the main body of the tool. Shank is always held in the holder. It is the back portion of the tool which is held by the tool post.

Flank: Flank is the surface that are vertical and adjacent to the cutting edge. There are two types of flank i.e. Side flank (major flank) and end flank (minor flank).

Face: The face is the top surface of the tool so that after cutting chips slides over it. The faces are the horizontal surface just adjacent to the cutting edge.

Nose: The nose is also called the cutting point of the single-point cutting tool. It is the intersection point of major cutting edge and minor cutting edge.

Side Cutting Edge angle: Side cutting edge angle is the angle between the side cutting edge and the line extending the shank. The angle is measured in a plane parallel to the base.

End Cutting Edge Angle: End Cutting Edge Angle Is the angle between the end cutting edge and the line passing through the tip perpendicular to the tool axis and the angle is measured in a plane parallel to the base.

Back rake angle: Back rake angle is the angle between the line parallel to the tool axis passing through the tip and the rake face and angle are measured in a plane perpendicular to the base.

Side Rake angle: Side Rake Angle is the angle between the rake face and the Line passing through the tip perpendicular axis and the angle is measured in a plane perpendicular to the base. Normally this angle varies 5-15 degrees.

Side Relief Angle: Side relief angle is the angle between the side flank and the line passing through the tip perpendicular to the base and the angle is measured in a plane perpendicular to the tool axis. This angle varies in the range of 5-15°.

End Relief Angle (Clearance angle): End relief angle is the angle between the end flank and the line passing through the tip perpendicular to the base and the angle is measured in-plane parallel to the tool axis. Relief is provided to the side and end flanks in order to minimize physical interference or rubbing contact with the machine surface of the workpiece.

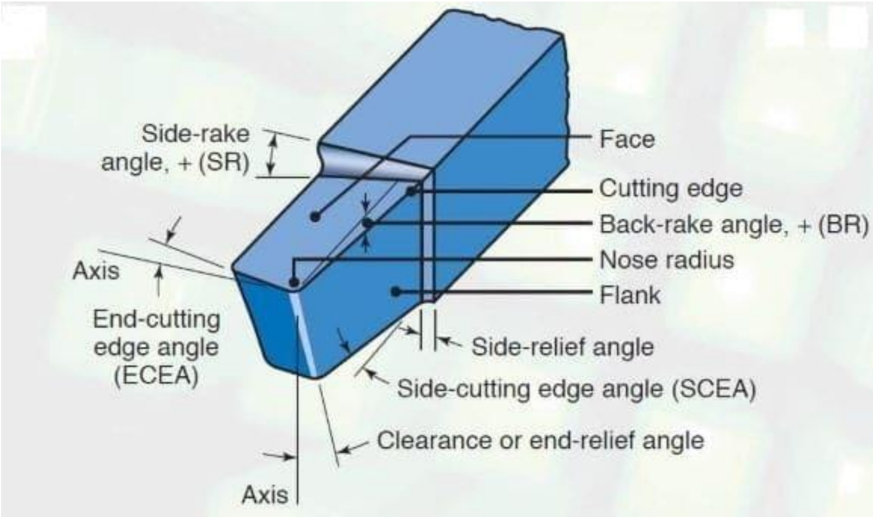


Fig: Single point cutting tool

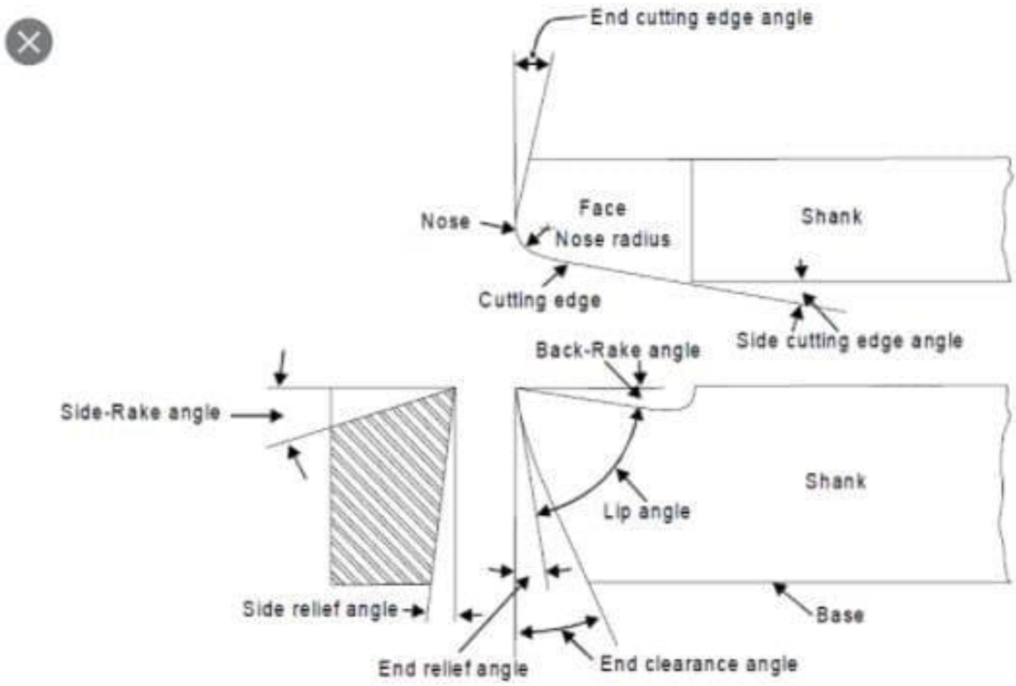


Fig: Different angles in single point cutting tool

Parts of Lathe Machine:

Headstock: The headstock is a critical component of the lathe, located at the machine's left end. It houses the main spindle, gears, and often the motor that drives the spindle. The primary function of the headstock is to hold and rotate the workpiece.

Tailstock: Positioned opposite the headstock, the tailstock supports the other end of the workpiece.

Bed: The bed of the lathe serves as a robust base that supports the major components of the machine, including the headstock, tailstock, and carriage.

Carriage: The carriage slides along the bed and is responsible for carrying the cutting tool.

Lead Screw: A long-threaded shaft that runs parallel to the bed.

Feed Rod: The feed rod, often running alongside the lead screw, also runs parallel to the bed.

Spindle: Located inside the headstock, the spindle is rotated by the motor.

Chuck: Attached to the spindle, the chuck grips and holds the workpiece in place.

Tool Post: Mounted on the carriage, the tool post holds the cutting tool.

Cross Slide: Mounted on the carriage, the cross slide moves perpendicular to the bed.

Apron: The apron is part of the carriage that houses the control mechanisms.

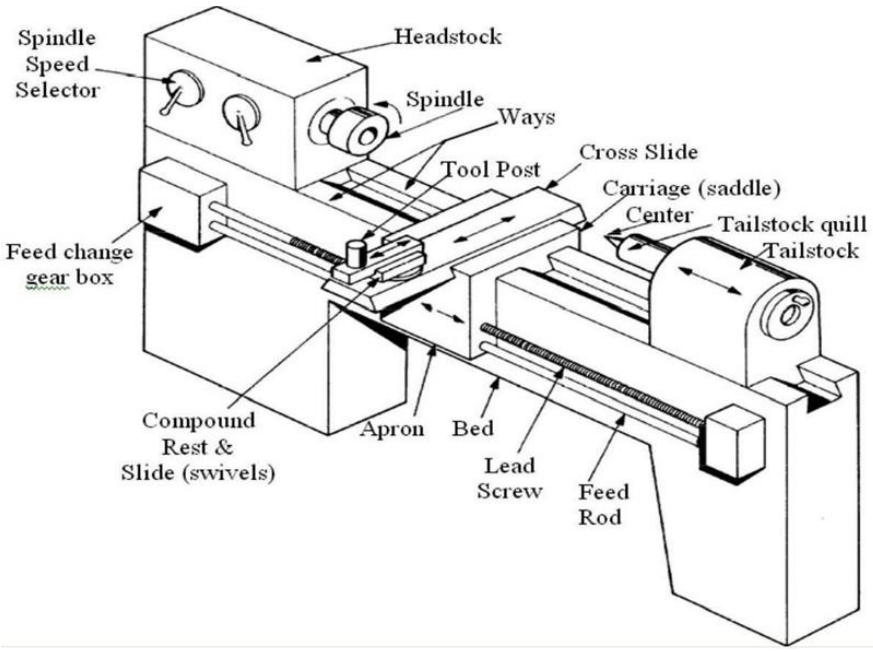


Fig: Lathe Machine

Types of Operation in Lathe:

Turning: Turning is the fundamental process of removing material from the outer diameter of a workpiece to produce a cylindrical shape. This operation can be performed in different ways, including:

- Straight Turning: Removing material along the external surface to reduce diameter.
- Taper Turning: Cutting a conical shape into the workpiece.

Facing: Facing involves cutting the end of the workpiece to produce a flat surface. It's often the first operation performed on a lathe. Facing is crucial to create a clean, flat starting point for further machining and is essential in preparing the workpiece for other operations like drilling or turning.

Drilling: Drilling on a lathe involves creating a round hole in the workpiece, typically using a drill bit secured in the tailstock. This operation is integral to many machining projects and allows for precise hole creation in terms of diameter and depth. Drilling can be done centrally or off-center based on the requirements of the job.

Boring: Boring on a lathe involves enlarging a hole that has already been drilled or cast. The process is used to achieve greater accuracy in diameter and to attain a smooth internal finish. A boring tool is mounted on the tool post and then advanced into the workpiece, which is held stationary on the lathe.

Threading: Threading is a precise operation performed on a lathe to create threads on the outer or inner surface of a workpiece. This is achieved by moving a threading tool at a predetermined feed rate along the rotating workpiece, matching the pitch of the desired thread.

Knurling: Knurling is the process of creating a regular, cross-patterned texture on the surface of a workpiece. This is typically done to provide a better grip on the finished part.

Grooving: Grooving involves creating narrow grooves or channels on a workpiece. In this operation, a lathe is used to cut a groove perpendicularly or parallel to the workpiece's surface.

Forming: Forming on a lathe involves shaping a workpiece into a specific contour or profile. This is achieved by using a forming tool whose cutting edge has the shape of the desired profile.

Chamfering: Chamfering involves cutting a bevel or angled edge on the workpiece. On a lathe, this is achieved by positioning the cutting tool at an angle to the workpiece's edge.

Reaming: Reaming is the process of finishing and sizing a hole to a precise diameter. On a lathe, a reamer tool is used, which is slowly fed into a pre-drilled hole while the workpiece rotates.

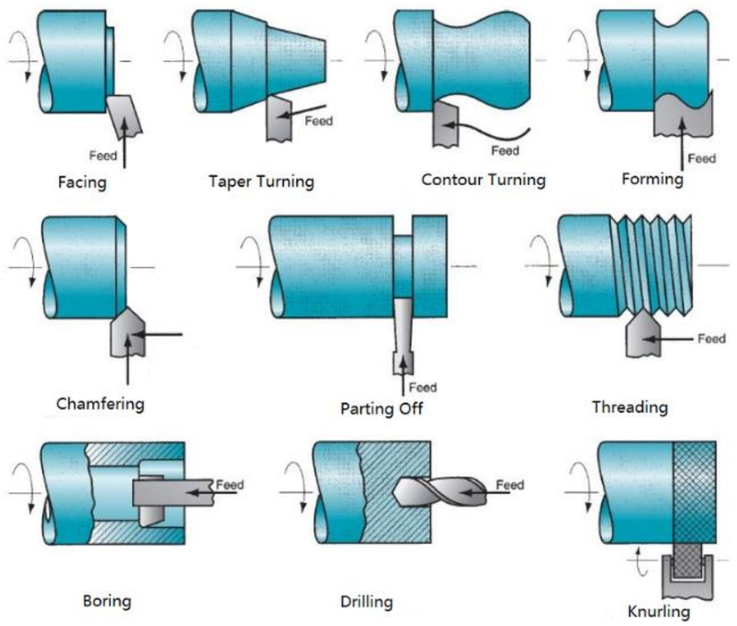


Fig: Lathe operations

Taper Turning: Taper turning is the process of creating a conical shape on a workpiece. This operation is performed on a lathe by adjusting the tailstock or the compound rest at an angle. As the workpiece rotates, the cutting tool moves diagonally, gradually decreasing the diameter of the material, resulting in a tapered shape.

