



C. V. RAMAN POLYTECHNIC  
Bidyanagar, Mahura, Janla, Bhubaneswar-752054  
DEPARTMENT OF MECHANICAL ENGINEERING

## LAB MANUAL

### ENGINEERING WORKSHOP PRACTICE (Pr-3(b)) (Semester- 1<sup>st</sup> and 2<sup>nd</sup> -Common to all Engineering Programme)



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## Outcome Based Education

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For the implementation of an outcome based education the first requirement is to develop an outcome based curriculum and incorporate an outcome based assessment in the education system. By going through outcome based assessments, evaluators will be able to evaluate whether the students have achieved the outlined standard, specific and measurable outcomes. With the proper incorporation of outcome based education there will be a definite commitment to achieve a minimum standard for all learners without giving up at any level. At the end of the programme running with the aid of outcome based education, a student will be able to arrive at the following outcomes (as per NBA guidelines):

1. **Basic and Discipline specific knowledge:** Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the engineering problems.
2. **Problem analysis:** Identify and analyse well-defined engineering problems using codified standard methods.
3. **Design/ development of solutions:** Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.
4. **Engineering Tools, Experimentation and Testing:** Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.
5. **Engineering practices for society, sustainability and environment:** Apply appropriate technology in context of society, sustainability, environment and ethical practices.
6. **Project Management:** Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.
7. **Life-long learning:** Ability to analyse individual needs and engage in updating in the context of technological changes.



Department of Mechanical Engineering

C. V. Raman Polytechnic, Bhubaneswar

**Vision, Mission, (PEOs) and PSOs Suggestion Format**

**Department Vision:**

Mechanical department is committed to provide value based and quality education through highly qualified professionals with the cutting-edge technologies to meet industrial and social challenges.

**Mission of the Department**

**M1:** To equip Mechanical Engineering students for competitive challenges by imparting knowledge on modern technology and industry-oriented program.

**M2:** To encourage and empower students to enhance their skills by providing training through various Centres of Excellence.

**M3:** To foster a spirit of entrepreneurship through industrial visits, internships and seminars conducted by academic experts.

**M4:** To motivate students to pursue higher studies for betterment of society.

**Program Educational Objectives (PEO):**

**PEO1:** Understand and analyze the industrial needs through knowledge gained in Mechanical Engineering fundamentals.

**PEO2:** Pursue entrepreneurial opportunities by acquiring special knowledge in training programs.

**PEO3:** Creating technical solutions that successfully address environmental and societal issues.

**PEO4:** Understanding technical concepts, engage in lifelong learning, exhibit leadership qualities with ethics in their professional career.

**Program Specific Outcomes (PSOs)**

<b>PSO-1</b>	Discipline knowledge	Demonstration and understanding of tools with advanced software for design specification and operation of Mechanical Engineering systems, components and processes.
<b>PSO-2</b>	Professional Skills	Apply contextual knowledge to analyze social, environmental, health, safety, legal, and cultural issues with professional ethics as part of the lifelong learning process. To be equipped to lead a team or operate successfully alone as an individual managing tasks in disciplinary areas.

**Course Outcomes (CO's)****Engineering Workshop Practice (1<sup>st</sup>/2<sup>nd</sup> semester) Code-Pr-3 (b) Full marks: 100**

Pr.3 (b) Engineering Workshop Practice		Levels
CO1	Use carpentry tools to make simple carpentry jobs	2
CO2	Use fitting tools and instruments to make simple jobs.	3
CO3	Prepare simple butt and lap joints using Arc, Gas, MIG welding equipment	3
CO4	Undertake simple sheet metal jobs using relevant operations and tools safely.	3
CO5	Undertake electric wiring works for various domestic applications.	3

**CO-PO Mapping**

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	Average CO
CO1	2.00	-	-	3.00	1.00	-	1.00	1.75
CO2	3.00	-	1.00	3.00	2.00	-	1.00	2.00
CO3	3.00	1.00	1.00	3.00	2.00	-	1.00	1.83
CO4	3.00	1.00	1.00	3.00	2.00	-	1.00	1.83
CO5	2.00	1.00	2.00	3.00	2.00	1.00	1.00	1.71
<b>Average PO</b>	2.60	1.00	1.25	3.00	1.80	1.00	1.00	<b>1.83</b> <b>1.66</b>

**Sessional Rubrics (25)**

	Attendance (3)			Record (5)			Experiment/Job (12)			Viva (5)		
	The student attends all the classes.			Presentation with good technical details and good communication skills, refers to the slides to explain the points and completely engaged with audience.			The seminar report is according to the specified format. The content is written with clarity and in organized manner. There is a logical flow in the text.			Defends all questions by providing clear and insightful answers to the questions.		
Rating/Performance criteria	12	11	10	9	8	7	6	5	4	3	2	1
Attendance (3)										Fulfills to 100% of set criteria	Fulfills to 70% of set criteria	Fulfills to 50% of set criteria
Record (5)								Fulfills to 100% of set criteria	Fulfills to 80% of set criteria	Fulfills to 60% of set criteria	Fulfills to 50% of set criteria	Fulfills to 30% of set criteria
Experiment/Job (12)	Fulfills to 100% of set criteria		Fulfills to 90% of set criteria	Fulfills to 80% of set criteria	Fulfills to 70% of set criteria	Fulfills to 60% of set criteria	Fulfills to 50% of set criteria	Fulfills to 40% of set criteria	Fulfills to 30% of set criteria			
Viva (5)								Fulfills to 100% of set criteria	Fulfills to 80% of set criteria	Fulfills to 60% of set criteria	Fulfills to 50% of set criteria	Fulfills to 30% of set criteria

**Sessional (25)**

Sl. No.	Name of student	Registration number	Attendance (3)	Record (5)	Experiment/Job (12)	Viva (5)	Total (25)

**Practical Rubrics (75)**

	Report (20)			Experiment/Job (40)				Answering viva questions (15)				
	Report is well written. The Contents are equipped with neat sketch, error free calculations and free from grammatical errors.			Identifying equipment, instruments and material and setting up of machine tool. Exhibits proper knowledge of the lab procedure. Runs the machine independently. Takes all the readings from machine/apparatus during experiment. The obtained result is calculated correctly to find the result. Analyses if any error occurred with the reason. The experiment is completed within the time limit with taking proper safety precautions.				A set of questions is asked relating to the experiment and subject.				
Rating/Performance	40	38	33	28	24	20	15	12	10	8	6	4
Report						Answers to 100% of questions asked	Answers to 80% of questions asked	Answers to 60% of questions asked	Answers to 50% of questions asked	Answers to 40% of questions asked	Answers to 30% of questions asked	
Experiment/Job	Follows 100% of the criteria	Follows 90% of the criteria	Follows 80% of the criteria	Follows 70% of the criteria	Follows 60% of the criteria	Follows 50% of the criteria	Follows 40% of the criteria	Follows 30% of the criteria	Answers to 25% of questions asked			
Viva						Answers to 100% of questions asked	Answers to 90% of questions asked	Answers to 75% of questions asked	Answers to 60% of questions asked	Answers to 45% of questions asked	Answers to 30% of questions asked	

**Practical (75)**

Sl. No.	Name of student	Registration number	Report (20)	Job (40)	Viva (15)	Total (75)

## Syllabus

## Engineering Workshop Practice

Course Code- PR 3(b)  
(Common to 1<sup>st</sup> & 2<sup>nd</sup> sem)

Period per week:	4	Sessional:	25 Marks
Total Period:	60	End Sem Exam:	75 Marks
Timing of End Exam:	4 Hours	No. Of Credit:	2

**Course outcomes**

At the end of the course, the student will be able to:

- ✓ Acquire skills in basic engineering practice to identify, select and use various marking, measuring, and holding, striking and cutting tools & equipment's and machines.
- ✓ Understand job drawing and complete jobs as per specifications in allotted time.
- ✓ Inspect the job for the desired dimensions and shape.
- ✓ Operate, control different machines and equipment's adopting safety practices.

**Course Content:**

S.No.	Details Of Practical Content
I	<b>Carpentry:</b> i) Demonstration of different wood working tools / machines. ii) Demonstration of different wood working processes, like planing, marking, chiseling, grooving, turning of wood etc. iii) One simple job involving any one joint like mortise and tenon dovetail, bridle, half lap etc.
II	<b>Fitting:</b> i) Demonstration of different fitting tools and drilling machines and power tools ii) Demonstration of different operations like chipping, filing, drilling, tapping, sawing, cutting etc. iii) One simple fitting job involving practice of chipping, filing, drilling, tapping, cutting etc
III	<b>Welding:</b> i) Demonstration of different welding tools / machines. ii) Demonstration on Arc Welding, Gas Welding, MIG, MAG welding, gas cutting and rebuilding of broken parts with welding. iii) One simple job involving butt and lap joint
IV	<b>Sheet Metal Working:</b> i) Demonstration of different sheet metal tools / machines. ii) Demonstration of different sheet metal operations like sheet cutting, bending, edging, end curling, lancing, soldering, brazing, and riveting. iii) One simple job involving sheet metal operations and soldering and riveting.
V	<b>Electrical House Wiring:</b> Practice on simple lamp circuits (i) one lamp controlled by one switch by surface conduit wiring, (ii) Lamp circuits- connection of lamp and socket by separate switches, (iii) Connection of Fluorescent lamp/tube light, (iv) simple lamp circuits-in- stall bedroom lighting. And (v) Simple lamp circuits- install stair case wiring.
VI	<b>Demonstration:</b> i) Demonstration of measurement of Current, Voltage, Power and Energy. ii) Demonstration of advance power tools, pneumatic tools, electrical wiring tools and accessories. iii) Tools for Cutting and drilling

**References:**

1. Engineering Workshop Practice (English) by Dr. A. K. Sarathe (Download from <https://ekumbh.aicte-india.org/dbook.php>)
2. S.K. Hajara Chaudhary, Workshop Technology, Media Promoters and Publishers, New Delhi, 2015
3. B.S. Raghuwanshi, Workshop Technology, Dhanpat Rai and sons, New Delhi 2014
4. K. Venkat Reddy, Workshop Practice Manual, BS Publications, Hyderabad 2014
5. Kents Mechanical Engineering Hand book, John Wiley and Sons, New York

### **DO'S**

- Students must always wear uniform and shoes before entering the lab.
- Proper code of conduct and ethics must be followed in the lab.
- Windows and doors to be kept open for proper ventilation and air circulation.
- Note down the specifications/drawings before working on the preparation of models.
- Receive the tools and materials required for preparation of models with signing in register.
- Properly fix hacksaw blade in frame with help of instructor.
- Use of safety goggles/ face shield during welding.
- Do the models under the supervision/guidance of a lecturer/lab instructor only.
- Keep the sufficient distance from other students while preparing models.
- In case of fire use fire extinguisher/throw the sand provided in the lab.
- In case of any physical injuries or emergencies use first aid box provided.
- Any unsafe conditions prevailing in the lab can be brought to the notice of the lab Be away from power tools while demonstrating.

### **DONT's**

- Do not touch electrical circuits of welding machine.
- Be cautious while fixing hacksaw blade in frame, that may cause injuries to hand.
- Don't touch /operate power tools without aid from instructors.
- Don't gather while preparing models, that may hurt other with tools.
- Don't unlock snip/sheet metal cutter lock, without use.







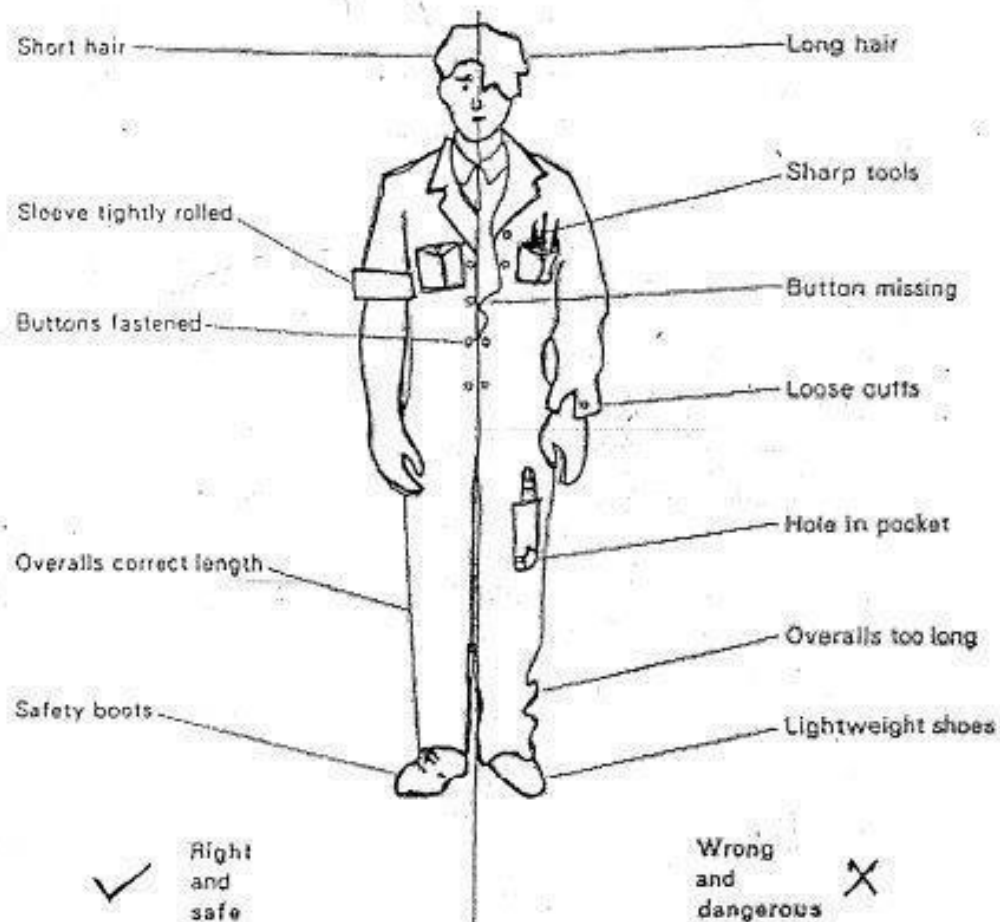
## SAFETY PRACTICE

### INTRODUCTION:

It is an action which organizes and controls all our acts in such a manner that we don't get involved, expose ourselves or others in accident. So, a technical person should have knowledge about safety.

### *Clothing and footwear*

Suitable and unsuitable working clothing for use in an engineering machine shop is shown in Fig. Overalls or protective coats should be neatly buttoned and sleeves should be tightly rolled. Safety shoes and boots should be worn (*not* trainers!). Overalls and protective



*Correct and incorrect clothing and footwear*

**Personal Protective Equipment:**

Goggles, face-shields, earplugs, helmets, respirators, gloves and aprons are types of personal protective equipment that reduce worker's exposure to hazards.

**SAFETY IN WORKSHOP:**

The first duty of the Manager or Instructor in a workshop is to brief a student or worker about various safety features and make them aware of various safety precautions to be observed while working on a particular machine/ machine tool. They should be sufficiently briefed about causes/ sources of injury or accidents and how to guard against them.

**FITTING SECTION****1. Demonstration on use of Hand Tools**

Fitting is the process of assembling metal parts precisely. The bench working a fitting shop consists of laying out, cutting the metal parts to the size required, and assembling of parts. The fitting shop is generally equipped with measuring and marking tools, work holding and tool holding accessories and shaping or metal cutting tools. One of the characteristics of the skilled fitter is the way in which he selects and uses the tools.

**HAND TOOLS FOR BENCH WORK****Measuring and marking tools**

A length may be expressed as the distance between two lines (called line measurement) or as the distance between two faces (called end measurement). The most common example of line measurement is the steel rule and examples of end measurement are calipers, micrometers, etc.

**STEEL RULES**

The simplest and most common linear measuring instrument is the steel rule shown in fig.1 steel rules are made of spring steel or stainless steel. Lines, called graduations are inscribed on the face of the rule. Metric rules usually have two sets of line graduations. Steel rules are available in different lengths, the common sizes being 1.50 m, 300

mm, 500 mm, and 1000 mm.

