Padre Conceicao College Of Engineering
WORKSHOP MANUAL
FE SEMESTER I

(Common for all Branches)

DEPARTMENT OF MECHANICAL ENGINEERING

Padre Conceicao College of Engineering.

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DEPARTMENT OF MECHANICAL ENGINEERING

Subject code : FE 170

Name of subject : Workshop I

Name : ……..

Branch : ……..

Year & Semester : ……

INSTITUTE VISION

"To establish a sustainable engineering ecosystem"

To strive towards excellence in Technical Education and Research by facilitating students with modern technology, interdisciplinary approach and problem solving ability to meet the needs of the industry, society and nation at large.

INSTITUTE MISSION

- To continuously improve students' educational outcomes through effective teaching learning methodology.
- To provide students and faculty with advanced technology and excellent scholastic ambience for research.
- To provide opportunities for holistic development of students with a focus on self-learning, ethics, leadership, and entrepreneurship skills.
- To strengthen the network with alumni and industries.

Department of Mechanical Engineering

VISION

"To empower the students to serve the society and nation, by imparting value based education through contemporary infrastructure, excellence in education and research, in the realm of Mechanical Engineering."

MISSION

- To provide an effective and appropriate pedagogy to instil critical and proactive thinking in mechanical engineering students and empower them to make cogent contributions to the society.
- To endow the students with ethical values, professional and entrepreneurial skills and make them competitive at the national as well as global level.
- To develop alliances with Research & Development organisations, industries and alumni for excellence in teaching, research and consultancy.

PROGRAM EDUCATIONAL OBJECTIVES:

Within a few years of graduating, the Mechanical Engineering graduates will:

PEO 1: Have successful careers in industry, academia and entrepreneurship in various fields of mechanical engineering and allied disciplines.

PEO 2: Have professional, ethical, leadership qualities, and proactively address a variety of technical and societal problems.

PEO 3: Retain intellectual curiosity and disseminate knowledge through lifelong learning, to tackle the rapidly evolving challenges of the modern world.

PEO 4: Contribute effectively towards the advancement of industry, society and nation through research and development.

PROGRAM OUTCOMES (POS)

At the end of this program the student will be able to:

1. **Engineering Knowledge:** Apply knowledge of mathematics, science and Mechanical engineering discipline specific competencies to the solution of engineering problems.
2. **Problem Analysis:** Identify, formulate, review research literature and analyze engineering problems using mathematics, natural sciences and engineering sciences to arrive at substantiated conclusions.
3. **Design/Development of Solutions:** Design solutions for engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety and aligned with the cultural, societal and environmental considerations.
4. **Conduct Investigations of Complex Problems:** Use research based knowledge and methodologies to analyze, interpret data and synthesize information to make valid conclusions.
5. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering software and tools to simulate and model engineering problems.
6. **The Engineer and the Society:** Practically contextualize in the society the Mechanical engineering concepts to address health, legal, reliability and safety concerns.
7. **Environment and Sustainability:** Understand and appreciate the impact of professional engineering solutions in societal and environmental context and to imbibe the professional concern for sustainable development practices.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and Team Work:** Contribute effectively as an Individual and as a member or leader in diverse teams amidst multi-disciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large in the form of technical reports, journal and conference papers, design documentation and presentations.
11. **Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work and in teams, to successfully manage projects in multidisciplinary environments.
12. **Lifelong Learning:** Recognize the need for, and have the ability to engage in independent and life-long learning in the context of continuous technological change.

Programme Specific Outcomes (PSO):

At the end of this program the student will be able to:

1. Apply the knowledge of design, industrial, manufacturing, thermal engineering and multidisciplinary perspectives to address the needs of Mechanical Engineering systems.
2. Develop and implement solutions for products and services with the help of engineering tools.

Course Outcomes:

The student will be able to:

CO ID	CO Description	Bloom's Level
FE 170.1	Understand and demonstrate the skills required for carpentry	2
FE 170.2	Understand and demonstrate the skills required for fitting	2
FE 170.3	Understand and demonstrate the skills required for forging	2
FE 170.4	Understand and demonstrate the skills required for welding	2

CO-PO/PSO Matrix of FE 170 Workshop -I

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3					2	2					2		
2	3					2	2					2		
3	3					2	2					2		
4	3					2	2					2		

TABLE OF CONTENT

SAFETY PRECAUTIONS
TO BE OBSERVED IN WORK SHOP

1. Always wear tight clothes
2. Never walk barefooted inside the Work Shop. Prefer to use Rubber soled shoes; closed shoe is recommended
3. Never try to operate any machine unless you know how to operate it.
4. Never touch moving parts.
5. Do not use defective tools.
6. Do not touch any live wire.
7. In case of fire, disconnect the electric supply.
8. Those who have long hair should take precaution by dressing them properly.
9. Tools which are not being used should always be kept at their respective places.
10. Never carry an open sharp tool in the pocket.
11. Do not cut work piece by holding it in hand.
12. Never work in a place where there is no sufficient light.
13. Always keep in mind the position of fire extinguishers and first aid box.
14. The job should be properly fitted in the vice.
15. Use always the right tool for the right job.
16. Don't use file or spanner as a hammer.
17. Always try to learn things sincerely from the instructors concerned.
18. Always keep your mind on the job.
19. Make sure that your work is not affecting the work of fellow students in the work shop.
20. Shop floor must be kept clean, free from scarp, oil and grease.

ACCIDENTS AND THEIR CAUSES

An accident is an unplanned incident which can cause damage to property or injury to people. It can happen due to anyone of the following reasons

1. Carelessness of the operator.
2. Lack of knowledge of the operator about the machine tool or job.
3. Lack of interest in the work.
4. Excessive confidence of the operator.
5. Operating a faulty machine.
6. Use of improper tools.
7. Running the machines at higher speeds or higher loads than recommended.
8. Improper or loose dress of the operator.
9. Improper lighting and ventilation in the workshop.
10. Lack of discipline among the operators.
11. Keeping objects in improper places, so as to interfere with free movement

WORKSHOP-I					
Course Code	**FE 170**		**Credits**	**1**	
Scheme of Instruction	**L**	**T**	**P**	**TOTAL**	
Hours/ Week	**0**	**0**	**2**	**26 hrs/sem**	
Scheme of Examination	**IA**	**TW**	**TM**	**P**	**O**
TOTAL = 50 marks	**0**	**50**	**0**	**0**	**0**

SN	Experimental List
1	**Fitting** a. Demonstration of various tools and equipments used in fitting shop. b. Practical Experiments: at least one job covering simple fitting practice.
2	**Carpentry** a. Demonstration of wood cutting machines, various tools and equipments used by a carpenter. b. Practical Experiments: at least one of the following jobs i. Wooden joint ii. Wood turning
3	**Forging** (a) Demonstration of various equipments used in Forging shop. (b) Practical Experiments: At least one job covering forging practice.
4	**Welding** a. Demonstration of various tools and equipments used by a welder. b. Practical Experiments: At least one job on electric arc welding.

FITTING

INTRODUCTION

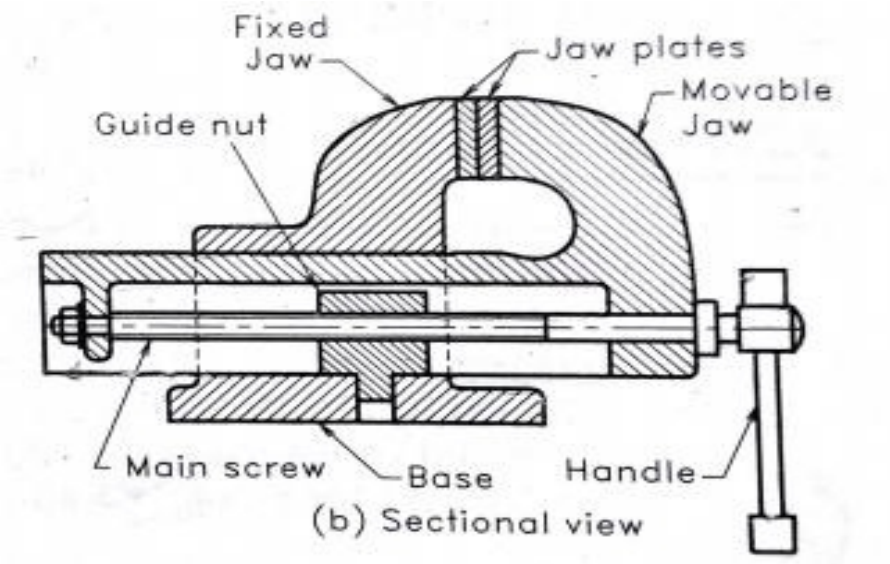
The term, "Bench work" refers to the production of components by hand on the bench, whereas fitting deals with the assembly of mating parts, through removal of metal, to obtain the required fit.

Both the bench work and fitting requires the use of number of simple hand tools and considerable manual effort. The operations in the above works consist of filing, chipping, scraping, sawing, drilling, tapping, etc.

FITTING TOOLS

HOLDING TOOLS

BENCH VICE: The bench vice is a work-holding device. It is the most commonly used vice in a fitting shop. It is fixed to the bench with bolts and nuts. The vice body consists of two main parts, fixed jaw and a movable jaws. Jaws are made of hardened steel. The size of the vice is specified by the length of the jaws.The vice body is made of cast iron which is strong in compression.



V-BLOCK WITH CLAMP: The V-block is a rectangular or square block with a V-groove on one or both sides, opposite to each other The angle of the 'V is usually 90°. V-block with a clamp is used to hold cylindrical work securely.

MARKING AND MEASURING TOOLS

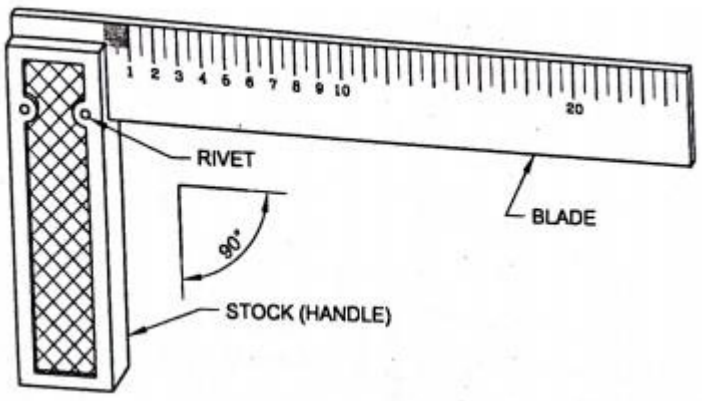
SURFACE PLATE: The surface plate is machined to fine limits and is used for testing the flatness of the work piece. It is also used for marking out small works and is more precise than the marking table. The surface plate is made of cast iron, hardened steel or granite stone. It is specified by length ' width ' height' and grade.

ANGLE PLATE: The angle plate is made of cast iron. It has two surfaces, machined at right angle to each other. Plates and components, which are to be marked out, may be held against the upright face of the angle plate, to facilitate the marking. Slots are provided on the angle plate to clamp the work in position.

UNIVERSAL SCRIBING BLOCK: This is used for scribing lines for layout work and checking parallel surfaces. It may be noted that its spindle can be quickly adjusted to any angle, by an adjusting screw.

SCRIBER: A scriber is a slender steel tool, used to scribe or mark lines on metal work pieces . It is made of hardened and tempered high carbon steel.

TRY-SQUARE: It is used for checking the trueness of an object and also for making. The blade of the try-square is made of hardened steel and the stock of cast iron or steel.



ODD-LEG CALIPER: This is also called 'Jenny Caliper' or 'Hermaphrodite'. This is used for marking parallel lines from a finished edge and also for locating the centre of round bars.

DIVIDER: It is basically similar to the calipers except that its legs are kept straight and pointed at the measuring edge. This is used for marking circles, arcs, laying out perpendicular lines, bisecting lines.

PUNCHES: These are used for making indentations on the scribed lines, to make them visible clearly. These are made of high carbon steel. A punch is specified by its length and diameter.

DOT PUNCH: This is used to lightly indent along the layout lines, to locate centre of holes and to provide a small centre mark for divider point. etc .The angle of the punch is 60° .

CENTRE PUNCH: It is used to mark the location of the holes to be drilled. This is similar to a dot punch .The angle of the punch is 90°.

CALIPERS: They are indirect measuring tools used to measure or transfer linear dimensions. These are used with the help of a steel rule to check inside and outside measurements. These are made of case hardened mild steel or hardened and tempered low carbon steel. These are specified by the length of the legs.

VERNIER CALIPERS: These are used for measuring outside as well as inside dimensions accurately . It may also be used as a depth gauge. It has two jaws. One jaw is formed at one end of its main scale and the other jaw is made part of a vernier scale. 49 main scale divisions are divided into 50 equal parts in the vernier scale. Hence, one division of vernier scale is 1/50 mm less than 1mm.This gives a least count of .02mm.