Some important Formulas in Turning:

1.Taper per unit length (usually per inch or per mm): $\text{Taper} = \frac{D-d}{L}$

Where,

D = Larger diameter of the taper

d = Smaller diameter of the taper

L = Length over which the taper occurs

2.Taper angle (α):

If you want the angle of the taper (half angle):

$$\alpha = \tan^{-1}\left(\frac{D-d}{2L}\right)$$

3.Cutting Speed Formula:

$$V = \pi DN$$

Where:

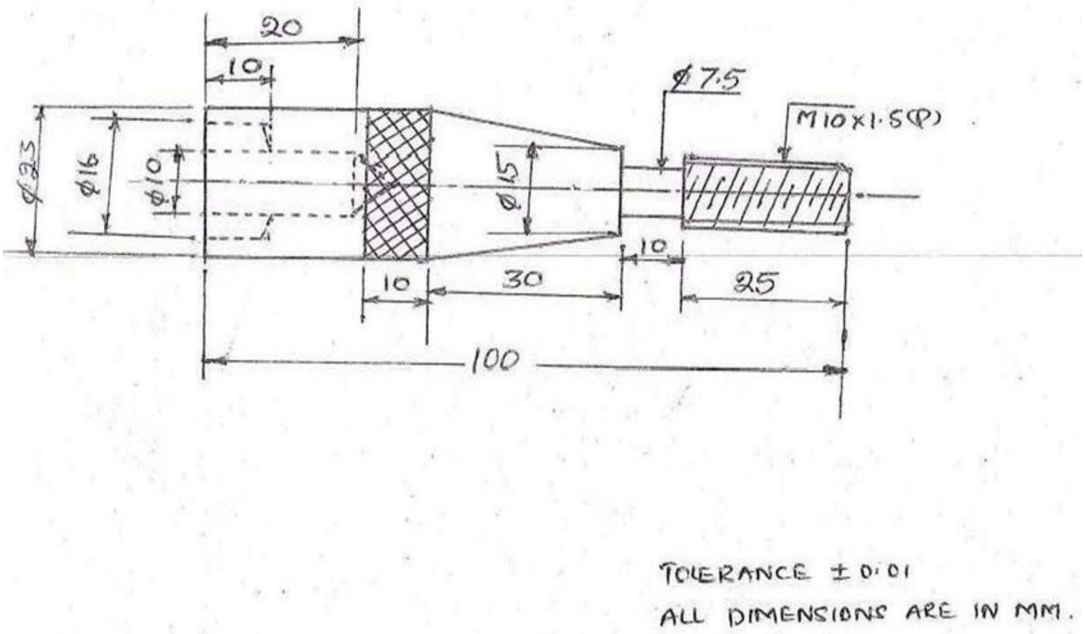
V = Cutting speed (m/min)

D = Diameter of the workpiece (in meters)

N = Spindle speed (revolutions per minute, rpm)

Experiment-1

Aim: To perform various lathe operations such as **Facing**, **plain turning**, **Step turning**, **Taper turning**, **under cut**, **Knurling**, **Thread cutting** and **chamfering**. "On a given material made of mild steel".



Materials Required: A mild steel rod of 25 mm diameter and 100 mm long.

Tools used: H.S.S. single point cutting tool, parting tool, V-tool for threading, Knurling tool, chuck key, tool post key.

Measuring instruments: outside calliper, steel rule, pitch gage etc.

Procedure:

1. Set the workpiece on the chuck and tool on the tool post.
2. Operations such as facing & plain turning are performed on a given M.S. rod. Then the step & undercut turning is performed using parting tool.
   One after another in the sequence upon the dimensions as shown.
3. Now the compound rest is swivelled by calculated half taper angle and taper is generated on the work piece by rotating the compound slide screen will cause the tool to be feed at the half taper angle.
4. H.S.S. tool is replaced by knurling tool in tool post. Knurling generation is performed at the slowest speed of the spindle.
5. Knurling must be done at low speed available and apply lubricating oil while knurling.
6. H.S.S. V-shape thread curing tool fix the tool post and set the workpiece on the chuck.
7. The change gears of correct size are calculated then fitted to the end of the bed between the spindle and the lead screw.

8. The top of the tool nose should be set at the same height as the centre of the job.
9. Thread cutting generation is performed at the slowest speed of the spindle.
10. Engage the lead screw lever and start the operation. Apply proper coolant during cutting point.

Precautions:

1. Operate the machine at specific speed.
2. Do not give the depth-of-cut more than 2 mm.
3. Apply lubrication oil while all operations.
4. Make sure that the workplace is neat and clean.
5. Take necessary safety precautions while performing operations.

Result: The required operations are successively completed.

Viva Questions:

1. What is the lathe.
2. What are the various operations can be performed on a lathe.
3. What are the principal parts of the lathe.
4. What are the types of head stock.
5. State the various parts mounted on the carriage.
6. What is an apron.
7. State any two specifications of the lathe.
8. List any four types of the lathe.

2. DRILLING MACHINE

A drilling machine is a versatile tool designed for boring holes into various materials like metal, wood, and plastic. By holding a drill bit firmly and using adjustable speeds and feeds, a drilling machine cuts into the workpiece, creating holes of specified depths and diameters. Drilling machines vary significantly in size, functionality, and complexity, from compact, portable models to advanced, industrial-grade machines like CNC and magnetic drills. Each machine type is tailored for specific applications, with distinct components and capabilities.

Types of Drilling Machines:

Different drilling machines are suited for specific applications, and each type has unique parts that enhance its performance. Here's an overview of some popular types:

1. Magnetic Drilling Machine

Magnetic drilling machines feature a magnetic base that allows them to attach securely to metal surfaces, making them ideal for drilling holes in structural steel. Unique parts like the magnetic base and adjustable arm make these machines invaluable for vertical and overhead drilling tasks.

2. Portable Drilling Machine

These compact, handheld machines are ideal for on-site work. Powered by batteries or electricity, portable drilling machines are versatile for various light-duty drilling tasks.

3. CNC Drilling Machine

CNC (Computer Numerical Control) drilling machines are used for high-precision tasks, where programmed instructions control every aspect of the drilling process. These machines include advanced components like servo motors and automated spindles for accuracy.

4. Radial Drilling Machine

Radial drilling machines have an extended radial arm, allowing the drill head to move horizontally and vertically across the workpiece without repositioning. This capability is essential in large-scale operations where moving the workpiece may not be feasible.

Key Parts of a Drilling Machine:

Base: The base of a drilling machine is the foundation that provides stability and prevents movement or vibrations during operation. It's generally made from durable materials like cast iron or steel to withstand the machine's weight and any pressure exerted during drilling.

Column: The column is the vertical structure attached to the base, supporting other components such as the radial arm and drill head. The column's design allows for the height adjustment of the machine's moving parts, providing flexibility for working on different materials and depths. This part is vital in larger machines, as it keeps the machine steady and aligns the drill head accurately with the work surface.

Radial Arm: The radial arm is a horizontal component that mounts onto the column. Its function is to allow the drill head to move up, down, and across the workpiece, extending the range of drilling positions without repositioning the work item. This flexibility makes radial drilling machines ideal for handling large or bulky materials that may be difficult to move.

Drill Head: The drill head contains the motor and is attached to the radial arm. It powers the rotation of the drill bit, providing the torque and speed required to penetrate various materials. The drill head is one of the most crucial drilling machine parts because it determines the machine's overall power and effectiveness.

Spindle: The spindle is responsible for holding and rotating the drill bit, moving vertically within the drill head to drive the bit into the workpiece. This part's accuracy and stability are crucial for precise drilling, as it controls the depth, placement, and angle of each hole.

Chuck: The chuck secures the drill bit in place, ensuring it doesn't slip or move during operation. There are different types of chucks, including keyed and keyless varieties, to accommodate different drill bit sizes and types. The chuck's primary purpose is to hold the bit tightly, which is essential for precision and safety. A loose drill bit can cause inaccuracies and even damage the material or machine.

Feed Mechanism: The feed mechanism controls the rate at which the drill bit is pushed into the material. This can be done manually or automatically, depending on the machine type. The feed rate is adjustable to suit different materials and hole depths, allowing for efficient and safe drilling. In more advanced machines, automatic feed mechanisms offer precise control over the drilling process, which is especially beneficial for intricate or repetitive tasks.

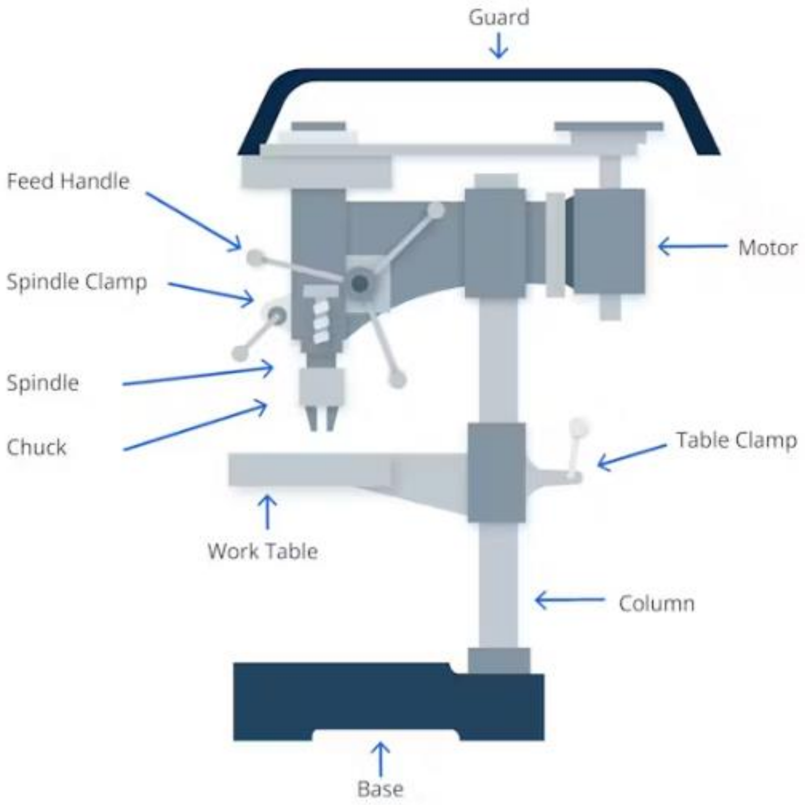


Fig: Drilling Machine

Drilling Operations:

Drilling: When you need a simple, not too large or small parallel sided hole in a workpiece, that requires a basic drilling operation.

Reaming: A high-precision hole-finishing procedure carried out with a multi-edge tool is known as reaming. High penetration rates and shallow cuts involved in the reaming process enable close dimensional tolerance, excellent hole quality, and a high surface finish of the previously drilled hole in the workpiece.

Countersinking: The process of enlarging one end of the hole giving it a conical shape is called countersinking. Countersinking creates a V-shaped edge near the hole's surface. It is frequently employed for deburring drilled or tapped holes, and to ensure fasteners sit tightly in the holes.

Tapping: The process of creating internal threads using a tool known as the tap is referred to as tapping. This allows a cap screw or bolt to be threaded into the hole after it has been tapped.

Boring: A cutting process that entails enlarging an existing hole in a workpiece with a single-point cutting tool or boring head is known as boring. Sometimes, the process is done to correct the roundness of the previously drilled hole.

Counterboring: The process of enlarging a hole over a particular section in the workpiece for screw clearance using counterboring tools is known as counterboring. This creates a shallow and enlarged cylindrical cut in the upper end of the hole to make a place for the head of a screw.

Trepanning: The process of creating a hole by removing metal using a hollow cutting tool is trepanning. This procedure is used to create big or larger diameter holes.

Tapping: The process of creating internal threads using a tool known as the tap is referred to as tapping. This allows a cap screw or bolt to be threaded into the hole after it has been tapped.

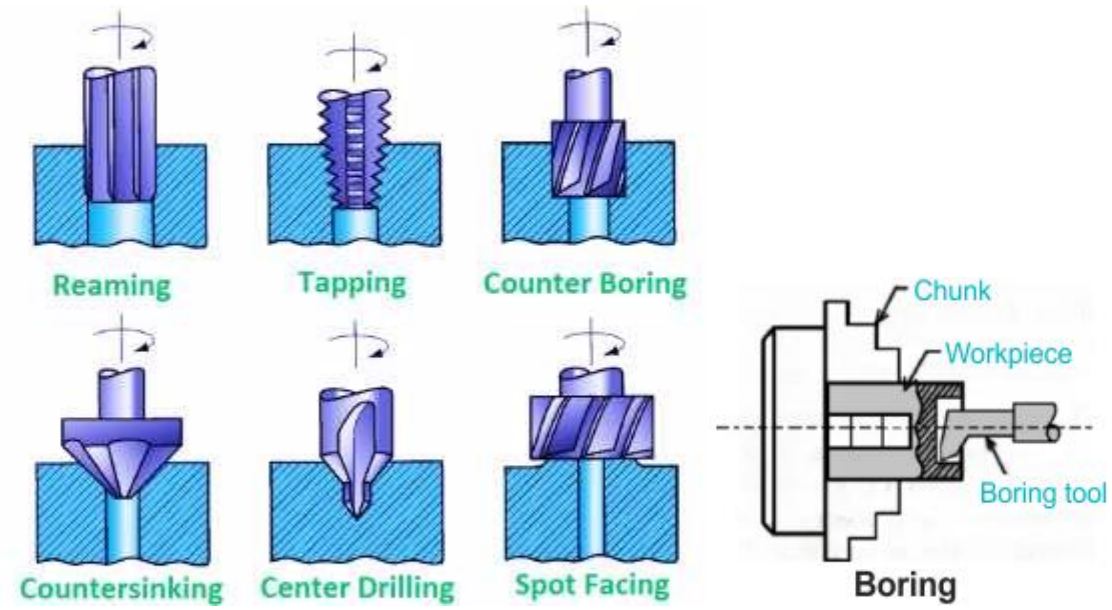


Fig. Various drilling operations

Experiment-2

Aim: To perform various drilling operations such as **Drilling, Boring, Counterboring and Countersinking**. "On a given material made of mild steel".