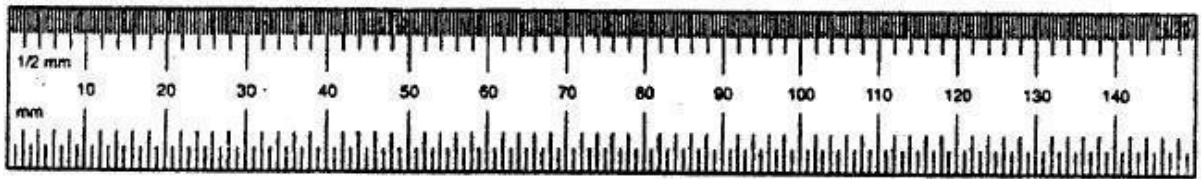


Fig. 1 Steel rule

### VERNIER CALIPER

The vernier caliper illustrated in fig. 3 is an end-measuring instrument available in various sizes that can be used to make both external and internal measurement to an accuracy of 0.02 mm. It consists of a beam carrying the main scale, inside and outside and outside measuring jaws, a depth gauge bar and an adjustable vernier head, which can be moved along the beam. For fine adjustment, an auxiliary head with a micrometer screw is provided. Both the heads are provided with locking screws to lock them firmly at any desired position. The graduated beam of the metric vernier caliper is divided into centimeters and millimeters. The 49 divisions (49 mm) of 1 mm each on the beam (main scale) are equal to 50 divisions of the vernier scale. Thus, one division on the vernier equals  $49/50$  mm. The least count of the instrument, i.e., the difference between a division on the main scale and division on the vernier is

$$= 1 - 49/50 = 1/50 \text{ mm or } 0.02 \text{ mm.}$$

The vernier caliper reading is established by adding the following two values.

- (i) The number of main scale divisions to the left of the 0 on the vernier scale A.
- (ii) The line number B on the vernier scale, which is aligned with a line on the beam (main scale)

Vernier caliper reading = A x Length of 1 main scale division + B x least count

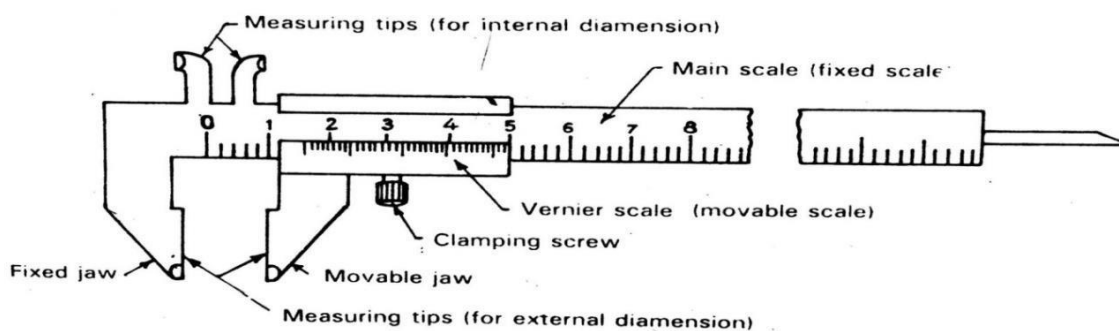


Fig. 2 Vernier caliper

Referring fig.2, the number of divisions on beam left of the 0 on the vernier is 19 and the 22nd line on the vernier scale is aligned with a line on the beam.

$$\text{Vernier caliper reading} = 19 \times 1 + 22 \times 0.02 = 19.44 \text{ mm}$$

## CALIPERS

With a caliper, linear dimension can be transferred from the work piece to a steel rule and vice versa. In spring type calipers shown in fig. 3, a pivot loaded with a spring assembles the legs, for opening and closing the legs. A screw and an adjusting nut are provided. There are outside and inside calipers. In outside calipers, the legs are curved inside and are used for measuring the outside diameters, thickness of plates, etc. The end of the inside caliper's legs are curved outside and are used for measuring inside diameters, width of slots, etc.

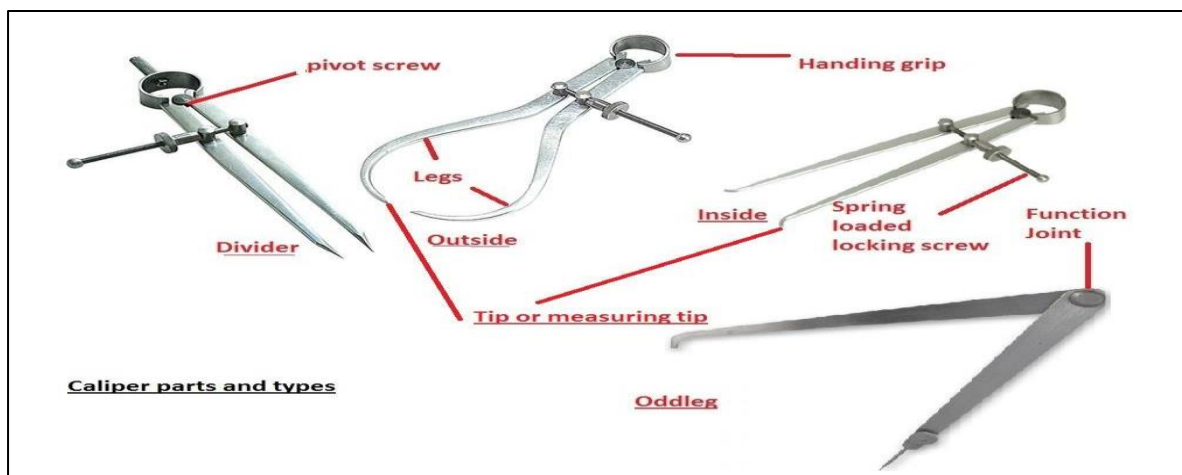


Fig.3 Calipers

## RULE DEPTH GAUGE & SQUARES

Solid steel squares (try square): Squaring a work is the operation of making and checking the work surfaces that must be perpendicular. The solid steel square shown in fig,6 is used to measure right angles, to check the squareness of surfaces and for layout. The right angle is found on both the inside and outside the square. They are available in various size.

The rule depth gauge shown in fig. 4 consists of a steel head that has a slot to receive a narrow rule. The rule is held in position by a knurled nut. It is used to measure the depth of holes, slots, keyways, and other recesses.

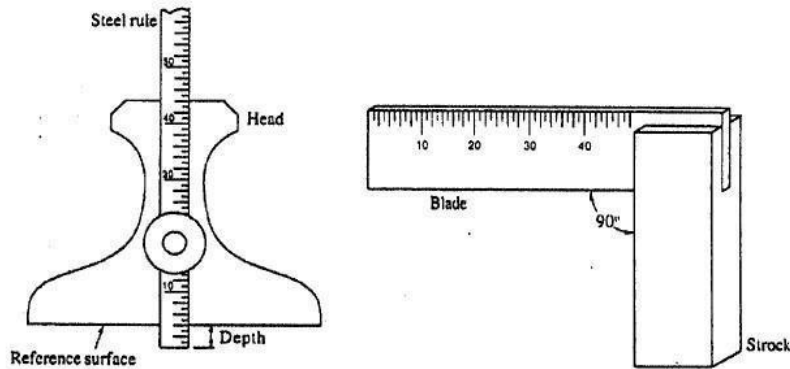


Fig. 4 Rule depth gauge  
5 Try Squa

Fig.

### **SURFACE PLATE**

A surface plate shown in fig.6 is used for laying out and inspecting work pieces. Surface plates are made of either case iron or granite. The case iron plates are machined very smooth and hand scraped to provide a true flat surface. The flat surface provides a datum for many types of measurements and for checking sizes, parallelism and angles. Surface plates are protected by cover when not in use. They are available in various shapes and sizes.

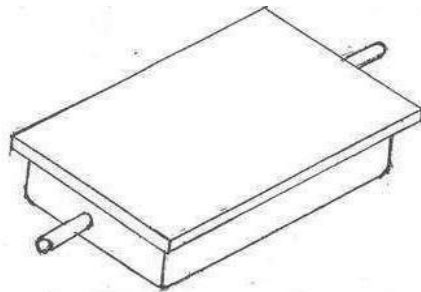
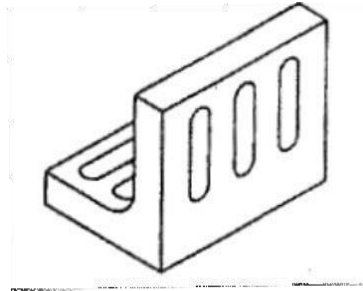


Fig.6 Surface plate

### **ANGLE PLATE**

Angle plates are made of cast iron or steel and are used to support the

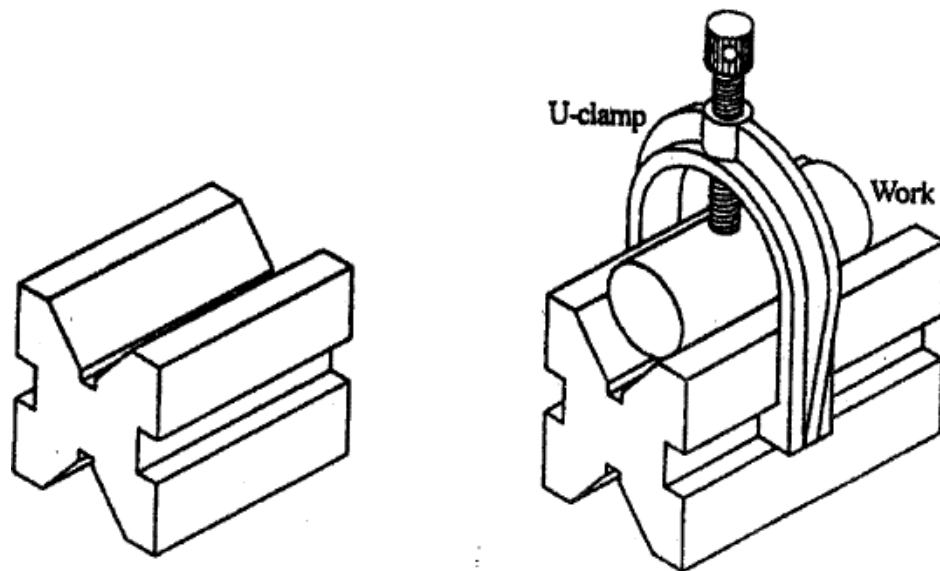
The flat faces are at right angles and may have threaded holes or slots for holding the work pieces. Cast iron angle plates are surface ground and hand scraped to a high degree of accuracy. The edges and ends are machined square.



**Fig. 7 (Angle plate)**

### **V-BLOCK**

V blocks are used for checking the roundness of cylindrical work piece and for marking centers accurately. The v-block shown in fig.8 has an included angle of  $90^\circ$ , but blocks with different angles are also available. V-blocks are finished to a high accuracy in respect of dimension, flatness and squareness. U-clamps are also provided which bridge the V to secure the work.



**Fig.8 V-Block**

### **PUNCHES**

Punches are used to mark points on metal. Both ends of the punch should be tempered and ground to the proper angle and the center portion is usually knurled in order to afford a good grip. Most commonly used punches are the prick punch and center punch and are shown in fig .9.

#### **PRICK PUNCH**

The point angle of prick punch is  $30^\circ$  or  $60^\circ$ . It is used for marking small dents or establishing points for dividers and trammel points.



## CENTER PUNCH

The point angle of center punch is  $90^\circ$ . It is used primarily for marking the location of points and the centers of holes to be drilled. A large and deep center mark gives a good seating for starting the drill.

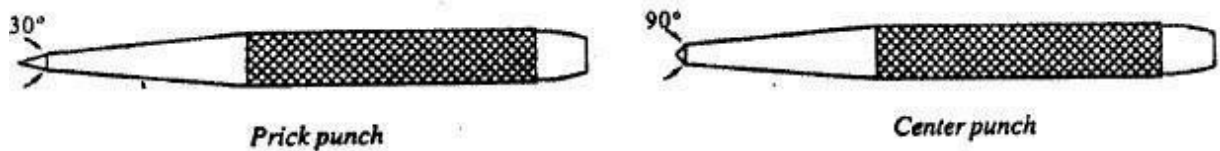


Fig. 9

## DIVIDERS

Dividers are similar to that of calipers. The legs of the dividers are straight and the ends are sharpened to point. The size of divider is the length of the leg from the pivot to the point. Dividers and trammels are used for laying out and scribing circles and arcs, stepping off distances on straight lines or circles, and transferring measurements.

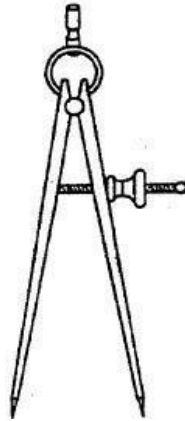


Fig. 10 Divider

## SCRIBER

A scribe is a sharp, pointed tool used to scribe lines on metal. The scribe is made from carbon tool steel, hardened and tempered. Scribes are available in various styles and sizes (fig.11).

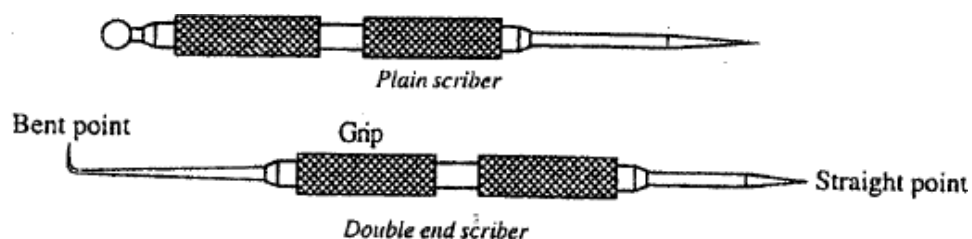
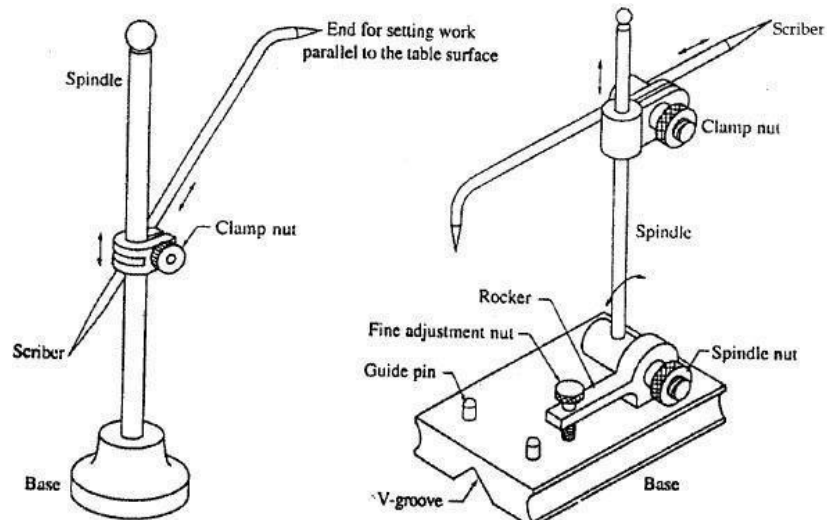


Fig.11 Scribes

## SCRIBING BLOCK OR SURFACE GAUGE

The surface gauge shown in fig.12 consists of a case iron base fitted with a vertical steel rod. A steel marker or scriber is fitted into an adjustable clamp. Normally it is used in conjunction with a surface plate. It is used to locate centers of round rods held in V-block, scribing lines parallel to datum surface and setting jobs on machines parallel to datum.



surface.

Fig.12 Surface gauge

Fig.13 Universal surface gauge

## VERNIER HEIGHT GAUGE

The vernier height gauge is widely used in layout work and for height measurement up to and accuracy of 0.02mm. It is generally used on a surface plate. The three main parts of height gauge are the base, the column, and the slide arm. The main scale is on the column and the vernier scale is attached to the slide arm. A flat scriber is secured to the slide arm for layout work as shown in fig.13.

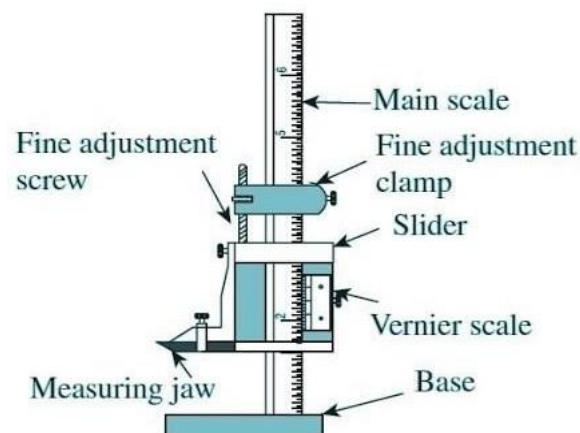


Fig. 13 Vernier height gauge

## WORK HOLDING DEVICE VISES

Vises are used to hold the work in required position during filing, hack sawing, chiseling, and bending light metal. They are also used for holding the work when assembling and disassembling parts. The most commonly used vises in fitting shop are; bench vise, pipe vise, hand vise, tool makers vise, etc.

