Workshop Practice Laboratory (ES 107): Working Manual

LIST OF EXPERIMENTS

EXPERIMENT NO. 1

To make Middle lap T joint, cross lap joint, mortise and Tenon T joint using carpentry tools

1. **Objective** **2. Apparatus** **3.Theory** **4.Procedure** **5. Observation**
6. Result and discussion **7. Conclusion** **8.Precautions** **9. Viva Questions**

1. Objective: To make Middle lap T joint, cross lap joint, mortise and Tenon T joint using carpentry tools.

2. Apparatus: Steel Rule, Pencil, Try square, Marking Gauge, Rip saw and Tenon saw, Jack Planeand Smooth Plane, Firmer Chisel, Mallet and Ball peen Hammer

Material Used: Wooden piece of "RED MARINDI"'Nails and fevicol.

3. Theory:

In carpentry workshop, wooden pieces of commercial sizes are given specific shape and size, as per the requirements. The processes involved in carpentry shop are making layout, marking, sowing, plaining, chiseling jointing etc.In this chapter we shall study about the raw material and tools used in carpentry shop various raw material used that shop are wood, nut, screw, nut and bolt and glue etc. The tools are classified as marking, cutting, planning, chiseling, striking etc.

VARIOUS TYPES OF TIMBER AND PRACTICE BOARDS

Types of Wood – Common wood are generally classified according to their degree of hardness ofsoftness.

3.1 Hardwood- Hard wood has closed structure, heavy in weight, dark in colour and is difficultto work on it, annual rings are not distinct and good tensile strength.

3.2 Soft Wood- Hard wood has less weight, less durable and is easy to work out. Soft woodcatches fire soon as compared to hardwood, annual rings are quite distinct.

3.3 Plywood: It consists of more than three layers. Middle layer is called care which is thick andnot of good quality. The top and bottom are called as face plys which is glued on the care at top and bottom. The grains of adjacent layers are kept perpendicular to each other which prevents plywood form warpage.

3.4 Types of Ply – Ply Board, Comarcal Board, Chip Board, Soft Board.

Advantage of Ply wood

1. Lighter in weight and easy to work.

2. Can be used for decorating the furniture as well as houses.

3. It is also available in bigger sizes.

4. Possesses bottom strength then solid wood of same thickness.

3.5 DEFECTS IN TIMBER

Following are the common defects occurring in the wood and it can be divided into following three categories.

a. Natural Defects are the defects which are caused in the tree due to abnormality in the grouts.

b. Defects are also caused during seasoning operation.

c. Some defects are also there due to termites or insects.

Natural defects – Wood being a product of nature is subjected of natural defects, some of them areexplained below:

Shakes: Shakes are caused due to the separation of wood grains, some times, burning oftissues and shrinkage of interior parts takes place which causes radial or circular rupture in tissues and creates cavities, which are called shakes are of three types

(i) **Heart and star shakes:** These defects in the heart wood in other older tree,especially. Hemlock heart shakes can be evidenced by a small point cavity at the center of the wood as shown in fig.

(ii) **Wind shakes or Cup shaker:** The separation of annual rings is called wind shake orcup shake. These defects are common in lines.

(iii) **Radial Shakes:** Radial shakes are the radial splits extending from bark towards thecenter. These cracks over the cross section of the log are winder at the bark and narrow down near the center as shown in fig.

Knots: Knot represent irregular in the body of a tree which interrupt the smooth course of thegrand. The fibers of the tree are turned from their normal shaped and grow around the knot at that point of a tree where a link is being formed. Knots are two types:

(iv) **Dead knots:** When the separation of benches or hurbs takes place before the tree is cut,the knot thus formed called leaf knot. This knot is not held firmly and wood having leaf knot is not recommended for engineering purposes.

(v) Live knots: If the separation occurs after falling of a tree the knot thus formed is calledlive knot. A wood having live knot can be used for engineering purposes. According to the shapes knot can be classified as shown in fig.

3.6 SEASONING OF WOOD

The process of removing moisture from freshly cut down trees is known as seasoning In these threes, the percentage of moisture is very high. The wood uses of engineering purposes containing high percentage of moisture may cause many types of problems, such as shrinkage, warpage distortion etc.
To a point this, seasoning is done. After seasoning the percentage of moisture is reduced to 10-20%.

Types of Seasoning

Air Seasoning: In this method, the timber balks are stacked in a sheet such that theyare not directly exposed to sun and rain but a free circulation of air takes place through them. The timber balks are allowed to remain in that condition for a long times. The balks be periodically turned upside which accelerates the rate of drying. Due to the circulation of free air through the stack, the excess moisture evaporates and the wood gets seasoned.

This is the commonly used method which takes much time but proper seasoning can be easily done with a little care.

Water Seasoning: In this method, timber balks are immersed in flowing water for afortnight. The flowing stream of water removes the sap. The timber is then taken out and air seasoning is done as usual. This method takes less time but the strength of wood reduced.
Artificial or Kiln Seasoning: This is a quick process of seasoning of this method,the timber balks are stacked and over large trollies which are then driven into hot chambers or kilus. Hot air or dry stem is pushed into the chamber under controlled temperature conditions. The moisture content is reduced because the evaporation takes place and ultimately the timber gets seasoned.

4. Procedure:

Drawing (LAP JOINT): -

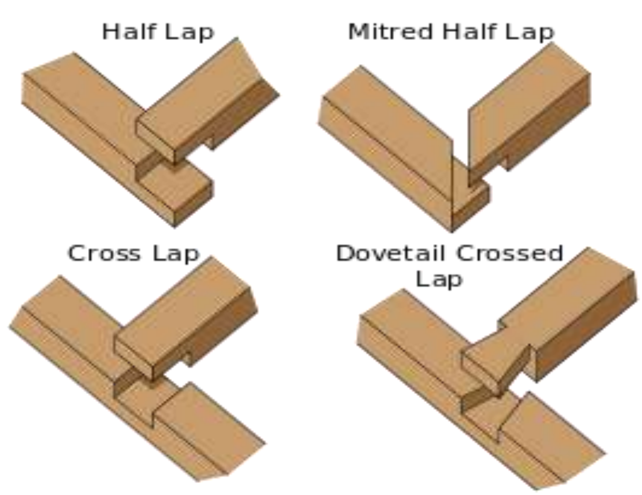

Fig. 1.1: Lap Joints

4.1 LAP JOINT

Procedure for Lap Joint:-

a. Taken a wooden piece slightly more than given dimension.

b. Fix the job piece in carpentry vice and do planning on width side the help of jack plane and smoothing with the smooth plane and check flatness and straightness of the work piece with the help of try square.

c. Same pervious process repeat on adjacent side upto make right angle (i.e. 90^0).

d. Make one size (i.e. 30 mm or 40 mm) on the work piece and remove extra material accordingly with the help of marking gauge, jack plane and smoothing plane.

e. Mark other size (i.e. 30 mm or 40 mm) on the job piece and remove extra material.

f. Mark two pieces each 150 mm in length with the help of pencil, try square and rip saw.

g. Mark on the both job piece as per given dimensions with the help of pencil, try square and marking gauge.

h. Remove extra material and produce recess on one work piece at one end and middle of the other job work as per given sketch with the help of rip saw and Tenon saw, firmer chisel and mallet.

i. Fit the job pieces in the shape of "T=- LAP JOINT"

4.2 Drawing(CROSS LAP JOINT): -

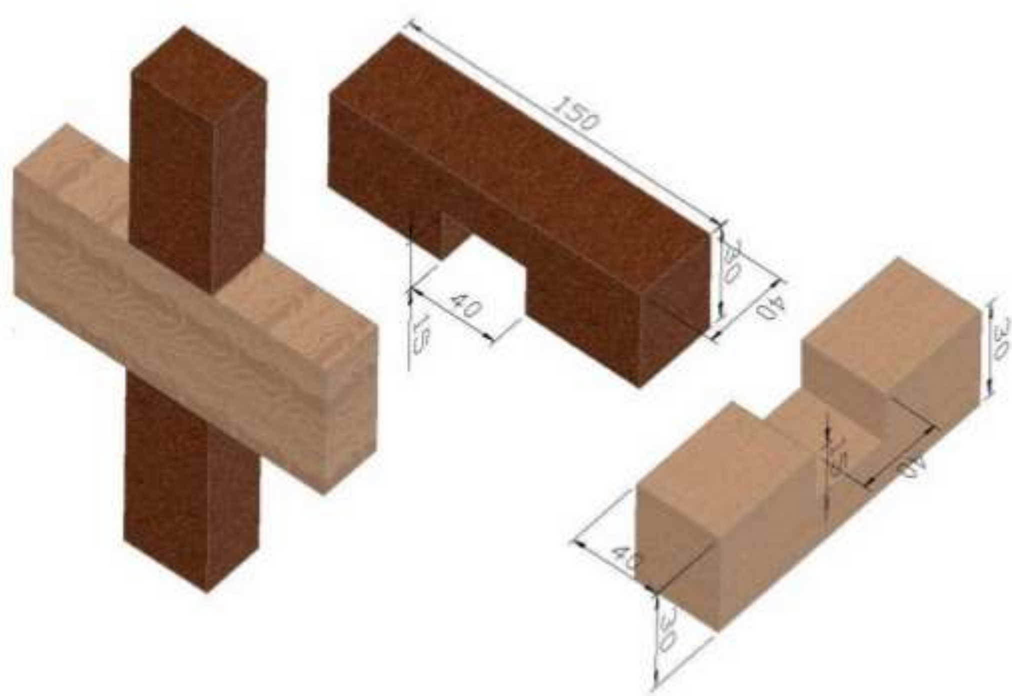

Fig. 1.2: Cross Lap Joints

4.3 CROSS LAP JOINT

Procedure for Cross Lap Joint:-

a. Taken a wooden piece slightly more than given dimension.

b. Fix the job piece in carpentry vice and do planning on width side the help of jack plane and smoothing with the smooth plane and check flatness and straightness of the work piece with the help of try square.

c. Same pervious process repeat on adjacent side upto make right angle (i.e. 90^0).

d. Make one size (i.e. 30 mm or 40 mm) on the work piece and remove extra material accordingly with the help of marking gauge, jack plane and smoothing plane.

e. Mark other size (i.e. 30 mm or 40 mm) on the job piece and remove extra material.

f. Mark two pieces each 150 mm in length with the help of pencil, try square and rip saw.

g. Mark on the both job piece as per given dimensions with the help of pencil, try square and marking gauge.

h. Remove extra material and produce recess on the middle of the both work piece as per given diagram with the help of Rip saw, firmer chisel and mallet.

i. Fit the job pieces in the shape of "CROSS LAP JOINT "

4.4 Drawing(MORTISE AND TENON JOINT): -

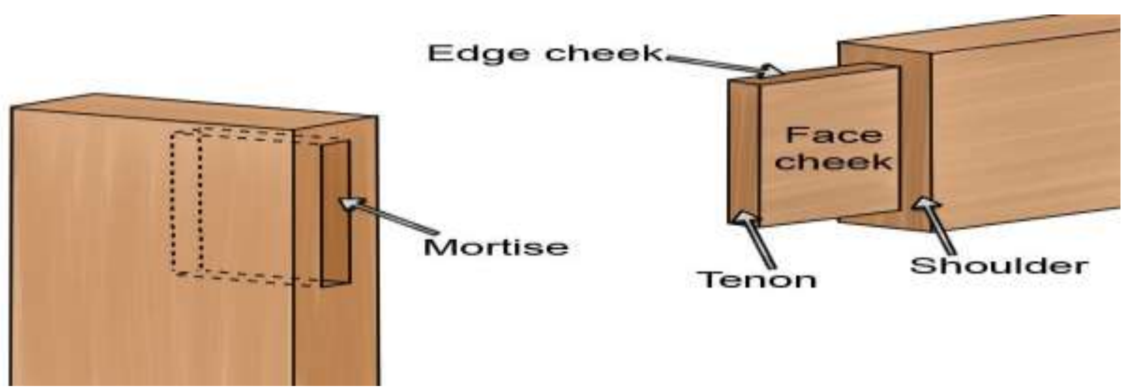

Fig. 1.3: Mortise &Tenon Joints

Procedure for Mortise and Tenon Joint:

a. Procure mortise and Tenon members of required dimension.

b. Square the piece to the suitable dimension and mark their faces.

c. Now, mark the length of the Tenon, and square a line all around it end at the point, which is the shoulder. Also mark the width of the Tenon member on the mortise at the point where they are jointed.

d. Now use a mortises gauge, mark the thickness of the Tenon. Also. Mark width of the mortises groove on the mortises member (for the face of the members that are to be flushed). Using the same gauge.

e. In order to avoid tearing of mortises while chiseling. Layout an additional check cut at both Tenon and mortises members.

f. Saw off the thin pieces of wood along the layout lines already marked, by using Tenon saw or rip saw.

g. Then trim off any unevenness with a sharp chisel.

h. When working on a plane it should be ensured that the blades are sharp and the cut is light. Use a push block for all face planning, especially on the short pieces of stock.

5.Observation

It has been observed that different type of joints prepared with the help of suitable carpentry tools. We have to learn about every procedure to make the required joints. It is also important to achieve the same dimensional accuracy of the finally produced joint as per the design consideration.

6. Result and discussion

Middle lap T joint, cross lap joint, mortise and Tenon T joint, Bridle T joint is made as per required dimensions using carpentry tools.

7. Conclusion

a. All the carpentry tools has identified before starts joints preparation.
b. Joints has been prepared with 2-5% dimensional inaccuracy.
c. Joints are being identified.

8. Precautions

a. Never feed the stock faster than its capacity.
b. Hold the job firmly with clamping devices while working at the machines.
c. Always keep the tools at proper position when not in use. They should not be scrapped on the wood floor.
d. Keep the floor area free from obstructed.

9. Viva Questions

a) Define Carpentry?

b) What is Timber?

c) Name the type of timbers and give examples?

d) What are the types of rules used for measuring?

e) What is the use of Try-square?

f) What is the need of Miter square and Bevel square?

g) What are the types of gauges used in carpentry?

h)What are the uses of following joints?

(i) Mortise and Tenon joint (ii) Bridle joint

EXPERIMENT NO. 2

To make wooden parts used in foundry with carpentry tools

1. **Objective** **2. Apparatus** **3.Theory** **4.Procedure** **5. Observation**
6. Result and discussion **7. Conclusion** **8.Precautions** **9. Viva Questions**

1. Objective: To make wooden parts used in foundry with carpentry tools

2. Apparatus: Try square, steel rule, marking gauge, smoothing plane, flat file, dividers, Hand saw,sand paper (soft wood)

Material Used : Wooden piece of “RED MARINDI”’Nails and fevicolof100 mm × 55 mm × 55 mm size.

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4. Procedure:

Drawing:

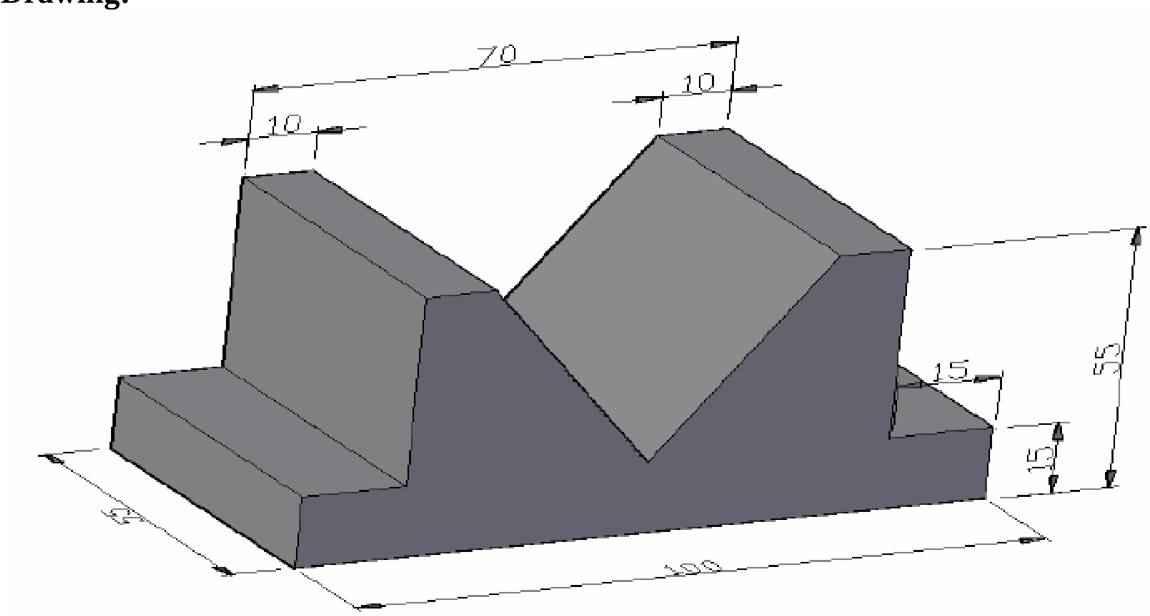


Fig 2.1 V Block Pattern

Procedure for V block pattern

1. Prepare the layout of V block pattern as per drawing.
2. Take all the allowances and core prints on the job.
3. Mark out the job as per the patterns layout.
4. Cut with handsaw and plane with the jack plane as per marking done as per layout.
5. Finish the V block pattern with the help of rasp file as per dimensions.
6. Check the dimensions as per drawing.
7. Finally use sand paper to give smooth finish to C.I. bracket pattern.