Apparatus/Equipment Required:

Drilling Machine, Drill bits (HSS) of various diameters, Boring tool (Single-point), Counterbore tool, Countersink tool (82° or 90° angle), Mild steel workpiece, Vise or clamp (for work holding), Vernier Caliper/Micrometer, hammer, Cutting fluid (lubricant) and Safety gear (goggles, gloves, etc.)

Experimental Procedure:

1. Preparation:

- Wear safety goggles and gloves.
- Clean the workpiece and secure it in the machine vise or clamp.
- Mark the hole centers using a center punch and hammer.

2. Drilling Operation:

- Select an appropriate HSS drill bit (e.g., Ø8 mm).
- Mount the drill bit in the chuck of the drilling machine.
- Apply a few drops of cutting fluid to the marked point.
- Align the drill bit with the center-punched mark.
- Start the drilling machine and feed the drill bit slowly into the workpiece.
- Drill through the workpiece at a moderate feed rate.
- Withdraw the tool and check the hole size using a vernier caliper.

3. Boring Operation:

- Mount the boring tool in the machine.
- Insert the tool into the drilled hole.
- Adjust the boring tool to increase the diameter (e.g., enlarge from 8 mm to 10 mm).
- Feed slowly to maintain accuracy and surface finish.
- Withdraw the tool and measure the final hole diameter.

4. Counterboring Operation:

- Select a suitable counterbore tool (e.g., for M8 bolt head).
- Mount the tool in the chuck.
- Align it with the pre-drilled and bored hole
- Apply cutting fluid and start the machine.
- Feed the counterbore tool slowly to a desired depth (e.g., 3 mm).
- Withdraw and check the stepped hole diameter.

5. Countersinking Operation:

- Select a countersink tool (e.g., 82° or 90° angle).
- Mount it in the chuck and align it with the same hole.

- Run the machine at a moderate speed.
- Feed gently to create a chamfer for flat-head screws.
- Withdraw and inspect the conical chamfer visually or with calipers

Observation Table:

Operation	Tool Used	Final Diameter (mm)	Depth (mm)	Remarks
Drilling	Ø mm Drill Bit			
Boring	Boring Tool			
Counterboring	Counterbore Tool			
Countersinking	Countersink Tool			

Precautions:

- Ensure the workpiece is tightly clamped.
- Do not apply excessive feed force
- Always use cutting fluid to reduce heat and wear.
- Measure tools and holes accurately.
- Do not wear loose clothing near rotating machinery.

Conclusion:

The various drilling operations—drilling, boring, counterboring, and countersinking—were successfully performed on the mild steel workpiece using appropriate tools and methods. The final dimensions matched the desired specifications within acceptable tolerances

Viva questions:

1. Mention the main parts of drilling machine.
2. Mention any four names of drilling operations.
3. Define reaming operation.
4. Define counter boring operation.
5. What is the difference between counter sinking and counter boring.
6. Define trepanning operation.
7. What are the types of drilling machines.

3. Shaping

A shaping machine is a mechanical device used to shape and form metal workpieces. It operates by removing material through a reciprocating cutting motion, resulting in the desired shape or contour. Shaping machines are commonly used in metalworking industries for various applications, including creating flat surfaces, slots, and grooves.

Working Principle of Shaping Machine:

The working principle of a shaping machine is based on a quick return mechanism like Whitworth.

A rigid table on the machine supports the workpiece. Over the workpiece, the ram moves back and forth. A vertical tool slide is adjusted to either side of the vertical plane along the stroke axis, which is located at the front of the ram.

The geometry of the linkage causes the ram to travel more quickly on the return stroke than the forward stroke (cutting stroke). As the shaper works on the quick return mechanism, the sliding action of the slider is aided by the rotating link.

One of the four mechanisms i.e. crank and slotted, whitworth quick return, hydraulic, and automatic table feed mechanism, is responsible for the quick return mechanism and reciprocating movement of the ram. The automatic table feed is commonly used today which employs a pawl and ratchet mechanism in a shaping machine.

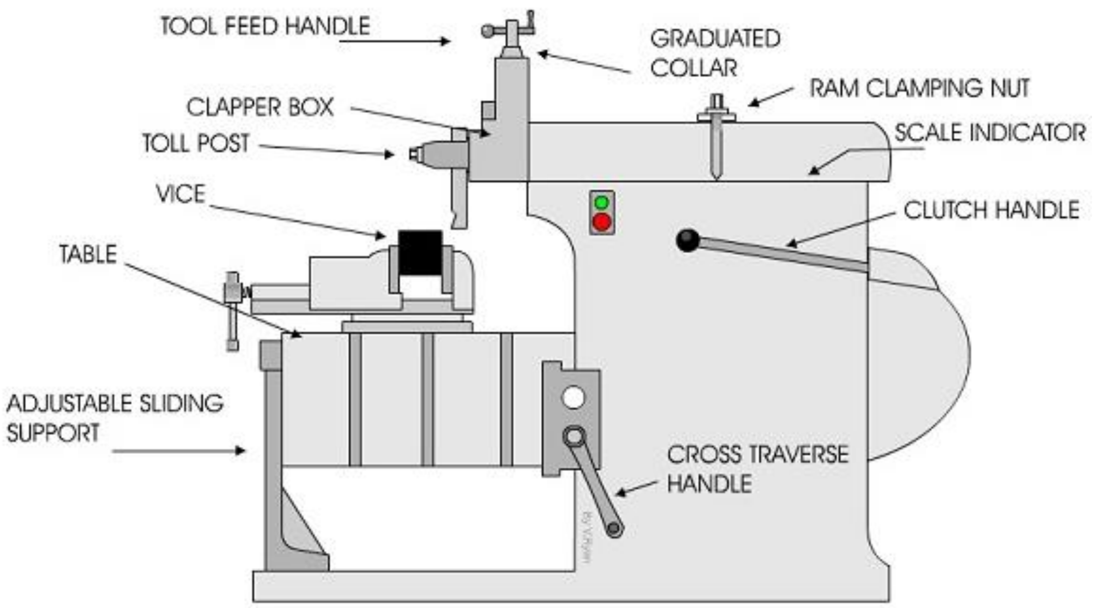


Fig. Shaping machine and its parts

Components of shaping Machine:

Base:

The base of the shaper holds all of the weight of the machine tool, and it is bolted to the shop floor. It is generally made of cast iron. It absorbs vibrations and other forces imparted during shaping operation.

Column:

The column is also made of cast iron in a box shape. It is set on the base of the shaper. It has precisely machined guideways on top that allow the ram to move back and forth. For the cross rail to move, there are guideways on the front vertical face. The ram-driving mechanism is inside the column. The base holds the column in place.

Table:

The table is one of the crucial components of the device which is mounted on the saddle. The elevating screw and crossfeed rod can be turned to move the table both horizontally and vertically. It is a casting that resembles a box with precisely machined top and side surfaces. The table has T-Slots to clamp the work and is secured with support to increase rigidity.

Vice:

Clamp or vice is mounted on the table to hold the workpiece firmly while the shaping process is in progress.

Crossrail:

This part is fixed to the vertical guideways of the column. By turning an elevating screw, which enables the cross rail to glide on the vertical face of the column, the table can be elevated or lowered to meet the varying sizes of the task.

Saddle:

It is fixed to the Crossrail securely on the top of the table. The rotation of the crossfeed screw causes the crosswise movement of the saddle which moves the table in the same direction.

Ram:

It is a component in the shaping machine that reciprocates using a quick return motion mechanism on the guideways at the top of the column while holding the tool in place. It contains a screwed shaft to adjust the working position.

Tool Head:

With the down-feed screw handle, the tool head secures the cutting tool and allows for both vertical and rotational movement. A tool head of shaping machine assembly has a vertical slide is made up of a swivel base with graduated degrees.

Types of Shaping Machines:

We now have a broader understanding of the principle and operations of the machines. These machines are sometimes referred as metal shaping machines and are classified based on their functions as discussed below.

- Hydraulic Shaping Machine
- Horizontal Type Shaping Machine
- Vertical Type Shaping Machine
- Crank Type Shaping Machine
- Standard Type Shaping Machine etc.

Calculation of cutting speed in shaping:

$$\text{Cutting Speed (m/min)} = \frac{2 \times L \times N}{1000}$$

Where,

L = stroke length (mm), and

N = number of strokes per minute

Key difference between shaping and planning machines:

- In shaping, the tool moves and the workpiece is stationary.
- In planning, the workpiece moves and the tool is stationary.

Applications of Shaping machine:

- Producing flat surfaces
- Machining keyways
- Cutting slots and grooves
- Angular surface machining

Limitations of Shaping machine:

- Slow production rate
- Limited to small-sized workpieces
- Not suitable for complex shapes

Experiment-3

Aim: To perform simple exercise in shaping machine.

Objective: To understand the working of a shaping machine and perform a simple cutting operation on a mild steel workpiece to produce a flat surface.

Apparatus/Equipment Required:

Shaping machine, Single point cutting tool (HSS), Mild steel workpiece, Vise or clamp (for work holding), Surface gauge or steel rule, Vernier caliper or micrometer, Cutting fluid (optional) and Safety gear (goggles, gloves).

Experimental Procedure:

1.Initial Setup:

- Wear proper safety gear (goggles, gloves).
- Clean the machine table and the workpiece.
- Mount the workpiece securely in the machine vise or clamp it on the table.

2.Tool and Machine Adjustment:

- Select an appropriate single-point cutting tool (e.g., HSS tool with a proper rake angle).
- Mount the tool in the tool post of the ram.
- Adjust the stroke length slightly longer than the workpiece length.
- Set the depth of cut using the vertical feed screw (e.g., 0.2–0.5 mm).
- Adjust the cross feed and ensure alignment of the tool with the surface to be machined.
- Set the speed of the machine according to the material (typically slower for mild steel).

3.Machining Operation:

- Start the shaping machine.
- Allow the ram to make a few cutting strokes across the workpiece surface.
- Observe that cutting only occurs in the forward stroke; the return stroke is idle.
- After a few strokes, stop the machine and check the surface.
- If more material is to be removed:
  - Increase the depth of cut slightly.
  - Apply cross feed to move the tool sideways.
  - Resume shaping.
- Continue until the entire surface is uniformly machined.

4.Finishing:

- Perform a final light cut (e.g., 0.1 mm depth) for surface finish.
- Stop the machine.
- Remove the workpiece and clean it.

Observation Table:

Parameter	Value
Material	
Stroke length	
Cutting speed	
Depth of cut (final)	
Final surface finish	

Precautions:

- Ensure proper clamping of the workpiece.
- Never try to touch the workpiece while the machine is running.
- Set stroke and tool positions properly before starting.
- Use proper cutting speed for the material.
- Keep hands clear of the machine during operation

Conclusion:

A flat surface was successfully produced on a mild steel workpiece using a shaping machine. The experiment demonstrated the working principle of a shaping machine and provided hands-on experience in performing basic shaping operations.

Viva Questions:

1. What is a shaping machine?
2. What type of motion does the tool perform in a shaping machine?
3. What are the main parts of a shaping machine?
4. Why is the return stroke faster than the forward stroke?
5. Which tool material is commonly used in shaping machines?
6. What is the difference between shaping and planning machines?
7. How do you calculate the cutting speed in shaping?
8. What is the function of the clapper box in shaping machine?

4.Planning

A Planer Machine is a robust machine used to remove material from workpieces to achieve flat and smooth surfaces with high precision. These machines are widely utilised in workshops and manufacturing industries for shaping metals, woodworking, and producing large and heavy components such as steel plates, machine beds, and industrial moulds. With its ability to handle substantial workpieces and deliver accurate results, the planer machine remains an indispensable asset in modern machining processes.

The planer is a machine tool designed to create precise flat surfaces and cut slots with efficiency. It shares similarities with the shaper machine, but its larger size sets it apart. In the planer, the workpiece slots move between points during operation, whereas the workpiece slots remain stationary in the shaper. The planer employs a single-point cutting tool.

Working Principle of Planer Machine:

In a Planer Machine, the workpiece is securely fixed to the machine table, while a single-point cutting tool is appropriately held in the tool post attached to the reciprocating ram. The reciprocating motion of the ram is achieved through a quick return motion mechanism, ensuring smooth back-and-forth movement.

During the forward stroke of the ram, the cutting tool engages with the material, removing the material to shape the workpiece. However, during the return stroke, there is no cutting action, and this stroke is known as the idle stroke. The idle stroke allows the cutting tool to reposition for the next pass without cutting into the material, preventing unnecessary wear and facilitating efficient machining.

Planer machines are known for handling large workpieces and producing accurate flat surfaces and slots.

