CHANDIGARH UNIVERSITY

LAB MANUAL

WORKSHOP TECHNOLOGY

24MEP-101

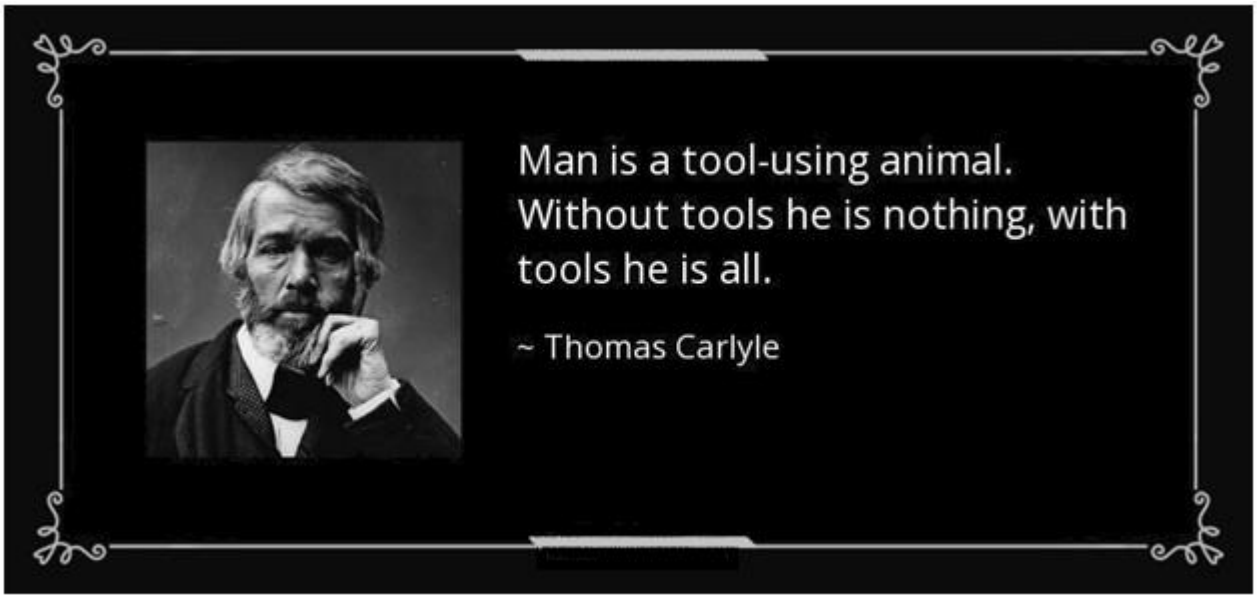
BATCH: 2024-2028

NAME:

UID:

BRANCH & SECTION:

CARPENTRY SHOP



Carpentry Shop:

SAFETY PRECAUTIONS:

1. Tools should be so placed on the Work Bench that their cutting edges are not damaged.
2. Wooden pieces with projected nails should never be allowed to remain on the floor.
3. Never stand in front of the blade while working on a Band saw.
4. Blunt tools slip rather than cutting, so should not be used.
5. Always wear tidy clothes while working on the Machines, loose clothing can get trapped.
6. Loose hair, wrist watches and anklets etc. can also be hazardous while working on the machines.
7. Rubber sole closed shoes only should be worn in the Carpentry Shop.
8. Moving parts of the machines, belts and tools should never be touched.
9. No machine should be operated without knowing how to operate it.
10. In case of fire, electric supply should be switched off immediately.
11. Make sure that your work and movement is not affecting others.
12. Should there be a risk of accident on a machine, rush to switch off electric supply.
13. Keep in mind the position of the fire Extinguishers and First Aid Box etc.

Introduction: It is a skilled trade in which the primary work performed is the use of Timber to construct items as large as buildings and as small as desk drawers. Carpentry has a vast field of application from artistic to industrial. For example, carpentry is required in Ship building on a very large scale at the same time it is required for making musical instruments.

Wood and Timber: Wood usually refers to the material in its natural state whereas Timber refers to it after it has been modified by man. When wood is cut in commercial forms like Beam, Board, Plank, Strip, Stock and Stringer etc. it becomes Timber.

Advantages of Timber:

- It is easy to work with the tools to give it desired shape and size.
- Structural joints and connections can be made easily.
- Responds very well to polishing and painting.
- It has been extensively used for doors, windows, furniture, and decorative designs.
- Being nonconductor of heat, it is favored for construction of houses in cold countries,
- It provides an indispensable combination of strength, durability, lightness, and economy.

Classification of Trees, depending upon the manner of growth:

- **Exogenous Trees (stem grows in size):** Timber from these trees is used for engineering purposes. These are further divided as
  - **a) Deciduous Trees or broad leaf Trees:** Ex. Sal, Teak, Shisham, Mango, Neem, Babool etc grow in plains and provide hard wood.
  - **b) Conifers or Ever Green Trees:** Ex. Kail, Pine, Deodar, Chir, Fir, Walnut etc. grow in mountainous areas and provide soft wood.
- **Endogenous trees (grow length wise):** Timber from these trees is useless for engineering purposes. Ex. Palm Trees.

Structure of wood:

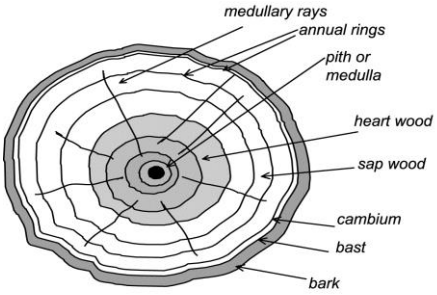


Fig. The cross section of a Tree trunk

Pith or medulla: It is the dark central part of the tree which is soft and spongy and feeds Sap from the roots to the growing plant in its early age. One Annual Ring is added around Pith every year.

Heart wood: The portion of wood around the Pith is called Heart Wood. It is darker in color, harder and stronger than the remaining wood in the tree. It carries less moisture than the Sap Wood surrounding it and is less likely to decay.

Sap wood: The portion of the wood between the Cambium layer and the Heart wood is called Sap wood. As opposed to Heart wood Sap flows through it and it softer and lighter as compared to the Heart wood Chances of decay are more in this part the wood.

Cambium layer: The Cambium "zone" produces the new living wood cells. It is the latest addition of an annual ring which is in the process of making just under the Bark. Cambium layer with the passage of time changes into Sap wood and a fresh Annual Ring is formed outside it.

Bast /Inner Bark: Inner bark develops from the outside layer of the Cambium and is the food track to the roots.

Bark or Cortex: it is a sort of anchor sheet on the outside surface of the tree to protect the Cambium layer from the attack of insects and frost. Food from the leaves to the Cambium layer is fed through its inner surface which is Inner Bark.

Modularly rays: These are radial rays running between the Pith and Cambium layer and help in binding the annual rings together to provide a solid structure to the tree.

Annual rings: These are concentric rings around Pith. One such layer is added every year and that is why they are known as Annual Rings.

Seasoning of Timber: This is a process by which moisture content in a fresh Timber is reduced to a suitable level. By doing so the durability of Timber is increased. The various methods of Seasoning used may be classified as:

(i) Natural Seasoning:

a) Air Seasoning: Air Seasoning is carried out in a shed with a platform. Timber balks are stacked On about 300 mm high platform as shown in the Fig. Care is taken to see that there is proper air circulation around each Timber balk. Over a period, in a natural process moisture content reduces. A well seasoned Timber contains only 15% moisture. This is a slow but a good process of Seasoning Timber.

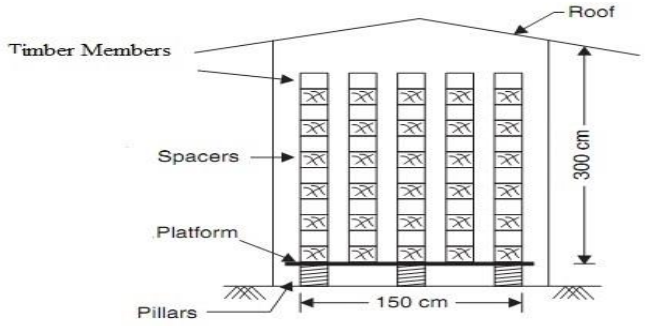


Fig. Air/Natural Seasoning

b) Water Seasoning: Water Seasoning is carried out on the banks of rivers. The thicker end of the Timber is kept pointing upstream side. After a period of 2 to 4 weeks the Timber is taken out. During this period sap contained in the Timber is washed out to a great extent. Then Timber is stacked in a shed with free air circulation.

(ii) Artificial Seasoning:

In this method Timber to be seasoned is stacked in a chamber with regulated heat, controlled humidity, and proper air circulation. Seasoning can be completed in 4 to 5 days only. The method of Kiln Seasoning is discussed below.

Kiln Seasoning: Kiln is an airtight chamber. Timber to be seasoned is placed inside it. Hot air at 35°C to 38°C is forced in the kiln. The relative humidity is gradually reduced, and temperature is increased, and maintained till desired degree of moisture content is achieved.

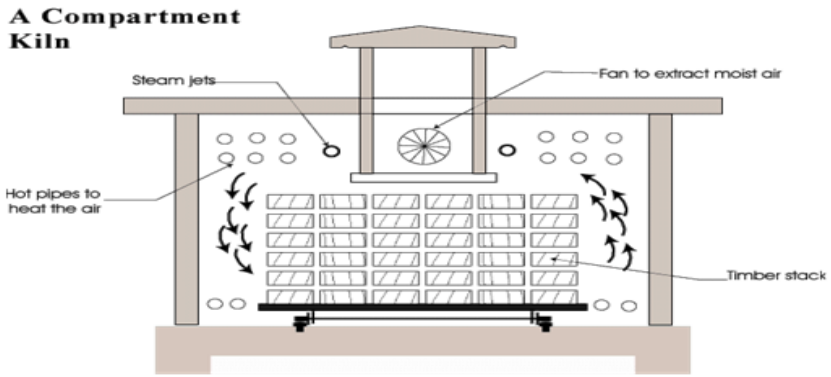


Fig. Artificial Seasoning

Advantages of Seasoning of Timber:

- Seasoning enhances strength.
- Reduces the weight of Timber and lessens the transportation and handling costs.
- Upgrades the electrical and thermal insulation properties of wood.
- Makes easy and ensures better results in wood working, machining, finishing and gluing. Paints and finishes last longer on dry Timber.
- Minimizes decay, fungal attack, larval attack and other such damages.
- Minimizes other seasonal defects such as Warping, Bowing, and Cracks etc. after use and ensures dimensional stability.

Comparison between hard and soft wood:

Soft wood	Hard wood
1. It is a resinous wood and has a fragrant smell.	It is a non-resinous wood with no fragrant smell.
2. It has wide fibers and smooth texture.	It has close fibers and relatively rough texture.
3. It is light in color and weight.	It is dark in color and heavy in weight.
4. The Annual Rings are quite distinct in it.	The Annual Rings are not so distinct.
5. It is relatively weaker and less durable	It is comparatively stronger and more durable.
6. It is easy to work with.	It is difficult to work with.
7. It catches fire easily and cannot withstand high temperature.	It doesn't catch fire easily can withstand high temperature.
8. Softwood trees have a faster rate of growth.	Hardwood trees have a slower rate of growth
9. Softwood trees don't shed leaves.	Hardwood trees shed leaves in autumn and winter.

Defects in wood: Defects in wood can be broadly classified into two categories:

(A) Natural defects:

1) Knots: Knots are the most common types of natural defects. As the tree increases in diameter it covers the bases of the lateral branches. The portions of the branches enclosed within the wood are called Knots. When live branch is enclosed it is called (a) Live Knot and when dead branch is enclosed it is (b) Dead Knot.

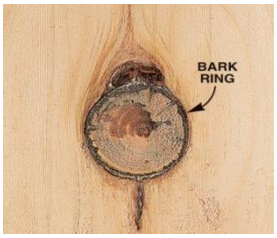
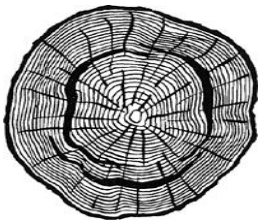
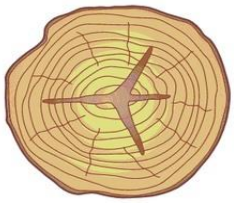


Fig. a: Live Knot **Fig. b: Dead Knot**

Knots spoil the appearance and reduce strength of wood. Knots also raise the chances of Seasoning defects and make wood working difficult.

2) Shakes: A separation of fibers along the grains of standing or freshly felled Timber is called Shakes. This forms crack or fissures that is generally confined to the interior part of the Timber but sometimes extend to the surface. When the cavities appear in between Annual Rings they are called Ring Shakes. These Shakes may be produced by excessive wind pressure. When the cavities are in a direction from Pith towards Sapwood, they are called Heart Shakes. Cavities originating from and extending towards the Pith are known as Star Shakes.





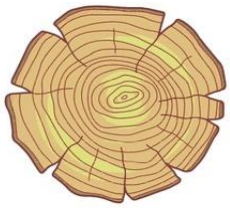


Fig. a: Cup & Ring Shake **Fig. b: Heart Shakes** **Fig. c: Star Shakes**

3) Cross Grains: This is general term depending upon the deviation of the wood fibers from a direction parallel to the longitudinal axis of the tree. This can be diagonal, spiral, or interlocked types in nature.

Cross / twisted grains **Rind Gall**

4) Rind Gall: At the places where branches are cut off a new Sap Wood grows which does not unite with the parent wood.

(B) Other than natural defects:

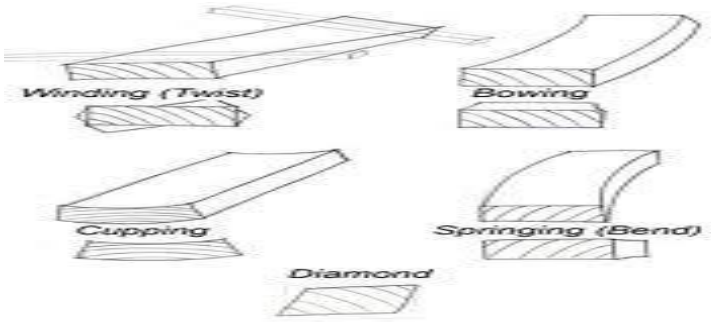
These defects include **(1)** Defects caused during Seasoning of Timber: Warping, Split, Shakes, Collapse, Case hardening, and **(2)** Defects resulting from activity of external agent (insects and fungii)

1. **Seasoning defects:** These are caused by faulty techniques of Seasoning.

Major types of Seasoning defects:

a) Case Hardening: During Seasoning, surface layer of wood usually dry before the interior layers and tend to shrink but they are prevented from doing so by the wetness of the wood. This situation is called Case Hardening. The case-hardened Timber is liable to Cupping, Warping and other forms of distortion.

b) Warping: The distortion in Timber causing departure from its original plane during Seasoning is called Warping. Warping can be Winding, Bowing, Cupping and Springing etc.



2. Defects caused by the external agents:

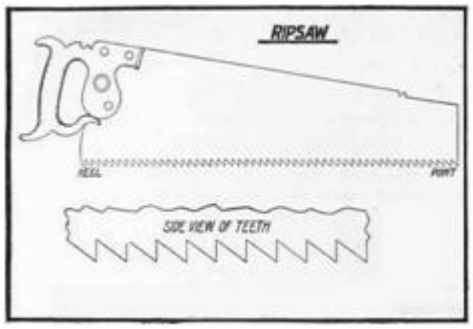
a) Stain: This defect is caused when fungus feeds on food materials stored in the Sapwood. However, fungi do not attack the Heart wood and does not affect strength of wood.

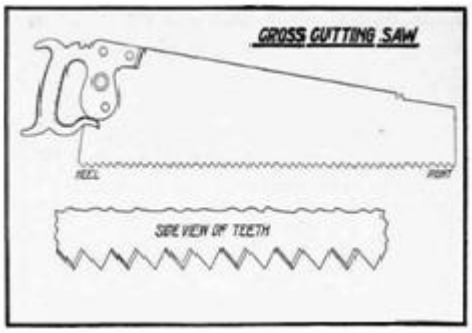
b) Decay: It is rotting of Timber due to fungi. Fungi attack both Sapwood and Heartwood and reduce strength of Timber.

Carpentry Tools:

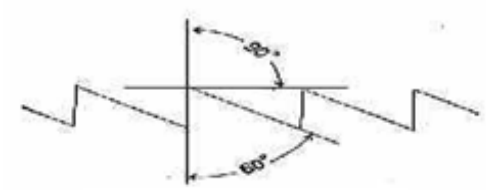
(A) The common Saws:

1) Rip Saw: A Rip Saw is an aggressive, push stroke handsaw with sharpened teeth top. It is used to cut along the grains. Its saw length varies from 60 to 70 cm with 5 to 7 teeth per 25 mm. All Saws blades are made of spring steel.

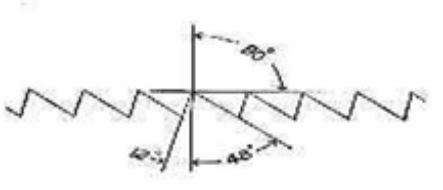




2) Cross Cut Saw: A Crosscut Saw is a general term for any saw blade for cutting wood perpendicular to the grains. Its design allows the Saw to cut on both the push and pull stroke. Its saw blade ranges from 55 to 70 cm with 8 to 12 teeth per 25mm.



Rip Saw Teeth



Gross Cut Saw Teeth

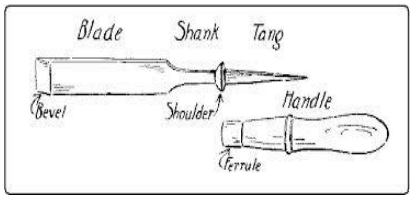
3) Back Saws: Back Saws got their names from its reinforced upper edge to prevent it from buckling during use. It has teeth as in Cross Cut Saw but smaller to achieve a fine cut. The various subtypes of Back Saw are the Mitre Saw; Dovetail Saw, and Tenon Saw. Back Saw blade size can range from 20 cm to 40 cm.

Tenon Saw.

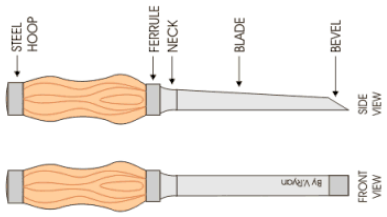
4) Keyhole Saw: The Keyhole Saw is good for cutting holes for pipes, electrical outlets, or fixtures in floors, walls, and ceilings. Its narrow, tapered blade goes where other saws can't. Its teeth are like that of Cross Cut Saw.

(B) The common Chisels:

1) The Firmer Chisel: It is one of the main chisels used in woodworking. It is used for taking wide and finishing cuts on surfaces in grooves. The blade has a rectangular cross section and width varies from3 to 38 mm. All Chisels are made up of High Carbon Steel.



Firmer Chisel

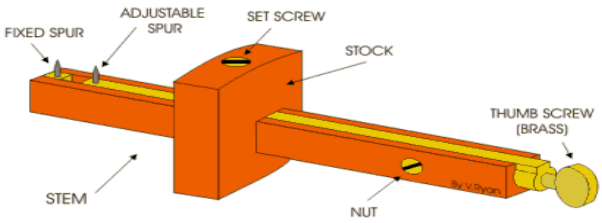


Mortise Chisel

2) The Mortise Chisel: They are particularly useful for cutting Mortise Joints as they are strong enough to withstand heavy blows with a Mallet. Thickness of blade varies from 6 to 15 mm and width is up to 15 mm

(C) The Marking Tools:

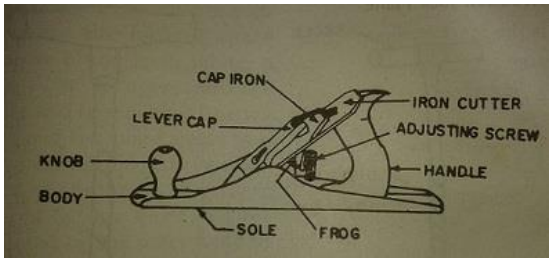
1) The Mortise Gauge: The Mortise Gauge is a special type of Marking Gauge, and it is used to mark wood so that a Mortise can be cut into it.



2) The Marking Gauge: A Marking Gauge is used to mark a line parallel to a straight edge. It is similar to Mortise Gauge except that it has no adjustable spur.

(D) Planing Tools:

1) Iron Jack Plane: It has a Cast Iron body and is heavier than the Wood Block Plane. It is easier to hold down on the surface of the wood being planed. It is used to plane longer pieces of wood.



(E) Miscellaneous Tools:

1) Rasp File: It is a tool used for shaping wood or other material. Rasps generally cut more coarsely than files. All files are made of High Carbon Steel.

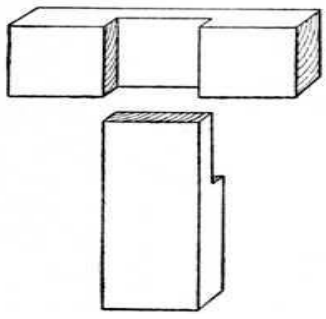
3) Claw Hammer: A Claw Hammer is a tool primarily used for pounding nails into, or extracting nails from wood. Like other hammers it is also made up of Cast Steel.

Carpentry Joints:

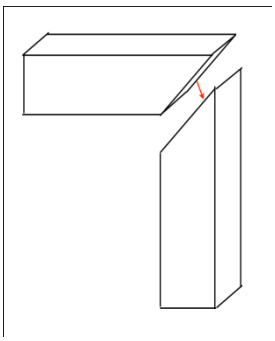
i) T-Lap joint: A **half lap joint** is a technique of joining two pieces of material together by overlapping them. A lap may be a Full Lap or Half Lap. Most commonly in half lap joints, the members are of the same thickness and half the thickness of each is removed.

ii) Mitre Joint: A **Mitre Joint** is made by beveling each of two parts to be joined, usually at a 45° angle, to form a corner; usually a 90° angle. Common applications include picture frames and molding.

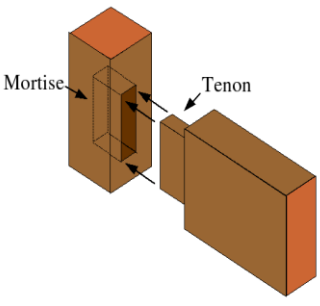
iii) Mortise and Tenon Joint: The Tenon will fit tightly into a hole cut for it (the Mortise). This is the traditional method of jointing frame and panel members in doors, windows, and cabinets.



