GRADE 10 NOTES

METAL TECHNOLOGY

COMPREHENSIVE HANDBOOK NOTES

Well-organized, simplified learning notes that provide clear, concise information in a logical sequence, making key concepts easily accessible and memorable, enhancing understanding and retention while fostering engagement and facilitating effective study. By providing a clear focus on key ideas, these Mwalimu Consultancy Ltd Notes foster better retention and comprehension, making learning more accessible and enjoyable.

MWALIMU VERSION

For Complete Notes, kindly contact

Mr Isaboke 0746-222-000 / 0753-222-000

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1.0 FUNDAMENTALS OF METAL TECHNOLOGY

1.1 Introduction to Metal Technology

1.1.1 Definition of Terms in Metal Technology

Understanding the terms is the foundation of learning Metal Technology. Below are the key terms explained simply:

- **Metal** – A solid material, usually hard, shiny, and malleable, that can conduct heat and electricity.
- ❖ **Examples:** Iron, Steel, Aluminium, Copper, Brass, Bronze.
- **Metal Technology** – The study and practice of working with metals to produce useful products and structures.
- ❖ **Example:** Making doors, chairs, gates, and kitchen utensils.
- **Material** – Any substance used to make objects. Metals, wood, plastics, and ceramics are examples.
- ❖ **Example:** Steel sheet used for roofing.
- **Tools** – Instruments used to perform specific tasks in metal work.
- ❖ **Examples:** Hammer, Screwdriver, Pliers, Hacksaw, Files.
- **Machines** – Mechanized devices that make metalworking faster and more precise.
- ❖ **Examples:** Lathe machine, Welding machine, Drilling machine, Grinding machine.
- **Personal Protective Equipment (PPE)** – Equipment worn to protect oneself from injury while working in a workshop.
- ❖ **Examples:** Safety goggles, Gloves, Apron, Ear muffs, Safety boots.
- **Workshop** – A place equipped with tools and machines for metalworking.
- ❖ **Examples:** School metal workshop, Fabrication workshop, Engineering workshop.

1.1.2 Importance of Studying Metal Technology

Studying Metal Technology opens career opportunities, develops practical skills, and contributes to community development.

- **Career Opportunities**:
  - Fitter and machinist
  - Welder
  - Sheet metal worker
  - Fabricator
  - Blacksmith
  - Mechanical engineer
- **Practical Benefits**:
  - Skills in repairing machines and metal structures.
  - Ability to manufacture household and industrial items.
  - Creativity in designing metal products.
- **Economic Benefits**:
  - Starting metalwork businesses like welding shops, fabrication units.
  - Reduces dependency on imported products.
- **Example Activities**:
  - Making metal gates, windows, and chairs for the community.
  - Repairing bicycles, scooters, and machinery parts.

1.1.3 Metal Technology Related Businesses in the Community

Metal technology is applied in many local businesses. Observing these helps students understand practical applications.

- **Welding and Fabrication Shops**
  - Services: Making gates, grills, metal doors, metal furniture.
  - Tools used: Welding machines, angle grinders, hammers.
- **Automobile Workshops**
  - Services: Repairing car parts, manufacturing engine components.
  - Tools used: Hydraulic lifts, wrenches, drills.
- **Construction Companies**
  - Services: Metal roofing, reinforcement bars, structural beams.
  - Tools used: Cutting machines, bending machines.
- **Blacksmith Workshops**
  - Services: Traditional iron tools like hoes, machetes, knives.
  - Tools used: Anvil, hammer, forge.

- **Metal Recycling Centers**

❖ Services: Collect scrap metals, melt, and reshape them into new products.

❖ Examples: Aluminum cans turned into new utensils.

Activity for Students:

- Visit local workshops to observe the tools, machines, and metals used.
- Identify the types of metal products made.

1.1.4 Importance of Metal Technology in Daily Life

Metal technology affects almost every part of our daily lives. Understanding its applications helps appreciate its value.

- **Household Items:**

❖ Cooking utensils (pots, pans)

❖ Furniture (metal chairs, tables, beds)

❖ Doors and windows

- **Transport:**

❖ Cars, bicycles, buses, motorcycles

❖ Railway tracks

- **Infrastructure:**

❖ Bridges, water tanks, electric poles

❖ Fencing and gates

- **Healthcare:**

❖ Surgical instruments

❖ Hospital beds and trolleys

- **Industrial Applications:**

❖ Manufacturing machines

❖ Storage tanks and containers

❖ Tools for workshops

Example:

- A blacksmith uses metal technology to make a door gate, improving security in homes.

1.1.5 Brainstorming and Research Activity

Objective: Build understanding by exploring concepts actively.

- **Step 1: Brainstorm**

❖ Discuss in class: What metals are you familiar with?

❖ Identify tools and machines in your school workshop.

- **Step 2: Research**

❖ Use books, digital media, or print media to search for:

▪ Types of metals and their properties.

▪ Local businesses using metal technology.

▪ Careers in metalwork.

- **Step 3: Presentation**

❖ Students present findings with examples, sketches, or photos.

1.1.6 Summary Table of Key Points

Term	Definition	Examples
Metal	Hard, shiny, malleable material	Iron, Copper, Aluminium
Metal Technology	Working with metals to make products	Welding, Fabrication
Material	Substance used to make objects	Steel, Wood, Plastic
Tool	Hand instruments for tasks	Hammer, File, Hacksaw
Machine	Mechanized devices for metalwork	Lathe, Drill, Grinder
PPE	Safety equipment in workshop	Gloves, Goggles, Apron
Workshop	Place for metalwork	School workshop, Welding shop

1.1.7 Illustrative Examples

Example 1 – Making a Metal Chair

- Materials: Steel rods, steel sheet
- Tools: Hacksaw, hammer, welding machine
- PPE: Gloves, goggles, apron
- Process: Cut rods → Weld frame → Attach seat → Finish with paint

Example 2 – Repairing a Bicycle Chain

- Materials: Metal chain, lubricants
- Tools: Wrench, pliers
- Process: Remove broken chain → Clean parts → Fit new chain → Test

Example 3 – Fabricating a Metal Gate

- Materials: Iron rods, sheet metal
- Tools: Welding machine, grinder, hammer
- Process: Measure → Cut rods → Weld → Grind → Paint

Key Takeaways:

- Metal Technology is essential for career development, community services, and daily life.
- Practical knowledge includes metals, tools, machines, PPE, and workshops.
- Observing local businesses enhances understanding of real-life applications.
- Safety is crucial when working with metals.

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2.0 SAFETY AT THE WORKSHOP

Safety is the foundation of metal technology. A workshop is full of sharp tools, heavy machines, and hot metals, so knowing safety rules can prevent accidents and save lives.