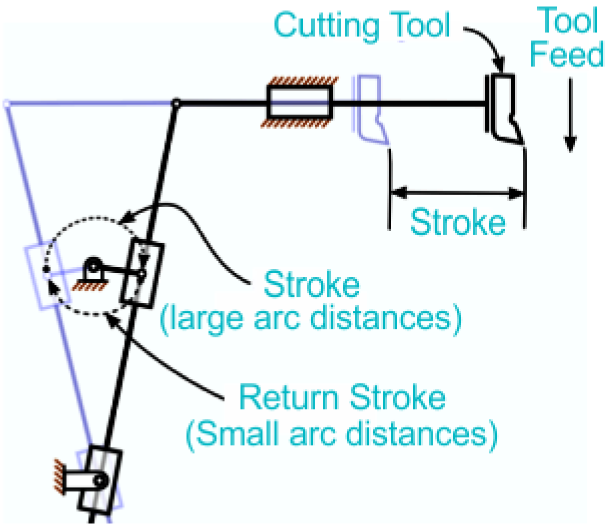


Fig.: Principle of planer machine

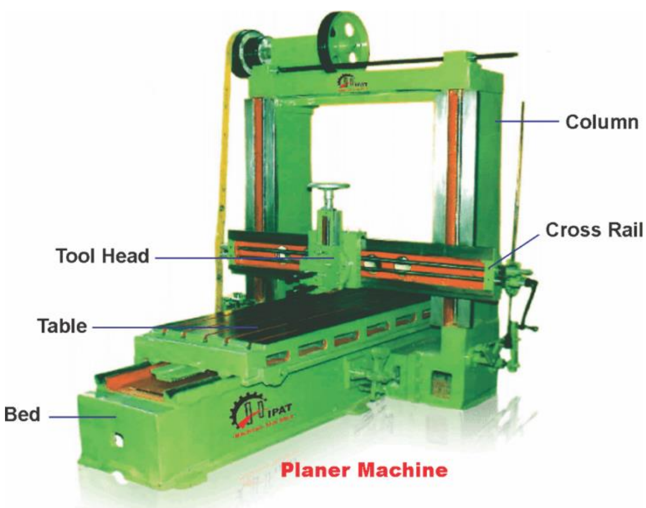


Fig.: Planer machine

Components of Planer Machine:

Bed: The bed serves as the sturdy foundation on which all other machine parts are mounted. It is designed to be large and heavy to provide stability and support during machining operations.

Column / Housing: The columns, also known as uprights, are rigid box-like vertical structures positioned on each side of the bed and firmly attached to it. These housings accommodate pulleys and gears, essential for power transmission within the machine.

Table: The table supports the workpiece and moves reciprocally along the bed's ways. It is crafted from high-quality cast iron for strength and durability. The upper surface of the table is meticulously finished and accurately machined to hold the workpiece securely during the planer operation.

Cross Rail: The cross rail features tool holders where cutting tools, such as single-point cutting tools, can be fixed. It is connected between the two housings and provides additional support to them, ensuring stability during cutting processes.

Tool Head: The tool head is responsible for holding and securing the cutting tools in place, enabling precise machining operations. It plays a pivotal role in shaping the workpiece as the planer moves back and forth.

Types of Planer Machines:

The planer machines are classified based on the size, application and construction. The most common type is a double housing planer, widely used for heavy-duty and large workpieces. Open side planer features one open side for machining wide jobs. Each type of planer serves a specific purpose, offering versatility in machining flat and contoured surfaces.

- Standard or Double Housing Planer Machine
- Open side Planer Machine
- Pit Planer Machine
- Edge or Plate-type Planer etc.

Calculation of cutting speed in shaping:

$$\text{Cutting Speed (m/min)} = \frac{2 \times L \times N}{1000}$$

Where,
L = stroke length (mm), and
N = number of strokes per minute

Experiment-4

Aim: To perform simple exercise in planning machine.

Objective: To understand the working of a planning machine and perform a basic machining operation (such as flat surface cutting) on a mild steel workpiece.

Apparatus/Equipment Required:

Planning machine, Mild steel workpiece, Single-point cutting tool (HSS), Work-holding devices (clamps, T-bolts, etc.), Surface gauge or steel rule, Vernier caliper or micrometer, Marking tools (scribe, square), Cutting fluid or lubricant and Safety gear (goggles, gloves, etc.)

Experimental Procedure:

1.Initial Setup:

- Wear appropriate safety gear (goggles, gloves).
- Clean the machine table and the workpiece.
- Mount the workpiece securely on the machine table using T-bolts and clamps.
- Mark the surface to be machined, if necessary.

2. Tool Setup:

- Mount a suitable single-point cutting tool on the tool post or tool head.
- Adjust the tool height and orientation so that it is properly aligned with the surface to be machined.
- Set the depth of cut (e.g., 0.2–0.5 mm) using the vertical adjustment mechanism.
- Apply cutting fluid to the workpiece, if required.

3. Machine Adjustment:

- Set the stroke length according to the size of the workpiece (slightly longer than the actual length).
- Adjust the return stroke speed to be faster than the cutting stroke (quick return mechanism).
- Set the cross feed to determine the width of the cut.
- Ensure all clamps and bolts are tight to avoid vibration.

4. Machining Operation:

- Start the machine.
- The table moves forward, and the tool cuts the surface.
- During the return stroke, the tool remains idle.
- After each stroke, provide cross feed to move the tool sideways for the next cut.
- Continue this process until the entire surface is machined.

5. Finishing:

- Take a final light finishing cut (e.g., 0.1 mm) for improved surface quality.
- Stop the machine.

- Remove the workpiece carefully.
- Clean the work area and tools.

Observation Table:

Parameter	Value
Workpiece material	
Stroke length	
Cutting speed	
Depth of cut	
Surface finish obtained	

Precautions:

- Ensure the workpiece is rigidly clamped.
- Never stand on the path of the moving table.
- Do not touch the moving tool or table.
- Use proper speed and depth settings for the material.
- Keep the machine and surroundings clean and free from chips.

Conclusion:

A flat surface was successfully machined on a mild steel workpiece using a planning machine. The experiment demonstrated the basic working principle and operation of the machine, emphasizing the relative motion between the tool and the workpiece.

Viva Questions:

1. What is planning machine.
2. What problems can arise if the workpiece is not properly clamped?
3. Which stroke is the cutting stroke in planning?
4. Name the main parts of a planning machine.
5. How is the depth of cut adjusted in a planning machine?

5.Milling

A milling machine is a versatile and essential machine tool used in the manufacturing industry for shaping solid materials, especially metals. It operates by rotating a cutting tool against a workpiece to remove material and create the desired shape. The milling process is highly precise and can produce complex components with intricate contours and surfaces. Milling machine come in various types, including horizontal, vertical, universal, and CNC (Computer Numerical Control) milling machines. The choice depends on the specific application, type of material, and production requirements. In a typical setup, the workpiece is securely clamped on the machine's table, and the cutting tool is mounted on a spindle that rotates at high speed.

The process of removing material from a workpiece by advancing rotary cutters cutter into it is called milling. The process is carried out by adjusting pressure, speed of cutter head, and direction of feed. A milling machine is a piece of equipment that removes a layer of material from the surface by using a multi-point cutting tool. With the aid of numerous cutting edges, the milling cutter revolves at high speed while rapidly removing metal. Cutters can be mounted simultaneously in groups. This machine is well-known for its high level of accuracy, even to the measure of microns.

Types of Milling:

Milling operations are generally classified into four categories based on direction of cut, operation type, cutter orientation and machining purpose

Classification Type	Milling Operation
Based on the Direction of Cut	Up Milling (Conventional Milling)
	Down Milling (Climb Milling)
Based on Operation Type	Face Milling
	Plain Milling (Slab Milling)
	Side Milling Operation
	Profile Milling Operation
	Gear Cutting Operation
	Angular Milling
	Slot Milling
	Gang Milling
	Straddle Milling
Based on Cutter Orientation	Horizontal Milling
	Vertical Milling
Based on the Machining Purpose	Rough Milling
	Finish Milling

Parts of Milling Machine:

Base: It supports every component of the machine and can dampen vibrations imparted by milling operations. Some machines have hollow bases that act as cutting fluid reservoirs. The base is generally constructed out of cast iron for rigidity.

Column: The major supporting part, positioned vertically on the base, is the column. It is box-shaped. It contains the table feed drive mechanism and spindle. A dovetail guideway is provided at the front of its vertical face to support the knee.

Knee: The knee, grey iron casting, slides along vertical guideways to modify the gap between the cutter and the workpiece on the table. This vertical motion is done by utilizing elevating screw provided below the knee.

Elevating Screw: The elevating screw has threads that can provide upward and downward movement to the knee and table by rotating it using a handwheel.

Saddle: The saddle is mounted on the knee at an angle of 90^{o} to the face of the column. It can be moved transversely along the guideways on the knee.

Table: The table, mostly made of cast iron, rests on guideways in the saddle and provides support for the workpiece. And, this workpiece placed on the worktable is moved in either of the three directions:

- Transverse motion generated by the saddle's movement about the knee.
- Vertical motion produced by the vertical motion of the knee.
- A hand wheel affixed to the side of the elevating screw provides longitudinal motion.

Overarm: Another name for this is ‘overhanging arm’. It is installed on the top of the column and functions as a support for the opposite end of the arbour and spindle, which extends beyond the column face.

Milling Machine Operations:

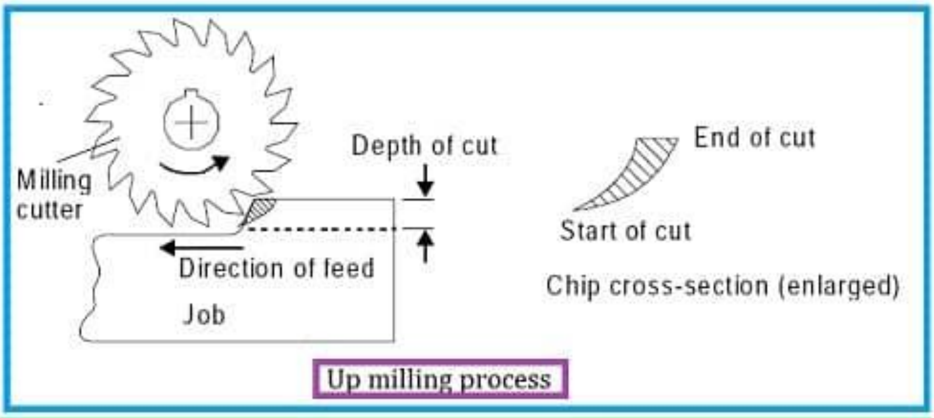
Based on the working principle, several operations are performed on milling machines in various industries where they are employed. Below are a few discussed in brief.

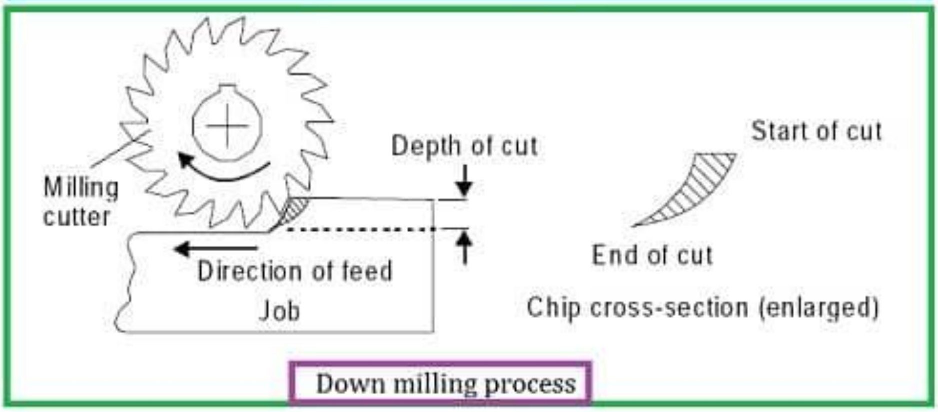
Up-Milling Operation:

The up-milling is also known as conventional milling. In this, a cutter revolving in the opposite direction of the workpiece removes the metal in the form of tiny chips as shown in the figure below. The chip thickness varies from minimum at the beginning and maximum at the end as the cutter advances. The primary drawbacks of the up-milling technique are the tendency of the cutting force to lift the work from the fixtures and the poor surface finish.

Down Milling Operation:

A down-milling operation is also known as ‘climb milling’. In this operation, the cutter rotates in the same direction as the feed. The chip thickness varies from maximum at the beginning to minimum at the end. There is always less friction in climb milling which produces less heat. Thin slots, lengthy cuts, and sharpening of the pieces can be easily achieved in this operation.





Plain Milling Operation:

The most commonly used milling machine operation is plain milling. It is also referred to as slab milling (Hence, the labelling in the image below). The workpiece is firmly mounted on the machine before this operation. After choosing the proper speed and feed, the machine is then turned on. This operation creates a smooth and horizontal surface that is parallel to the axis of rotation of the cutter as shown in the figure below.