**Bench vise:** (Fig.14) The bench vise is the work holding device most commonly used by the machinist. It consists of the fixed jaw, movable jaw, the screw and nut assembly, the handle and jaw inserts. The body of the vise is made of ductile iron or malleable iron. The screw which usually has an Acme thread, is made of steel, and the nut, which is fastened inside the fixed jaw is of bronze casting. The hardened steel jaw inserts on the jaws are serrated for greater gripping power. The solid base of the vise is mounted on a workbench by means of bolts and nuts. The size of the bench vise is specified by the width of the jaws.

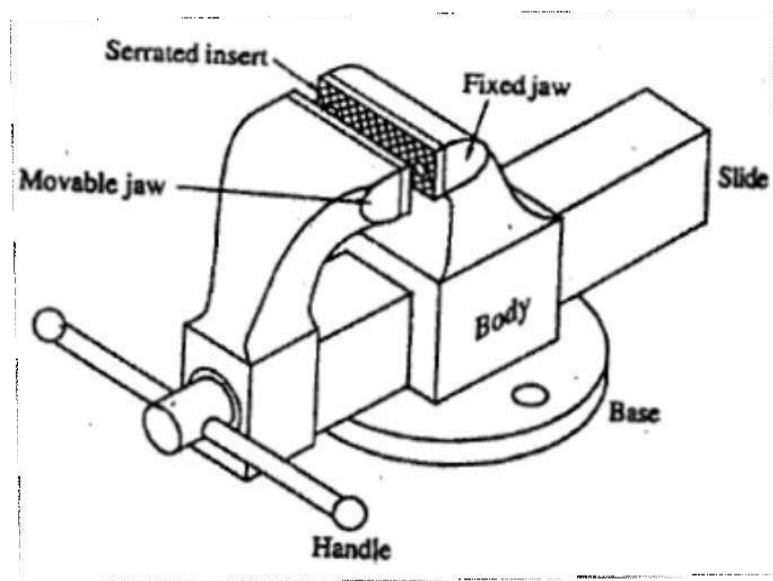


Fig. 14 Bench Vise

**Hammers:** The hammer is a very simple striking tool. It is just a weighted head and a wooden handle, which directs its course. The head is usually made of medium carbon alloy steel, and is forged to shape. The two ends must be hardened and tempered; the center of the head being left soft. Hammers are made in different shapes and weight varies from 125 gms to 1500 gms. A machinist hammer is a hand tool used for striking purposes while punching, bending, straightening chipping, forging, riveting and swaging.

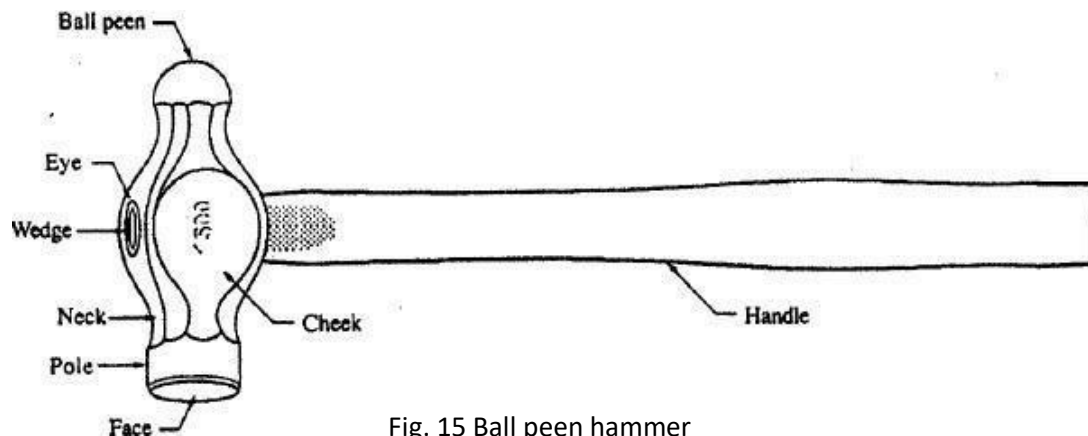


Fig. 15 Ball peen hammer

The hammer commonly used by machinist is the ball-peen hammer as shown in fig.15. The top of the hammer head is called the peen and the flat bottom is called the *face*. The *cheek* is the middle portion of the hammer, where the weight of the head is usually stamped. An eye is a hole in the hammer head to receive the handle. The handle is held in place with a soft steel wedge. The peen is available in three common shapes, the ball peen for riveting, and the straight and cross peen types for swaging. Straight peen hammer has its peen end parallel to the axis of the handle and in cross peen hammer, the peen end is perpendicular to the axis of the handle (fig.16).

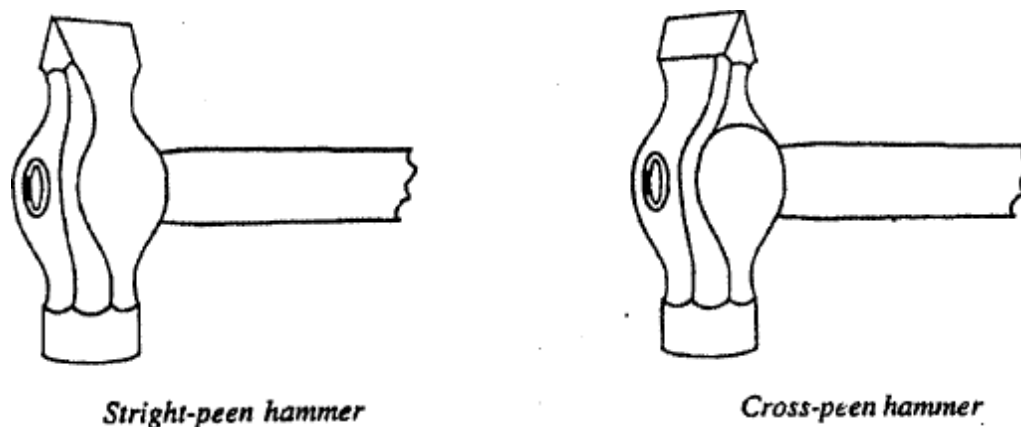


Fig. 16 Types of hammers

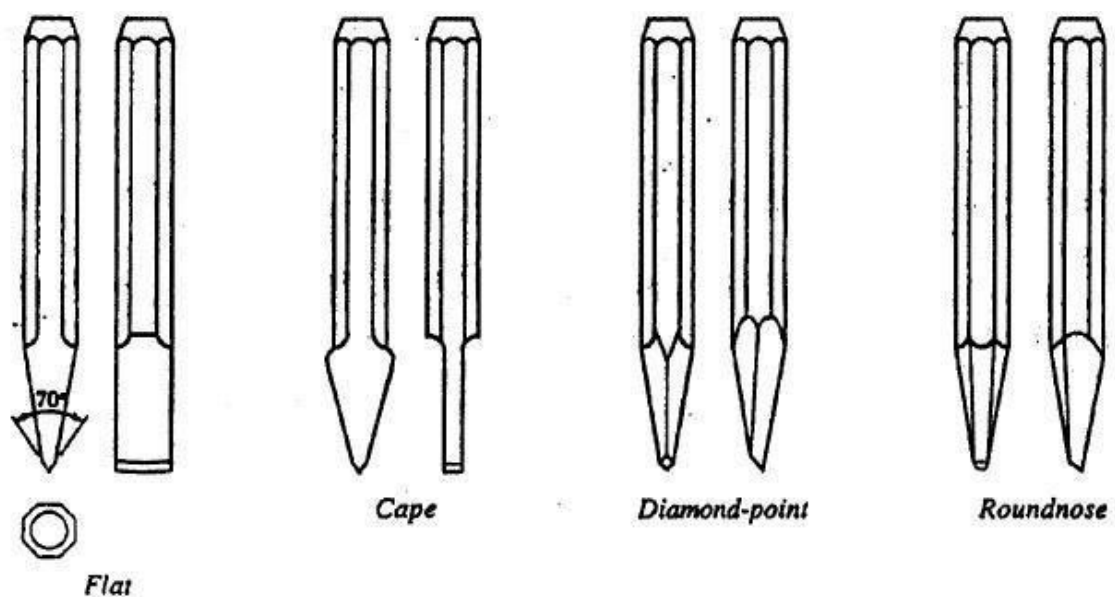
## METAL CUTTING TOOLS

**Chisels:** One method of shaping a metal piece is to chip away the unwanted material with a hammer and chisel. Chisels may be classified as hot chisel and cold chisel, depending on whether the metal to be cut is hot and cold, Hot chisels are used in smithy shops and cold chisels are used in fitting shops.

**Cold chisels:** Cold chisels are usually made of medium carbon tool steel of octagonal cross section. After being forged to shape, the cutting edge of the chisel is hardened and tempered to reduce brittleness. The head of the chisel is left soft so it will not chip when struck with hammer. Cold chisels are used to cut metal to required size and shape, to chip the surface of metal to required thickness, to cut off rods and bars to desired lengths, and to cut off rivets or bolt heads.

Chisels are classified by overall length, type of cutting edge, and width of the cutting edge. The four most widely used types of cold chisels shown in fig. 30 are the flat, cape, diamond-point, and round nose chisels.

**Flat Chisel:** The flat chisel is the type most commonly used and has a slightly rounded cutting edge formed by a double bevel. The included angle at the cutting edge is usually



between 50° and 70° depending upon the material on which it is to be used. The cutting angle is high for hard materials and less for soft materials. It is used for chipping a considerable amount of metal from large surfaces that cannot be field or surface machined.

Fig. 17 Type of cold chisels

**Cape Chisel:** The cutting edge of a cape chisel has a double bevel similar to that of a flat chisel, but is narrower for chipping of grooves and keyways.

**Diamond-point nose:** The diamond-point chisel has a tapered shank ground on an angle across diagonal corners, forming a diamond shaped cutting edge. It is used for cutting grooves, for squaring up the corners of slots, and for removing broken screws.

**Round nose chisel:** The cutting edge of a round nose chisel is formed by a single bevel. It is used for cutting semicircular grooves.

**Cutting with a chisel:** The cold chisel is held loosely between the thumb and the first finger of the left hand. The shank of the tool is held loosely with the remaining fingers. Hold the cutting edge of the chisel at the point where the cut is desired. Holding the ball-peen hammer in the right hand, strike sharp, quick blows with the flat face of the hammer and gradually increase the force of the blows as the work progresses.

#### Hints on chipping

1. Always wear goggles.
2. Do not try to chip with a dull chisel.
3. Do not permit formation of a large mushroom on the head of the chisel. Grind it off occasionally.
4. Do not make too deep a cut.
5. Watch the cutting edge of the chisel and not the end being hammered.

#### Hand Hacksaws

Hand hack sawing is done with a straight rigid blade having cutting teeth along one edge. The saw blade is pushed under pressure across the surface of the workspace and each tooth removes a small chip of metal. The hand hack saw is used for cutting different metal bars, rods and tubes to the desired length. It consists of a frame, a handle and a blade. The frame is adjustable or non-adjustable. The adjustable frame can hold the blade of various lengths and non-adjustable frame can hold blade of only one length.

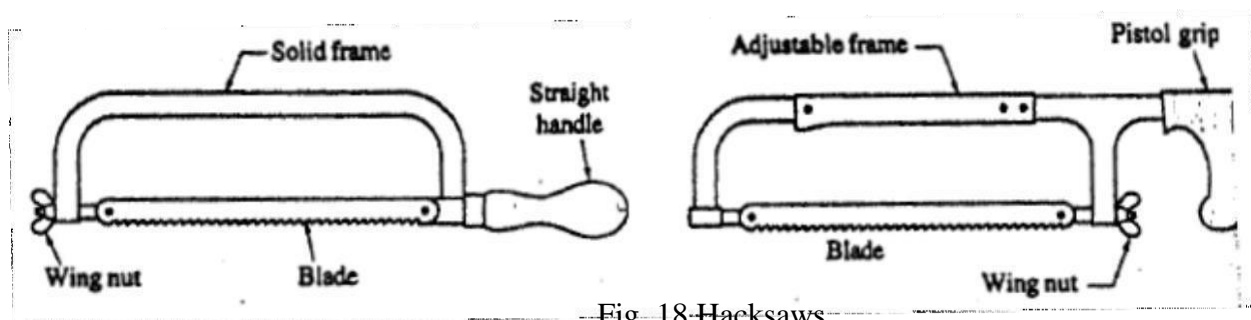


Fig. 18 Hacksaws

Hacksaw blades have a hole in each end to fit over pins in the stretchers at each end of the handle frame. The blade is placed between the pins with the teeth pointing away from the handle and the wing nut

is tightened until the blade is under proper tension. The handle of the hand hacksaw may be of straight type or of pistol grip. A pistol type grip is usually provided so the operator can grasp the saw firmly and comfortable.

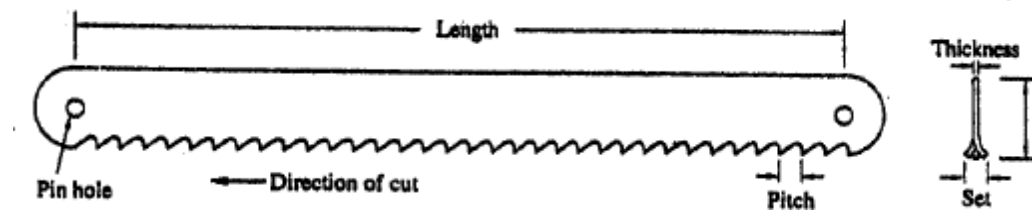
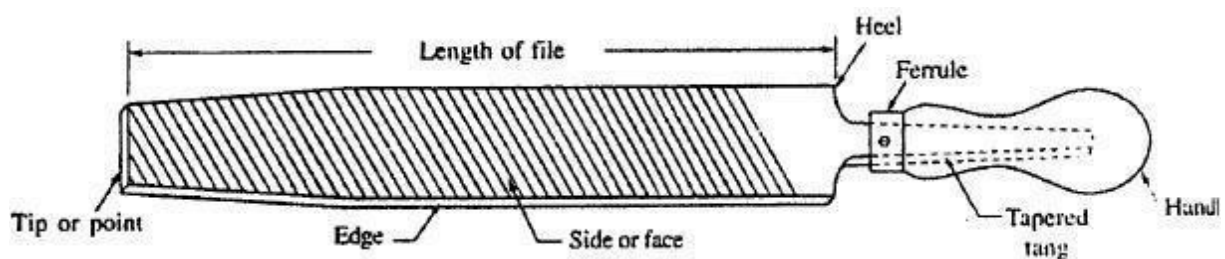


Fig. 19 Hacksaw blade

**Hacksaw blade:** Hacksaw blade shown in fig.19 is straight, relatively rigid with teeth on one edge. It is made with a hole in each end to fit over pins at each end of the hacksaw frame. The length of the blade is the distance between the two end holes. Typically, a hand hacksaw blade is 12.7 mm wide, 0.63 mm thick and about 305mm long. The pitch of the hacksaw blade is the stance between the two adjacent teeth. The pitch of the course, medium and fine teeth are 1.8 mm, 1mm and 0.8 mm respectively. The teeth on blades are arranged so that the teeth will cut a groove (kerf) in a workpiece, which is wider than the blade thickness and prevents binding of blade and the work piece. This feature is called set. That is, the teeth are alternately pushed out hacksaw blade are shown in fig.19 Hand hacksaw blades are made from high carbon steel or high-speed steel. They may be finished either with the teeth only hardened (flexible blades) or they may be hardened throughout (all hard blades).

## FILES

*File* is a hand cutting tool mad of hardened high carbon tool steel. Files are used for finishing and shaping all metals, and for the sharpening of the tools. The parts of a file are



named as shown in fig.34.

Fig. 20 Parts of a file



*Tang*: It is the narrow and tapered part of a file, which fits into the handle.

*Heel*: It is the broad portion of the file without cutting edges.

*Face or side*: It is the broad part of the file with teeth cut on its surface.

*Edge*: It is the thin part of the file with or without teeth cut on its surface. The uncut edge is called safe edge.

*Tip or point*: It is the end opposite to tang.

*Ferrule*: It is a protective metal ring to prevent splitting of the handle.

### Classification of files

Files can be classified according to the following ways.