2.1 Importance of Safety in a Metal Workshop

- Ensures **personal safety** from injuries (cuts, burns, eye injuries).
- Protects **equipment and tools** from damage.
- Reduces **risk of fire and electric accidents**.
- Promotes a **safe working environment**, increasing productivity.
- Encourages **responsibility and discipline** in the workshop.

Example: Wearing goggles while grinding metal prevents eye injuries from sparks.

2.2 Workshop Safety Rules and Regulations (OSHA Guidelines)

The **Occupational Safety and Health Act (OSHA)** provides rules to prevent accidents. Key rules include:

2.2.1 Personal Safety Rules

- Always wear **Personal Protective Equipment (PPE)**.
  - ❖ Safety goggles – protect eyes from flying particles.
  - ❖ Gloves – protect hands from sharp edges and heat.
  - ❖ Aprons – protect clothes and skin from sparks.
  - ❖ Ear muffs – protect ears from loud noise.
  - ❖ Safety boots – protect feet from falling objects.
- Do **not wear loose clothing** or jewelry; they can get caught in machines.
- Tie back long hair to prevent entanglement in tools.

2.2.2 Equipment Safety Rules

- Inspect tools and machines before use.
- Do not use damaged tools; report broken machines immediately.
- Switch off machines when not in use.
- Keep machines **clean and well-lubricated**.
- Only trained personnel should operate machines like welding machines or lathes.

2.2.3 Environmental Safety Rules

- Keep the workshop **clean and organized**; remove scrap metal and oil spills.
- Ensure **good ventilation** to avoid inhaling fumes.
- Store flammable liquids safely away from heat.
- Mark emergency exits and keep them **unobstructed**.

Example: A tidy workshop reduces trips and falls.

2.3 Possible Causes of Accidents in a Metal Workshop

Accidents in workshops often happen due to negligence or lack of knowledge.

- **Human error:** Carelessness, rushing tasks, lack of training.
- **Faulty equipment:** Broken machines, damaged tools, frayed electrical cords.
- **Environmental hazards:** Wet floors, poor lighting, cluttered workspace.
- **Ignoring PPE:** Not wearing gloves, goggles, or helmets.
- **Fire hazards:** Sparks, flammable materials, or overheating equipment.

Example: A student cutting metal without gloves may suffer a deep hand cut.

2.4 First Aid Procedures for Workshop Accidents

Accidents can occur despite precautions. Knowing first aid is essential.

2.4.1 Minor Cuts and Abrasions

- Clean the wound with **clean water or antiseptic**.
- Apply **antibiotic cream**.
- Cover with a **sterile bandage**.

2.4.2 Burns

- Cool the affected area under **running cold water** for 10-20 minutes.
- Do not apply ice directly.
- Cover with a **clean, dry cloth**.
- Seek medical attention for severe burns.

2.4.3 Eye Injuries

- **Do not rub eyes**.
- Rinse immediately with **clean water**.
- Remove any visible metal particles carefully with tweezers if possible.
- Seek medical attention immediately.

2.4.4 Electric Shock

- **Switch off power source** immediately.
- Do not touch the victim with bare hands if still in contact with electricity.
- Call for medical assistance.
- Keep the victim **lying down** and check for breathing.

2.4.5 Fractures

- Immobilize the injured part using a **splint or firm support**.
- Avoid moving the person unnecessarily.
- Seek medical attention immediately.

Example: A spark from welding burns a hand; immediately rinse with cold water, cover, and report.

2.5 Components of a Metal Workshop Layout

A well-organized workshop reduces accidents and improves workflow. Key components include:

- **Entrance and exit** – clearly marked for emergency access.
- **Workbenches** – for handwork, cutting, filing, and assembly.
- **Machine area** – lathes, drilling, grinding machines with safety zones.
- **Storage area** – organized storage for raw materials, tools, and PPE.
- **Chemical/flammable storage** – away from sparks and heat.
- **First aid station** – easily accessible with first aid kits.
- **Fire safety equipment** – extinguishers, fire blankets, sand buckets.
- **Waste disposal area** – for scrap metals and used consumables.

Illustration Example:

- Welding machines in one corner with a safety barrier.
- Workbenches arranged in rows with clear walking paths.
- Storage racks for metals and tools along walls.

2.6 Brainstorming and Practical Activities

Objective: Students actively explore workshop safety.

- **Step 1: Brainstorm**

❖ List all possible hazards in the workshop.

❖ Discuss examples of past accidents in local workshops.

- **Step 2: Research**

❖ Search online for OSHA guidelines.

❖ Watch videos on safe metalworking practices.

- **Step 3: Practical Demonstration**

❖ Demonstrate correct PPE use.

❖ Simulate a minor injury and perform first aid procedures.

- **Step 4: Workshop Visit**

❖ Observe safety measures in real workshops.

❖ Note the placement of fire extinguishers, first aid kits, and PPE stations.

2.7 Summary Table of Workshop Safety

Aspect	Explanation	Examples
Personal Safety	Use of PPE	Goggles, Gloves, Apron, Boots
Equipment Safety	Check tools and machines	Lathe, Welding machine, Hacksaw
Environmental Safety	Clean, ventilated, organized	Remove scrap metal, Proper lighting
Causes of Accidents	Human error, faulty equipment, unsafe environment	Cuts, burns, electric shocks
First Aid	Immediate care for injuries	Clean cuts, Cool burns, Rinse eyes
Workshop Layout	Organized areas to reduce accidents	Workbenches, Storage racks, Machine zones

2.8 Illustrative Examples

Example 1 – Proper PPE Use

- Student grinding metal wears goggles, gloves, and apron.
- Sparks hit apron instead of skin → injury avoided.

Example 2 – Accident Scenario

- Wet floor causes slipping → Student falls → Minor cuts → First aid applied → Learning point: keep floors dry.

Example 3 – Workshop Layout

- Welding corner is separated by a **metal screen** → prevents sparks from reaching other students.
- Fire extinguisher mounted nearby → quick response to small fires.

Key Takeaways:

- Safety prevents accidents, injuries, and fatalities.
- PPE, proper layout, and environmental cleanliness are crucial.
- Understanding OSHA rules is essential for legal and safe practice.
- First aid knowledge saves lives in case of accidents.
- Visiting real workshops helps students see safety measures in action.

2.0 Tools and Materials in Metal Technology

2.1 Hand Tools and Bench Tools

Hand tools and bench tools are essential in metal workshops for performing precise work, shaping, joining, and measuring metals. They are the foundation of practical metalworking skills.