Face Milling Operation:

Face milling is widely used in machining to create flat surfaces on a workpiece. It is highly efficient for removing large amounts of material quickly and achieving smooth finishes. Common applications include the milling of engine blocks, metal plates, and large casting surfaces. Face milling is essential for manufacturing components with precise flatness requirements and is an integral part of various industries, such as automotive, aerospace, and general engineering.

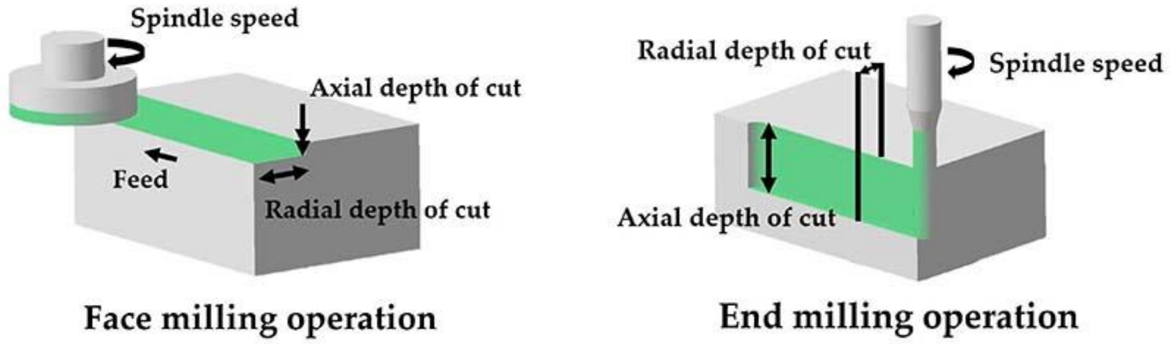


Fig.: face milling process and End milling operation

Gang Milling Operation:

The operation of simultaneously milling multiple surfaces of a workpiece by feeding the table against numerous cutters with the same or various diameters mounted to the arbour is called gang milling operation. The speed of this group of cutters is determined by the cutter with the greatest diameter. The approach reduces machining time significantly and is commonly utilised for repeated tasks.

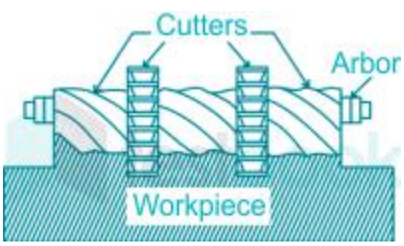


Fig.: Gang milling

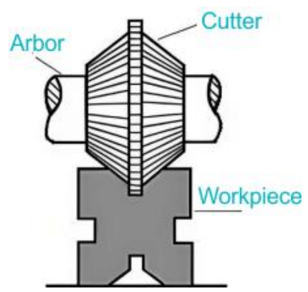


Fig. Angular Milling

Angular Milling Operation:

The process of generating an angular surface on a workpiece which is not at right angles to the spindle axis of the milling machine is known as angular milling. The angular groove may have a single or double included angle which depends on the type and geometry of the angular cutter employed. V-block manufacturing is an example of angular milling.

Form Milling Operation:

The process of creating an uneven shape like convex, concave, or any other form employing form cutters is called form milling operation. The selection of form cutters depends on the shape needed. This operation has a 20% - 30% slower cutting rate than plain milling.

Side Milling Operation:

The process of side milling involves using a side milling cutter to create a flat, vertical surface on the side of a workpiece. The depth of cut is provided by adjusting the vertical feed with the help of the screw on the table.

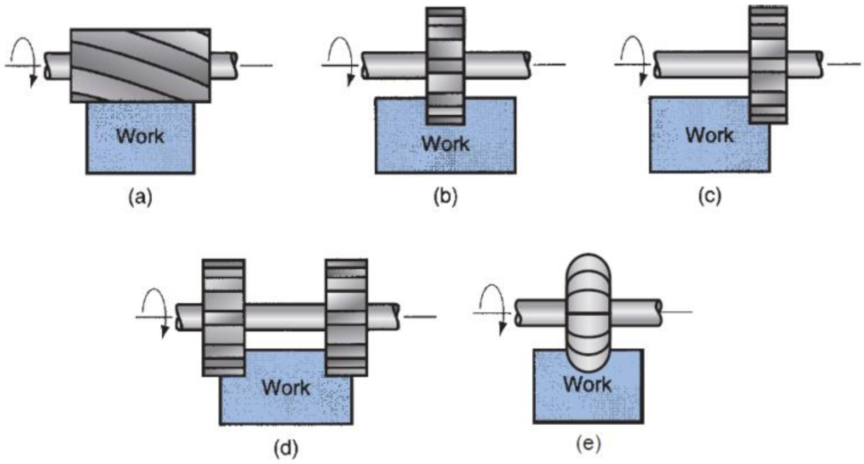


Fig.: Different Types of Peripheral Milling Operations: (a) Slab (b) Slotting (c) Side (d) Straddle (e) Form

Gear Cutting Operation:

A form-relieved cutter on a milling machine executes the gear-cutting operation. The cutter type may be either cylindrical or end mill. The cutter profile is made to precisely match the gear tooth spacing. A universal diving head is used to hold the workpiece while a process called indexing creates evenly spaced gear teeth on a gear blank

Formulas in Milling:

Feed Rate = Feed per tooth × Number of teeth × Spindle speed (rpm)

Cutting speed (V) = $$V = \frac{\pi \times D \times N}{1000}$$

V = Cutting speed (in meters per minute, m/min)

D = Cutter diameter (in millimeters, mm)

N = Spindle speed (in revolutions per minute, RPM)

Divided by 1000 to convert mm/min to m/min

Experiment-5

Aim: To perform simple exercise in plain milling operation.

Objective: To understand and carry out the plain (slab) milling operation and observe the process of removing material from the surface of a workpiece to produce a flat surface.

Apparatus/Equipment Required:

Horizontal milling machine, Plain (slab) milling cutter (HSS/Carbide), Mild steel workpiece, Machine vise or T-slot clamps, Vernier caliper or steel rule, Surface gauge (optional), Marking tools (scriber, square), Spanner and wrench set, Cutting fluid or coolant (if required) and Safety gear (goggles, gloves, apron).

Experimental Procedure:

1. Preparation:

- Wear appropriate safety gear (goggles, gloves, apron).
- Clean the workpiece and milling machine table.
- Mount the workpiece securely in the machine vise or with T-slot clamps.
- Mark the area to be milled using a scriber and try square.

2. Tool Setup:

- Select a suitable plain milling cutter (e.g., Ø100 mm × 25 mm width).
- Mount the cutter onto the horizontal arbor of the milling machine.
- Tighten the cutter and arbor supports properly.
- Set the cutting speed and feed rate according to the material (e.g., 20–30 m/min for mild steel).

3. Machine Adjustment:

- Adjust the table height to bring the workpiece in contact with the cutter.
- Set the depth of cut (e.g., 0.3 mm) using the vertical feed handle.
- Align the cutter with the marked surface.

4. Machining Operation:

- Start the spindle (rotate the cutter).
- Start the table feed so that the workpiece passes under the rotating cutter.
- Maintain a steady feed rate for a smooth finish.
- Once the desired length is milled, stop the table feed.
- Raise the table slightly if another pass is needed and repeat.

5. Finishing:

- Perform a final light finishing cut (e.g., 0.1 mm) to improve surface finish.
- Stop the machine after the final cut.
- Clean the workpiece and measure the final dimensions using a vernier caliper.

Observation Table:

Parameter	Value
Workpiece Material	
Cutter Used	
Depth of Cut	
Cutting Speed	
Feed Rate	
Surface Finish	

Precautions:

- Ensure all clamps are tight to avoid vibration.
- Do not touch the rotating cutter.
- Do not wear loose clothing or jewelry during operation.
- Use cutting fluid to reduce heat and improve finish (if applicable).
- Keep the machine and surrounding area clean.

Conclusion:

The plain milling operation was successfully performed on a mild steel workpiece using a horizontal milling machine. A smooth and flat surface was obtained, demonstrating the fundamental working of the milling process.

Viva Questions:

1. What is plain milling?
2. What are the main components of a milling machine?
3. What is the difference between up milling and down milling?
4. What materials are typically used for milling cutters?
5. How does surface finish vary with feed and speed in milling?
6. What is the difference between face milling and plain milling?

Experiment-6

Aim: To perform simple exercise in Gear milling (step milling, slot milling) operation.

Apparatus / Equipment Required:

Milling Machine, Gear Milling Cutter, Workpiece, Vernier Caliper or Micrometer, Clamp/Vice, Surface Gauge (optional), Cutting fluid (if applicable) and Safety gear (goggles, gloves, etc.)

Experimental Procedure:

A. Preparation:

1. Study the Drawing:

- Analyse the given component drawing for step milling and slot milling operations.
- Note dimensions, positions, and depth of cuts.

2.Machine Setup:

- Clean the machine and work area.
- Mount the appropriate milling cutter (slab cutter for step milling; slot cutter for slot milling).
- Set the correct spindle speed and feed rate based on material and cutter.

3.Workpiece Mounting:

- Secure the workpiece firmly in the machine vice or on the table using clamps.
- Ensure the workpiece is properly aligned with the milling table (use a dial gauge or edge finder if available).

◆ **B. Step Milling Operation:**

4.Position the Workpiece:

- Move the worktable so that the cutter is aligned to the starting point of the step.

5.Perform Step Milling:

- Start the spindle.
- Feed the workpiece slowly into the rotating cutter to create a step.
- Withdraw the workpiece and return to the start position.
- Lower the cutter for the next step depth and repeat if multiple steps are required.

6. Check Dimensions:

- Stop the machine and measure the milled step with a Vernier caliper or micrometer to ensure accuracy.

C. Slot Milling Operation:

7.Align for Slot:

- Adjust the cutter and align the workpiece for the desired slot location.

8. Perform Slot Milling:

- Start the spindle.
- Feed the workpiece along the axis to cut a slot to the required length and depth.
- Retract the cutter after the operation is completed.

9.Dimension Check:

- Measure the width, depth, and position of the slot using a caliper.

Observation Tables:

Table 1: General parameters

S. No.	Parameter	Value / Setting
1	Type of Operation	Step Milling / Slot Milling
2	Type of Cutter Used	Slab Cutter / Slotting Cutter
3	Cutter Diameter (mm)	
4	Number of Cutter Teeth	
5	Material of Workpiece	
6	Spindle Speed (N) – RPM	
7	Feed Rate (mm/min)	
8	Depth of Cut (mm)	
9	Coolant Used	Yes / No (Type)

Table 2: Step Milling Dimensions

S. No.	Step No.	Expected Length (mm)	Measured Length (mm)	Expected Depth (mm)	Measured Depth (mm)	Remarks
1	Step 1					
2	Step 2					

Table 3: Slot Milling Dimensions

S. No.	Slot No.	Expected Width (mm)	Measured Width (mm)	Expected Depth (mm)	Measured Depth (mm)	Slot Length (mm)	Remarks
1	Slot 1						
2	Slot 2						

Precautions:

- Ensure the workpiece is clamped securely before machining.
- Always wear safety goggles and follow lab safety procedures.
- Select proper cutting speeds and feed rates to avoid tool damage.
- Do not touch the cutter while it is rotating.
- Use coolant/lubricant as needed.

Result:

Milling operations (slot & step) were successfully performed on a mild steel workpiece using a milling machine. A smooth and flat surface was obtained.

Viva Questions:

1. What is slot milling?
2. What is step milling?
3. Which type of cutter is used for slot milling?
4. Which cutter is suitable for step milling?
5. What is the difference between step milling and slot milling?
6. How does the cutter diameter affect the slot width?
7. What is backlash and how can it affect milling?

Soldering

What Is Soldering?

- Soldering uses a filler metal with a low melting point, also known as solder, to join metal surfaces.
- The solder is usually made up of an alloy consisting of tin and lead whose melting point is around 235°C and 350°C, respectively.
- But when tin and lead are mixed then the melting point of the mixture is reduced to 183°C. The alloy is melted by using a hot iron at above 316 °C (600 °F).
- As the solder cools, it creates a strong electrical and mechanical bond between the metal surfaces. The bond allows the metal parts to achieve electrical contact while it is held in place.
- Note that lead-free solders are increasingly used as an alternative to environmentally harmful lead-based solders due to regulations.

Soldering Process:

- Firstly, the soldering iron should be preheated.
- For cleaning the soldering tip, you can use a wet sponge. Likewise, any residue on the workpiece surface should be wiped off.
- After finishing the preparations, it’s time to heat the base metal to a working temperature using the hot iron. Doing so will help prevent thermal shock, activate the solder, and overall improve the quality of the joint.
- A good indicator that the metals are well-heated is when the molten solder freely flows into the joint. The filler material solidifies as it cools down, making it the best time for inspection.
- The key to successful soldering is ensuring that the metals being joined are clean and free of any oxides or other contaminants.