Least count may be defined as the minimum dimension which can be measured by the device. For measuring the size of an object; it is held between its jaws and noting the main scale and vernier scale readings; the size can be determint.

Vernier caliper is generally made of nickel-chromium steel. Its size is specified by the maximum length that can be measured by it.

VERNIER HEIGHT GAUGE: The vernier height gauge, clamped with a scriber. It is used for layout work. An off-set scriber is used when it is required to take measurements from the surface, on which the gauge is standing. The accuracy is same as vernier calipers. Its size is specified by the maximum height that can be measured by it. It is made of nickel-chromium steel.

VERNIER DEPTH GAUGE: It is used for precision measurement of blind holes, slots, grooves, etc. The working principle of this instrument is the same as that of the vernier caliper. It is made of nickel-chromium steel. Its size is specified by the maximum depth that can be measured by it.

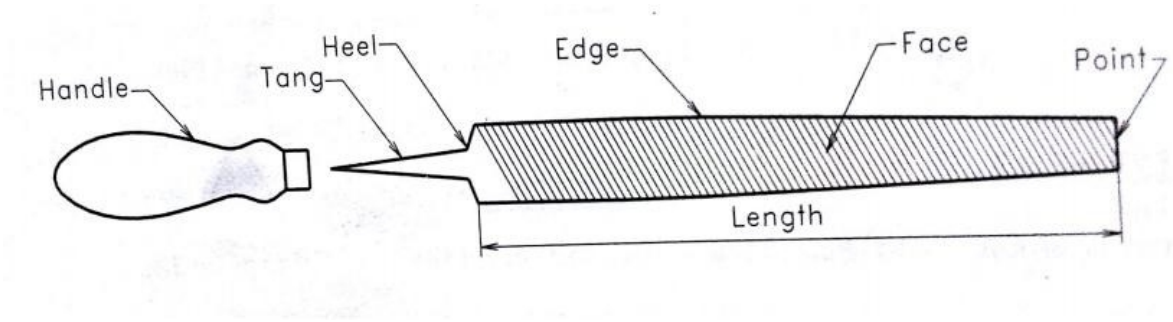
CUTTING TOOLS

FILE:A file is a hardened piece of steel containing a percentage of carbon or tungsten. Fine teeth are cut on the surface of the teeth in slanting rows. Files are classified according to the following factors:

1. The cut.

2. The shape.

3. **The length**.



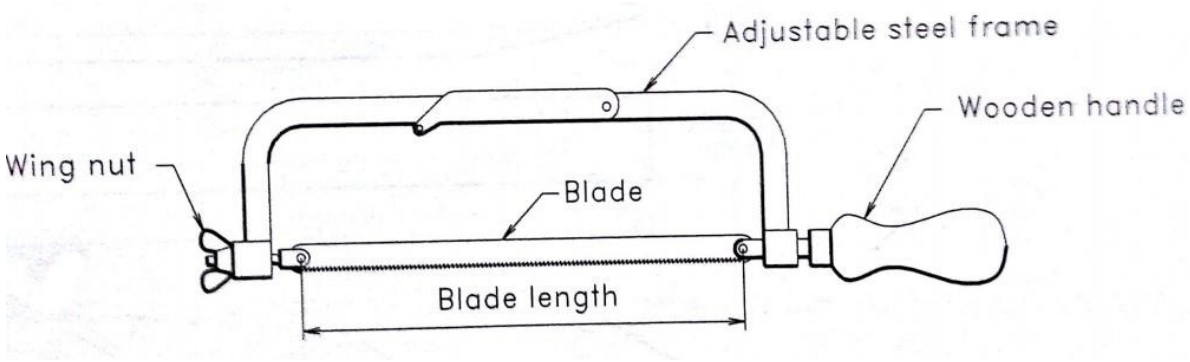
SINGLE CUT FILE:A single cut file will be having parallel teeth at 60 degree inclination to the centre line.

DOUBLE CUT FILE:double cut files have two times cut-teeth; one as 60 degree and the other cut is 80 degree.

FILE CARD: It is a metal brush, used for cleaning the files, to free them from filings, clogged in- between the teeth .

CHIPPING: Removing the metal with a chisel is called chipping and Is normally used where machining is not possible .While chipping, safety goggles must be put on, to protect eyes from the flying chips.

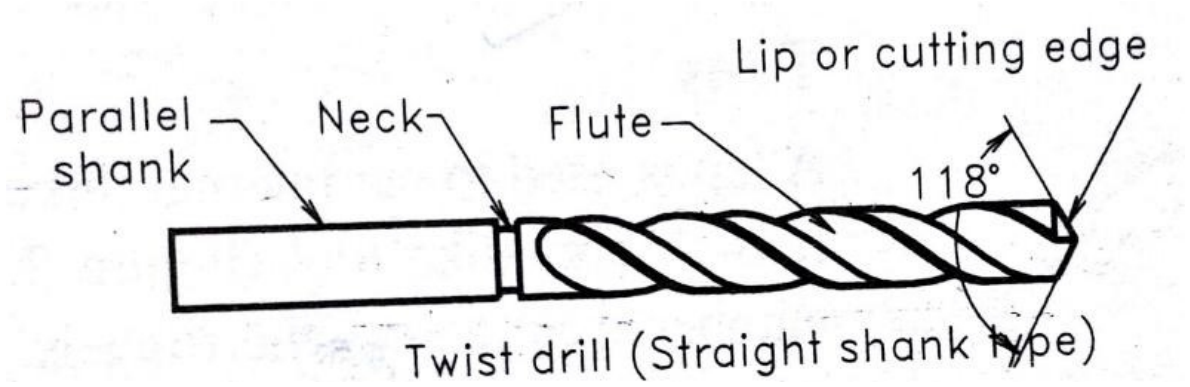
HACKSAW: The hacksaw is used for cutting metal by hand. It consists of a frame, which holds a thin blade, firmly in position. Hacksaw blade is specified by the number of teeth per centimeter. Hacksaw blades have a number of teeth ranging from 5 to 15 per centimeter (cm). Blades having lesser number of teeth per cm are used for cutting soft materials like aluminum, brass and bronze. Blades having larger number of teeth per centimeter are used for cutting hard materials like steel and cast iron.



HACKSAW BLADES ARE CLASSIFIED AS: (i) All hard and (ii) flexible types. The all hard blades are made of H.S.S, hardened and tempered throughout to retain their cutting edges longer. These are used to cut hard metals. The size of the blade is measured by the distance between the pin holes.

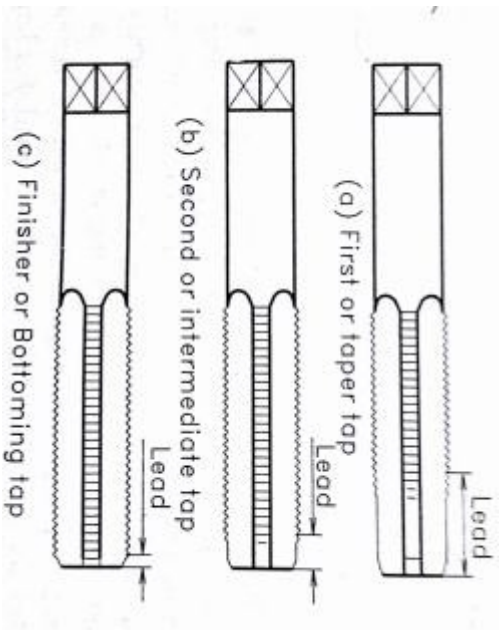
CHISELS: Chisels are used for removing surplus metal or for cutting thin sheets. These tools are made from carbon steel of octagonal or hexagonal section. Chisels are annealed, hardened and tempered to produce a tough shank and a hard cutting edge. The cutting angle of the chisel for general purpose is about 60°.

TWIST DRILL: Twist drills are used for making holes. These are made of high speed steel. Both straight and taper shank twist drills are used. Cutting angle of the twist drill is 118°.



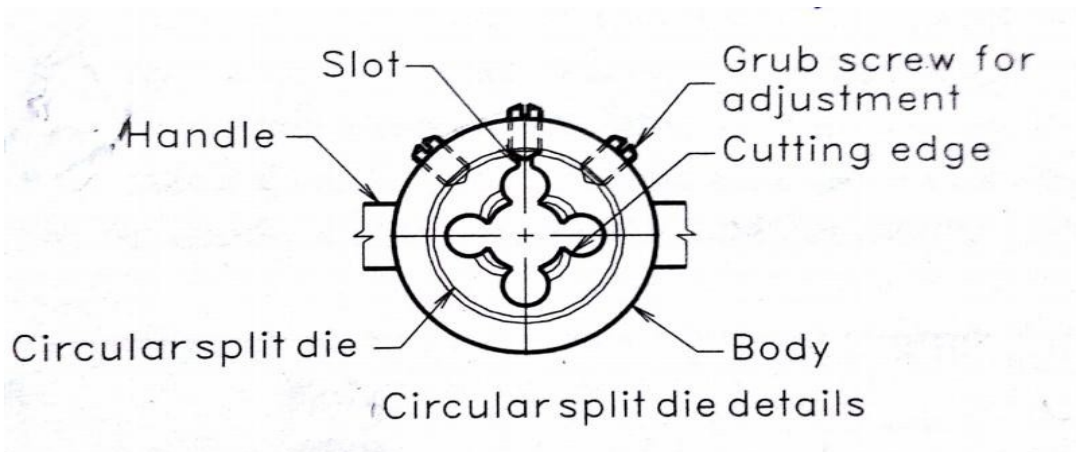
TAPS AND TAP WRENCHES: A tap is a hardened steel tool, used for cutting internal threads in a drilled hole. Hand taps are usually supplied in sets of three for each diameter and thread size. Each set consists of a taper tap, intermediate tap and plug or bottoming tap. Taps are made of high carbon steel or high speed steel.

1. First tap, or rougher - to start threading.
2. Second tap or intermediate - to cut the thread.
3. Bottoming tap or finisher - to finish the thread.



TAPS

DIES: Dies are used to cut external threads on round rods. A die is a round block of hardened steel with a hole having internal threads and flutes across the threads. The die is fitted inside a die holder called *die stock.*

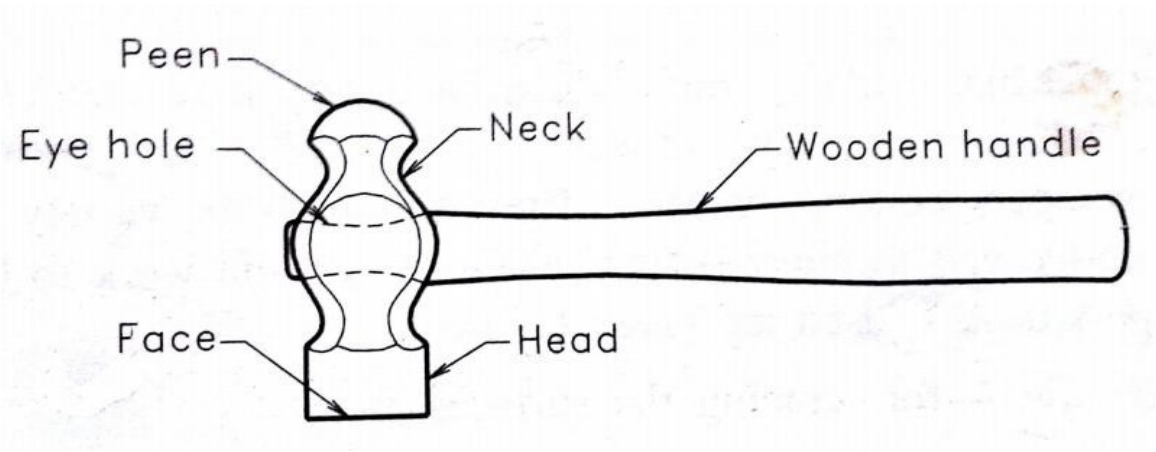


BENCH DRILLING MACHINE: Holes are drilled for fastening parts with rivets, bolts or for producing internal threads. Bench drilling machine is the most versatile machine used in a fitting shop for the purpose . Twist drills, made of tool or high speed steel are used with the drilling machine for drilling holes.

HAMMERS

Hammers are used to strike on a tool fastener or workpiece.They are made up of steel by forging process. Wooden or bamboo handle is fitted in the elliptical eye hole of the hammer.

BALL-PEEN HAMMER: Hammers are named, depending upon their shape and material and specified by their weight. A ball-peen hammer has a flat face, which is used for general work and a ball end, particularly used for riveting.



CROSS-PEEN HAMMER: It is similar to ball peen hammer, except the shape of the peen . This is used for chipping, riveting, bending and stretching metals and hammering inside the curves and shoulders.

