QMP 7.1 D/F

Channabasaveshwara Institute of Technology

(An ISO 9001:2008 Certified Institution)

NH 206 (B.H. Road), Gubbi, Tumakuru – 572 216.Karnataka.

Department of Mechanical Engineering

Work Shop Practice

15WSL16/26

I/II Semester

Lab Manual 2016 -2017

Name: _____

USN: _____

Batch: _____ Section: _____

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Department of Mechanical Engineering

Work Shop Practice

Version 1.0

August 2016

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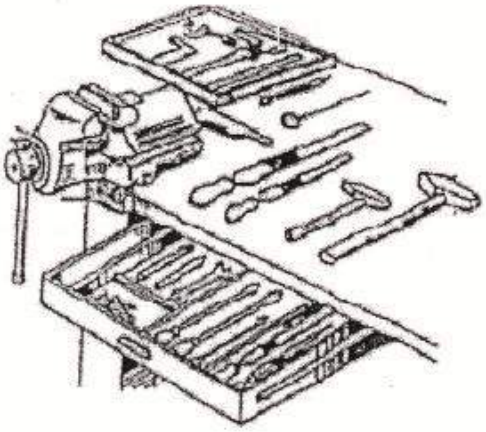
Professor & Head,
Dept. of ME

+ SAFETY IN SHOP +

Observe the following safety to avoid injury to your self and co-workers

1. Be well dressed i.e., avoid loose garments, roll up sleeves, put on suitable footwear and remove watch and ring.
2. Keep the work place neat and clean i.e., place the tools at proper position. The scraps and chips should be dropped in waste bins.
3. Concentrate on your job and avoid talking with co-workers.
4. The shops are no place to play. Running and pushing in the shop may cause accidents.
5. Understand the use of tools and machines before handling.
6. Never use dull tools. The use may damage the tools completely or may lead to injury.
7. In case you are in doubt contact the instructor.
8. Always chuck the fitting of the handle in the hammerhead.
9. Be familiar with the locations of First Aid Box and Fire Extinguisher in the shop. In case of emergency one should reach them quickly.
10. Laziness and carelessness are your deadly enemies. Always be active and careful in the shop

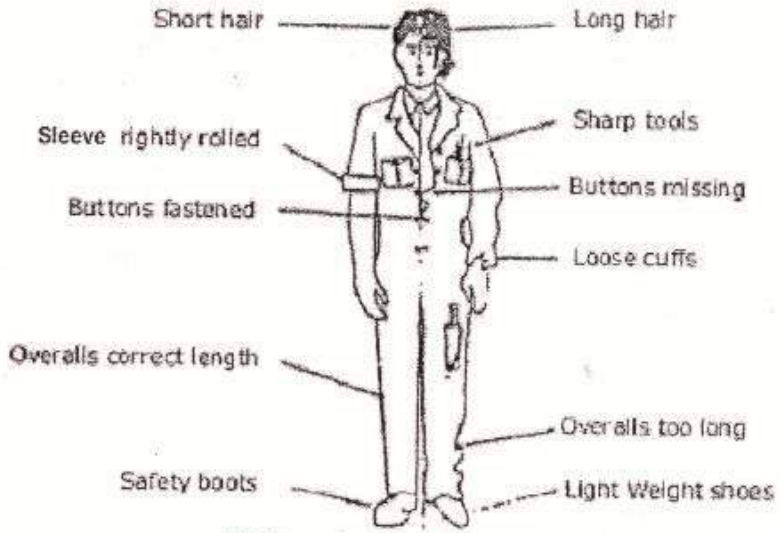
SAFETY FIRST – WORK NEXT



Arrangement of the working place

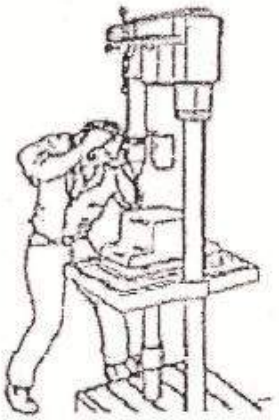


Sharp tools carried in pockets may inflict injury

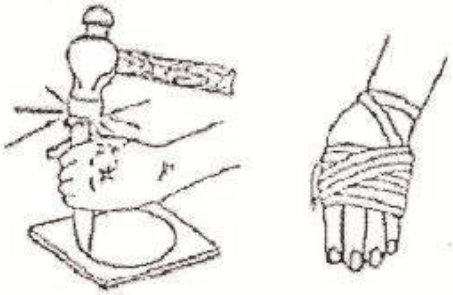


Right and safe | Wrong and dangerous

DRESS



The hazard of long hair



Mushroomed heads when hit with hammer produce chips which fly at bullet speed and injure

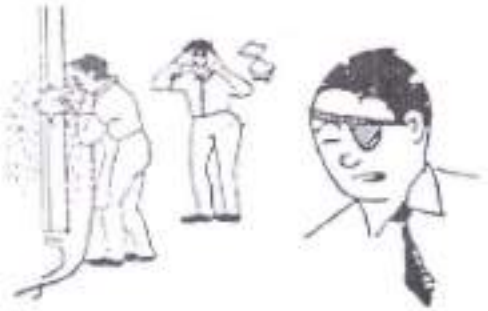
PREVENTION IS BETTER THAN CURE



Do not clamp the work with excess effort. It will damage the work / vice.



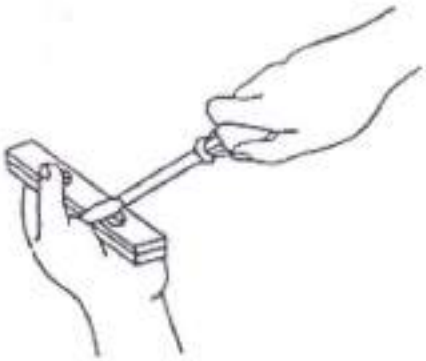
Hammers not properly secured are extremely dangerous.



Seeing the electric arc without the shield will burn your eyes.



Files used without handles may injure the hand.



Using screw driver with work held in hand may slip and cause a serious wound

SYLLABUS

WORKSHOP PRACTICE LAB

Sub code: **14WSL16/14WSL26** IA Marks: 25
Hrs / Week: 03 Exam Hours: 03
Total Hours: 42 Exam Marks: 50

Course Objectives:
Students belonging to all branches of Engineering are trained in understanding fundamental metal removing process like fitting and joining processes like welding and soldering.

1. **Demonstration on use of Hand Tools**: V- block, Marking Gauge, Files, Hack Saw, Drills, Taps. Two Models showing the joints using the above tools.

2. **Welding:** Study of electric arc welding tools & equipments, Models: Butt Joint, Lap Joint, T- Joint & L – Joint.

3. **Sheet metal & soldering work: Development & soldering of the models:** Frustum of Cone, Prisms (Hexagon & pentagon), Truncated Square Pyramid.

4. Study & Demonstration of power tools in Mechanical Engineering.

Course outcomes:
Students will demonstrate the knowledge and the skills acquired with respect to
1. The metal removal process by fitting practice and preparation of joints using appropriate fitting tools.
2. Preparation of welded joints.
3. Development of surfaces and forming models by soldering work.

Scheme of examinations
Fitting/ Sheet Metal Work: 30 marks(50% of the batch to be given fitting and remaining 50% to be given Sheet Metal work including soldering

1. Fitting/ Sheet Metal		: 30 Marks
2. Welding		: 10 Marks
3. Viva voce		: 10 Marks
	Total	: 50 Marks

Reference Books:

1. Elements of workshop Technology: Vol 1: Manufacturing Processes, S K Hajra Choudhury A, K Hajra Choudhury, 15th Edition required 2013, Media promoters & publishers Pvt Ltd, Mumbai.

Note: No mini drafters and drawing boards required. Drawings (Developments) can be done on sketch sheets using scale, pencil and geometrical instruments.

Engineering:-

- Engineering is a professional art of applying science and technology to optimize the conversion of natural resources to the benefit of mankind. (Natural resources available in the universe are Iron ore, Air, Sun, Water, Space, Human etc.)
- Human resource is a supreme strength to develop Engineering to contribute the welfare and progress of the society or to this nation.

Engineer:-

- Engineer is a person having creative thoughts and ideas to develop technology for the noble cause of the society or to nation.
- All objects begins an idea, Conceived and visualized by the Engineer. He makes an internal representation of the object in his mind and communicates it to others through media of expression.

Professional activities of an engineer:

1. Planning: (Proposal of doing something)

- It means a set of preparation is to do in order to achieve something or any kind of task/work. (Preparation means programmes, drawings, Materials requirement and their sources, time schedule, cost estimate, scheme and design and method of preparation etc.)
- It is a management function of defining goal of an individual / organizations.
- It determines the task/work and resources necessary to achieve set goals.
- It helps to save materials, labor, time, money efforts and process etc. so that any kind of work/task can be performed successfully without having any difficulty with full confidence.

2. Visualization (related to vision / creating picture in mind)

- It is a behavioral technique of improving performance of his individual.
- It encourage for creating metal picture for successful execution of any work.