Desoldering:

- The process of Separating components from each other which are mechanically held in place with solder, is called desoldering, which removes the material cleanly and safely.
- A soldering iron or a heat gun can be utilised to melt the solder, allowing to safely remove any soldered components.
- To remove the liquid solder, you can use a desoldering pump as a vacuum, or a soldering wick to absorb the molten solder.
- Alternatively, you can resort to an aggressive method using compressed air that can blow off the liquid solder.

Soldering vs Welding:

- While soldering and welding are processes that join two pieces of metal alloy together, there are some key differences in how the metals are joined.
- Soldering uses melted filler metals to bond heated base materials. It works at a lower temperature than welding but requires preheating the base materials to create an effective joint.

- Welding runs at higher temperatures to melt both filler material and workpiece together. It results in a stronger bond, with some changes to the mechanical properties of the metal from heating and cooling.

Metals:

- Soldering works well with the following base metals:
  - Gold
  - Silver
  - Iron
  - Brass
  - Copper
  - Aluminium
  - Steel
  - Titanium
- While some of these metals can easily be soft-soldered, harder metals may require filler materials with a higher melting point to be joined.

Soldering Tools:

- Soldering irons are hand tools that heat the solder above its melting temperatures.

Solders:

- **Lead-based solder**
  - Most soldering projects are typically performed using lead solder consisting of a 60-40 tin-to-lead ratio. This solder melts in a range of 180 to 190°C and is usually the best choice for soldering electrical connections.
- **Lead-free solder**
  - As a way to mitigate the use of harmful elements, lead-free solders were developed. These usually come as solder wire and are composed of metals with higher melting points: tin, copper, bismuth, silver, brass, indium, and antimony.
- **Flux core solder**
  - These filler metals come as paste or soldering wires that contain a flux solder core. The flux releases a protective layer around the workpiece as it is consumed, which achieves cleaner electronic connections and better wetting properties.

Flux:

- **Rosin flux:** It is also called as passive flux. It is used for electronics as it leaves a residue that doesn’t lead to corrosion.
- **Acid flux:** Acid flux solders contain aggressive properties, which are effective in removing the oxides of the metal surface. This leads to stronger and cleaner metal joints compared to rosin.

Types of Soldering:

Here are three soldering types that are used at varying temperature levels that result in different joint strengths:

- **Soft soldering (90 °C – 450 °C)**
  The solder melts alloys containing lead that has a low melting point. With a lower melting point, this soldering type minimises the thermal stress wherein the base metals are subjected.
- **Hard soldering (above 450 °C)**
  Brass and silver are usually hard soldered, with the use of a flame via blowtorch to melt the filler metal. Hard soldering has better mechanical strength than soft soldering, which applies to crafting jewellery and some machining operations.
- **Brazing (above 450 °C)**
  Brazing uses metals with a much higher melting point compared to hard and soft soldering. It produces the strongest result, which is perfect for metal repairs and for pipe joining.

Advantages of Soldering:

- Soldering is operated at lower temperatures compared to common welding methods.
- Most metals and non-metals can be soldered.
- A simple process makes it easy to learn.
- The base metal isn't melted in the process, unlike welding techniques such as stick welding, flux-cored welding, etc.
- Soft soldering can be undone using a desoldering tool without damaging the base materials.

Disadvantages of Soldering:

- Weaker joints compared to other welding methods such as MIG and TIG.
- Soldering isn't suitable at high temperatures, as the solder has a low melting point.
- Heavy metals aren't suitable for soldering.
- Melted solder might leave a toxic flux residue.
- Improper heating may cause deformities or voids in the solder.

Applications:

Electronics Industry

The most popular application of this fusion process is electronics soldering, where wires are joined, and electronic components are fused to a circuit board. This technique allows soldering components together with the luxury of desoldering when needed.

Roofings

Soldering can be used in creating leak-proof roofings wherein the galvanised steel is infused with solder. The soldering iron tip is far broader when used in this application compared to other uses.

Sections

Soldering is applied in the piping and plumbing industry as a way to create joint sections. It is a straightforward process and a reliable solution in sealing the connections in copper pipes, for example.

Art

Soldering can be used to create stained glass art, wire modelling, sculptures, jewellery and other creative works.

Metalwork

The soldering material can be used to fill cavities and even out rough surfaces. This process is practiced to fuse metal sheets, pipes and other applications where metals don't undergo high temperatures.

Automation

Technology allows us to automate the soldering process through the use of programmed robots. Not only does it create precise joints, but it is also fast in production speed.

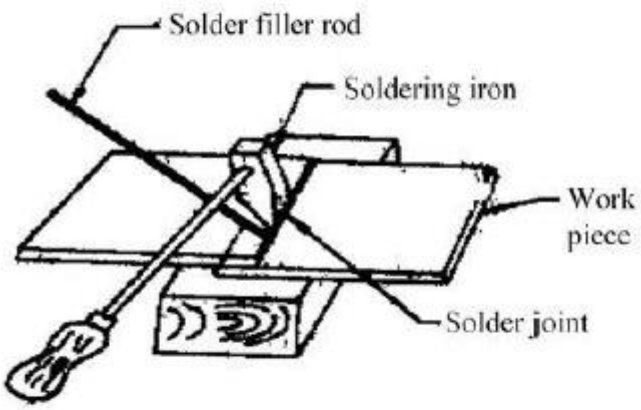


Fig. Soldering process

Experiment-7

Aim: To join two metal sheets using the soldering process.

Apparatus / Tools Required:

Two metal sheets (usually copper or tin-coated), Soldering iron, Solder wire (commonly Sn-Pb alloy), Flux (e.g., rosin or zinc chloride), Soldering stand, Emery paper or wire brush, Clamp or vice, Safety goggles and gloves

Experimental Procedure:

1. Preparation of Metal Surfaces

- Clean the metal sheets thoroughly using emery paper or a wire brush to remove rust, dirt, grease, or oxide layers.
- Ensure that the surfaces to be joined are smooth and free from any contaminants to ensure good adhesion.

2. Application of Flux

- Apply an appropriate flux to the area where the joint is to be made.
- The flux helps to prevent oxidation during heating and improves the flow of solder.

3. Fixing the Metal Sheets

- Position the two metal sheets in the desired configuration (e.g., lap joint or butt joint).
- Hold the sheets together firmly using a clamp or vice to avoid movement during soldering.

4. Heating the Joint

- Plug in and heat the soldering iron to the required working temperature (typically between 300–400°C depending on solder type).
- Place the hot soldering iron tip at the joint area to heat the metal surfaces evenly.

5. Applying Solder

- Once the joint is heated sufficiently, touch the solder wire to the joint (not directly to the iron).
- Allow the solder to melt and flow into the joint area by capillary action.
- Avoid adding excessive solder; a thin, even layer is ideal.

6. Cooling and Cleaning

- Remove the soldering iron and allow the joint to cool naturally without disturbance.
- Once cooled, inspect the joint for uniformity and shine, which indicates a good bond.
- Clean off any remaining flux residue with a suitable cleaning agent (like isopropyl alcohol).

Precautions:

- Always wear safety goggles and heat-resistant gloves.

- Work in a well-ventilated area to avoid inhaling fumes.
- Keep the soldering iron in its stand when not in use.
- Do not touch the hot tip of the soldering iron.
- Wash hands after handling flux or solder, especially if lead-based solder is used.

Observation Table:

S. No.	Parameter	Observed Value / Description
1	Type of metal sheets used	
2	Dimensions of metal sheet	
3	Type of flux used	
4	Type of solder wire used	
5	Soldering iron temperature	
6	Joint type	
7	Joint strength (manual check)	

Result:

The two metal sheets were successfully joined using the soldering process. The joint was found to be mechanically strong and visually acceptable.

Viva Questions:

1. What is soldering?
2. What is the difference between soldering and welding?
3. What materials are commonly used as solder?
4. What is flux and why is it used in soldering?
5. Why is surface cleaning important before soldering?
6. What is the function of the soldering iron?
7. Can dissimilar metals be soldered together?
8. How can you identify a good solder joint?

CNC Machining

CNC machining is an electromechanical process that manipulates tools around three to five axes, with high precision and accuracy, cutting away excess material to produce parts and components.

The initial designs to be machined by CNC machining are created in CAD, which is then translated into CNC codes to provide programmed instructions to the tools in a CNC machine.

CNC machining produces cutting edge quality on turned components using a wide variety of applications that require vertical and horizontal machining.

The multitasking ability of CNC machines allows for the completion of a component or part in a single operation, with ease and efficiency.

Programming of CNC machine with the use of standard codes is called as part programming. Each and every standard code indicates the name of the programme written per standard moment of tool.

Whenever repeatable movement of tool required in manufacturing of component; for the repeatable moment of tool, a program is written called as sub program. This sub program is called in the main program whenever repeatability moment is required during machining.

Advantages of CNC:

- Due to usage of servo motors, higher positional accuracy can be achieved; due to this higher accuracy of components can be produced.
- Due to usage of mini computer, the written program will be fed into it by using keyboard and kept in the memory as a soft copy in mini computer.
- The soft copy of program can be copied into any device and this copied into any number of machines also.
- Because of software programs, the design modifications can be incorporated very easily.
- By using the software programs and graphics simulator the cutter path can be generated by observing the cutter path it is possible to identify weather the program written is correct or not.
- Because of many of the manual controls are replaced by mini-computer, the mechanization and automation of CNC machine is possible.

Working Principle of CNC Machine:

The process of CNC machining involves several integral components working seamlessly in tandem. Initially, the part program is input into the MCU (Machine Control Unit) of the CNC system. All data processing occurs within the MCU, and based on the prepared program, it formulates precise motion commands, subsequently transmitting them to the drive system.

he drive system acts upon these motion commands from the MCU, taking charge of controlling the movement and velocity of the machine tool. Simultaneously, a feedback system comes into play, diligently recording the position and velocity measurements of the machine tool and relaying this information back to the MCU via a feedback signal. These feedback signals are meticulously compared within the MCU with reference signals, and any discrepancies or errors are promptly corrected. The MCU then dispatches refined signals to the machine tool, ensuring precise and accurate operations. To facilitate human interaction and observation, a display unit serves as the machine's "eye," providing a comprehensive view of commands, programs, and other essential data, thus enhancing the overall operational efficiency of the CNC system.

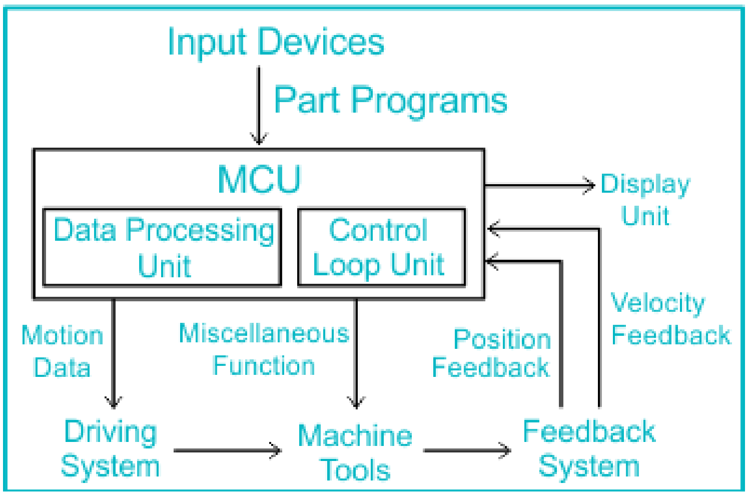


Fig: Working principle of CNC

Components of a CNC Machine:

(i) Input Devices: These devices are responsible for inputting the part program into the CNC machine. There are three commonly used input devices: punch tape reader, magnetic tape reader, and computer via RS-232-C communication.

(ii) Machine Control Unit (MCU): Serving as the heart of the CNC machine, the MCU performs all controlling actions. Its various functions include reading the coded instructions, decoding them, implementing interpolation (linear, circular, and helical) to generate axis motion commands, feeding these commands to the amplifier circuits for driving the axis mechanisms, receiving feedback signals of position and speed for each drive axis, and implementing auxiliary control functions such as coolant or spindle on/off and tool changes.

(iii) Machine Tool: The CNC machine tool comprises a slide table and a spindle to control the position and speed. The machine table is controlled in the X and Y-axis direction, while the spindle is controlled in the Z-axis direction.

(iv) Driving System: The driving system consists of amplifier circuits, drive motors, and ball lead screws. The MCU feeds the signals of each axis (i.e., position and speed) to the amplifier circuits, which then augment (increase) the control signals to actuate the drive motors. The actuated drive motors, in turn, rotate the ball lead screw to position the machine table.

(v) Feedback System: This system incorporates transducers that act as sensors and measuring devices. It continuously monitors the position and speed of the cutting tool at any given moment. The MCU receives signals from these transducers and utilises the difference between reference and feedback signals to generate control signals for correcting position and speed errors.

(vi) Display Unit: A monitor is used as a display unit to showcase CNC machine programs, commands, and other pertinent data.