STRAIGHT- PEEN HAMMER: This is similar to cross-peen hammer, but its peen is in-line with the hammer handle. It is used for swaging, riveting in restricted places and stretching metals.

SPANNERS: A spanner or wrench is a tool for gripping nuts and bolts. It is usually made of forged steel. There are many kinds of spanners. They are named according to the application. The size of the spanner denotes the size of the bolt on which it can work

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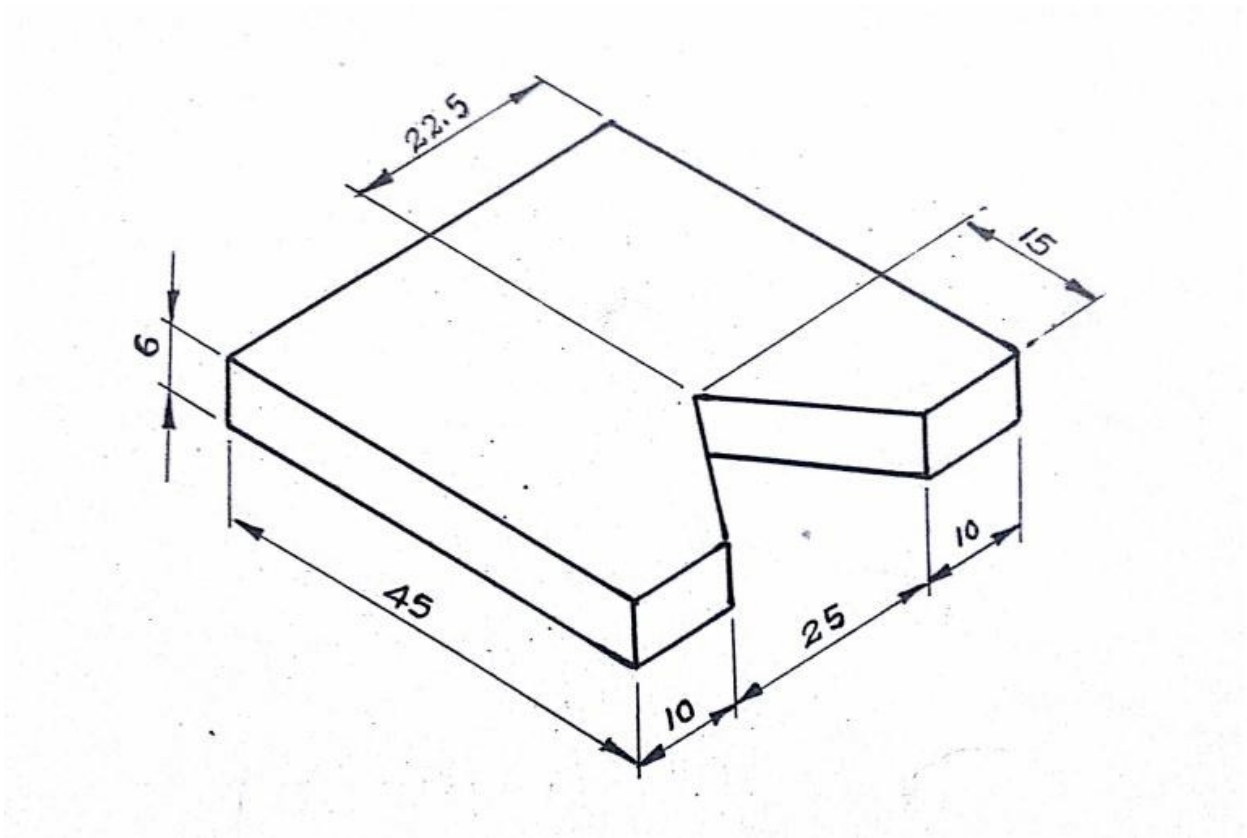
MODEL NO : 1

V-GROOVE



Scale 1:1

All dimensions are in mm

MODEL NO : 1

V-GROOVE

AIM: To make a V-Groove on a given m.s flat as in the dimensions shown in fig.

MATERIALS REQUIRED : Mild steel flat of 50 X 50X 6mm.

TOOLS REQUIRED:

- **Steel rule**
- **Scriber**
- **Centre punch**
- **Surface plate**
- **Vernier height gauge**
- **Hack saw**
- **Flat file**
- **Try square**

LIST OF OPERATIONS :

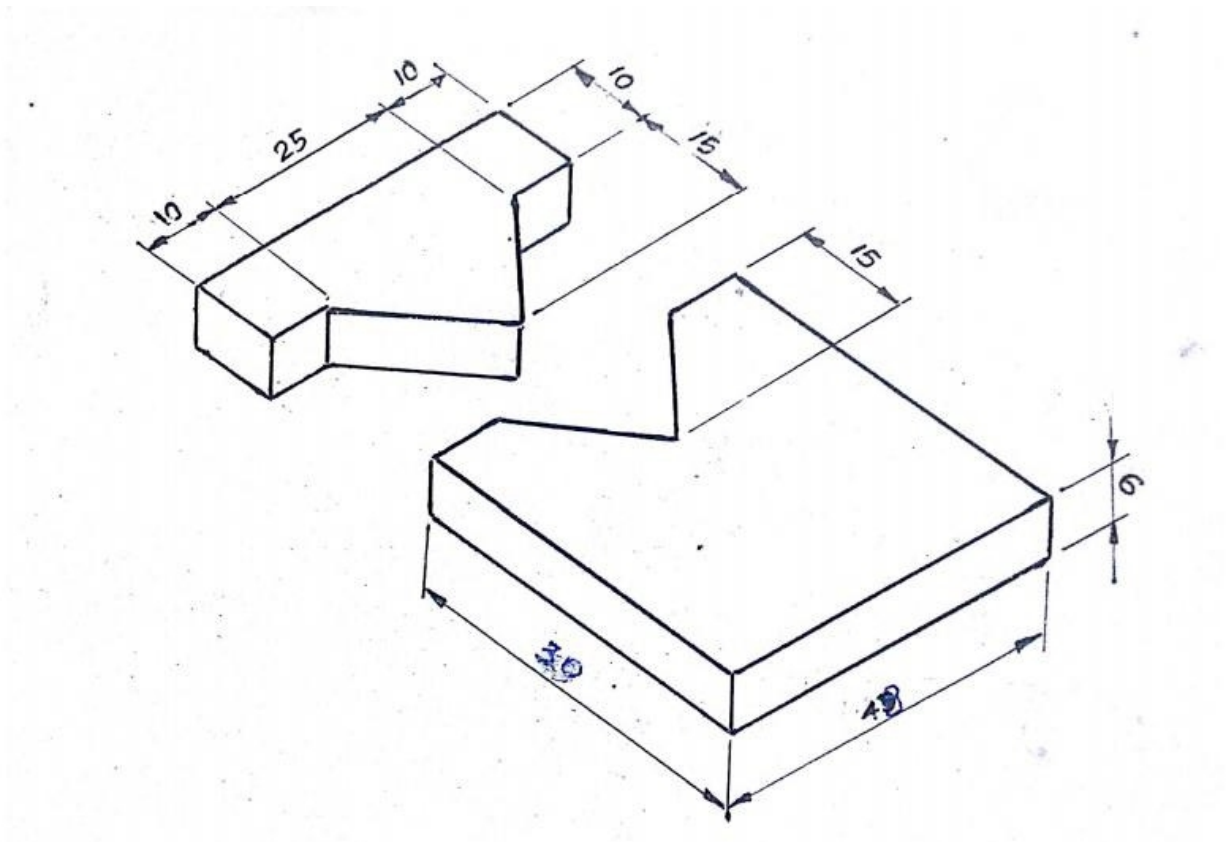
- **Laying out and marking**
- **Punching**
- **Cutting**
- **Rough filing**
- **Smooth filing**

PROCEDURE :

1. **Copy the given drawing.**
2. **Collect the tools and work piece.**
3. **Mark the layout on the work piece then punch the required lines.**
4. **Cut unwanted material from the work piece.**
5. **After completing the square cut the V-groove .**
6. **Filed the V-Groove to the exact angle.**
7. **Check the angles of 'V' and finish the model.**

MODEL NO: 2

V-JOINT



Scale 1:1
All dimensions are in mm

MODEL NO: 2

V-JOINT

AIM: To make a v joint as per the given dimension shown in fig.

MATERIALS REQUIRED: Mild steel flat of 50X50X6mm

30x50X6mm

TOOLS REQUIRED:

- Steel rule.
- Scriber.
- Centre punch.
- Surface plate..
- Vernier height gauge.
- Hack saw.
- Flat file.
- Try square.

LIST OF OPERATIONS:

- Laying out and marking.
- Punching.
- Cutting.
- Rough filing.
- Smooth filing.

PROCEDURE:

1. Copy the given drawing.
2. Collect the tools and work piece.
3. Mark the layout on the work piece then punch the required lines.
4. Complete the cutting operation of two pieces.
5. Filed the two pieces together to form the joint.
6. Check the joints for dimensional accuracy.

CARPENTRY

INTRODUCTION

Carpentry may be defined as the process of making wooden components. It starts from a marketable form of wood and ends with a finished product. It deals with the building work, furniture, cabinet making, etc. Joinery, i.e., preparation of joints is one of the important operations in all wood-works.

TIMBER: Timber is the name given to the wood obtained from well grown trees. The trees are cut, sawn into various sizes to suit building purposes.

The word, 'grain', as applied to wood, refers to the appearance or pattern of the wood on the cut surfaces

MARKET SIZES OF TIMBER: Timber is sold in the market in various standard shapes and sizes. The following are the common shapes and sizes:

1. Log - The trunk of the tree, which is free from branches.
2. Balk - The log, sawn to have roughly square cross-section.
3. Plank - A sawn timber piece, with more than 275 mm in width, 50 to 150 mm in thickness and 2.5 to 6.5 meters in length.

CLASSIFICATION OF TIMBER: Wood suitable for construction and other engineering purposes is called timber. Woods in general are divided into two broad categories: Soft woods and hard woods.

Soft woods are obtained from conifers, kair, deodar, chir, walnut. Woods obtained from teak, sal, oak, shisham, beach, ash, mango, neem and babul are known as hard woods.

SEASONING OF WOOD: A newly felled tree contains considerable moisture content. If this is not removed, the timber is likely to wrap, shrink, crack or decay. Seasoning is the art of extracting the moisture content under controlled conditions

CHARACTERISTICS OF GOOD TIMBER

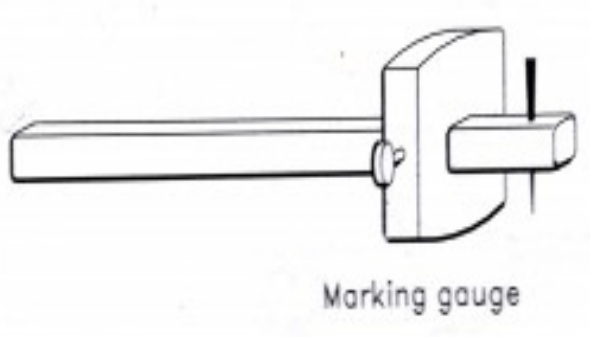
1. It should have minimum moisture content.
2. The grains of wood should be straight and long.
3. It should produce metallic sound on hammering.
4. It should be free from knots or cracks.
5. It should be of uniform in color.
6. It should respond well to the finishing and polishing operations.

CARPENTRY TOOLS

The following are the tools that are made use of in all the wood working operations.

MARKING AND MEASURING TOOLS: Accurate marking and measurement is very essential in carpentry work, to produce parts to exact size. To transfer dimensions onto the work; the following are the marking and measuring tools that are required in a carpentry shop:

MARKING GAUGE: It is a tool used to mark lines parallel to the edge of a wooden piece. It consists of a square wooden stem with a sliding wooden stock (head) on it. On the stem is fitted a marking pin, made of steel. The stock is set at any desired distance from the marking point and fixed in position by a screw. It must be ensured that the marking pin project through the stem, about 3 mm and the end is sharp enough to make a very fine line.



Marking gauge

MORTISE GAUGE: It consists of two pins. In this, it is possible to adjust the distance between the pins, to draw two parallel lines on the stock.

COMPASS AND DIVIDER: It is used for marking arcs and circles on the planed surfaces of the wood.