5.Observation

It has been observed that V block type pattern is prepared with the help of suitable carpentry tools. We have to learn about every procedure to make the V block pattern. It is also important to achieve the same dimensional accuracy of the finally produced pattern as per the design consideration.

6. Result and discussion

V Block Pattern is made as per required dimensions using carpentry tools.

7. Conclusion

a. All the carpentry tools has identified before starts V block preparation.
b. V Block has been prepared with 2-5% dimensional inaccuracy.

8.Precautions

1. Never feed the stock faster than its capacity.
2. Hold the job firmly with clamping devices while working at the machines.
3. Always keep the tools at proper position when not in use. They should not be scrapped on the wood floor.
4. Keep the floor area free from obstructions.

9. Viva Questions

a) What is the need of Bench vice?

b) What is the need for seasoning the wood?

c) What are the types of plane?

d) What is the cutting bevel angle in a chisel?

e) What is the material used for making the chisel?

f) What are the types of saws used in carp

EXPERIMENT NO. 3

To create fitting of Square joint, V joint, half round joint, dovetail joint

1. **Objective** **2. Apparatus** **3.Theory** **4.Procedure** **5. Observation**
6. Result and discussion **7. Conclusion** **8.Precautions** **9. Viva Questions**

1. Objective :To create fitting of Square joint, V joint, half round joint, dovetail joint

2. Apparatus:

a) 1.6”try square
b) 6”sriber
c) Odd leg caliper
d) 3.12”hack saw Frame
e) 4 Blades (12 TPI)
f) 10”rough file
g) 10”smooth file
h) 10”Square file
i) Dot punch
j) Ball peen hammer (0.5 Ib).
k) Steel Rule

Materials Used: Mild steel flat (40*40*3mm).

3.Theory

3.1 Introduction

Fitting jobs involves the removal of excess / unwanted material from a blanks with the help of hand tools so that they could be assembled as specified in drawing. It is done for the assembly practice by mating surfaces/edges of components leading to assembly.

PHYSICAL PROPERTIES OF METALS
1. **Lustre:** Lustre is the ability of a metal surface to reflect light rays.
2. **Colour:** Colour is the property of a metal to show specific surface appearance.
3. **Plasticity:** This is the property of metal where it can be converted in to required shape and
size by application of heat or pressure both.
4. **Elasticity:** It is the property of metal by which it return back to its original shape and size
after removal of external force / pressure.

5. **Malleability:** By this property metal can be drawn in the form of a thinner sheet without
failure.
6. **Toughness:** Due to this property metal can withstand bending without failure.
7. **Ductility:** By this property metal can be drawn in the form of wires without failure.

3.2 Classification Of Metals

Metals are classified into two categories:

1. **Ferrous Metals** – In ferrous metals iron acts as base (highest percentage) metal.. Some othermaterials like carbon, sulfur, nickel, etc are also mixed into ferrous metals to change theproperties. They are magnetic in nature. Some ferrous metals are discussed as under.

i) **Steel** – Steel is a mixture of iron, carbon and other alloying elements.

(a) Plain Carbon Steel: is a mixture of iron, carbon with negligible alloying elements.
Low Carbon Steel – Carbon content 0.05 to 0.30%.
Medium Carbon Steel - Carbon content 0.30 to 0.60%.
High Carbon Steel - Carbon content 0.60 to 1.50%.

(b) **Alloy Steel** – Alloy steel is made by combining some percentage of additional elements like nickel, phosphorous, silicon, chromium, molybdenum in the plain carbon steel to give strength, hardness, resistance to corrosion properties.
i. Tool Steel – is alloy steel used for making cutting tools, mainly designated as HSS(High Speed Steel) with 18% tungsten, 4% chromium, 1%
vanadium and 0.7% carbon.
ii. Invar steel – is an alloy steel with 36% Nickel leading to zero coefficient of thermal expansion used for making precision instruments.

iii. **Spring Steel** – alloy steel used for making springs.

ii) **Cast Iron** – also referred, as iron is a ferrous metal containing more than 2% of carbon is known as cast iron. It is hard and brittle material, used in machine beds, heavy parts of machines.

iii) **Wrought Iron** – It is almost pure iron containing 99.9% of iron. It is ductile and soft.

2. **Non Ferrous Metals** - The metals which has base metal other than iron are known as nonferrous metals, copper, aluminum, brass, bronze, tin, lead are common non ferrous metals.
i). **Copper:** Reddish brown color, soft, ductile, high electrical and thermal conductivity.
ii). **Brass:** Alloy of copper and zinc, soft and ductile.
iii). **Bronze:** Alloy of tin and copper, wear resistance material.
iv). **Aluminum:** Soft metal, white in color, light in weight, good electrical conductivity.
v). **Gun metal:** Alloy of copper, tin and zinc, used in making casting.

3.3 Tools Used In Fitting Shop

3.3.1 CLAMPING TOOLS

Clamping tools are used for holding the job firmly during various fitting operations.

i). **Bench vice:** It is a common tool for holding the jobs. It consists of cast iron body and iron jaws .The jaws are opened up to required length, job is placed in the jaws and is fully tightened with handle.

ii). **Leg vice:** It is stronger then bench vice and used for heavy work.
iii). **Hand vice:** It is used to grip very small objects.
iv). **Pin vice:** Pin vice is used to hold wire or small diameter rods.
v). **Pipe vice:** It is used to hold pipes. It grips the pipe at four places and is fixed on bench or can be grouted.

3.3.2 MEASURING AND MARKING TOOLS

i). **Try Square:** It is used for checking square ness of two surfaces. It consists of a blade made up of steel, which is attached to base at 90°.
ii). **Bevel Protector:** It consists of a steel dial divided into 360° divisions, used for measuring angles.
iii). **Combination Set** – Multipurpose instrument can be used as a protector, a level, a meter, a center square and a Try square.
iv). **Centre Square** – It is used to find the centre of the round jobs, Angle of punching end is 60°.
v). **Scriber and Surface Gauge** – It is used for marking of lines parallel to a surface. Scriber
mounted on a vertical bar is called surface gauge.
vi). **Dot Punch** – It is used for marking dotted lines. Angle of punching end is 60°.
vii). **Centre Punch** – It is like a dot punch used to mark the centre of hole before drilling. Angle of punch end is 90°.
viii). **Surface Plate** – Surface plate is used for testing the flatness, trueness of surfaces; its
upper face is planed to form a very smooth surface.
ix). **Angle Plate** – It consists of cast iron in which two ribs of metal are standing at right angle to each other, used for holding and supporting the jobs.
x). **'V' Block** – It is used for supporting as well as marking of round jobs.
xi). **Steel Rules** – It is made up of stainless steel and marked in inches or millimeters, available in various sizes ½ ft to 3 ft.
xii). **Vernier Caliper** – It is a precision instrument used for measuring lengths and diameters. Minimum dimension that can be expressed on Vernier caliper is known as least count, which is usually 0.001 or 0.02 mm.
xiii). **Micrometer** – It is used for measuring diameters or thickness of any Job. The graduation on micrometers is available in inches as well as in millimeters.
xiv). **Dial Indicator** – A round gauge in which a pointer moves over a graduated scale. The movement is magnified through links. It is used to check the run out or ovality of Jobs.
xv). **Dividers** – Dividers have two legs having sharp feet. It is used for marking arcs, dividing a line or transferring the dimensions.
xvi). **Calipers:** it is generally used to measure the inside or outside diameters. There are four types of calipers.
a) Outside calipers

b) Inside calipers
c) Spring calipers
d) Odd leg calipers

xvii) **Gauges**
i).**Depth Gauge:** It is used to measure the depth of a hole. The beam is graduated in inches or millimeters.

ii).**Feelers Gauge:** It is used to check the gap between two mating parts. It consists of a number of metal leaves of different thickness marked on the leaves.
iii).**Radius Gauge:** It is used to check the radius of outer and inner surfaces. Every leave has different radius.
iv).**Vertical Height Gauge:** It is used to measure the height of work pieces.
v).**Thread Gauge**: It is used to check the pitch of the threads. It consists of a number of leaves, pitch of the threads marked on each leaves.
vi).**Wire Gauge:** It is used to check the diameter of wires and thickness of sheets.

3.3.3 CUTTING TOOLS
These tools are used to remove the materials.
1. **Hacksaw** – It is used of cutting of flats, rods etc. The blade of hacksaw is made up of high carbon steel and frame is made from mild steel. The blade is placed inside the frame and is tightened with the help of a flange nut. The teeth of hacksaw blades are generally forward cut. There are two types of hacksaw frames, fixed frames and adjustable frame. The material to be cut with hacksaw is clamped in a vice. The hacksaw should be moved perfectly straight and horizontal.

2. **Files** – It is used to remove material by rubbing it on the metal. Classification of files.
i) **Size** – The length of file vary from 4 inch to 14 inch.
ii) **Shape** – The shapes available are flat, square, round, half-round, triangular etc.
iii) **Cuts** – Single and Double Cut.
iv) **Grade** –
Rough - 20 Teeth per inch
Bastard - 30 Teeth per inch
Second Cut - 40 Teeth per inch
Smooth – 50-60 Teeth per inch
Dead Smooth - 100 Teeth per inch
Rough and Bastard files are used for rough cutting, smooth and dead smooth files are used for finishing work. Files should be used in perfect horizontal position. Pressure should be applied on the forward stroke only. Work is held in a vice.

3. **Chisels** – They are used for chipping away the material from the work piece. Commonly used forms of chisels are flat, cross cut, half round, and diamond point chisels. Flat chisel is used for chipping a large surface. Crosscut chisel is used for groover. Half round chisel is used to cut oil-grooves. Diamond point chisel is used for chipping plates.

3.3.4 STRIKING TOOLS
Hammers are the only tools used for striking in fitting shop like chipping, fitting, punching etc.

Main types of hammer
1. Ball Pean Hammer
2. Straight Pean Hammer
3. Cross Pean Hammer

3.3.5 MISCELLANEOUS TOOLS
1. Drill Bit– It is used for making round holes. Twist drill is most commonly used for making
holes.
2. Reamer – It is used to finish the drilled hole to accurate size.
3. Taps – It is used for making internal threads. The tap holder holds tap, normally it comes in a set of three, taper Tap, Intermediate Tap, Plug Tap.
4. Die – It is used for cutting external threads. It is held in a diestock, the handle is rotated by hand and job is held firmly in a vice.

3.4 BENCH WORKING PROCESSES
1. **Marking** – Measurement is performed on the job by measuring instrument and scriber does marking.
2. **Chipping** – Material is removed with the help of chisels.
3. **Sawing** – This operation is required to cut the metal in different sizes and shapes by hacksaw.
4. **Filing** – This operation is performed with the help of files, pressure should be exerted in the forward stroke and backward stroke is ideal.
5. **Scrapping** – This is done for reducing more accurate finish that obtained by filing.
6. **Drilling** – This is done to produce holes with the help of drills. It is done on a drilling machine and job is held in a machine vice. Drill is fixed on the drilling machine,
7. **Tapping** – This is done to cutting the internal threads with the help of tap and tap holder.
8. **Dieing** – This is done to cut the external threads by the help of die and die holder.

4. Procedure:

Drawing

1. **SQUARE JOINT**

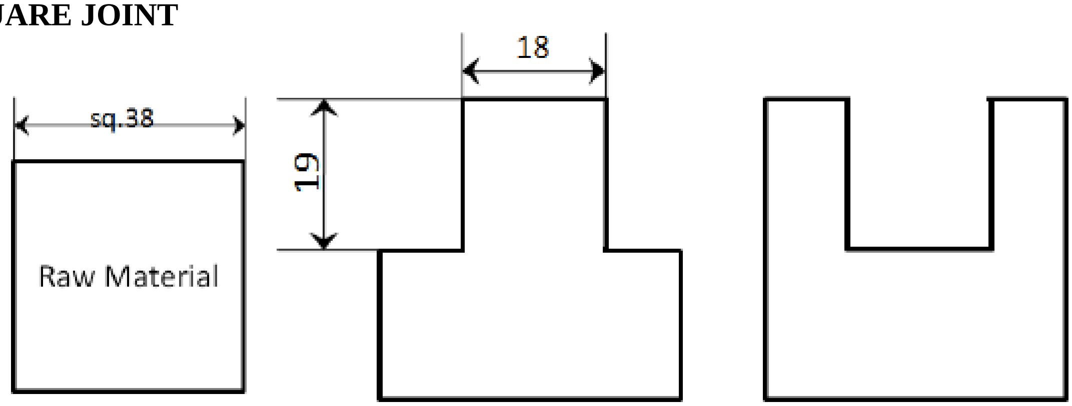


Fig 3.1 Square Joint

2. V JOINT

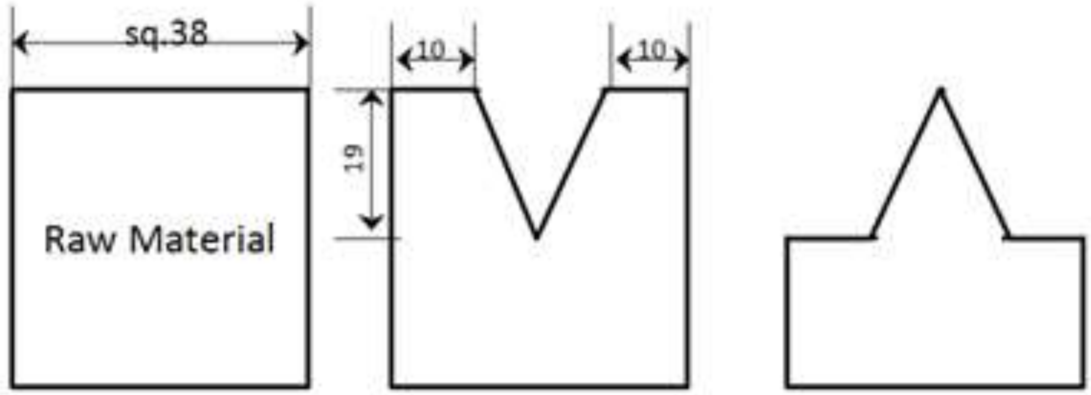


Fig 3.2 V Joint

3. HALF ROUND JOINT

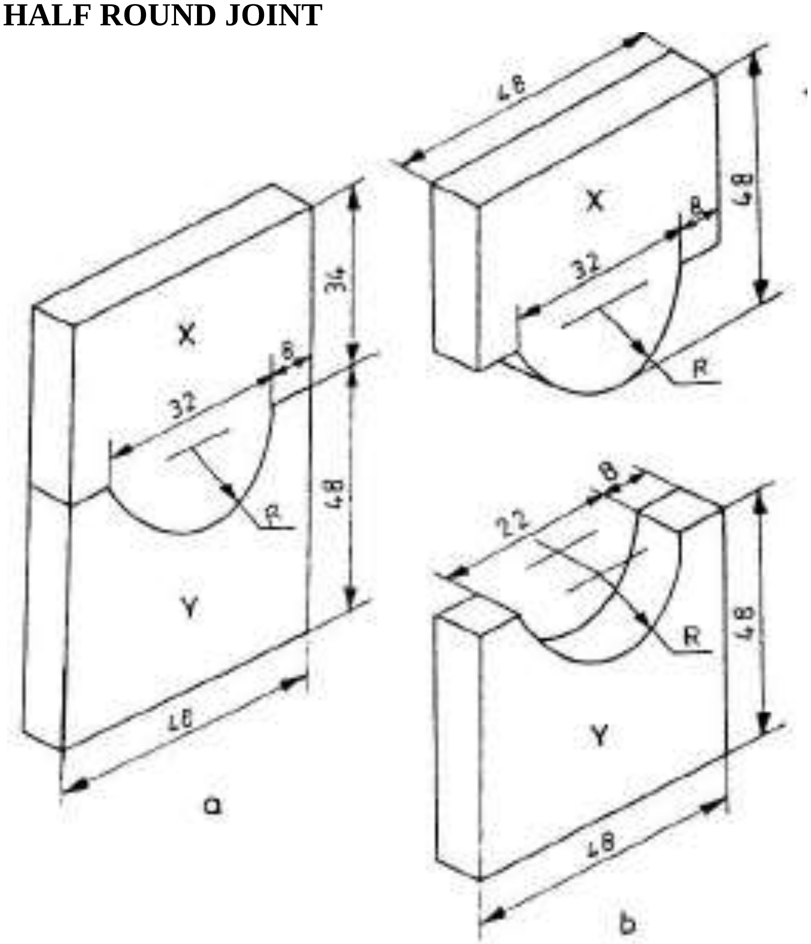


Fig 3.3 Half Round Joint

4. DOVETAIL JOINT

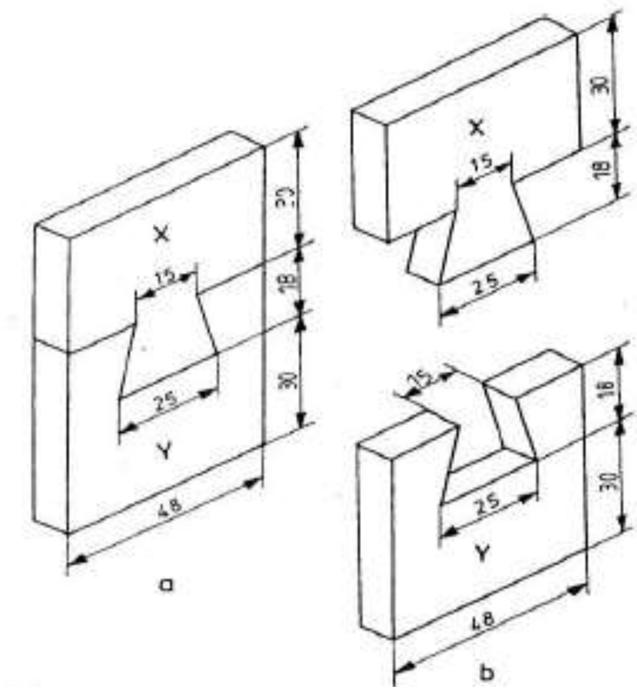


Fig 3.4 Dovetail Joint

Sequence of Operations:

a) Filling
b) Marking
c) Punching
d) Sawing
e) Filling
f) Finishing

Procedure:

a) The given mild steel flat piece is checked for given dimensions.
b) One edge of given is filled to straightness with rough and smooth files and checked with try square.
c) An adjacent is also filled such that is square to first edge and checked with try square.
d) Wet chalk is applied on one side of the flat and dried for making.
e) Lines are marked according to given figure, using odd leg caliper and steel rule.
f) Using the dot punch are made along the marked lines.
g) The excess materials removed from the remaining two edges with try square level up to half of the marked dots.
h) Finally buts are removed by the filling on the surface of the fitted job.