3. Hard work and practice (doing something repeatedly)

There is no substitute for hard work. A spiritual person says that "Work is Worship", "Practice makes the man perfect". Practice makes a person to acquire skill to use their knowledge for gaining self assurance and confidence to handle any kind of work without any difficulty.

4. Punctuality (being in time):

Punctuality is a moral goodness, which is to be practiced very well punctuality is nothing but courtesy to others. By being punctual you respect the value of time of others. This is more than anything else. It helps you to plan your activities and schedule with precision and efficiency.

5. Work place Environment:

Workplace environment is to be maintained neat and clean, and spread happiness, cheerful, love & affection around your work place, at home and also to the community.

6. Efficiency: It is the ability to do what ever we expected of us as promptly accurately and economically as possible.
These activities are to be performed by an engineer to maintain quality and integrity for successful execution of any task & to face the challenge of globalization.

Workshop:-

It is a place of work for preparing variety of jobs/products by using different kinds of Instruments, hand tools and Machines.

In order to prepare the products in W/s, the w/s is divided in to many branches according to nature of work.

Ex: 1.Fitting shop
2. Welding shop
3. Sheet metal shop
4. M/c Shop
5. Foundry & Forging shop etc

What are the information required to prepare the product?
It is a common experience that when we want to prepare any product, the following information are required.

1. Actual Shape
2. Accurate Size
3. Manufacturing Method

Before taking up the construction of a product, the person who prepares it must have a clear picture of the shape and size of the object in his mind and to know the method of manufacturing process for successful execution of the work.

Engineering Drawing:-

A graphic form of representation of an object which contains all the necessary information like actual shape, accurate size, manufacturing methods etc. required for construction of an object is called Engineering Drawing. It is prepared on certain basic principles, symbolic representation, standard conventions, notations etc.

Engineering drawing is said to be the language of an engineer and it can be considered as a powerful tool to convey his ideas.

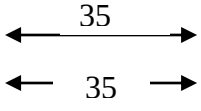
In Engineering, it is a practice to record ideas in the form drawing. Since engineering drawing is a graphical medium of expression of all technical details without the barrier of word language. It is also called the universal language of an engineer.

1. Orthographic projection or view. : 2D

2. Isometric projection or view. 3D

Elements of Dimensioning

1. Aligned system.



2. Uni-directional systems

Line Conventions:

1. All visible out lines, edges are drawn in bold, i.e. thick continuous lines.
2. Dimension lines, projection line, leader lines are drawn thin continuous.
3. Arrowhead and dimension figure are shown thick.

Free hand Sketching:

1. Drawing of 2D/3D sketches is drawn using only pencil and eraser is called Free Hand Sketch.
2. Designers, teachers/ instructors and artists use this for immediate graphical communications.
3. To start with Graph/grid sheets help in practice well
4. The parallel horizontal lines are to be drawn from left to right by right handed people and right to left from left handed people.
5. Vertical lines are to be drawn from top to bottom.
6. Inclined lines are to be drawn from lower left to upper right.
7. Small arcs, circles and ellipses may be drawn in one motion on a trial basis.
8. Big circles and ellipses may drawn by box method.

Prime use of free hand sketches:

1. To serve teaching aid during discussion in class rooms.
2. To prepare tabular column.
3. To sketch circuit diagram of electrical engineering problem.
4. To prepare the layouts of laboratory, Buildings & Production shops etc.
5. To convey information regarding repair of machine on spot.
6. To help the designer is developing new ideas.
7. To covey the idea's of the designer to the draughtsman, management etc.
8. To serve as a basis for discussion between engineers and workmen in the shop floor.

Orthographic View or Projection or 2 D:-

In the orthographic projection, two or more number of principle views are drawn to show the shape and sizes of an object.

Front View

The object is viewed or seen from the front, the shape & size formed in **Vertical Plane** is called the Front View or Elevation.

Top View

The object is viewed or seen from the Top, the shape & size is formed in **Horizontal Plane** is called Top View or PLAN.

Side View

The object is viewed or seen from the left or right, the shape & size is formed in **Profile Plane** is called Left or Right View.

NOTE: To obtains the view of an object to same size. The visual rays should run on parallel to each other and perpendicular to plane of projections.

All Orthographic views are two dimensional

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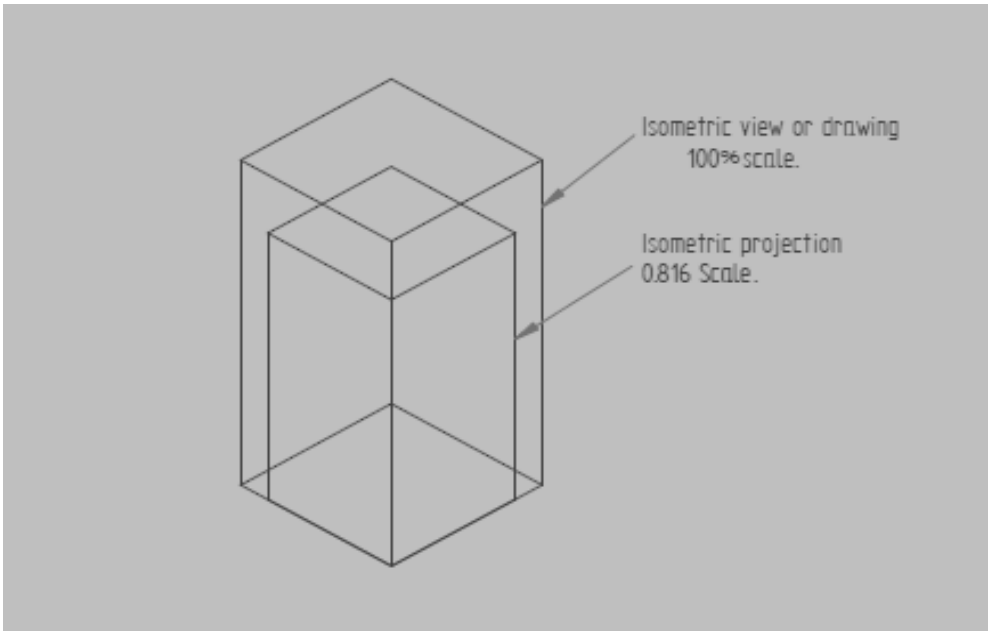
ISOMETRIC PROJECTION (OR) Pictorial drawing:-

- Isometric projection is a 3D (pictorial) view.
- It enables the observer not only see the three dimensions of an object in a single view but also measure them directly.
- This is used to convey information to persons, who cannot visualize an object from 2D views and also to show complicated structures such as Air Craft, Rocket cell, **Service manual** layout of pipelines, assembly and disassembly of parts required in maintenance.

ISOMETRIC CONSTRUCTION:-

When once the Orthographic projection are drawn using isometric scale, then simply transferred the distances from the orthographic views to get the isometric projection.

Differences between isometric projection & isometric view or drawing



FITTING

It is the process of removing unwanted material with the help of hand tools, from a given stock for making a component or fitting pair.

Fitting Operations

Fitting work involves a large number of hand operations to finish the work to desired shape, size and accuracy.

Some common fitting operations:

1. Measuring
2. Marking
3. Punching
4. Drilling
5. Reaming
6. Boring
7. Counter Boring
8. Hack sawing
9. Chipping
10. Filing
11. Scraping
12. Tapping
13. Dieing
14. Grinding

1. Measuring : It is a process of finding the dimensions of the work piece by using steel scale, calipers, micrometer, gauge etc.

2. Marking : Making a series of definite lines on the job. These lines act as guidelines to the fitter who works on the job.

3. Punching : It is the operation of making series of dent or punch marks on the line of marking using center punch and ball peen hammer.

4. Drilling : It is the operation of producing holes in the solid materials using Drilling Machine with suitable drill bit.

5. Reaming : It is the operation of smoothening the inner surface of the drilled hole with a reamer.

6. Boring : Boring is the operation of enlarging the size of Previously drilled hole.

7. Counter Boring : It is the operation of increasing the size of the hole at one end through a small depth using counter bore tool.

8. Cutting or Hack Sawing : It is the operation of cutting flat, round rods, pipes etc. using hacksaw frame with suitable blade.

9. Chipping : It is the operation or removing thick layer of metal using cold chisel.

10. Filing : It is the operation of removing thin layer of metal using using different types of files.

11. Scraping : It is the operation of producing a precision surface or smooth a accurate surface. This is done with tools called scrapers, which have very hard with no rake.

12. Tapping : It is the operation of cutting internal threads with a thread cutting tool called taps. Drill size for taping= size of the tap- pitch of the thread.

13. Dieing : It is the operation of cutting external threads using die set.

14. Grinding : Grinding is the process of removing metal using grinding wheel. Grinding is a finishing operation used for accuracy and smoothness. The accuracy in grinding is in the order of 25 microns.

What is the need for maintenance of machine and equipment?

It is necessary to properly maintain machine and equipment to obtain long life of machine. Maintenance can be done by cleaning of machines, oiling of various parts of machines and by regular maintenance done daily, weekly, monthly or yearly. The life of machine will increase it will avoid the sudden breakdown and machine will not stop and by this production can be increased.

What are the advantages of preventive maintenance? Describe.