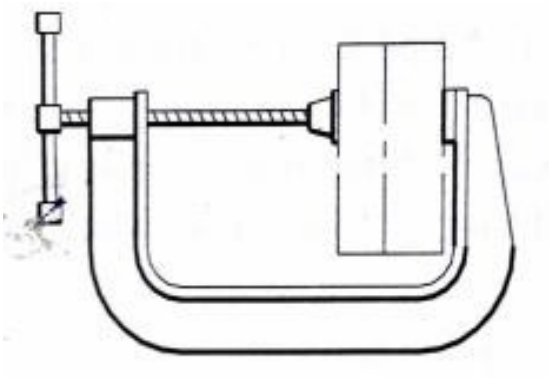
SCRIBER OR MARKING KNIFE: It is used for marking on timber . It is made of steel, having one end pointed and the other end formed into a sharp cutting edge.

BEVEL SQUARE: It is used for laying-out and checking angles. The blade of the bevel is adjustable and may be held in place by a thumb screw. After it is set to the desired angle, it can be used in much the same way as a try-square. A good way to set it to the required angle is to mark the angle is to mark the angle on a surface and then adjust the blade to fit the angle.

HOLDING TOOLS

CARPENTER'S BENCH VICE: It is used as a work holding device in a carpenter shop. Its one jaw is fixed to the side of the table while the other is movable by means of a screw and a handle. The jaws are lined with hard wooden faces.

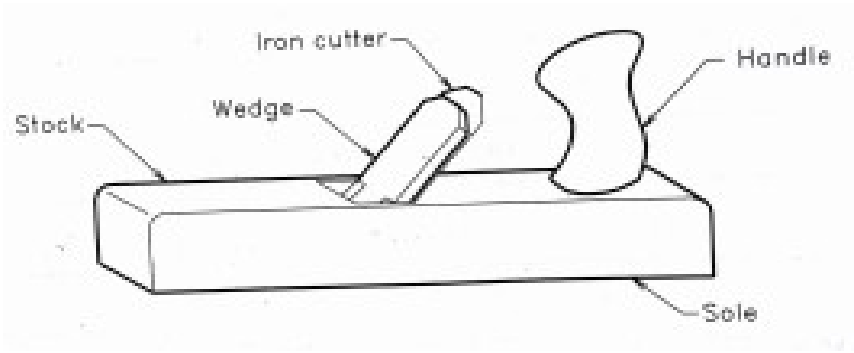
C-CLAMP: The clamp of the shape of letter C or G is used to clamp short pieces together as the bar cramp.



BAR CRAMP: It is made of steel bar of T-section, with malleable iron fittings and a steel screw. It is used for holding wide works such as frames or tops.

PLANING TOOLS

JACK PLANE: It is the most commonly used general purpose plane. It is about 35 cm long. The cutting iron (blade) should have a cutting edge of slight curvature. It is used for quick removal of material on rough work and is also used in oblique planing.



SMOOTHING PLANE: It is used for finishing work and hence, the blade should have a straight cutting edge. It is about 20 to 25 cm long. Being short, it can follow even the slight depressions in the stock, better than the jack plane. It is used after using the jack plane.

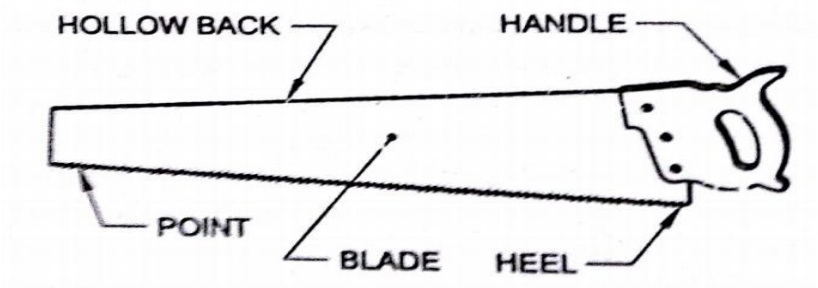
REBATE PLANE: It is used for making a rebate. A rebate is a recess along the edge of a piece of wood, which is generally used for positioning glass in frames and doors.

PLOUGH PLANE: It is **used to cut grooves, which are used to fix panels in a door.**

CUTTING TOOLS

SAWS: A saw is used to cut wood into pieces. There are different types of saws, designed to suit different purposes. A saw is specified by the length of its toothed edge.

CROSS-CUT OR HAND SAW: It is used to cut across the grains of the stock. The teeth are so set that the sawkerf will be wider than the blade thickness .

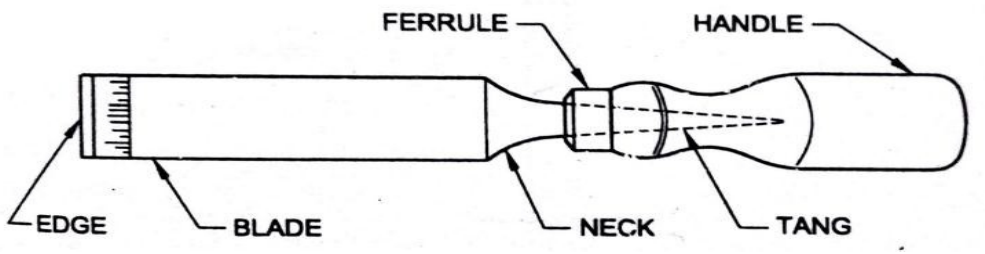


RIP SAW: It is used for cutting the stock along the grains. The cutting edge of this saw makes a steeper angle, i.e., about 60° .

TENON SAW: It is used for cutting the stock either along or across the grains. It is used for tutting tenons and in fine cabinet work.

CHISELS

FIRMER CHISEL: The word 'firmer' means 'stronger' and hence firmer chisel is stronger than other chisels. It is a general purpose chisel and is used either by hand pressure or by a mallet. The blade of a firmer chisel is flat, as shown in..



DOVETAIL CHISEL: It has a blade with a beveled back, as shown in . due to which it can enter sharp corners for finishing, as in dovetail joints.

MORTISE CHISEL: It is used for cutting mortises and chipping inside holes, etc. The cross-section of the mortise chisel is proportioned to withstand heavy blows during mortising. Further, the cross-section is made stronger near the shank.

DRILLING AND BORING TOOLS

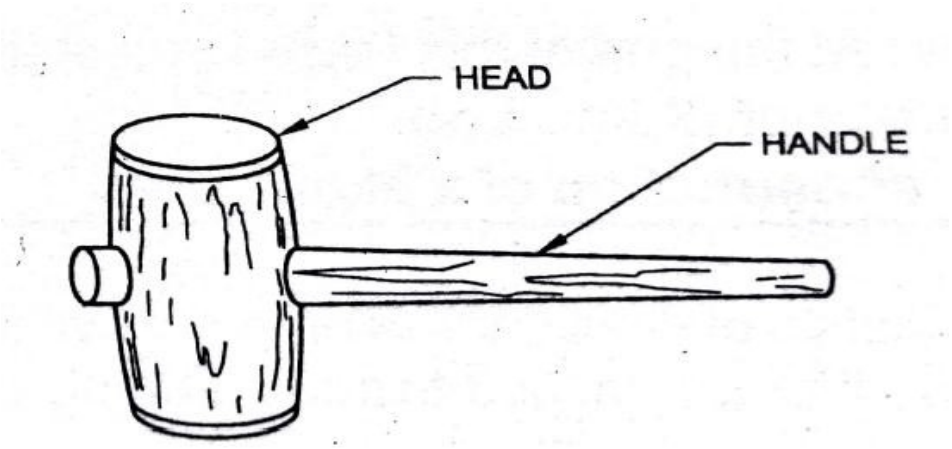
CARPENTER'S BRACE: It is used for rotating auger bits, twist drills, etc., to produce holes in wood. In some designs, braces are made with ratchet device.

AUGER: It is the most common tool used for making holes in wood. During drilling, the lead screw of the bit guides into the wood.

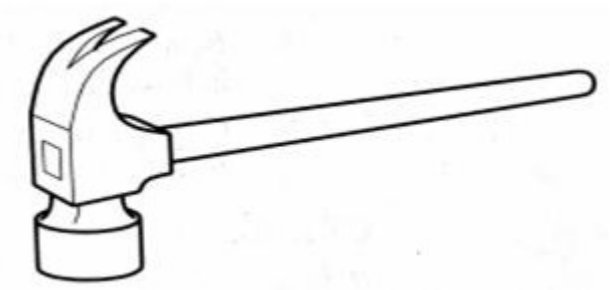
HAND DRILL: Carpenter's brace is used to make relatively large size holes; whereas hand drill is used for drilling small holes.

STRIKING TOOLS

MALLET: It is used to drive the chisel, when considerable force is to be applied, which may be the case in making deep rough cuts. Steel hammer should not be used for the purpose, as it may damage the chisel handle.



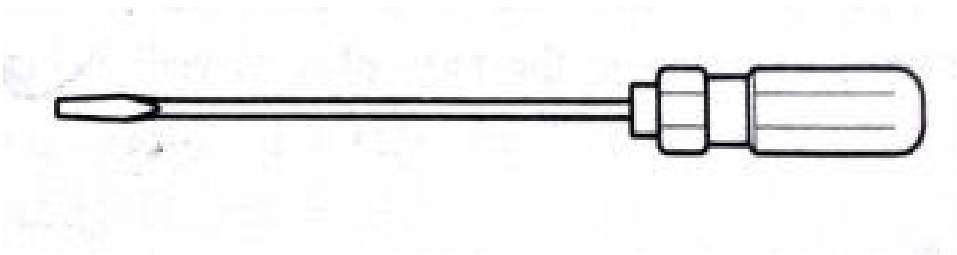
CLAW HAMMER: It has a striking flat face at one end and the claw at the other face is used to drive nails from wood and for other striking purposes.



MISCELLANEOUS TOOLS

PINCER: It is made of two forged steel arms with a hinged joint and is used for pulling-out small nails from wood.

SCREW DRIVER: It is used for driving wood screws into wood or unscrewing them. The length of a screw driver is determined by the length of the blade.



WOOD RASP FILE: It is a finishing tool used to make the wood surface smooth, remove sharp edges, finish fillets and other interior surfaces.

WOOD JOINTS: There are many kinds of joints used to connect wood stock. Each joint has a definite use. The strength of the joint depends upon the amount of contact area.

SAFE PRACTICES

1. Make sure that your hands are not in front of sharp edged tools while you are using them.
2. Use only sharp tools. A dull tool requires excessive pressure, causing the tool to slip.
3. Wooden pieces with nails should never be allowed to remain on the floor.
4. Test the sharpness of the cutting edge on wood or paper, but not on your hand.
5. Never chisel towards any part of the body.
6. Keep the screw driver properly pointed to prevent injury to hands.

CARE AND MAINTENANCE OF TOOLS

CHISELS

1. Do not use chisels where nails are present.
2. Do not use it as a screw driver.

SAWS

1. Do not use a saw with a loose handle.
2. Always use triangular file for sharpening the teeth.
3. Apply grease when not in use.
4. Do not use a saw on metallic substances.