5.Observation

It has been observed that different type of joints prepared with the help of suitable fitting workshop tools. We have to learn about every procedure to make the required joints. It is also important to achieve the same dimensional accuracy of the finally produced joint as per the design consideration.

6. Result and discussion

Square joint, V joint, half round joint, dovetail joint is made as per required dimensions using fitting workshop tools.

7.Conclusion

a. All the fitting workshop tools has identified before starts joints preparation.
b. Joints has been prepared with 2-5% dimensional inaccuracy.
c. Joints are being identified.

8.Precautions:

a) The perpendicularity of face ends edges is checked perfectly by using try square.
b) Finishing is given by using only with smooth files.
c) Marking is done without parallax error.

9. Viva Questions

a) What is meant by fitting?

b) What is the use of vice and give the various types of vice?

c) State the different types of hammers used in fitting work.

d) What is the use of V- block?

e) What are the materials used for files?

f) What are the methods of filing?

EXPERIMENT NO. 4

To make Tray, cylinder, hopper and funnel of zinc coated iron sheet

1. **Objective** **2. Apparatus** **3.Theory** **4.Procedure** **5. Observation**
6. Result and discussion **7. Conclusion** **8.Precautions** **9. Viva Questions**

1.Objective : To make Tray, cylinder, hopper and funnel of zinc coated iron sheet

2. Apparatus
a) Steel rule
b) Flat file
c) Scriber
d) Try square
e) Snips
f) Dot punch
g) Stakes
h) Mallet

Materials Required: Galvanized Iron sheet (150*110*26 gauge)

3. Theory:

3.1 Introduction
Sheet metal working covers the use off thin metallic sheets with hand tools and sheet metal machines. Many important engineering articles made up of sheet metal find their application in airconditioning ducts, aircraft industry, agriculture implements, decorative articles and household goods. For effectively working in sheet metal one should have knowledge of hand tools, sheet metal machines, properties of metals and thorough knowledge of projective geometry i.e. development of surfaces.

3.2 Types Of Sheet Metal

1. Ferrous Sheet
i) *Mild Steel sheets* – These are black iron sheets, suspected to rust and corrosion, mostly used in water tanks and fabrication works.
ii) *Galvanized Iron (GI Sheet)* – It is soft steel sheet coated with zinc, which is corrosion resistance due to zinc coating, used for making air-conditioning ducts, roofs, boxes, buckets, coolers etc.
iii) *Stainless steel sheets* – It is an alloy of high-grade steel with chromium, nickel, phosphorous and manganese. It is used in household goods, food-processing plants etc.
iv) *Tin Plate* – steel coated with tin is called Tin steel. It is used for making food containers.

2. Non-ferrous sheets

i) *Aluminum Sheets* – It is two and half times lighter than iron but lacks in tensile strength. Small percentage of other elements like copper, manganese and silicon is added to make it suitable for production in aircraft industry and other industrial goods. It is also called aluminum alloy sheets.

ii) *Copper and Brass sheets* – These are non-ferrous sheets used in electrical industry and various other industrial and household articles.

3.3 MEASUREMENT OF THICKNESS OF SHEETS

Thickness of sheet is generally measured by gauge number which is obtained by actually measuring the sheet thickness with a sheet gauge or wire gauge. Each slot in the standard wire gauge is numbered, a number, which represents gauge number such as 20 SWG (Standard Wire Gauge). The more the SWG number, lesser is the thickness of sheet.

3.4 Tools Used In Sheet Metal

3.4.1 Marking Tools

1. **Steel Rule:** Available in different sizes, it could be steel foot rule, folding rule or tape rule
2. **Steel Square:** It is L-shaped piece of hardened steel, used to make square corners, checking
and making right angles.
3. **Scriber:** It is a steel wire with one end sharp and hardened to mark lines on metallic sheet.
4. **Divider:** It is used to scribe arcs and circles on metallic sheets.
5. **Trammel points:** It is used for drawing large circles and arcs
6. **Punches:**

(a) *Prick Punch:* Used for making indentation marks for locating center position for dividers, it has a taper angle of 30º.

(b) *Centre Punch:* Used for marking the location of points and centering hole to be drilled. it has a taper angle of 90º.

3.4.2 Cutting Tools

1. **Straight Snips:** It's blades are straight, it is used to cut 22 SWG or lighter sheets along straight line.
2. **Bent snip:** Blades are curved back from the cutting edges; it is used to cut discs and round articles from sheets.
3. **Hollow Punch:** Hollow punch is used to cut circular holes on thin sheets.
4. **Chisels:** This is used for cutting sheets, rivets and bolts.

3.4.3 Striking Tools

1. **Hammers:** Hammers are used for bending of sheets, smothering of sheets, locking of joints and riveting work.

(a) *Ball Pean Hammer:* General purpose, face is slightly curved, and head is round.

(b) *Square face hammer:* It has square flat face, used for flattening of seams

(c) *Raising Hammer:* It is used to form flat surface of sheet into curved surface.

(d) *Riveting Hammer*: Face is square slightly curved with beveled edges.

(e) *Mallet:* Made of good quality of wood or plastic used whenever light force is required.

3.4.4 Supporting Tools

1. **Stakes –** Stakes are used to support sheets in bending, seaming, forming, riveting, punching etc. Some commonly used stakes are:

(a) *Hand stake:* It is handy with flat face, two straight edges one concave edge, other convex edge, used for pressing the inner sides of straight joint.

(b) *Half Round stake:* It is used for pressing round seam joint on inner side.

(c) *Taper stake:* It is used for rounding of tapering jobs such as conical jobs.

(d) *Grooving stake:* It is made up of forged steel, used for grooves of different sizes.

(e) *Horse stake:* There are two square holes for holding two stakes at a time for carrying out different operations.

3.5 Sheet Metal Working Machines

1. **Rolling & Bending Machine:** This machine is used to form cylindrically shaped articles; this machine consists of three rollers that can be adjusted for different radii.
2. **Sheet Bending Machine:** This is used for bending and folding the edges of sheet metal.
3. **Swaging Machine:** It is used to provide different types of swages to give strength to thin sheets.
4. **Lever shearing machine:** It is used for sheet cutting, round bar shearing mostly used in sheet metal shop.
5. **Universal Cutting machine:** It is used for cutting sheet into desired shape & size machine has two circular tools used for circle cutting.
6. **Grooving machine:** It is used to make grooves; depth of groove can be adjusted.

3.6 Sheet Metal Joints

1. **Lap Joint** – It can be prepared by means of soldering or riveting.
2. **Seam Joint** – When two or more sheets are folded and fastened together is called seam joint.

There are two types of seam joints.

i) Single Seam Joint

ii) Double Seam Joint

3. **Groove Seam Joint** – In this joint two single edges are hooked together and flattened with a small mallet to make them tight, seam is then grooved with a hammer and a hand groover.
4. **Wired Edge** – It is one of the methods of strengthening the thin metal by turning over the edge on a wire in it.
5. **Hinged Joint** – It is used for easy movement of opening or closing doors, window etc.
6. **Cap Joint** – It provides another useful form of locked seam joint.
7. **Hem Joint-** This is turning over the edge of the sheet to give the strengthening on the edge of the sheet.

3.7 Sheet Metal Operations

1. **Measuring and Marking –** Sizes are marked on large sheet to cut the latter into small pieces.
2. **Development of Surface (Laying Out) –** Operation of scribing the development of surface of the component on the sheet together with the added allowance for overlapping, bending, hammering etc.

3. **Cutting and shearing –** The term shearing stands for cutting of sheet metal by two parallel cutting edges moving in opposite direction.
4. **Hand Forming –** It stands for shaping, bending of sheet metal in three dimensions in order to give the desired shape and size of final product.
5. **Nibbling –** It is a process of continuous cutting along a contour which may be of straight or irregular profile.
6. **Piercing and Blanking –** Piercing is basically a hole punching operation while blanking is
an operation of cutting out a blank.
7. **Edge Forming or Wiring –** Edges of sheet metal products are folded to provide stiffness to the products and to ensure safety of hand due to sharp edges.
8. **Joint Making –** Sheet metal parts can be joined by folded joints, riveting, welding, brazing, soldering, self-tapping screws, screwed fastening, and by adhesives.
9. **Bending –** Bend in sheet metal is to be bent at different angles to shape it to required form.
10. **Circle Cutting –** It is an operation of cutting circular blanks or curved contours with the help of circular cutting machines.
11. **Hollowing –** It is the process whereby a flat sheet metal is beaten up into spherical shape by placing the metal upon a sand bag or hollowing block, beating with hollowing hammer, starting from boundaries towards center.
12. **Raising –** It is the process of hammering the metal from oxide to form a hollow article, working around from center towards edge.
13. **Turned over Edge –** It is the method of strengthening the thin metal at edge. The edges are turned with some radius.
14. **Swaging –** This is also a method of strengthening thin sheet metal by making impressions in the bodies. It is done by machine or by hand.

4. Procedure:

Drawing 1

4.1 Rectangular Tray:

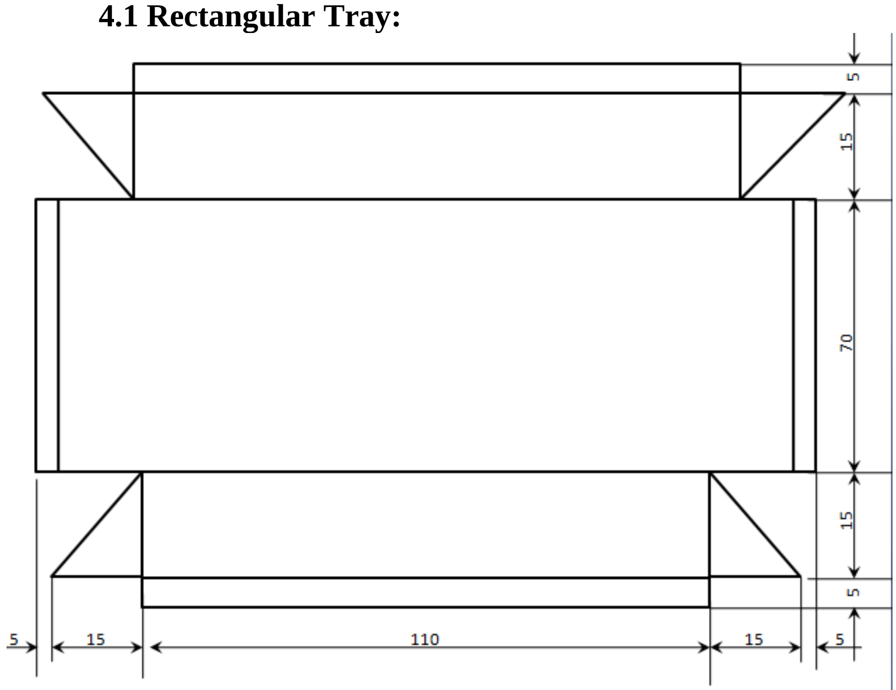


Fig 4.1 Rectangular Tray

4.2 Operations To Be Carried Out:

1. Planning
2. Marking
3. Cutting
4. Bending
5. Seaming
6. Soldering

Procedure for Rectangular Tray:

1. The size of the given sheet is checked with steel rule.
2. Mark the measurement and make the development surface sketch diagram.
3. The layout of the tray is marked on given sheet.
4. The layout of the tray is cut by using the straight snips.
5. The sheet is bent to the required shape using stakes and mallet.
6. Now the bent edges are made to overlap each other and stuck with a mallet to get the required joint.
7. The joint is soldered.

Drawing 2

4.3 Cylinder:

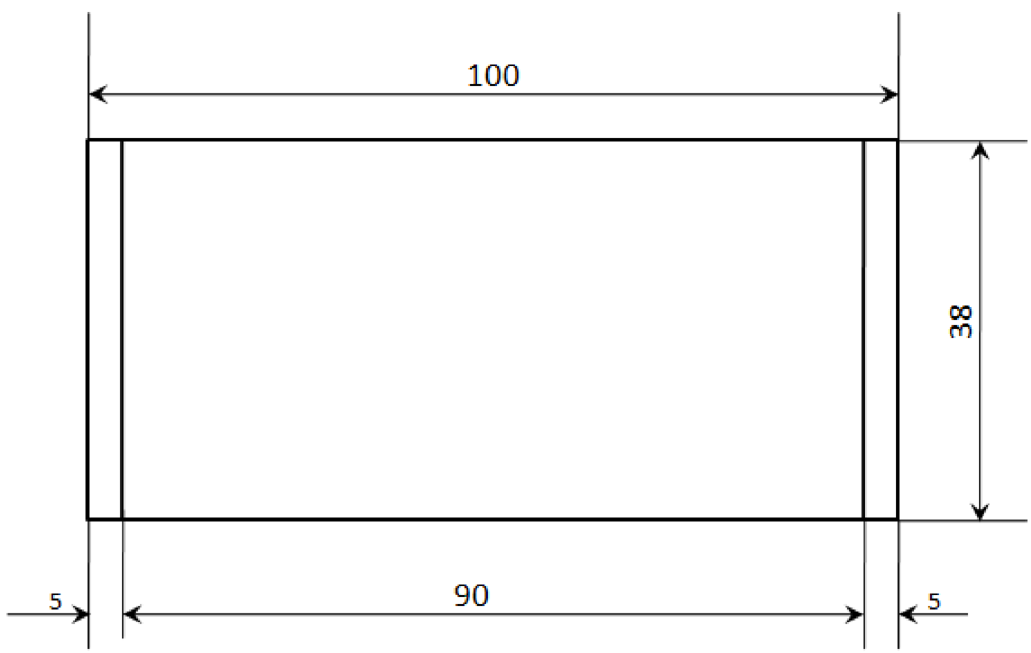


Fig 4.2 Cylinder

Procedure for Cylinder:

1. The size of the given sheet is checked with steel rule.

2. Mark the measurement and make the development surface sketch diagram.
3. The layout of the cylindrical shape pipe is marked on the given sheet.
4. The sheet is bent to the required shape using stakes and mallet.
5. Now the edges are slightly bent to one is one side and the other is opposite side, using stakes and mallet.
6. Join both the ends with in a cylindrical shape.