Preventive maintenance means planning and scheduling the maintenance in advance.

1. To avoid sudden breakdown of machine
2. Damage of costly parts is avoided
3. Shut down of production is avoided
4. Longer life of equipment is ensured
5. Possibility of serious accidents is minimized
6. Preventive maintenance is less cost than breakdown maintenance
7. Preventive maintenance can be planned in advance.

What are the benefits of workshop practice?

1. This practice help in proper “Planning” and time scheduling of work while preparing an object as it avoids unnecessary waste of time, material money and efforts and process.

2. It help in “Visualizing “the actual shape and size of the object.

3. The ability to read and draw the orthographic (2D) and Isometric projections (3D) as it improve s the communication skill through “Graphic language”. (media of expression)

4. To know the name specification use and other details of "hand tools', "instruments" and "machines".

5. It helps in learning a systematic working procedure 'Work style and culture" as it improves quality of work and for improving performance of body language.

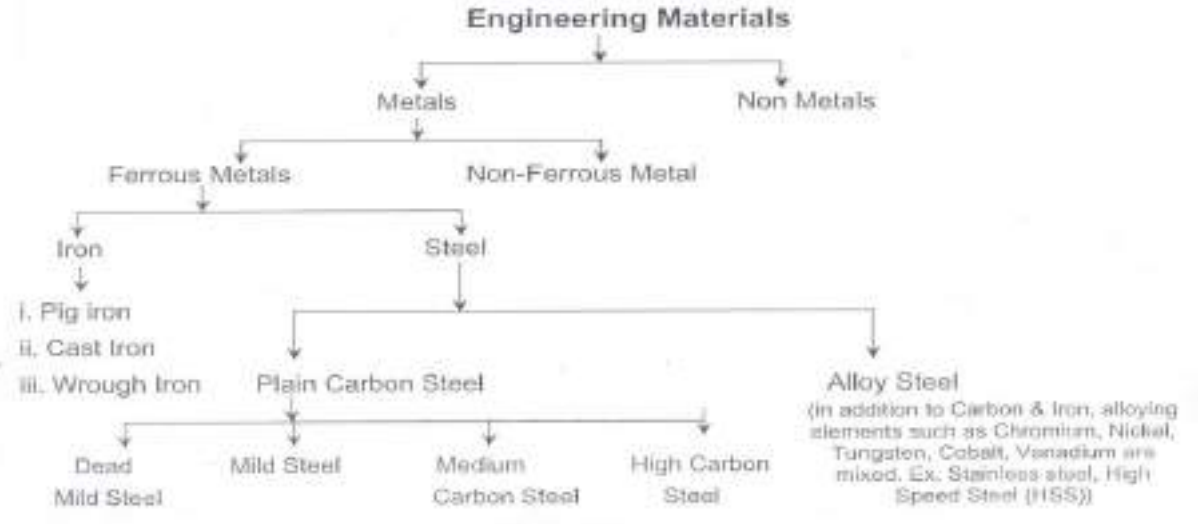
6. The hard work and practice make the person to become more active, efficient, smart and talented.

7. It helps to follow the work safety rules regulations to avoid injury and accident himself.

8. It is providing information in engineering work as it improves personality development and self discipline.

WHAT ARE ENGINEERING MATERIALS?

Materials which are used in the Engineering practice/purpose are called engineering materials. These have Physical, Mechanical and Chemical properties.



METALS:
A metal is a solid (Expect Mercury) having weight. It is opaque and a good conductor of heat and electricity.

NON- METALS:
These available in the form of liquids, gases or solids such as Wood, Stone, Rubber, Plastic, Ceramic, Concrete, Asbestos etc.

FERROUS METALS:
Iron containing metals such as pig iron, wrought Iron, Cast Iron, Steel, Carbon Steel, Nickel Steel etc, are called ferrous metals. These can be attracted by magnets and are susceptible to rusting.

NON- FERROUS METALS:
Metals like Gold, Silver, Copper, Aluminium, Tin, Platinum, Zinc, neither rust nor can be attracted by magnets.

IRON:
Metal like Pig Iron, Cast Iron, Wrought Iron containing small percentage of carbon with Graphite, Silicon, Manganese, Sulphur & Rest Iron.

STEEL:

It is an alloy of iron and in addition there are minute percentage of Silicon, Phosphorus, Sulphur and Manganese.

ALLOY STEEL:
In addition to iron and Carbon, alloying elements such as chromium Nickel, Tungsten cobalt, Vanadium are mixed. Ex. Stainless Steel (SS), High Speed Steel (H.S.S)

FERROUS METALS, COMPOSITION AND THEIR USES

Sl. No.	METALS	MAIN COMPOSITION (General)	USES
1	Pig Iron (White pig Iron) (A Product from Blast Furnace)	0.3 - 2% C with graphite and small percentages silicon sulphur, phosphorus and manganese	To produce cast Iron and wrought Iron. Also used in Iron Foundry for common jobs
2	Cast Iron (A product from cupola, a mini blast furnace) There are 7 types. Important are grey C.I., White C.I Malleable C.I. Alloy C.I. and Chilled C.I.	1-4 % Iron carbide and 2-4% graphite 2-3% silicon and with traces of, manganese, phosphorus and sulphur, rest iron.	To manufacture castings like Frames, machine beds, engine cylinders, pistons piston rings etc.
3	Wrought Iron (Pure Iron) (A product by puddling process or Aston process)	99.8 % Pure iron, 0.01 – 0.02% carbon (With slag behind)	To manufacture chain links, crane hooks, water pipes, Nails and Farming Implements.
4	Dead mild steel (Forging steel)	0.05 – 0.1 % Carbon	Chains, Rivets, Nails, Pipes and materials subjected to drawing and pressing
5	Mild Steel (Low Carbon Steel) Medium carbon steel	0.1 – 0.3 % Carbon 0.3 – 0.8 % Carbon	Wires, Iron Sheets, Angles, Fasteners etc., Shafts, drop forgings, chasis of vehicles, ordinary tools, Leaf springs, wheels of railway trains etc.
6	High carbon Steel	0.8 – 1.5 % Carbon	To manufacture Cutting tools for woods. Milling machine, Lathe, Hammers, dies for forging & Pressing machine, Centre punch, drifts, drills, reamers, Files, gauges thick sheets, shearing machine blades etc.
7	Stain Less Steel	Less than 1% Carbon, 8% Nickel 18% chromium and rest iron.	Daily use utensils, surgery equipments, shaving blades, Fine cutting tools, parts of automobile and aircraft.
8	High Speed steel (H.S.S) (Tool Steel)	14-18% Tungsten; 4% Chromium 1 – 1.5% Vanadium 2 - 3 % Cobalt upto 1.0% Carbon, rest iron	To manufacture Lathe Cutting tools, Drills, reamers and milling Cutters, to cut at speeds 50-80 m/min.

FITTING TOOLS AND INSTRUMENTS

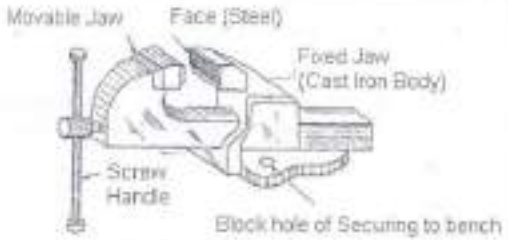
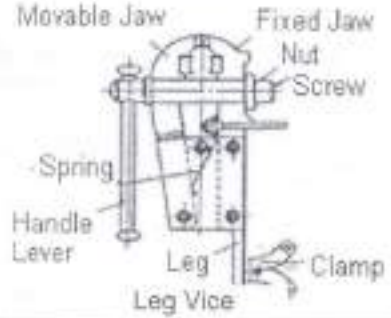
Holding Tools	Measuring Instruments	Marking Instruments	Punching Tools	Cutting Tools	Miscellaneous
Bench Vice Leg Vice Pipe Vice Drill Vice 'V" Block Tap Wrench	Steel Scale Out side Caliper Inside Caliper Divider Try Square Vernier Caliper Micrometer (Inside & Out side) Wire gauge Depth Gauge Feeler Gauge Radius Gauge Steel Protractor Pitch Gauge	Jenny Caliper Vernier height Gauge Surface gauge Granite surface plate Scriber	Centre Punch Ball peen hammer Anvil Number Punch Letter Punch Smith hammer	Hack Saw Chisels Files Scrapers Drills Reamers Taps & Dies Bolt cutters	Cutting Player Screw driver Nose Player D.E spanner Ring Spanner Allen Keys Adjustable spanner

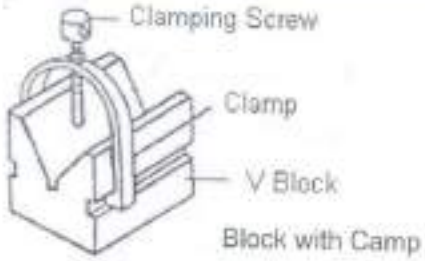
Instruments: The devices used for measuring and inspection are called instrument. Eg. Calipers, Micrometer, Gauges etc

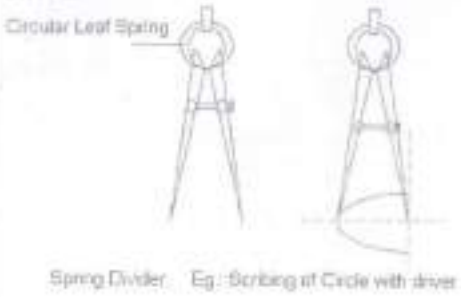
Hand Tools: The devices used for preparing the job with various operations by hand are called hand tools.