AUGER

1. Do not use it without a handle.
2. Keep it straight while drilling; otherwise, the screw position may get altered.

BRADAWL

1. Keep it well sharpened.
2. Do not use it on metals.

MALLET

1. Do not use it on hard substances.
2. Do not use it on nails.

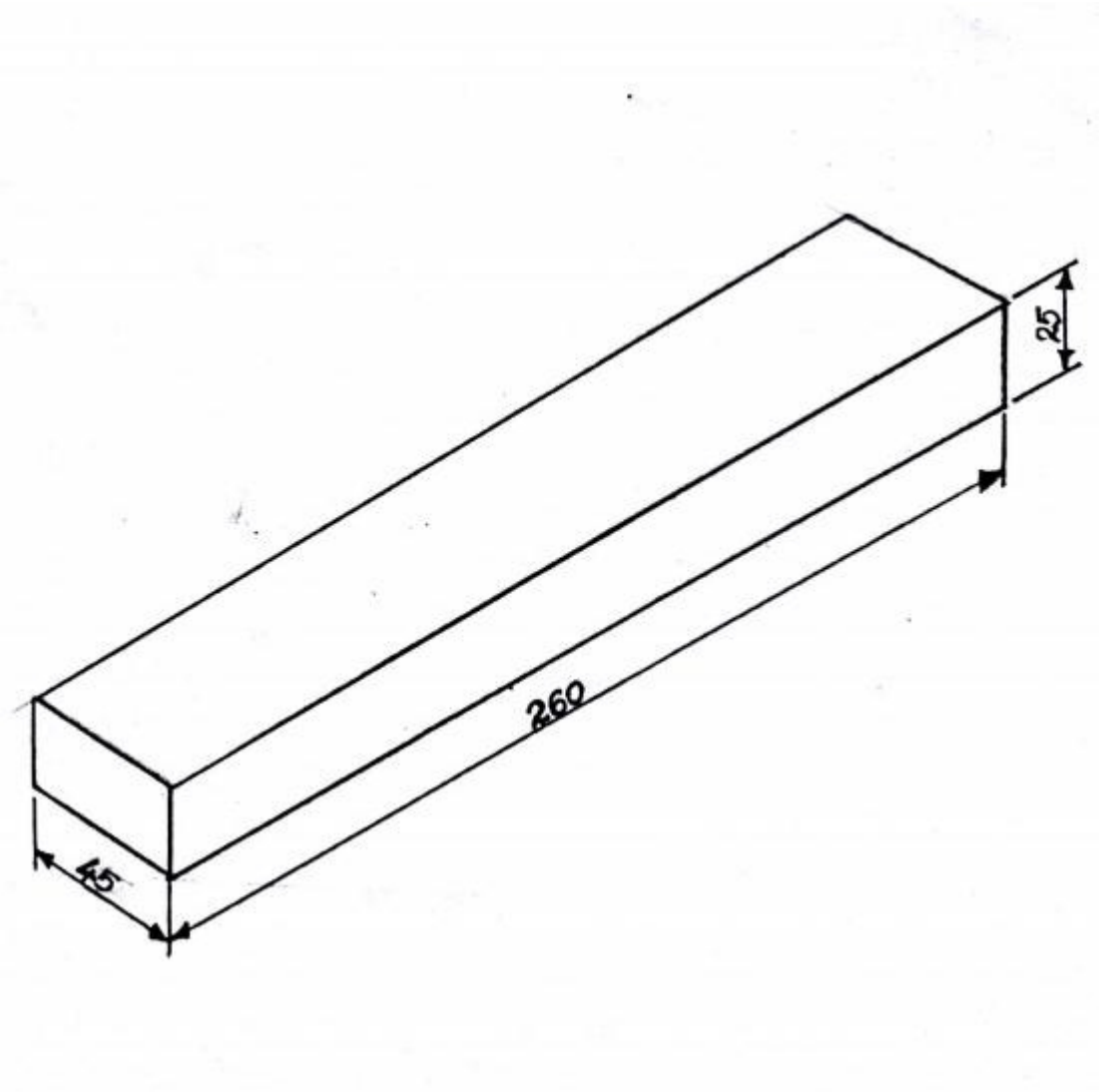
PLANE

1. Do not use it at the places, where a nail is driven in the wood.
2. Keep its blade well sharpened.

……

MODEL NO:1

PLANING PRACTICE



Scale 1:2

All dimensions are in mm

MODEL NO:1

PLANING PRACTICE

AIM:

Planing practice using the given wood piece.

MATERIALS REQUIRED:

Material: Hard wood (Jack fruit)

Size: 260x50x30 mm

TOOLS REQUIRED:

1-Steel rule,

2-Try square,

3-Metal jack plane**,**

4- Marking gauge,

5- Carpentry Vice,

6- Hand saw

LIST OF OPERATIONS:

1- Marking,

2-Planing

PROCEDURE:

1- Copy the given drawing.

2- Collect the tools and wood piece.

3- Check the size of the wood piece for its suitability to make the model as per the drawing.

4- Plane one side of the wood piece using metal jack plane and check the straightness.

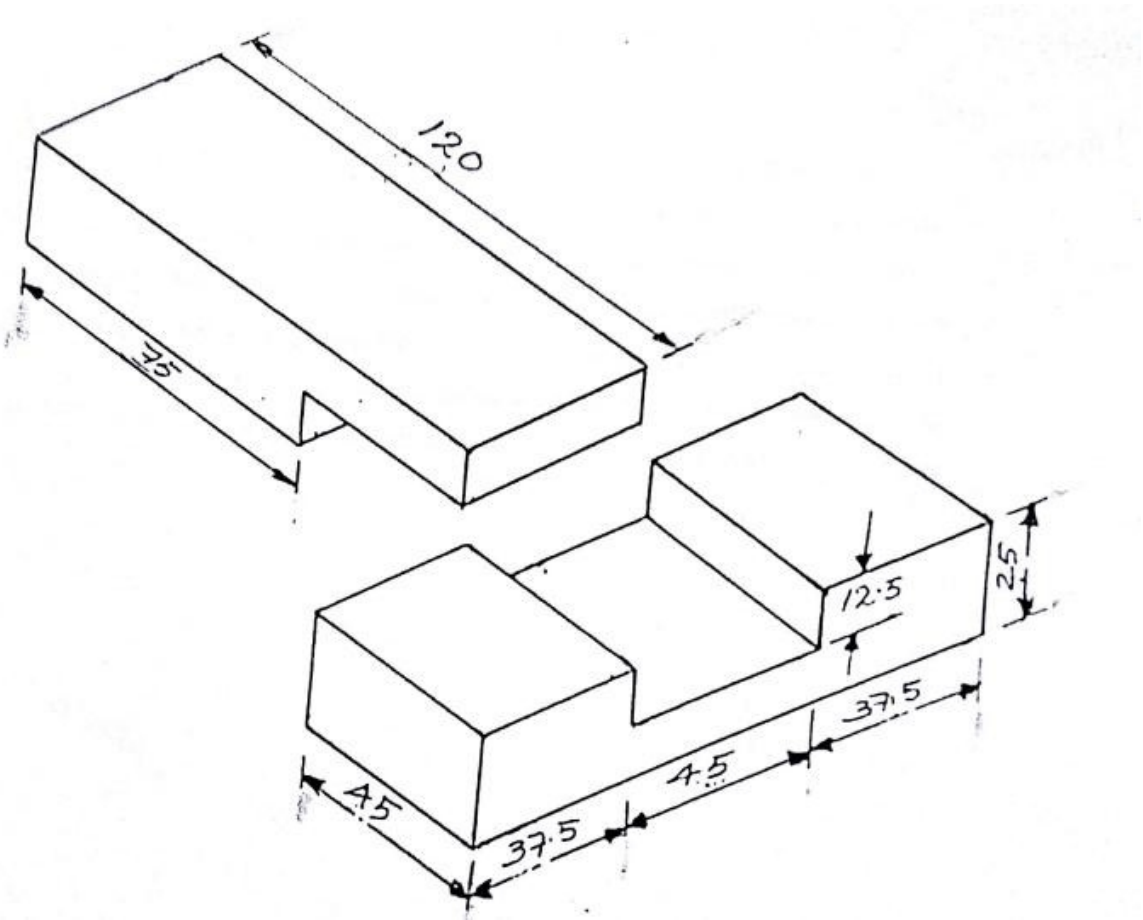
5- Plane the adjacent side of the wood piece and checked geometrical accuracy.

6- Mark the thickness and width as per drawing using marking gauge.

7- Finish the planning operation and check the dimensions as per the drawing.

MODEL NO:2

T-HALVED JOINT



Scale 1:1

All dimensions are in mm

MODEL NO:2

T-HALVED JOINT

AIM:

To make a T-Halved joint using the given wood piece

MATERIALS REQUIRED:

Material: hard wood (Jack fruit). Size:

260x50x30 mm.

TOOLS REQUIRED:

1-Steel rule,

2-Try square,

3-Metal jack plane,

4- Marking gauge,

5- Carpentry Vice,

6- Hand saw,

7- Firmer chisel,

8-Mallet.

LIST OF OPERATIONS:

1- Marking,

2-Planing,

3- Sawing,

4- Chiseling.

PROCEDURE:

1- Copy the given drawing.

2- Collect the tools and wood piece.

3- Check the size of the wood piece for its suitability to make the model as per the drawing.

4- Plane one side of the wood piece using metal jack plane and check the straightness.

5- Plane the adjacent side of the wood piece and checked geometrical accuracy. 6-

Mark the thickness and width as per drawing using marking gauge.

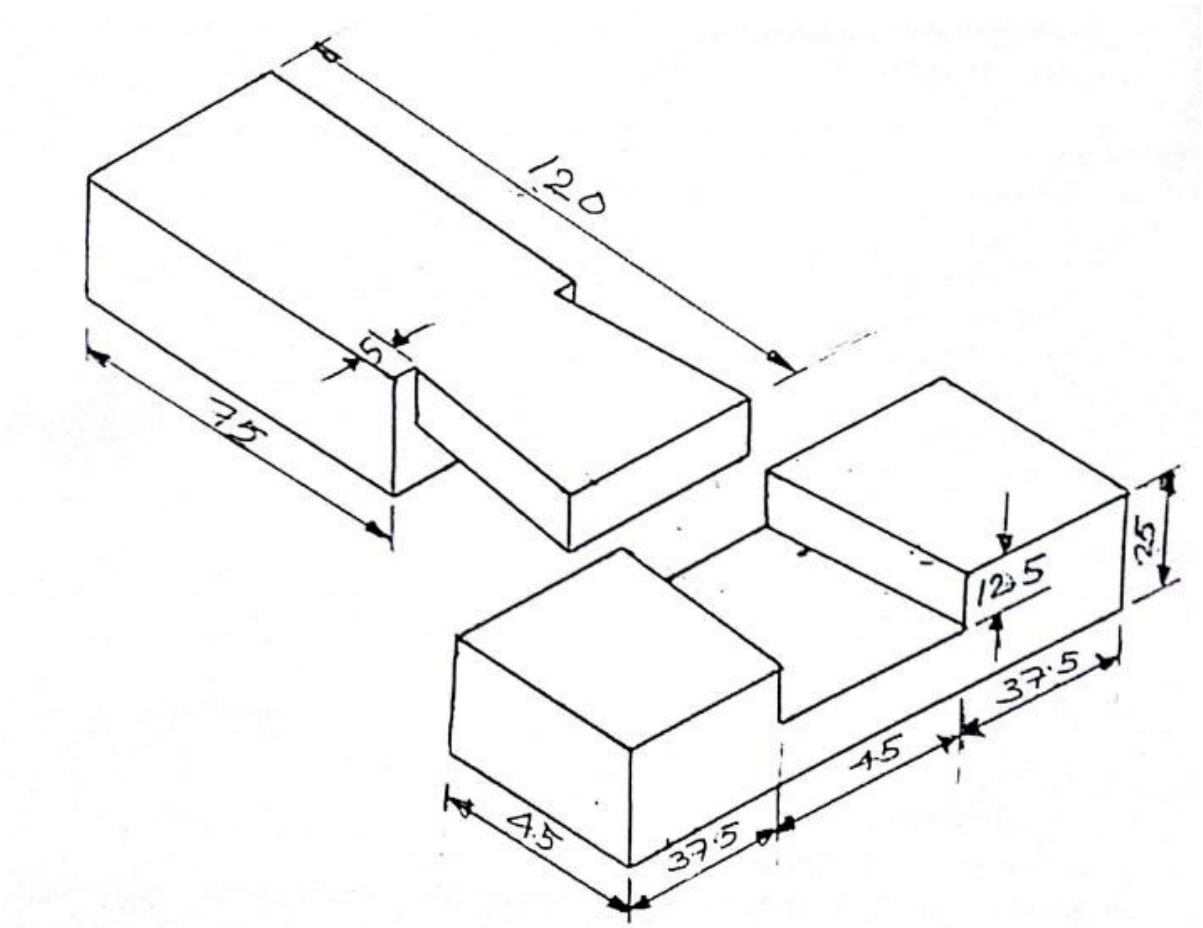
7- Cut the wood piece in to two halves using hand saw and layout the dimensions of the T-halved joint on each piece.

8- Remove the excess wood by saw cutting and chiseling keeping allowance for final chiseling.

9- Finish all chiseling operations with the help of firmer chisel on the marked lines.

MODEL NO:3

T-HALVED DOVE TAIL JOINT



Scale 1:1
All dimensions are in mm

MODEL NO:3

T-HALVED DOVE TAIL JOINT

AIM:

To make a T-Halved Dove tail joint using the given wood piece.

MATERIALS REQUIRED:

Material: Hard wood ((Jack fruit)

Size: 260x50x30 mm

TOOLS REQUIRED:

1- **Steel rule,**
2- **Try square,**
3- **Metal jack plane,**
4- **Marking gauge,**
5- **Carpentry Vice,**
6- **Hand saw,**
7- **Firmer chisel,**
8- **Mallet.**

LIST OF OPERATIONS:

1- **Marking,**
2- **Planing,**
3- **Sawing,**
4- **Chiseling.**

PROCEDURE:

1- Copy the given drawing.
2- Collect the tools and wood pi**ece.**
3- **Check the size of the wood piece for its suitability to make the model as per the drawing.**
4- **Plane one side of the wood piece using metal jack plane and check the straightness.**
5- **Plane the adjacent side of the wood piece and checked geometrical accuracy.** 6- **Mark the thickness and width as per drawing using marking gauge.**
7- **Cut the wood piece in to two halves using hand saw and layout the dimensions of the T-halved dove tail joint on each piece.**
8- **Remove the excess wood by saw cutting and chiseling keeping allowance for final chiseling.**
9- **Finish all chiseling operations with the help of firmer chisel on the marked lines.**
10- **Finish the joints by correcting the contact surfaces of the joints and checked all the dimensions.**

FORGING

INTRODUCTION

Forging or hand forging is an ancient trade. It consists of heating a metal stock till it acquires sufficient plasticity, followed by hand forging involving hammering bending pressing etc., till the desired shape is attained.