(i) Lap Joint joint



(ii) Mitre joint



(iii) Mortise &Tenon joint

<u>Practical Exercise No. 1.1:</u>

Aim: To make a Mortise & Tenon Joint from soft wood in carpentry shop.
Material Used: Soft wood piece of 240X42X36 mm.
Tools Required: Steel Rule, Try Square, Marking Gauge, Rip Saw, Tenon Saw, Iron jack plane, Firmer Chisel, Cross Peen or Claw Hammer etc.

Procedure:

1. Grip the wooden piece in Carpentry Vice.

2. Plane one broad Surface of the wooden piece and check its trueness using a try square.

3. Then plane the adjacent narrow surface and check its trueness and squareness using a Try Square.

4. Likewise, Plane the remaining two surfaces and check the squareness of all the surfaces with their adjacent surfaces and check for dimensions 40 mm & 30 mm.

5. Mark mid line on the work piece and name two halves as A & B by writing, and cut from the mid line to have Mortise and Tenon as separate parts.

6. Do Marking for the Mortise in the half marked ‘A’ with the help of a mortise gauge as per the given dimensions.

7. Using Mortise Chisel & Mallet, cut out Material throughout the depth; use firmer chisel to maintain width of the Mortise.

8. Clean all sides of the Mortise using Rasp file if required; and take care that the dimensions of the mortise are as per sketch.

9. Now do marking on the half marked ‘B’ for making a Tenon as per the sketch.

10. Hold the piece in the Carpentry Vice, and use a Tenon Saw cut away unwanted material from the piece 'B' to get the Tenon part.

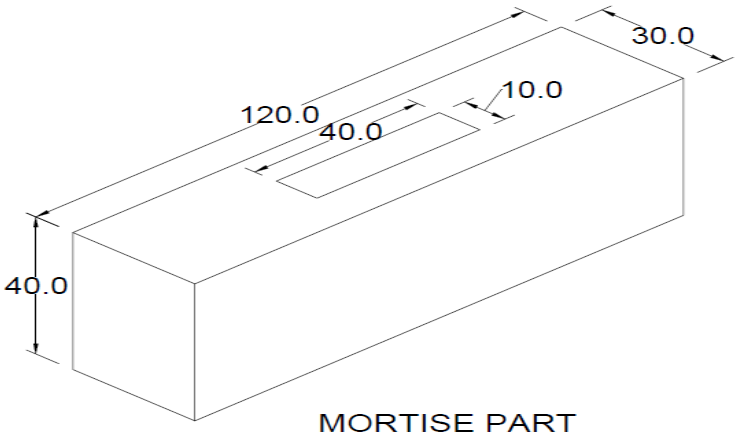
11. Clean the Sawn faces of the Tenon using a Rasp File and Sand paper, then try assembling Tenon with the Mortise part.

12. Smoothen the surfaces of Mortise and Tenon using Rasp file if you find the assembly to be too tight, then make final assembly as per the sketch.

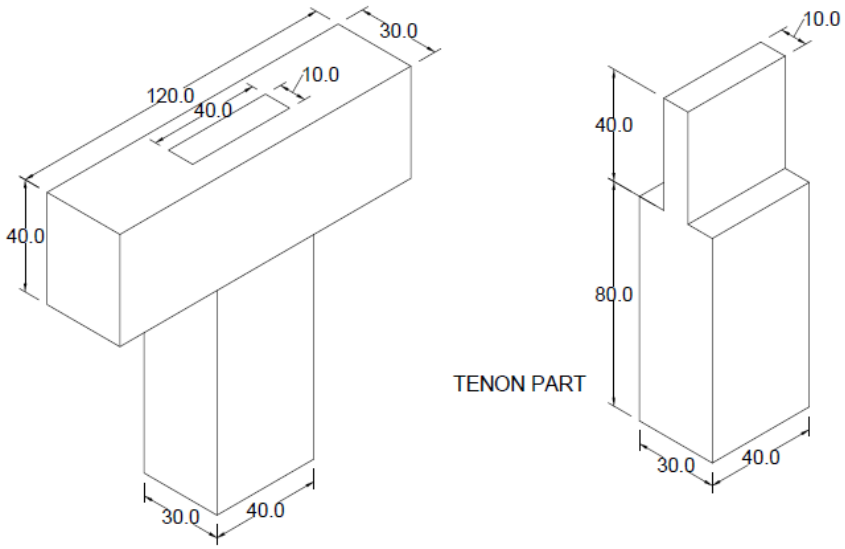
13. Note that the joint should be a close fitting one as over tight assembly may rip apart the Mortise.

14. Finally use an emery paper to polish the assembled joint.

Job Sketch:



MORTISE PART



Observations:

Measuring Instrument Used	Required Dimensions (mm)	Actual Dimensions (mm)
Steel rule	Mortise Length 120mm	
Steel rule	Mortise Width 30mm	
Steel rule	Mortise Height 40mm	
Steel rule	Mortise 40X10mm	
Steel rule	Tenon Length 120mm	
Steel rule	Tenon Width 30mm	
Steel rule	Tenon Height 40mm	
Steel rule	Tenon 40X10mm	
Try Square	Perpendicularity	
Visual	Over all finish	
Visual	Type of fit	

Actual Job Snap:

Lab Instructor (Sign.) Teacher (Sign.)

Sample Viva questions with Answers for Carpentry Shop:

1. What is the difference between Wood and Timber? ***Wood for engineering purposes obtained from full grown exogenous trees becomes Timber when converted into commercial sizes after Sawing.***
2. Name some common Timber names for standard shapes and sizes. ***Balk, Post, Deal, Plank, Board, Batten and Scantlings etc.***
3. What is Wood Seasoning? ***The process of removing moisture from the wood.***
4. What are the methods of wood Seasoning? ***(i)Natural Seasoning (ii) Artificial Seasoning.***
5. Characteristics of Soft Wood. ***Light in color, light in weight, having aromatic smell, easy to work with.***
6. Characteristics of Hard Wood. ***Dark in color, heavier in weight, having no smell, difficult to work with.***
7. What is Plywood? ***Artificial wood made in three layers.***
8. What is Particle Board? ***Simply put, particle board is a waste-wood product made by heat pressing wood chips, sawmill shavings or even sawdust and resin together.***
9. What is MDF Wood? ***MDF stands for medium-density fiberboard, which is an engineered wood composite made up of wood fibers.***
10. Name some Hard Wood Trees found in India. ***Shisham, Neem, Kikar (Acacia Arabia), Mulberry and Mango***
11. Name some Soft Wood Trees found in India. ***Chir, Kail, Deodar, Fir etc.***

12. Where do you find Hard Wood Trees? ***In plain areas***

13. Where do you find Soft Wood Trees? ***In mountainous areas.***

14. In what units Timber is sold? ***Timber is sold in cubic feet or cubic meters.***

15. Classify Carpentry Tools. ***Holding Tools, Measuring Tools, Marking Tools, Sawing and Cutting Tools, Plaining Tools, Drilling and Boring Tools.***

16. Classification of Timber defects***. (i) Natural defects, due to abnormal growth (ii) Defects occurring during Conversion and Seasoning (iii) Defects caused by Fungi and Insects.***

17. Name some natural defects***. Knots, Shakes, Twisted fibers, and Rind Galls***

18. Name some defects occurring during Seasoning. ***Twisting, cupping, bowing warping, end splitting, case hardening and honey combing.***

19. Name some marking and measuring tools***. Carpenter's folding rule, steel rule, measuring tape, try square, bevel square, scriber, marking gauge, mortise gauge etc.***

20. Name some holding tools. ***Carpenter's vice, bench hook, bar cramp, C- clamp etc.***

21. Commonly used saws in carpentry shop***. Rip saw, panel saw, compass saw, crosscut saw, keyhole saw, Tenon saw, dove tail saw and bow saw***

22. Name some chisels used in Carpentry Shop***. Firmer Chisel, Mortise Chisel, Gouge Chisel, Socket Chisel.***

23. Chisels are made up of High Carbon Steel (HCS)

24. All Carpentry saw blades are made up of Spring Steel.

25. Planning tools***. Wooden jack plane, Iron jack plane, Trying plane, Smoothing plane, Rebate plane etc.***

26. Name some boring tools***. Auger, gimlet, bradawl, ratchet brace etc.***

27. Name some striking tools***. mallet, claw hammer***

28. Some misc tools***. Screwdriver, pincer, rasp file, axe, side axe, and adze.***

29. Classification of carpentry joints. ***lengthening joints, widening joints, framing joints, box joints, circular joints***

30. Some very common joints***. Mortise and Tenon joint, Mitre joint, grooved joint, Dowel joints, Dove tail joint.***

31. Carpentry joint used in doors and windows is ***Mortise and Tenon joint.***

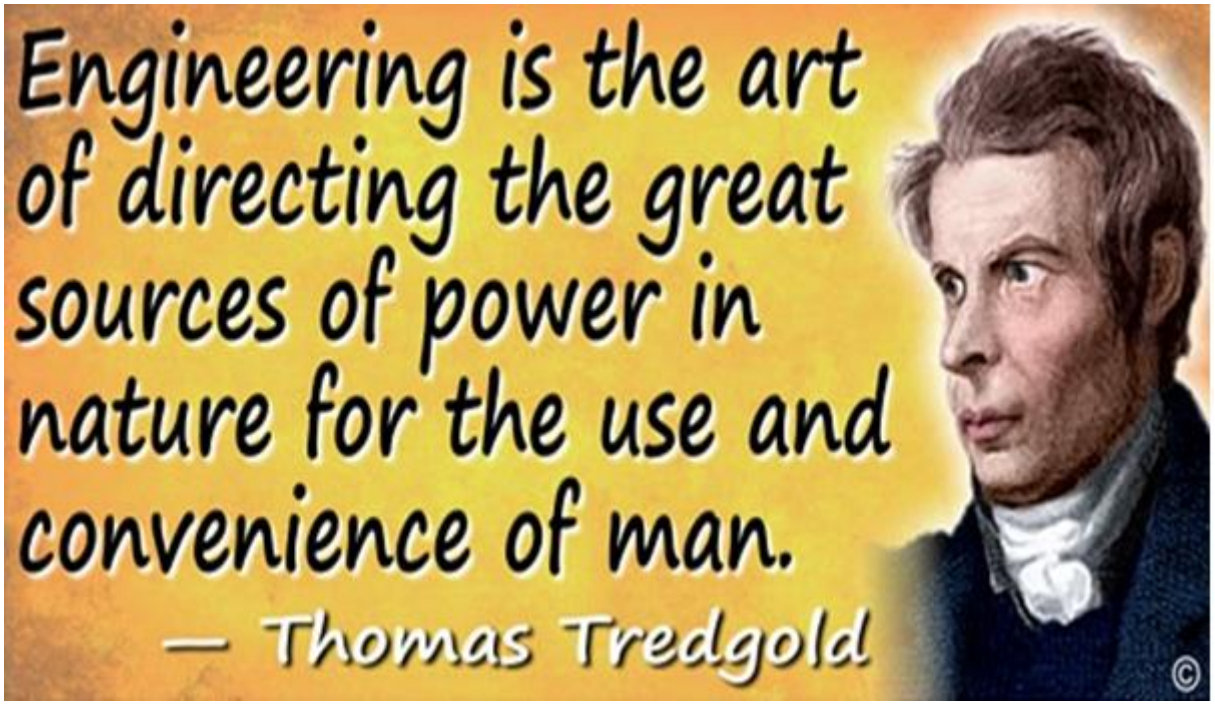
32. Joint used in boxes having bursting load is ***Dove Tail joint.***

33. Joint used in photo frames is ***Mitre joint***

34. Some wood working machines are ***Universal Wood Working M/C, Band Saw, and Wood Turning Lathe etc***.

35. What is water stone used for? ***Re sharpening of Carpentry Tools.***

FITTING SHOP



Fitting Shop:

SAFETY PRECAUTIONS:

1. Always wear the Apron and closed shoes in the Shop.
2. Do not wear any necktie, jewelry, rings, and watches during working in the shops.
3. Do not play with the tools because they are sharp.
4. All Files should be fitted with suitable handles.
5. When using chisel its direction should be kept away from other working persons.
6. When filing apply force in forward stroke only and vice versa.
7. When using Hacksaw see that its blade is fitted to cut in forward Direction with requisite Tension.
8. Handle measuring instruments like Micrometer, Vernier Caliper, Dial Indicator and Height Gauge etc. with due care.
9. While tapping, do not apply excessive force, it may break the Tap.
10. Clean up oil and grease or other liquid which spills on the floor last they may be a cause of accident.
11. Do not drop metal pieces on Surface Plate.

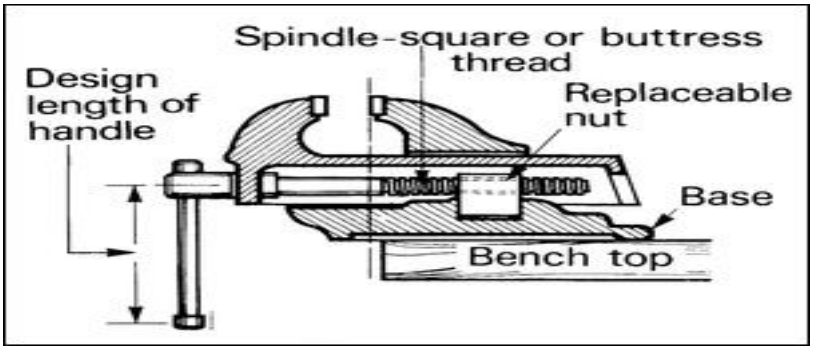
Introduction to Fitting Work: It is an assembling of parts in industrial enterprises. Fitting may also be required as a part of the repair and adjustment work done on machines and their sub-assemblies in repair shops.

Fitting Shop: It is the Shop where fitting work is carried out manually and includes Filing, Threading, Bending and Straightening, Drilling, Countersinking, Reaming, Lapping, and Riveting etc.

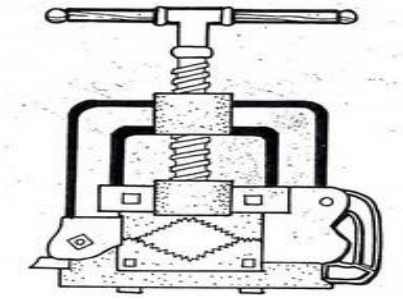
Tools used in the Fitting shop:

(A) The holding tools:

The Bench Vice: It is the most common type of vice used in the Fitting shop. It is used to clamp metal instead of wood. It is typically made of Cast Steel or malleable Cast Iron. The jaws are often separate and replaceable, usually engraved with serrated or diamond teeth. An Engineer's Vice is bolted onto the top surface of a workbench.



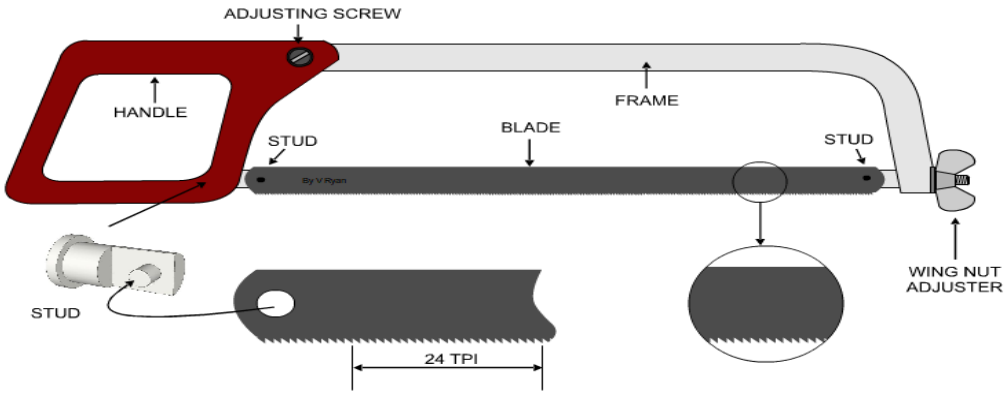
The Pipe Vice: It is used to hold small diameter pipes for Cutting and Threading etc.



The Hand Vice: it is used to hold small work pieces for filing and drilling which are otherwise difficult to hold.

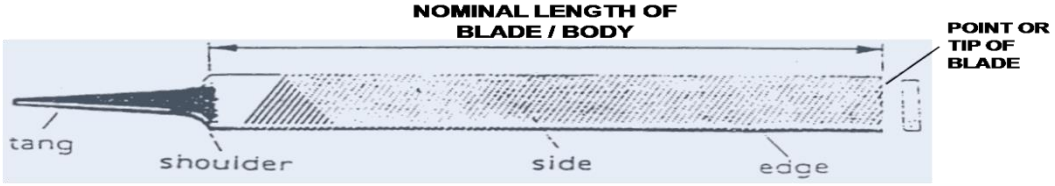
(B) The Cutting Tools:

The Hacksaw: It is used for cutting of rods, flats etc. The blade of the hacksaw is made up of high carbon steel or high-speed steel and 12" long blade is used in fixed frame hacksaw. The blade is placed inside the frame and is tightened with the help of wing nut. The teeth of blade are forward cut.



Files: Files of different types are the principal cutting tools used in the fitting shop. Files are generally made of high carbon steel.

a) Parts of a File:



b) Classification of files: files are classified according to

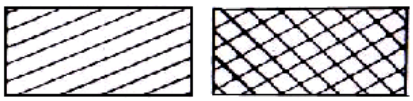
i. Length varying from 10 cm to 40 cm.

ii. Shape i.e., flat, round, half round, knife edge, square file etc.

iii. Grade i.e., rough, bastard, second cut, smooth, dead smooth

iv. Cut i.e., single cut, double cut

c) Cut of a File: These cuts are selected according to the material of the work piece, the desired removal of material and the surface finish.



Single Cut Double Cut

d) Grade of a File: Grade of a file means no of teeth per unit length. As per grade files are classifies as

i. Rough file having 8 teeth/cm

ii. Bastard file having 12 teeth/cm

iii. Second cut file having 16teeth/cm

iv. Smooth file having 20-24 teeth/cm

v. Dead smooth file having 40 or more teeth/cm

e) Some common types of Files

i) FLAT FILE: Used for general filing of metals such as Steel. They are rectangular in section and are the most common type of file used in workshops.

ii) HALF ROUND FILE: Used for filing curved surfaces. A normal hand file with its flat cutting edges is unsuitable for filing curved surfaces. However, the half round file has a curved surface which is especially useful for filing internal curves.

iii) THREE SQUARE FILE: Is triangular in section and very useful when filing 'tight' corners / angles. The sharp edges allow the file to fit into corners when filing.

iv) KNIFE EDGE FILE: Knife files are very useful when filing where there is little space. Knife files are very thin and can fit into small gaps.

v) SQUARE FILE: The square file is quite thin and fits into corners well. They can be used to file slots in metal or for filing where there is little space.

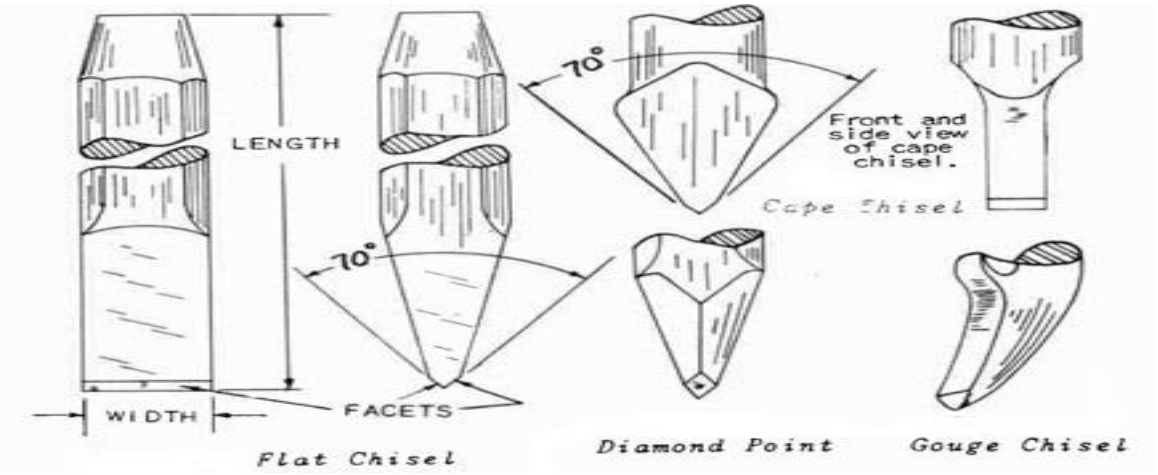
Cold Chisels: There are four common types of cold chisel.

i) The F**lat Chisel**, the most widely known type, which is used to cut bars and rods to Reduce surfaces and to cut sheet metal which is too thick or difficult to cut with tin Snips.

ii) The C**ross Cut chisel/Cape chisel** is used for cutting grooves and slots. The blade narrows behind the cutting edge to provide clearance.

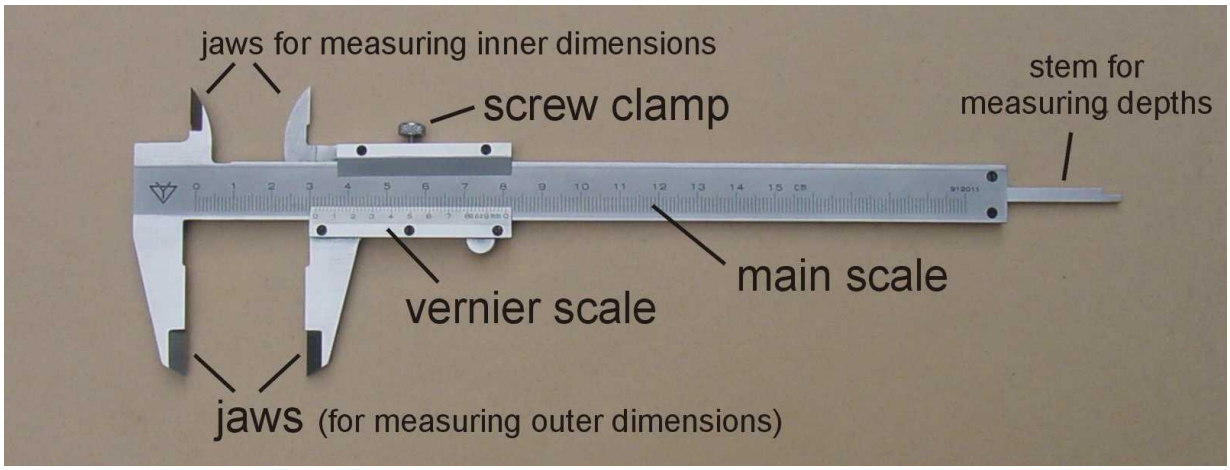
iii) The R**ound Nose Chisel** is used for cutting semi-circular grooves for oil ways in Bearings.

iv)The Diamond Point Chisel is used for cleaning out corners or difficult places and pulling over centre punch marks wrongly placed for drilling.