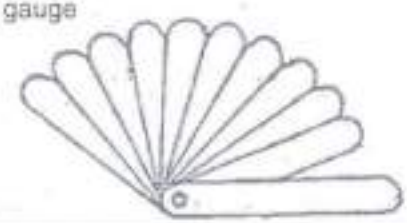
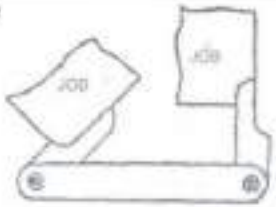
Machine Tools: The devices used for making various operations with machines like, lathe, milling m/c, etc.

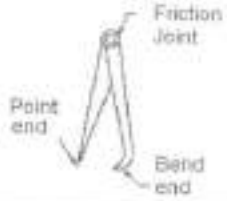
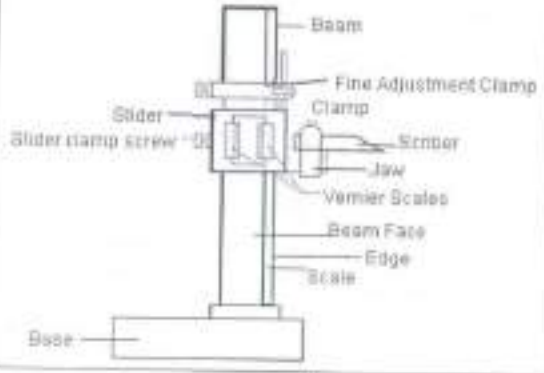
Holding Tools

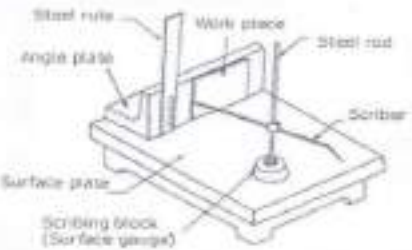
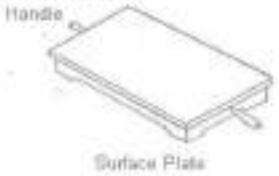
Sl. No.	Tools	Specification	Materials	Uses
1	 Bench Vice	**Maximum width of jaws :** 75 mm to 300 mm	Body : Cast iron Screw spindle: medium carbon steel Jaws : Tool steel Caps : To finished surfaces, Al, Cu, or Brass to be used.	Bench vice is used to hold the job firmly & carry out different operations like Filing, Hacksawing, Tapping, Dieing, and Chipping etc.
2	 Leg Vice	**Maximum width of jaws:** 75 mm – 200 mm.	Body is made from forged steel and jaws are hardened steel	Leg vice is used in workshop while chipping, bending etc.
3	 Pipe Vice	**Maximum diameter of pipe :** Up to 150 mm	Body is made from forged steel and jaws are made from cast steel	It is used to hold pipe / rod while cutting and threading.
4	Machine Vice or drill Vice	Maximum width of jaw its available from 50 mm to 200 mm	Screw spindle : M.S., Jaws : Tool Steel Body is made from cast iron	Machine vice used in workshop while drilling, reaming , etc.

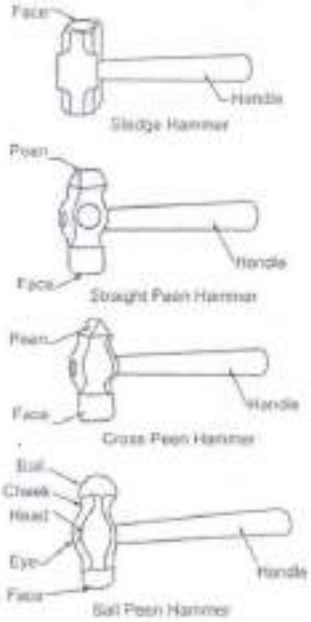
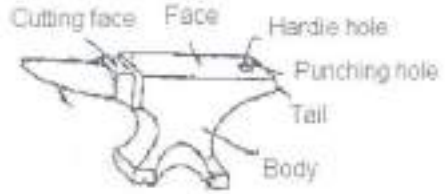
Sl. No.	Tools	Specification	Materials	Uses
5	 Block with Camp	Size of 'V' Block Length x Square Eg. 75 x 50 x 50	Hardened steel or Cast iron	It is used for holding, supporting the work piece while marking and to find centre of round jobs.
6	Tap wrench	Size of tap holding : 3 to 25 mm	Medium carbon steel	Holding the taps & reamers.
	Measuring Instruments			
1	Steel Scale 	Available from 150 mm to 1000 mm	Stainless steel	It is used for linear measurement.
2	Out side caliper  Outside	Measured from the joint to the point. Available in sizes: 75 to 1500 mm	Tool Steel	It is used for measure the out side diameter and thickness of any job with the help of steel scale.
3	Inside caliper  Inside	measure from the joint to the point . Available in sizes : 75 to 1500 mm	Tool Steel	It is used for measuring inside diameter with the use of steel scale.

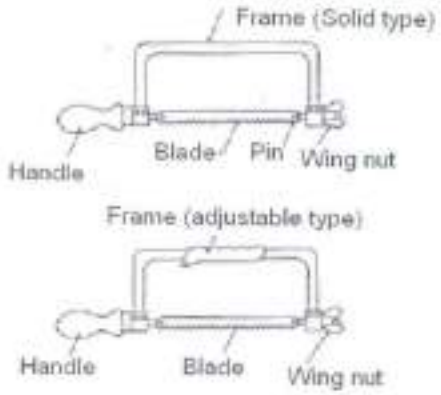
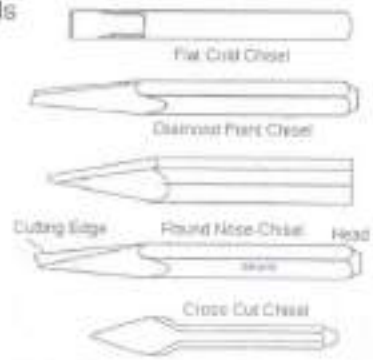
Sl. No.	Tools	Specification	Materials	Uses
4	Divider  Spring Divider Eg.: Scribing of Circle with driver	Measure from the joint to the point. Available in sizes : 75 to 1500 mm	Tool steel	It is used for construction of an Arc. circle & to Find the distance between two points.
5	Try square 	Length of blade will be the size. Available from : 75 to 450 mm.	Hardened Steel	It is used for check the squareness, surface level and perpendicularity
6	Vernier Caliper 	Metric: 150 to 300 mm, L.C. 0.02 British 6" to 12", L.C. 0.001"	Alloy Steel	Used for measuring outside, inside and depth of the job.

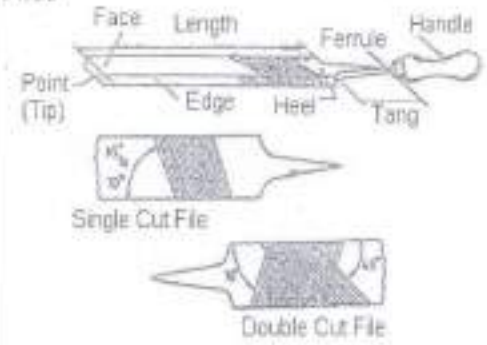
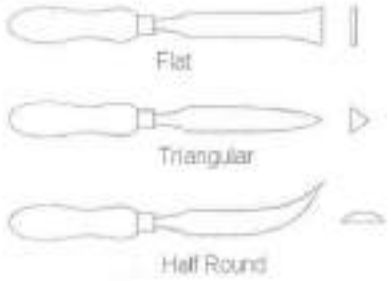
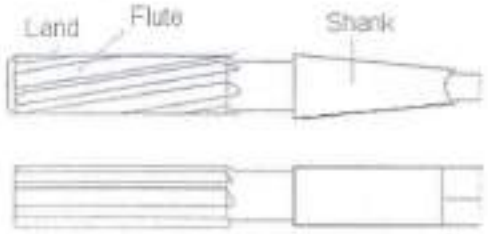
Sl. No.	Tools	Specification	Materials	Uses
7	Micrometer (inside and outside) 	i. Range of micrometer, Viz. 0-25 mm ii. Type of Micrometer, iii. Shape of Micrometer	Alloy Steel	Accurate measurement of out side, inside diameter and thickness.
8	Wire gauge	To measure from 0.19 mm to 7.62 mm (63 G – 1 G)	Stainless Steel	Used to find the thickness of sheet and diameter of wire both in gauge as well as in mm.
9	**Depth gauge** 	To measure from 1 mm to 300 mm	Stainless steel	It is used for measuring the depth of any job.
10	Feeler gauge 	Set of each 100 mm long blades to check the clearance.	Stainless steel	It is used for measuring the gap or clearance between two mating parts.
11	Radius gauge 	A set of 16 Convex and 16 Concave blade	Steel	It is used for measure the radius of concave and convex surface