Hand forging is the term used when the process is carried out by hand tools. If power operated machines are used for the process, it is known as machine forging. Hooks, links, lifting tackles and agricultural implements are some of the items that are produced by machine forging. The following are the advantages of forging:

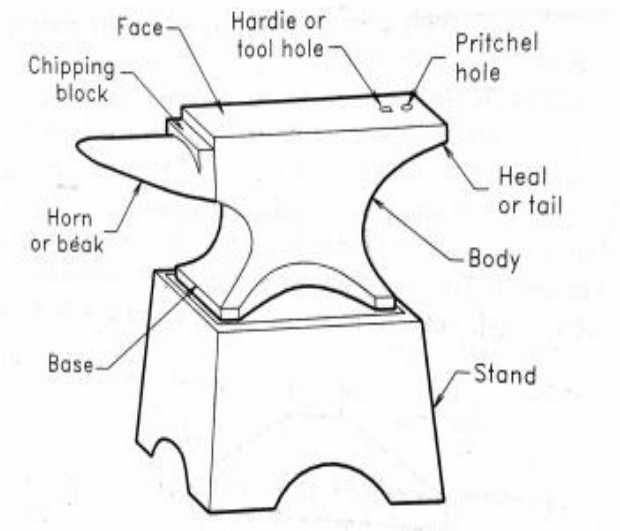
1. Strength and toughness is high.
2. Strength to weight ratio is high.
3. Internal defects are eliminated.
4. Forged parts need less or no machining.

TOOLS AND EQUIPMENTS

FORGE OR HEARTH: A smith's forge or hearth is used to heat the metal to be shaped. Hearths are used for heating small jobs to be forged by hand. Gas, oil or coal firing may be used for the purpose. The required air for the fire is supplied under pressure by a blower through the pipe into the hearth. The blowers may either be hand operated or power driven.

Metal	Forging temperature, °C
Mild steel	750-1300
Wrought iron	700-1300
Medium carbon steel	750-1850
High carbon and alloy steel	800-1150

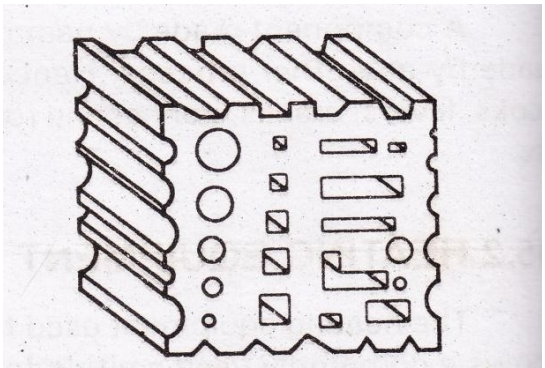
ANVIL: It is a supporting tool used in smithy shop. It is useful for operations such as bending, swaging, etc. Its body is generally made of cast steel, wrought iron or mild steel, with a hardened top layer.



The beak or horn is used for bending metal to round shape of different radii. The portion between the beak and face is called chipping block, which is used as a base for cutting operations, using hot chisels. The square hardy hole is used to hold square shank tools like swages and fullers. A round hole is also provided near the hardy hole, which is used for bending round rods and as a die for hot punching operation.

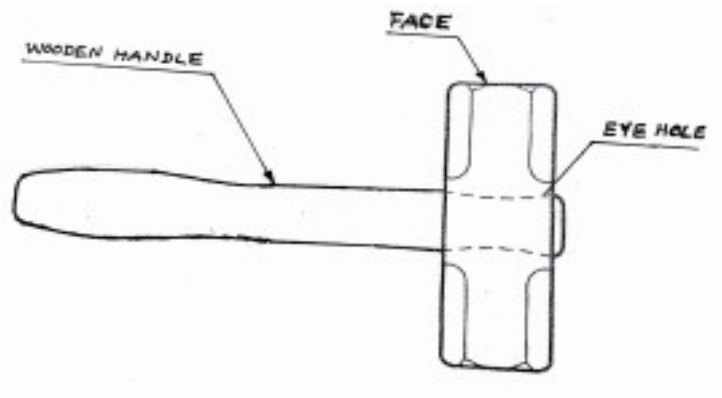
Anvils are made in sizes weighing from 85 kg to 850 kg. An anvil weighing about 75 kg is suitable for general purpose.

SWAGE BLOCK: It is also a supporting tool used in a forge shop. It has a number of slots of different shapes and sizes along its four side faces and through holes of different shapes and sizes, running from its top to bottom faces. This is used as a support while forming (swaging) different shapes, bending and in punching holes. It is generally made of cast iron or steel.



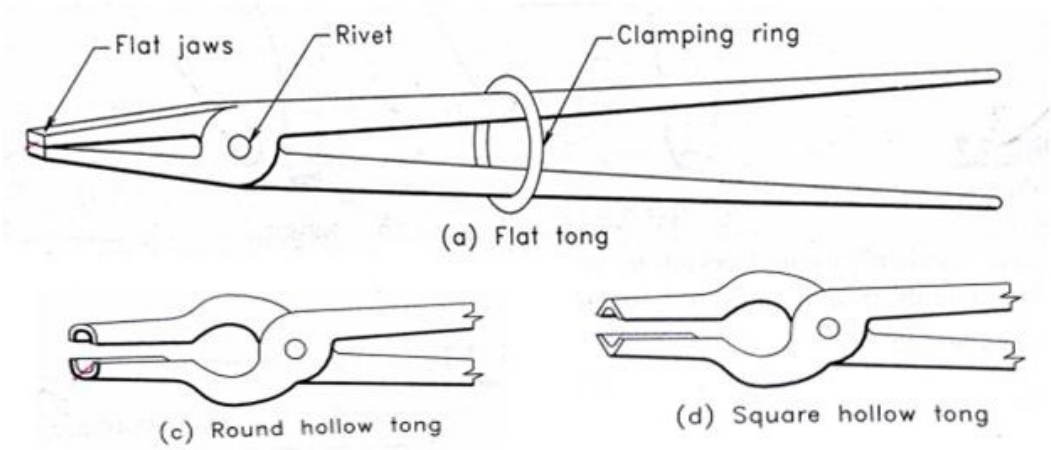
LEG VICE: It is a heavy duty vice, fixed to the work bench at one end of a leg set in a concrete base. It is mainly used for light forging and bending work.

HAMMERS: Hammers of different types and weights are used in smithy. The ball-peen



hammer used for light forging works. The sledge hammer which is used for heavy work.

TONGS: It is a holding device .Figure shows the most commonly used shapes in a smithy shop they are made of mild steel. A flat tongs I used for holding works in rectangular section, round tongs used for holding round rod, Square tongs is used for holding square rod.



FORGING OPERATIONS

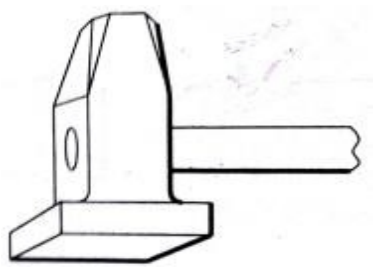
The following are the basic operations that may be performed by hand forging:

DRAWING-DOWN: Drawing is the process of stretching the stock while reducing its cross-section locally. Forging the tapered end of a cold chisel is an example of drawing operation.

UPSETTING: It is a process of increasing the area of cross-section of a metal piece, with corresponding reduction in length. In this, only the portion to be upset is heated to forging temperature and the work is then struck at the end with a hammer.

FULLERING: Fullers are used for necking down a piece of work. Fullers are made of high carbon steel in two parts, called the top and bottom fullers.

FLATTENING: Flatters are the tools that are made with a perfectly flat face. These are used for finishing flat surfaces. A flatter of small size is known as sethammer and is used for finishing near corners and in confined spaces.



FLATTENER

SWAGING: Swages, like fullers are also made of high carbon steel and are made in two parts called the top and bottom swages. These are used to reduce and finish to round, square or hexagonal forms.

BENDING: Bending of bars, flats, etc., is done to produce different types of bent shapes such as angles, ovals, circles, etc. Sharp bends as well as round bends may be made on the anvil.

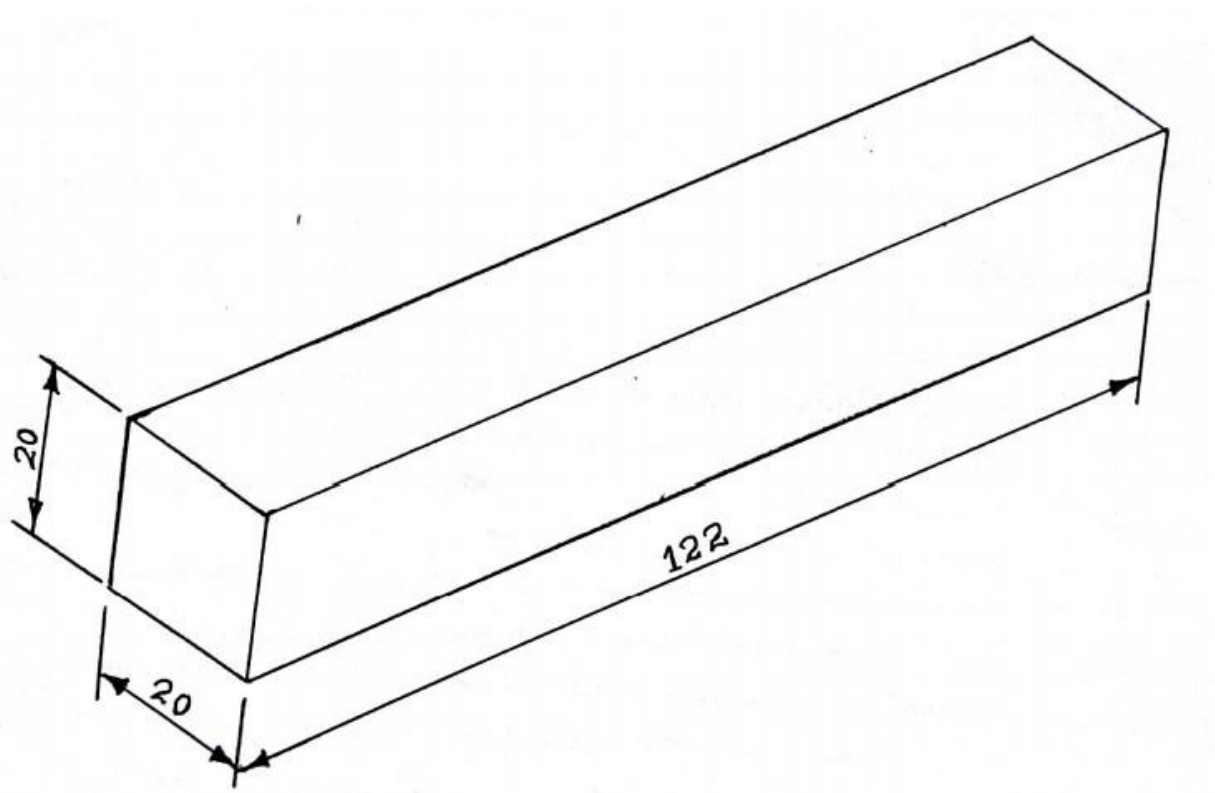
TWISTING: It is also one form of bending. Sometimes, it is done to increase the rigidity of the work piece. Small pieces may be twisted by heating and clamping a pair of tongs on each end of the section to be twisted and applying a turning moment.

CUTTING (HOT AND COLD CHISELS): Chisels are used to cut metals, either in hot or cold state. The cold chisel is similar to fitter's chisel, except that it is longer and has a handle. A hot chisel is used for cutting hot metals and its cutting edge is long and slender. Chisels are made of tool steel, hardened and tempered.

SAFE PRACTICES

1. Hold the hot work downwards close to the ground, while transferring from the hearth to anvil, to minimize danger of burns; resulting from accidental collisions with others.
2. Use correct size and type of tongs to fit the work.
3. Care should be taken in the use of the hammer.
4 Wear face shield when hammering hot metal.
5 Wear gloves when handling hot metal.
6 Wear proper safety shoes.
7. Ensure that hammers are fitted with tight and wedged handles.

MODEL NO:1
SQUARE PRISM



Scale 1:1
All dimensions are in mm

MODEL NO:1
SQUARE PRISM

AIM: To make a square prism using the given cylindrical M.S rod.

MATERIALS REQUIRED:

Cylindrical M.S rod of dia 25 mm and length 100 mm, and coke for heating**.**

TOOLS REQUIRED:

1- Hammer,
2- Tongs,
3- Flattener,
4- Anvil,
5- Forge,
6- Brass rule.