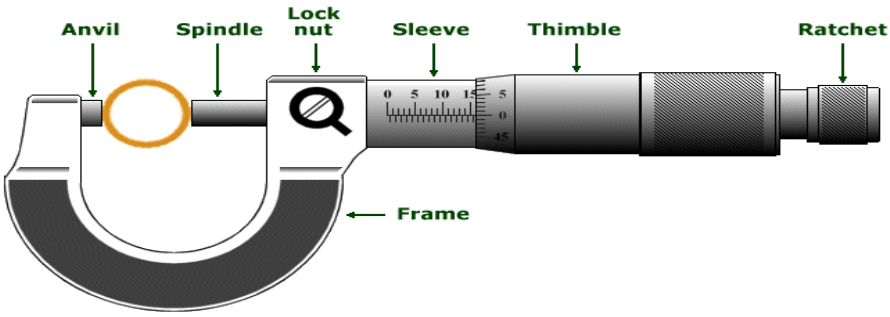
(C) The Measuring and Marking Instruments and Tools:

i) Vernier Caliper: It is a precision instrument used for measuring lengths and diameters. It can be used for measuring internal and external dimensions. The least count of Vernier Caliper is 0.02mm. Generally, the material of all parts is stainless steel.



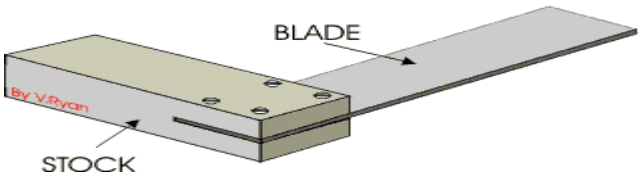
ii) Micrometer: A **micrometer** also known as a S**crew Gauge** is a device having a calibrated screw widely used for precise measurement of components in mechanical engineering. The three most common types of micrometers; are

- **Outside Micrometer** used to measure wires, spheres, shafts, and blocks.
- **Inside Micrometer**, used to measure the diameter of holes.
- **Depth Micrometer** used to measure depths of slots and steps.

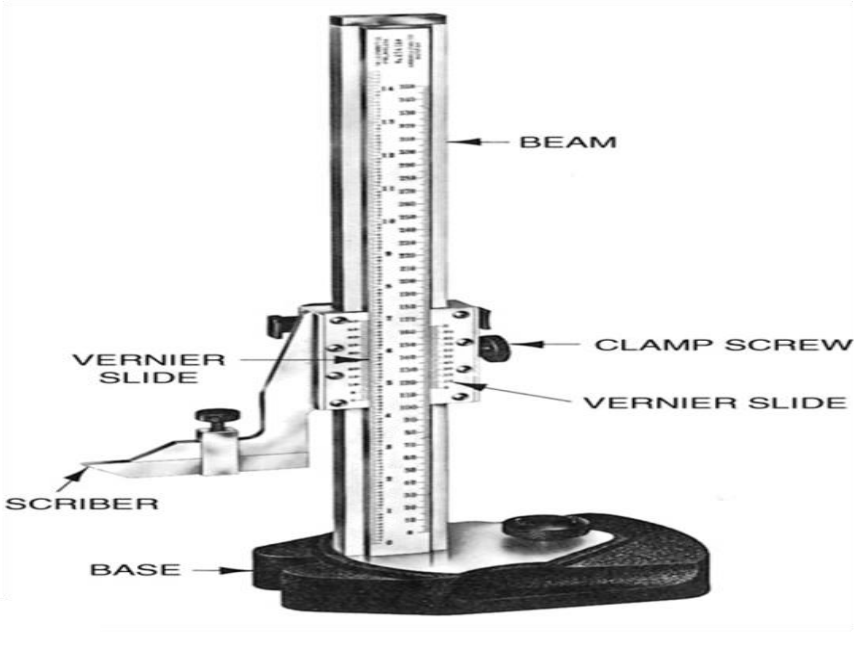


An outside Micrometer

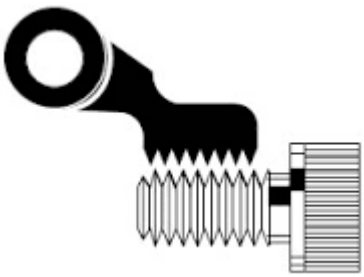
iii) Try Square: it is used to measure 90^{o}angle.

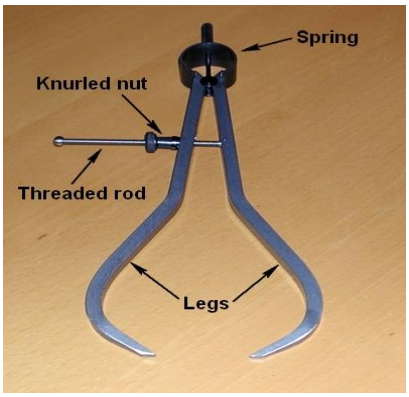


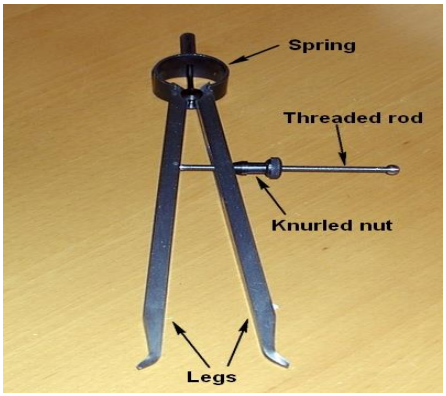
iv) Height Gauge: It is used for marking lines on a work piece at specific height and to measure the height of work piece. It is always used by placing it on surface plate. The base of the height gauge is made up off cast iron and the beam is made up of stainless steel.



v) Thread Pitch Gauge: it is used to check pitch of the thread on the nuts and bolts.





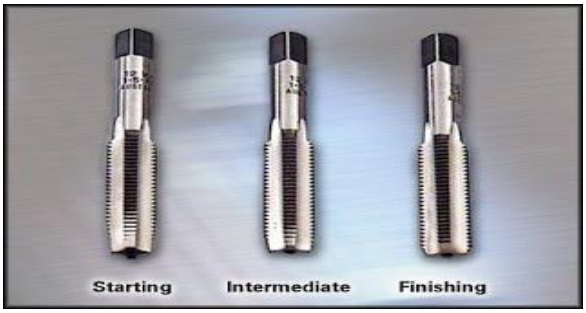


vi) The Outside Spring Caliper: are used for measuring external dimensions such as the length, diameter, or even the thickness of a solid.

vii) The Inside Spring Caliper: These are used for measuring internal dimensions such as the diameter of a hole, or the width of a slot etc

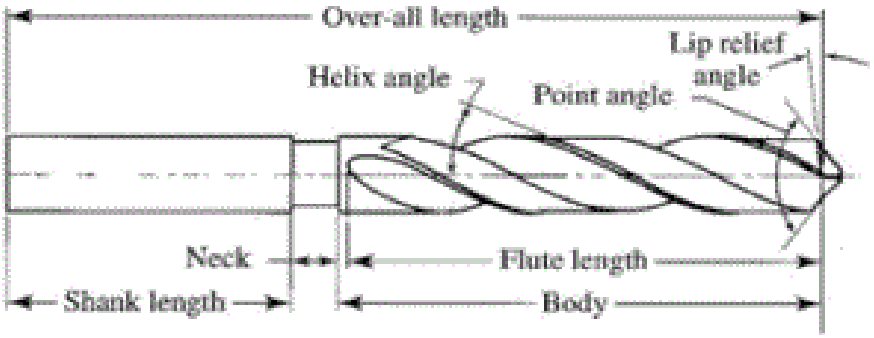
(C) Some Other Important Tools and Devices:

i) Taps: Hand taps are used for making internal threads in the Fitting Shop. The hand taps come in a set of three pieces. The taps are used in a sequence of starting, intermediate, and finishing.

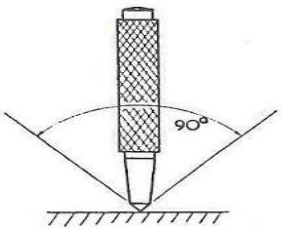


ii) Surface Plate: It is used for testing the flatness, trueness of the surface. It is made up of cast iron or granite. Its upper face is flat to form a very smooth surface. This plate is used as a base for V-block, sine bar etc. and other measuring instruments during measurement.

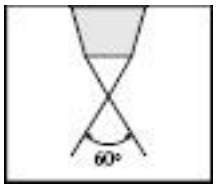
iii) Twist drill: The tool used for making new round holes or to enlarge the premade holes is called a twist drill. It is made up of high-speed steel.



iv) Centre Punch: It is used to mark the centre of a hole before drilling. It is made up of high carbon steel. One end is sharpened; Hammering is done on the second end while working. Angle of the punching end is 90^{o}.



Centre Punch



Dot Punch

v) Dot Punch: It is like a Centre Punch except that the angle of the punching end is 60^{o}. It is used for marking dotted lines.

Practical Exercise No. 1.2:

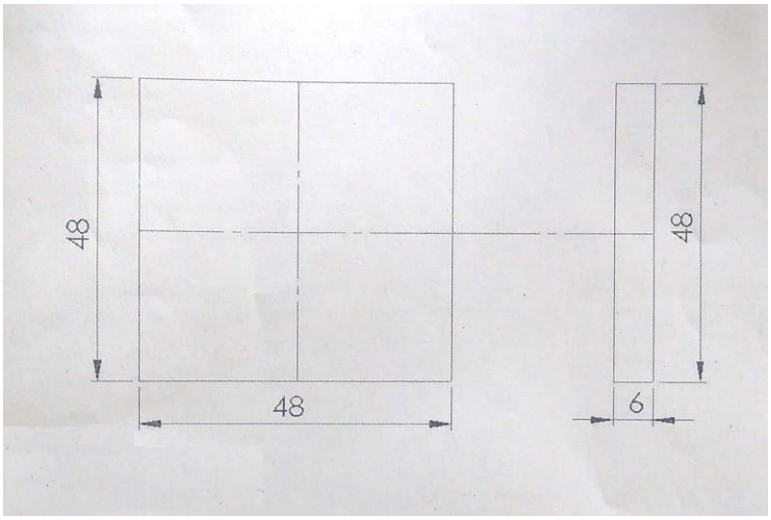
Objective: To make a job to controlled dimensions, involving different operations like, marking, measuring, punching, hack sawing, filing, drilling and tapping & Radiusing etc.

Tools and equipment used: File, Hand hacksaw, Bench Vice, Twist Drill, Try Square, Drilling Machine, Surface Plate, Angle Plate, Vernier Caliper, Vernier Height Gauge, Round File, Half Round file, Dot Punch, Triangular File & Hammer.

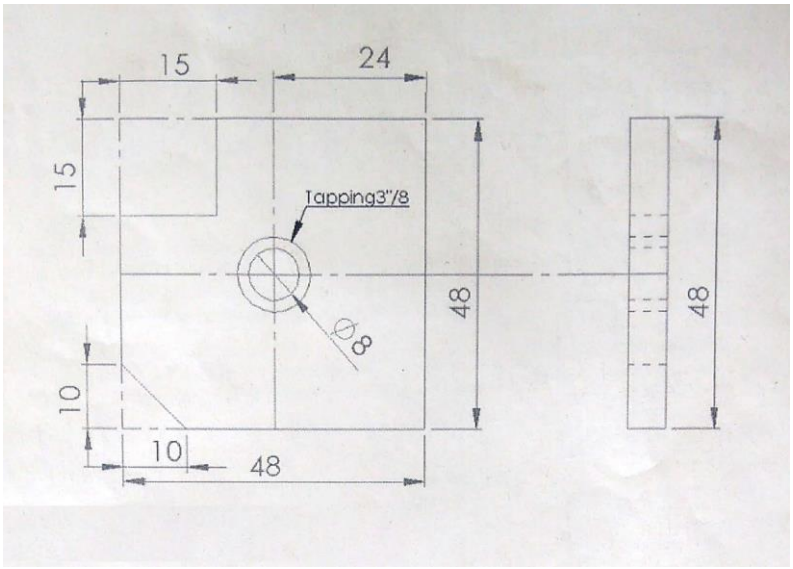
Material required: Mild Steel flat 50x50x6 mm.

Procedure:

1. Cut a work piece of 50x50mm from the given flat using Hand hacksaw.
2. Hold it in Bench Vice and file two adjacent sides. Check that these two sides are at right angle.
3. Mark for dimensions 48x48mm, using a height gauge, taking the two filed sides as reference.
4. Use prick punch to firm up the marking lines.
5. File all the four sides to the size 48x48mm and check for the squareness of the sides.
6. De burr all the sharp corners.



7. Do marking for the inclined cutting, square cutting and the tapped hole using Height Gauge.
8. Drill a tap hole of size 8mm using the Bench Drilling Machine.
9. Do tapping in the hole using a tap of size (3/8").
10. Deburr and finish using a second cut file.



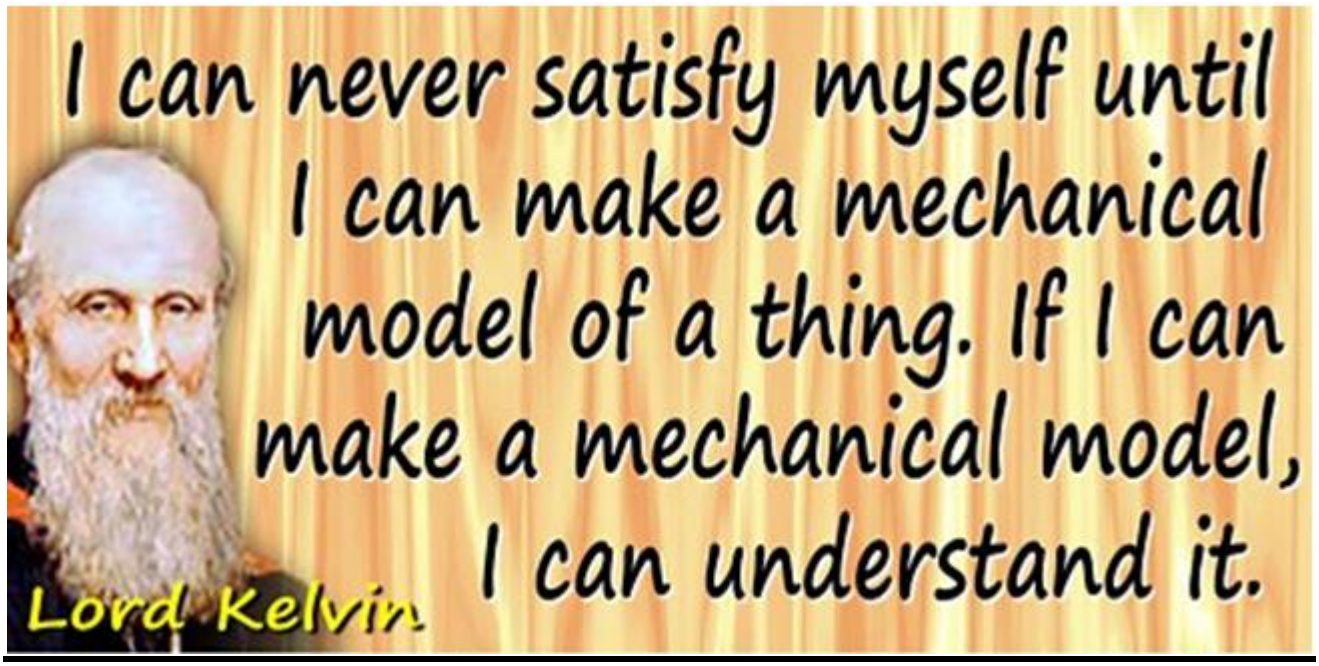
Observations:

Designed Parameters	Observed parameters	Measuring Instrument Used
Length 48mm		Vernier caliper
Width 34 mm		Vernier caliper
Thickness 6mm		Vernier caliper
Flatness of the sides		Vernier caliper
Perpendicularity of the sides		Try Square
Overall finish		Visual

Sample Viva questions with Answers for Fitting Shop:

1. What is the Material of Hacksaw blade? ***HCS/HSS***
2. Classify tools used in the Fitting Shop***. (i) Holding tools (ii) marking and measuring tools (iii) cutting tools and (iv) striking tools.***
3. Surface plates are made of***. Grey Cast Iron or granite***
4. Name some holding tools***. Bench vice, hand vice, pin vice, pipe vice and machine vice.***
5. Name some measuring instruments used. ***Vernier height gauge, Vernier Caliper, micrometer, bevel protractor.***
6. Most important cutting tool in Fitting Shop is. ***A File***
7. Files are made up of***. High Carbon steel (HCS)***
8. How to classify a File. A File is classified ***according to its (i)length(ii)shape(iii)grade(iv) cut***
9. Operation of making internal threads in the Fitting Shop is called. ***Tapping***
10. Operation of making external threads in the Fitting Shop is called. ***Dieing***
11. Which is the first standardized thread system in the world. ***British standard Whitworth (BSW) thread.***
12. Who standard the BSW thread? ***Sir Joseph Whitworth of England.***
13. Difference between Iron and steel. ***Iron is an element soft and low in strength. Steel is an alloy of Iron, carbon, and other alloying elements.***
14. What is mild steel? ***Steel with carbon up to 0.25%***
15. What are different chisels used***. Flat chisel, crosscut chisel, diamond chisel etc.***
16. Thread size M12 means***. Metric thread having 12mm major diameter with standard pitch.***
17. What are the important thread parameters? ***Major diameter, Minor diameter and Pitch are the important thread parameters.***
18. How to check pitch of a thread? ***By using a thread pitch gauge.***
19. What is the use of a Feelers Gauge? ***It is used to check gap between to mating surfaces.***
20. What is drilling? ***Making new hole or enlarging the premade hole using a multipoint cutting tool called Twist Drill.***
21. What is reaming? ***Operation of correcting the size and geometry of drilled hole using a cutting tool called Reamer.***
22. Size of Hole drilled before tapping ***Tap hole size.***
23. ***What is tap hole size for M12. It is (major dia.-pitch) i.e.,12.00-1.75=10.25mm***
24. Different methods of filing***. (i)straight filing(ii)Cross filing(iii)draw filing.***
25. File used for wood working***. Rasp file***
26. Function of a surface plate***. To check flatness of a surface.***
27. What is center punch***? Punch used to mark center for drill to take exact position.***
28. Point angle of center punch***.90deg.***
29. Prick punch/dot punch***. Punch to mark dots for marking on a job.***
30. A chisel is specified by its***. (i) length (ii) width of cutting edge.***
31. What is meant by a grade of a file? ***no. of teeth /unit length***
32. Name some files as per shape***. Flat file, round file, square file, half round file, knife edge& triangular file.***
33. What is safe edge file***? A file having no teeth on its edges.***
34. What is the concept of interchangeability? ***The ability to select components for assembly at random and fit them together within proper tolerances.***
35. *What is engineering tolerance*? ***It is the permissible limit of variation in a physical dimension.***

SHEET METAL SHOP



Sheet Metal Shop:

SAFETY PRECAUTIONS:

1. Handle sheets very carefully. Sharp edges can cause cuts and even serious injuries.
2. Do not drop sheet shavings on the ground. These can penetrate shoes and cause injuries.
3. Wear closed shoes with rubber sole in the sheet Metal shop.
4. Use soft hammer or mallet to work upon sheets, hard hammers can damage or even cut the sheets.
5. Never do excessive hammering of sheets it can cause warping.
6. Use sharp scriber for marking, use of pencil should be avoided.
7. Keep checking the dimensions from time to time during layout marking and shearing.
8. Use appropriate stake for your work.
9. Make sure your work is not affecting others.
10. Seek medical care in case of cut or injury immediately.
11. Keep your mind engaged.

Introduction: Sheet metal is a metal formed by industrial processes into thin, flat pieces normally called sheets. It is one of the fundamental forms used in metalworking and can be cut and bent into a variety of shapes. Countless everyday objects are constructed from sheet metal. Thicknesses can vary significantly; extremely thin thicknesses are considered foil or leaf, and pieces thicker than 3 mm are considered plate. Sheet metal is available in flat pieces or coiled strips. Sheet metal is used for car bodies, airplane wings, medical tables, and roofs for buildings, air conditioning ducts, tubs, funnels, storage tanks and many other

applications. Sheet metal of iron and other materials with high magnetic permeability, also known as laminated steel cores, has applications, in transformers and electric machines.

Types of sheets used in sheet metal shop:

Ferrous Sheets: These are two types

a. Coated Sheets:

i. **Galvanized Iron Sheet:** It is an Iron sheet coated with zinc.GI Sheet is used for making of AC Ducts, Buckets, and boxes etc.

ii. **Tin sheet:** It is an Iron sheet coated with Tin. It is used for making Tooth paste tubes, Coca Cola cans and containers for edible oil and ghee etc.

b. Uncoated Sheets:

i. **Black Iron Sheet (mild steel sheet):** It is used for making almirahs, water tanks, agricultural parts, vehicle bodies and refrigerator bodies etc.

ii. **Stainless Steel sheet:** SS sheet is used for making Kitchen Ware, machinery and containers for food industry and chemical industry.

Non-Ferrous Sheets:

i. **Aluminum Sheet:** Due to its light and resistance to corrosion it finds applications for making airplane bodies, doors, and windows, cook ware and fancy fitting etc.

ii. **Brass Sheet:** Due do its ability of getting bright shine it is used for making scientific equipment and models, fancy fitting, and utensils etc.

iii. **Copper sheet:** Copper being the very good electrical conductor it is used for making contacts in switches, thermostats, electrical appliances and as a base in cook ware due to it better thermal conductivity.

iv. **Lead Sheet:** It is for making containers for storing and transportation of acid and very reactive chemicals.

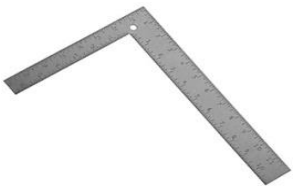
<u>Tools used in sheet metal Shop</u>:

(a) Marking and measuring tools:

i) Steel Rule: It is basic a instrument for general measurement of linear dimensions and to draw the lines.

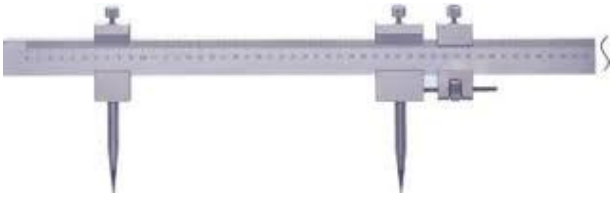
ii) Scriber: It is used to mark thin lines on sheets.

iii) Tin Mans Square: It is Try Square having uniform thickness.



iv) Wing Compass: It is used for drawing arcs and circles on sheets.

v) Trammel Points: It used to mark large circles on the sheets.



vi) Standard Wire Gauge: It is used to measure the thickness of sheet and diameter of wire.