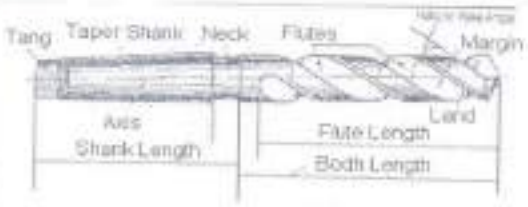
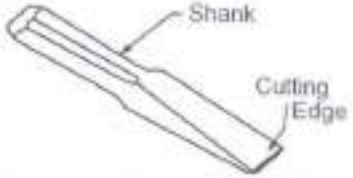
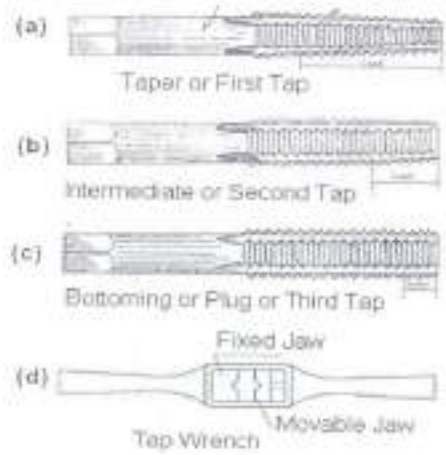
Sl. No.	Tools	Specification	Materials	Uses
12	Steel protractor 	0 – 180°	Kristeel	Used to set and mark 0 – 180°
13	Pitch gauge 	Metric : 0.4 to 7 mm British : 62 G – 8 G	Steel	Used to determine the pitch of the thread on a given bolt or nut
	Marking instrument			
1	Jenny caliper 	Measured from the joint to the point. Available in sizes 75 mm - 1500 mm	Tool steel	It is used for marking purpose. One leg for supporting and One leg for scribing.
2	Vernier height gauge 	Available from 150 mm - 300 mm L.C. 0.02 mm.	Body : Alloy steel Tip : HSS or Carbide	It is used for accurate marking of various jobs placing on surface plate and 'V' Block.

Sl. No.	Tools	Specification	Materials	Uses
3	Surface gauge 	Spindle size and base	Medium Carbon Steel	It is used for marking the work piece using steel scale & 'V' block placing on surface plate.
4	Granite surface plate 	Length x Beadth x Tickness 600 x 400 x 100 x grade 'A' Accuracy : 0.02 mm	Granite stone or Cast Iron	It is used for marking & checking surface of the job.
5	Scriber  Double Edge Scriber  Plain Scriber  Pocket Scriber - Open	Length of wire : 150 mm to 300 mm	Carbon tool steel, hardened and tempered	It is used for scribing lines.
	Punching tools			
1	Centre punch 	Length and dot thickness (t)	High carbon steel	It is used to punch a centre for a hole to be drilled.

Sl. No.	Tools	Specification	Materials	Uses
2	Ball peen hammer and smith hammer Cross peen hammers 	Hammer are classified according to the shape and weight i. Straight peen ii. ball peen iii. Cross peen etc. Weight from 0.2 kg to about 1 kg.	Tool steel The face and peen are heat treated to HRC 49 – 56 Made from structural and tool steel	It is used for driving the chisels, punches, number punchers, flattening, riveting, bending and similar operations.
3	Anvil 	Available sizes in from 25 - 200 kgs.	Wrought Iron Top Hardened and Tempered	Used for block smiths and work shops
4	Number punch	It is available in 1/16 " to ½ "	Drop forged steel, hardened finished in block designed.	It is used for making number punch

Sl. No.	Tools	Specification	Materials	Uses
5	Letter punches	It is available in sizes 1/ 16 " to ½ "	Drop forged steel Hardened finished in block designed	It is used for making letter punch.
	Cutting tools			
1	Hack saw 	i. Fixed type or adjustable of frame ii. Thickness of blade iii. Length and width of blade iv. No.of teeth as per nature of work. v. class of blade(hardened or flexible)	Tool steel Hardened and Tempered	It is used for cutting of the materials.
2	Chisels 	Wedge angle 30°, 45°, 60° and 70°. Lesser angle for soft materials and larger angles for hard materials	Tool steel (Hardened and Tempered)	It is used for cutting cold metals.

Sl. No.	Tools	Specification	Materials	Uses
3	Files 	Files are specified according to the length from point to heel, shape, grade from 20TPI to 100 TPI and cut of teeth (single, double, rasp, spiral & curve)	High Carbon steel	It is used for removing the thin layer of material
4	Scrapers 	Cross section with length and width Sizes : 100 to 400 mm long 5 to 30 mm width	High carbon steel or tool steel	It is used for removing high spot after filing.
5	Reamers 	According to their diameters (straight shank and taper shank)	High speed steel or High carbon steel	It is used for finishing the drilled hole.

Sl. No.	Tools	Specification	Materials	Uses
6	Drills  Taper Shank Twist Drill	Drills specification are i. size of drill ii. type of shank iii. Material iv. Special kinds (according to the shape of body of drill)	HSS or High Carbon Steel	It is used for making a hole on the material.
7	Bolt Cutter 	According to length x size of the bolt to cut. Eg. 300 x 6 mm	Body : Forged steel Blades : Tool Steel	Used for cutting bolts and Round rod.
8	Tap set & Die set  Taps and Tap wrench	According to diameter of M-1 to M-27 Dies in M-1 to M-27	Carbon Steel or High Carbon Steel or H.S.S.	Taps are used for cutting internal threads. Dies are used for cutting external threads.

Sl. No.	Tools	Specification	Materials	Uses
		Miscellaneous tools		
1	Cutting pliers	According to length Sizes available in 100 mm to 200 mm	Drop forged steel	It is used for Holding purpose, Wire twisting and Wire cutting.
2	Nose player	Specified total length. Available sizes from 100 mm to 200mm	Drop forged	It is used for electrical work and general work holding purpose
3	Double ended Spanners 	According to across flat on both ends Sizes available from : 6 x 7 mm - 30 x 32 mm	Drop forged Chrome vanadium steel	It is used for tightening and loosing of bolt and nuts.
5	Ring spanner	According to across flat on both ends Sizes available from : 6 x 7 mm - 30 x 32 mm	Drop forged Carbon steel	It is used for tightening and loosening of bolt and nuts.
3	Screw driver	According to specified total length. Available in sizes 108 mm to 577 mm	High Grade Steel and Transparent Green cellulose acetate handle	It is used for screws tightening or loosening.
6	Adjustable spanner	Available size form 150 – 300 mm	Drop forged, Chrome vanadium steel	It is used for tightening or loosening of small and big nuts/bolts.

TYPES OF FILES

Files are classified based on their cross section VIZ Hand file, square file, Round File etc., and type of cut Rough File, Smooth file etc., as follows.

TYPE	FORM	No. of teeth per 25 mm
Rough (R)		20
Bastard (B)		30
Second Cut (S-C)		40
Smooth (S)		50 - 60
Dead Smooth (D-S)		100 - 120
Super Smooth (S-S)		150 - 200

Grades of Files Based on Cut and No. of Teeth

Application of Files :

To finish different cross sectional surfaces, suitable files should be selected as follows,

1. Flat File – General work
2. Hand File – To file steps or shoulders
3. Pillar File – For key ways, slots & grooves
4. Warding File – To file narrow slots
5. Mill File – For forming the radius on saw teeth & in slots.
6. Square File – To file corners & slots
7. Triangular File - To file Square of shoulder & for
8. Round File – For opening out holes, slots, corners etc.
9. Half Round File – To file curved surfaces
10. Knife Edge File – To finish sharp corners of grooves & slots.
11. Needle File – For file work on sheet metal