**According to the cross-sectional shape:** The standard cross-sectional shapes for files are flat square, triangular, round, and half-round as shown in fig.21. The half-round file is actually a segment of a circle in cross section. A blunt file has the same cross section size throughout its length and taper file has a cross section that gradually narrows in width and thickness for one half length and taper file has a cross section that gradually narrows in width and thickness for one-half to two thirds of its length. Some flat files have a safe edge with no teeth.

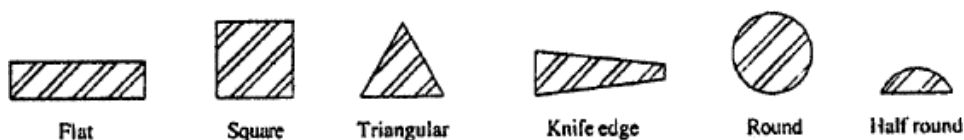


Fig. 21 Cross sectional shapes of common files

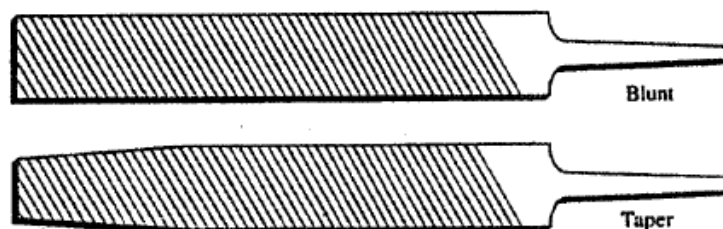


Fig. 22 Blunt and taper file

According to the type of cut:

The cut of a file describes the shape of the teeth. The basic tooth types are single-cut, double cut, rasp-cut and curved-tooth as illustrated in fig.23.

**Single-cut files:** Single-cut files have series of parallel individual teeth that extend at an angle across the face of the file. The angle of the cut to the longitudinal axis may vary between 45degree and 85degree.

Single-cut files are used with light pressure to produce a smooth surface finish.

**Double-cut files:** Double-cut files have two series of diagonal rows of teeth that cross each other on the face. The deep cut is at 70 degrees to 80-degree angle to the longitudinal axis of the file, and the shallower cut is at about 110-degree angle to the deep cut. These files are used for fast metal removal and where a rough finish is permissible.

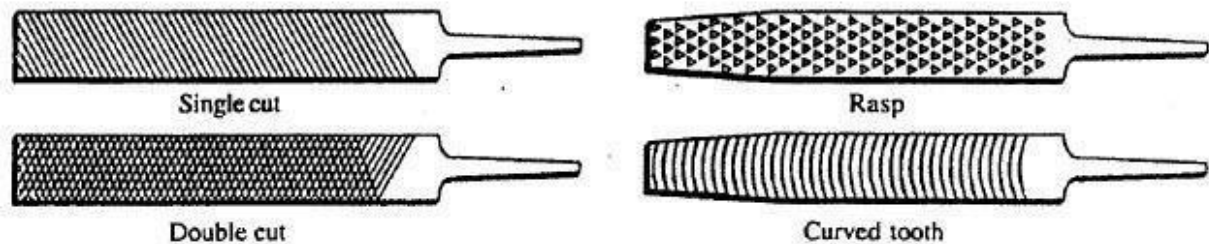


Fig. 23 Types of cuts

**Rasp-cut files:** Rasp-cut files have a series of individual teeth cut by a sharp and narrow punch like cutting chisel. These files are used for rapid removal of soft materials such as aluminum, lead, wood, and leather.

**Curved-tooth files:** In curved tooth files, the curved teeth are milled and have a larger opening between the teeth to accommodate heavy chips. The curved-tooth files are ideal for filing aluminum, and lead because of rapid metal removal and the self-cleaning action of the curved teeth.

**According to grades of cut:** The grade or coarseness of a file is an indication of the spacing of the teeth. Files may be cut with teeth of the following grades. Rough file having 8 teeth per cm, coarse file having 10 teeth per cm, Bastard file having 12 teeth per cm, second-cut file having 16 teeth per cm, smooth file having 20 to 24 teeth per cm, and dead smooth file having 40 or more teeth per cm. For general machine shop work, bastard, second-cut and smooth files are most frequently used.

file and retain its contact with the work. The various filing methods are given below:

**According to the length of file:** The length of file is measured from the heel to point. Lengths between 100mm to 150mm are generally used for fine work, between 150mm to 200mm for medium work, and between 200 to 500 mm for heavy work.

Files are specified according to their length, grade, cut and shape.

### The art of filing

Filing is a method of removing small amounts of material from the work piece. The method of holding the file and the correct working height are important during filing. The

height of the vice should be such that with a bent arm the elbow is at the same level as the top of the vise. The feet are well apart, left foot about 500mm in advance of the right.

Hold the file with the handle in the right hand and the tip of the file in the left hand. The file handle rests in the palm of the right hand, and the thumb is along the top of the handle. The pressure is applied first to the left hand at the beginning of the stroke, then later to both hands equally in the middle of the stroke, and finally to the right hand at the end of the stroke. On return stroke, relieve the pressure on the

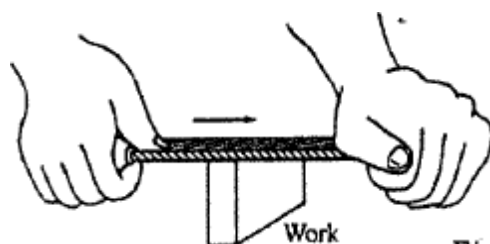


Fig. 24 Cross sectional shapes of common files

*Straight filing:* It is the one of the most common filing operations (refer fig. 38) and is used for rough and finish work.

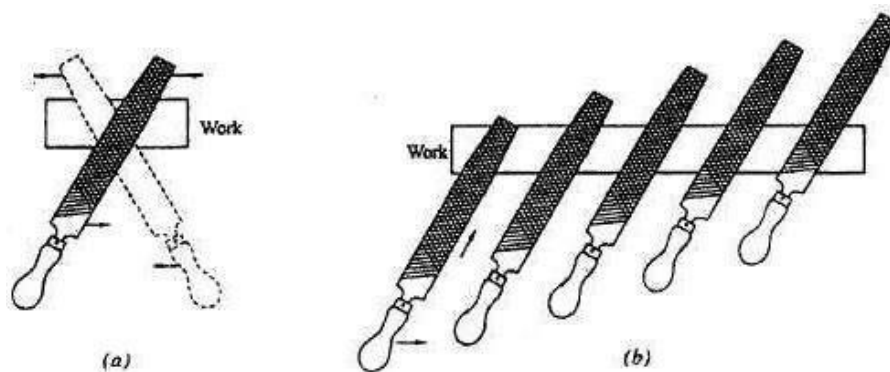


Fig. 25 Method of holding a file

*Cross filing:* In order to remove the metal at faster rate, the method of crossing strokes should be used. First the file is swept diagonally as in full lines shown in fig 39a and then after a while in the other direction as shown by the dotted lines. The second action has the result of topping off the ridges left from the strokes. These ultimate diagonal positions are continued until the surface is ready for the finishing.

When filing narrow metal pieces, the file may be kept flat by holding it diagonally to the work. Move the file forward and to the right in one stroke as shown in fig. 39b after a few strokes, move forward and to the left.

*Draw filing:* Draw filing is basically a finishing operation. A single cut smooth file is used for draw filing. Grasp the file firmly at each end and alternately push and pull it sideways across the work with an even pressure (fig.26).

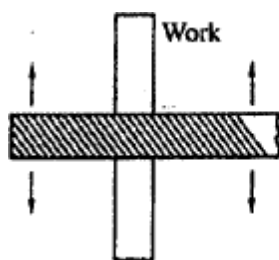


Fig.26 Draw filing

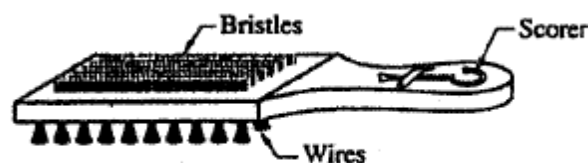


Fig. 27 File brush

Soft metals when filed tend to clog the file. This is called pinning of a file. Pinning reduces the efficiency of the file and causes scratches on the surface of the work. Brush the file frequently along the direction of file teeth with a file card or brush shown in fig.27 one side of the brush has fine wires, which are used to loosen the embedded material. The other side has bristles, which are used to finish the job. A scorer attached to the hand of the brush is used to remove pinning that cannot be loosened by the wires.

## Types of files

The most commonly used files and their uses are given below.

**Flat file:** This file is parallel for about two-thirds of its length and then tapers in width and thickness. It is cut on both faces with double cut and both edges with single cut. It is used where fast cutting is needed. This type of file produces rough finish.

**Hand file:** The width of the file is parallel throughout, but its thickness tapers similar so that of flat file. It is cut on both faces with double cut and one or both edges. It is used for filing slots and shoulders.

**Square file:** The sides of the square file are parallel for two-third its length and then tapers off. It is double cut on all sides and is used for filing corners and slots.

**Three square or triangular files:** These files are usually double cut on all faces and tapered files.

It is used for filing corners less than 90degrees and for sharpening the wood saws. The type that does not taper is known as three square parallel files,

**Round file:** It is a regular cylinder for two-thirds of its length and then tapers off., the round file is used for filing circular holes, round ended slots, etc.

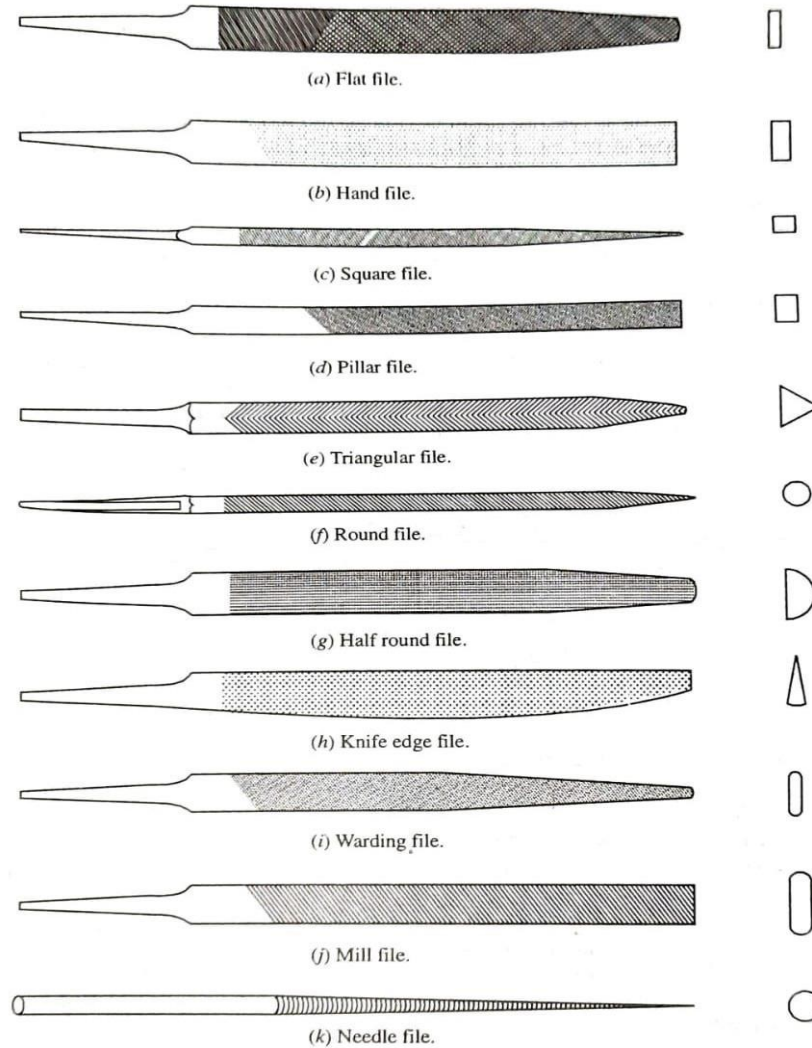


Fig.28 Types of files

**Half round file:** In half round file, the one side of the file is of a segment of a circle and the other side is flat. It is a double cut file used to file curved surfaces.

**Knife-edge file:** This file tapers to the point in width and thickness. It is double-cut on both flat sides and single cut on both edges. It is used for cleaning out acute-angled corners.

**Mill file:** It is similar to that of flat file but parallel on both width and thickness and is a single cut file. Mill saw file have one or both edges rounded for forming the radius on saw teeth and in slots.

## DRILLING

Drilling is the operation of making hole in a work piece by using a rotating tool called a drill. The drill does not produce a precision hole. If hole of accurate size and finish is required, the reaming or boring must follow the drilling operation.

**Twist drill:** Twist drill is the most widely used tool in modern drilling practice. It is made from a round bar of tool material such as high-speed steel or high carbon steel. It has a pair of helical flutes. Which form the cutting surfaces? Twist drills can be provided with a variety of shanks, but the straight shank and the Morse taper shank are the most common. The different parts of a straight shank twist drill are shown in fig.29.

**Drill chuck:** The straight shank drills are held in a drilling machine by a drill chuck shown in fig.30. The jaws of the chuck are tightened around the drill by means of a key. Most drill spindles have a tapered hole (Morse taper) into which the tapered shank of the drill chuck is fastened.

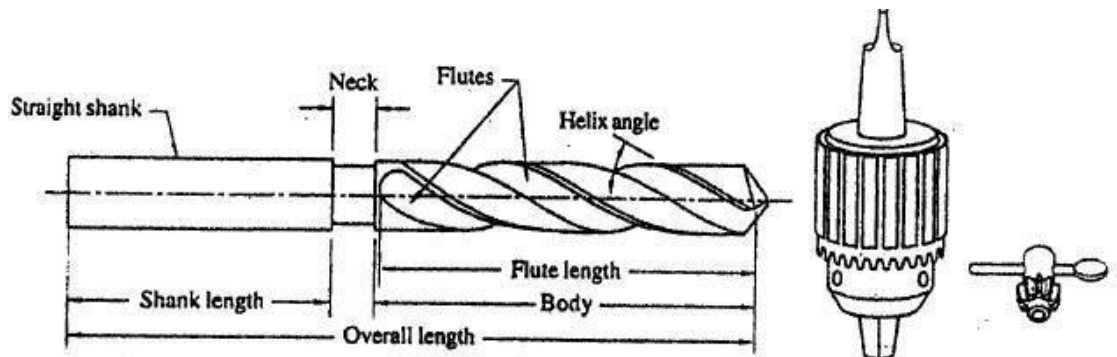
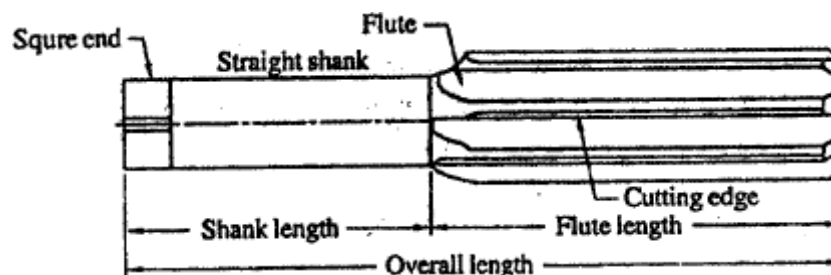


Fig.29 Twist drill

Fig.30 Drill chuck

**Reaming:** As twist drills do not make accurately sized or good finish holes a reamer of some type is often used to cut the final size and finish. A reamer will not make the original hole; it will only enlarge a previously drilled or bored hole. Reamers are usually





made of highspeed steel. The hand reamer shownn fig.46 is intended to be turned and fed by hand and to remove a small amount of material. One end of the shank is square shaped for turning it with a tap wrench.

Fig.31 Reamer

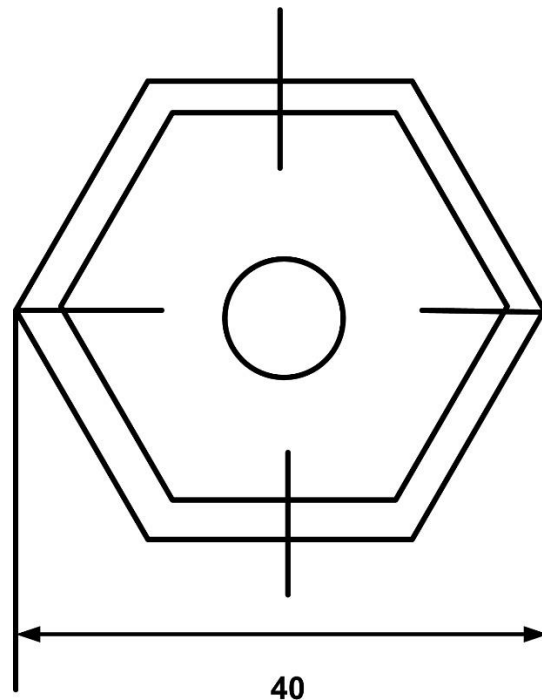
**FITTING OPERATION****JOB-I**

**Aim of the experiment** - Make a hexagon paper weight.

Part-I Making a hexagon.