(b) Striking Tools:

i) Riveting hammer: It is used for heading the rivets in riveted joints.


ii) Raising hammer: This hammer features two wide, flat rectangular faces designed to create seamless forms in metal without thinning.

iii) Mallet: It is the soft faced striking tool used for working on sheets.

(c) Punching cutting and shearing tools:

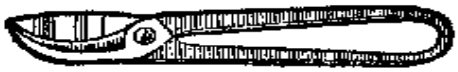
i) Hollow punch: It is used for making circular holes in sheets.


ii) Solid punch: It is used for making small circular holes in sheets.

iii) Flat Chisel: It is used for cutting Sheet, Rivets and Bolts etc. Its cutting-Edge angle is 40-45°. Flat Chisel is made of high carbon steel (HCS).

iv) Straight snips: It is used for cutting along a straight line.

v) Bent snips; It is used for cutting along a curvature.


vi) Lever Shearing Machine: It is used to cut long sheets.

(c) Supporting tools:

Stakes: These are very useful group of tools used to form sheet metal into various shapes. They work as supporting cum forming tools. Some of these tools are explained below:

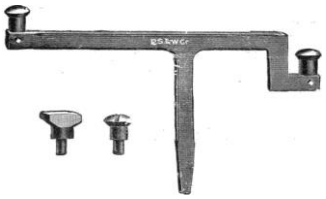
i) Bick iron: It is used in forming long tapered cylindrical items.


ii) Hatchet stake: It is used for forming, bending, and seaming of the edges.

iii) Funnel stake: It is used for making conical items.

iv) Half-moon stake: It is used for working on the edges of the discs.

v) Pipe stake: It is used for forming tubes and cylindrical jobs.



vi) Horse head stake: It is used for bending and general work for supporting & holding other stakes

Sheet Metal joints: It is the process of joining sheet metal parts together by various means. Different joints are used to join parts depending upon the requirement.

i) Lap joint
ii) Seam joint
iii) Locked seam joint
iv) Hem joint
v) Wired edge joint
vi) Cup or circular joint
vii) Flanged joint
viii) Angular joint
ix) Cap joint

Sheet Metal operations:

i) Laying out: It means operation of scribing the development of surface of the product on the sheet together with the added allowances for overlapping, bending and hammering etc.

ii) Cleaning: It is the process of cleaning the sheet by mechanical and chemical means. It is required for proper working and handling.

iii) Marking and measuring: It is done to draw the dimensions of the Layout on the sheet.

iv) Cutting and shearing: It is the process for cutting the marked part from the sheet.

v) Edge forming and wiring: The edges of a sheet metal parts are formed for safety of hands to provide stiffness. For still stronger edges they are reinforced by inserting a wire and then forming the edge around it.

vi) Joint making: It is the process of joining sheet metal parts together by various means.

vii) Bending: It is the process to give different angles and curvatures to the sheet for the require form.

viii) Soldering and brazing: Soldering is method of joining sheet metal parts with the help of a low melting point alloy called Solder. Brazing uses an alloy called Spelter to joins sheet metal parts. Brazing is stronger than soldering.

Practical Exercise No. 1.3 :

Objective: To make a Rectangular Tray.

Raw Material: G.I. sheet of 28 SWG.

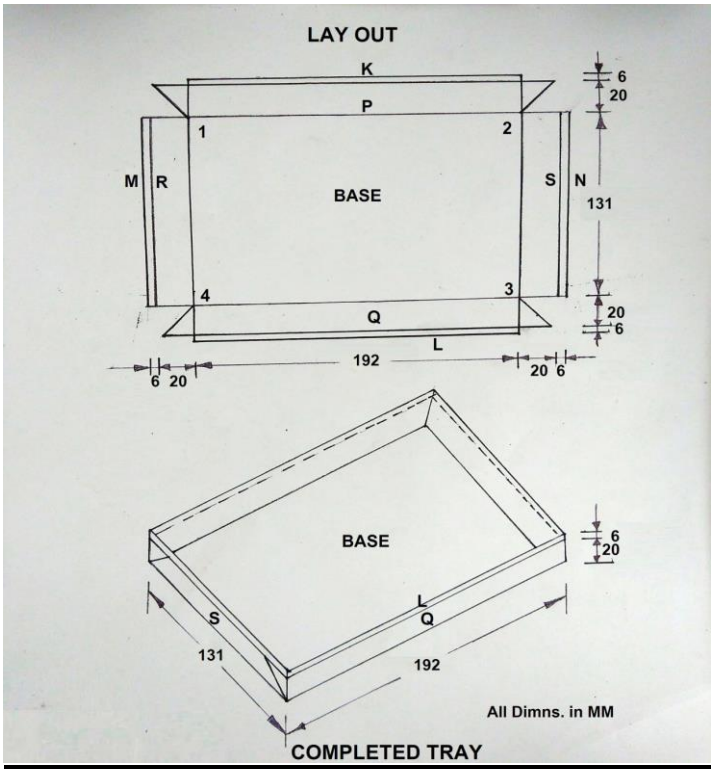
Tools Required: Flat Steel plate, Hand Shears, Steel Rule, Steel Square, Scriber, Mallet, Soft Face Hammer, Try square, and Stakes.

Procedure:

1. Mark and cut piece of size 244 mm x 183 mm from the given G.I. sheet.
2. Place it on the flat surface and straighten with the help of the mallet, and soft face hammer (if required).
3. The layout of the required tray is given in figure III. Mark it on the straightened piece and check all the dimensions properly.
4. Cut away the unwanted material from the metal piece to obtain the final figure, as shown in layout fig. III
5. Again, straighten the piece and check it dimensions, make necessary corrections, if needed.
6. Using suitable stake and soft face hammer/mallet, bend the surface P, Q, R, S along the lines 1-2,3-4,2-3 and 1-4, to make them perpendicular to horizontal base of the tray.
7. In the same way, bend the four triangular surfaces along the vertical edges of surface R and S.
8. Check the squareness of the entire four bent surface, with reference to the rectangular base of the tray, by means of a try square.
9. Finally bend the smaller rectangular surface K, L, M and N at 180^{o} outwards for edge folding.
10. This, in addition to providing reinforcement and rigidity to the tray, will also avoid the sharp edges making handling safe.

Precautions:

1. To avoid injury to hands by the sharp edges and corners of the cut piece, always work carefully.
2. Periodically check squareness of all adjacent surfaces, during the operation.
3. Use mallet or soft hammer on sheets.
4. Hammering, punching or similar other striking operations should not be done on a surface plate to avoid spoiling of its top surface.



Sheet Metal Diagram – III

Observations:

Required Parameters	Observed parameters	Measuring Instrument Used
Length 238mm		Steel rule
Width 138mm		Steel rule
Height 20mm		Steel rule
Edge Folding 6mm		Steel rule
Perpendicularity		Try Square
Sharp Edge, dents		Visual
Overall Finish		Visual

Viva questions for Sheet Metal shop:

1. Differentiate between foil, sheet, and plate***. Foil thickness up to 0.152 mm, sheet thickness from 0.152 mm up to 3 mm and plate from 3 mm onwards***

2. What is GI sheet? ***It is galvanized Iron sheet***

3. What is galvanized Iron sheet? ***Iron sheet coated with zinc.***

4. What are applications of GI sheet? ***It is used in making, almirahs, buckets, AC ducts, and vehicle bodies.***

5. What are the applications of brass sheet? ***Now a days it is mainly used for decorative purposes.***

6. Galvanizing is done***. To protect iron sheet from corrosion.***

7. Why G I sheet metal should not be welded? ***Poisonous gas will be produced at elevated temperature.***

8. What is tin sheet? ***Iron sheet coated with Tin.***

9. What are the applications of Tin sheet***? Containers for edible oils and coke cans etc.***

10. Uses of aluminum sheet***. Airplane bodies, kitchen, and household items etc.***

11. Uses of lead sheet. ***Used as cladding in containers for holding acids.***

12. Uses of SS sheet***. Used in making kitchen ware, food handling equipment, dairy equipment, chemical plants, and food processing equipment.***

13. How thin sheets are manufactured? ***Using process called Cold Rolling.***

14. What is supporting tool used in Sheet metal shop called***? A stake***

15. Different types of stakes***. Bick iron, hatchet stake, half-moon stake, pipe stake, horse head stake***

16. What is mallet? ***It is a soft hammer made of wood, nylon, plastic or hide etc.***

17. Name some sheet metal operations. ***laying out, Measuring, and marking, nibbling, piercing, blanking, edge forming and wiring, joint making, soldering, and brazing etc.***

18. Some joints used in sheet metal shop***. lap joint, seam joint, locked joint, wired edge joint, cup or circular seam joint, flanged seam joint etc.***

19. Classification of sheet metal tools. ***(i) supporting and striking tools (ii) punching cutting and shearing tools(iii)marking and measuring tools***

20. Name some marking &measuring tools***. scriber, wing compass, trammel points, steel square***

21. Cutting tools***. straight snip, bent snip***

22. What is nibbling? ***Cutting along a contour which may be straight or irregular with a machine called nibbler***

23. What is edge forming? ***Edges of the sheet metal product are formed or folded to ensure safety in handling and to provide stiffness to the product.***

24. Try square used in sheet metal shop is called***. Tin man's square.***

25. Hollow punch is used for ***making holes in sheets and belts.***

26. Methods of securing sheet metal joint***. Brazing, soldering, riveting.***

27. How to measure the thickness of a sheet*?* ***By using standard wire gauge or micrometer.***

28. How many mm is one inch? ***25.4 mm***

29. Increasing Gauge number means, ***reducing thickness of sheet***

30. How is a sheet metal specified? ***The material it is made of the thickness and the size of the sheet.***

31. What is shearing? ***Cutting a sheet with the help of two blades moving in opposite direction.***

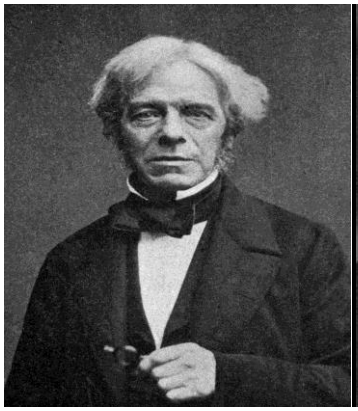
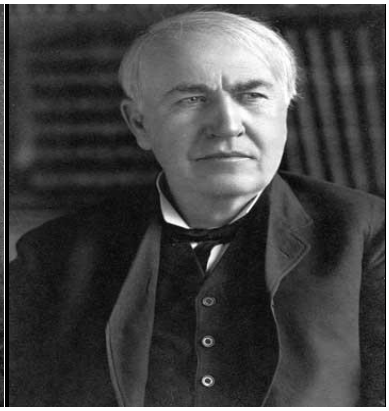
32. How to differentiate straight and cross peen hammer. ***A hammer having peen in line with handle and across handle respectively.***

33. What is Trammel points used for? ***For drawing big arcs and circles.***

34. What happens if the sheet is worked with a hard hammer? ***Blow from a hard hammer can reduce the thickness of a sheet and it causes bulging.***

35. What type of seam is used to join bottom of a bucket? ***It is a double locked seam joint.***

Electrical, Electronics &Computer Shop

MICHAEL FARADAY THOMAS ALVA ADDISON



William Bradford Shockley | John Bardeen | Walter Houser Brattain

Michael Faraday's greatest discovery in the electrical field was the principle of Electromagnetic Induction, which led to the modern Electric Motor, Generator and Transformer.

Thomas Alva Edison has been described as America's greatest inventor, holding 1,093 US patents to his name, as well as many patents in the United Kingdom, France, and Germany. His inventions in the field of electric light, power utilities, sound recording, and motion pictures help establish major new industries worldwide.

John Bardeen, William Shockley, and Walter Brattain shared the Noble Prize in Physics for their discovery of the Transistor In 1956.Transistor is considered one of the greatest inventions of the 20th century. The integrated circuits, microchips, microprocessors etc would never have existed without Transistor.

Electrical & Electronics Shop:

SAFETY PRECAUTIONS:

1. Always remember, electricity is a good servant but bad Master.
2. Always wear closed shoes with rubber sole.
3. Never touch any bare conductor in the E&E Shop.
4. Appliances should be disconnected from power supply before attempting any repair.
5. All electrical equipment should be properly earthed.

6. Never disconnect a plug by pulling it from the cord.
7. In case of fire supply should be disconnected immediately.
8. Never use water to extinguish electrical fire, CO_2 fire extinguisher or dry chemical fire extinguisher should be used.
9. In case no fire extinguisher is available sand is the best option to control electrical fires.
10. Before replacing burnt fuse, the power supply should be cut off.
11. Always ask for guidance from the shop instructor in Case of doubt.

INTRODUCTION: Undoubtedly the modern life of ours is due only to electricity. Needless to mention that from a kitchen appliance to a train, it takes electricity to function. The man of today cannot imagine his life without electricity. On the other hand, nothing like mobile phones, computers, robots, missiles, rockets etc. could have been possible without the advent of electronics. The modern industry using Robots and CNC machining systems has been possible due to advances in the fields of Electrical and Electronics Engineering.

Alternating current (AC): Is an electric current that reverses its direction at regular intervals, typically used in power supplies. Its symbol is (~) and its frequency in India is 50 Hz.

Direct current (DC): Is an electric current that does not reverse its direction at regular intervals. Its symbol is (—). Direct current is produced by sources such as batteries, thermocouples, solar cells, dynamos and Rectifiers etc. Direct current is used to charge batteries, and in nearly all electronic systems, as the power supply. Direct current is used for railway propulsion also.

Conductors: A conductor is a type of material that allows the flow of electrical current easily. For example, a copper wire is an electrical conductor that can carry electricity along its length e.g., Silver, Copper and Aluminum etc.

Insulators: An Insulator is a type of material that does not allows the flow of electrical current through it easily e.g., Ceramics, Dry Wood and Paper etc.

Semi-Conductors: Those materials which are neither good conductors nor bad conductors e.g. Silicon and Germanium.

Soldering: Soldering is an electrically conductive joining technique. It is a process of joining metal parts with the help of a low melting point metal called Solder, without their surfaces being melted.

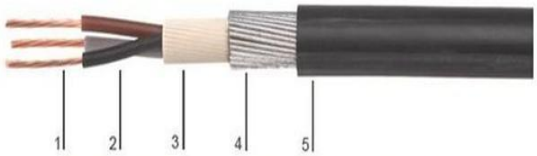
Electric Wire: It is a conductor of circular cross section which provides a passage for continuous flow of electrical current. It may be insulated or bare.

Electric Cable: An electric **cable is** an assembly of one or more electrical conductors, usually held together with an overall sheath. The assembly **is** used for transmission of electrical power

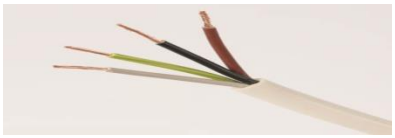
Core: In a cable consisting of a number of insulated wires each wire is called a core and has a different color.

Armoured Cable: It is a cable which carries a metallic covering over its normal insulation for safety.

Flexible Cable: It is a cable in which core consists of cluster of thin wires and provided with insulating covering outside.



1. Conductor (Cu/Al) 2. Insulation (XLPE) 3. Bedding (PVC)
4. Armouring (Al/Steel) 5. Sheath (PVC)



Electrical accessories:

1. Switch: it is a device which makes or breaks an electrical circuit. It is interposed in a phase wire**.** The common types of switches are:

a) Surface or Tumbler switch: It is fitted on a mounting block or a wooden board and projects out of the surface.

b) Flush Switch: it is fitted in a Bakelite sheet and does not project outside the surface.

2. Fuse: it is a small wire, or a thin strip of a low melting point material inserted in an electrical circuit. It acts as a protection against excessive flow of current. Tin Lead, Copper etc. are the common materials used for making Fuse.

3. Ceiling Rose: Pendent Lamps, Ceiling Fans and Fluorescent Lamps are connected to installation through it.

4. Socket Outlet: it is used to provide temporary electric supply to different electrical appliances from the circuit.

5. Plugs: All the domestic appliances are connected to the sockets through their leads and plugs.

6. Lamp Holder: it holds and supports the lamp and connects the lamp to the supply terminals. The following types of lamp holders are in common use.

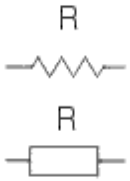
(a) Batten Holder: it is used when lamp is to be secured to the wall or roof.

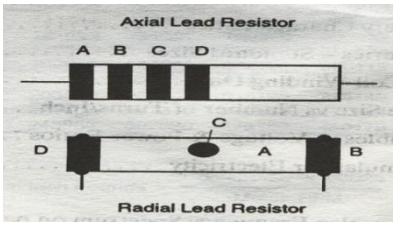
(b) Pendent Holder: it is used when the lamp is to be suspended from the ceiling Rose.

(c) Angle Holder: This type of Lamp Holder is directly secured to the wall. After fixing it remains inclined downwards.

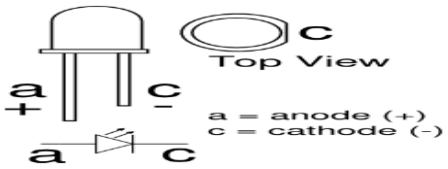
Some electronics components:

1. Resistor: Resistors are the most commonly used component in electronics and their purpose is to create specified values of current and voltage in a circuit. Two different resistors are shown in the photo. The symbol for a resistor is shown in the following diagram.



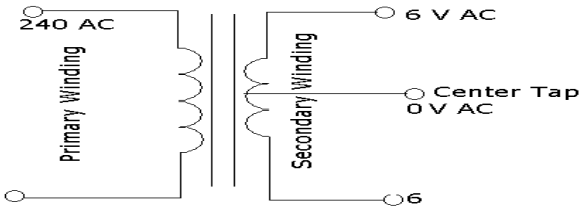


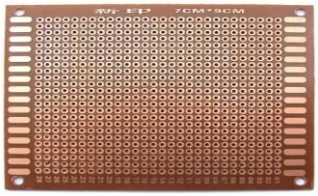
2. Capacitor: The Capacitor is a component which has the ability to store energy in the form of an electrical charge producing a potential difference across its plates, much like a small rechargeable battery.



3. LED: Light Emitting Diodes, are heroes of the electronics world. They do dozens of different jobs and are found in all kinds of devices like digital clocks, remote controls and watches etc. Collected together, they can form images on a jumbo television screen or illuminate a traffic light.

4. Transformer: Transformer is a static device which transforms and transfers electrical energy from one circuit to another without any direct electrical connection. It transforms voltage without changing its frequency.





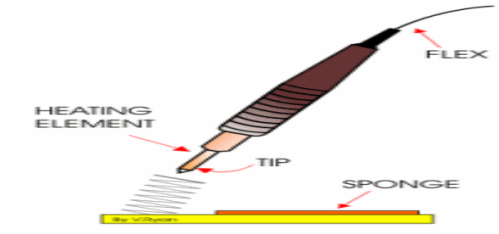
5. PCB: A Printed Circuit Board (PCB) mechanically supports and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto a non-conductive substrate.

Tools and instruments used in E&E Shop:

Multimeter: Also known as multitester, and VOM (Volt-Ohm meter), is an electronic measuring instrument that combines several measurement functions like Voltage, Current, and Resistance in one unit.

Kilo Watt hour Meter: it is a device that measures the amount of electric energy consumed by a residence, business, or an electrically powered device. The consumed energy is measured in units called kilowatt hour [*kWh*].

Soldering Iron: A Soldering Iron is a hand tool used in Soldering. It supplies heat to melt the Solder so that it can flow into the joint between two work pieces.



Wire Stripper: A simple manual wire stripper is a pair of opposing blades much like scissors or wire cutters. The addition of a center notch makes it easier to cut the insulation without cutting the wire.

Combination Pliers: The Combination Pliers are the pair of Pliers which can do (almost) everything. In one tool it combines the most important basic functions of pliers i.e., gripping and cutting.

Side Cutting Pliers: It is a General purpose pliers to snip light-gauge wire. Its jaws have both a gripping and a cutting section.

Long Nose Pliers: Long Nose Pliers are engineered to operate in tight spaces. A crosshatched teeth pattern provides reliable grip in either direction, while a narrow nose profile provides extra precision.

Electrical Wire Cutter Pliers: These are pliers intended for the cutting of wire and are generally not used to grab or turn anything.

Standard Wire Gauge: Also known as **British Standard Gauge** has now been withdrawn, but is still being used as a measure of thickness in guitar strings and some electrical wires etc.

Line Tester: It's used to check the power supply and loosening/tightening the small screws.

<u>Practical Exercise No. 2.1:</u>

Objective: To make a house wiring circuit with Staircase configuration using an energy meter and other electrical accessories in Electrical & Electronics shop.

Tools Required: Neon Tester and Screwdriver Set.

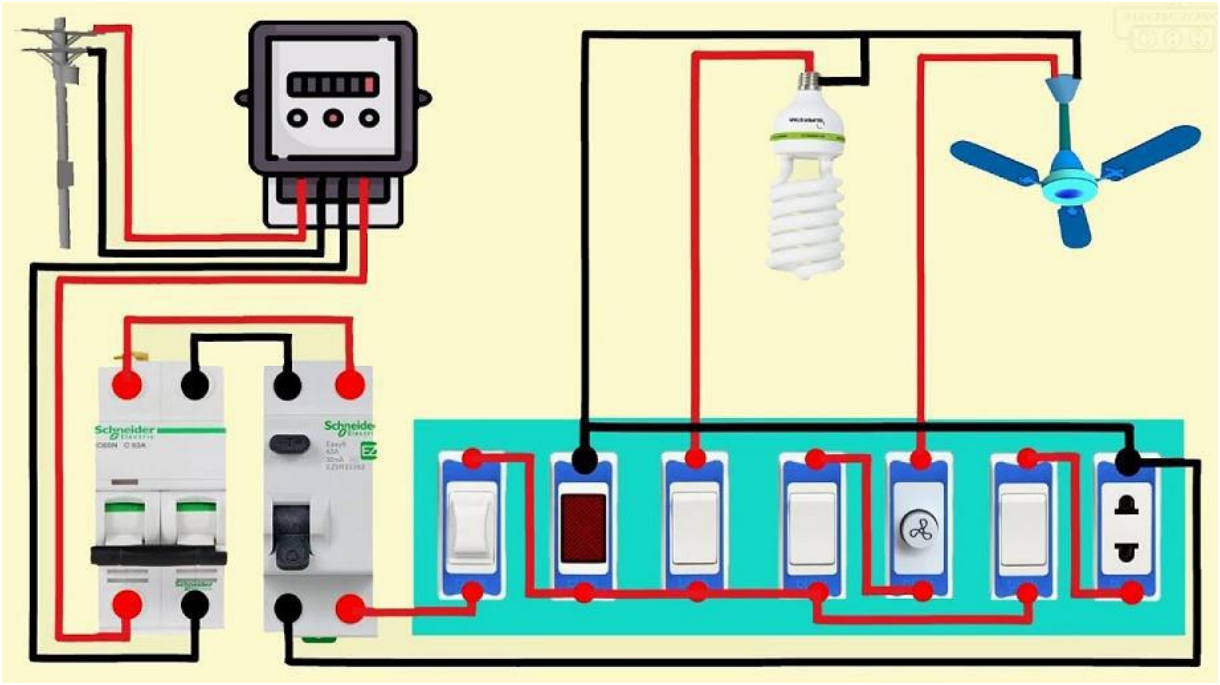
Materials required: Energy meter, main switch, MCB, one way regulator, lamp holder, two pin socket, fan regulator and supply indicator etc.