DRAWING 3

4.4 Funnel

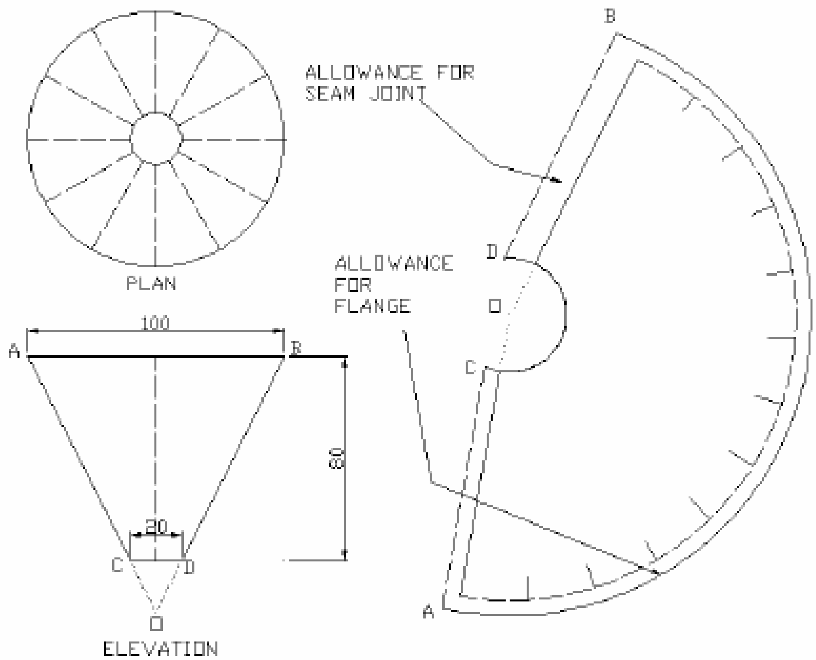


Fig 4.3 Funnel

Procedure for funnel: -

4.4.1 Body of Funnel

1. Draw the pattern of body of funnel on a drawing sheet as per dimension by Radial line method as shown in diagram
2. Mark the allowance for flange and lock seam joint.
3. Cut the pattern from drawing sheet with sharp blade
4. Keep the cut out pattern on G.I sheet and mark all around with scriber without moving the
pattern.
5. Cut the sheet on the marked line with a suitable snip,
6. Remove the burrs with a smooth file.
7. Make closed folds on both ends for lock seam joint
8. Fold the sheet to the shape of body of funnel on funnel stake and lock the seam joint
9. Flange out top edge of body of funnel as per diagram.

4.4.2 Development Of Round Funnel (Frustrum Of A Cone)

Procedure: A round equally tapering body having top and base parallel is Frustrum of a right cone.Draw the elevation and plan of Frustrum of the cone as shown in figure. Produce the edge line AC &BD to an apex marked O. Divide the outer circle of the plan in equal number of parts (i.e. 12).For the development mark a point O in a suitable position and with radius OA from the elevation describe arc of indefinite length. Take one of the spacing of the outer circle of the plan and divide the arc into twelve equal parts. Draw another arc of O as centre taking radius equal to OD. Join OB and OA. ABCD is the required development of frustrum of a cone.

1.Draw the pattern for bottom of funnel by triangulation method on drawing sheet as shown in diagram.
2. Mark the allowance for soft soldering Lap joint.
3. Cut the pattern from drawing sheet.
4. Keep the cut out pattern on G.I sheet and mark all around with a scriber without moving the pattern.
5. Cut the sheet on the marked line with suitable snip
6. Remove burrs with a smooth file.
7. Form the sheet to required shape.
8. Soft solder the over lap joint.
9. Join the bottom piece to the body of funnel by soft soldering.

4.4.3 Development of a long equal taper Article (bottom of Funnel)

Procedure: Draw the elevation ABCD and plan of the round equal tapering body. Divide the outer Circle in the plan to number of equal Parts 0,1,2,3 … and a, b, c, d ….. Find the true length BL taking a1 (aL) as base and vertical height aB at right angles.

To set out the development draw any line OA equal to slant height BD. A as a centre taking radiusequal to any one of the division of the outer Circle, draw an arc on either side of A. Now O as acentre and take radius equal to any one of the divisions of small circle, draw arcs on either side of O. now A as a centre, taking radius equal to true height BL, cut previous arcs either sides of O. Now, O as a centre taking the same true height radius cut previous arcs in either side of A. Now again from the new formed points (1, 1 b, b) again form the points (2, 2 c, c) by repeating the same method. Continue this up to six parts on either side of the central line OA. Join the last points g6 on both sides. ABCD is the required pattern of round taper article. Take allowance on either side for lock seam joint.

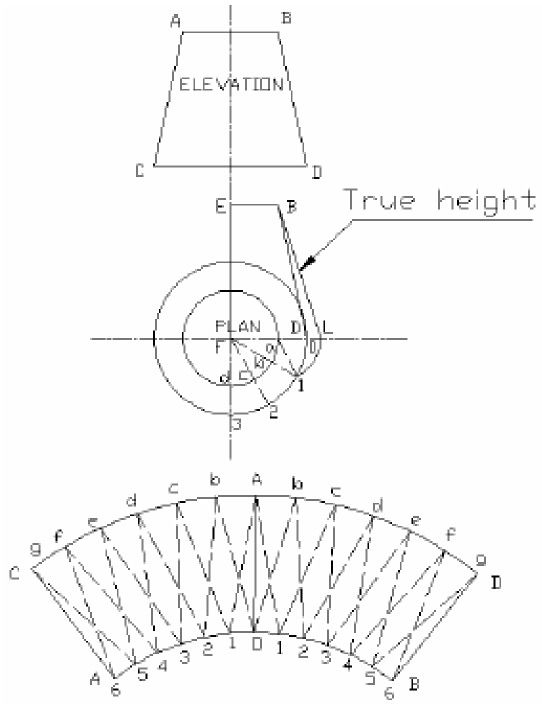
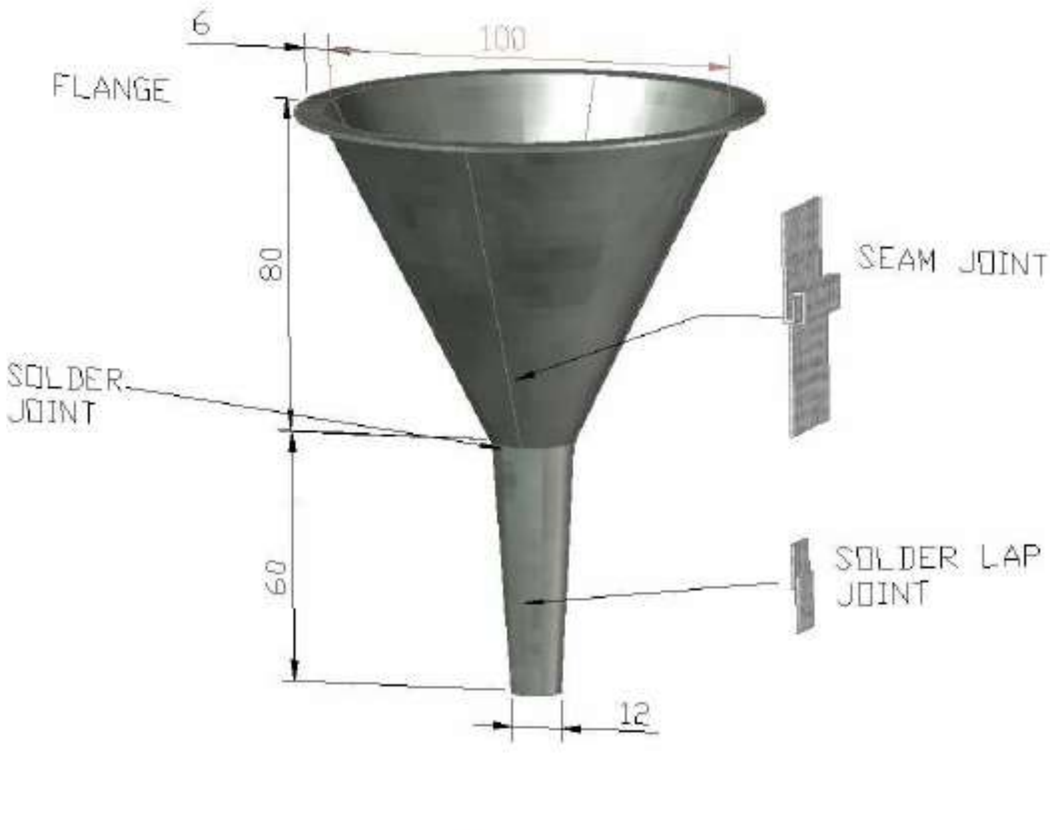


Fig 4.4 Bottom of Funnel



All dimensions are in mm
Material : G.I. Sheet 28 SWG

Fig 4.5 Development of Long Equal Taper Article

5.Observation

It has been observed that Tray, cylinder, funnel of zinc coated iron sheet using sheet metal working tools. We have to learn about every procedure to make the required geometry. It is also important to achieve the same dimensional accuracy of the finally produced product as per the design consideration.

6. Result and discussion

Tray, cylinder, funnel of zinc coated iron sheet is made as per required dimensions using sheet metal working tools..

7. Conclusion

a. All the sheet metal working tools has identified before Tray, cylinder, funne preparation.
b. All the object has been prepared with 2-5% dimensional inaccuracy.
c. Joints are being identified

8. Precautions

1. Be careful while working on sharp edges of sheets to avoid injury.
2. Do not use blunt cutting edges tools.
3. Appropriate cutting tools and machines must be used for cutting tin sheets
4. Extra allowance must be provided in the sheets while cutting so that finished product is of correct size and finish.

9. Viva Questions

a) Define sheet metal work?
b) What are the applications of sheet metal working?
c) What is the principle behind the sheet metal layout?
d) How do you identify the thickness of metal sheet?
e) What will be the result of the sheet thickness when increasing the gauge number?
f) What are the metals used in sheet metal work?
g) Name the striking tools used in sheet metal work?
h) Name the five tools and equipments which are used for cutting sheet metal?

EXPERIMENT NO. 5

Simple exercises based on black smithy operations

1. **Objective** **2. Apparatus** **3.Theory** **4.Procedure** **5. Observation**
6. Result and discussion **7. Conclusion** **8.Precautions** **9. Viva Questions**

1. Objective: Simple exercises based on black smithy operations

2. Apparatus:
a) Open hearth furnaces.
b) Blower
c) Anvil
d) Swage block
e) Pressure or mechanical hammer
f) Anvil
g) swage block
h) iron blocks
i) tongs
j) hammers
k) chisels
l) flatter
m) set hammer
n) hand hammer
o) fullers
p) swages
q) punches.
r) Hacksaw
s) Brass Rule
t) Template
u) Try square

Materials Used: Mild Steel Flat 30 mm+ 120mm long,
Mild steel round bar φ20mmX150mm

3.Theory:

3.1 Introduction: Various machine part are manufactured by different process such as casting, machining, forging, etc. forging me be defined as the plastic flow of metal by the application of compressive forces in which a metal is altered in shape permanently without rupture. The application of heat increase the plasticity of metal thus making it possible to conduct the operations necessary for the fabrication of various shapes of product.

This is one of the oldest manufacturing process. The working of the small object heated in an open hearth furnace, operated by manual labour, is known as ”SMITHING” whereas, the large objects heated in closed hearth furnaces and working by heavy hammers or forging machines are called “FORGING”. In smithy and forging shop ones motto should be “THINKING BEFORE, ACT AFTERWARDES”.

Forging processes are extremely important in any machine building industry such as in the manufacturing of tractors, Automobiles, Agriculture machinery, Ship building, and Locomotive building Rail Road equipments, Aeroplane manufacturing and cutting tools etc.

It has the following advantages of the forging processes

a) It refines the structure of metal.
b) It increases the strength of metal.
c) It saves time, material &labour.

3.2 Forge Ability Of A Metal:

Forge ability is the capacity of a heated metal to undergo deformation under compression without rupture.

3.3 Forging Temperature:

Forging is a hot working process. In this heating on a material to proper temperature is essential as excessive temperature may result in burning of the material that destroys cohesion between the atoms. Insufficient temperature also result in cold working defects like strain hardening and cracking. To obtain a fine grained structure the forging operation must be finished at lower temperature. So that no grain growth takes places.

Forging Temperature For Various Metal

Sr. no	Name of metal/alloy	Forging temp. c starting	Finishing
1.	Mild steel	1300	750
2.	Wrought iron	1250	900
3.	Medium carbon steel	1250	750
4.	High carbon steel	1150	825
5.	Stainless steel	1180	940
6.	High speed steel	1250	970
7.	Carbon tool steel	900	800
8.	Spring steel	1000	900
9.	Copper brass &	950	600
	bronze		
10	Aluminium&	500	350
	magnesium alloys		

3.4 Equipments Used:

a. Open hearth furnaces.
b. Blower
c. Anvil
d. Swage block

e. Pressure or mechanical hammer

3.5 Tool Used in a Smithy Shop:

a. *Supported tools:* Anvil, swage block, iron blocks.
b. *holding tools:* various type of tong.
c. *striking tools:* hammers
d. *cutting tools:* chisels
e. *forming& finishing tool:* flatter, set hammer, hand hammer, fullers, swages, punches.

S. No	Tool	Part name	Material
1.	Anvil	Face body stand	Cast steel
2.	Hammer	Body	Medium carbon steel
3.	Tong	-	Mild steel
4.	Hot chisel	-	High carbon steel
5.	Cold chisel	-	Medium carbon steel
6.	Flatter	-	High carbon steel
7.	Punch	-	High cabon steel
8.	Drift	-	High speed steel
9.	Fuller	-	High carbon steel
10.	Swages	-	High carbon steel
11.	Swage block	-	Cast iron, cast steel

1. **OPEN HEARTH FURNACES:** It is used for heating the metal for hand forging.

The main part of a forging furnace are shown as under.
Hearth: the iron bottom where wire fire is lightened is known as hearth.
Hood: the upper part of the furnace is called hood.
Chimney: chimney is fitted on the upper end of the hood. It is used for the purpose of easyescaping of exhaust gasses and smoke.
Water tank: a small iron tank is attached with the hearth of the furnace.

3.6 ACCESSORIES:

a) Blower
b) Regulator
c) Showel
d) Poker
e) Raker

3.7 TOOLS USED:

1. FURNACE: the space inside the hearth is filled with soft wood. It is slowly brought to the center of the hearth regulating the air supply from the blower.

2. ANVIL: It is used to support the work while hammering or carrying out other forging operations. It is made up of a malleable cast iron, steel or wrought iron.

a) Body
b) Horn or beak.
c) Chipping block.
d) Face
e) Hardie/ square hole.
f) Round hole.
g) Tail.
h) Legs.
i) Stand.

The central part is known as body. Horn or beak is used while bending or ringing making. Face is important part of the work is done on face. Tail is used for right angle bending purpose.

3. **HAMMERS:** Hammers are used as striking tools. These are used for finishing flat or curvedsurfaces.

These are classified as under:

i. Hand hammer: ball peen, cross peen, straight peen hammer weight ¼ kg to 2kg.
ii. Sledgehammer: double face hammer weight 4kg to 10kg.
iii. Power hammer: spring hammer, pneumatic hammer, and steam hammer, drop hammer.

4. **TONG:** Tong are used for holding and turning hot metal pieces. Depending upon their uses& according to work size & shapes. A tong has two legs riveted from a suitable place. These are made up of mild steel. Various type of tong used in forging shop.

i. Round hollow bit tong: used to grip round bars only.
ii. Square hollow bit tong: used to grip square bars only.
iii. Close flat tong: used to grip flat only.
iv. Pick- up tong: used to pick the hot job in the furnaces.
v. Chisel tong: used to holding the chisel for cutting purpose.

6. **CHISEL:** Chisel are used for cutting metal pieces hot and cold stat. chisel are dividing intofollowing categories:

i. Cold or flat chisel: it is made up of carbon tool steel. It is use for cutting metal in cold stat.
ii. Hot chisel: it is made up of tough tool steel generally high carbon steel.it is use for cutting metal in hot state these are not heat treated.
iii. Hardie set: these chisel are normally made in pair consists of a top tool, which is a chisel and the bottom tool, which is called hardie.

3.8 FORGING OPERATIONS: In forging shop, the following operation are used to change the shapeand size of the raw material to the finished form. The typical forging operation are:

i. Drawing down: drawing down is the process of increasing the length of any work pieces, while the cross-section area is reduced.
ii. Jumping & up setting: it is the operation in which the thickness of the bar or cross-section is increased at increasing at the expense of its length. If the and of the bar is required to be upset, its end is heated to a bright red height and hammered while holding the bar vertically on an anvil.
iii. Swaging: swaging is the process used to form or finish different shapes such as circular, hexagonal and square etc.
iv. Flattening: flattening process is done on an anvil face. Hot work piece is placed on anvil and flatten the work piece with the help of flatter and hammers blow.
v. Punching & drifting: in thicker work piece the holes are punched. The work piece is heated to 1000c and placed on the anvil hardie hole as explained above.
vi. Bending: the process of giving desired angels or curvature to hot piece is known as bending. The process is done on the edge of anvil or on chipping block.