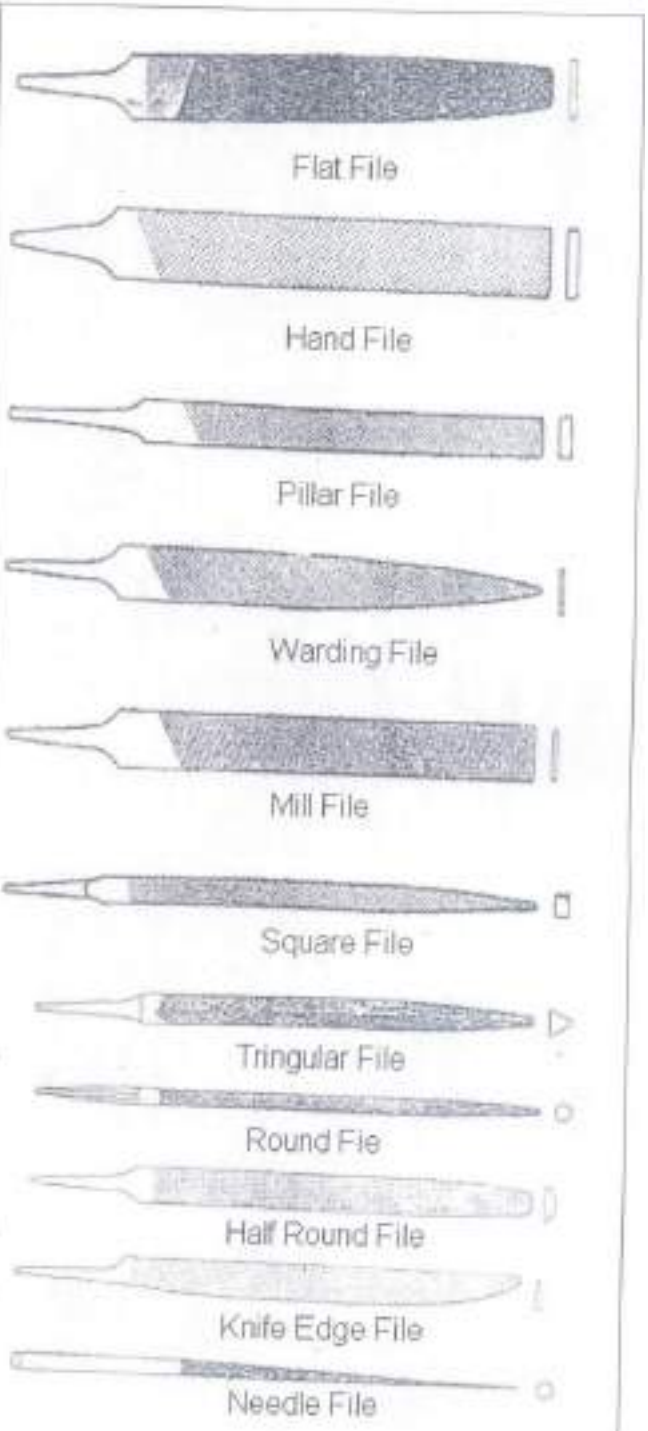
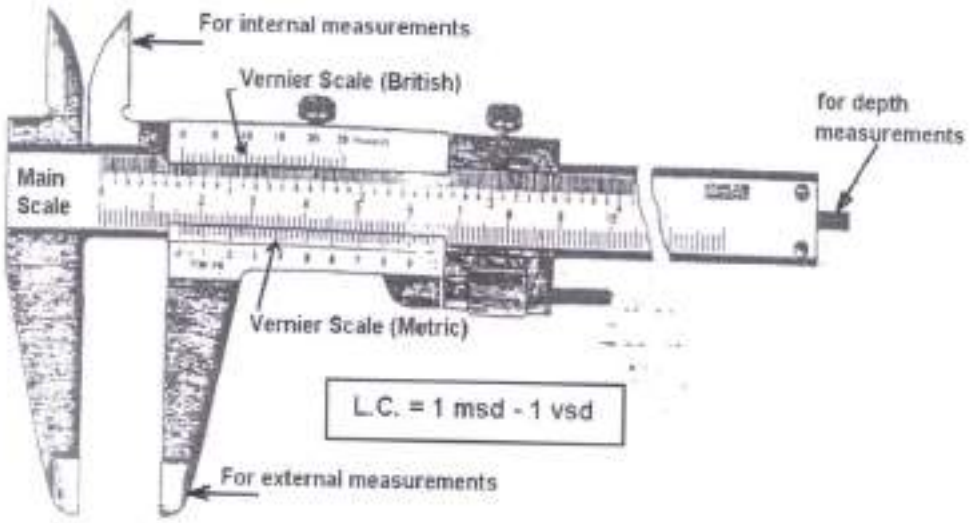


Fig. 1.38 Types of Files (Based on Cross Section)

Method of reading a Vernier Caliper



Note down the L.C. of the vernier caliper.

Generally its L.C. will be $\frac{1}{50}$ mm or **0.02 mm.**

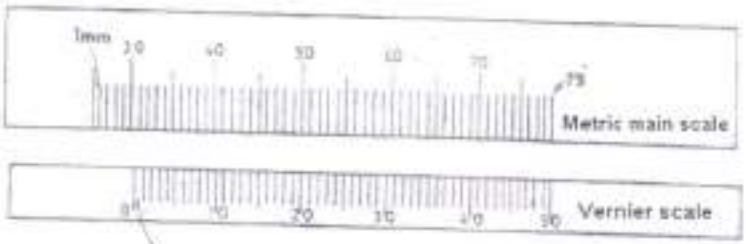
Case 1: Here 49 main scale divisions are divided into 50 Vernier scale divisions.

Value of 1 msd = 1mm

Value of 1 vsd = $\frac{49}{50}$ mm

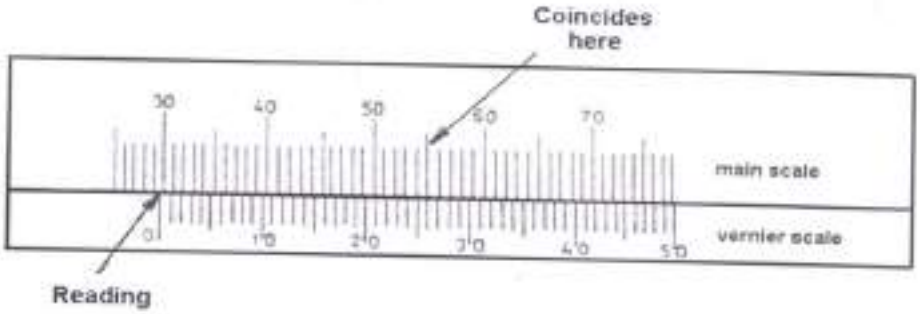
Least Count = 1 msd – 1 vsd

L.C. = $\left(1-\frac{49}{50}\right) mm = 0.02\ mm$



1 vsd = Value of each division on vernier scale = $\frac{49}{50}$ mm

Example



In a given example the zero of the vernier reads 29 mm on main scale.

The 26th division on the vernier coincides with the graduations on the main scale.

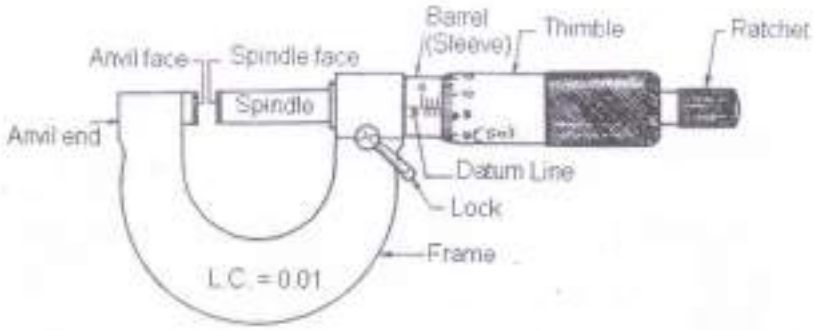
The value of the reading is

= 29 mm + 26 x value of L.C.

= 29 mm + 26 x 0.02 mm

= 29.52 mm

METHOD OF READING A MICROMETER



Micrometer

LEAST COUNT (L.C.): ***Definition:*** It is the least possible measurement that can be made with the instrument. It is the ratio of pitch of the spindle screw to the number of division on the thimble

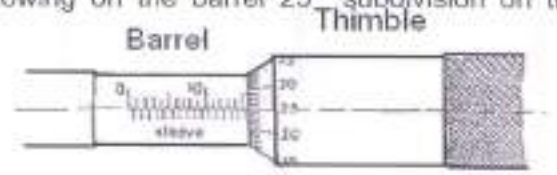
To read a micrometer

$$L.C. = \frac{Pitch\ of\ the\ Screw\ on\ the\ Barrel}{No.\ of\ divisions\ on\ the\ Thimble} = \frac{0.5\ mm}{50} = 0.01\ mm$$

1. Note the number of millimeters visible on the barrel
2. Note the number of divisions on the thimble which matches with the datum line. Multiply it from the L.C.
3. Add (1) and (2) to get final reading.

Example 1 (Fig. 1.40)

In this example there are 15.5 mm showing on the barrel 25th subdivision on the thimble lines up with the datum line.