LIST OF OPERATIONS:

1- Heating,
2- Hammering to square prism,
3- Jumping to reduce length .

PROCEDURE:

1- Copy the given drawing.

2- Collected the tools and material for the model.

3- Heat the given work piece in the hearth to red hot temperature.

4- Take the work piece from the hearth and keep it on the anvil in lengthwise and then hammer.

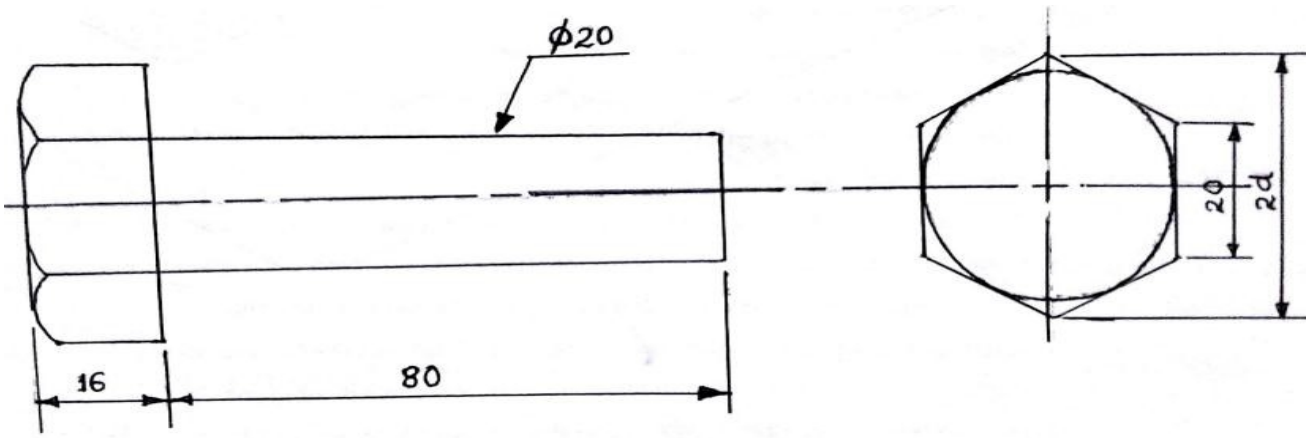
5- Turned the work piece to 90 degree after flattening the opposite sides and continued the heating & hammering to get exact shape of square prism.

6- To reduce the length of the prism to 122 mm, the jumping operation is performed by keeping the square prism on the anvil in the vertical position.

7- Finally flattened the four faces of the prism using the flattener and finished the square prism. 8- Then checked the dimensions using steel rule.

MODEL NO:2

HEXAGONAL BOLT



Scale 1:1

All dimensions are in mm

MODEL NO:2

HEXAGONAL BOLT

AIM:To make a hexagonal bolt using the given cylindrical M.S rod.

MATERIALS REQUIRED:

Cylindrical M.S rod of dia 20 mm and length 100 mm, and coke for heating.

TOOLS REQUIRED:

1- **Hammer**
2- **2- Tongs,**
3- **Flattener,**
4- **Anvil,**
5- **Forge,**
6- **Brass rule.**

LIST OF OPERATIONS:

1- **Heating,**
2- Jumping one end of the work piece to make bolt head,
3- Hammering to form hexagonal head .

PROCEDURE:

1- Copy the given drawing.

2- Collected the tools and material for the model.

3- Heat the given work piece in the hearth to red hot temperature.

4- Take the heated work piece from the hearth for jumping operation on the heated end to form the bolt head by hammering.

5- Repeated this operation to form the end of work piece to the required size of head.

6- Then heated the head again and place the unheated end of the work piece in the pritchel hole of the anvil and hammered it suddenly to form the cylindrical head of the bolt.

7- Again heated the cylindrical head and keeping the end on the anvil and hammered it to form the hexagonal head. This is repeated to form a regular hexagonal head of the bolt.

8- Finished the hexagonal headed bolt and checked the dimensions using brass rule.

WELDING

INTRODUCTION

Welding is the process of joining similar metals by the application of heat, with or without application of pressure or filler metal, in such a way that the joint is equivalent in composition and characteristics of the metals joined. In the beginning, welding was mainly used for repairing all kinds of worn or damaged parts. Now, it is extensively used in manufacturing industry, construction industry(construction of ships, tanks, locomotives and automobiles) and maintenance work, replacing riveting and bolting, to a greater extent.

The various welding processes are:

1. Electric arc welding,
2. Gas welding
3. Thermal welding
4. Electrical Resistance welding and
5. Friction welding

However, only electric arc welding process is discussed in the subject point of view.

Electric arc welding

Arc welding is the welding process, in which heat is generated by an electric arc struck between an electrode and the work piece. Electric arc is luminous electrical discharge between two electrodes through ionized gas.

Any arc welding method is based on an electric circuit consisting of the following parts:

a. Power supply (AC or DC);
b. Welding electrode;
c. Work piece;
d. Welding leads (electric cables) connecting the electrode and work piece to the power supply.

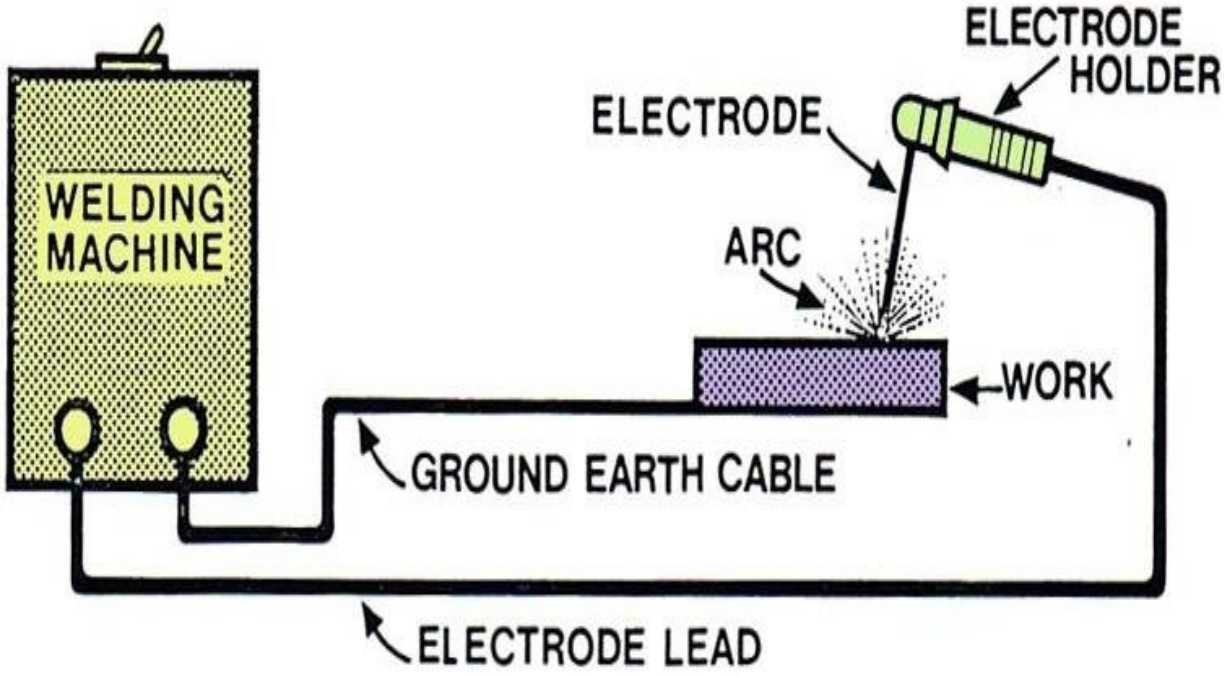


Fig:1 Arc welding set up

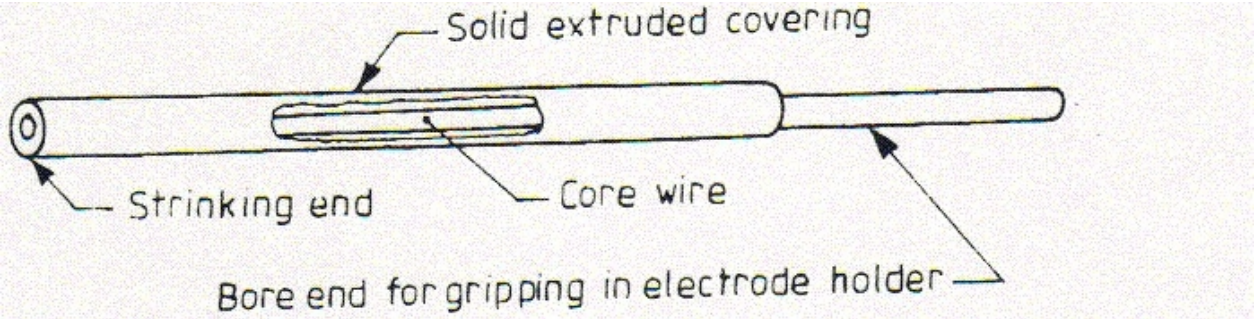


Fig :2 parts of an electrode

Electric arc between the electrode and work piece closes the electric circuit. The arc temperature may reach 10000°F (5500°C), which is sufficient for fusion the work piece edges and joining them. When a long joint is required the arc is moved along the joint line. The front edge of the weld pool melts the welded surfaces when the rear edge of the weld pool solidifies forming the joint.

Transformers, motor generators and rectifiers' sets are used as arc welding machines. These machines supply high electric currents at low voltage and an electrode is used to produce the necessary arc. The electrode serves as the filler rod and the arc melts the surface so that, the metals to be joined are actually fixed together.

Sizes of welding machines are rated according to their approximate amperage capacity at 60% duty cycle, such as 150,200,250,300,400,500 and 600 amperes. This amperage is the rated current output at the working terminal.

Transformers

The transformers type of welding machine produces A.C current and is considered to be theleast expensive. It takes power directly from power supply line and transforms it to the voltage required for welding. Transformers are available in single phase and three phases in the market.

Motor generators

These are D.C generators sets, in which electric motor and alternator are mounted on the same shaft to produce D.C power as pert the requirement for welding. These are designed to produce D.C current in either straight or reversed polarity. The polarity selected for welding depends upon the kind of electrode used and the material to be welded.

Rectifiers

These are essentially transformers, containing an electrical device which changes A.C into D.C by virtue of which the operator can use both types of power (A.C or D.C, but only one at a time).In addition to the welding machine, certain accessories are needed for carrying out the welding work.

Welding cables

Two welding cables are required, one from machine to the electrode holder and the other, from the machine to the ground clamp. Flexible cables are usually preferred because of the case of usingand coiling the cables. Cables are specified by their current carrying capacity, say 300 A, 400 A, etc.

Electrodes

Filler rods are used in arc welding are called electrodes. These are made of metallic wire called core wire, having approximately the same composition as the metal to be welded. These are coated uniformly with a protective coating called flux. While fluxing an electrode; about 20mm of length is left at one end for holding it with the electrode holder. It helps in transmitting full current from electrode holder to the front end of the electrode coating. Flux acts as an insulator of electricity. In general, electrodes are classified into five main groups; mild steel, carbon steel, special alloy steel, cast iron and non-ferrous. The greatest range of arc welding is done with electrodes in the mild steel group. Various constituents like titanium oxide, potassium oxide, cellulose, iron or manganese, Ferro silicates, carbonates, gums, clays, asbestos, etc., are used as coatings on electrodes. While welding, the coating or flux vaporizes and provides a gaseous shield to prevent atmospheric attack. The size of electrode is measured and designated by the diameter of the core wire in SWG and length, apart from the brand and code names; indicating the purpose for which there are most suitable

Electrodes may be classified on the basis of thickness of the coated flux. As

1. Dust coated or light coated
2. Semi or medium coated and
3. Heavily coated or shielded

Electrodes are also classified on the basis of materials, as

1. Metallic and
2. Non-metallic or carbon

Metallic arc electrodes are further sub-divided into

1. Ferrous metal arc electrode (mild steel, low/medium/high carbon steel, cast iron, stainless steel, etc)
2. Non-ferrous metal arc electrodes (copper, brass, bronze, aluminum, etc).

In case of non-metallic arc electrodes, mainly carbon and graphite are used to make the electrodes.