Forge welding: the process of joining two metal pieces by heating & hammering is kwon as forge welding. The metal piece to be welded are cleaned & heated in a furnace up to the welding temp

4. Procedure:

Drawing(Pipe Clamp): -

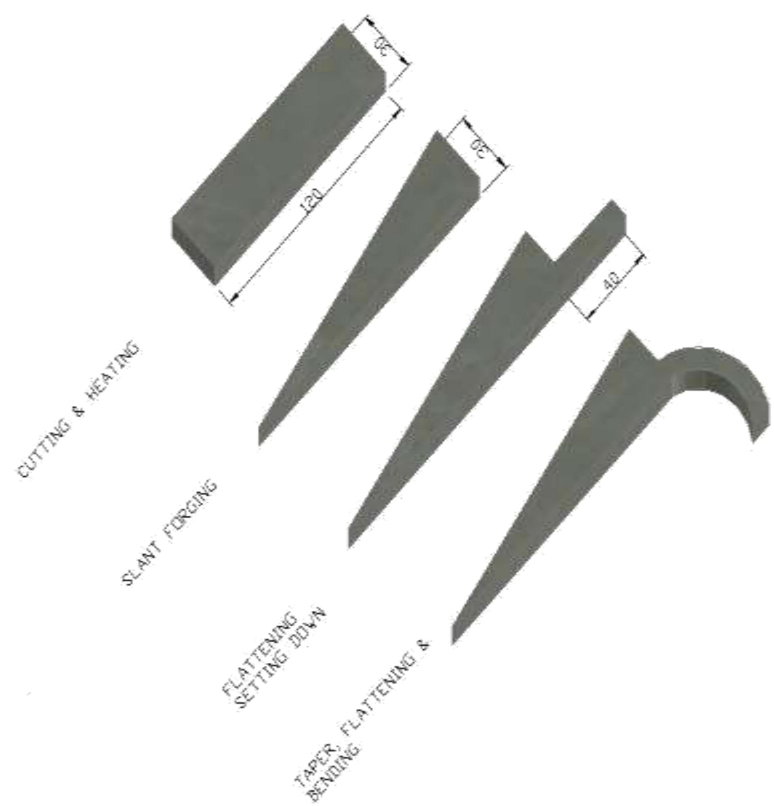


Fig 5.1 Pipe Clamp

Procedure for pipe clamp:

1. Check the tools and equipments required and see that they are in good working.
2. Do marking on the raw material by scale and cut the pieces as per dimension.
3. Start the forge and heat the job up to the forge temperature which depends on the materials (for steel 1080 to 1250^0 C) or till the materials is red hot.
4. After the job is red hot, bring out form the forge and set on anvil with the help of close flat tongs and forge with hammer as shown in the
5. Again make the job red hot and set down the other end about 20mm long Continue till the end elongates to about 40mm length. Make a uniform taper as round
6. Heat the job again and as shown in the figure.
7. Heat the while job again and cut the excess metal to maintain dimensions. Then do finishing operation.

Drawing(Flat Chiesel)

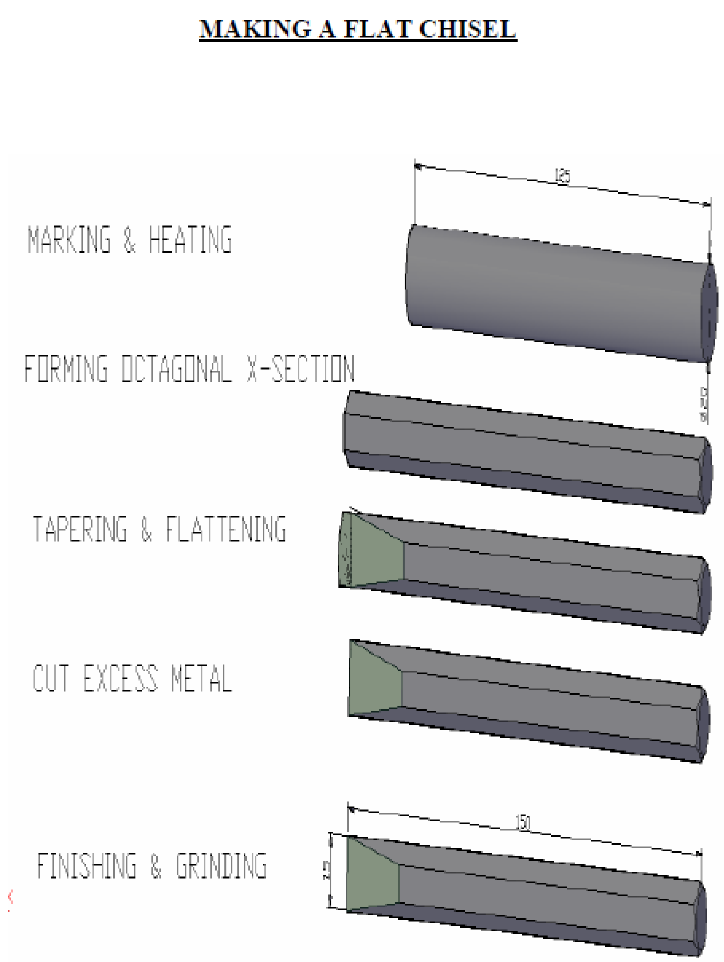


Fig 5.2 Flat Chiesel

MAKING A FLAT CHISEL

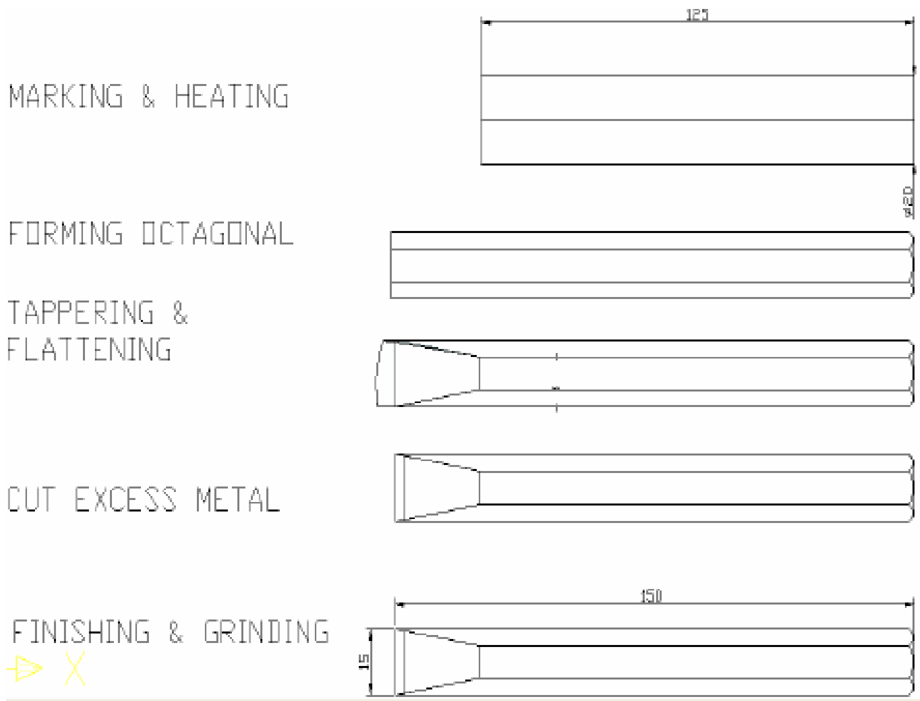


Fig 5.3 Flat Chiesel

Procedure for Flat Chiesel:

a) Do marking on the raw material by scale and cut the piece as per the dimension with the help of hexa frame. (See diagram)

b) Start the furnace and heat the job upto forgeable temperature (1250° C) or till metal is red hot

c) Keep the red hot metal piece on the anvil with the help of tongs. Then give octagonal shape to the job with flatter and hammer. (See diagram)

d) Re heat the octagonal job and place horizontally on the anvil with tongs and taper one end. To make chisel head with hammer. The other end of the job is taper flattening to make chisel mouth with flatter and hammer. (See diagram)

e) Heating the whole chisel again, cut the access metal to maintain dimensions then do finishing with the chisel.(See diagram)

f) Keep the chisel in a restricted place for cooling in air.

g) After the job has cooled grind the cutting edge of the chisel to 60 ° angle. (See diagram)

h) Do hardening and tempering on the cutting edge of the chisel

5.Observation

It has been observed that Pipe clamp and Flat Chisel is prepared with the help of suitable tools. We have to learn about every procedure to make the Pipe clamp and Flat Chisel. It is also important to achieve the same dimensional accuracy of the finally produced as per Pipe clamp and Flat Chisel the design consideration.

6. Result and discussion

Pipe clamp and Flat Chisel is made as per required dimensions using Smithy shop tools.

7. Conclusion

a. All the Smithy Shop tools has identified before starts joints preparation.
b. Pipe clamp and Flat Chisel has been prepared with 2-5% dimensional inaccuracy.

8.Precautions

a) Don't wear wrist watched and finger rings while working
b) don't use mushroom headed tools
c) always use suitable togs as per the job shape and size
d) Clean the oil substance from the tools
e) Heat the job carefully as per the forgebility of the metal
f) Start hammering on the red hot job only
g) Take great care during hammering of the job. Improper hammering may cause job to jump out of the tongs and hit somebody
h) Do not touch the hot jobs

9. Viva Questions

a. What is the raw material used in Tin smithy for doing experiments
b. Classify the tools used in Tin smithy
c. Name some measuring tools
d. Name some marking tools
e. Name some cutting tools
f. Name some finishing tools
g. What is the sequence of operations in Tim Smithy

EXPERIMENT NO. 6

To Study Heat Treatment Processes (Annealing & Tempering) Applied To A Given Specimen.

1. **Objective**	**2. Apparatus**	**3.Theory**	**4.Procedure**	**5. Observation**
6. Result and discussion	**7. Conclusion**		**8.Precautions**	**9. Viva Questions**

1.Objective: To Study Heat Treatment Processes (Annealing & Tempering) Applied To A Given Specimen.

2. Apparatus:

a) Electric arc furnace
b) Swage block
c) Pressure or mechanical hammer
d) Anvil
e) Swage block
f) Iron blocks
g) Tongs
h) Hammers
i) Chisels
j) Flatter
k) Set hammer
l) Hand hammer
m) Fullers
n) Swages
o) Punches.
p) Hacksaw
q) Brass Rule
r) Template
s) Try square

3. Theory:

Hardening of steels is done to increase the strength and wear properties. One of the pre-requisites for hardening is sufficient carbon and alloy content. If there is sufficient Carbon content then the steel can be directly hardened. Otherwise the surface of the part has to be Carbon enriched using some diffusion treatment hardening techniques Hardening is performed to impart strength and hardness to alloys by heating up to a certain temperature, depending on the material, and cooling it rapidly. Steel is heated and held there until its carbon is dissolved, and then cooled rapidly. Quenching is performed to cool hot metal rapidly by immersing it in brine (salt water), water, oil, molten salt, air or gas. Quenching sets up residual stresses in the work piece and sometimes results in cracks. Residual stresses are removed by another process called annealing.

Stages of hardening are:

Stage 1 Heating: Steel with sufficient carbon (0.35-0.70%) is heated to a suitable temperature.

Stage 2 Soaking: The specimen is held at that temperature from 15 to 30 minutes per 25 mm of cross section.

Stage 3 Cooling: The specimen is cooled rapidly or quenched in a suitable medium brine, water, oil etc.

3.1 Types Of Heat Treatment

Four basic types of heat treatment are used today. They are annealing, normalizing, hardening, and tempering. The techniques used in each process and how they relate to Steelworkers are given in the following paragraphs.

3.1.1 Annealing

In general, annealing is the opposite of hardening, You anneal metals to relieve internal stresses, soften them, make them more ductile, and refine their grain structures. Annealing consists of heating a metal to a specific temperature, holding it at that temperature for a set length of time, and then cooling the metal to room temperature. The cooling method depends on the metal and the properties desired. Some metals are Ferrous Metal furnace-cooled, and others are cooled by burying them. To produce the maximum softness in steel, you heat in ashes, lime, or other insulating materials. The metal to its proper temperature, soak it, and then let Welding produces areas that have molten metal next it cool very slowly. The cooling is done by burying the to other areas that are at room temperature. As the weld hot part in an insulating material or by shutting off the cools, internal stresses occur along with hard spots and furnace and allowing the furnace and the part to cool brittleness. Welding can actually weaken the metal. together. The soaking period depends on both the mass of the part and the type of metal. The approximate Annealing is just one of the methods for correcting these soaking periods for annealing steel.

3.1.2 Normalizing

Normalizing is a type of heat treatment applicable to ferrous metals only. It differs from annealing in that the metal is heated to a higher temperature and then removed from the furnace for air cooling. The purpose of normalizing is to remove the internal stresses induced by heat treating, welding, casting, forging, forming, or machining. Stress, if not controlled, leads to metal failure; therefore, before hardening steel.Usually, low-carbon steels do not require normalizing; however, if these steels are normalized, no harmful effects result. Castings are usually annealed, rather than normalized; however, some castings require the normalizing treatment. In the normalized condition, steel is much tougher than in any other structural condition. Parts subjected to impact and those that require maximum toughness with resistance to external stress are usually normalized. In normalizing, the mass of metal has an influence on the cooling rate and on the resulting structure. Thin pieces cool faster and are harder after normalizing than thick ones. In annealing (furnace cooling), the hardness of the two are about the same.

3.1.3 Hardening

The hardening treatment for most steels consists of heating the steel to a set temperature and then cooling it rapidly by plunging it into oil, water, or brine. Most steels require rapid cooling (quenching) for hardening but a few can be air-cooled with the same results. Hardening increases the hardness and strength of the steel, but makes it less ductile. Generally, the harder the steel, the more brittle it becomes. To remove some of the brittleness, you should temper the steel after hardening. Many nonferrous metals can be hardened and their strength increased by controlled heating and rapid cooling. In this case, the process is called heat treatment, rather than hardening. The addition of alloys to steel decreases the cooling rate required to produce hardness. A decrease in the cooling rate is an advantage, since it lessens the danger of cracking and warping.

3.1.4 Tempering

Tempering is a process done subsequent to quench hardening. Quench-hardened parts are often too brittle. This brittleness is caused by a predominance of Martensite. This brittleness is removed by tempering. Tempering results in a desired combination of hardness, ductility, toughness, strength, and structural stability.

The mechanism of tempering depends on the steel and the tempering temperature. The prevalent Martensite is a somewhat unstable structure. When heated, the Carbon atoms diffuse from Martensite to Cementite, which is the stable form.

Tempering is done immediately after quench hardening. When the steel cools to about 40 ºC (104 ºF) after quenching, it is ready to be tempered. The part is reheated to a temperature of 150 to 400 ºC (302 to 752 ºF). In this region a softer and tougher structure Troostite is formed. Alternatively, the steel can be heated to a temperature of 400 to 700 ºC (752 to 1292 ºF) that results in a softer structure known as Sorbite. This has less strength than Troostite but more ductility and toughness.

After the hardening treatment is applied, steel is often harder than needed and is too brittle for most practical uses. Also, severe internal stresses are set up during the rapid cooling from the hardening temperature. To relieve the internal stresses and reduce brittleness, tempering should be done to reduce hardness.

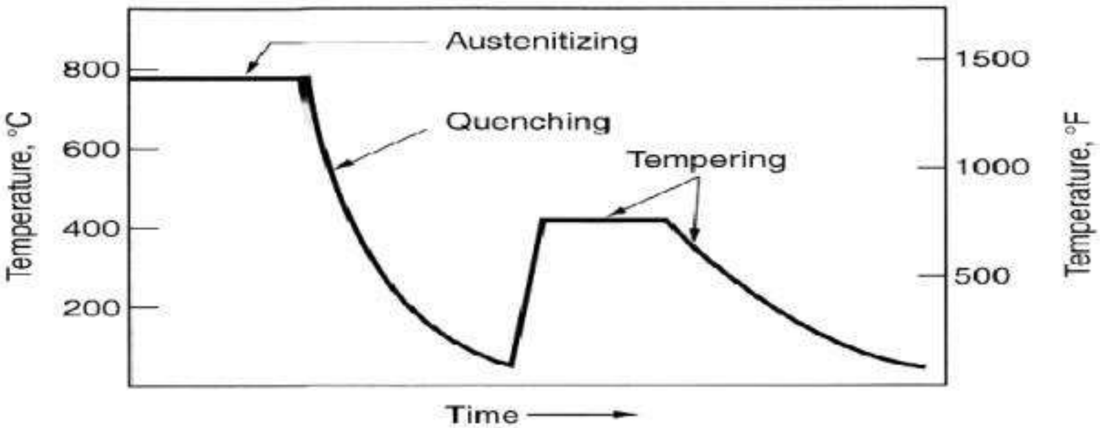


Fig 6.1 Heat Treatment Curves

Tempering consists of heating the steel to a specific temperature (below its hardening temperature), holding it at that temperature for the required length of time, and then cooling it, usually instill air. The resultant strength, hardness, and ductility depend on the temperature to which the steel is heated during the tempering process.

The purpose of tempering is to reduce the brittleness imparted by hardening and to produce definite physical properties within the steel. Tempering always follows, never precedes, the hardening operation.

Tempering is always conducted at temperatures below the low-critical point of the steel. In this respect, tempering differs from annealing, normalizing, and hardening in which the temperatures are above the upper critical point.