2.1.1 Selection of Hand and Bench Tools

Selecting the right tool ensures efficiency, safety, and accuracy in tasks.

- **Types of Tools**:

A) Cutting Tools

Used to cut, shape, or trim metals.

- **Hacksaw** – for cutting metal rods, bars, and sheets.
- **Tin snips** – for cutting thin metal sheets.
- **Files** – for smoothing rough edges and finishing metal surfaces.
- **Chisels** – for cutting or carving metal.
- **Example Task:** Cutting a steel rod to make a metal frame.

B) Driving Tools

Used to hit or drive objects.

- **Hammer (ball peen, cross peen, claw)** – shaping, striking chisels, driving nails/pins.
- **Mallet** – used when striking surfaces that should not be damaged.

- **Screwdrivers** – driving screws into metal or machinery.
- **Example Task:** Hammering a metal pin into a joint.

C) Holding Tools

Used to hold metal pieces firmly in place during work.

- **Bench vice** – securing metal for filing, cutting, or drilling.
- **Clamps** – temporary holding of small pieces.
- **Pliers** – gripping and bending small metal parts.
- **Example Task:** Holding a metal plate in a vice to drill a hole.

D) Measuring Tools

Used to ensure accuracy in dimensions.

- **Steel rule** – measuring lengths.
- **Vernier caliper** – precise internal and external measurements.
- **Tape measure** – measuring long sections.
- **Try square** – checking right angles.
- **Example Task:** Measuring a metal bar to cut it to 30 cm.

E) Marking Out Tools

Used to mark metal before cutting or shaping.

- **Scriber** – marks lines on metal surfaces.
- **Centre punch** – marks drilling points.
- **Surface gauge** – transferring measurements accurately.
- **Example Task:** Marking a drilling point on a steel plate.

2.1.2 Performing Tasks Using Hand and Bench Tools

Proper use of tools is crucial to achieve quality work and avoid accidents.

- **Cutting Metal with Hacksaw**

1. Secure the workpiece in a bench vice.
2. Select the correct blade (fine for thin metal, coarse for thick).
3. Use long, steady strokes, applying pressure only on the forward stroke.
4. Smooth edges with a file.

- **Filing Metal**

1. Secure the piece in a vice.
2. Hold the file handle with one hand and push with the other.
3. Use even strokes, keeping the file flat.

- **Drilling Metal**

1. Mark the hole with a centre punch.
2. Secure the metal in a vice.
3. Use appropriate drill bit and lubricate for smooth drilling.

- **Hammering and Bending**

1. Place metal on an anvil or flat surface.
2. Use correct hammer type.
3. Bend or shape metal gradually to avoid cracking.

Tip: Always use the correct tool for the task to prevent accidents and damage.

2.1.3 Maintenance of Hand and Bench Tools

Maintaining tools extends their life and ensures safety.

- **Cleaning**

❖ Wipe tools after use to remove dirt, oil, and metal dust.

❖ Remove rust using sandpaper or rust remover.

- **Sharpening**

❖ Files, chisels, and hacksaw blades must be kept sharp for efficient work.

- **Lubrication**

❖ Hinges, moving parts of pliers, screwdrivers, and vices should be oiled.

- **Storage**

❖ Keep tools in toolboxes, racks, or drawers.

❖ Avoid leaving tools on the floor or benches to prevent accidents.

Example: Sharpening a chisel regularly ensures clean cuts on metal.

2.1.4 Importance of Hand and Bench Tools in a Workshop

- **Efficiency:** Speeds up metalwork tasks.
- **Precision:** Accurate cutting, measuring, and marking.
- **Safety:** Proper tools reduce chances of accidents.

- **Skill Development:** Mastering hand tools is foundational for advanced metalwork.
- **Cost-saving:** Maintaining and using the right tools reduces material wastage.

Examples of Use in Daily Life:

- Making a metal gate (cutting, bending, welding with hand tools first).
- Repairing a bicycle chain (using pliers, wrenches).
- Fabricating a metal shelf (using hacksaw, files, clamps, and hammer).

2.1.5 Illustrative Examples of Common Hand and Bench Tools

Tool Type	Tool Name	Use/Task Example
Cutting	Hacksaw	Cutting steel rods
Cutting	File	Smoothing edges of metal sheet
Driving	Hammer	Driving pins into metal
Driving	Screwdriver	Fixing screws on metal brackets
Holding	Bench vice	Securing metal for drilling
Holding	Pliers	Bending metal wire
Measuring	Steel rule	Measuring length of metal rod
Measuring	Vernier caliper	Measuring diameter of pipe
Marking	Centre punch	Marking drilling points
Marking	Scriber	Drawing cutting lines

2.1.6 Safe Use and Demonstration Tips

- Always **check tools for defects** before use.
- Hold tools **firmly** but comfortably.
- Cut or hammer **away from the body**.
- Keep hands **clear of sharp edges** and moving parts.
- Use **bench tools with clamps or vices** for stability.
- Wear **PPE** at all times (goggles, gloves, apron, boots).

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Activity for Students:

- Pick a metal task (cutting, drilling, filing) and perform it using appropriate hand and bench tools.
- Demonstrate maintenance by cleaning and storing the tools properly.
- Discuss which tool was most effective for the task and why.

2.1.7 Summary Table of Key Points

Aspect	Points to Remember	Examples
Cutting Tools	Hack saw, files, chisels – for shaping metal	Cutting rods, smoothing sheets
Driving Tools	Hammer, mallet, screwdrivers – for striking/driving	Hammering pins, driving screws
Holding Tools	Vice, clamps, pliers – for securing work	Holding sheet for drilling
Measuring Tools	Rulers, calipers, try square – for accuracy	Measuring rods, marking angles
Marking Tools	Scriber, punch – for layout work	Marking drilling points
Maintenance	Cleaning, sharpening, oiling, storing tools	Sharpen files, oil pliers, store safely
Importance	Efficiency, precision, safety, skill development	Making gates, repairing machines

2.1.8 Illustrative Practical Examples

Example 1 – Making a Metal Bracket

- Tools: Hacksaw (cutting), file (finishing edges), hammer (bending), bench vice (holding).
- Steps: Measure → Mark → Cut → File → Bend → Assemble.

Example 2 – Repairing a Bicycle

- Tools: Pliers (remove chain), screwdriver (tighten bolts), hammer (adjust parts).
- Outcome: Smooth operation of bike.

Example 3 – Fabricating a Small Shelf

- Tools: Hacksaw, hammer, file, bench vice, steel ruler, centre punch.
- Steps: Measure metal → Mark → Cut → Drill holes → Assemble → Finish.

Key Takeaways:

- Correct selection and use of hand and bench tools ensure safety and quality work.