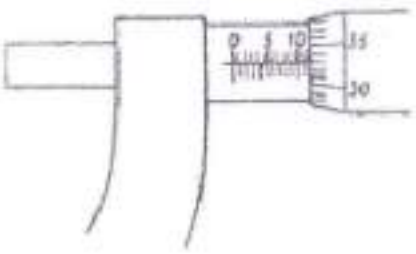
1) Reading on barrel is 15.5 mm
2) Reading on thimble is 25

   L.C. = 0.01 mm

   Total reading on Thimble = 25 x 0.01 = 0.25 mm
3) Final reading = (1) + (2) = 15.5 + 0.25 = 15.75 mm

Example 2 (Fig. 1.41)

1) Reading on barrel = 11.5 mm
2) Reading on thimble = 33 x 0.01 mm = 0.33 mm
3) Final reading = 11.5 + 0.33 = 11.83 mm



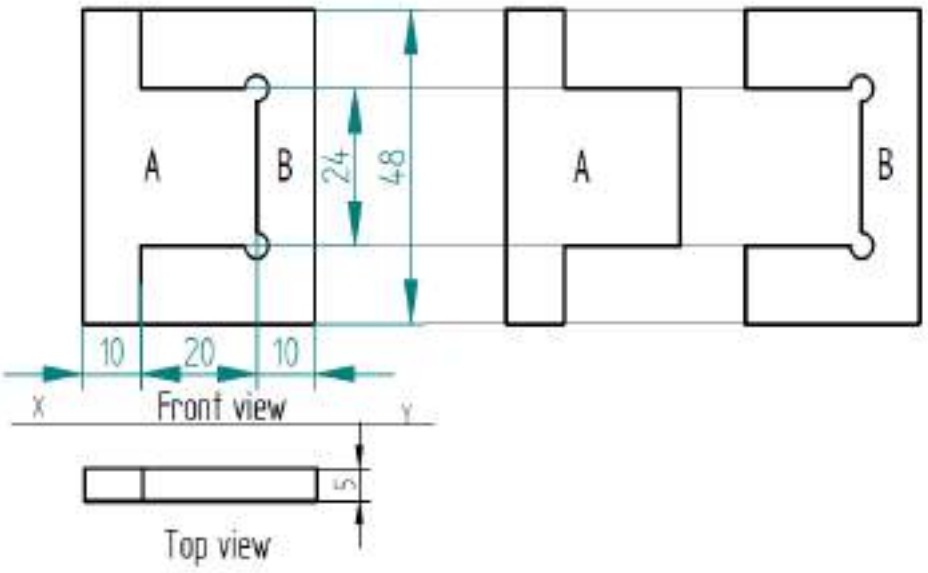
Sequence of operation and methods for preparing Fitting Models (Step by step procedure)

Sl no	Sequence of Operation	Method/ System adopted	Tools/ Equipments required to perform the operation
1	Sketching/ Drawing	Orthographic: 2D Isometric: 3D	Using all conventions, notations and symbolic representations
2	Sketching separately A & B Pieces	By Projection	Shift 'A' pieces to left side Shift 'B' pieces to right side
3	Note down the marking dimensions	By cumulative	i) 'A' piece from right to left ii) 'B" piece from left to right iii) Bottom to top for both 'A' & 'B'
4	Filling adjacent edges to correct level	Cross, draw and St. filling (To identify the reference line for marking	i) Hand file or flat file (300 mm rough) ii) Hand file or flat file (200 mm smooth) iii) Try square (150 mm) iv) Granite surface plate
5	Marking	Similar dimensions to be marked simultaneously to A & B	i) Vernier height gauge (300mm) ii) 'V' block iii) Diveder (150mm)
6	Punching	Punch (thin mark) with equal distance on the marked lines	i) Center punch (100mm) ii) Ball peen hammer (250mm) iii) Anvil (50kg)
7	Deep punching	Drilling purpose	i) Center punch(100 mm) ii) Smith hammer (500 gms0
8	Drilling	Machining process	Drilling machine 12.5 mm with 4 mm drill bit
9	Hack sawing or cutting	i) 'A' piece outside the punch mark ii) 'B' piece inside the punch mark iii) keeping 0.5mm away from punch mark iv) To fix line of cutting is perpendicular	i) Hack saw frame with suitable blade(12" or 300mm) ii) Teeth of the hacksaw blade in forward direction iii) Movement of hacksaw is straight iv) Apply pressure in forward stroke only
10	Chipping /Chiseling	Chipping/ chiseling on both faces on the anvil	i) Flat chisel (150 x 12mm) ii) Smith hammer (500 gms)
11	Filing	i) Punch mark is parallel to jaw plates of the vice ii) keeping the horizontal when filing iii) Finish filing operation up to half of the punch mark	Different shapes of files
12	Measurements	Inspection / Check	i) Vernier caliper (150mm) ii) Micrometer (0-25mm) iii) Temperature

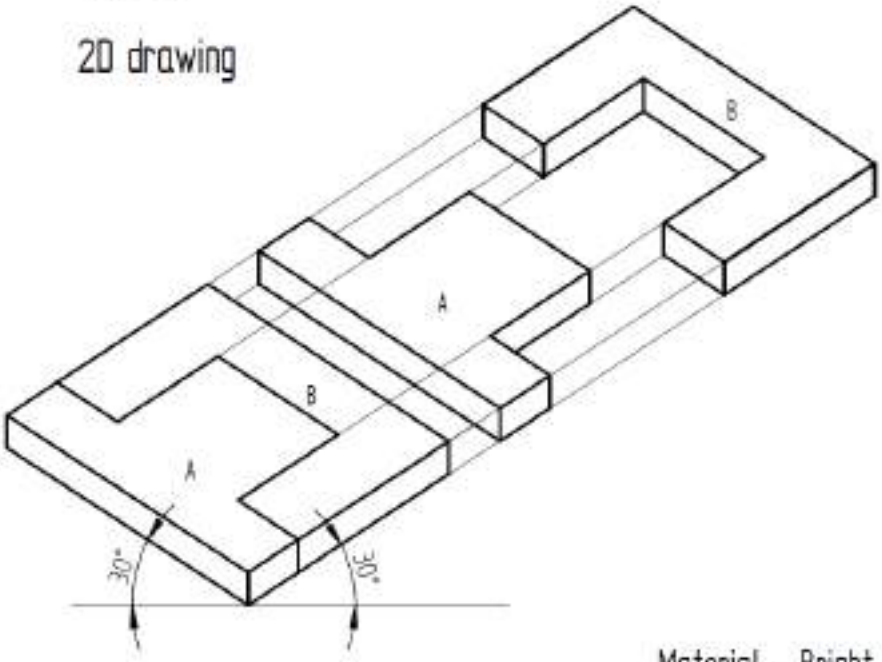
MODEL:-1

RECTANGULAR JOINT

XY Reference line,
Intersection of VP & HP.



2D drawing



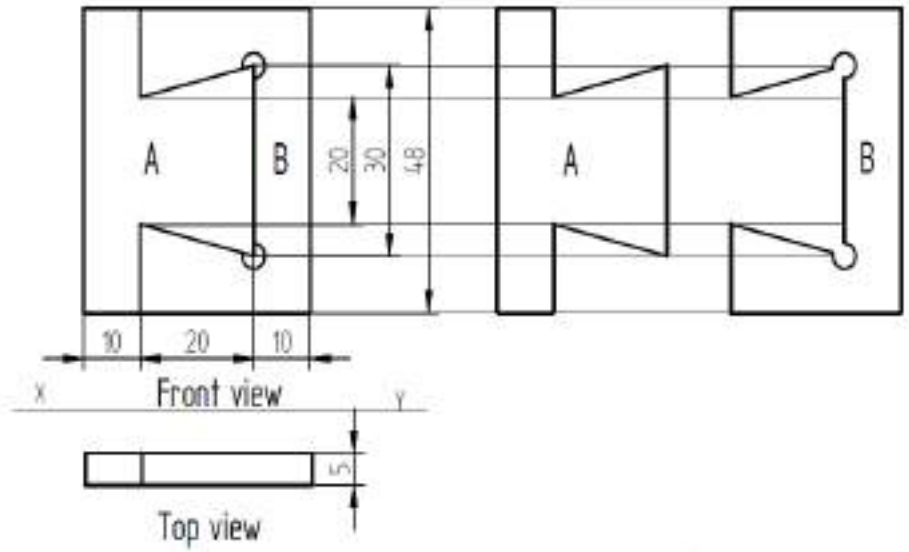
3D Drawing

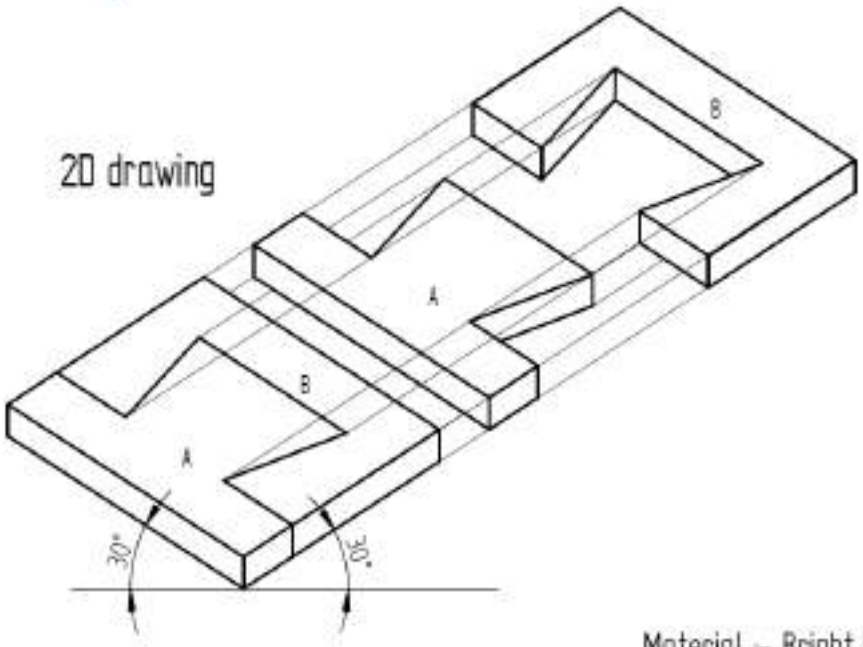
Material :- Bright Mild Steel
50x32x5-2 pieces
All dimenssions are in mm.