Fig :3 Electrode holder

Fig :4 Ground Clamp

Fig :5Wire brush

Fig :6Chipping hammer

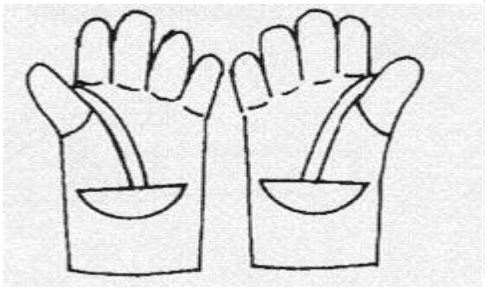


Fig :7Hand gloves

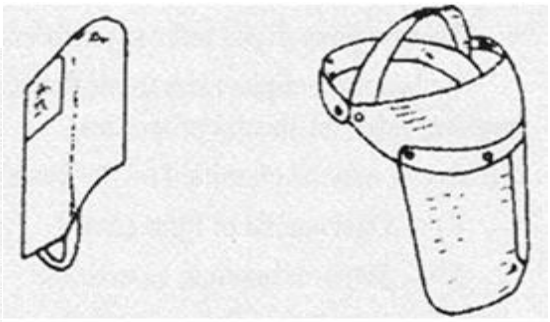


Fig :8Face shield

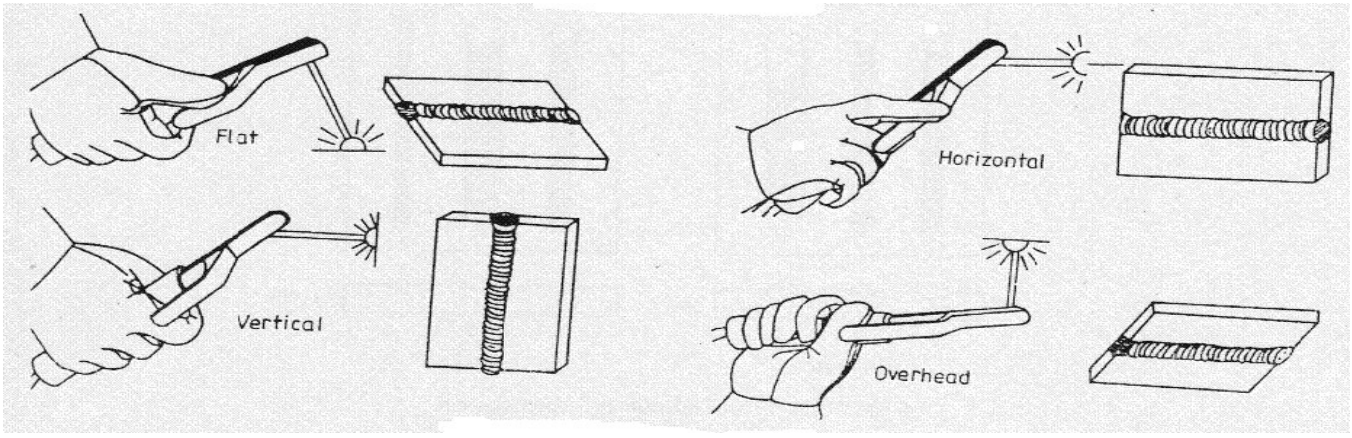


Fig :9Weld positions

WELDING TOOLS

Electrode holder

The electrode holder is connected to the end of the welding cable and holds the electrode. Itshould be light, strong and easy to handle and should not become hot while in operation. Figure shows one type of electrode holder. The jaws of the holder are insulated, offering protection from electric shock.

Ground clamp

It is connected to the end of the ground cable and is clamped to the work or welding table to complete the electric circuit. It should be strong and durable and give a low resistance connection.

Wire brush and chipping hammer

A wire brush is used for cleaning and preparing the work for welding. A chipping hammer is used for removing slag formation on welds. One end of the head is sharpened like a cold chisel and the other, to a blunt, round point. It is generally made of tool steel. Molten metal dispersed around the welding heads, in the form of small drops, is known as spatter. When a flux coated electrode is used in welding process, then a layer of flux material is formed over the welding bead which contains the impurities of weld material. This layer is known as slag. Removing the spatter and slag formed on and around the welding beads on the metal surface is known as chipping.

Welding table and cabin

It is made of steel plate and pipes. It is used for positioning the parts to be welded properly. Welding cabin is made-up by any suitable thermal resistance material, which can isolate the surrounding by the heat and light emitted during the welding process. A suitable draught should also be provided for exhausting the gas produced during welding.

Face shield

A face shield is used to protect the eyes and face from the rays of the arc and from spatter or flying particles of hot metal. It is available either in hand or helmet type. The hand type is convenient to use wherever the work can be done with one hand. The helmet type though not comfortable to wear, leaves both hands free for the work.

Shields are made of light weight non-reflecting fiber and fitted with dark glasses to filter out the Harmful rays of the arc. In some designs, a cover glass is fitted in front of the dark lens to protect it from spatter.

Hand gloves

These are used to protect the hands from electric shocks and hot spatters

TECHNIQUES OF WELDING

Preparation of work

Before welding, the work pieces must be thoroughly cleaned of rust, scale and other foreign material. The piece for metal generally welded without beveling the edges, however, thick work piece should be beveled or veed out to ensure adequate penetration and fusion of all parts of the weld. But, in either case, the parts to be welded must be separated slightly to allow better

penetration of the weld. Before commencing the welding process, the following must be considered

a) Ensure that the welding cables are connected to proper power source.

b) Set the electrode, as per the thickness of the plate to be welded.

c) Set the welding current, as per the size of the electrode to be used.

WELDING POSITIONS

Depending upon the location of the welding joints, appropriate position of the electrode and hand movement is selected. The figure shows different welding positions.

Flat position welding

In this position, the welding is performed from the upper side of the joint, and the face of the weld is approximately horizontal. Flat welding is the preferred term; however, the same position is sometimes called down hand.

Horizontal position welding

In this position, welding is performed on the upper side of an approximately horizontal surface and against an approximately vertical surface.

Vertical position welding

In this position, the axis of the weld is approximately vertical as shown in figure.

Overhead position welding

In this welding position, the welding is performed from the underside of a joint

WELDING

Lap joint

EXPERIMENT No: **DATE:**

Aim

To make a double lap joint, using the given mild steel pieces and by arc welding.

Material used: Two mild steel pieces of 100X40X6 mm.

Tools and equipment used

1. Arc welding machine,
2. Mild steel electrodes,
3. Electrode holder,
4. Ground clamp,
5. flat nose Tong,
6. Face shield,
7. Apron,
8. Hand gloves,
9. Metallic work Table,
10. Bench vice,
11. Rough flat file,
12. Try square,
13. Steel rule,
14. Wire brush,
15. Ball peen hammer,
16. Chipping hammer.

Operations to be carried out

1. Cleaning the work pieces
2. Tack welding
3. Full welding
4. Cooling
5. Chipping
6. Finishing

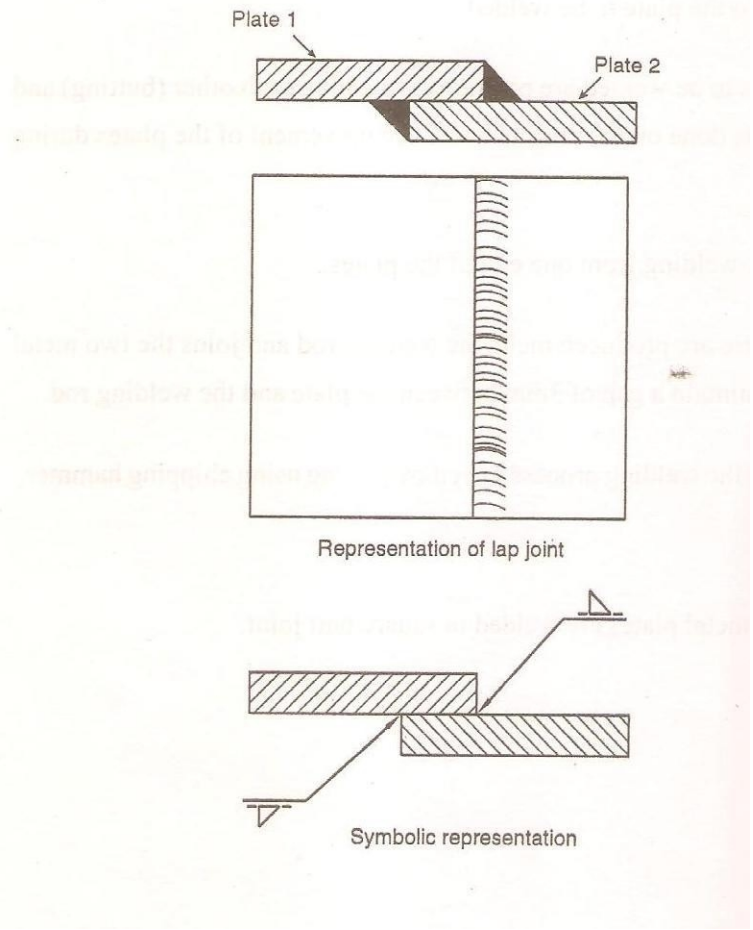


Fig: lap joint

Procedure

1. Take the two mild steel pieces of given dimensions and clean the surfaces thoroughly from rust, dust particles, oil and grease.
2. Remove the sharp corners and burrs by filing or grinding and prepare the work pieces.
3. The work pieces are positioned on the welding table, to form a lap joint with the required over lapping.
4. The electrode is fitted in to the electrode holder and the welding current is set to a proper value.
5. The ground clamp is fastened to the welding table.
6. Wearing the apron, hand gloves, using the face shield and holding the over lapped pieces the arc is struck and the work pieces are tack-welded at the ends of both the sides
7. The alignment of the lap joint is checked and the tack-welded pieces are reset, if required.
8. Welding is then carried out throughout the length of the lap joint, on both the sides.
9. Remove the slag, spatters and clean the joint.

Precautions:

1. Use goggles, gloves in order to protect the human body.
2. Maintain the constant arc length.

Result The lap joint is thus made, using the tools and equipment as mentioned above.

WELDING

BUTT JOINT

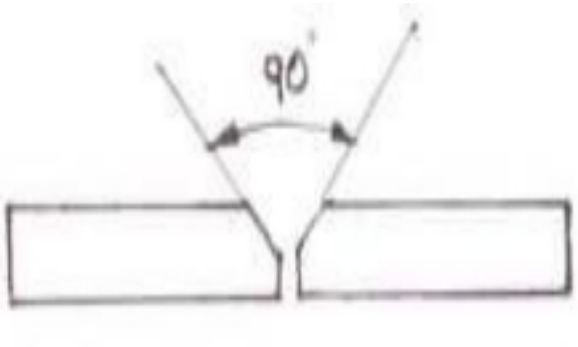
EXPERIMENT No: **DATE:**

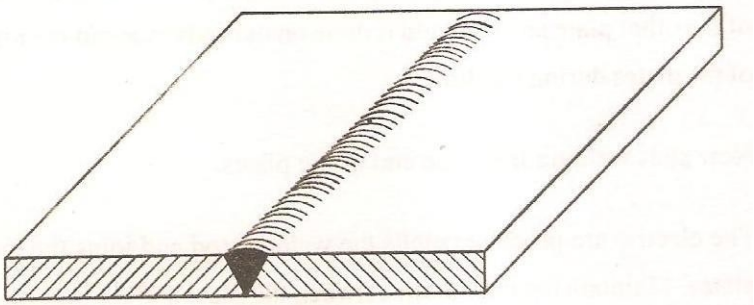
Aim: preparation of butt joint as shown in figure using shielded metal arc welding process.

Material required: 2m.s flat pieces of given size.

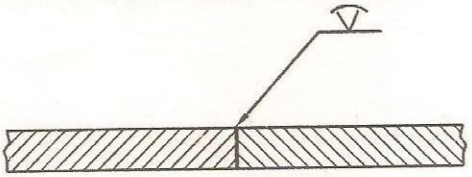
Tools required:

1. welding transformer,
2. connecting cables,
3. electrode holder,
4. ground clamp,
5. electrodes,
6. hipping hammer,
7. Welding shield etc.





Representation of single V butt joint



Symbolic representation

V – butt joint

Procedure:

1. The given metallic pieces filled to the desired size.
2. On both pieces beveled in order to have V groove.
3. The metallic pieces are thoroughly cleaned from rust grease, oil, etc.
4. The metallic pieces are connected to terminals of Trans former.
5. Select electrode dia based on thickness of work piece and hold it on the electrode holder. Select suitable range of current for selected dia.
6. Switch on the power supply and initiates the arc by either striking arc method or touch and drag method.
7. Take welding to be done before full welding.
8. In full welding process after completion one part before going to second part. Slag is removed from the weld bed. With the metal wire brush or chipping hammer.
9. Then the above process will be repeated until to fill the groove with weld bed or weld metal.

Precautions:

1. Use goggles, gloves in order to protect the human body.
2. Maintain the constant arc length.

Result: butt joint is prepared as shown in figure by using arc-welding proce