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- Maintenance and storage prolong tool life.
- Mastery of these tools forms the basis for all metalworking tasks.
- Observing examples in workshops improves understanding and skills.

2.2 Measuring and Marking Out Tools

Measuring and marking tools are critical in metalwork because **accuracy determines the quality of finished products**. A small mistake in measurement can ruin the entire workpiece.

2.2.1 Identification of Measuring and Marking Out Tools

A) Measuring Tools

Used to determine the **length, thickness, angle, and diameter** of metal workpieces.

- **Steel Rule:** Measures length and distance.
- ❖ **Example:** Measure a 50 cm steel rod before cutting.
- **Vernier Caliper (outside and inside):** Measures internal and external diameters accurately.
- ❖ **Example:** Measuring diameter of a metal pipe.
- **Micrometer:** Measures very small thicknesses or diameters precisely.
- ❖ **Example:** Measuring sheet metal thickness (0.5 mm).
- **Tape Measure:** For measuring long lengths of metal sheets, rods, or beams.
- ❖ **Example:** Measure a 3 m metal sheet for roofing.
- **Try Square:** Checks and marks **right angles (90°)**.
- ❖ **Example:** Ensuring a metal frame corner is perfectly square.
- **Angle Block / Protractor:** Measures or marks specific angles.
- ❖ **Example:** Marking a 45° bevel cut on a metal sheet.
- **Surface Plate / Surface Table:** Flat reference surface for accurate measurement or marking.
- ❖ **Example:** Checking flatness of a metal plate before drilling.
- **Odd Leg Caliper:** Used for marking lines parallel to the edge of a metal sheet.
- ❖ **Example:** Drawing parallel lines for bending a sheet.
- **Vee-block:** Holds cylindrical metal objects for marking or drilling.
- ❖ **Example:** Holding a round metal rod for drilling a hole.
- **Scribing Block:** A holder to hold scribers for marking straight, parallel lines.
- ❖ **Example:** Drawing parallel lines on a metal plate for cutting.
- **Trammel:** Measures and marks large circles or arcs.
- ❖ **Example:** Marking a 50 cm diameter circle on a steel plate.

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B) Marking Tools

Used to **transfer measurements onto metal surfaces** accurately.

- **Scriber:** Marks lines on metal surfaces using scratches.
- ❖ **Example:** Marking cutting lines on sheet metal.
- **Dot Punch / Centre Punch:** Creates small indentations to guide drilling points.
- ❖ **Example:** Making a dent before drilling to prevent drill slip.
- **Divider:** Used to mark **equal distances or arcs**.
- ❖ **Example:** Dividing a metal rod into 5 equal segments.

- **Example List of Common Tools:**

Tool	**Use / Application**
Steel rule	Measuring length of rods, sheets
Vernier caliper	Measuring external/internal diameters
Micrometer	Measuring thickness of sheets
Tape measure	Measuring long distances
Try square	Marking right angles
Angle block	Marking angles like 30°, 45°, 60°
Surface table	Reference flat surface
Odd leg caliper	Parallel line marking
Vee-block	Holding round rods for drilling
Scribing block	Marking straight, parallel lines
Trammel	Marking large circles/arcs
Scriber	Drawing cutting lines
Dot punch	Making drill guides
Divider	Equal spacing marking

2.2.2 Performing Tasks Using Measuring and Marking Tools

Proper use ensures **accuracy, precision, and quality work**.

- **Example Tasks:**

1. **Measuring and Cutting a Steel Rod**

❖ Measure 50 cm using steel rule or tape.

❖ Mark cutting line with scriber.

❖ Dot punch the line for drill point if needed.

❖ Cut along marked line using hacksaw.

2. **Marking a Metal Sheet for Drilling Holes**

❖ Use try square to mark straight lines.

❖ Dot punch at drilling points.

❖ Drill safely along punched marks.

3. **Drawing Circles or Arcs on Metal Plates**

❖ Use trammel or divider.

❖ Mark with scriber.

❖ Check measurements with steel rule.

4. **Checking Dimensions of Cylindrical Rods**

❖ Use vee-block to hold rod.

❖ Use outside calliper or vernier caliper to check diameter.

5. **Parallel Line Marking on Metal Sheets**

❖ Use odd leg caliper or scribing block.

❖ Draw lines parallel to the edge.

❖ Ensures proper bending or cutting.

6. **Angle Marking**

❖ Use protractor or angle block.

❖ Mark desired angle (e.g., 30°, 45°, 60°).

❖ Check with try square.

2.2.3 Maintenance of Measuring and Marking Tools

Maintaining tools ensures **accuracy, longevity, and safety**.

- **Cleaning**: Wipe tools after use to remove metal dust and oil.
- **Rust Prevention**: Apply light oil on steel tools.

- **Storage**: Keep tools in designated boxes or racks.
- **Calibration**: Periodically check vernier calipers, micrometers, and squares for accuracy.
- **Handling**: Avoid dropping tools; precision tools are fragile.

Example: Vernier caliper stored in a padded case remains accurate for years.

2.2.4 Importance of Measuring and Marking Tools in Metal Workshop

- **Accuracy:** Ensures correct dimensions in metal parts.
- **Quality Work:** Properly marked metals fit and assemble correctly.
- **Efficiency:** Reduces mistakes and wastage of materials.
- **Safety:** Correct measurements prevent misaligned cuts or unsafe assemblies.
- **Skill Development:** Teaches precision and attention to detail.

Examples of Importance:

- Measuring correctly before cutting steel sheets for a gate ensures pieces fit perfectly.
- Using a centre punch prevents drills from slipping and causing accidents.
- Parallel lines drawn with odd leg calipers help in bending metal sheets accurately.
- Checking angles ensures structures like frames and supports are strong and safe.

2.2.5 Illustrative Examples

Example 1 – Cutting a Metal Plate Accurately

- Measure length and width with steel rule.
- Mark using scriber.
- Punch holes using dot punch.
- Cut along lines → Perfect rectangle.

Example 2 – Drilling Holes on Round Rods

- Hold rod in vee-block.
- Mark centre with dot punch.
- Measure diameter with callipers.
- Drill safely → Hole in correct position.

Example 3 – Bending Metal Sheet Along Parallel Lines

- Mark lines with odd leg caliper.
- Check with scribing block.
- Bend along lines → Accurate bends.

Example 4 – Fabricating a Triangular Frame

- Use angle block to mark 45° angles.
- Check angles with try square.
- Mark cutting lines with scriber.
- Cut and assemble → Perfect triangular frame.