Procedure:

1. All the accessories have been fixed over the practice board.

2. The students will have to make the required the required circuit as shown in the figure.
3. The red line in the figure shows the live wire, and black the neutral wire.
4. Strip wire ends properly to remove plastic completely.
5. Tighten wires correctly for secure connectivity.
6. Please show the circuit connections to the shop instructor before switching on.

Practical Exercise No. 2.3:



Observations:

Required Parameters	Observed parameters	Measuring Instrument Used
Electrical wiring		Line Tester
Connectivity		Series Lamp, Test lamp
Bulb Glows		Visual check

Practical Exercise No. 2.2:

Objective: To make a Center-Tap Full-Wave Rectifier.

Tools Required: Soldering Iron 25w, Solder Wire, Soldering Flux, Neon Tester and Screwdriver Set and Twizzer.

Items required: Transformer 6-0-6 V, Diode In 4007, Transistor 7805, Resistance 1kΩ, Capictor1000µF, LED 3V, Printed Circuit Board 5x3 cm and Jumper Wire.

Theory: In full-wave rectification, when AC supply is applied at the input, during both the half cycles (i.e., positive as well as negative) current flows through the load in the same direction. This can be achieved by using at least two crystal diodes, conducting current alternatively.

A transformer with secondary winding AB tapped at the center point C. The two diodes D1 and D2 are connected in the circuit so that each one of them uses one half cycle of input AC voltage. The diode D1 utilizes the AC voltage appearing across the upper half (AC) of secondary winding for rectification while D2 user the lower half (CB) of secondary winding.

Operation: When AC supply is switched on, the alternating voltage (V) appears across the terminals AB of secondary winding of transformer. During positive half-cycle at secondary voltage, the end A become positive and end B negative. This make the diode D1 forward biased and diode D2 reverse biased. Therefore, diode D1 conducts while diode D2 does not. Thus, current (i) flows through diode D1, load resistor Rl and the upper half of secondary bold arrowhead. During negative half cycle, the end B becomes positive and end A becomes negative. This makes diode D2 forward biased and diode D1 reverse biased.

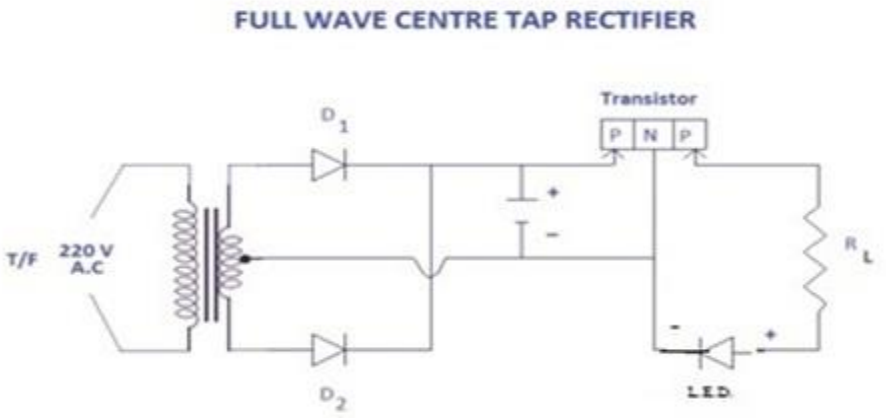
Therefore, diode D2 conducts while diode D1 does not. Thus current (i) flows through diodeD2, load resistor RL and the lower half of the secondary winding. It may be seen that the current flows through the load resistor RL in the same direction (i.e., from M to L) during positive as well as negative half of input AC voltage. Therefore, DC output is obtained across the load resistor RL.

Procedure:

1. Take PCB and all components required; then install components as per the circuit diagram.
2. Solder the components by Soldering Iron and check the circuit continuity by Multimeter.
3. Install LED then Solder it and connect the assembly to the 220v supply.
4. LED glow indicates the output of Direct current, and our job is successfully completed.

Precautions:

1. Clean components before Soldering.
2. Solder carefully to avoid dry Soldering.



Observations:

Required Parameter	Actual Parameter	Measuring Instrument Used
A/C Voltage (220/240 V)		**A/C Voltmeter**
D/C Voltage (6 to 12 Volt V)		**D/c Voltmeter**
Component Capacity Test Electronic components (Txr, D1 D2, C1, PNP, R/L LED)		**Multimeter**
Electrical wiring	**Good/ Bad**	**Line Tester**
Connectivity	**OK/ Not Ok**	**Series Lamp, Test lamp**
Bulb Glow	**Y/N**	

Practical 2.3

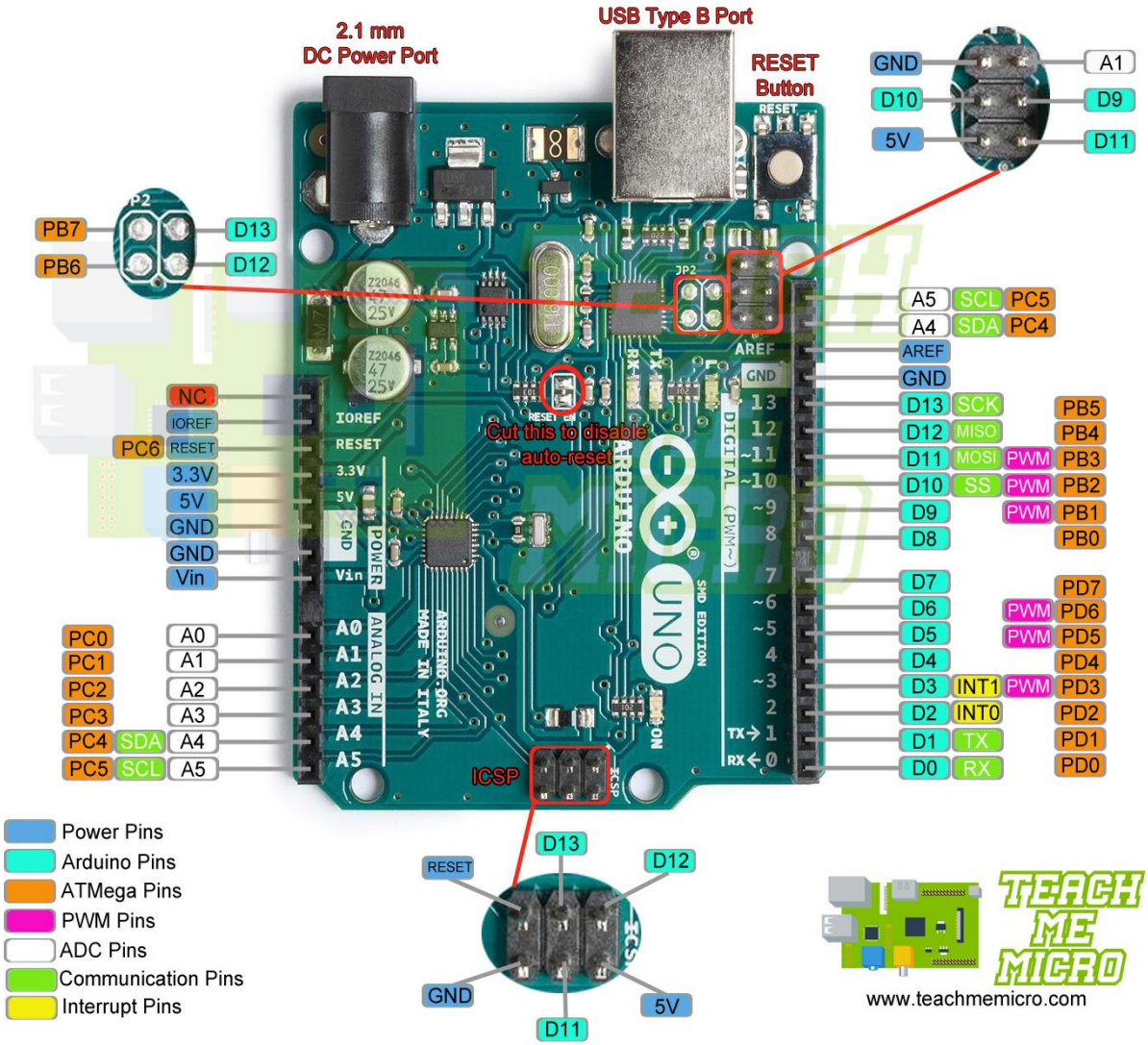
Objective : To make a Arduino / ESP32 based Bluetooth controlled cabin Lock.

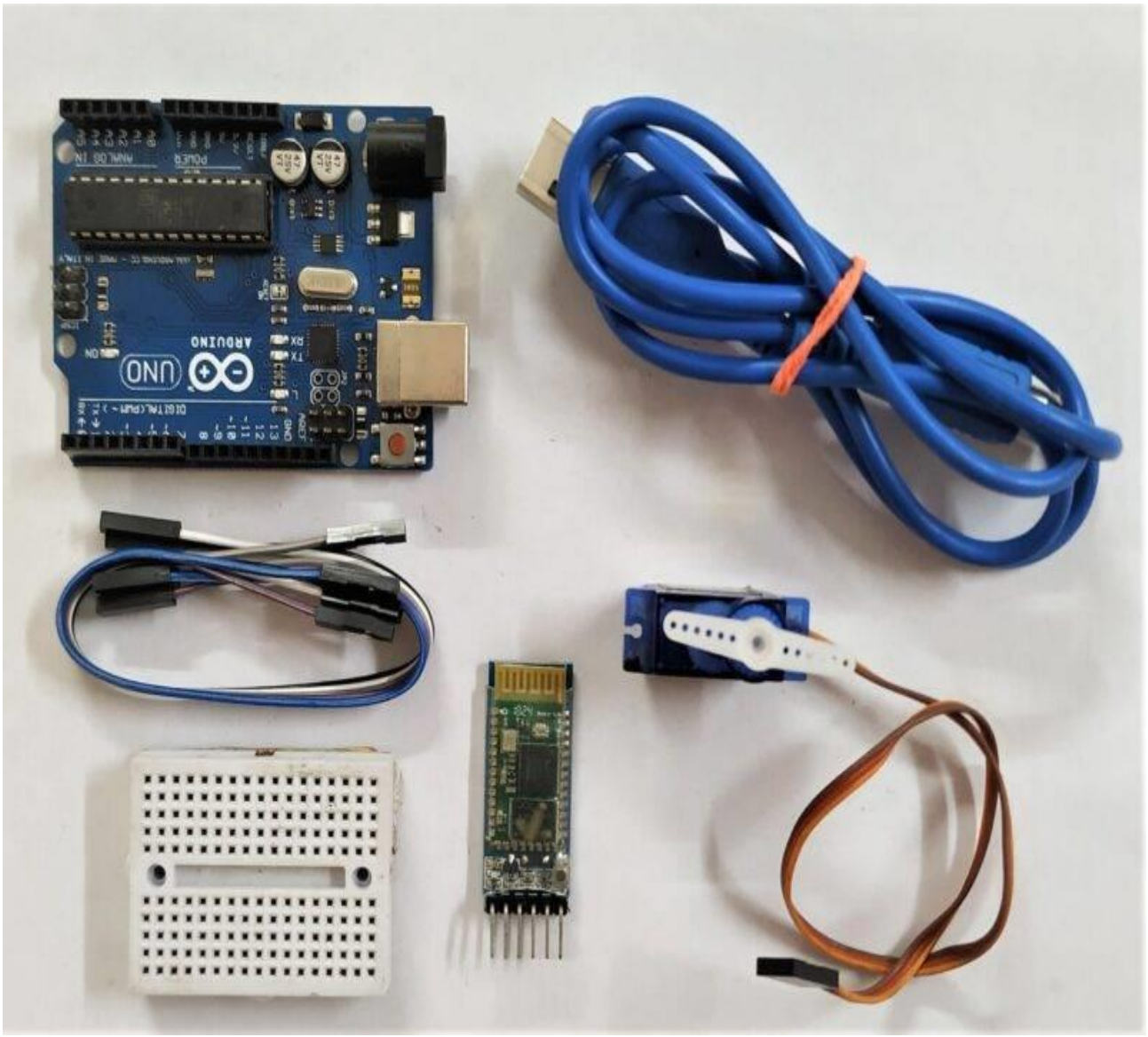
Tools required : Arduino uno, servo (SG90), connecting jumper wires, HC-05 Bluetooth module, breadboard, Android phone or tablet with a Bluetooth app, etc.

Software used: Arduino IDE

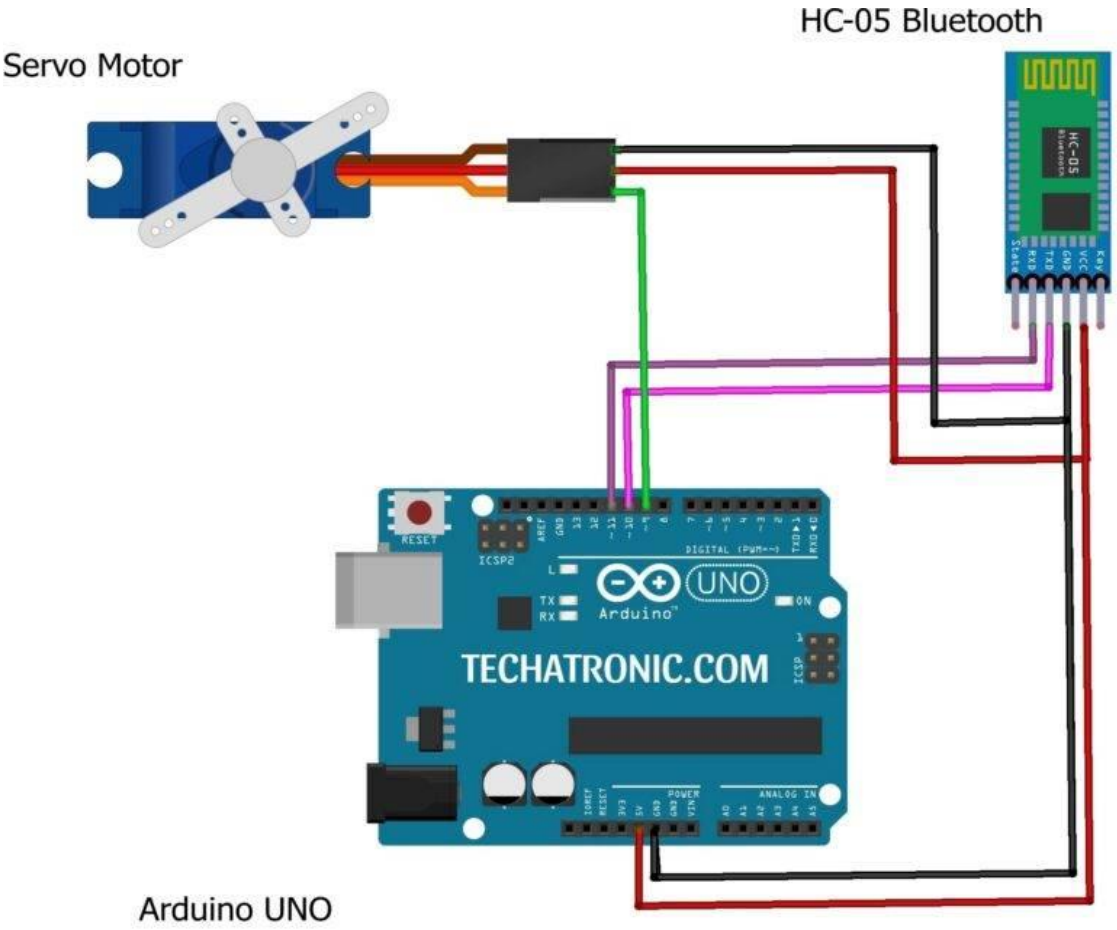
Procedure:

Diagram :

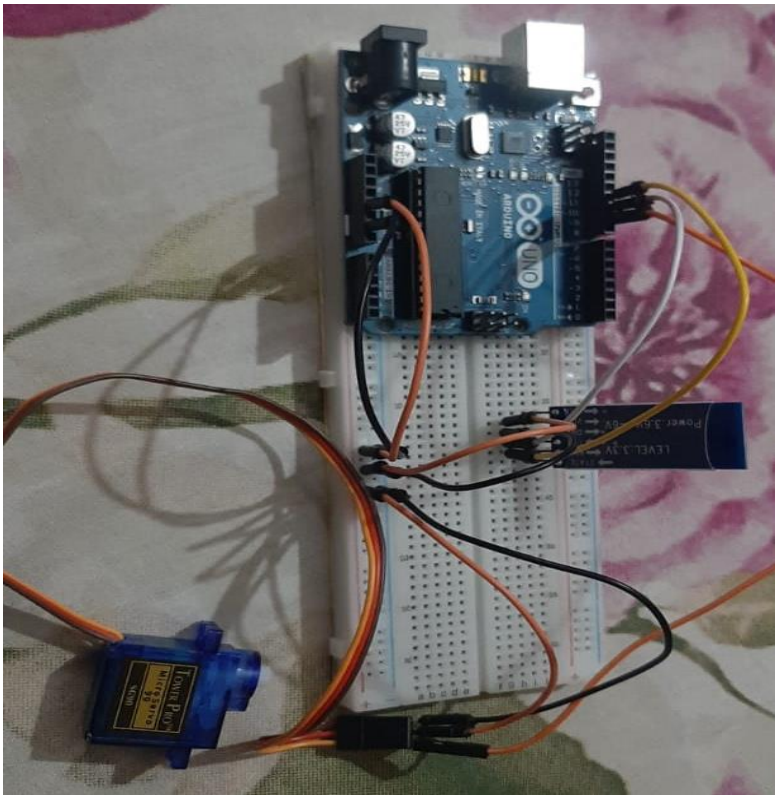

2.1 mm
DC Power Port
USB Type B Port
RESET
Button
Cut this to disable
auto-reset
ICSP
Power Pins
Arduino Pins
ATMega Pins
PWM Pins
ADC Pins
Communication Pins
Interrupt Pins
www.teachmemicro.com



1. Make the circuit as per the given diagram



2. After connecting the wires and modules your work piece should look like



3. Connect the Arduino Uno to your computer using a USB cable.
4. Open the Arduino IDE.
5. Install the HC-05 Bluetooth library.

6. Download the Android app.
7. Open the Android app (Bluetooth serial monitor) and connect it to the HC-05 Bluetooth module.
8. Write the following code to the Arduino:

Code snippet

```
// Import the necessary libraries
#include <Servo.h>
#include <SoftwareSerial.h>

// Define the pins for the servo and the Bluetooth module
const int servoPin = 9;
const int bluetoothTX = 10;
const int bluetoothRX = 11;

// Create a servo object
Servo myServo;

// Initialize the Bluetooth module
SoftwareSerial bluetooth(bluetoothTX, bluetoothRX);

void setup() {
  // Attach the servo to the specified pin
  myServo.attach(servoPin);

  // Initialize the Bluetooth module
  bluetooth.begin(9600);
}

void loop() {
  // Check if there is any data available from the Bluetooth
module
  if (bluetooth.available()) {
    // Read the data from the Bluetooth module
    int angle = bluetooth.read();

    // Move the servo to the specified angle
    myServo.write(angle);
  }
}
```

9. Upload the code to the Arduino.
10. Open the Android app (Bluetooth serial monitor) and then move the slider to control the servo by entering the angle in degrees.

Result: The code is running perfectly and servo is also working.

Precautions:

1. Handle the apparatus carefully.
2. Do not forget to select the board name in Arduino IDE.

3. Do not make wrong connections.

Troubleshooting:

- If the servo does not move, check the connections to the Arduino and the servo.
- If the servo moves erratically, check the code and make sure that the angle values are within the valid range for the servo.
- If the Bluetooth connection is not working, check the Bluetooth settings on your phone or tablet and make sure that the HC-05 Bluetooth module is in discoverable mode.

Practical 2.4

Objective: Write down the steps to assemble/disassemble the Personal Computer.
Material Required: Plain A-4 size Sheet, Pen.

Disassembling:

Disassembling means parting the different components of a computer from the system unit. To perform disassembling, the tasks goes like unplugging, unscrewing and then lifting the adapters, drives & other components.

STEPS TO DISASSEMBLE A PC:

1. **Unplug every cable:**

Wear a grounding strap or touch an unpainted metal part of the computer to discharge any static electricity. If you walk across a carpet at any point, touch an unpainted metal part of the computer again to discharge the built up static electricity. The first thing we have to do, is unplug every cable that's plugged in to computer. That includes the following cables:

• Power

• USB

• Mouse

• Keyboard

• Internet

• Ethernet

• Modem

• AM\FM Antenna

• Cable TV, etc.

Figure 9.1 Unplugging

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2. Remove the Cover:

The standard way of removing tower cases used to be to undo the screws on the back of the case, slide the cover back about an inch and lift it off. The screwdrivers as per the type of screw are required to do the task.

Figure 9.2 Remove Cabinet case

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3.Remove the adapter cards:

Make sure if the card has any cables or wires that might be attached and decide if it would be easier to remove them before or after you remove the card. Remove the screw, if any, which holds the card in place. Grab the card by its edges, front and back, and gently rock it lengthwise to release it.

4.Remove the power supply:

The power supply is attached into tower cabinet at the top back end of the tower. Make sure the power connector is detached from the switchboard. Start removing the power connector connected to motherboard including CPU fan power connector, cabinet fan, the front panel of cabinet power buttons and all the remaining drives if not detached yet. Now remove the screws of SMPS from the back of the cabinet and the SMPS can be detached from the tower cabinet.

Figure 9.3 Remove Power Supply

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The Power Supply is a large metal box located in the top left corner.