The following phases are involved in the transformation, occurring with iron-carbon alloys:

a) L - Liquid solution of carbon in iron;
b) δ-ferrite – Solid solution of carbon in iron.
c) Maximum concentration of carbon in δ-ferrite is 0.09% at 2719 ºF (1493ºC) – temperature of the peritectic transformation.
d) The crystal structure of δ-ferrite is BCC (cubic body centered).
e) Austenite – interstitial solid solution of carbon in γ-iron.
f) Austenite has FCC (cubic face centered) crystal structure, permitting high solubility of carbon – up to 2.06% at 2097 ºF (1147 ºC).
g) Austenite does not exist below 1333 ºF (723ºC) and maximum carbon concentration at this temperature is 0.83%.

h) α-ferrite – solid solution of carbon in α-iron.
i) α-ferrite has BCC crystal structure and low solubility of carbon – up to 0.025% at 1333 ºF (723ºC).
j) α-ferrite exists at room temperature.

k) Cementite – iron carbide, intermetallic compound, having fixed composition Fe_3C.
l) Cementite is a hard and brittle substance, influencing on the properties of steels and cast irons.

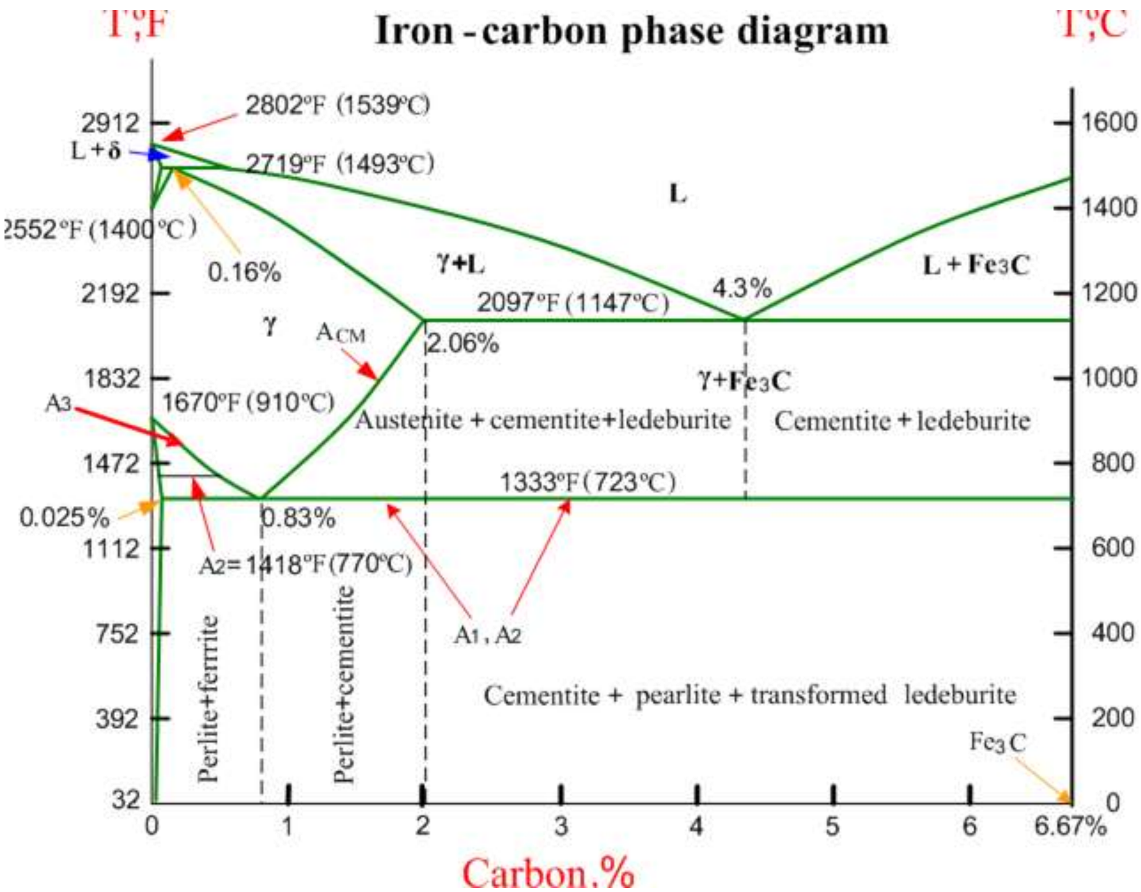


Fig. 6.2 : Iron Carbon Phase Diagram

The following phase transformations occur with iron-carbon alloys:

Alloys, containing up to 0.51% of carbon, start solidification with formation of crystals of δ-ferrite. Carbon content in δ-ferrite increases up to 0.09% in course solidification, and at 2719 ºF (1493ºC) remaining liquid phase and δ-ferrite perform peritectic transformation, resulting in formation of austenite.
Alloys, containing carbon more than 0.51%, but less than 2.06%, form primary austenite crystals in the beginning of solidification and when the temperature reaches the curve ACM primary cementite stars to form.

Iron-carbon alloys, containing up to 2.06% of carbon, are called steels.
Alloys, containing from 2.06 to 6.67% of carbon, experience eutectic transformation at 2097 ºF (1147 ºC). The eutectic concentration of carbon is 4.3%.
In practice only hypoeutectic alloys are used. These alloys (carbon content from 2.06% to 4.3%) are called cast irons. When temperature of an alloy from this range reaches 2097 ºF (1147 ºC), it contains primary austenite crystals and some amount of the liquid phase. The latter decomposes by eutectic mechanism to a fine mixture of austenite and cementite, called ledeburite.

All iron-carbon alloys (steels and cast irons) experience eutectoid transformation at 1333 ºF (723ºC). The eutectoid concentration of carbon is 0.83%.
When the temperature of an alloy reaches 1333 ºF (733ºC), austenite transforms to pearlite (fine ferrite-cementite structure, forming as a result of decomposition of austenite at slow cooling conditions).
Critical temperatures

a) Upper critical temperature (point) A_3 is the temperature, below which ferrite starts to form as a result of ejection from austenite in the hypoeutectoid alloys.
b) Upper critical temperature (point) A_{CM} is the temperature, below which cementite starts to form as a result of ejection from austenite in the hypereutectoid alloys.
c) Lower critical temperature (point) A_1 is the temperature of the austenite-to-pearlite eutectoid transformation. Below this temperature austenite does not exist.
d) Magnetic transformation temperature A_2 is the temperature below which α-ferrite is ferromagnetic.

Phase compositions of the iron-carbon alloys at room temperature

- Hypoeutectoid steels (carbon content from 0 to 0.83%) consist of primary (proeutectoid) ferrite (according to the curve A3) and pearlite.
- Eutectoid steel (carbon content 0.83%) entirely consists of pearlite.
- Hypereutectoid steels (carbon content from 0.83 to 2.06%) consist of primary (proeutectoid)cementite (according to the curve A_{CM}) and pearlite.
- Cast irons (carbon content from 2.06% to 4.3%) consist of proeutectoid cementite C_2 ejected from austenite according to the curve A_{CM} , pearlite and transformed ledeburite (ledeburite in which austenite transformed to pearlite).

4. Procedure:

a) Do marking on the raw material by scale and cut the piece as per the dimension with the help of hexa frame. (See diagram)
b) Start the furnace and heat the job upto temperature (1250° C) or till metal is red hot
c) Keep the red hot metal piece on the anvil with the help of tongs. Then give required shape to the job with flatter and hammer.
d) Heating the whole job again, cut the access metal to maintain dimensions then do finishing with the chisel.
e) Keep the job in a restricted place for cooling in air.
f) Do hardening and tempering on the cutting edge of the chisel

5.Observation

It has been observed that (Annealing & Tempering) is applied to a given specimen is done successfully with the help of suitable tools. We have to learn about every procedure to apply Annealing & Tempering to given work piece . It is also important to achieve the same dimensional accuracy of the finally produced as per the design consideration.

6. Result and discussion

Study of Heat Treatment Processes (Annealing & Tempering) applied to a given specimen is done successfully.

7. Conclusion

a. All the study related to heat treatment processes is done.
b. Required job has been prepared with 2-5% dimensional inaccuracy.

8. Precautions

a) Don’t wear wrist watched and finger rings while working
b) Don’t use mushroom headed tools
c) always use suitable togs as per the job shape and size
d) Clean the oil substance from the tools
e) Start hammering on the red hot job only
f) Do not touch the hot jobs.

9. Viva Questions

a) What is Heat Treatment Processes?
b) Why Heat Treatment is done?
c) What is Hardening Process?
d) What is Annealing Process?
e) What is tempering Processs?
f) What is iron carbon Diagram?

EXPERIMENT NO. 7

To make mould casting using single pattern and double pattern

1. **Objective** **2. Apparatus** **3.Theory** **4.Procedure** **5. Observation**
6. Result and discussion **7. Conclusion** **8.Precautions** **9. Viva Questions**

1. Objective: To make mould casting using single pattern and double pattern

2. Apparatus:

Molding flask, single piece pattern, split pattern, core, molding sand, shovel, trowel, sieve.

3.THEORY:

Patterns are of various types, each satisfying certain casting requirements.

a) Single piece pattern

b) Split or two piece pattern

c) Match plate pattern

3.1 Single Piece Pattern:

The one piece or single pattern is the most inexpensive of all types of patterns. This type of pattern is used only in cases where the4 job is very simple and does not create any withdrawal problems. It is also used for application in very small-scale production or in prototype development. This type of pattern is expected to be entirely in the drag and one of the surface is expected to be flat which is used as the parting plane. A gating system is made in the mold by cutting sand with the help of sand tools. If no such flat surface exists, the molding becomes complicated.

3.2 Split or Two Piece Pattern:

Split or two piece pattern is most widely used type of pattern for intricate castings. It is split along the parting surface, the position of which is determined by the shape of the casting. One half of the pattern is molded in drag and the other half in cope. The tow halves of the pattern must be aligned properly by making use of the dowel pins, which are fitted, to the cope half of the pattern. These dowel pins match with the precisely made holes in the drag half of the pattern.

3.3 Green Sand Molding:

Green sand is the most diversified molding method used in metal casting operations. The process utilizes a mold made of compressed or compacted moist sand. The term “green” denotes the presence of moisture in the molding sand. The mold material consists of silica sand mixed with a suitable bonding agent (usually clay) and moisture.

3.4 Advantages:

Most metals can be cast by this method.

Pattern costs and material costs are relatively low.

No Limitation with respect to size of casting and type of metal or alloy used

3.5 Disadvantages:

Surface Finish of the castings obtained by this process in not good and machining is often required to achieve the finished product.

4.Procedure:

a) A molding box is placed around the pattern on a boar.

b) The box is filled with sand and compacted around the pattern

c) When the mould has hardened the pattern is withdrawn from the mould

d) Cores locate in the core prints formed by the pattern and the top half of the mould is placed over the bottom.

e) Molten metal is poured into the closed mould and allowed to solidify and cool.

f) The mould is broken up to remove the casting and the running system is removed to leave the finished casting.

5.Observation

It has been observed that mould casting is prepared with the help of single and double piece pattern. We have to learn about every procedure to make the required mould casting. It is also important to achieve the same dimensional accuracy of the finally produced casting as per the design consideration.

6. Result and discussion

Mould casting is prepared with the help of single and double piece pattern successfully.

7. Conclusion

a. All the types of patterns has identified before starts joints preparation.

b. Mould Casting has been prepared with 1-3% dimensional inaccuracy.

8. Precautions:

1. Check to see if the metal molds are clean and free of any greasy substance.
2. Mold handles should be used on the metal molds. They are threaded onto the screw located on the back side of each mold.

9. Viva Questions

a) What is Casting Process?
b) What is expendable pattern?
c) What is Gating system?
d) What are the types of patterns?
e) What are the benefits of sand casting?
f) What are casting defects?

EXPERIMENT NO. 8

To make a Butt joint, Lap joint and T- joint with the help of Gas welding and Electric arc welding

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1.Objective 2. Apparatus 3.Theory 4.Procedure 5. Observation 6. Result and discussion 7. Conclusion 8.Precautions 9. Viva Questions

1. Objective: To make a Butt joint, Lap joint and T- joint with the help of Gas welding and Electric arc welding

2.Apparatus:

Tools & Equipment(Arc Welding):

a) Welding helmet shade 10 or high
b) Electrodes, usually 6010 and / or 6013
c) Leather gauntlet gloves
d) Welding machine with proper clamps and lead
e) Metal or weld on Plasma arc cutter or oxy fuel torch (optional).

Tools & Equipment(Gas Welding):

a) Gas cylinders (two)
b) Hose pipes and valves
c) Cylinder pressure gauge
d) Outlet pressure gauge
e) Pressure regulators
f) Blow pipe or torch and spark lights
g) Welding screens
h) Goggles, screens, gloves and apron
i) Wire brush, trolley, chipping hammer

Consumables:

a) Oxygen gas
b) Acetylene gas
c) Filler Metal (rod or wire)
d) Fluxes.

3.Theory:

3.1 Joint Type

Vertical welding is used on most types of joints. The types of joints you will most often use it on are tee joints, lap joints, and butt joints. Whem making fillet welds in either tee or lap joints in the vertical position, hold the electrode at 90 degrees to the plates or not more than 15 degrees off the horizontal for proper molten metal control. Keep the arc short to obtain good fusion and penetration.

3.1.1 T JOINTS:

- To weld tee joints in the vertical position, start the joint at the bottom and weld upward. Move the electrode in a triangular weaving motion, as shown in fig. 7-37, view A. Aslight pause in the weave, at the point indicated,improves the sidewalls presentation and provides good fusion at the root of the joint.
- When the weld metal overheats, you should quickly shift the electrode away from the crater without breaking the arc, as shown in fig. 7- 37, view B. This permits the molten metal to solidify without running downward. Return the electrode immediately to the crater of the weld in order to maintain the desired size of the weld.
- When more than one pass is necessary to make a tee weld, you may use either of the weaving motion shown in fig. 7 – 37, view C and D. a slight pause at the end of the weave will ensure fusion without undercutting the edges of the plates.

3.1.2 LAP JOINTS:

To make welds on lap joints in the vertical position, you should move the electrode in the triangular weaving motion, as shown in fig. 7-37, view E. Use the same procedure as outlined above for the tee joint, except direct the electrode more toward the vertical plate marked “G”. Hold the arc short, and pause slightly at the surface of the plate G. Try not to undercut either of the plates or to allow the molten metal to overlap at the edge of the weave. Lap joints on heavier plate may require more than one bead. If it does, clean the initial bead thoroughly and [lace all subsequent beads as shown in fig. 7-37 view F. The precautions to ensure good fusion and uniform weld a deposit that was previously outlined for tee joints also apply to lap joints.

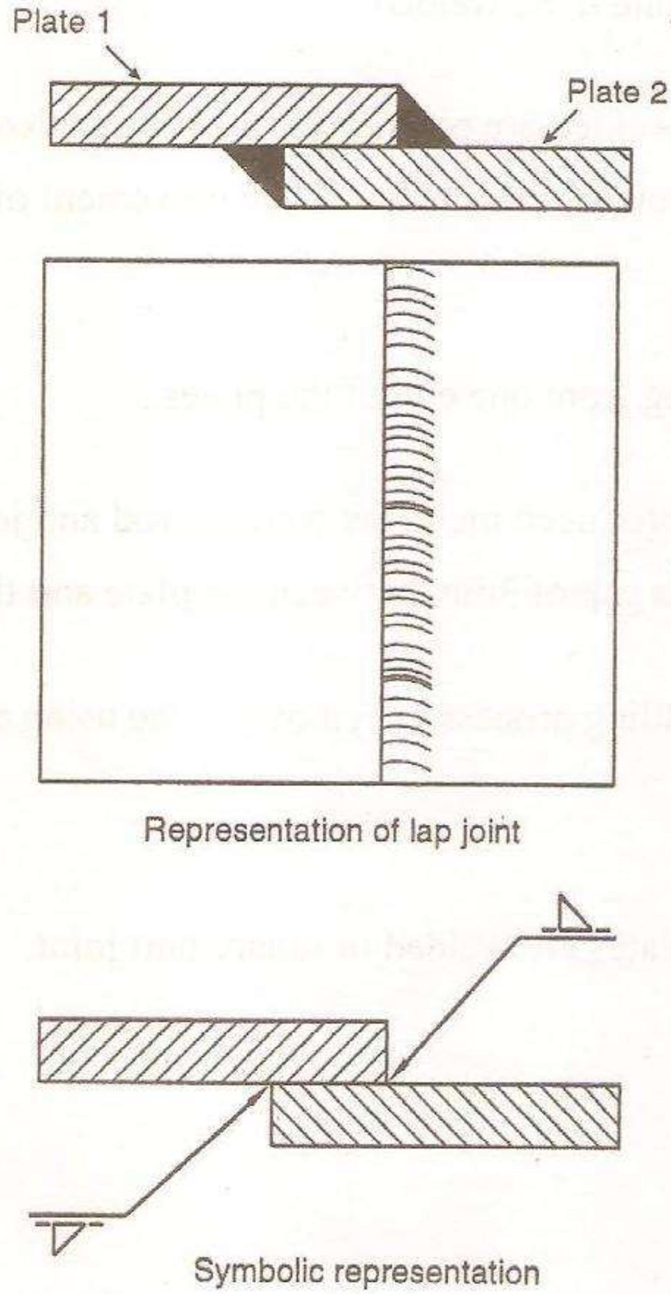

Fig 8.1 Lap Joint

3.1.3 BUTT JOINTS:

Prepare the plates used in vertical welding identically to those prepared for welding in the flat position. To obtain good fusion and penetration with no undercutting, you should hold a short arc and the motion of the arc should be carefully controlled.