Role of G & M – codes in CNC:

- M-code is a part of the language that AutoCAD and CAM (computer aided manufacturing), use to input instructions into CNC machines.
- M-code structure is relatively straightforward, comprising a letter "M" followed by a numerical value. The combination of the letter and number represents a specific command or instruction for the CNC machine.
- M-codes are used for guiding the machine‘s actions. M-codes, miscellaneous or machine codes, control the operations of the equipment telling it when to operate or cease operation.
- Specifically, M-code handles instructions related to machine operations such as turning the spindle on or off, coolant control, tool change, and program stops. In essence, M-code serves as the backbone of the manufacturing process, allowing the CNC machine to perform precise actions beyond simple movements.
- While the G-code can direct a machine to move in a line or arc, once the tool is positioned, it won‘t know to stop, change tools, add coolant, or complete any other actions, which are provided by M-codes. Instructions for a tool to turn on or off is part of the M-code language.
- Essentially, M-code is a set of commands that control machine functions not related to movements.

G codes in CNC Machining:

G- codes : General purpose codes (G00 to G999)

G00 – Rapid traverse

Whenever the tool is travel ideally it has to travel at a maximum possible speed to minimize the machining time for this the 'G00' code is used. So that, the machine is automatically adopting the maximum possible speed in the machine.

G01 – linear interpolation

Whenever the tool is required to travel in a straight line path 'G01' code will be given.

G02 – circular interpolation (clock wise)

G03 – circular interpolation (counter clock wise)

Whenever the tool is required to travel in conclude path for producing conclude components "G02 or G03" are used.

G04 – Dwell: Temporary stoppage of tool for specified duration.

G05 – hold: It indicates the ultimate stoppage of duration.

G08 – acceleration: tool is started at low velocity and reaches to maximum velocity at end.

G09 – retardation: whenever the tool is reaching to destination to reduce the velocity it can be used.

G17 – XY plane section; **G18** – YZ plane section; **G19** – ZX plane section

G20 - inch system selection; **G21**- millimetre system selection

G70 – English programming (inches); **G71** – Metric programming (mm)

G90 – absolute mode of programming; **G91** – incremental mode of programming

M- Codes in CNC machining:

M codes are ranging from 00 to 99. Some of code meaning are mentioned in below:

M00 Program stop

M01 Optional program stop

M02 End of program

M03 Spindle start forward CW

M04 Spindle start backward CCW

M05 Spindle stop

M06 Tool change

M08 Coolant on

M09 Coolant off

M29 Rigid tap mode

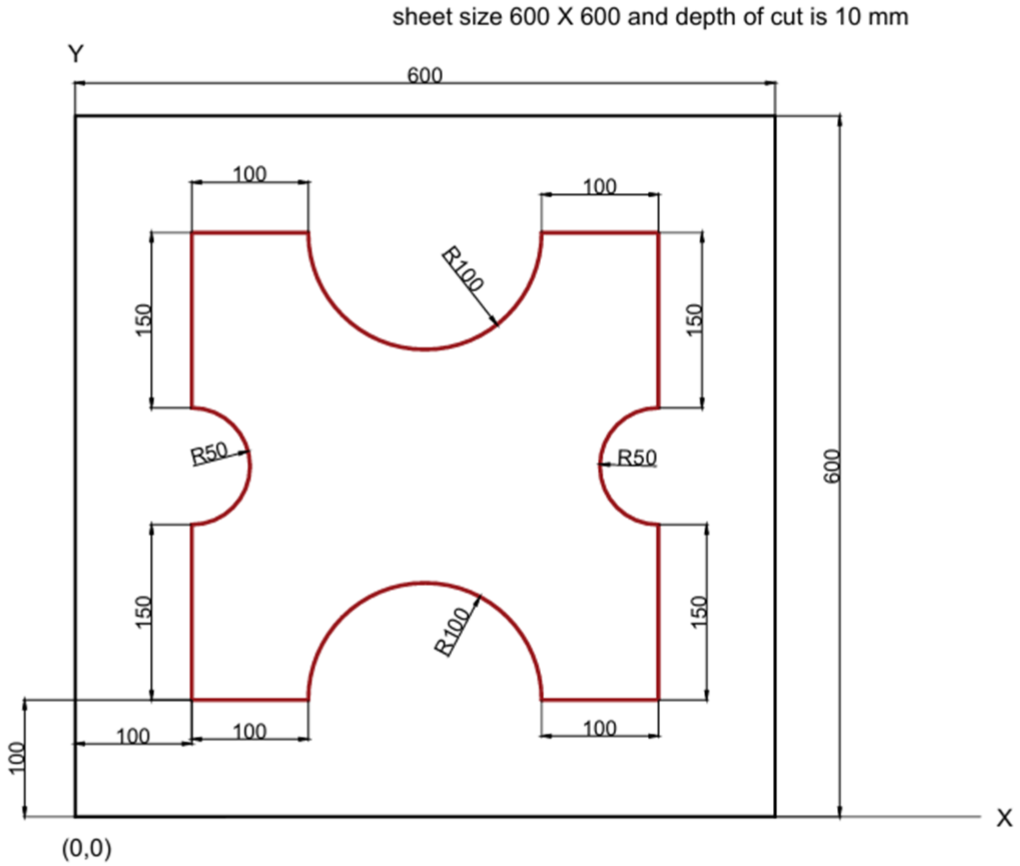
M30 End of program (Reset)

M98 Subprogram call

M99 End of program

Experiment-8

Aim: To perform simple exercise in CNC machining and program generation.



Program Code:

G90 G21;

G00 X100 Y100 Z20;

G01 Z-10 F40.0;

G01 X200 Y100;

G02 X400 Y100 R100;

G01 X500 Y100;

G01 X500 Y250;

G02 X500 Y350 R50;

G01 X500 Y500;

G01 X400 Y500;

G02 X200 Y500 R100;

G01 X100 Y500;

G01 X100 Y350;

G02 X100 Y250 R50;

G01 X100 Y100;

G00 Z20;

Viva Questions:

1. What is CNC?
2. What are the main components of a CNC machine?
3. What is the difference between G-code and M-code?
4. Explain the difference between absolute and incremental programming.
5. What is interpolation in CNC?
6. What is G-code?

Gas Welding

What is Welding?

Welding is a metal fabrication process used to join two metals by heating them above melting temperatures and fusing them by cooling them. Along with the heat, pressure is also used to produce the weld.

What is Gas Welding?

Gas welding is a metal joining process conducted by melting the metals with the help of fuel gases like acetylene, propane, or hydrogen mixed with oxygen to produce the weld. This welding type is commonly known as 'Oxy Acetylene Welding'.

This is because oxygen and acetylene are the most commonly used gases in this type

Working Principle of Gas Welding:

The basic principle behind most types of welding remains to melt the two metals (by heating them above their melting points), add flux, and fuse them. Let us learn the working principle of gas welding.

The metals are melted by the heat from the reaction of fuel gas (Acetylene, Propane, Butane, Hydrogen, etc) and oxygen. When the gases from the cylinder stored at high-pressure are released, they flow through the torch at high velocity and are mixed.

The mixture has high temperatures with traits of carbon dioxide, and this is ignited by an external spark. The flame starts blowing from the torch. The heat from this flame can be increased by increasing the pressure of the outflow gas.

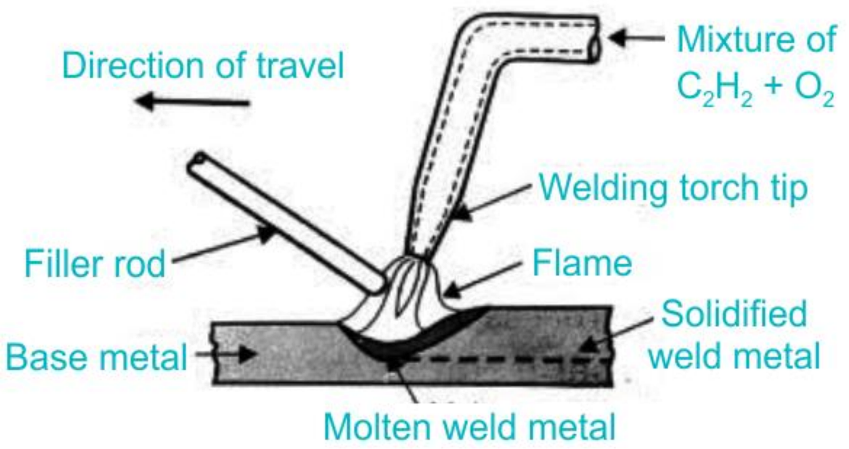


Fig.: Gas welding process

Parts of Gas Welding Equipment:

(a) Regulator: It is used to adjust the required pressure at which the gas should be released for the operation.

(b) Fusible Plugs: It is a safety valve which is used when the pressure in the system goes beyond the optimum. Plugs are usually made of Tin which has a low melting point.

(c) Hose: They are simply pipes that are designed to allow the flow of various gases without reacting with them. Usually, every gas welding equipment has two hoses: One for oxygen and the other for fuel gas. In India, oxygen hose has a standard colour of black and acetylene has red.

(d) Non-return valve: These valves are essential to prevent the oxygen and fuel gas from flowing back into the cylinder, which may cause the cylinder to explode.

(e) Check valve: It is a chamber with a ball pressed against one end through a spring. The check valve is used to aid the flow in one direction.

(f) Torch: This is the working tool that the operator uses to make the weld. It is the getaway for the final output of reactions from the cylinder to the metal.

Types of Flames in Gas Welding:

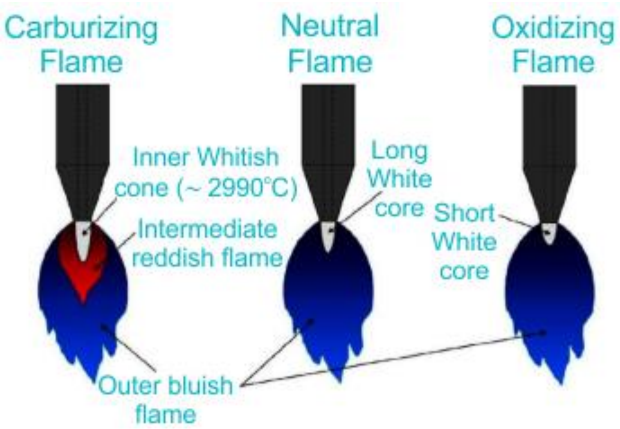


Fig.: Types of Flames in Gas welding

Carburising Flame:

- The quantity of acetylene gas is more than oxygen in the carburising flame
- It is a special flame with three zones: a luminous inner zone, a feather of acetylene, and a blue outer envelope.
- It is used to weld high carbon steels (HCS) and cast iron.

Neutral Flame:

- When the acetylene and oxygen are mixed in equal proportions through the torch, the neutral flame is obtained
- This flame consists of two cores: Inner core (white colour) and outer core (blue colour)
- It is used to weld stainless steel, copper, cast iron, aluminium, and mild steel.

Oxidising Flame:

- The oxygen flowing through the torch is more than acetylene in the oxidizing flame
- These flames have the highest temperature and make a roaring noise
- It is used for welding alloys like brass, Iron carbide, and brazing ferrous metals.

Advantages of Gas Welding:

- No need for a high-skill operator to operate on this machine or setup
- Anyone can set it up as the initial cost is low compared to arc and resistance welding machines
- One can travel with it to the site where welding needs to be done, in other words, the machine is portable
- Easy maintenance and easy to repair.

Disadvantages of Gas Welding:

- Welding speed is low due to the rate of metal joining.
- By the end of the welding process, there will be large heat-affected areas.
- Welding Titanium, Zirconium, or High-Speed steel (HSS) is not recommended for gas welding.
- It is suitable for thinner sheet metals but not thicker sheet metals.

Applications of Gas Welding:

- This welding process is used for joining non-ferrous metals, cast iron, carbon steel, nickel, alloys of aluminium, etc.
- It is used to join thin metals which have as low as 1.6 mm thickness.
- It is commonly used in sheet metal industries.
- It is used to join metals with a low rate of cooling and heating.
- Sometimes, this is used to repair tools and equipment of other welding processes.
- They are used in automobile industries, shipbuilding, heavy vehicle manufacturing, and agricultural machinery manufacturing to weld thinner sections.

Experiment-9

Aim: To understand and perform basic gas welding operations using oxy-acetylene equipment on mild steel workpiece.

Apparatus and Equipment Required:

Oxy-acetylene welding setup (oxygen and acetylene cylinders with regulators), Welding torch and nozzles, Welding table and clamps, Filler rod (if required), Personal protective equipment (PPE): goggles, gloves, apron, Mild steel workpieces, Spark lighter, Wire brush or chipping hammer.

Experimental Procedure:

1.Safety Checks and PPE:

- Wear appropriate PPE (welding goggles, gloves, apron).
- Ensure the work area is well-ventilated and free of flammable materials.
- Check hoses, regulators, and torch for any damage or leaks.

2. Setup of Welding Equipment:

- Secure the oxygen and acetylene cylinders in upright positions.
- Open cylinder valves slowly and set desired pressure using the regulators (typically: Oxygen ~2–3 bar, Acetylene ~0.5–1 bar).
- Connect hoses to the torch (red for acetylene, blue for oxygen).