The power supply supplies power to every component in a computer, therefore it has the most wires out of every other component in the computer. The first thing you do is unplug every wire coming from the power supply. The list below is everything that you have to disconnect:

- Motherboard (very large connector/plug)
- CD/DVD drive[s] power
- Internal hard drive power
- Portable hard drive slot power

Once everything is unplugged, unscrew the screws holding the power supply in place, on the back of the computer. Next, push the power supply from the outside, then lift it out.

Keep the screws/bolt aside in a bag so when you assembling it back, it will be easier.

5.Remove the drives:

Removing drives is easier. There can be possibly three types of drives present in your computer system, Hard disk drive, CD/DVD/Blue-ray drives, floppy disk drives (almost absolute now a day). They usually have a power connector and a data cable attached from the device to a controller card or a connector on the motherboard. CD/DVD/Blue Ray drive may have an analog cable connected to the sound card for direct audio output. The power may be attached using one of two connectors, a Molex connector or a Berg connector for the drive. The Molex connector may require to be wiggled slightly from side to side and apply gentle pressure outwards. The Berg connector may just pull out or it may have a small tab which has to be lifted with a screwdriver.

Figure 9.4 Remove drives

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Now pull data cables off from the drive as well as motherboard connector. The hard disk drive and CD/DVD drives have two types of data cables. IDE and SATA cables. The IDE cables need better care while being removed as it may cause the damage to drive connector pins. Gently wiggle the cable sideways and remove it. The SATA cables can be removed easily by pressing the tab and pulling the connector straight back.

Now remove the screws and slide the drive out the back of the bay.

6.Remove the system FAN:

Most computers have two fans: the system fan, the one blowing air into the computer, and the CPU fan, the one blowing air onto the CPU heat sink.

The system fan is located at the back side of the computer, the side with all the component plugins. First, unplug the fan from the motherboard. You can find the plug by following the wire from the fan. It should be labelled "SYS_FAN1". Next, you will have to unscrew the fan from the outside.

You should now be able to lift the fan out of the PC.

Keep the screws/bolt aside in a bag so when you assembling it back, it will be easier.

Figure 9.5 Remove System FAN

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7.Remove the memory module:

Memory modules are mounted on the motherboard as the chips that can be damaged by manual force if applied improperly. Be careful and handle the chip only by the edges. SIMMs and DIMMs are removed in a different way:

1. SIMM - gently push back the metal tabs while holding the SIMM chips in the socket. Tilt the SIMM chip away from the tabs until a 45% angle. It will now lift out of the socket. Put SIMM in a safe place.

2. DIMM- There are plastic tabs on the end of the DIMM sockets. Press the tabs down and away from the socket. The DIMM will lift slightly. Now grab it by the edges and place it safely. Do not let the chips get dust at all.

Figure 9.6 Remove RAM chips

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8.Remove the motherboard:

Before removing all the connectors from the motherboard, make sure u memorize the connectors for assembling the computer if required, as that may require connecting the connectors at its place.

Remove the screws from the back of the motherboard and you will be able to detach it from the cabinet. Now remove the CPU fan from the motherboard. The heat sink will be visible now which can be removed by the pulling the tab upward. Finally, the processor is visible now, which can be removed by the plastic tab which can be pulled back one stretching it side way.

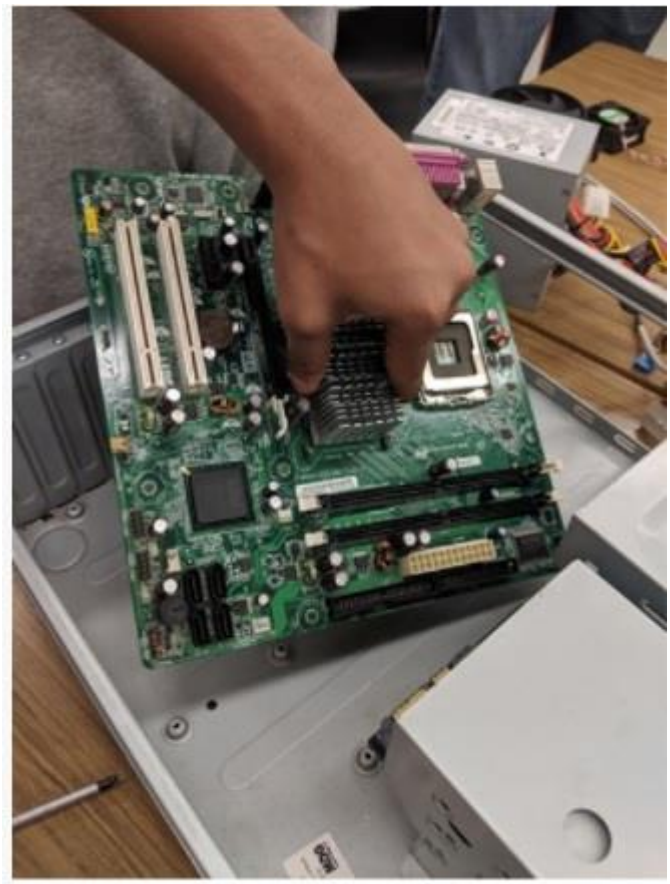

Figure 9.7 Remove Motherboard

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ASSEMBLING A PC

1. INSTALL POWER SUPPLY

Power supply installation steps include the following:

- Insert the power supply into the case
- Align the holes in the power supply with the holes in the case
- Secure the power supply to the case using the proper screws

2. ATTACH CPU ON MOTHERBOARD

- Align the CPU so that the Connection 1 indicator is lined up with Pin 1 on the CPU socket.
- Place the CPU gently into the socket.
- Close the CPU load plate and secure it by closing the load lever and moving it under the load lever retention tab.

CAUTION:

- When handling a CPU, do not touch the CPU contacts.
- The CPU is secured to the socket on the motherboard with a locking assembly.
- The CPU and motherboard are sensitive to electrostatic discharge
- Use a grounded anti-static mat and wear an anti-static wrist strap.

3. THERMAL COMPOUND

Thermal compound helps to keep the CPU cool. To install a used CPU,

- Clean the base of the heat sink with isopropyl alcohol to remove the old thermal compound.
- Follow manufacturer's recommendations about applying the thermal compound.
- Apply a small amount of thermal compound to the CPU and spread it evenly.

4. HEAT SINK/FAN ASSEMBLY

The Heat Sink/Fan Assembly is a two-part cooling device.

- The heat sink draws heat away from the CPU.
- The fan moves the heat away from the heat sink.
- The heat sink/fan assembly usually has a 3-pin power connector.
- Line up the heat sink/fan assembly retainers to the holes on the motherboard.
- Place the heat sink/fan assembly onto the CPU socket, being careful not to pinch the CPU fan wires.
- Tighten the heat sink/fan assembly retainers to secure the assembly in place.
- Connect the heat sink/fan assembly power cable to the header on the motherboard.

5. INSTALL RAM MEMORY MODULES

- RAM provides temporary data storage for the CPU while the computer is operating.
- RAM should be installed in the motherboard before the motherboard is placed in the computer case.

RAM installation steps:

- Align the notches on the RAM module to the keys in the slot and press down until the side tabs click into place.
- Make sure that the side tabs have locked the RAM module and visually check for exposed contacts.

6. INSTALL THE MOTHERBOARD

The motherboard is now ready to install in the computer case.

CAUTION:

- Plastic and metal standoffs are used to mount the motherboard and to prevent it from touching the metal portions of the case.
- Install only the standoffs that align with the holes in the motherboard.
- Installing any additional standoffs may prevent the motherboard from being seated properly in the computer case.

STEPS TO INSTALL THE MOTHERBOARD:

- Install standoffs in the computer case.
- Align the I/O connectors on the back of the motherboard with the openings in the back of the case.
- Align the screw holes of the motherboard with the standoffs.
- Insert all of the motherboard screws.
- Tighten all of the motherboard screws.

7. INSTALL INTERNAL DRIVES

- Drives that are installed in internal bays are called internal drives.
- A hard disk drive (HDD) is an example of an internal drive.

HDD installation steps:

- Position the HDD so that it aligns with the 3.5-inch drive bay.
- Insert the HDD into the drive bay so that the screw holes in the drive line up with the screw holes in the case.
- Secure the HDD to the case using the proper screws.

Drives, such as optical drives (CD and DVD) and floppy drives, are installed in drive bays that are accessed from the

front of the case.

- Optical drives and floppy drives store data on removable media.
- Drives in external bays allow access to the media without opening the case.

8. Installing OPTICAL Drive:

An optical drive is a storage device that reads and writes information to CDs or DVDs.

- Position the optical drive to align with the 5.25 inch drive bay.
- Insert the optical drive into the drive bay so that the optical drive screw holes align with the screw holes in the case.
- Secure the optical drive to the case using the proper screws.

9. INSTALL ADAPTER CARDS

Adapter cards are installed to add functionality to a computer. Adapter cards must be compatible with the expansion slot.

Some adapter cards:

- PCIe x1 NIC
- PCI Wireless NIC
- PCIe x16 video adapter card

Installing Network Interface Card (NIC):

A NIC enables a computer to connect to a network. NICs use PCI and PCIe expansion slots on the motherboard.

- Align the NIC to the appropriate slot on the motherboard.
- Press down gently on the NIC until the card is seated.
- Secure the NIC PC mounting bracket to the case with the appropriate screw.

10. CONNECT INTERNAL CABLES

Power cables are used to distribute electricity from the power supply to the motherboard and other components.

- Data cables transmit data between the motherboard and storage devices, such as hard drives.
- Additional cables connect the buttons and link lights on the front of the computer case to the motherboard.

Power Connector Installation Steps:

- Plug the SATA power connector into the HDD.
- Plug the Molex power connector into the optical drive.
- Plug the 4-pin Berg power connector into the FDD.
- Connect the 3-pin fan power connector into the appropriate fan header on the motherboard, according to the motherboard manual.
- Plug the additional cables from the case into the appropriate connectors according to the motherboard manual.

SATA Cable:

The SATA data cable has a 7-pin connector.

- One end of the cable is connected to the motherboard.
- The other end is connected to any drive that has a SATA data connector.

Connect External Cables:

- Attach the monitor cable to the video port.
- Secure the cable by tightening the screws on the connector.
- Plug the keyboard cable into the PS/2 keyboard port.
- Plug the mouse cable into the PS/2 mouse port.
- Plug the USB cable into a USB port.
- Plug the network cable into the network port.
- Connect the wireless antenna to the antenna connector.
- Plug the power cable into the power supply.

11. BOOT COMPUTER

When the computer is booted, the basic input/output system (BIOS) will perform a power-on self test (POST) to check on all of the internal components.

- A special key or combination of keys on the keyboard is used to enter the BIOS setup program.
- The BIOS setup program displays information about all of the components in the computer.

Identify Beep Codes for any hardware connection error

- POST checks to see that all of the hardware in the computer is operating correctly.
- If a device is malfunctioning, an error or a beep code alerts the technician that there is a problem.
- Typically, a single beep denotes that the computer is functioning properly.
- If there is a hardware problem, the computer may emit a series of beeps.
- Each BIOS manufacturer uses different codes to indicate hardware problems.
- Consult the motherboard documentation to view beep codes for your computer.

Video Link: Assembly of PC:
https://www.youtube.com/watch?v=lTFJK2E5qf0

Video Link: Installation of Windows
https://www.youtube.com/watch?v=ETK4TFzyXQI

Sample Viva questions with answers for electrical & electronics shop:

1. What is electric current/electricity? ***Flow of electrons through a conducting material***
2. What is a conductor? ***Material which allows the current to flow through it easily.***
3. List some good conductors. ***Silver, Copper, Aluminum etc.***
4. What is insulator? ***Material which does not allows the current to flow through it.***
5. What is a semiconductor? ***Materials having electrical conductivity between that of a conductor and an insulator.***
6. What is a superconductor? ***It is a material that can conduct electricity with no resistance.***
7. At what temperature a material becomes super conductor? ***At absolute zero.***
8. What are piezoelectric materials? ***Piezoelectric materials are those that produce an electric current when they are placed under mechanical stress.***
9. What are the uses of piezoelectric materials? ***These materials are used in various sensors, audible alarms, speakers, telephones, guidance systems, and sonars etc***.

10. What are the most commercially important semi-conductor materials? ***Silicon and Germanium.***

11. How important are the semi-conductors? ***Semiconductors are the foundation of modern electronics, including Transistors, Solar Cells, Light-Emitting Diodes (LEDs), Quantum Dots and Digital and Analog Integrated Circuits.***

12. What are the distinct properties of semi-conductors? ***Semiconductors can display a range of useful properties such as passing current more easily in one direction than the other, variable resistance, and sensitivity to light or heat.***

13. What is a transformer? ***A safe and efficient voltage converter to change the AC voltage at its input to a higher or lower voltage at its output.***

14. What is the principle of working of a transformer? ***Transfer of energy between two circuits through electromagnetic induction.***

15. Why is Magnetic Core used in a Transformer? ***The use of a Magnetic Core can enormously concentrate the strength and increase the effect of magnetic field.***

16. What is Material of the Core? ***Silicon Steel.***

17. What are Instrument transformers? ***Current transformers, together with voltage transformers (VTs), which are designed for measurement, are known as instrument transformers.***

18. What is Silicon Steel, ***also called Electrical steel, lamination steel, silicon electrical steel, relay steel or transformer steel is special steel tailored to produce small hysteresis loss and high permeability.***

19. What is function of a fuse in electrical circuit? ***Is a type of low resistance resistor which melts under flow of heavy current due to short circuit or overloading to break the circuit?***

20. What is a circuit breaker***? an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset to resume normal operation***.

21. What is meant by one unit of electricity? ***1KWh***

22. What is meant by Green Energy? ***Energy produced from non-polluting and renewable sources like solar, hydro, wind and geothermal etc.***

23. Name the components used in a Centre Tap Full Wave Rectifier? ***Transformer, LED, Capacitor, Resistor.***

24. Units of Capacitance? ***farad***

25. What is color coding in 3 phase power supply? ***RYBB.***

26. Explain the difference between earth and neutral: ***Neutral is a part of the electrical circuit whereas earth is not***

27. Who is known as the father of electricity? ***Michal Faraday***

28. Who invented Transistor? ***John Bardeen, Walter Houser Brattain, and William Bradford Shockley.***

29. Material of Filament in incandescent lamp. ***Tungsten***

30. What is a Fluorescent Lamp? ***An electric current in the gas excites mercury vapor which produces short-wave ultraviolet light causing a phosphor coating on the inside of the lamp to glow.***

31. What is Inverter? ***Inverter is an electronic device or circuitry that changes direct current (DC) to alternating current (AC).***

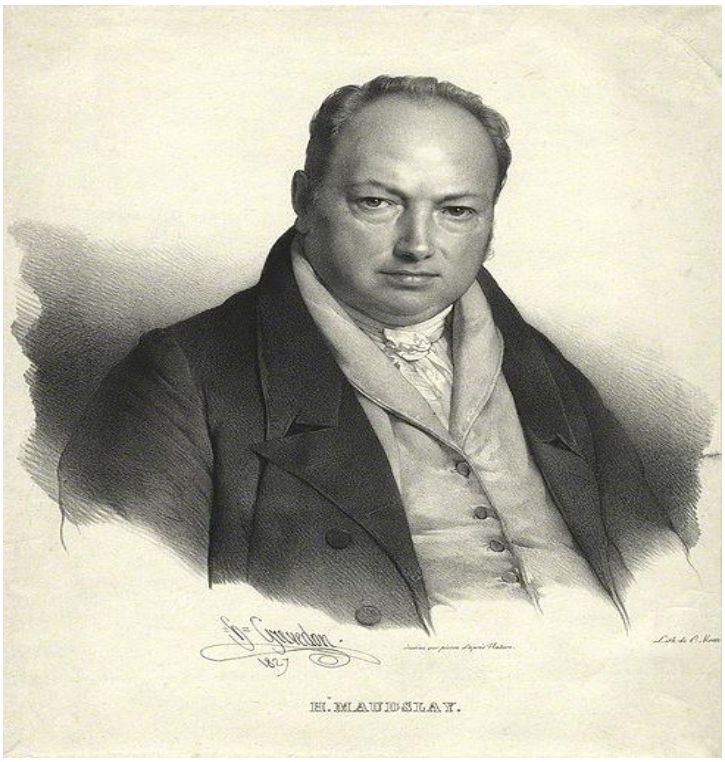
32. What is a Rectifier? ***An electrical device which converts an alternating current into a direct one by allowing a current to flow through it in one direction only.***

33. What is Diode? ***A semiconductor device with two terminals, typically allowing the flow of current in one direction only.***

34. Name some types of diodes***: Zener diode, Tunnel diode, Laser diode and photodiode etc.***

35. Why is mica sheet used in electric Iron? ***Because it allows heat to pass and stop current from flowing to metallic base.***

MACHINE SHOP



Henry Maudslay

- Henry Maudslay developed the first industrially practical screw-cutting lathe in 1800.
- He pioneered the idea of standardization of screw thread sizes for the first time.
- He also produced sets of Taps and Dies that would make nuts and bolts consistently to those standards.
- He also invented the first bench micrometer capable of measuring to one ten-thousandth of an inch (0.0001 in ≈ 3 μm)

MACHINE SHOP:

SAFETY PRECAUTIONS:

1. Machine shop has powered rotating machines like Centre Lathe. Take extreme care to ensure that anything which could get entangled in rotating parts is kept away.
2. Always wear lab coat in the Turning shop, loose clothing could be a serious safety hazard for chances of its entanglement in rotating parts.
3. Wearing neckties, bangles, bracelets, watches etc. while working on lathes could also be hazardous due to the risk of their getting caught in lathe chuck
4. Long loose hair have history of causing fatal accidents on lathes.
5. Wear closed shoes with rubber sole, hot chips can cause burns.
6. Never operate any Machine unless you know how to operate it.
7. Never touch moving parts like Chuck, Belt or rotating grinding wheels etc.
8. Stay clear of the starting switch on the lathe. Accidental pressing of the switch may cause fatal accident.
9. In case of risky or dangerous situation immediately cut off power supply by pressing red button on the starter.
10. Always stay careful while working on powered machines like lathes etc.

Metal Cutting/Machining: Metal Cutting or "Machining is the process, by which parts are produced by removing unwanted material from a block of metal in the forms of chips. This process is the most important as almost all the products get their final shape and size by machining.

Machine Shop: Parts having been formed to preliminary shapes by Casting or Forging etc. are finished to final shape & Size by machines called Machine Tools. The workshop where these Machine Tools are used for carrying out finishing operations on the parts is called the "Machine Shop."

Turning Shop: Machine Shop with only one type of Machine tools i.e., a Centre Lathe is used for manufacturing and finishing parts is called 'Turning Shop'. In any manufacturing activity the role of the Lathe is indispensable.

Machine Tool: - Machine tool is a powered device which performs material removal operation on the work piece to give desired shape and size to the work piece. Machine tool performs the following four main functions: It

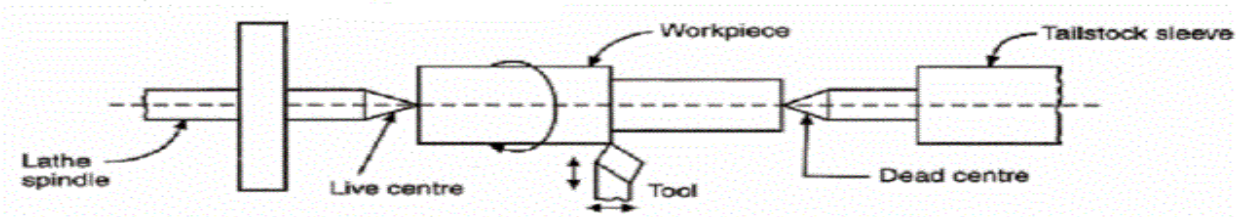
1. Holds the work piece.
2. Holds the cutting tools.
3. Moves one or both of these.
4. Provides feeding motion to one of them.

Examples of Machine Tools:

1. Centre /Engine lathe. 2. Shaper / Shaping Machine. 3. Drilling Machine. 4. Planer / planing Machine. 5. Power Hacksaw. 6. Milling Machine. 7. Cylindrical Grinder etc.

Centre Lathe. It is so called because it has two Centres between which the work piece can be held and rotated. It is also called "Engine Lathe" because firstly this type of lathe was driven by a steam engine. Its main objective is to remove material by rotating the work piece against the cutting tool. It may also be used for many other purposes such as Threading, Drilling Reaming, Boring, Grinding and Milling etc.

Working principle of Lathe. In this Machine Tool work piece is held in a chuck or between the Centres and rotated about its axis at a uniform speed. Cutting tool is held in the Tool Post and is fed into the work piece in the desired direction i.e., in linear, transverse, or lateral.



Types of lathes: Though the fundamental principle of operation of all lathes is same yet they are classified accordingly to design, type of drive, arrangement of gears, and the purpose of use etc, following are the important types of lathes: 1. Speed lathe 2. Engine / Center lathe 3. Bench lathe 4. Tool Room lathe 5. Capstan & Turret lathe 6. Automatic lathe 7. Special purpose lathe etc.

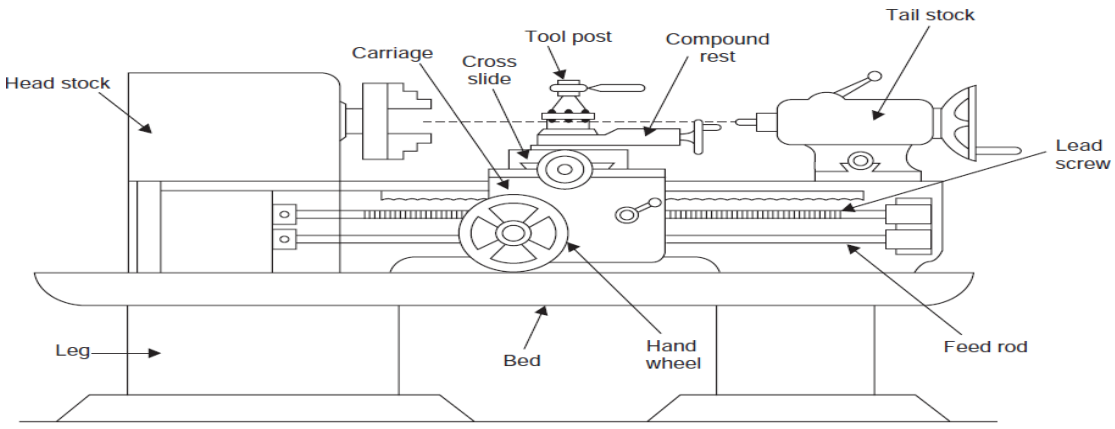


Fig: Block diagram of a Centre Lathe

The Main parts of lathe.