Butt joints on beveled plates ¼ inch thick can be welded in one pass by using a triangular weave motion, as shown in fig. 7-38, view A.

Weld made on half inch plate or heavier should be done in several passes, as shown in fig. 7-38, view B. Deposit the last pass with the semicircular weaving motion with a slight "whip up" and pause of the electrode at the edge of the bead. This produces a good cover pass with no undercutting. Welds made on plates with the backup strip should be done in the same manner. E – 7018 Electrode welding technique the previously described vertical welding techniques generally cover all types of electrodes, however, you should modify the procedure slightly when using E-7018 electrodes.

When vertical down Welding you should drag the electrode lightly using a very short arc. Refrain from using a long arc since the weld depends on the molten slag for shielding. Small weaves and stringer beads are preferred to wide weave passes. Use higher amperage with ac than with dc. Point the electrode straight in to the joint and tip it forward only a few degrees in the direction of travel.

On vertical up welding, a triangular weave motion produces the best results. Do not use a whipping motion or move the electrode from the molten puddle. Point the electrode straight in to the joint and slightly upward in order to allow the arc force to help control the puddle.

Adjust the amperage in the lower level of the recommended range.

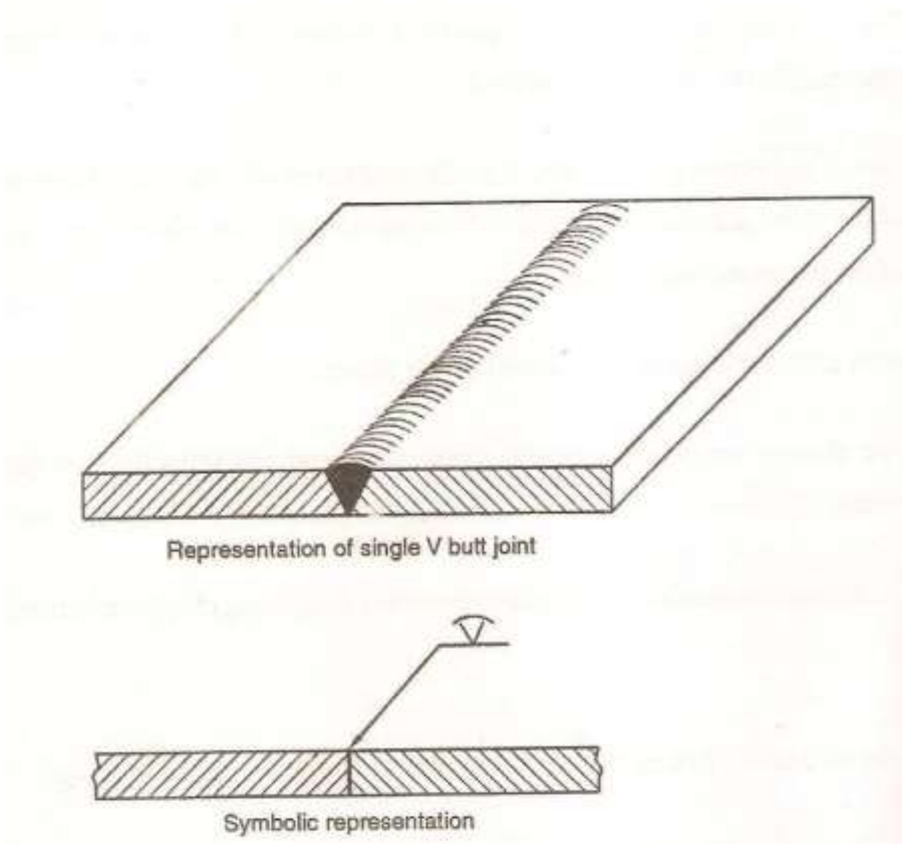

Fig 8.2 Butt Joint

3.2 Gas Welding:

It is fusion welding in which a strong gas flame is used to generate heat and raise temperature of metal pieces to be joined are heated. The metal thus melted starts flowing along the edges where joint is to be made. A filler metal may also be added to the flowing molten metal to fill up the cavity at the edges. The cavity filed with molten metal is allow to solidify to get the strong joint. Different combinations of gases can be used to obtain a heat flame. The popular gas combinations are oxy- hydrogen mixture, Oxygen acetylene, etc. different mixing proportion of two gases in the mixture can generate different type of flames with different characteristics.

3.2.1 Oxy – Acetylene Welding:

Oxy – Acetylene welding can use for welding of wide range of metals and alloys. Acetylene mixed with oxygen when burnt under a controlled environment produces large amount of heat giving higher temperature rise. This burning also produces carbon dioxide which helps in preventing oxidation of metals being welded.

Highest temperature that can be produced by this welding is 3200 C. The chemical reaction involved in burning of acetylene is

$2C_2H_2+5O_2=4CO_2+2H_2O+HEAT$

On the basis of supply pressure of gases oxy-acetylene welding is categorized as high pressure welding in this system both gases oxygen and acetylene supplied to welding zone are high pressure from their respective high pressure cylinders.

The other one is low pressure welding in which oxygen is supplied from high pressure cylinder but acetylene by the action of water on calcium carbide and supplied at low pressure. In this case high pressure supply of oxygen pulls acetylene at the welding zone.

A comparison can be drawn between low pressure and high pressure welding. High pressure welding equipment is handy, supplies pure acetylene at constant pressure, with better control and low expenses as compared to low pressure welding.

3.3 TYPES OF FLAMES:

Three types of flames in Oxyacetylene Welding:

3.3.1 Carburizing Flame:

This flame is obtained when excess of acetylene is supplied than which is theoretically required. This flame is identified by three zones the inner cone which is not sharply defined, an outer envelope as same in case of neutral flamed and middle zone surrounds inner one extended to outer envelope. It is white in color due to excess acetylene. Larger the excess of acetylene larger will be its length. To get a neutral flame a systematic procedure is to make carburizing flame first and then increase oxygen supply gradually till the excess acetylene zone disappears. The resulting flame will a its temperature generation range is 3100 C to 3300 C.

3.3.2 Oxidizing Flame :

This flame as an excess of oxygen over that required for a neutral flame. The ratio $O2 :C2H2= 1.15$ to 1.50. To have this flame set carburizing flame first convert it to neutral flame and then reduce the supply of acetylene to get oxidizing flame. Its inner cone is relatively shorter and excess oxygen turns the flame to light blue color. It burns with a harsh sound. It is used for metals which are not oxidized readily like brasses and bronzes.

3.3.3 Neutral Flame:

A neutral flame is obtained when amount of O2 equal and C2H2 are mixed and burnt at the outlet of welding torch. The flame consists of two sharply defined zones inner white flame cone outer envelope of blue color as shown in fig. 5.2. In this flame none of two gases is supplied in excess. This flame is of white cone and has the maximum use for successful welding of many metals.

4. Procedure:

4.1 Procedure for Arc Welding

a. Obtain all necessary equipment. This should be a welding machine, electrode and work piece clamps (and their leads), a welding helmet darker than shade 10, welding gloves, and appropriate safety clothing.
b. Prepare the metal to be welded. This includes grinding down rough edges and cleaning the areas to be welded.
c. Bevel the edge of the metal if it is thicker than ¼ inch. Beveling allows for better penetration of the root pass and subsequent passes. Beveling can be done with an oxy fuel torch or a plasma arc cutter, but isn’t necessary on thinner metal.
d. Align your metal to make sure the edge line up well. They should be smooth and align cleanly.
e. Turn your pieces over. This should be the flat side if on or more pieces are beveled, or the side you don’t want to start welding.
f. Make tack welds. These will hold the metal together and prevent it from warping or bending inward when the weld is finished. To make a tack weld, strike an arc and let it sit for few seconds. A few tack welds are usually needed and you should be able to break them with a hammer or wrench.
g. Flip your metal over to be welded.
h. Strike an arc and create your root pass. This is going to be the first and deepest pass on your weld, and if the metal is thick enough the only pass you will need. If you beveled the steel start at the bottom for your root pass. You need to ensure the root pass penetrates deeply enough, and for this reason 6010 electrode are frequently used for this purpose.
i. Clean the weld with a hammer and wire brush and make subsequent passes if needed. These passes should strengthen the weld and fill it in. Make sure clean each pass before you start a new one.

4.2 Procedure for Gas Welding

a. Assemble all of the materials needed to make the weld. This includes parts, OA equipment, fixture, tools, safety mask, gloves and filler rod.
b. Clean the parts to be welded to remove any oil, rust or other contaminants. Use a wire brush if needed to remove any rust.
c. Assemble and fixture the parts in place – the parts need to be stable for a good weld line. Ceramic bricks, vise grips, pliers and clamps are available in a file cabinet in the weld room for fixture.
d. Select the nozzle you plan to use for welding. Nozzles come in a variety of sizes, from 000 (for a very small flame – typically used for thin materials) to upwards of 3 (for a large flame – needed for thick materials). Large nozzles produce larger flames and, in general, are more appropriate for thicker material. Choosing the right size nozzle become easier with more experience. Ask aTA or make some test welds to determine if you are using the right size nozzle.
e. Clean the nozzle, carbon deposits can build up on the nozzle which interfere with flame quality and cause backfiring. The cleaning tool has a wide flat blade (with a file like surface) which is used to clean carbon de[posits on the exterior of the nozzle. Use it to scrape any deposits from the flat face of the tip. Use the wire - like files to clean the interior of the nozzle. Pick the largest wire which will fit inside the nozzle, and the scrape the edges of the hole to remove any carbon buildup.
f. Attach the nozzle to the gas feed line by hand. Don't over torque – the nozzle and hose fitting are both made of brass with does not stand up well to abuse. A snug, finger tight fit is sufficient.
g. Check the pressure levels in the oxygen and acetylene tanks. There should be at least 50 psi in the acetylene tank. The oxygen tank can be used until it is completely empty. If needed ask a TA to change bottles. Note: The oxygen used in OA welding in NOT for human consumption. It contains contaminants that could be unhealthy if taken in large quantity.

4.2.1 Lighting The Flames:

a. Open the main valve on the acetylene tank ½ turn. This changes the pressure regulator at the top of the tank.
b. Open the pressure regulator valve on the acetylene tank (turn clockwise to open) and adjust the pressure in the acetylene line to psi.
c. Open the acetylene pin valve on the handle of the welding tool, letting acetylene escape. Tweak the pressure regulator valve until the regulator pressure is constant at 5 psi. Close the acetylene pin valve.
d. Open the main valve on the oxygen tank. Turn the valve until it is fully open (Until it stops turning).
e. Open the pressure regulator valve on the oxygen tank (turn clockwise to open)and adjust the pressure in the oxygen line to 10 psi.
f. Open the oxygen pin valve on on the handle of the welding tool, letting oxygen escape. Tweak the pressure regulator valve until the regulator pressure is constant at 10 psi. Close the oxygen pin valve.
g. Slightly open the acetylene valve (~ 1/8), until you can just barely hear acetylene escaping

h. Make sure there is no person or anything flammable in the path of the nozzle. Use the strikes to ignite the acetylene. The flame should be yellow / orange and will give off a lot of shoot.

4.2.2 Backfiring:

Improper operation of the torch may cause the flame to go out with a loud snap or pop. This is called backfire. It is caused by one of few things. The first thing to do is turn the gas in the torch off, check all the connections and try relighting the torch. Backfiring can be caused by torching the pip against your work piece, overheating the tip, operating the torch at other than recommended gas pressures, by a loose tip or head or by dirt on the seat.

4.2.3 Shutting Down And Cleaning Up:

When you're completely finished welding and are ready to quit for the day, you need to clean up.

1. With the flame extinguished and the pin valves closed, close the main valve on the oxygen tank. It should be firmly seated at the bottom.
2. Open the oxygen pin valve to bleed off all of the oxygen in the regulator and feed line. Close the pin valve once the feed line pressure has gone to zero.
3. Fully back out the oxygen regulator valve so there is no pressure in the line. DO NOT close the valve, as this will pressurize the line once the tank is open again . In the case of the acetylene, if it is pressurize over 15 psi, it may explode! If you are not sure about doing this properly, Find a TA to help you.
4. Repeat steps 1 through 3 for the acetylene line.
5. Return all of the tools to their proper storage places and coil the feed lines around the handle on the gas cylinder cart. Note: Do not remove the nozzle from the feed line. The feed line should always have a nozzle attached to prevent accidental damage to the threads used to attach the nozzle.

5.Observation To make a Butt joint, Lap joint and T- joint with the help of Gas welding and Electric arc welding

It has been observed that different type of joints prepared with the help of Gas welding and Electric arc welding**.**We have to learn about every procedure to make the required joints. It is also important to achieve the same dimensional accuracy of the finally produced joint as per the design consideration.

6. Result and discussion

Butt joint, Lap joint and T- joint is made as per required dimensions Gas welding and Electric arc welding.

7. Conclusion

a. All the study related to Gas welding and Electric arc welding is done before joint preparation..

b. Joints has been prepared with 5-6 % dimensional inaccuracy.
c. Joints are being identified.

8.Precautions:

a) Make sure your welding helmet's lens is the proper shade for the amperage and process you are using.
b) Plasma cutters use an electric arc, so safety precautions from arc welding apply to this also.
c) Always wear pants without cuffs , shirts without pockets, and safety glasses when chipping slag off welds.
d) If using a torch to bevel the metal, use caution and avoid setting a brass torch tip on a hard surface.
e) Oxygen and acetylene cylinders must be securely stored in an upright position.
f) An oxyacetylene torch can produce large amount of heat. Be ware that any objects you direct the flame towards which become hot.
g) Always have a suitable fire extinguisher near your work area.
h) Do not use an oxyacetylene torch near any flammable materials.
i) Make sure that you understand an observe all legislative and personal safety procedures when carrying out the following tasks. If you are unsure of what these are, ask your supervisor.

9. Viva Question

a) What is welding?
b) Which is the welding process you have carried out in workshop?
c) Name the welding tools used in workshop?
d) Which outer cover is on the welding rod
e) Which welding process uses non-consumable electrodes?
f) What are the types of flames?

EXPERIMENT NO. 9

To study and work on 3-D printing technology

1.Objective	**2. Apparatus**	**3.Theory**
4. Result and discussion	**5. Conclusion 6.Precautions**	**7. Viva Questions**

1.Objective: To study and work on 3-D printing technology

2.Apparatus: 3 D Printer

3.THEORY:

3.1 Introduction:

3D printing allows for rapid prototyping and onsite manufacturing of products.
Initially done with plastic, 3D printing now uses new techniques with new materials, such as aluminum, bronze, and glass. Biomaterials are also being incorporated, such as 3D printing ear cartilage and liver tissue. As the 3D printing industry grows, 3D printing will become a big part of many engineering fields.

Flow layout of Pre 3D Printing

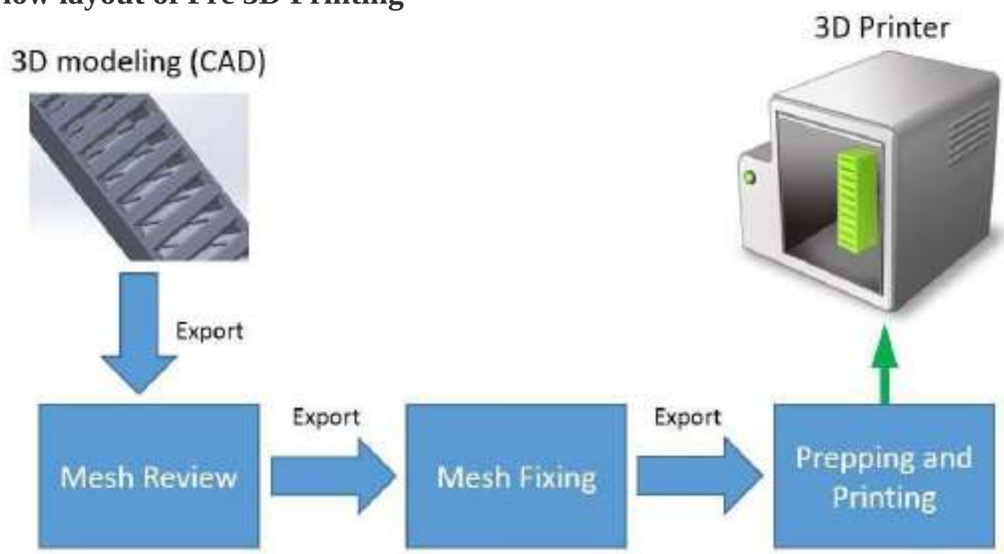

Fig 9.1 Flow layout of 3-D Printing

3.2 Components of 3D Printer: -

3.2.1. Axes
Fixed Rods The three axes that the 3D printer utilizes are on the Cartesian coordinate system. The linear fixed rods are maintained at right angles to each other and each represents a coordinate axis.
Movement The timing belts and pulleys allow the movement of the hot end (or the print bed, depending on the type of 3D printer) along each axes according to the g-code

(generated by slicing software). The stepper motors power this movement.