**Tools required-**

- |                               |                              |
|-------------------------------|------------------------------|
| 1. File- Bastard-12"          | 9. Vernier height gauge      |
| 2. Second cut file-10"        | 10. Steel rule               |
| 3. Smooth file- 10"           | 11. Try square               |
| 4. Hacksaw frame (fixed type) | 12. Surface plate- 500×500×5 |
| 5. Hacksaw blade-300×12×0.62  | 13. Angle plate              |
| 6. Drill bit-8.5 mm           | 14. Drill chuck & key        |
| 7. Tap-10 mm (1 set)          | 15. Tap handle               |
| 8. Vernier caliper            |                              |



**All dimensions are in mm**

Raw material – (50×50×8) mm

**Procedure:**

1. At first study the drawing of the job carefully.
2. Then collect the raw material of required size.
3. After this file one flat surface & its two adjacent side for marking right angle.
4. Then apply marking media for marking & mark the job as per sketch.
5. Then punch the job according to the drawing by dot punch & hammer.
6. After punching, cut the unwanted material by a hacksaw.
7. Then start filing operation & file the job using different types of files & check with a measuring tool to make a perfect hexagon shape of the job.
8. Then make a drill hole in the center of the hexagon.
9. After this cut accurate internal thread by using tap set & handle.
10. At last, check all its trueness & hand over to your instructor

**Safety:** During cutting, punching, filing, safety precautions should be followed properly, otherwise it may damage our hand and body.

**Conclusion:** A hexagonal paper weight from Mild Steel (MS) as raw material is prepared having dimension (40×40×5) mm.

**JOB NO. 02**

**Aim of the experiment:** H-fitting in the Mild Steel (MS) square

**Objective of the experiment:**

1. Use Hacksaw to cut the required material after marking.
2. File the material to get required dimensions.

**Tools required:**

<b>Serial No</b>	<b>Name of equipment</b>
01	Bench vice
02	Try Square
03	Steel Rule
04	File Flat Bastard
05	Square file
06	Hacksaw Frame with blade
07	Surface Plate
08	Scriber
09	Dot Punch
10	Ball Peen Hammer
11	Angle Plate
12	Vernier height gauge
13	Vernier Caliper

**Raw material required:**

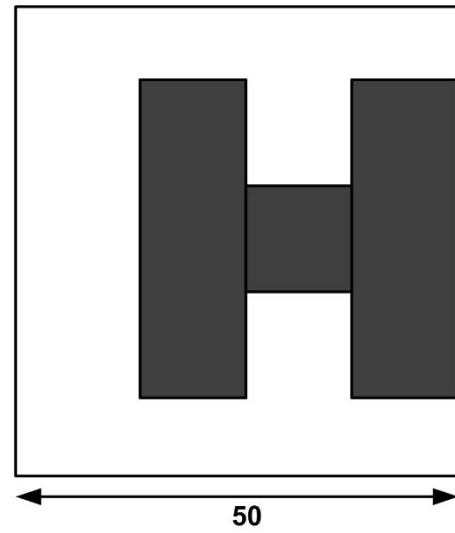
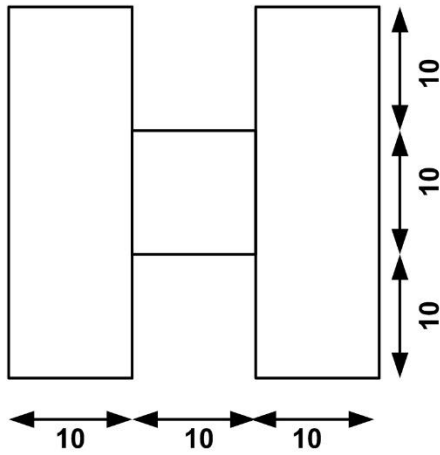
1. M.S. FLAT: 50×50×5 mm
2. M.S. FLAT: 35×35×5 mm

**Procedure:**

1. Study the job figure and select the required raw material.
2. Mark it with help of Scriber, Try Square, and keep cutting Allowances.
3. Hold the job on the Bench vice and cut from the markings using a hacksaw.
4. File the sides to make it all sides of the job right angle by using Try square.
5. Make chalking in one side of job and marking using a dot punch and hammer.
6. Place the job on the surface plate and mark using height gauge.

7. Mark the part to be removed and start cutting.
8. After cutting remove the undesired part and file the surface keeping tolerance in mind.
9. The H fitting is finally made.

**Job figure:**



**Conclusion:**

Explain the reasons for deviation from the given specifications of the finished job.  
Suggest methods for improvement of quality of the job.

**JOB NO. 03**

**Aim of the experiment:** Prepare a triangular Male and Female joint

**Objective of the experiment:**

1. Use hacksaw to cut the required material after marking.
2. File the material to the required dimension and angle.
3. Bring together the Male and Female part and look for any light gap if present.
4. File the rough surfaces to give it a shiny finish.

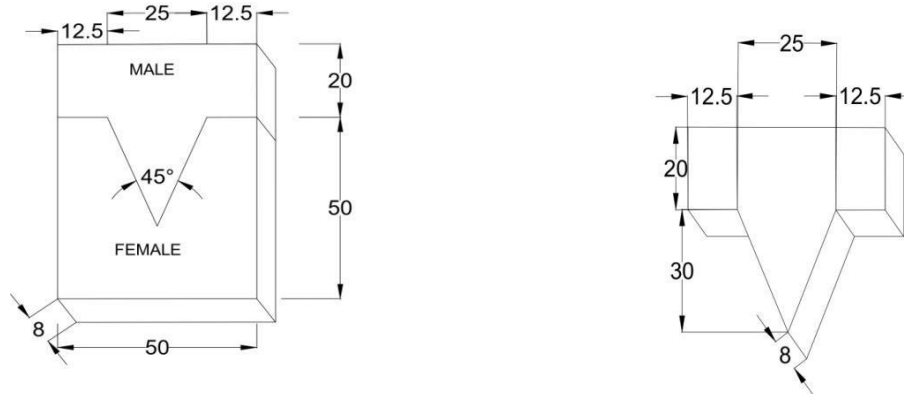
**Tools required:**

Serial No	Name of equipment
01	Bench vice
02	Try Square
03	Steel Rule
04	File Flat Bastard
05	File triangular
06	Hacksaw Frame with blade
07	Surface Plate
08	Scriber
09	Dot Punch and Centre punch
10	Ball Peen Hammer
11	Angle Plate
12	Vernier height gauge
13	Vernier Caliper
14	Chisel

**Rawmaterial Required:**

M.S. FLAT: 50×50×8 mm (2 NUMBERS)



**JOB FIGURE:****PROCEDURE:**

1. Study the job figure and choose the raw material according to the dimensions.
2. Mark the raw material and cut accordingly for the Male and Female part.
3. File adjacent sides for right angle using TRY SQUARE.
4. Mark one surface of both the joints.

**FOR MALE:**

1. Mark one side of the job using Surface Plate, Angle Plate and Vernier Height Gauge.
2. Make punch on the marked lines.
3. Cut out the undesired part and use file to get the required dimensional accuracy.

**FOR FEMALE:**

1. Follow the same procedure for female part.
2. Fit the triangular male and female parts.

**CONCLUSION:**

Hence, a triangular male and female joint is made.

## **CARPENTRY SHOP**

### **Introduction**

Carpentry may be designed as the process of making wooden articles and components such as roofs, floors, partitions, doors and windows. Carpentry involves cutting, shaping and fastening wood and other materials together to produce a finished product. Preparation of joints is one of the important operations in wood work. Joinery denotes connecting the wooden parts using different points such as lap joints, mortise and T- joints, bridle joints, etc.

### **Carpentry Tools**

Carpentry tools are used to produce components to an exact size. The types of carpentry tools are as follows.

1. Marking tools
2. Measuring tools
3. Holding tools
4. Cutting tools
5. Planning tools
6. Boring tools
7. Striking tools
8. Miscellaneous tools

### **Marking tools**

**It is used to marking lines parallel to the edges of a wooden piece. It consists of a square wooden stem with a sliding wooden stock on it. On the stem, a marking pin is attached which is made up of steel. This stem is provided with a steel nail to scratch the surface of the work. It consists of two pins; the distance between the pins is adjustable. It is used to draw parallel lines on the stock.**

### **Measuring tools**

The carpentry measuring tools are classified as follows

1. Steel tape
2. Steel rule
3. Caliper

Steel tapes and steel rules are mainly used for measuring short and lengths in millimeters.

A try square is used for testing squareness and marking of joints.

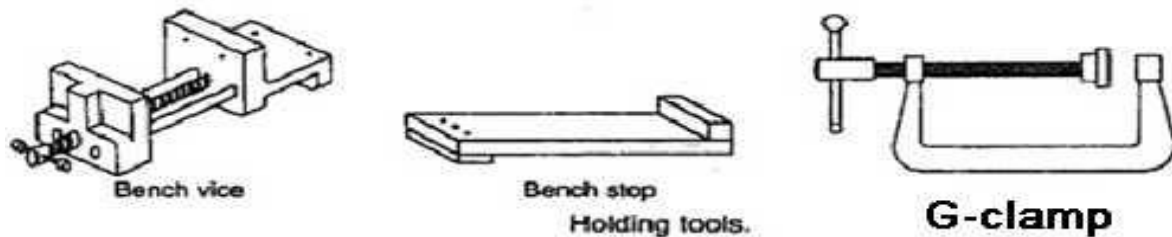
A meter square is used for marking and measuring an angle of 45 degree.

A bevel square is used for marking and listing angles between 0 degree to 180 degree.

Calipers are used for the precision measurement of cylindrical surface. Inside calipers are used for measuring outside diameter and outside calipers are used to measure inner diameter of a pipe.

## Holding tools

The carpentry holding tools are shown in fig.



## Carpentry vice

A carpentry vice is the common work holding device. It consists of one fixed jaw and one movable jaw. Its one jaw is fixed to the side of the table while the other is movable by means of a screw and a handle.

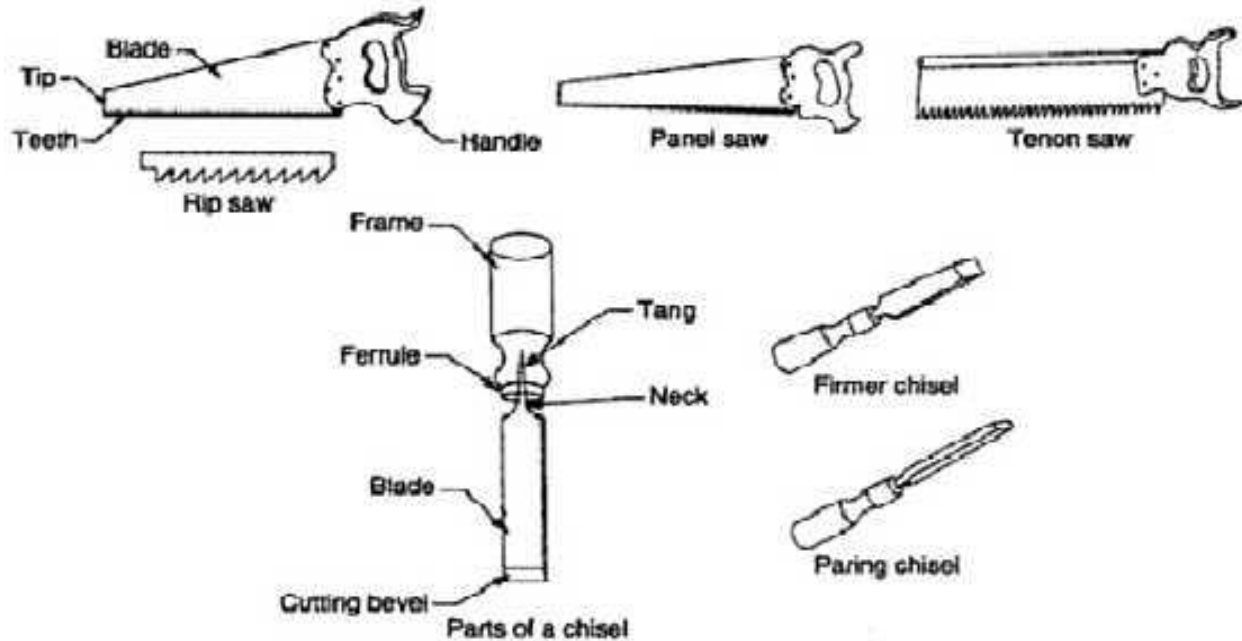
## Bar clamp

The bar clamp (or) sash cramps are generally used in pairs in gluing up operations at the final assembly of joinery work. It is made up of a steel bar of T-section, wide malleable iron fittings and a steel screw.

## G-clamp

G-clamp is made up of malleable iron with acme threads of high quality steel. It can be used for clamping small work when gluing up.

## Cutting Tools



### Saws

A saw is used to cut wood into pieces. There is different type of saws, designed to suit different purpose. A saw is specified by the length of its tooled edge. The following saws are used in the carpentry section.

#### Rip Saw

The blade of rip saw is either straight or skew-backed. The teeth are so set that the cutting edge of this saw makes a steeper angle about  $60^{\circ}$ .

#### Cross Cut saw

This is similar in shape of a rip saw. It is used to cut across the grain of the stock. The correct angle for cross cutting is  $45^{\circ}$ . The teeth are so set that the saw kerf is wider than the blade thickness. This allows the blade to move freely in the cut without sticking.

#### Tenon or back saw

A tenon saw is used for fine and accurate work. It consists of a very fine blade, which is reinforced with a rigid steel back. The teeth are shaped like those of cross cut saw.

### Chisels

Chisels are used for cutting and shaping wood accurately. Wood chisels are made in various blade widths, ranging from 3 to 50mm. Most of the wood chisels are made into tang type, having a steel shank which fits inside the handle.

### Firmer chisels

These are general purpose chisels and are used either by hand pressure or by a mallet. The blade of a firmer chisel is flat and their sloping face is at an angle  $15^{\circ}$  to  $52^{\circ}$ .

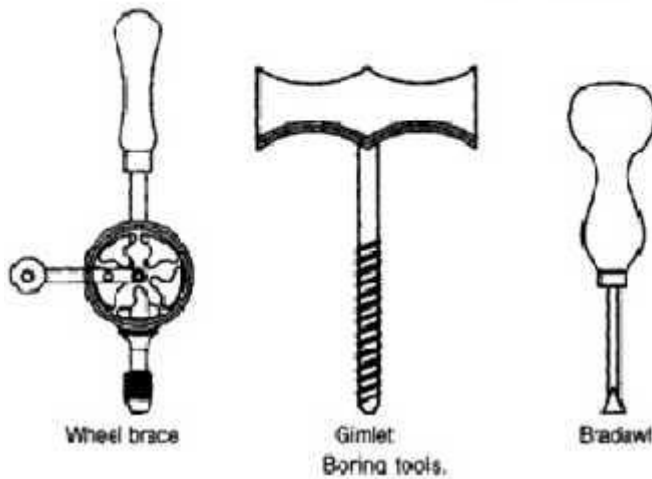
### Boring Tools

Boring tools are used to make holes in wood. common types of boring tools are as follows.

1. Bradawl
2. Gimlet
3. Brace
4. Bit and drill

A brace holds and turns the bit and boring of a hole is obtained. A brace having two jaws is used for holding the bit in one end. It has two types, namely ratchet brace and wheel brace. A bradawl and a gimlet are used for boring small holes. These tools are hand operated.

### Striking Tools



**JOB NO. 01**

**Aim of the experiment:** Prepare Mortise and Tenon joint

**Operation performed:** Male part

**Tools required:**

<b>Serial No.</b>	<b>Name of tools</b>
01	Carpenter's vice
02	Try Square
03	Steel Rule
04	Planner
05	Scriber
06	Cross cut saw
07	Marking gauge
08	Wood rasp file and smooth file
09	Chisel
10	Mallet

**Raw material Required:**

Wooden pieces of size-50×35×250 mm- 2 nos.