1. Bed - The Bed is the base or foundation of the lathe. It is a massive and rigid casting made in one piece to resist deflection and vibrations. It supports or holds all other parts of the lathe.

2. Head Stock- It supports the main spindle in the bearings and aligns it properly and provides different spindle speeds. Holding devices like Three Jaw Chuck, Four Jaw Chuck and Faceplate etc, are mounted on Head Stock spindle.

3. Tail Stock - It is movable part located opposite to Head Stock on the Bed ways. It is used for two purposes. (a) To support free end of the long jobs during machining. (b) To hold certain cutting tools for performing operations like drilling, reaming & tapping etc.

4. Carriage-It is located between Headstock and Tailstock. It can slide along Bed ways and can be located at any position by tightening the Carriage lock screw. It consists of following five main parts. (a)Tool post (b) Compound Rest (c) Cross Slide (d) Saddle (e) Apron

5. Feed mechanism-provides feed motion to the cutting tool and consists of (a) Feed Gear Box (b) Feed Shaft(c) Feed Selectors etc.

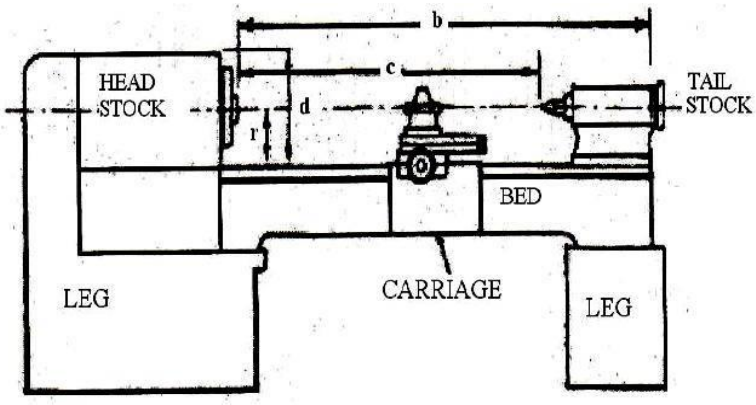
Specifications of lathe- The size of the lathe is specified as below:

b: Length of Bed.

c: Admittance b/w centers i.e., Maximum Job length that can be admitted b/w live & dead center.

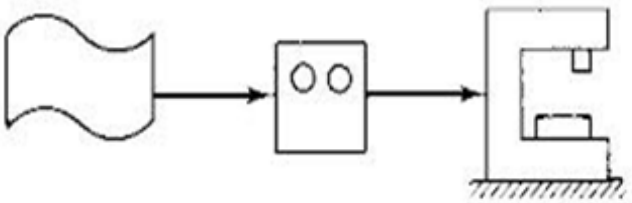
d: Swing over Bed i.e., Maximum diameter of the work piece that can be rotated over Bed.

r: Centre height.



Numerical control (NC) of Machine Tools: It is the automation of machine tools that are operated by precisely programmed commands encoded on a storage medium, as opposed to manual control. Most NC today is **computer numerical control** (**CNC**), in which computers play an integral part of the control.

History of Numerical control (NC) John T Parson is regarded as the Father of Numerical Control. His brilliant conceptualization of NC marked the beginning of an age in which the control of machines and industrial processes would pass from imprecise craft to exact science. His team built a first NC machine tool at University of Michigan in 1952

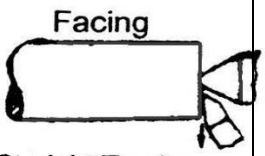


Program of Instructions **Control Unit** **Machine Tool**

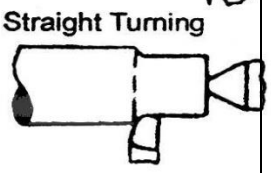
Fig: Three Basic Component of Numerical Control System

Operations performed on Lathe:

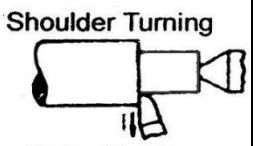
Facing: In the context of Turning work, it involves moving the cutting tool at right angle to the axis of rotation of the rotating work piece. This can be performed by the operation of the cross-slide.



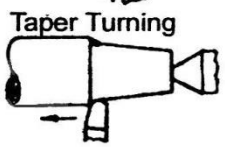
Straight Turning: It is one of the most basic machining operations. That is, the part is rotated while a single point cutting tool is moved parallel to the axis rotation.



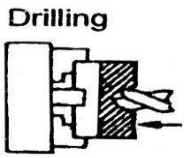
Shoulder turning: In Shoulder turning, there is a 90-degree face moving from one diameter to the other as you can see in the fig. It is done by moving Cutting tool at Rt angle to the job axis using cross slide.



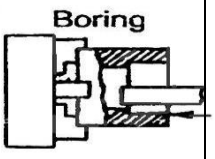
Taper Turning: Machining a cone or frustum of a cone by turning at an Angle to the job axis.



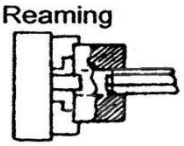
Drilling: is used to remove material from the inside of a work piece. This process utilizes standard drill bits held stationary in the tail stock of the lathe.



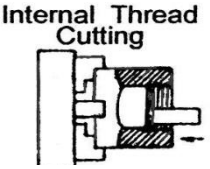
Boring : Enlarging or smoothing an existing hole created by drilling, moulding etc. by using a cutting tool mounted in a Boring bar.



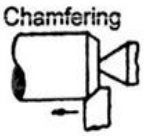
Reaming: The sizing operation that removes a small amount of metal from a hole already drilled. It is done for making internal holes of very accurate diameters.



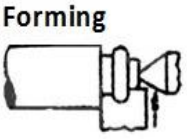
Threading : Both standard and non-standard screw threads can be turned on a lathe using an appropriate cutting tool. (Usually having a 60, or 55° nose angle) either externally, or within a bore.



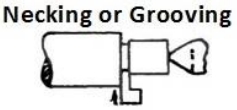
Chamfering: Chamfering connects two surfaces with a beveled edge. If the surfaces are at right angles, the chamfer will typically be symmetrical at 45 degrees. A form tool is used for chamfering.



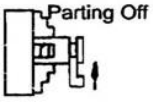
Forming: The forming is an operation that produces a convex, concave or any irregular profile on the work piece, using a form tool having a form cut in opposite direction.



Grooving: Grooving is like parting, except that grooves are cut to a specific depth, instead of severing a completed / part-complete component from the stock.



Parting Off: This operation is also called **cut off.** It is used to create deep grooves which will remove a completed or part-complete component from its parent stock.



Lathe tool materials: The tool used in a lathe for general purpose work is a single point cutting tool. The material used for lathe tools should have hardness, toughness, heat resistance and low wear. The commonly used cutting tool materials are High Speed Steel, Cemented Carbides, Cubic Boron Nitride (CBN), Diamond and Ceramics etc.

Practical Exercise No. 3.1:

Aim: To make a job, involving Facing, Plain turning, Step turning, Grooving, Taper turning, Knurling & Chamfering on a Center Lathe machine.

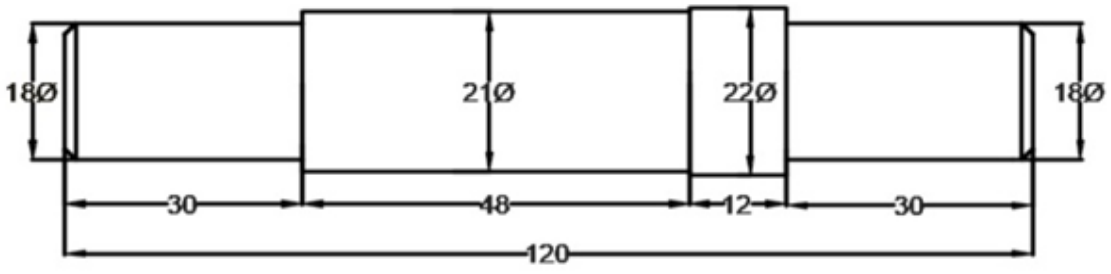
Equipment & tools used: Centre Lathe machine, Turning Tool, Grooving Tool, Steel Rule & Vernier Callipers etc.

Material Used: Mild Steel bar **Ø** 25 x 125 mm.

Procedure:

1. Hold the bar in 3 jaw chuck in a way that at least 20 mm of bar stock is projected outside the chuck.
2. Do facing of both the ends of bar and maintain dimension 120 mm.
3. Hold the turning tool in Tool post so that it projects out of the tool post about 25 mm. The cutting edge of the tool should coincide with the center of work piece.
4. Hold the job in a 3-jaw chuck, about 45 mm of the job projecting out. The Ø22 mm is obtained first taking one or more rough cuts then finally a finishing cut of not more than 0.50 mm depth is taken.
5. Similarly turn Ø18 mm to a length of 30 mm from the free end.
6. Chamfer the free end.
7. Remove job from the Chuck and hold from Ø18 mm resting against Ø22 mm shoulder.
8. Reduce and finish Ø25 mm to Ø21 mm up to length 78 mm from end by plain turning.
9. Turn Ø18 mm up to length 30 mm as explained above.
10. Do Chamfering on the free end at the same setting.
11. De burr all over and remove job from the Chuck.
12. Hold the job from Ø 21 mm and about 60 mm length projected outside the chuck.
13. Turn Ø 22 mm to Ø 21 mm and turn a groove of 8 mm width and Ø 17 mm using a parting tool.
14. Do diamond knurling on Ø 21 mm.
15. Chamfer the free end.
16. Remove job from the chuck and hold from Ø 18 mm resting against the step Ø 22 mm.
17. Turn Ø 21 mm to Ø 19 mm throughout length.
18. Find the half taper angle using the relation
19. Tan θ = D-d/2L=19-16/2x40=0.0375, θ = 2.15°
20. Set the Compound slide at the calculated angle.
21. Turn taper slowly till a regular taper connecting Ø 16 mm to Ø 19 mm is achieved.
22. Chamfer the free end.
23. Deburr all over.
24. Remove job from the chuck and inspect

Job Sketch 3.1(a):

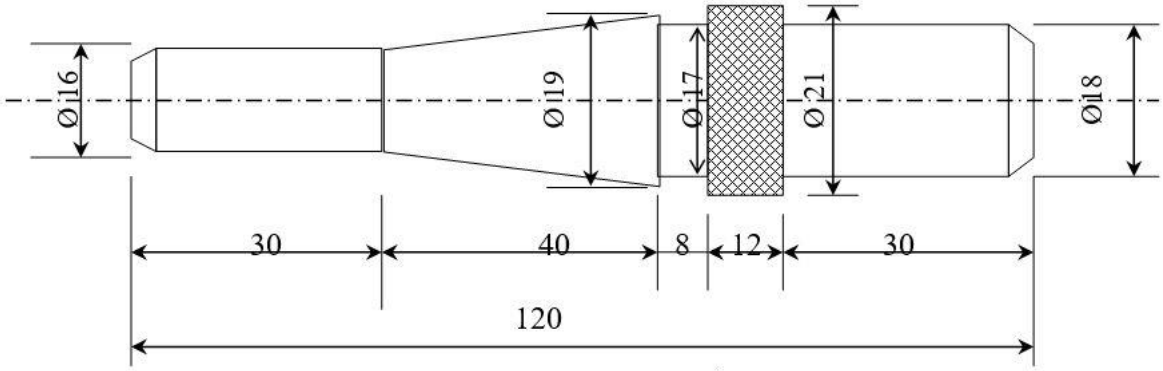


[Tolerance ± (0.5, 0.1) mm on length and diameter respectively]

Observations 3.1(a):

Measuring Instrument Used	Required Dimensions (mm)	Actual Dimensions (mm)
Vernier Callipers	Ø 18, 18 mm	
Vernier Callipers	Ø 22 mm	
Vernier Callipers	Ø 21 mm	
Vernier Callipers	Length 120 mm	
Vernier Callipers	Length 30 mm	
Vernier Callipers	Length 12 mm	
Vernier Callipers	Length 48 mm	
Vernier Callipers	Length 30 mm	

Job Sketch 3.1(b):



All Dimensions are in mm
Tolerance on length and dia ± 0.5, 0.1mm respectively.

Observations 3.1(b):

Measuring Instrument Used	Required Dimensions (mm)	Actual Dimensions (mm)
Vernier Callipers	Ø 16 mm	
Vernier Callipers	Ø 19 mm	
Vernier Callipers	Ø 17 mm	
Vernier Callipers	Ø 21 mm	
Vernier Callipers	Ø 18 mm	
Vernier Callipers	Length 30 mm	
Vernier Callipers	Length 12 mm	
Vernier Callipers	Length 8 mm	
Vernier Callipers	Length 40 mm	
Vernier Callipers	Length 30 mm	

Lab Instructor (Sign.) Teacher (Sign.)

Sample Viva questions with answer for Machine Shop

1. What are the important safety precautions to be observed in a Machine Shop?

2. What is a Machine? ***It is a device that uses energy in some available form, and converts this energy into useful form of work. Ex. Bicycle, Sewing Machine and hydraulic press etc.***

3. What is a Machine Tool? ***A powered device which performs material removal operation, with the help of cutting tools to give desired shape and size to the w/p.***

4. Name some Machine Tools: ***Centre Lathe, Shaper, Drilling machine, Power Hacksaw, grinding machine and boring machine etc.***

5. What are different types of Lathes? ***Speed lathe, Bench lathe, Tool Room lathe, Centre Lathe, Copying lathe, CNC lathe, Turret lathe and Capstan lath etc.***

6. Who invented the first ever screw cutting lathe? ***Henry Maudslay in1800.***

7. What is the principle of working of lathe? ***A job is held between Centres and turned on its axis. A cutting tool is brought in contact with the W/P and the metal is removed in the form of chips. Hardness of the cutting tool must at least be 1.5 times the hardness of the W/P.***

8. List some of the operations that can be done on the Centre Lathe. ***Plain Turning, Parting Off, Grooving, Threading, Knurling, Drilling, Chamfering and Necking etc***

9. Name the five main parts of a Lathe**.** ***Bed, Head Stock, Tail Stock, Carriage and Feed Mechanism.***

10. Why is Lathe bed commonly made of Cast Iron? ***Due to the following reasons (i) It can be cast in a single piece for strength and rigidity (ii) CI has self-lubricating properties due to free graphite in it (iii) CI has noise and vibration damping properties.***

11. Why is Centre Lathe so called? ***Since it has two Centres called Live and Dead Centre.***

12. Why centre lathe is also called Engine Lathe? ***Because it used to be run by steam or diesel engine before the advent of Electric motor.***

13. Name the five main parts of a Carriage? ***Tool post, Compound Slide, Cross Slide, Saddle and Apron.***

14. What is 'live' and 'dead Centre' in regards to Centre lathe? ***Live Centre is a powered Centre located in Head Stock spindle and Dead Centre is without power located in Tail Stock.***

15. What is the use of Lead screw on a Centre lathe? ***It gives motion to the Carriage during Threading operation.***

16. What are the different holding devices used On Lathe? ***3 Jaw Chuck, 4 Jaw Chuck, Face Plate, Collet Chuck and Pneumatic Chuck etc.***

17. Name some Lathe accessories. ***3 Jaw Chuck, 4 Jaw Chuck, Face Plate, Collet Chuck, Pneumatic Chuck, Steady Rest, Follower Rest, Mandrel, Angle Plate ,Dead Centre, Lathe Dog and Revolving Centre etc***.

18. What is the difference between 3jaw and 4 jaw Chuck? ***3 Jaw Chuck also called Self Centering Chuck, is used for holding symmetrical jobs. 4 Jaw Chuck also called independent Chuck, is used for holding Asymmetrical jobs.***

19. Explain the use of a Face Plate**.** ***Jobs which can't be held in chucks due their shape are held in Face plate.***

20. Where do we use a Collet Chuck? ***It is used for holding cylindrical jobs in production lathes.***

21. What is the use of Rests? ***Rests are used to support long jobs.***

22. What is the difference between a Steady Rest and a Follower Rest? ***Steady Rest does not move and is fixed to the Lathe Bed. It is used when operation is to be done on the end of a job. Follower Rest moves is fixed on Carriage and moves with it. It is used to support long slender jobs while turning.***

23. Name some Cutting tool materials used for Lathe tools? ***High Speed Steel (HSS), Tungsten Carbide (WC), Ceramics, Cubic Boron Nitride (CBN) and Diamond etc.***

24. What is CBN? ***The second hardest material after diamond is a heat and chemically resistant refractory compound of boron and nitrogen.***

25. What is a refractory material? ***Material which can retain its hardness at very high temperatures.***

26. Which is the most common cutting tool material in use these days? ***It is Cubic Boron Nitride (CBN)***

27. Why can't be use HSS tool for machining hard metals? ***Because it cannot retain its hardness at elevated temperature.***

28. What are the major Lathe specifications? ***Admittance between Centres (ABC), Height of Centres (HOC), Swing, No. of Spindle speeds, range of feeds and thread pitches.***

29. What is the least count of a Vernier Caliper? ***It is 0.02mm.***

30. Who invented the Vernier Scale? **Pierre Vernier** ***a French mathematician in 1631.***

31. What is the least count of a Micrometer? ***It is 0.01mm.***

32. What is the use of a Dial Indicator? ***It is used to show the total indicated run out (TIR) of the W/P***

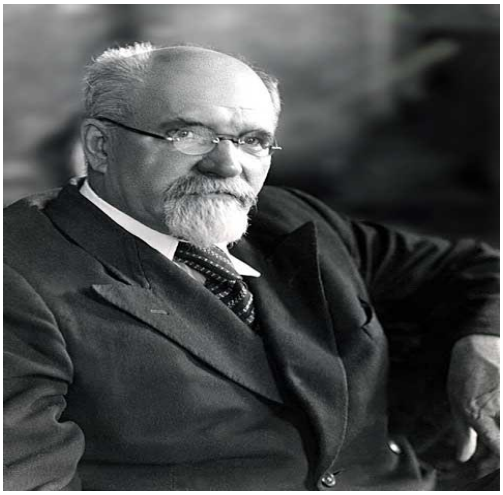
33. Name the principal parameters of machining**.** ***Cutting velocity, feed and depth of cut.***

34. What is a Turret Lathe? ***A sturdy Lathe used in mass production, capable of working with no. of cutting tools at a time.***

35. Why you must be very careful while working on Lathe? ***Since Lathe is a powered Machine Tool and has parts rotating at high rpm. Risk of getting loose clothes and hair entangled in rotating parts is very real.***

WELDING SHOP

NIKOLAY BENARDOS



NIKOLAY SLAVYANOV

NIKOLAY BENARDOS invented Arc Welding in 1881 and used carbon electrodes. It was the first practical welding method ever used.

NIKOLAY SLAVYANOV in 1888 introduced Arc Welding with consumable metal electrodes, the second historical Arc Welding method after Carbon Arc Welding.

Welding Shop:

SAFETY PRECAUTIONS: To prevent injury to personnel, extreme caution should be exercised when using any types of welding equipment. Injury can result from fire, explosions, electric shock, or harmful agents. Both the general and specific safety precautions listed below must be strictly observed by workers who weld or cut metals:

- Do not permit unauthorized persons to use welding or cutting equipment.
- Do not weld in a building with wooden floors, unless the floors are protected from hot metal by means of fire-resistant fabric, sand, or other fireproof material. Be sure that hot sparks or hot metal will not fall on the operator or on any welding equipment components.
- Remove all flammable material, such as cotton, oil, gasoline, etc., from the vicinity of welding.
- Before welding or cutting, warm those in close proximity who are not protected to wear proper clothing or goggles.
- Remove any assembled parts from the component being welded that may become warped or otherwise damaged by the welding process.
- Do not leave hot rejected electrode stubs, steel scrap, or tools on the floor or around the welding equipment. Accidents and/or fires may occur.

- Always keep a suitable fire extinguisher nearby. Ensure the fire extinguisher is in operable condition.
- Mark all hot metal after welding operations is complete. Soapstone is commonly used for this purpose.

Welding: The process of joining together two pieces of metal so that bonding accompanied by appreciable inter atomic penetration takes place at their original boundary surfaces. The boundaries disappear at the weld, and integrating crystals develop across them. Welding is carried out using heat or pressure or both and with or without added metal.

Electric Arc welding: It is a group of welding processes which uses a welding power supply to create an electric arc between an electrode and the base material to melt the metals at the welding point.

Historical background: While examples of forge welding go back to the Bronze Age , arc welding did not come into practice until much later. In 1802, Vasily Petrov discovered the continuous electric arc and it was Nikolay Benardos, a Russian scientist was able to use it practically for welding steel. He patented the first electric arc welding process using carbon electrodes in the year 1887. He is considered the father of welding technique as his invention formed the basis for the subsequent development of the welding processes.

Some types of Electric Arc welding processes:

- Shielded Metal Arc Welding / Manual Metal Arc Welding
- Submerged Arc Welding
- Plasma Arc Welding
- Electro Gas Welding
- Atomic-hydrogen Welding
- Underwater Welding
- Metal Inert Gas Welding
- Tungsten inert Gas Welding

Shielded Metal Arc Welding (SMAW): Also known as **Manual Metal Arc Welding** (MMAW), is a manual arc welding process that uses a consumable electrode coated with flux to lay the weld. An electric current, in the form of either alternating current or direct current from a welding power supply, is used to form an electric arc between the electrode and the metals to be joined. As the weld is laid, the flux coating of the electrode disintegrates, giving off vapors that serve as a shielding gas and providing a layer of slag, both of which protect the weld area from atmospheric contamination.