2.2.6 Summary Table of Key Points

Aspect	Details / Points	Examples
Measuring Tools	Steel rule, tape, calipers, micrometer, try square, angle block	Measure rods, pipes, sheets, angles
Marking Tools	Scriber, dot punch, divider, scribing block, trammel	Mark cutting lines, drilling points, circles
Task Performance	Measure → Mark → Punch → Cut / Drill	Cutting rods, marking holes, bending sheets
Maintenance	Clean, oil, store, calibrate	Oil calipers, keep scriber in rack
Importance	Accuracy, quality, efficiency, safety, skill	Correct fitting of metal parts, safe drilling

2.2.7 Practical Tips for Students

- Always **measure twice, mark once**.
- Keep a **clean, flat surface** for measuring and marking.
- Use **dot punch before drilling** to prevent drill slippage.
- Verify angles with **try square or angle block**.
- Use **appropriate tools** for the task (don't improvise).
- Wear **PPE** when marking, measuring, and cutting metals.

Key Takeaways:

- Measuring and marking tools are the **foundation of accurate metalwork**.
- Using tools correctly ensures **precision, safety, and quality**.
- Maintenance and proper storage keep tools accurate and durable.
- Real-life examples include: gates, frames, brackets, shelves, furniture, piping systems, and mechanical parts.

2.3 FERROUS AND NON-FERROUS METALS

Metals form the backbone of all metalwork. They are classified into **ferrous** (contain iron) and **non-ferrous** (do not contain iron) metals. Understanding their **types, properties, sources, and applications** is essential for metalworking.

2.3.1 Distinguishing Ferrous and Non-Ferrous Metals

A) Ferrous Metals

- Contain **iron** as the main component.
- Usually **magnetic**.
- Prone to **rust** when exposed to moisture.
- Used where **strength and hardness** are required.

Examples:

- **Mild steel / Low carbon steel** – used in rods, sheets, gates, nails.
- **High carbon steel** – used for cutting tools, springs, chisels.
- **Cast iron** – used for engine blocks, machinery bases, manhole covers.
- **Alloy steels** – steel mixed with other metals for special properties.

Properties:

- Strong and durable
- Tough and hard
- Magnetic
- Conducts electricity moderately
- Rusts easily

B) Non-Ferrous Metals

- Do **not contain iron**.
- **Non-magnetic**.
- Resistant to **rust and corrosion**.
- Usually **lighter and more malleable** than ferrous metals.

Examples:

- **Copper** – electrical wires, plumbing, roofing.
- **Aluminium** – aircraft, windows, drink cans.
- **Lead** – batteries, radiation shields.
- **Tin** – coating steel, making cans.

- **Zinc** – galvanizing steel, roofing sheets.
- **Brass (Copper + Zinc)** – musical instruments, valves.
- **Bronze (Copper + Tin)** – statues, bearings.

Properties:

- Lightweight and malleable
- Non-magnetic
- Corrosion-resistant
- Conducts heat and electricity (especially copper and aluminium)
- Softer than most ferrous metals

2.3.2 Properties of Metals Found in a Metal Workshop

Understanding properties helps **choose the right metal for a job**.

A) Physical Properties

- **Color and lustre:** Copper (reddish), Aluminium (silver), Steel (greyish).
- **Density / Weight:** Aluminium is light; steel is heavy.
- **Melting point:** Iron melts at 1538°C, Aluminium at 660°C.
- **Conductivity:** Copper is an excellent conductor.

B) Mechanical Properties

- **Toughness:** Ability to withstand shock (steel).
- **Hardness:** Resistance to scratching and indentation (high carbon steel).
- **Ductility:** Ability to be stretched into wires (copper, aluminium).
- **Malleability:** Ability to be hammered into sheets (aluminium, copper).
- **Strength:** Ability to withstand force without breaking (steel, cast iron).

Practical Examples:

- Aluminium sheets in roofing → lightweight, corrosion-resistant.
- Copper wires in electrical circuits → excellent conductivity.
- High carbon steel blades → hard and durable for cutting tools.

2.3.3 Production of Iron from its Ore

Iron is produced from **iron ore** through several processes in a **blast furnace**.

Steps:

1. **Mining of iron ore** – extraction from rocks containing iron.
2. **Crushing and washing** – ore is crushed and impurities removed.
3. **Smelting in blast furnace** – ore is heated with **coke** and **limestone**.
4. **Chemical reaction:** Iron oxide + carbon → molten iron + carbon dioxide.
5. **Casting / Solidifying:** Molten iron is poured into molds to form **ingots** or **pig iron**.
6. **Refining:** Further processed into steel by removing impurities (basic oxygen process).

Key Raw Materials:

- Iron ore
- Coke (carbon source)
- Limestone (removes impurities)

Example Applications of Produced Iron:

- Mild steel rods for construction.
- Cast iron for machinery bases.
- Alloy steel for tools and automotive parts.

2.3.4 Forms of Material Supply in a Metal Workshop

Metals come in **various shapes and sizes** depending on the project.

A) Sheets and Plates

- **Metal sheets:** Thin, flexible; used for roofing, cabinets.
- **Plates:** Thick, heavy; used for machine bases, beams.

B) Bars and Rods

- **Round rods:** Axles, shafts.
- **Square / Flat bars:** Frames, supports, brackets.
- **Angle bars / Channels:** Construction frames, supports.

C) Tubes and Pipes

- Circular or square hollow sections; used in plumbing, railings, structures.
- **Example:** Aluminium tubes for window frames.

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D) Wires

- Copper, aluminium wires for electrical work.
- Mild steel wires for fencing.

E) Ingots

- Raw cast metal blocks; used in forging or rolling into sheets.

F) Other Forms

- **Foils:** Thin aluminium foil for packaging.
- **Coils / Rolls:** Sheet metals supplied in rolls for continuous use.

Practical Examples:

- Aluminium sheet → roofing sheets, car body panels.
- Steel bar → gate frame, furniture frame.
- Copper wire → electrical connections.
- Cast iron plate → machinery mounting plate.

2.3.5 Applications of Ferrous and Non-Ferrous Metals in Daily Life

Metals are everywhere in our lives; their **selection depends on properties**.

Ferrous Metals Applications

- Mild steel rods → construction bars.
- High carbon steel → tools, knives, chisels.
- Cast iron → stoves, machinery bases, pipes.
- Alloy steel → car parts, machinery components.

Non-Ferrous Metals Applications

- Aluminium → aircraft, windows, soda cans.
- Copper → wiring, plumbing, coins.
- Lead → batteries, radiation shielding.
- Zinc → galvanizing steel, roofing.
- Brass → valves, musical instruments.
- Bronze → statues, bearings, medals.

Everyday Examples:

- Door gates → mild steel (ferrous).
- Cooking pots → aluminium (non-ferrous).