**Sequence of operations: -**

1. Measuring and Marking
2. Planning
3. Check for squareness
4. Removal of extra material
5. Sawing
6. Chiseling
7. Finishing

**PROCEDURE:**

1. The given reaper is checked for dimensions.
2. They are planed with jack plane and checked for straightness.
3. The two surfaces are checked for squareness with a try square.

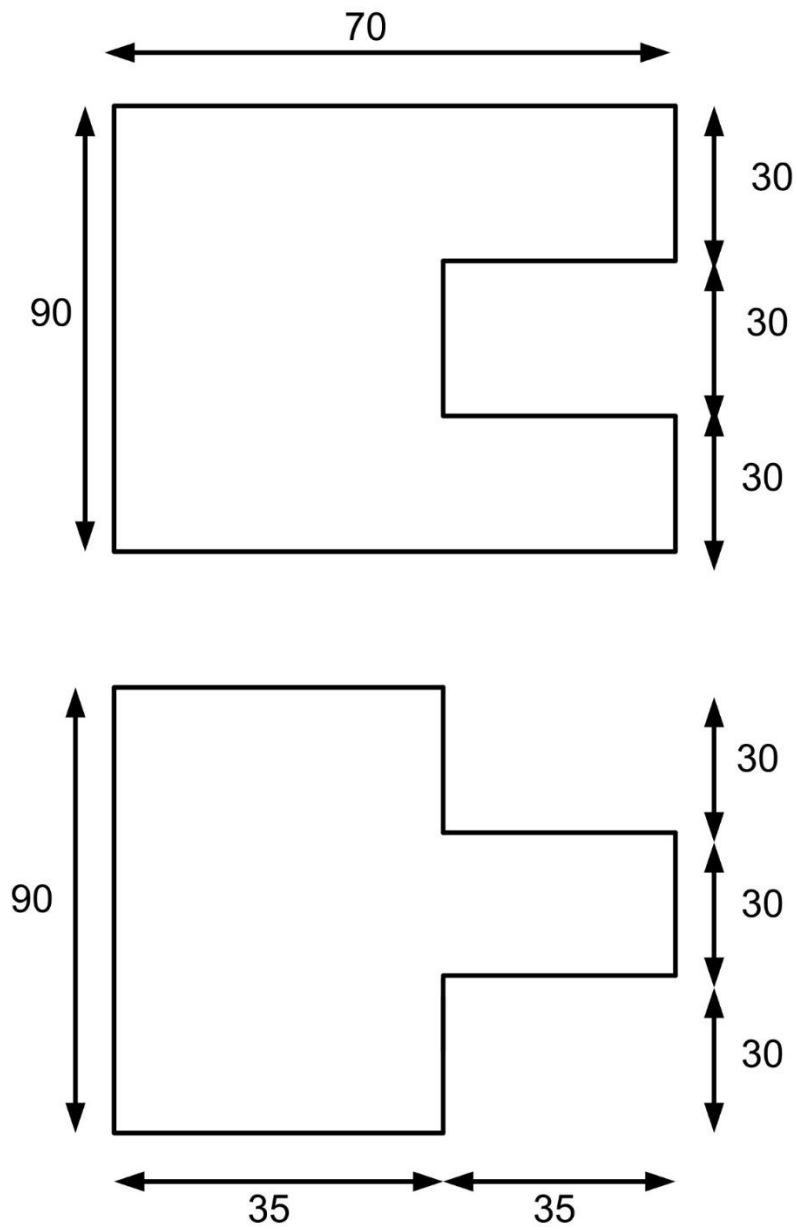
4. Marking gauge is set and lines are marked at 30 and 45 mm to mark the thickness and width of the model respectively.
5. The excess material is first chiseled with firmer and then planned to correct size.
6. The mating dimensions of the parts X and Y are then marked using steel rule and marking gauge.
7. Using the crosscut saw, the portions to be removed are cut in both the pieces, followed by chiseling.
8. The ends of both the parts are chiseled to the exact lengths.
9. The fine finishing is given to the parts, if required so that, proper fitting is obtained.
10. The parts are fitted to obtain a slightly tight joint.

**Safety precautions:** -

1. Loose cloths are to be avoided.
2. Tools to be placed at their proper placed.
3. Hands should not be placed in front of sharp-edged tools.
4. Use only sharp tools.
5. Care should be taken, when thumb is used as a guide in cross cutting and ripping.
6. Handle while chiseling, sawing and planning with care.

**Result:** - Mortise and Tenon joint is made as per the required dimensions.

**JOB FIGURE:**



(All dimensions are in mm)

**CONCLUSION:**

Hence, a triangular male and female joint is made.



# WELDING

Welding is a material joining process which produces coalescence of materials by heating them to suitable temperatures with or without the application of pressure or by the application of pressure alone, and with or without the use of filler material. Welding is used for making permanent joints. It is used in the manufacture of automobile bodies, aircraft frames, tanks, furniture, boilers, general repair work and ship building. Welding is usually the most economical way to join components in terms of material usage and fabrication costs.

Types of welding: There are two major groups of welding.

- **Plastic Welding or Pressure Welding:** The piece of metal to be joined are heated to a plastic state and forced together by external pressure like in the case of Resistance Welding.
- **Fusion Welding or Non-Pressure Welding:** The material at the joint is heated to a molten state and allowed to solidify like in the case of Electric Arc Welding and Gas Welding.

## ARC WELDING PROCESS

The process, in which an electric arc between an electrode and a workpiece or between two electrodes is utilized to weld base metals, is called an arc welding process. The basic principle of arc welding is shown in figure. However, the basic elements involved in arc welding process are shown in figure. Most of these processes use some shielding gas while others employ coatings or fluxes to prevent the weld pool from the surrounding atmosphere.

- 1) Switch box
- 2) Secondary terminals
- 3) Welding machine
- 4) Current reading scale
- 5) Current regulating hand wheel
- 6) Leather apron
- 7) Asbestos hand gloves
- 8) Protective glasses strap
- 9) Electrode holder
- 10) Hand shield
- 11) Channel for cable protection
- 12) Welding cable
- 13) Chipping hammer
- 14) Wire brush

15) Earth clamp

16) Welding (metallic)

17) Job

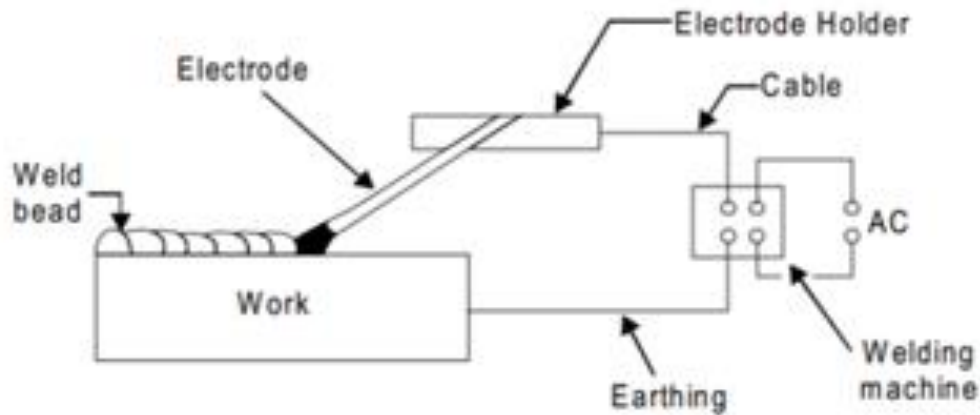


Fig1.The basic principle of arc welding

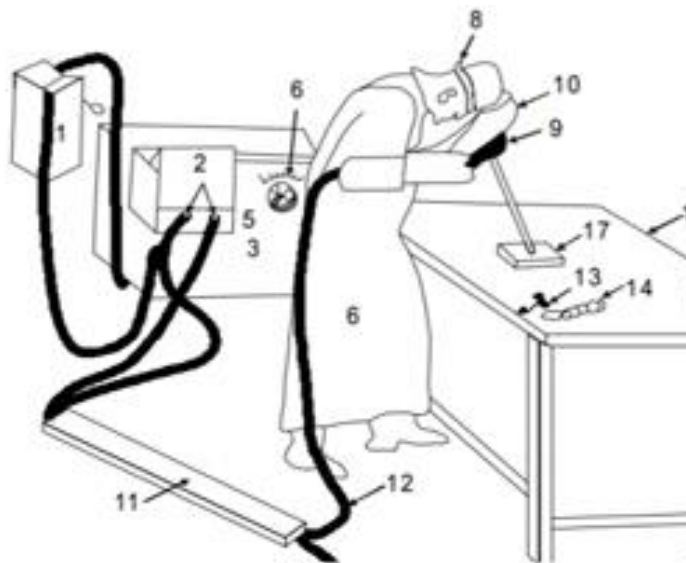


Fig2.The basic elements of arc welding

## Arc Welding Equipment

Arc welding equipment, setup and related tools and accessories are shown in figures below. However, some common tools of arc welding are shown separately. Few of the important components of arc welding setup are described as under.

### 1. Arc welding power source

Both direct current (DC) and alternating current (AC) are used for electric arc welding, each having its particular applications. DC welding supply is usually obtained from generators driven by electric motor or

if no electricity is available by internal combustion engines. For AC welding supply, transformers are predominantly used for almost all Arc-welding where main electricity supply is available. They have to step down the usual supply voltage (200-400 volts) to the normal open circuit welding voltage (50-90 volts). The following factors influence the selection of a power source:

- a. Type of electrodes to be used and metals to be welded
- b. Available power source (AC or DC)
- c. Required output
- d. Duty cycle
- e. Efficiency
- f. Initial costs and running costs
- g. Available floor space
- h. Versatility of equipment

## 2. Welding cables

Welding cables are required for conduction of current from the power source through the electrode holder, the arc, the work piece and back to the welding power source. These are insulated copper or aluminum cables.

## 3. Electrode holder

Electrode holder is used for holding the electrode and conducting current to it. These are usually to the size of the lead, which in turn matched to the output of the arc welder. Electrodes are available in range from 150 to 500 Amps.



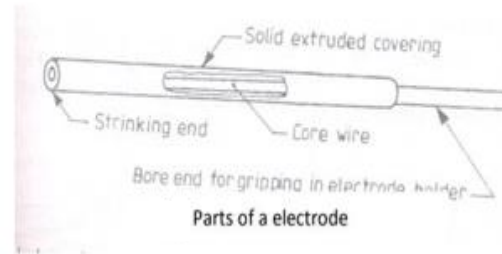
Electrode Holder

manually  
matched  
amperage  
sizes that

## 4. Welding Electrodes

An electrode is a piece of wire or rod of a metal or alloy, with or without coatings. An arc is set up between electrode and workpiece. Welding electrodes are classified into following types:

- I. Consumable electrodes
  - a. Bare electrodes
  - b. Coated electrodes
- II. Non-consumable electrodes
  - a. Carbon or Graphite electrodes
  - b. Tungsten electrodes



Consumable electrode is made of different metals and their alloys. The end of this electrode starts melting when arc is struck between the electrode and workpiece. Thus, consumable electrode itself acts as a filler metal. Bare electrodes consist of a metal or alloy wire without any flux coating on them. Coated electrodes have flux coating which starts melting as soon as an electric arc is struck. This coating on melting performs many functions like prevention of joint from atmospheric contamination, arc stabilizers etc.

Non-consumable electrodes are made up of high melting point materials like carbon, pure tungsten or alloy tungsten etc. These electrodes do not melt away during welding. But practically, the electrode length goes on decreasing with the passage of time, because of oxidation and vaporization of electrode material during welding. The materials of non-consumable electrodes are usually copper coated carbon or graphite, pure tungsten, thoriated or zirconated tungsten.

### 5. Hand screen

Hand screen used for protection of eyes and supervision of weld bead.

### 6. Chipping hammer

Chipping hammer is used to remove the slag by striking.

### 7. Wire brush

Wire brush is used to clean the surface to be weld.

### 8. Protective clothing



Operator wears the protective clothing such as apron to

keep away the exposure of direct heat to the body.

### **Safety recommendations for ARC welding**

The beginner in the field of arc welding must go through and become familiar with these general safety recommendations which are given as under:

- i. The body or the frame of the welding machine shall be efficiently earthed. Pipe lines containing gases or inflammable liquids or conduits carrying electrical conductors shall not be used for a ground return circuit. All earth connections shall be mechanically strong and electrically adequate for the required current.
- ii. Welding arc in addition to being very is a source of infra-red and ultra-violet light also, consequently the operator must use either helmet or a hand shield fitted with a special filter glass to protect eyes.
- iii. Excess ultraviolet light can cause an effect similar to sunburn on the skin of the welder.
- iv. The welder's body and clothing are protected from radiation and burns caused by sparks and flying globules of molten metal with help of the following:
  - Gloves to protect hands of a welder
  - Goggles to protect eyes while welding.
  - Leather or asbestos apron is very useful to protect welder's clothes and his trunk and thighs while seated and doing welding.
  - For overhead welding, some form of protection for the head is required.
  - Leather skull cap or peaked cap should be used.
  - Leather jackets and leather pants are also available as clothes for body protection
  - Welding equipment shall be inspected periodically and maintained in safe working order at all times.
  - Arc welding machines should be of suitable quality.
  - All parts of welding set shall be suitably enclosed and protected to meet the usual service conditions.

## GAS WELDING

A fusion welding process which joins metals, using the heat of combustion of an oxygen /air and fuel gas (i.e. acetylene, hydrogen propane or butane) mixture is usually referred as 'gas welding'. The intense heat (flame) thus produced melts and fuses together the edges of the parts to be welded, generally with the addition of a filler metal. Details of Gas welding equipment

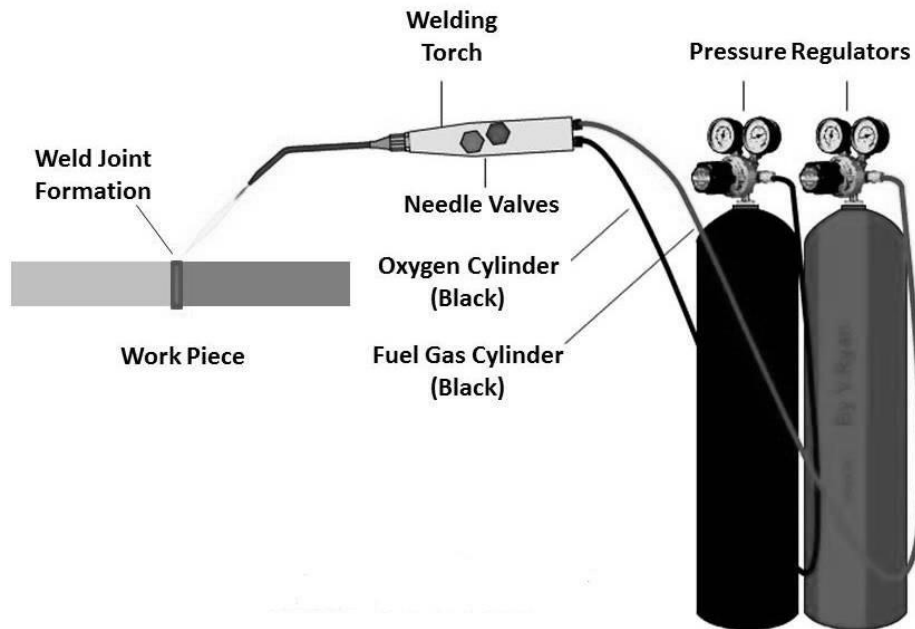


Fig.1 Gas Welding Setup

### Welding torch

The torch is the tool that the welder holds and manipulates to make the weld. It has a connection and valve for the fuel gas and a connection and valve for the oxygen, a handle for the welder to grasp, and a mixing chamber (set at an angle) where the fuel gas and oxygen mix, with a tip where the flame forms.



Fig.2 Welding torch

### Welding pins

Weld pins are designed with a long narrow shaft that is spot welded to a metal surface, primarily to fasten duct liner to metal ductwork, or other materials onto metal surfaces.

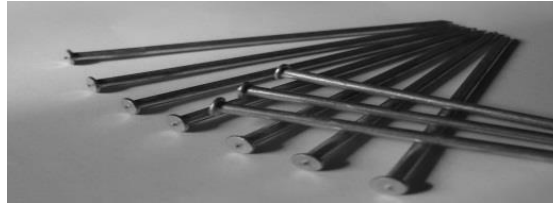


Fig.3 Gas Welding pins

**Pressure regulator**

A pressure regulator is a control valve that reduces the input pressure of a fluid to a desired value at its output. Regulators are used for gases and liquids, and can be an integral device with an output pressure setting.