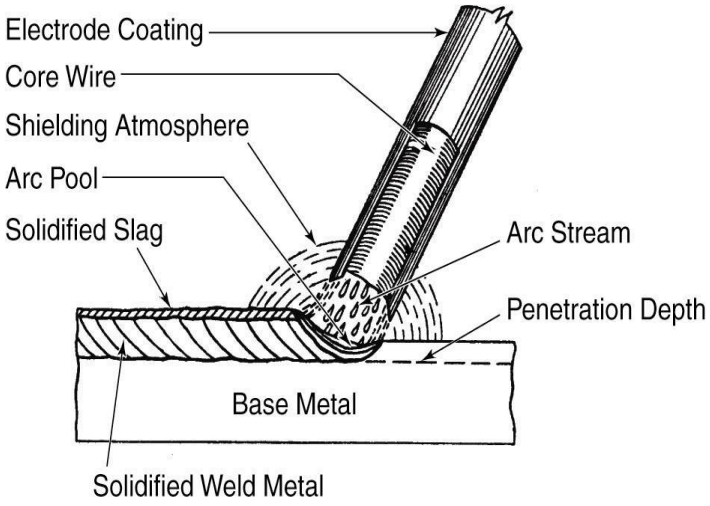


Fig: Mechanism of welding in SMAW/MMAW

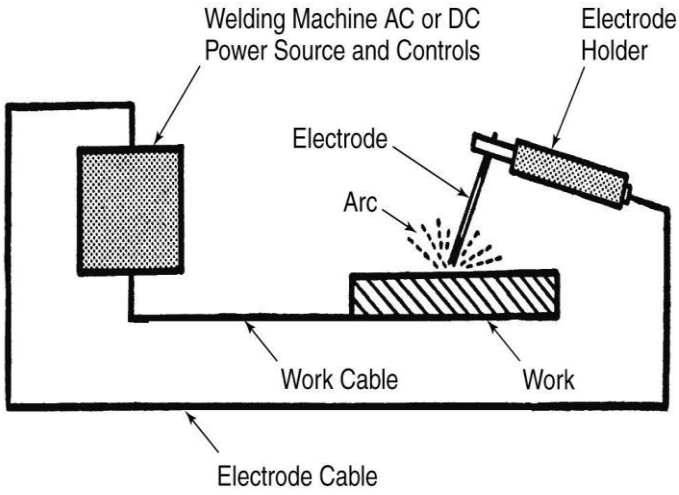


Fig: Equipment set up in MMAW/SMAW

Functions of an Electrode in SMAW:

a. It completes the electrical circuit.
b. It keeps the electric arc struck between electrode and work piece.
c. It provides the filler metal in the weld.

d. The flux coating on the electrode changes into slag during welding and protects the newly formed weld from the atmospheric contamination.

Comparison between AC and DC welding:

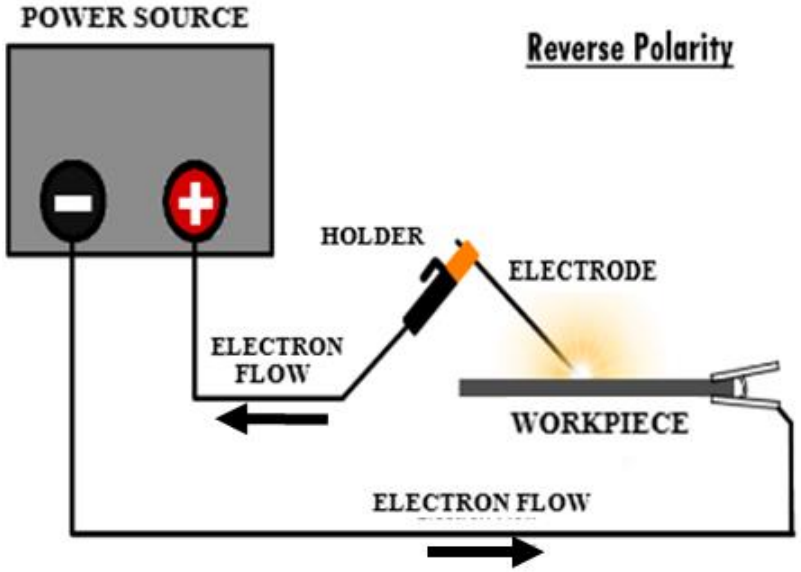
AC Welding	DC Welding
1.An AC welding transformer is cheaper and easy in operation	DC welding equipment is costlier and cumbersome in operation.
2.Arc blow is not a problem	Arc blow is a major problem.
3. Can weld only ferrous metals.	Can weld both ferrous and non-ferrous metals.
4. Only coated electrodes can be used.	Both coated and bare electrodes can be used.
5. Equipment has no moving parts and needs less maintenance.	Equipment may have moving parts necessitating frequent maintenance
6. Polarity is not available.	Polarity is available and is used to advantage.
7. Less suitable at low currents for small diameter electrodes.	Better suited at low currents for small diameter electrodes.
8. Used for general and medium quality work.	Used for specialized and high-quality work

Polarity in DC Electric Arc Welding:

The term 'polarity' is used to describe the electrical connection of the electrode in relation to the terminal of a power source. In DC Electric Arc Welding 2 types of polarity in is there, namely Reverse Polarity and Straight Polarity. Reverse Polarity in DC Welding gives better & Deepest Penetration as compared to Straight Polarity.

1. Reverse Polarity:

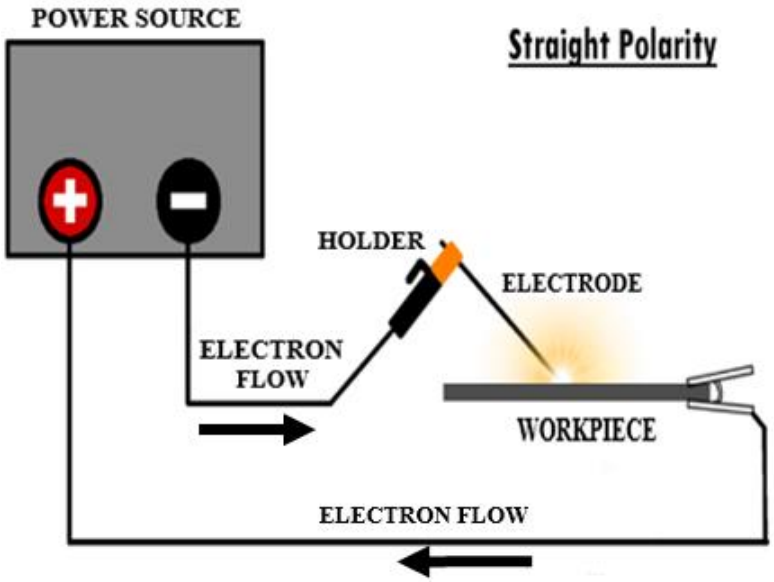
"Reverse" Polarity are common terms for "electrode-positive" polarity i.e., the work piece is attached to the negative pole of supply and electrode is attached with the positive one. In reverse polarity the electrons travel from negative to positive (this means from the work to the electrode). This super heat the electrode (about 66%) and the rod material travels across the arc stream with a high velocity and digs into the metal causing deeper penetration. Two thirds of the heat is directed at the electrode and one third to the work.



2. Straight Polarity:

Straight Polarity are common terms for "electrode-negative" polarity i.e., the work piece is attached to the positive pole of supply and electrode is attached with the negative one. In straight polarity the electrons

travel from the electrode to the work. Two thirds of the heat (around 66%) is directed to the work piece and one third to the electrode. Even though more heat is directed to the work the penetration is not as deep as with electrode positive. while electrode-negative (straight) polarity has the benefit of faster melt-off and faster deposition rate. Different shielding gases may further affect the weld as well.



Conclusion: For deepest penetration, use DC Reverse Polarity (Electrode Positive) and for lower penetration & higher deposition rate, use DC Straight Polarity (Electrode Negative).

DC has got an advantage that polarity can control the heating rate. Straight polarity is when electrode is connected to the negative terminal and the workpiece is connected to the positive terminal of the power source.

Since the electrons are emitted from the cathode terminals that is the negative terminal, so the electron will move from the negative terminal with very high speed and when they collide with the workpiece surface their kinetic energy changes into the thermal energy. so, the positive terminal will receive 66% of the heat and the negative terminal will receive 33% of the heat. More melting of the workpiece will be done i.e., more melting of the base metal will be done, so electrons will strike the work piece that will give us a **deeper penetration with straight polarity.**

Straight polarity or DCEN (Direct curent electrode negative) is a situation where the electrode is made negative and the work is made positive. Since, electrons flow from negative to positive, a large amount of heat appears on the work, usually 2/3rd of total heat. *More heat implies deeeper penetration.* DCEN is required for thicker plates and materials of higher thermal conductivity.

Reverse polarity or DCEP (Direct current electrode positive) is a situation where the electrode is made positive and the work is made negative. So, a large amount of heat appears at the electrode here (not on the work). This is done for the purpose of welding thinner plates. Weld penetration is less due to less amount of heat available to the work.

In DCEN (DC electrode negative) the electrode is negative and workpiece is positive.

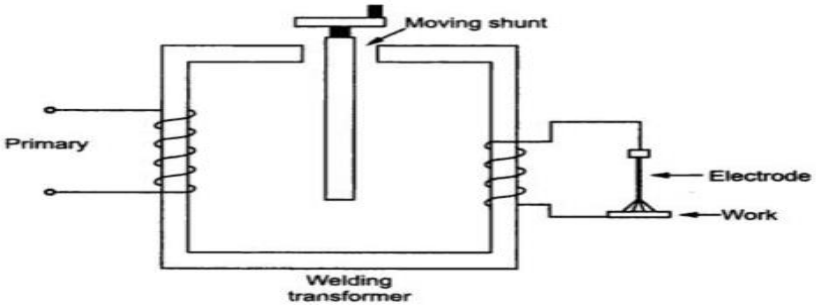
Current flows from positive to negative whereas the electrons will be from negative to positive terminal. So, in DCEN (straight polarity) the electrons hit the workpiece and the kinetic energy of electrons is transferred to the workpiece in addition to the spark (heat energy) so it produces more heat on workpiece as well as deep penetration. (As an analogy think that you hit a workpiece with metal ball which produces indentation on work piece).

In DCEP (DC electrode positive) the electrode will be at positive terminal and work piece will be at negative terminal. As the electrons flow from workpiece to electrode. So here the electrons move from workpiece to electrode generating heat as well as the Kinetic energy of the electrons will produce additional heat on electrode (electrons hit electrode from workpiece). This produces more heat on electrode and consumes more electrode. As heat is more, they easily melt and provide wider weld width.

DCEP (reverse polarity) produces deeper penetration as compared to straight polarity. The reason for it is that in case of reverse polarity the electrons are transferred from the plate to the electrode and since the available surface area for electrons to escape is higher, greater heat is generated at the plate surface resulting in deeper penetration.

Welding equipment and Accessories:

Transformer (welding power source): It is basically a step-down transformer that reduces the voltage from the source voltage to a lower voltage that is suitable for welding, usually between 15 and 45 volts. The secondary current is quite high. 200 to 600 amps would be typical, but it could be much higher. The secondary coil may have several taps for adjusting the secondary voltage to control the welding currents.



A moving shunt type welding transformer

Electrode holder: A device used for mechanically holding the electrode and conducting current to it.

Welding leads:

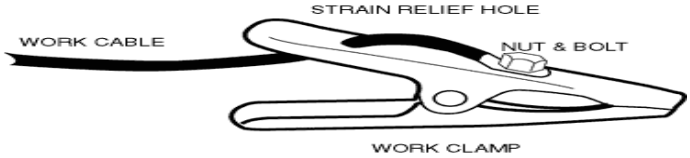
(a) Electrode lead: The electrical conductor between the source of the arc welding current and the electrode holder.

Welding Lead

Work/ Ground lead

(b) Work lead: The electrical conductor between the source of the arc welding current and the work piece.

Work clamp: **C**onnects the work lead to the work piece.



Cable Lugs: These are very important items for connecting welding leads to the welding power source.

Hand shield: A device used in arc welding to protect the face and neck. It is equipped with a filter glass lens and is designed to be held by hand.

Jackson Products Co.

Helmet: A device used in arc welding to protect the face and neck. It is equipped with a filter glass and is designed to be worn on the head.

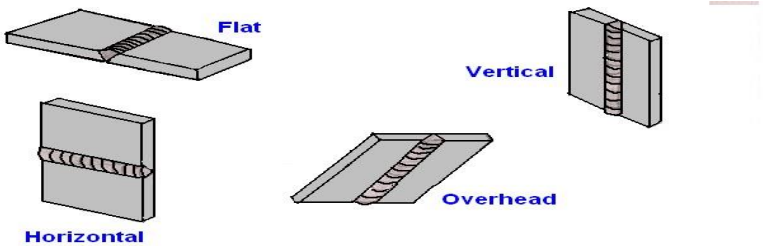
Chipping hammer: A chipping hammer is a tool used to remove welding slag from a weld and welding spatter from alongside weld.

Steel Wire Brush: Used to clean the work piece surfaces before welding and to remove the slag after welding by brushing.

Positions of welding: All welding is accomplished in one of four positions: flat, horizontal, overhead, and vertical.

Flat position: The position in which welding is performed from the upper side of the joint and the face of the weld is approximately horizontal.

Vertical position: The position of welding in which the axis of the weld is approximately vertical. In pipe welding, the pipe is in a vertical position and the welding is done in a horizontal position.

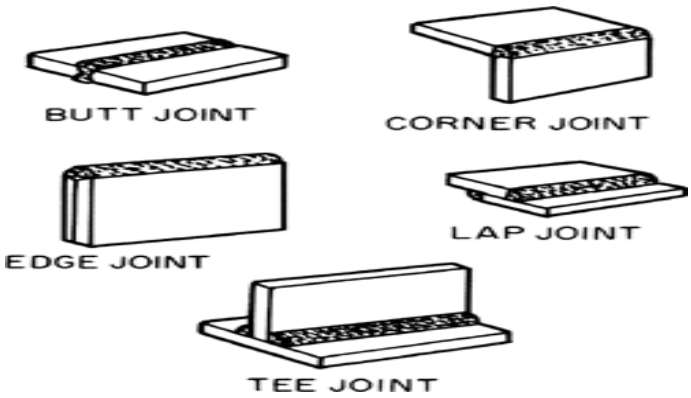


Welding Positions

Horizontal position: A bead or butt weld with its linear direction horizontal or inclined at an angle less than 45 degrees to the horizontal, and the parts welded being vertically disposed.

Overhead position: The position in which welding is performed from the underside of a joint and the face of the weld is approximately horizontal.

Weld joints:



Butt joint: A joint between two work pieces in such a manner that the weld joining the parts is between the surface planes of both of the pieces joined.

Corner joint: A joint between two members located approximately at right angles to each other in the form of an L.

Edge joint: A joint between the edges of two or more parallel or nearly parallel members.

Lap joint: A joint between two overlapping members.

Tee joint: A joint between two members located approximately at right angles to each other in the form of a T.

Common welding Defects:

1. Porosity: Porosity refers to the entrapment of gas bubbles in the weld metal resulting either from decreased solubility of a gas as the molten weld metal cools or from chemical reactions that occur within the weld metal.

2. Slag inclusions: Slag inclusions refer to nonmetallic solids trapped in the weld deposit, or between the weld metal and base metal.

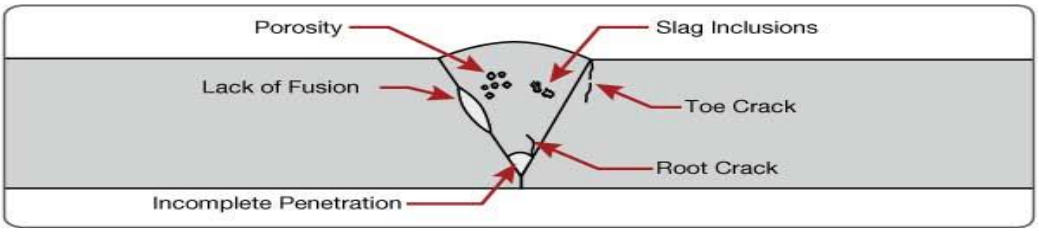


Fig: Showing 1-4 defects

3. Incomplete fusion: Incomplete fusion refers to lack of complete melting between adjacent portions of a weld joint.

4. Cracking: Cracks appear as linear openings at the metal surface. Cracking of weld metal can be critical and has led to frequent failures.

5. Under Cut: The undercut refers to the creation of a continuous or intermittent groove melted into the base metal at either the surface or at the root of the weld.

6. Overlapping: When the face of the weld extends beyond the toe of the weld without fusing with the Base metal.

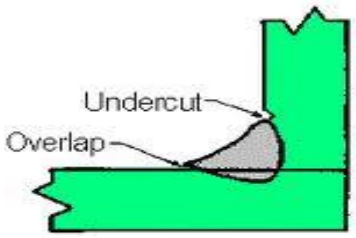


Fig: Showing 5-6 defects

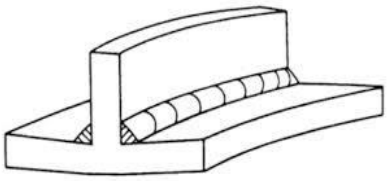


Fig: Distortion in a Fillet weld

7. <u>Distortion:</u> Shrinkage in welds introduces residual stresses and distortion. Distortion can pose a major problem, since the final product is not the desired shape.

<u>Futuristic trends in the welding process:</u> Developments in the field of welding have continued with the invention of Under Water Welding, Laser Beam Welding, Electron Beam Welding, Electromagnetic Pulse Welding and Friction Welding etc. Today, the Robot welding is commonplace in industrial settings, and researchers continue to develop new welding methods and gain greater understanding of weld quality.

<u>Practical Exercise No. 3.2:</u>

Objective: To make a Butt joint by Manual Metal Arc Welding.
Equipment and Tools used: Arc welding set, electrodes, Bench vice, Steel Rule, Try square, Flat Bastard file 12", Chipping hammer, Anvil, flat Tongs, Steel wire Brush, Face Shield, Number punch set.
Material Used: Mild steel flat of size 80x32x5mm and MS electrode size 3.15m.
Procedure:
1. Cut metal pieces (02 nos.) of dimensions 80x32 x 5 mm from Mild Steel Flat using Lever Shearing Machine.
2. Straighten the cut pieces on Anvil using hammer.
3. File ends of the work pieces to make them at right angle to the length. Check with a Try Square.
4. Put pieces alongside length and Tack weld at both ends, so that pieces do not shift under welding stresses.
5. Keep Root Gap of about 2mm.
6. Place the job on the Work Table and Tack weld two pcs at ends.
7. Weld the job alternatively from ends toward middle.
8. Remove the Slag using Chipping Hammer.
9. Clean the job with the help of a steel wire brush.
10. Punch your UID on the job using punch set and a hammer.

Precautions:
1. Check for broken insulation on cables and electrode holder.
2. Always use a face shield during welding.
3. See that welding machine is earthed.
4. Always use rubber sole shoes in work shop.
5. Welding area must always be kept dry to avoid electric shock.
6. Do not touch bare electrodes.

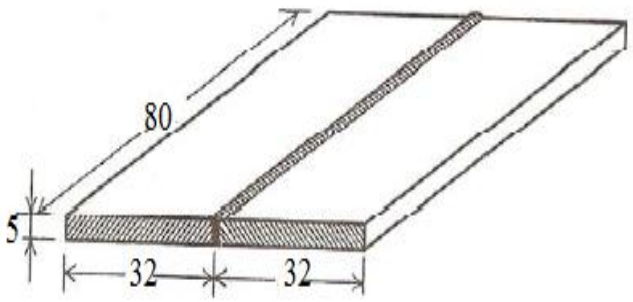


Fig: Butt Joint (All dimention in mm)

Observations:

S No	Dimensions (As per Drawing)	Dimensions (Actual made on the job)	Measuring Instrument Used
1	Length 80,80 mm		Steel Rule
2	Squareness of ends to sides		Try Square
3	Flatness		visually
4	Bead Shape & Straightness		Visually
5	Spatter		Visually

Viva questions for Welding Shop:

1. What are the important safety precautions to be observed in a welding Shop?

2. Define Welding. ***The process of joining together two pieces of metals/materials so that bonding accompanied by appreciable interatomic penetration takes place at their original boundary surfaces. The boundaries disappear at the weld, and integrating crystals develop across them. Welding is carried out using heat or pressure or both and with or without added metal.***

3. How were joints made before the advent of welding? ***Joints were made by the Riveting process***.

4. What are the two basic types of welding***? (i) Fusion welding (ii) plastic welding***

5. What is a parent and filler metal in weld joint? ***Metal of the W/p and the metal filled in the joint.***

6. What are the different heat sources used in welding processes? ***Electric arc, electrical resistance, heat of exothermic reaction, energy rays (electron beam and laser beam) mechanical friction, Smith's forge and gas flame etc.***

7. What is the most ancient type of welding known to the mankind? ***The Forge welding.***

8. How was Forge welding done? ***Two metal pieces to be joined were heated to the plastic stage in Smith's forge and then beaten together.***

9. Who invented Arc welding and when? ***Nikolay Nikolayevich Benardos in 1887.***

10. What are the functions of an electrode? ***(i) to complete the electrical circuit (ii) maintain arc between electrode and work(iii)provide filler metal***

11. What are the basic types of electrodes? ***Coated and Bare, consumables & non consumables and Flux cored***

12. List the equipment used in Arc welding? ***Welding power source (step down transformer) welding cables, face shield, chipping hammer, flat tongs and wire brush etc.***

13. Why do we use step down transformer in Arc welding? ***It decreases the voltage thereby increasing the current required for higher heat production.***

14. Which of the following parameters is a must for maintaining of an electric Arc, (i) Current (ii) voltage (iii) gap between the electrode tip and work? ***Gap***

15. What are the different Arc welding processes? ***Carbon Arc, Manual Metal Arc, Submerged Metal Arc, Metal Inert Gas, Tungsten Inert Gas, Electroslag and Electro gas etc.***

16. What is the use of flux in welding? ***Flux forms a gaseous shield around the weld area to save the newly formed weld from the atmospheric contamination.***

17. What is atmospheric Contamination? ***Atmospheric gases like nitrogen and oxygen react with the hot weld metal to form nitrides and oxides, making the weld brittle and susceptible to break under bending load.***

18. Define electric arc. ***Sustained flow of electrons through an ionized media column.***

19. What is the temperature of an electric arc***?5000 to 6000^{o}C***

20. Which will give stable arc AC or DC***? DC***

21. Which will give better welding results AC or DC***? DC***

22. What is magnetic arc blow***? Deflection of arc from its intended path due to magnetic effects.***

23. Magnetic arc blow is a problem with AC or DC? ***DC***

24. Which welding process has the maximum arc temperature? ***Plasma arc welding.***

25. What are some common welding defects? ***Poor fusion, slag inclusion, incomplete penetration, poor weld bead appearance, pin hole porosity distortion and bending etc.***

26. Why must you never expose your face to naked Arc? **Because your skin may be harmed by *Visible light rays, Infrared ray and Ultraviolet rays.***

27. What is a Fillet weld? ***Fillet weld refers to the joining two pieces of metal together whether they are perpendicular or at an angle.***

28. What is weld ability? ***The relative ease with which a metal can be welded.***

29. Out of mild steel, stainless steel and cast iron which metal has best weld ability? ***Mild steel.***

30. What is the application of Thermit welding? ***It is used for welding Railway lines.***

31. Which welding process is used to weld LPG cylinders? ***Submerged Arc Welding.***

32. Can you Arc in Submerged Arc Welding? ***No, it is submerged in Granular flux.***

33. Which welding process can weld plates up to half meter thick in one go? ***Elecrtroslag welding.***

34. What are the different heat sources employed in welding processes? ***Electric Arc, Exothermic reaction, chemical energy, mechanical friction, and high energy beams etc.***

35. Welds in rockets and missiles are made by using ***high energy beams.***