- Electrical wires → copper (non-ferrous).
- Car engine → cast iron and steel (ferrous).
- Coins → copper, nickel alloys (non-ferrous).

2.3.6 Summary Table

Metal Type	Examples	Properties	Applications
Ferrous	Mild steel, High carbon steel, Cast iron	Strong, hard, magnetic, rusts	Tools, gates, construction, machines
Non-Ferrous	Copper, Aluminium, Lead, Tin, Zinc, Brass, Bronze	Light, corrosion-resistant, non-magnetic, ductile	Wires, roofing, plumbing, cans, statues

2.3.7 Illustrative Examples for Practice

1. **Fabricating a Steel Gate**

❖ Use mild steel bars → strong, durable.

❖ Sheet steel panels → decorative inserts.

2. **Electrical Wiring**

❖ Copper wire → excellent conductivity, corrosion-resistant.

3. **Aluminium Roofing**

❖ Lightweight → easy to install.

❖ Corrosion-resistant → lasts long.

4. **Tool Making**

❖ High carbon steel → hammerheads, chisels, saw blades.

5. **Industrial Machines**

❖ Cast iron base → vibration-resistant, strong.

6. **Household Items**

❖ Aluminium pots, pans, trays → lightweight, corrosion-resistant.

❖ Brass taps → corrosion-resistant, decorative.

7. **Art and Decoration**

❖ Bronze statues, medals, ornamental handles.

2.3.8 Practical Tips for Students

- Identify metals by **magnet test** (ferrous → magnetic, non-ferrous → non-magnetic).
- Consider **strength, weight, corrosion resistance** before choosing metal.
- Always **measure and mark accurately** before cutting or shaping.
- Understand **forms of metal supply** to select the right material for the task.
- Use **ferrous metals for strength-heavy jobs**; non-ferrous for corrosion-resistant or electrical applications.

Key Takeaways:

- Metals are classified as **ferrous and non-ferrous**.
- Knowing **properties and applications** is crucial for metalwork.
- Metals come in **sheets, plates, rods, bars, wires, pipes, ingots**.
- Proper selection ensures **quality, safety, and efficiency**.
- Everyday life depends on metals for **construction, transport, electrical work, utensils, and decoration**.

2.4 Project Work in Metal Technology

Project work in metal technology allows learners to **apply theory into practice**. It emphasizes **problem-solving skills**, creativity, and practical use of **tools, materials, and machines** to address real-life needs in the community.

2.4.1 Identifying Problems in the Community

The first step in any project is **observing the community to identify problems that can be solved using metal technology skills**.

- **Examples of Community Problems:**

1. Broken or unsafe gates in homes or schools.
2. Lack of proper waste bins in neighborhoods.
3. Weak or broken furniture in schools, offices, or homes.
4. Need for water tanks or storage containers.
5. Poorly secured windows or doors in houses.
6. Broken bicycle frames or machinery parts.
7. Lack of animal feeding troughs in farms.
8. Unsafe playground equipment.
9. Missing or damaged fence posts.
10. Lack of tool storage racks in schools or workshops.

- **Activity for Learners:**

❖ Walk around your community or school to **observe problems**.

❖ List at least **5 problems** that can be solved using metal fabrication skills.

2.4.2 Suggesting Items to Solve the Problem

After identifying problems, **think of metal items that can solve them using locally available materials**.

- **Examples of Items to Make:**

1. **Steel gate** → for broken or insecure gates.
2. **Metal waste bins** → for litter collection.
3. **Metal chairs, tables, or shelves** → for weak or broken furniture.
4. **Water tanks or metal drums** → for water storage.
5. **Metal window frames with grills** → for home security.
6. **Bicycle frames or metal repair kits** → for broken bicycles.
7. **Animal feeding troughs or cages** → for farms.
8. **Metal playground swings and slides** → for schools or public areas.
9. **Fence posts and boundary rails** → for secure farms or properties.
10. **Tool racks and holders** → for workshops and storage solutions.

- **Criteria for Selection:**

o Locally available materials.

o Simple fabrication process suitable for learners.

o Solves a real community problem effectively.

2.4.3 Fabrication of the Selected Item

Fabrication involves **applying knowledge of tools, materials, measurement, marking, cutting, joining, and finishing metals** to make the item.

- **Steps in Fabrication:**

1. **Planning**

❖ Identify materials needed: steel rods, sheets, wires, nuts, bolts, etc.

❖ Draw simple **sketch of the item** with measurements.

❖ List **tools and machines** required: hacksaw, hammer, files, welding machine, vice, pliers.

2. **Measuring and Marking**

- Measure metal using steel rule, tape, or vernier calipers.
- Mark cutting points using scriber, dot punch, or dividers.
- Check angles using try square or angle blocks.

3. **Cutting / Shaping**

- Cut rods, sheets, or bars to the correct size.
- Bend sheets using hammer, mallet, or bending brake.
- Shape rods using pliers or hammers.

4. **Joining Metals**

- **Welding:** Join metal pieces permanently.
- **Bolting / Screwing:** Join pieces where future disassembly is needed.
- **Riveting:** Join thin sheets where welding is not possible.

5. **Finishing**

- Smooth rough edges with files or grinders.
- Clean surfaces from dust or grease.
- Paint or coat to prevent corrosion.

6. **Inspection**

- Check dimensions and angles.
- Test stability and functionality.

2.4.4 Appreciation of Tools and Equipment in Fabrication

- Tools and machines **make fabrication easier, faster, and safer**.
- Proper use ensures **quality work** and prevents injuries.

Examples:

- Hacksaw → cutting rods and sheets accurately.
- File → smoothing edges to prevent injuries.
- Welding machine → permanent joining of metal structures.
- Bench vice → holds metal securely during cutting or filing.
- Pliers → bending small metal pieces accurately.

2.4.5 Examples of Community Projects

1. Security Solutions

- **Problem:** Broken school gate.
- **Solution / Item:** Welded steel gate with hinge.
- **Materials:** Mild steel rods, angle bars, welding rods.
- **Tools:** Hacksaw, welding machine, hammer, bench vice.

2. Waste Management

- **Problem:** Litter in neighborhood.
- **Solution / Item:** Metal waste bins.
- **Materials:** Mild steel sheets, hinges, metal rods.
- **Tools:** Scriber, hammer, welding machine, pliers.

3. Furniture Fabrication

- **Problem:** Weak school chairs.
- **Solution / Item:** Metal-framed chairs with wooden or metal seats.
- **Materials:** Mild steel rods, wooden planks.
- **Tools:** Hacksaw, drill, file, welding machine.