Fig.4 Pressure Regulator

**Oxygen acetylene cylinder**

Acetylene gas is commonly used for gas welding because of its simplicity in production and transportation and its ability to achieve high temperature in combustion (e.g. around 5,000o F).

**Spark lighter**

A spark lighter is a tool used to ignite flammable gas appliances such as Bunsen burners, welding torches, and gas grills. A spark lighter produces a spark having sufficient heat to ignite flammable gas vapor.





Fig.5 Oxygen Acetylene Cylinder



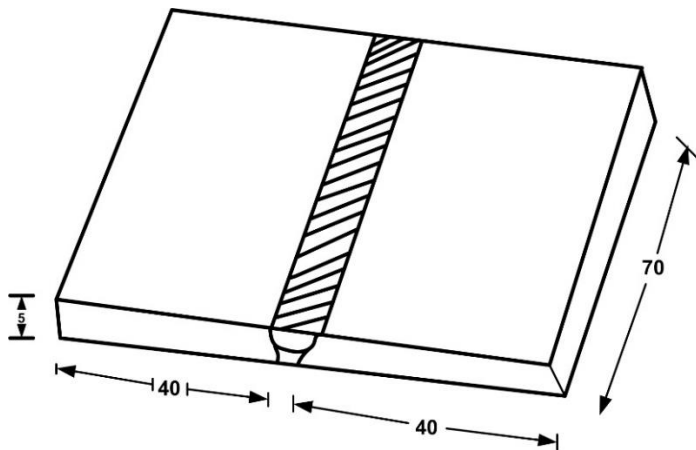
Fig.6 Spark lighter

**Aim of the experiment:**

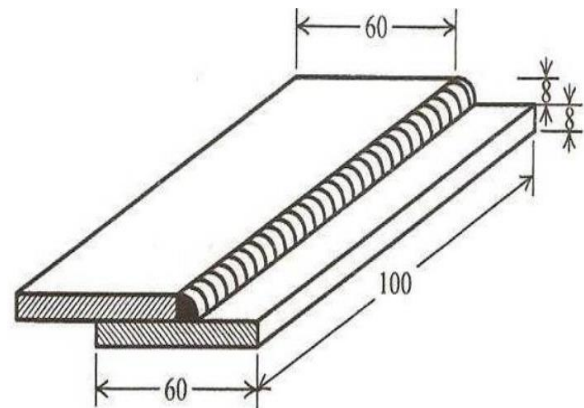
To prepare Lap and Butt Joint through Arc welding.

**Apparatus required:**

Sl no.	Name of the apparatus	Specification	Quantity
01	Rough File	300 mm	01
02	Arc welding Machine	350 amperes	01
03	Electrode Holder	300 amp/800 amp	01
04	Ground Clamp	100 mm	01
05	Tongs	300 mm	01
06	Welding Hand Screen	(108 x 82) mm	01
07	Hammer	Chipping Type	01
08	Apron	Leather	01
09	Gloves	Leather	01 pair
10	Goggles	Protecting glasses	01



(a) Butt joint



(b) Lap joint

(All dimensions are in mm)

**Raw material required for butt joint:**

1. Two number of M.S Flat with dimension (70x40x5) mm.
2. M.S. Electrode – 10 SWG and 8 SWG

**Raw material required for lap joint:**

1. Two number of M.S Flat with dimension (100x60x8) mm.
2. M.S. Electrode – 10 SWG and 8 SWG

**Steps to follow before welding:**

- Before welding operation some precaution has to be taken. These are wearing apron, using hand gloves and hand screen.
- The welding process is done with proper selection of welding parameters (accelerating voltage, welding current, welding speed) on the welding machine.
- Then welding is done by the help of electrode holder with filler metals, then arc is created by the contact with electrode and work piece.
- During the process of welding the electrode is kept at  $15^\circ$  to  $25^\circ$  angle from vertical and the direction of welding respectively.

**Procedure:**

- Single 'V' cutting by hacksaw.
- The given M.S Flats are thoroughly cleaned.
- The two pieces of M.S Flat positioned on the welding table such that they are separated slightly for better weld joints and well penetration of the weld.
- Select the 10 SWG electrodes and set the current of 120 amp.
- Tack the pieces at both ends and at center.
- Check the alignment of tack pieces and reset it, if necessary.
- Place the joint in flat position on the welding table.
- Select 8 SWG electrode and set current of 150 amp.
- Deposit the first bead along the joint line with correct arc length, chip the slag
- Deposit the second bead on this side using the same setting.
- Chip the slag or scale formation on the welding zone and from the bead with a chipping hammer and brush with a wire brush.

**Conclusion:**

Lap and Butt Joint are thus made using above procedure.

## **SHEET METAL WORKING**

### **INTRODUCTION:**

Many engineering and house hold articles such as boxes, cans, funnels, ducts etc., are made from a flat sheet of metals. This process being known as tin smithy. For this, the development of the article is first drawn on the sheet metal then cut and folded to form the required shape of the article. The edge of the articles is then secured through welding, brazing, soldering, riveting etc.

### **SAFETY PRACTICES**

1. Use hand leather gloves while handling heavy sheets.
2. Avoid feeling the cut portion by hand while cutting with snips.
3. Do not let sheet metal slip through your hands. Most cuts from sheet metal result from allowing it to slide through the hands.

### **Sheet metal materials: -**

A variety of metals used in a sheet metal shop such as black iron, aluminum and stainless steel. A sheet of soft steel which is coated with molten zinc is known as galvanized iron. The zinc coat forms a coating that resists rust, improves the appearance of the metal and permits it to be soldered with greater care.

### **Hand tools:-**

The common hand tools used in sheet metals work are steel rule, usually of 60 cm length, Vise gauge, dot punch, scribe, trammels, ball peen hammer, and straight peen hammer, cross peen hammer, mallets, snips and soldering iron.

### **Trammels:-**

Sheet metals layouts require marking of arcs and circles. This may be done by using the trammels. The length of the beam decides the maximum size of the arc that can be scribed.

### **Wire gauge:-**

The thickness of the sheet metal is referred in numbers known as standard wire gauge (SWG). The gaps in the circumference of the gauge are used to check the gauge number.

### **Bench shears:-**

Sheet metal may be cut by shearing action. In this the force is applied through a compound lever, making it possible to cut sheet metal up to 4mm thick. The chopping hole can shear a mild steel rod up to 10mm diameter.

### **Snips:-**

Snips are hand shears, varying in length from 200mm to 600mm. 200mm to 250mm being the commonly used. The straight lines are curved snips or bent snips are for trimming along inside curves.

**Hammers:-**

Ball peen hammer has a cylindrical slightly curved face and a ball head straight peen and similar to the cross peen, but it is positioned paralleled to the handle which can be used conveniently for certain operations of folding.

**Stakes:-**

Stakes are nothing but anvils, which are used as supporting tools and to form seam, bend, rivet sheet metal objects.

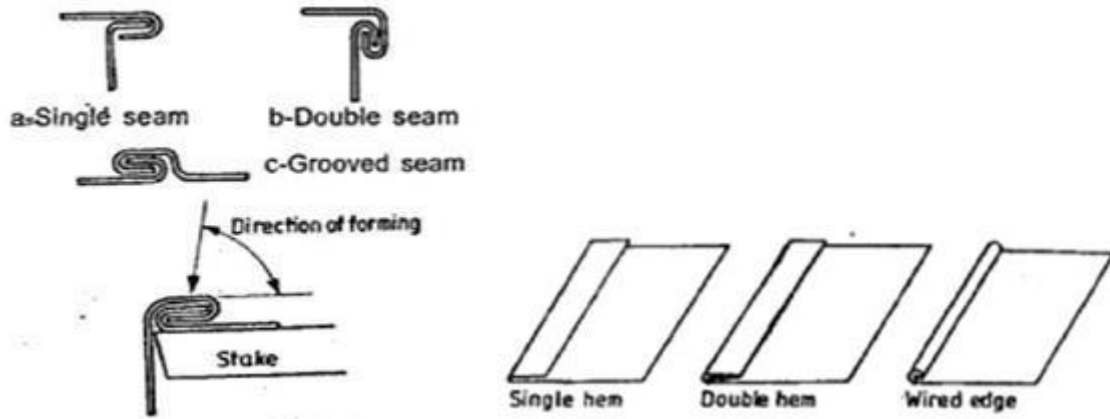


Fig: 1 Sheet metal joints

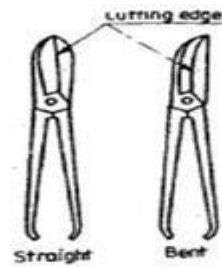
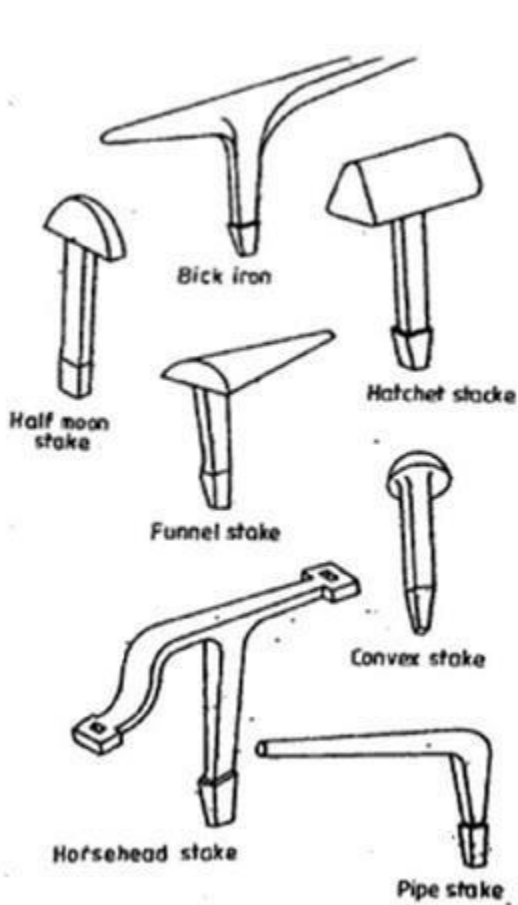


Fig. 10.4 Snips

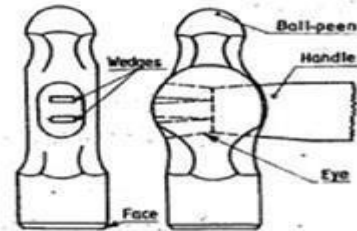


Fig. 8.34 Ball-peen hammer

Table 10.1

SWG No	Thickness, mm
10	3.20
12	2.60
14	2.30
16	1.60
20	1.00
22	0.70
24	0.65
26	0.45
30	0.30

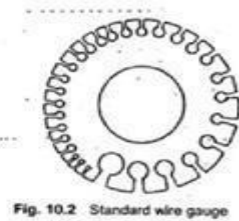


Fig. 10.2 Standard wire gauge

Fig: 2 Stakes

**Snips:-**

Snips are hand shears, varying in length from 200mm to 600mm. 200mm to 250mm being the commonly used. The straight lines are curved snips or bent snips are for trimming along inside curves.

**Hammers:-**

Ball peen hammer has a cylindrical slightly curved face and a ball head straight peen and similar to the cross peen, but it is positioned paralleled to the handle which can be used conveniently for certain operations of folding.

**Stakes:-**

Stakes are nothing but anvils, which are used as supporting tools and to form seam, bend, rivet sheet metal objects.

***SHEET METAL JOINTS:***

Various types of joints are used in sheet metal work to suit the varying requirement. These are self-secured joints, formed by joining together two pieces of sheets metal and using the metal itself to form the joints. These joints are to be used on sheets of less than 1.6mm thickness.

**Riveting:-**

Rivets are used to fasten two or more sheets of metal together. It is the common practice to use the rivets of the same material as that of the sheets having fastened.

**Sheet metal screws:-**

These are used in sheet metal work to join and install duct work for ventilation air conditioning etc. These screws are also known as self-tapping screws since they cut their own threads.

**Soldering:-**

Soldering is one method of joining two pieces of metal with an alloy that melts at a lower temperature than the metals to be joined for a good job. The metals to be joined must be free from dirt, grease and oxide. Solder is made of tin and lead in equal proportions. It comes either in the form of wire and bar.

**Soldering iron:-**

Soldering requires a source of heating. A common method of transmitting heat of the metal surfaces is by using a soldering iron.

**TAPERED TRAY**

**AIM:** - To make a tapered tray using the given G.I. Sheet.

**TOOLS REQUIRED:** -

SERIAL NO	NAME OF EQUIPMENT	SPECIFICATION / TYPE	QUANTITY
01	Steel Rule		
02	Folding Rule		
03	Straight Edge		
04	Try Square		
05	Scriber		
06	Divider		
07	Punch		
08	Chisel		
09	B.P Hammer		
10	Straight Snip		
11	Soldering Iron		
12	Wooden Mallet		
13	Bench vice		
14	Cutting plier		

**MATERIAL REQUIRED:** - Galvanized Iron (G.I) sheet 110 x 125 mm size.

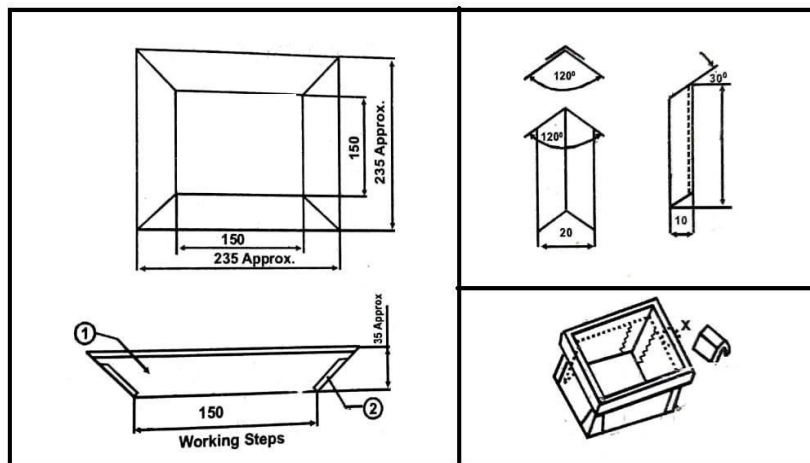
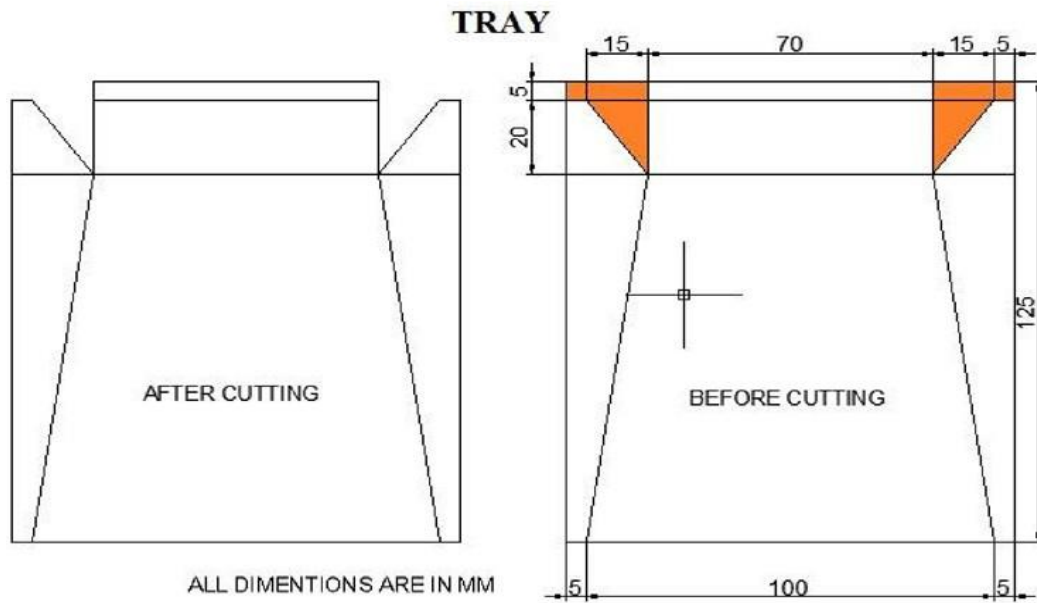
**SEQUENCE OF OPERATIONS:-**

1. Cleaning
2. Surface leveling
3. Marking
4. Cutting
5. Folding

**PROCEDURE:** -

1. Clean the given sheet with cotton waste.
2. The size of the given sheet is checked with the steel rule.
3. Flatten the surface of the given sheet with wooden mallet.
4. Check the G.I. Sheet for dimensions and remove extra material, if any.
5. Mark all the measuring lines on the given sheet with scriber.
6. Cut the given sheet with straight snips as required.
7. Fold the given sheet by using stakes and ball peen hammer to the required shape.