3.Lighting the Torch:

- Open the acetylene valve on the torch slightly and ignite with a spark lighter.
- Slowly open the oxygen valve to adjust the flame to a neutral flame (clear inner cone, balanced outer envelope).

4.Preparation of Workpieces:

- Clean the surfaces of the metal pieces to be welded using a wire brush.
- Align and clamp the pieces in position on the welding table.

5.Performing the Weld:

- Hold the torch at a 45° angle to the work surface.
- Begin welding with a steady travel speed, maintaining a consistent molten pool.
- Use filler rod if needed by dipping it into the molten pool with proper rhythm.
- Maintain a neutral flame throughout.

6.Shutting Down the Torch:

- First close the acetylene valve on the torch, then the oxygen valve.
- Close both cylinder valves.
- Release pressure from hoses by opening torch valves briefly, then close them again.
- Turn regulator screws counterclockwise to relieve spring tension.

7.Post-Weld Operation:

- Allow the workpiece to cool naturally.
- Clean the weld using a wire brush or chipping hammer.
- Inspect the weld visually for continuity, penetration, and uniformity.

Precautions:

- Always perform welding in a well-ventilated area.
- Do not light the torch with a match; use a spark lighter.
- Never use oil or grease near gas welding equipment.
- Always check for gas leaks before lighting the torch.
- Keep a fire extinguisher nearby.

Result:

Successfully Understand the basic gas welding operations using oxy-acetylene equipment on mild steel workpieces.

Viva Questions:

1. What is gas welding?
2. Name the types of flames used in gas welding.
3. What is a neutral flame?
4. What is the function of regulators in gas welding?
5. What types of joints can be made using gas welding?
6. Why is pre-cleaning of the metal surface important?

Arc Welding

Arc welding is a type of welding process using an electric arc to create heat to melt and join metals. A power supply creates an electric arc between a consumable or non-consumable electrode and the base material using either direct (DC) or alternating (AC) currents.

Arc welding is a fusion welding process used to join metals. An electric arc from an AC or DC power supply creates an intense heat of around 6500°F which melts the metal at the join between two work pieces.

The arc can be either manually or mechanically guided along the line of the join, while the electrode either simply carries the current or conducts the current and melts into the weld pool at the same time to supply filler metal to the join.

Because the metals react chemically to oxygen and nitrogen in the air when heated to high temperatures by the arc, a protective shielding gas or slag is used to minimise the contact of the molten metal with the air. Once cooled, the molten metals solidify to form a metallurgical bond.

What are the Different Types of Arc Welding?

This process can be categorised into two different types; consumable and non-consumable electrode methods.

Consumable Electrode Methods:

1.Metal Inert Gas Welding (MIG) and Metal Active Gas Welding (MAG):

Also known as Gas Metal Arc Welding (GMAW), uses a shielding gas to protect the base metals from contamination.

2.Shielded Metal Arc Welding (SMAW):

Also known as manual metal arc welding (MMA or MMAW), flux shielded arc welding or stick welding is a process where the arc is struck between the metal rod (electrode flux coated) and the work piece, both the rod and work piece surface melt to form a weld pool. Simultaneous melting of the flux coating on the rod will form gas, and slag, which protects the weld pool from the surrounding atmosphere. This is a versatile process ideal for joining ferrous and non-ferrous materials with a range of material thicknesses in all positions.

3.Submerged Arc Welding (SAW):

A frequently-used process with a continuously-fed consumable electrode and a blanket of fusible flux which becomes conductive when molten, providing a current path between the part and the electrode. The flux also helps prevent spatter and sparks while suppressing fumes and ultraviolet radiation.

4.Electro-Slag Welding (ESW):

A vertical process used to weld thick plates (above 25mm) in a single pass. ESW relies on an electric arc to start before a flux addition extinguishes the arc. The flux melts as the wire consumable is fed into the molten pool, which creates a molten slag on top of the pool. Heat for melting the wire and plate edges is generated through the molten slag's resistance to the passage of the electric current. Two water-cooled copper shoes follow the process progression and prevent any molten slag from running off.

Non-consumable Electrode Methods:

1.Tungsten Inert Gas Welding (TIG):

Also known as Gas Tungsten Arc Welding (GTAW), uses a non-consumable tungsten electrode to create the arc and an inert shielding gas to protect the weld and molten pool against atmospheric contamination.

2.Plasma Arc Welding (PAW):

Similar to TIG, PAW uses an electric arc between a non-consumable electrode and an anode, which are placed within the body of the torch. The electric arc is used to ionise the gas in the torch and create the plasma, which is then pushed through a fine bore hole in the anode to reach the base plate. In this way, the plasma is separated from the shielding gas.

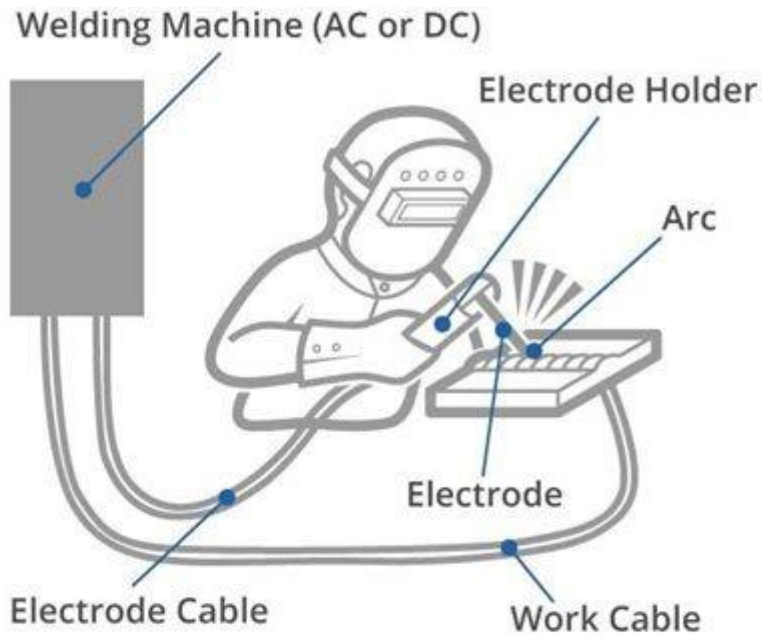


Fig.: Basic Arc welding process

Experiment-10

Aim: To perform the simple exercise in Arc welding.

Apparatus and Equipment Required:

Arc welding machine (AC or DC), Mild steel workpieces, Welding electrodes, Welding cables and holder, Welding helmet or goggles with dark lens, Welding gloves and apron, Wire brush, Measuring instruments (steel rule, vernier caliper) and Clamps or welding fixtures.

Experimental Procedure:

1. Safety Precautions:

- Wear personal protective equipment (PPE): helmet, gloves, apron, leather shoes.
- Ensure the welding area is dry, clean, and well-ventilated.
- Keep fire extinguishing equipment nearby.

2. Equipment Setup:

- Connect the welding electrode holder and earth clamp to the welding machine.
- Attach the workpiece securely on the welding table using clamps.
- Insert the electrode (e.g., 3.15 mm E6013) into the holder.

3. Setting Welding Parameters:

- Set the current based on electrode size and material thickness (typically 90–130 A for E6013).
- Choose AC or DC depending on machine and electrode type.

4. Surface Preparation:

- Clean the metal surfaces using a wire brush to remove rust, scale, oil, or paint for better arc stability.

5. Striking the Arc:

- Strike the arc by gently tapping or scratching the electrode on the workpiece.
- Maintain an arc length approximately equal to the electrode diameter.

6. Performing the Weld:

- Hold the electrode at a 70°–80° angle from the workpiece.
- Move the electrode steadily to create a uniform weld bead.
- Maintain consistent speed, arc length, and travel angle.
- For beginners, perform a bead-on-plate or straight line weld as an exercise.

7. Finishing the Weld:

- Allow the weld to cool naturally.
- Remove slag using a chipping hammer and clean the area with a wire brush.

8. Shut Down:

- Turn off the welding machine.
- Remove the electrode from the holder.
- Disconnect cables safely.

Precautions:

- Never look at the arc directly without proper eye protection.
- Keep hands and body parts away from the hot metal and arc.
- Do not weld in wet or damp conditions.
- Ensure proper ventilation to avoid inhaling fumes.
- Avoid using damaged or wet electrodes.

Result:

Understand the working of arc welding process and experiment was done.

Observations to Record:

- Type of electrode used
- Welding current and polarity
- Type and appearance of weld bead
- Any defects observed (e.g., porosity, undercut, spatter)
- Dimensions of the weld (length, width, penetration)

Viva Questions:

1. What is arc welding?
2. What is the principle of arc welding?
3. What are the main types of arc welding?
4. What is the difference between a consumable and non-consumable electrode?
5. Why is flux used in arc welding?
6. What is slag?
7. What are some common welding defects?

Wood Gluing

Wood glue is one of the most essential materials needed for carrying out woodworking or carpentry projects. It's a form of adhesive for bonding or joining two or more pieces of wood together.

Whether it's furniture making, cabinet or home re-modelling, wood glue is a one adhesive you're going to make use of a lot when carrying out your projects.

Although there are many other ways of joining wood pieces together such as using of nails and screws, the use of glue still creates the strongest and toughest bonds if done properly.

The strong chemical bond created is as a result of the glue soaking into the fibers of the wood, thus creating an inseparable joint.

In fact, the bond created is stronger than the wood itself, such that any attempt to break the joint or separate the wood pieces usually results in the wood breaking instead of the joint.

When carrying out your projects, not every joint or assembling process will require the use of glue. For instance, it's very unlikely to use glue when carrying out framing projects.

How To Choose the Right Wood Glue:

Remember, when it comes to adhesives for woodworking purposes, no one size fits all. So, depending on the type of project you're working on, the type of wood you're using and the type of joint you're making, choosing the right wood glue can either be straightforward or quite complicated. While selecting glue the following factors should consider.

- Strength of the Glue
- Water Resistance
- Dry Time / Curing Time
- Viscosity / Thickness – Gap Filling
- Color / Stain Absorption
- Shelf Life
- Temperature Resistance

Types of Wood Glue:

- PVA (Polyvinyl Acetate) Wood Glue
- Polyurethane Glue
- Hide Glue
- Epoxy
- CA Glue

Points to remember before buying a glue:

- First, the material you're gluing up should decide the type of glue you buy. You shouldn't buy a one just because it's the strongest.
- For instance, Polyurethane or Gorilla glue as it is commonly known is very strong, but it's not recommended for finished or final assembly projects as it can form a mess on your finished project.

- Epoxy is also very strong, but it’s best for filling up large cracks or loose joints instead of tight fitting ones.
- So, the material you’re trying to join should determine the adhesive you choose.
- Secondly, buy just the right amount of glue you need. Don’t buy in bulk. Buy in small containers so that it remains fresh.

Sandwich Structures

What is a sandwich Structure?

- Sandwich Structure is typically constructed from a core material bonded between two thin, high strength face-sheets via adhesives.
- Core carries the shear loads while spacing the high strength material away from the neutral axis, where the tensile or compressive loads are high

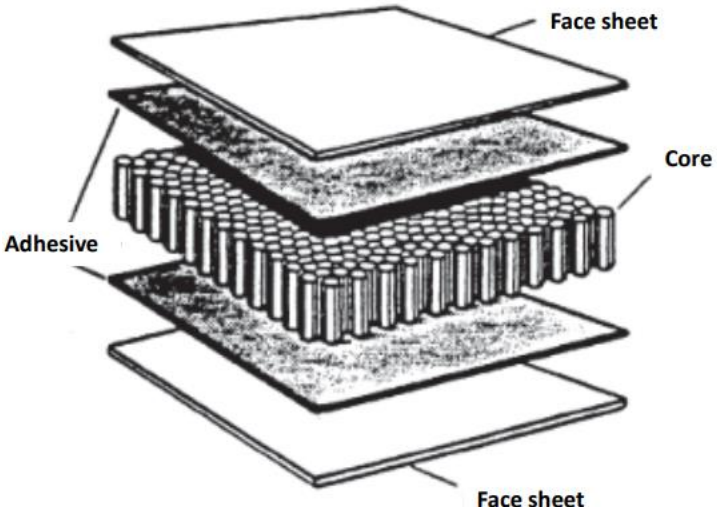


Fig.: Anatomy of Sandwich Structure

Materials of sandwich structure:
Core materials:

- Honeycomb
  - Nomex (aramid)
  - Aluminum
  - Others
- Foam
- Wood

•Face sheet materials

- CFRP
- GFRP
- Aluminum
- Others

Adhesive

- Film
  - Supported
  - Unsupported

• Bulk

Applications:

- Marine
- Wind energy
- Aerospace – control surfaces, engineer covers, galleys, lavatories, bulkheads, partitions, storage compartments
- Automotive transportation
- Building and construction (insulating, stiff, light weight)
- Medical – X-ray imaging
- Sports equipment (skis, snowboards, surf boards)