4. Animal Farming

- **Problem:** Cattle feed scattered on the ground.
- **Solution / Item:** Metal feeding trough.
- **Materials:** Steel sheets, angle bars.
- **Tools:** Scriber, hacksaw, hammer, welding machine.

5. Water Storage

- **Problem:** Shortage of clean water storage.
- **Solution / Item:** Metal water tank or drum.
- **Materials:** Steel sheets, welding rods.
- **Tools:** Sheet bending tools, welding machine, hammer.

6. Bicycle / Motorcycle Repairs

- **Problem:** Broken bicycle frame.
- **Solution / Item:** Fabricate replacement frame or brackets.
- **Materials:** Mild steel rods, small steel sheets.
- **Tools:** Hacksaw, welding machine, pliers, files.

7. Household Improvement

- **Problem:** Weak window grills.
- **Solution / Item:** Metal grills for windows.
- **Materials:** Mild steel rods.
- **Tools:** Hacksaw, welding machine, hammer, vice.

8. Tool Organization

- **Problem:** Messy workshop tools.
- **Solution / Item:** Metal tool rack with compartments.
- **Materials:** Mild steel rods, sheets.
- **Tools:** Hacksaw, welding machine, drill.

9. Playground Equipment

- **Problem:** Broken swings at school.
- **Solution / Item:** Metal swing frame.
- **Materials:** Mild steel tubes, rods.
- **Tools:** Hacksaw, welding machine, files, paint.

10. Fencing / Boundary Solutions

- **Problem:** Unsecured farm boundary.
- **Solution / Item:** Metal fence posts and rails.
- **Materials:** Mild steel rods, wires.
- **Tools:** Hacksaw, pliers, hammer, welding machine.

2.4.6 Practical Steps in Presenting a Fabricated Project

1. **Demonstrate functionality:** Show how it works (e.g., gate opens, chair holds weight).
2. **Explain materials used:** Mention ferrous/non-ferrous metals applied.
3. **Discuss tools and machines:** Explain why each was chosen.
4. **Highlight safety measures:** PPE used, careful handling of machines.
5. **Document process:** Sketches, step-by-step photos, or video recordings.

2.4.7 Summary Table for Project Work

Step	Description	Examples
Identify problem	Observe community, list issues	Broken gates, litter, weak chairs
Suggest item	Design item to solve problem	Gate, waste bin, feeding trough
Fabricate item	Measure, cut, shape, join, finish	Welding steel rods, bending sheets, drilling holes
Use of tools	Select proper tools for each task	Hacksaw, hammer, welding machine, files, pliers
Presentation	Demonstrate item, explain process	Show water tank, swing frame, or metal rack

2.4.8 Key Takeaways

- Project work bridges **theory and practical skills** in metal technology.
- Choosing the **right materials and tools** ensures durability and efficiency.
- Projects solve **real community problems**, improving lives.
- Safety, measurement accuracy, and finishing are **critical in fabrication**.
- Examples of projects: gates, bins, furniture, water tanks, grills, troughs, racks, playground equipment, fences.

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3.0 RELATED DRAWING IN METAL TECHNOLOGY

3.1 Scales and Conventions

Technical drawings are essential in metal technology because they provide **precise instructions** for fabrication. Understanding **symbols, abbreviations, conventions, and scales** ensures correct interpretation and communication.

3.1.1 Symbols, Abbreviations, and Conventions Used in Metal Drawings

A) Identification of Symbols

Symbols represent **materials, processes, and features** in drawings.

Common Symbols in Metal Technology:

1. **Welding Symbols**
   - **Fillet weld** → triangle symbol.
   - **Groove weld** → U, V, or bevel shapes.
   - **Spot weld** → small circle.
   - **Plug weld** → filled circle.
2. **Cutting and Bending Symbols**
   - **Bend line** → dashed line with arrow.
   - **Cut line** → thick solid line with scissors symbol.
3. **Surface Finish Symbols**
   - **Machining** → check mark (√) on surface.
   - **Grinding** → horizontal line with roughness number.
4. **Sectional View Symbols**
   - **Hatching** → diagonal lines to indicate cut surfaces.
5. **Fastening Symbols**
   - **Bolt** → circle with cross inside.
   - **Nut** → hexagon symbol.
   - **Rivet** → filled circle on joined parts.

Common Symbols in Metal Technology

1. Welding Symbols

1. **Fillet Weld** → represented by a **triangle**

▲

2. **Groove Weld** → represented by **U, V, or bevel shapes**

U-shaped groove: U

V-shaped groove: V

Bevel groove: ⌒

3. **Spot Weld** → represented by a **small circle**

○

4. **Plug Weld** → represented by a **filled circle**

●

2. Cutting and Bending Symbols

1. **Bend Line** → represented by a **dashed line with an arrow**

- - - - - →

2. **Cut Line** → represented by a **thick solid line with scissors symbol**

——————✂——————

3. Surface Finish Symbols

1. **Machining** → represented by a **check mark (√) on the surface**

√

2. **Grinding** → represented by a **horizontal line with roughness number**

——Ra 3.2

(*Ra = roughness average*)

4. Sectional View Symbols

1. **Hatching** → represented by **diagonal lines** to indicate cut surfaces

///////

///////

///////

5. Fastening Symbols

1. **Bolt** → represented by a **circle with a cross inside**

⊕

2. **Nut** → represented by a **hexagon**

⬡

3. **Rivet** → represented by a **filled circle on joined parts**

●

Examples of Use:

- Triangle for **fillet weld** on a steel angle in a gate.
- V-shape groove weld on a **machine base plate**.
- Machined surface symbol on **shaft ends**.

B) Abbreviations in Metal Drawings

Abbreviations save space and clearly communicate instructions.

Common Abbreviations:

Abbreviation	Meaning	Example
Ø	Diameter	Ø25 mm rod
R	Radius	R50 mm for bend
THK	Thickness	THK 6 mm steel plate
LG	Length	LG 1 m bar
DIA	Diameter	DIA 12 mm bolt
BEND	Bend	90° BEND sheet
FL	Fillet	FL weld on plate edge
FIN	Finish	FIN all surfaces
CL	Center line	CL hole position
REF	Reference	REF dimension for info

Examples of Use:

- Ø25 → mark diameter of a round rod.
- THK 6 → indicate thickness of sheet metal for tray.
- 90° BEND → mark fold line for metal bracket.

C) Conventions in Metal Drawings

Conventions are **agreed methods** for representing parts and features.

Common Conventions:

- **Line Types:**

❖ Continuous thick → visible edges.

❖ Dashed → hidden edges.

❖ Chain → centerlines.