***SAFETY PRECAUTIONS: -***

1. For marking purpose use scribe only. Do not use pencil or pen.
2. Sufficient care is to be taken while cutting and folding of G.I. sheet.
3. Remove the waste pieces immediately from the work place.

**RESULT:** Tapered tray is made as per the required dimensions.

## HOUSE WIRING

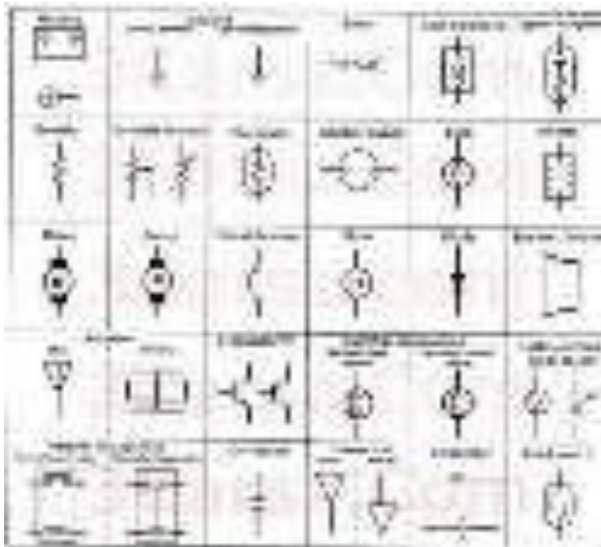
### INTRODUCTION:

Power is supplied to domestic installations through a phase and neutral, forming a single phase AC 230 v to wire system. For individual establishment power is supplied through three phase two wire system. To give 440V, the neutral is earthed at to the domestic utilities; power is fed to kilo watt meter and then to distributes power along several circuits. It also protects these circuits from over load by safety devices like fuses or circuit breakers.

### ELEMENTS OF HOUSE WIRING:

1. Fuses and circuit breakers
2. Electric switch
3. Plug
4. Socket out let
5. Lamp holder
6. Main switch
7. Incandesant tight

**WIRING METHOD:** A circuit is path along which the electric current flows from negative side of power source to positive side.



### COMMON HOUSE WIRING REPAIRS:

1. Replacing a fuse
2. Resulting a circuit beaker
3. Resulting a switch or an out let
4. Repair of house hold appliances

### PRECAUTIONS:

1. Ensure that the insulation of wire reaches up to accessory
2. Do not over tighten the screw
3. Ensure that the base wire is not touching any part of accessory.

### RULERS OF WIRING:

1. Every fitting or appliances must also be controlled by a switch.

2. The switch should be on the line conductor
3. Every sub-circuit must have a separate fuse.

All the metals covering frames etc. should be earthed.

### **Incandescent Light:**

Incandescent means 'glowing at white hot'. A lamp actually works like a heating element, except that it gives off light by becoming white hot. Figure 3.9 shows the parts of a bulb. The amount of power it consumes is stamped on the bulb. The higher the wattage, brighter the light. The bulbs have filaments made of tungsten. However, special bulbs are available with inside coating and filled with gas.

### **Wires and Wire Sizes:**

A wire is defined as a bare or an insulated conductor consisting of one or several strands. An insulated wire consists of a conductor with insulating material made of vulcanized India rubber (VIR) or polyvinylchloride (PVC). The wire may consist of one or several twisted strands. A multi-core conductor consists of several cores insulated from one another and enclosed in a common sheathing (fig. 3.10).

Wire sizes are specified by diameter of the wire, using a standard wire gauge (SWG), which also gives an idea of the current carrying capacity. This specification consists of the number of strands and the diameter of each wire in it. For example, the specification, (i) *silk wire 14/36* indicates 14 strands of 36 SWG each and (ii) *3/18 PVC* indicates 3 strands of 18 SWG each.

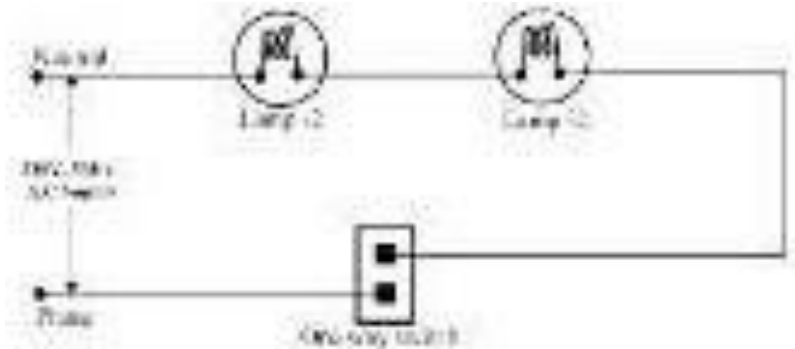


**EXPT NO:2 TWO LAMPS CONTROLLED BY SINGLE SWITCH****DATE:****AIM:** to control two lamps by a one switch with provision for plug socket with switch control.**MATERIALS REQUIRED WITH DIMENSIONS:**

1. 1/18" pvc wire of sufficient length
2. One way switch – 2 no.
3. Two-pin plug socket-1no.
4. Bulb-1no.
5. Bulb holder-1no.

**TOOLS AND EQUIPMENT USED:**

1. 6" cutting pliers
2. 1.5 IB ball peen hammer.
3. Wire stripper
4. Tester
5. 6" screw drivers
6. Hack saw
7. 12mm hand drilling machine.

**OPERATIONS TO BE CARRIED****OUT:**

1. Fitting the wires
2. Connection of the bulb holder
3. Connection of plug socket
4. Connection of switch
5. Circuit connections
6. Power from mains
7. Operation the bulb
8. Testing the plug socket.

**PROCEDURE:**

1. The outline wiring diagram marked on the wooden board and clips are nailed to the board following the diagram, six wire pieces are taken and insulation is removed at the ends by using wire stripper.
2. A phase wire is connected to one point switch s1 and s2.
3. The lower points of switches s1 and s2 are connected to one point of bulb holder and one point of plug socket respectively.
4. Two neutral wires are taken and one is connected to the remaining point of the bulb holder.
5. The other is connected to the remaining points of plug socket.
6. After checking the proper circuit connections the power supply is given.
7. Now the bulb is ready to glow bright and the plug socket is also ready with control.

**PRECAUTIONS:**

1. All the wire connections of the switches, bulb holder and sockets be tight.
2. Too many load connections from a single junction are avoided.

**RESULT:**

1. In series connection if one bulb does not glow the other bulb also does not glow.
2. In parallel connection if one bulb does not glow the other bulb glows.

**EXPT NO: 3 STAIR CASE WIRING**

**DATE:**

**Aim:** To do stair case wiring (i.e. control of one lamp by two switches fixed at two different places).

**Materials required:**

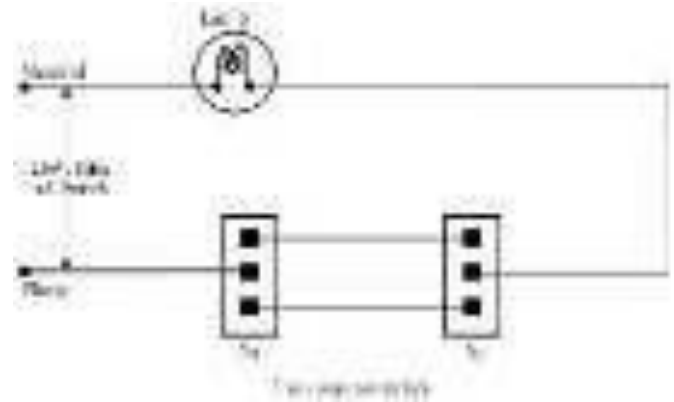
PVC wire of sufficient length 5-no, Two-way switches, bulb holders, ceiling rose and bulb.

**Tools and equipment used:**

1. 6'' cutting pliers,
2. 6''screwdrivers,
3. Wire stripper
4. Tester

**Operations to be carried out:**

1. Fitting the wires
2. Connection of the bulb holder
3. Connection of switches
4. Circuit-connection
5. Power from mains
6. Operating the lamp



**Procedure:**

A phase wire is taken and its one end is connected to the middle point of two – way switch, S1. While the other end is connected to the phase point of main supply. Another phase wire (second wire) is taken and used for connecting the lower points of the two switches S1; S2. The third phase wire piece is taken and is connected between the middle point of S2 and one of the points of the bulb holder. A neutral wire piece is taken and its one end is connected to the remaining points of bulb holders, while the other end is connected to main supply. Now the glowing of the bulb is controlled by two way switches.

**Precautions:**

1. All wire connections to the switches and bulb holders should be right.
2. Always red wire should be used for phase and black for neutral.
3. Too many load connections from a single junctions are avoided
4. Switch should be connected in phase only.

**Result and conclusion:**

Stair case wiring (i.e. control of one lamp by two switches fixed at two different places) is done.

S.No.	S1	S2	Lamp
1	Up	Up	Bright
2	Up	Down	Off
3	Down	Up	Off
4	Down	Down	Bright

**EXPT NO: 4 CONTROLLING TWO LAMPS BY TWO INDEPENDENT SWITCHES**

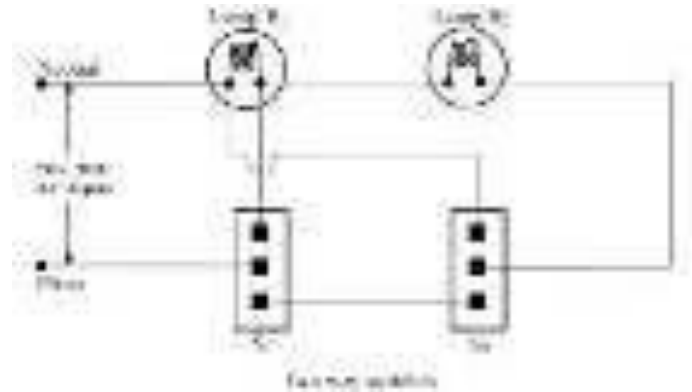
**DATE:**

**Aim:** To control two lamps by two independent switches located at two different places.

**Materials required:** 1/18" PVC wire of sufficient length 5-no, two way switches, bulb holders, ceiling rose and bulbs.

**Tools and equipment used:**

1. 6" cutting pliers,
2. 6" screwdrivers,
3. 1.5 lb ball-peen hammer
4. Hacksaw
5. Wire stripper
6. 12mm handdrilling machine
7. Tester



**Operations to be carried out:**

1. Fitting the wires
2. Connection of the bulb holder
3. Connection of switches
4. Circuit-connection
5. Power from mains
6. Operating the lamp

**Procedure:**

Five phase wire pieces are taken and insulation is removed at the ends by wire stripper. The first phase wire is connected by seconds phase wire. The middle point of switches S2 is connected to one point of bulb holder "B2". By using another phase wire the remaining point of the bulbholder "B1". At the same point of bulb "B1" a phase wire connected to the upper point of switch "S1". Two neutral wire pieces are taken and connected to the remaining point of bulbholder "B1". One of it is connected to the main supply. After checking the proper circuit connects the power supply is given to switches. Now the bulbs are ready to show bright and dim.

**Precautions:**

1. All wire connections to the switches and bulb holders should be right.
2. Always red wire should be used for phase and black for neutral.
3. Too many load connections from a single junctions are avoided
4. Switch should be connected in phase only.

**Result:**

Controlling of two lamps by two independent switches located at two different places is done.

S. No	S1	S2	L1	L2
1	UP	DOWN	BRIGHT	OFF
2	UP	UP	BRIGHT	BRIGHT
3	DOWN	UP	OFF	OFF
4	DOWN	DOWN	DIM	DIM

**EXPT NO: 5**

**FLUORESCENT LAMP WIRING**

**DATE:**

**Aim:** To prepare the "Fluorescent Lamp".

**Materials required:**

1/18" PVC wire of sufficient length 5-no, one-way switch-1, starter-1, choke-1, fluorescent lamp, holders with frame.

**Tools and equipment used:**

6" cutting pliers, 6" screwdrivers, 1.5 lb ball-peen hammer, Hacksaw, Wire stripper, 12mm hand drilling machine, Tester

**Operations to be carried out:**

Fitting the wires

Connection of the fluorescent lamp

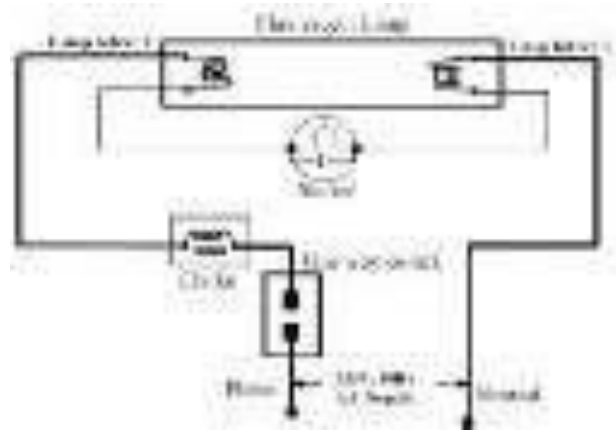
Connection to choke

Connection of switches

Circuit-connection

Power from mains

Operating the lamp

**Procedure:**

6" PVC wire pieces are taken and insulation is removed at the ends by using wire stripper. A phase wire is connected to one point on the switch. The other point of the switch is connected to Choke. The other point of the Choke is connected to one point of the starter and the other point of 1 amp holder-1. The other point of the lamp holder-1 is connected to one point of the Starter. A neutral wire pieces taken and connected to one point of the lampholder-2. The other point of the lamp holder-2 is connected to Remaining point of the Starter. After checking proper circuit connections the power supply is given. Now the lamp is ready to glow.

**Precautions:**

1. All wire connections to the switches and bulb holders should be tight.
2. Always red wire should be used for phase and black for neutral.
3. Switch should be connected in phase only.
4. The switches must be in off position before giving power supply

**Result:** Operating the fluorescent lamp is done.

**EXPT NO: 6**

**GODOWN WIRIN**

**DATE:**

**Aim:** To prepare a Godown wiring circuit with PVC conduit wiring system.

**Materials required:**

PVC wire of sufficient length 5-no, Two-way switches, bulb holders, ceiling rose and bulb,

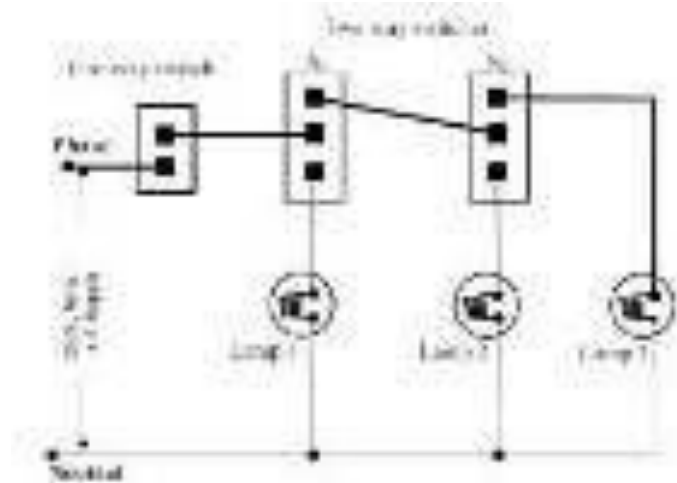


**Tools and equipment used:****Operations to be carried out:**

1. Fitting the wires
2. Connection of the bulb holder
3. Connection of switches
4. Circuit-connection
5. Power from mains
6. Operating the lamp

**Procedure:**

A phase wire is taken and its one end is connected to the middle point of two – way switch, S1. While the other end is connected to the phase point of main supply. Another phase wire (second wire) is taken and used for connecting the upper points of the two switches S1 with middle point of switch S2..The third phase wire piece is taken and is connected between the upper point of S2 and one of the points of the bulb holder .A neutral wire piece is taken and its one end is connected to the remaining points of bulb holders, while the other end is connected to main supply. Now the glowing of the bulb is controlled by two way switches.

**Precautions:**

5. All wire connections to the switches and bulb holders should be right.
6. Always red wire should be used for phase and black for neutral.
7. Too many load connections from a single junctions are avoided
8. Switch should be connected in phase only.

**Result and conclusion:**

GD wiring is done.