3.2.2 Extruder

Extrusion is the feeding of filament into the hot end of the 3D printer. This movement is also powered by a stepper motor.
Retraction This mechanism is the pulling of the melted filament from the hot end. This movement is primarily programmed through the g-code to prevent the formation of unwanted filament creating a bridge between two areas. The bridging of unwanted filament is referred to as stringing or the formation of cobwebs.
Dual Extrusion Some models of 3D printers are equipped with dual extrusion capabilities. This allows for mixed material objects to be printed. Dual extrusion can be used to print out complex objects with a different colour material as the support, making it easy to differentiate between the object and the support.

3.2.3 Hot End

The hot end is heated to temperatures ranging from 160 C to 250 C, depending on the type of filament to be used. The hot end melts the filament and pushes the melted filament through the nozzle. The hot end needs to be thermally insulated from the other components of the 3D printer to prevent any damage.

3.2.4. Print Bed

Heated Print beds that are heated improve print quality of 3D printed objects. The heated bed is heated to the glass transition temperature of the filament being used. This allows the model layers to slightly melt and stick to the heated bed.
Non-Heated Print beds that are not heated require adhesion in the form of glue, tape, hairspray, etc. In the innovation lab, painters tape is frequently used for adhesion.

3.2.5. Filament

Filament is a consumable used by the 3D printer to print layers. Filament comes in a variety of materials and colors. Filament can be composed of metal, wood, clay, biomaterials, carbon fiber, etc.

a). **ABS**: - ABS is a thermoplastic that needs to be heated to temperatures from 210C to 250C. ABS can only be printed on a 3D printer with a heated bed, which prevents the cracking of the object. When ABS is heated, it emits a strong unpleasant odor. ABS requires a complete enclosure while printing.

b). **PLA**: - PLA is a thermoplastic that needs to be heated to temperatures from 160C to 220C. PLA is also biodegradable and emits slight odors. PLA is most frequently used in the Innovation Lab on all 3D printers.
PVA PVA is a water soluble plastic that is frequently used for support in dual extrusion 3Dprinters. The printed object is left in water where the PVA support is dissolved and the finished object printed in the other filament remains.

3.3 Preparing your 3D Model in CAD Software: -

CAD software is used to create 3D models and designs. This software is available on our computers and the level of difficulty varies. With the exception of Sketch up Pro and the industry standard software mentioned, all of these programs are available on the innovation lab computers.

Solid works main idea is user to create drawing directly in 3D or solid form. From this solid user can assemble it directly on their workstation checking clashes and functionality of it.
Creating drawing is pretty easy just drag and drop the solid to drawing block.

3.4 Preparing your 3D Model for print in Idea maker software:-
These are following step for 3D printing of model
1. Install the 3D print software idea maker
2. Check repair option in this software
3. Set the nozzle parameter and build tack temperature according to the printer guide.
Step:-1 Prepare the design Model using Designing Software(Solids Work,Autocad etc.)
Step:-2 Convert the designed Model file in Stl ,obj format.
Step:-3 Prepare the design model for printing Using Software Idea Maker and Ultimaker. Then
set all parameter (nozzle temp., buildtak temp and support) and also repair your design using
software option. Then after generate the file in gcode format

Step:-4 ON the 3D Printer and load the filament in nozzle and give the command print by using3D Printing Machine.

3.5 Application of 3D Printer: -
1. Automotive
2. Marine
3. Aerospace
4. Medical
5. Engineering
6. Architecture

3.6 Advantages: -
1. Complex shapes
2. Freedom for design
3. Customize parts
4. Less waste
5. Fewer unsold products
6. Less transport
7.

3.7 Limitations: -
1. Time
2. Cost
3. Skill
4. Materials

4. Result and discussion

Study and work on 3-D printing technology is done successfully

5. Conclusion
The study on 3-D printing technology is completed.

6. Precautions:

These are some following precaution when you print the design in 3D Printer

a) Mechanical: Do not place limbs inside the build area while the nozzle is in motion.
b) The printer nozzle moves in order to create the object.
c) High Temperature: Do not touch the printer nozzle – it is heated to a high temperature in order to melt the build material.
d) Always buy replacement parts from the manufacturer for safety related equipment
e) Choose an area that has adequate ventilation and exhaust capability

9. Viva Questions

a) What is 3 D Printing?
b) How does 3D Printing work?
c) What Are The Limitations Of 3d Printing?
d) Is There A Difference Between 3d Printing And Additive Manufacturing?
e) Are 3d Printed Goods As Good As Those Manufactured "traditionally"?
f) Who Invented 3d Printing?
g) What Types of 3d Printing Filaments Are There?

EXPERIMENT NO. 10

To study about fabrication of robotic chassis

1.Objective	**2. Apparatus**	**3.Theory**
4. Result and discussion	**5. Conclusion**	**6. Viva Questions**

1. Objective: To study about fabrication of robotic chassis

2. Apparatus: motors, pistons, grippers, wheels, and gears

3.Theory:

3.1 Introduction

Robotics is nothing but the branch of science and technology related to robots, and their design, manufacturing and structure deposition. Robotics is related to the electronics, mechanics, and software. In other words the robot is a mechanical device with links and joints, guided by sensors and driven by actuators and controlled through programmed software, to hold and operate parts, resources, equipment and machine for performing a variety of everyday jobs in range of work surroundings. The study and understanding "Robotics" is interdisciplinary with mechanical in the domain and other stream similar to electrical, electronics and computer, organism the additional and necessary for the engineering robot to be flexible, well-organized and exact in process. The links and joints are to be designed for strength and rigidity through static and dynamic force analysis. While the electric motors and hydraulic/pneumatic actuators produce robot motion. The requires positions are computed through transformations.

The electronics contributes in the shape of control system to strictly equal the required productivity with the achieved amount produced. The computer programs add flexibility for performing variety of jobs executed by the robotic manipulators. The software programs with the developed algorithms, controls and sensing systems make the robot to possess intelligence to carry out jobs with in the work envelope, defined by the movements (degree of freedom) given to links. The motion of the links is translator and/or rotary explaining the configuration and category of a robotic manipulator. In this highly developing society time and man power are critical constrains for completion of tasks in large scales. The automation playing important role to save human effort in most of the regular and frequently carried works. One of the main commonly performed works is picking and placing of jobs from source to destination.

Nearby day manufacturing is more and more turn in the direction of computer based mechanization mostly because of the need for increased output and release of end goods with consistent quality. The inflexibility and generally high cost of hard automation systems, which have been used for automated manufacturing tasks in the past, have led to a broad based interest in the use of robots capable of performing a variety of manufacturing functions in a flexible environment and at lower costs. The use of industrial robots characterizes some of contemporary trendsin automation of the manufacturing process. A robotic arm is a robotic manipulator, usually programmable, with similar functions to a human arm. Servo motor is used for joint rotation. However, present day industrial robot also exhibit a monolithic mechanical structure and closed system software architecture. They are concentrated on simple repetitive tasks, which tend not to required high precision.

3.2 Laws of the robotics

The "Three Laws of the robotics" also known as "Asimov's law," given by the author Isaac Asimov. The three laws are given below:

1. **First law:** A the robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. **Second law:** A the robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. **Third law:** A the robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

Now a day's the robotics can be applied to most of the areas to provide efficient work with the highest precision and in less time. So there is an overview of areas where robots can be applied in day to day life as well.

- a Military Area
- b Industrial Area
- c Agriculture Industries
- d Domestic Areas
- e Medical Areas
- f Researches

A robot which looks like overall as a Human body is known as a Humanoid robot. A Humanoid robot can have human facial expressions with the features. There are two types of the Humanoid robot to resemble as male and female:

- a **Android Humanoid:** They are built to resemble a male body
- b **Gynoids Humanoid:** They are made to resemble a female body.

A humanoid robot is entirely an automatic robot which can interact with the Humans and also can react according to the surrounding.

3.3 Basic Aspects of The Robotics

The basic aspects of the robotics to create a robot are given below:

- **Electrical/electronic components-** The robotics required electrical and electronic components as power supply, sensors, and microcontroller and motors circuits.
- **Mechanical equipment-** The robotics required mechanical equipment for giving shape or designing the body of a robot
- **Computer programs-** The robotics also includes computer programs to provide the instructions to the robot as what type of task, when it should be done, how it should be done, etc. Robo ML, ROBOFORTH, XRCL, and visual programming are the programming languages which are used in the robotics.

3.4 Components of A Robot

There are the basic components of a robot which are given below:

a **Power supply-** Power supply is the main components for the run of any device or machine. So a robot also takes energy from the power supply to perform a task. It can be provided from the batteries, hydraulic, solar power or pneumatic power sources.

b **Actuators-** Actuators are the devices which convert energy into movement.

c **Electric motors (DC/AC) -** Motors are used to convert electrical energy into mechanical energy. Most of the robots used these motors to provide various type of movements to their parts. Brushless and brushed DC motors used in portable the robots and AC motors used in industrial the robots.

d **Sensors-** Sensors are used to sense the changes in surrounding and produce a signal. Hence the robots are also equipped with the various types of sensors to detect the environment and responded accordingly.

e **Controller-** Controller is the brain of a robot, which controls and co-ordinate with all parts of the robot. And with the help of the controller, the robot can perform all the assigned task. A Microprocessor is a core part of the controller, which takes various signals as Input and generate a corresponding output signal.

3.5 Types of Sensors Used In The Robotics

Here are the following sensors which can be used in the robotics:

a **Light sensors-** A light sensor detect light and create a voltage difference, which is equivalent to the light intensity fall on the sensor.
The two main Light sensors which used in the robotics are:

1. Photovoltaic cells

2. Photo-resistor sensor

b **Sound sensors-** This sensors are microphones which detects sound and return a voltage difference equivalents to the level of sound. Example of a sound sensor is: Instruct a robot by clap.

c **Temperature sensor-** Temperature sensors sense the change in temperature of the surrounding. It provides a voltage difference equivalent to a change in temperature occurred.
Example of temperature sensor IC's are LM34, LM35, TMP35, TMP36, and TMP37.

d **Proximity sensor-** Proximity sensor can sense any nearby object without any physical contact. Following are the type of proximity sensor used in the robotics:

1. Infrared (IR) Transceivers,
2. Ultrasonic Sensor
3. Photo-resistor sensor

e **Acceleration Sensor-** Accelerometer is a device which detects the acceleration and can tilt accordingly.

f **Navigation sensor-** These are the sensors which are used to identify the position of the robot. Some of the navigation sensors are:

1. GPS (global positioning system)
2. Digital Magnetic compass
3. Localization

3.6 RAPID PROTOTYPING

Rapid Prototyping or Layered Manufacturing is a fabrication technique where threedimensional solid models are constructed layer upon layer by the fusion of material under computer control. This process generally consists of a substance, such as fluids, waxes, powders or laminates, which serves as the basis for model construction as well as sophisticated computer-automated equipment to control the processing techniques such as deposition, sintering, lasing, etc . Also referred to as Solid Freeform Fabrication, Rapid Prototyping complements existing conventional manu-facturing methods of material removing and forming. It is widely used for the rapid fabrication of physical prototypes of functional parts, patterns for molds, medical prototypes such as implants, bones and consumer products. Its main advantage is early verification of product designs. Through quick design and error elimination,

Rapidly Prototyped parts show great cost savings over traditionally prototyped parts in the total product life cycle. Currently, there are over 30 different types of Rapid Prototyping processes in existence, such as Stereolithography, which is used here and described below. Stereolithography (SL) is a three-dimensional building process, which produces a solid plastic model. In this process, an ultraviolet (UV) laser traces two-dimensional cross-sections on the surface of a photosensitive liquid plastic (resin). The laser partially cures the resin through low energy absorption of laser light thus producing a solid. The first cross-sectional slice is built on a depth-controlled platform, which is fully submerged under the first thin layer of resin. This and each successive thin layer of liquid resin has a depth equal to that of the vertical slice thickness of the part. After each slice is traced on the surface of resin, the platform lowers by a depth equal to that of the slice thickness. Successive 2-D slices are cured directly onto the previous layer as the part is built from bottom to top.

Support structures are needed to maintain the structural integrity of the part and supports overhangs, as well as provide a starting point for the overhangs and for successive layers on which to be built. These supports are constructed from a fine lattice structure of cured resin. After the part is fully built, the support structures are removed and the part is cleaned in a bath of solvent and air-dried. The prepared parts are then flooded with high-intensity UV light in a Post-Cure Apparatus (PCA) to fully cure the resin.

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The main objective is to study the fabrication of the fabrication of the robot which is completely works as per design. The project interfaces are,

1. Design module

2. Manufacturing module

The Main Objectives are

1) Robotic Arm perform pick and place operation
2) Design arm
3) Easy to controlling
4) Gear Selection
5) System is compact and easily movable
6) Initial cost should be less

3.7 WORKING PRINCIPLE

A typical robotic arm is made up of several metal segments, joined by joints. To controls the robot by rotating individual motors connected to each joint. Motor shaft is connected to gear mechanism frame is fixed already, as gear rotate each joint of the robotic arm get start to rotate. In our project we provide motor at each joint for pick purpose. We used gripper so, any kind of shape can be pick up easily.

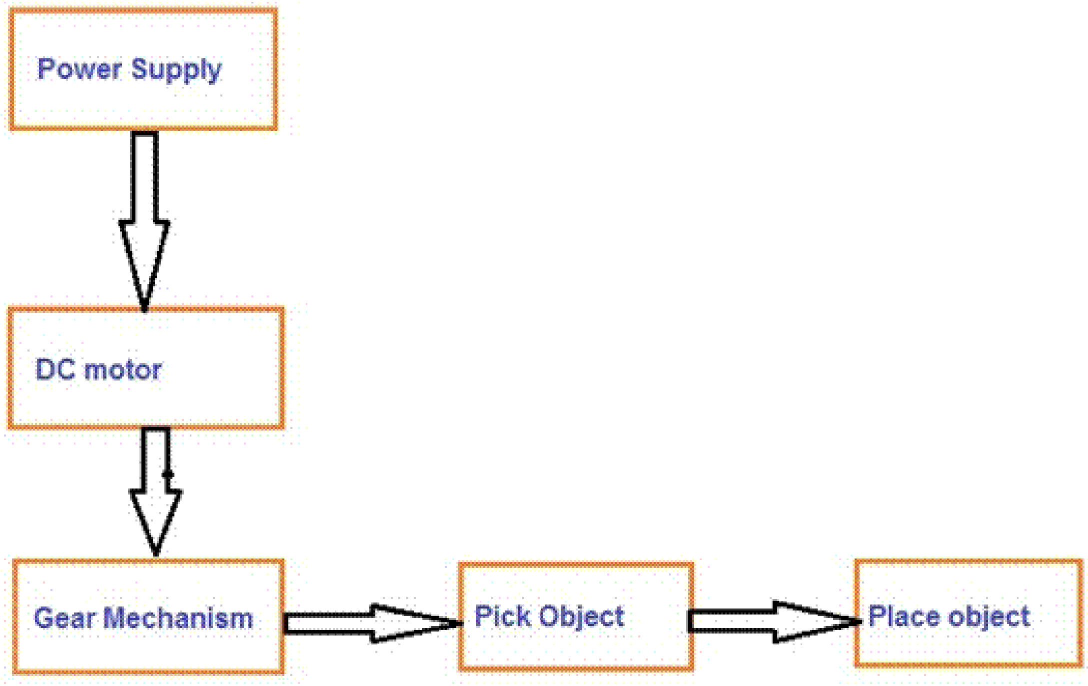

Fig 10.1 Working Principle of robot

3.4 STRUCTURE The frame will fabricated first so that other components could be attached as they will be completed. The lowest level of the chassis was welded first, and then the vertical members will be welded on by sighting along the chassis. Our whole project will be set on the structure only. This is the main part of the project. A machine structure is a fixed constructed object which functions as part of some mechanized process or which performs mechanized processes independently. The various types of machine structures may differ vastly from each other in appearance. These do not include structures built to shelter or enclose machinery; the machinery must be inextricably linked to the structure's form.

Fig 10.2 Robot Assembly

The popular concept of a robot is of a machine that looks and works like a human being. The industry is moving from current state of automation to Robotization, to increase productivity and to deliver uniform quality. In some configurations, links can be considered to correspond to human anatomy as waist, upper arm and forearm with joint at shoulder and elbow. At end of arm a wrist joint connects an end effector which may be a tool and its fixture or a gripper or any other device to work. Here how a pick and place robot can be designed for a workstation where loading and packing of lead batteries is been presented. All the various problems and obstructions for the loading process has been deeply analyzed and been taken into consideration while designing the pick and place robot.

4. Result and discussion

Study about fabrication of robotic chassis is done successfully.

5. Conclusion

a. The study related to robotic chassis is done.
b. All the parts of robotic chassis has identified.

5. Viva Question

a) What do you understand by the term, the robotics?
b) Which was the first industrial robot?
c) List the name of the areas where the robotics can be applied?
d) What are the basic aspects of the robotics?
e) Why do we use robots in the industry?
f) What is a robot Locomotion?