- **Views:**

❖ **Front view**, **top view**, **side view** → standard orthographic projection.

- **Sectioning:**

❖ Cut surfaces shown with hatching.

- **Dimensioning:**

❖ Units in mm, arrows at ends, clear numbers.

Examples:

- Hidden edges of a welded angle → dashed line.
- Bolt hole at center → chain line (centerline) with Ø symbol.
- Machined surface → check mark with finish number.

3.1.2 Interpreting Symbols, Abbreviations, and Conventions

- Symbols indicate **type of weld, cut, or finish**.
- Abbreviations indicate **dimensions, materials, and operations**.
- Conventions provide **clarity and standardization**.

Examples:

1. Triangle symbol + FL → **fillet weld** at indicated edge.
2. Ø12 CL → **hole with 12 mm diameter at centerline**.
3. THK 5 BEND 90° → **bend 5 mm sheet at 90°**.
4. Machined surface symbol + Ra 3.2 → **grind surface to 3.2 µm roughness**.

Activity:

- Interpret drawing of a metal bracket:

❖ Identify weld type.

❖ Identify sheet thickness.

❖ Identify hole diameter and position.

3.1.3 Construction of Scales in Technical Drawing

Scales allow **reducing or enlarging dimensions** to fit drawings on paper.

A) Types of Scales

1. **Full Scale (1:1)** → Actual size.
2. **Reduction Scale (1:2, 1:5, 1:10)** → Draw smaller than real size.

3. **Enlargement Scale (2:1, 5:1)** → Draw larger than real size.

Examples:

- Gate frame actual size 2 m × 1 m → 1:10 scale → draw 20 cm × 10 cm.
- Bolt Ø12 mm → 2:1 scale → draw 24 mm diameter.

B) Plane Scale Construction (Simple Ruler Method)

Steps:

1. Draw a line representing unit length (e.g., 10 cm = 1 m).
2. Mark divisions along the line according to scale ratio.
3. Draw vertical lines from divisions to construct scale grid.
4. Use scale to measure and draw components accurately.

Examples:

- 1:5 scale → 1 m = 20 cm on paper.
- 1:2 scale → 50 cm rod → 25 cm on drawing.

C) Diagonal Scale Construction (For Fractional Measurement)

Steps:

1. Draw main horizontal line.
2. Divide into equal parts for **primary units**.
3. Draw **vertical lines** at each division.
4. Draw **diagonal lines** for subdivision (secondary units).
5. Project points from diagonal to main line → precise measurement.

Examples:

- Measuring 2.35 m on 1:5 scale using diagonal scale → 47 cm + 7 mm.
- Accurate placement of holes or bends on sheet metal.

3.1.4 Applications and Importance of Symbols, Abbreviations, Conventions, and Scales

- **Accuracy:** Provides exact dimensions and locations for fabrication.
- **Communication:** Engineers, welders, and technicians understand the design.
- **Efficiency:** Saves time, reduces mistakes in cutting, welding, or machining.
- **Standardization:** Everyone follows the same method worldwide.

Examples of Application:

1. Gate fabrication → weld type and dimensions from drawing.
2. Metal shelf → thickness, hole positions, and bends from drawing.
3. Machine part → scale used to fit drawing on A4 paper.
4. Bolt hole positions → interpreted using centerline conventions.

3.1.5 Common Symbols and Abbreviations Summary Table

Symbol / Abbreviation	Meaning / Use	Example
△	Fillet weld	Triangle at joint
V	V-groove weld	Edge weld on plates
●	Spot weld	Circle on sheet
Ø	Diameter	Ø12 mm hole
R	Radius	R50 mm bend
THK	Thickness	THK 6 mm sheet
BEND	Bend line	90° BEND
√	Machining finish	Surface Ra 3.2
CL	Center line	Hole at CL
Dashed line	Hidden edges	Hidden hole or feature
Chain line	Center of circle or symmetry	Bolt circle

3.1.6 Examples of Drawing Interpretation

1. **Gate Bracket Drawing:**

- Triangle → fillet weld at 45° angle.
- THK 5 → 5 mm steel sheet.
- Ø12 CL → hole for bolt at centerline.

2. **Shelf Drawing:**

- 1:5 scale → measure dimensions for cutting.
- 90° BEND → fold sheet accurately.
- Machining symbol → smooth edges for safety.

3. **Machine Part Drawing:**

- V-groove weld → joint assembly.
- DIA 25 mm → hole for shaft.

❖ Chain line → centerline for hole alignment.

3.1.7 Practical Tips for Students

- Always **refer to scale** before cutting or assembling.
- Recognize **symbols and abbreviations** before starting fabrication.
- Use **plane and diagonal scales** for accurate dimensioning.
- Draw **orthographic views** for clarity (front, top, side).
- Verify dimensions using **measuring tools** from the workshop.
- Always **apply conventions** for line types, hatching, and sectioning.

3.1.8 Key Takeaways

- **Symbols** indicate weld types, cuts, fasteners, and surface finishes.
- **Abbreviations** save space and provide material, thickness, and size info.
- **Conventions** standardize line types, views, and sectional drawings.
- **Scales** allow drawing real items on paper accurately, either reduced or enlarged.
- Proper use of **drawing knowledge ensures accuracy, efficiency, and safety** in metalwork.

3.2 Pictorial Drawing

Pictorial drawings are **three-dimensional (3D) representations of objects** that show **height, width, and depth** on a two-dimensional (2D) surface. They are essential in metal technology to **visualize metal components, machines, and fabricated products** before making them.

3.2.1 Types of Pictorial Drawings

1. **Isometric Drawing**

❖ Shows **all three dimensions (height, width, depth)** equally.

❖ Uses **30° angles from horizontal** for width and depth.

❖ Objects appear more **realistic and proportional**.

2. **Oblique Drawing**

❖ Front face shown **true size**.

❖ Depth is **projected at an angle**, usually 30° or 45°.

❖ Simpler to draw than isometric but less realistic.

3. **Perspective Drawing**

❖ Mimics how the **human eye sees objects**.

❖ Objects appear **smaller as they recede**.

❖ Commonly used in **design presentation and artistic work**.

4. **Axonometric Drawing** (variant of isometric)

- Includes **dimetric** and **trimetric projections**.
- Shows objects in proportion but with **distorted angles for clarity**.

5. **Exploded Pictorial Drawing**

- Shows parts **separated but aligned** to illustrate **assembly**.
- Used for **machines, tools, and welded components**.

Examples in Metal Technology:

- Isometric drawing → steel gate with rods and welds.
- Oblique drawing → metal toolbox showing depth.
- Perspective drawing → workshop machine layout.
- Exploded drawing → bolt and nut assembly.

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