MODEL:-2

DOVETAIL JOINT

XY Reference line,
Intersection of VP & HP.





Material :- Bright Mild Steel
50x32x5-2 pieces
All dimenssions are in mm.

Sheet metal Work

To make a sheet metal object first the sheet has cut to a particular shape. Which is formed by laying its entire lateral surfaces one adjacent to the other on it and then after bending, forming, folding appropriately is finally joined by soldering, welding or riveting.

Sheet Metal Process:

1. Study of drawing
2. Developments
3. Patterns/ Template
4. Operation of sheet metals
5. Joining

Practical Applications

Many industries like automobile, aircraft, ship building, packing, air conditioning, ventilating system, fabrication of funnels, hoppers, bins, paint tins, trays, oil tins, buckets, storage tank, chimney boilers, involves sheet metal fabrication.

Development

The complete surface of an object is opened to one plane is drawn on paper provided with suitable allowances for seam and hem is called **Development.**

Methods of Developments:

1. **Parallel line method of development**: The surfaces of right prisms, cylinders, cubes, Rectangular Trays & Similar objects.
2. **Radial line method of development**: The lateral surfaces of right pyramids and cones may be developed by this method.
3. **Triangulation method of development:** The surfaces are made of a No of Triangular strips laid out in their true size. Ex. Square to round Rectangular to square etc.
4. **Approximate Method of development:** This method is used to draw the development of a sphere etc.

Pattern or Template

It is a metal sheet obtained by laying all the outer surfaces of the object together provided with suitable allowances for seam and hem is called **Pattern or Template.**

Metal used in sheet metal work

A large variety of metals are used in the form of sheet & plate. The specifications of metal sheets are given in terms of their gauge numbers and length & width.

The gauge number correspond to thickness of sheet is measured by using standard wire gauge. The higher the gauge no, the smaller the thickness and vice versa.

Common metal sheets used in sheet metal Work are:

1. B.P or H R Sheet (Black plain sheet or Hot rolled sheet)
2. C R sheet plain sheet (cold rolled sheet) – 0.1-0.3 % of Carbon
3. Galvanized plain sheet (Galvanizing Zinc)
4. Aluminum sheet

5. Copper sheet
6. Tin Sheet
7. Stainless steel sheet – (Alloy steel) contains 18%, Chromium 8%, Nickel less than 1% carbon rest is iron
8. Brass sheets

Sheet Metal Hand Tools

a. Measuring and Marking Tools:

1. Steel scale
2. Wire gauge, Micrometer, Vernier Caliper
3. Steel square
4. Scriber
5. Divider
6. Trammel point and

b. Cutting Tools

1. Hand snips or Tin Cutters,
(i) Straight snip (ii) Bend snip (iii) Combination blade hand snip and (iv)Circular snip

c. Punches:

(i) Prick Punch (ii) Solid Punch (iii) Centre punch and (iv) Hallow Punch

d. Chisels. (Flat, cross cut, diamond point, circular shape)
e. Stakes of different shapes.
f. Hammer, Mallets.
g. Files
h. Pliers
i. Soldering Iron

Sheet metal Operations

1. Measuring & Marking
2. Laying out
3. Cutting & shearing
4. Hand forming
5. M/c Shearing
6. Nibbing
7. Circle Cutting
8. Piercing and blanking
9. Edge forming Or wiring
10. Joint making Or seaming
11. Bending
12. Notching
13. Soldering
14. Planising.

1. Marking

Place the development on given sheet (G P sheet 28G) mark the boundary line and punch the line of bending and draw all bending lines with scriber.

2. Cutting & Shearing

Cutting is normally used when the sheet metal is cut by mean of chisel.

The term shearing stand for cutting sheet metal manually by using hand snip or tin cutter or by means of shearing machines is called shearing.

3. Circle Cutting

It is an operation of cutting circular blank or curved contours by curved chisel/bent tin cutter/hand snip/with circle cutting m/c.

4. Hand forming

The process of shaping or bending a sheet metal in three dimensions to give it to the desire shape and size of the final product is termed as metal forming.

5. Hemming, Edge Stiffening and Wiring

The edge of sheet is folded to ensure safety on hand stiffness of the product & it gives good appearance.

6. Joint Making / Seaming:

The method used joining the sheet metal parts by means of folded joints or self securing joint.

7. Bending

Sheet metal can be bent by hammering / over a stake by hand or by means of bending or rolling m/c.

8. Notching

The opening left at the corners of seam and edges are known as notches in order to prevent bulging at such a place, the operation is called Notching

Straight Notch
Square Notch
'V' Notch etc.

9. Drawing

The drawing operation is carried out with the help of a die and a punch on a suitable press.

10. Hallowing

In this process of beating the sheet metal into a particular shape such as sauce pan lid or bowl. It is usually done on the hallowing block, which is a worker block with hallow cuts on it.

The hallowing process many also be done on a sand bag. There is no indentation on the top.

11. Sinking

Sinking is a process used to sink the bottom for forming a tray with a flat rim.

12. Rising

It is the process of dinting/ blows the metal down to shape over a tool with a raising hammer or mallet.

13. Planishing

It is a process which is applied to sheet with the main object of shaping the metal with an improved surface the process brings the article to it final shape & surface finish.

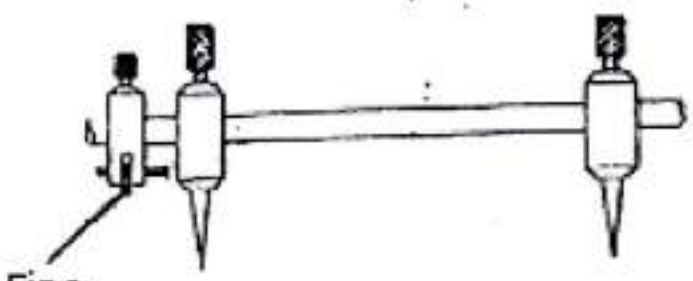
14. Soldering

It is a very common method of joining sheet metal parts. It involves spreading of a low melting point alloy known a solder in molten condition between the surfaces or edges to be joined and allow it to solidity there.

Gauge number corresponding to the thickness of sheet or wire diameter.

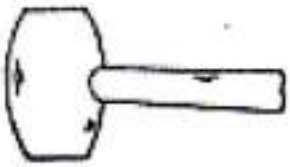
Sl. No	Gauge No	Thickness of sheet or diameter of wire in mm
1	10 G	3.25
2	12 G	2.64
3	14 G	2.03
4	16 G	1.63
5	18 G	1.22
6	20 G	0.91
7	22 G	0.71
8	24 G	0.56
9	26 G	0.46
10	28 G	0.38
11	30 G	0.30

SKETCHES OF SHEET METAL TOOLS

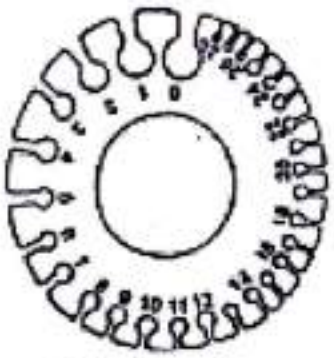


Fine Adjustment

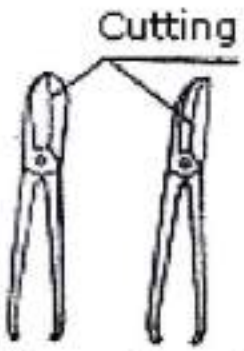
Trammel



Mallet



Standard Wire gauge



Straight Bend

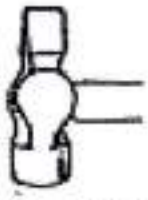
Snips



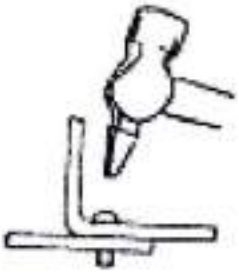
Groover



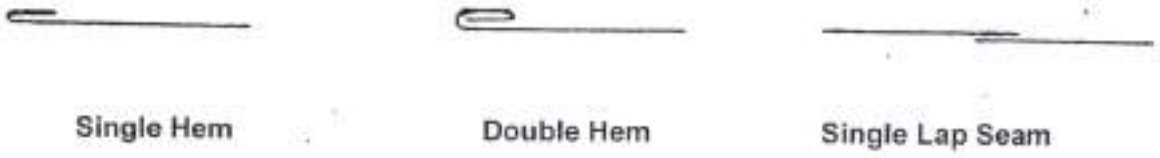
Cross Peen



Straight Peen



Hammers



Single Hem Double Hem Single Lap Seam



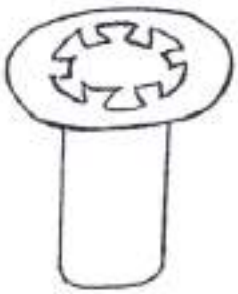
Making a Wired Edge



Making a Grooved Seam



Making a Double Seam

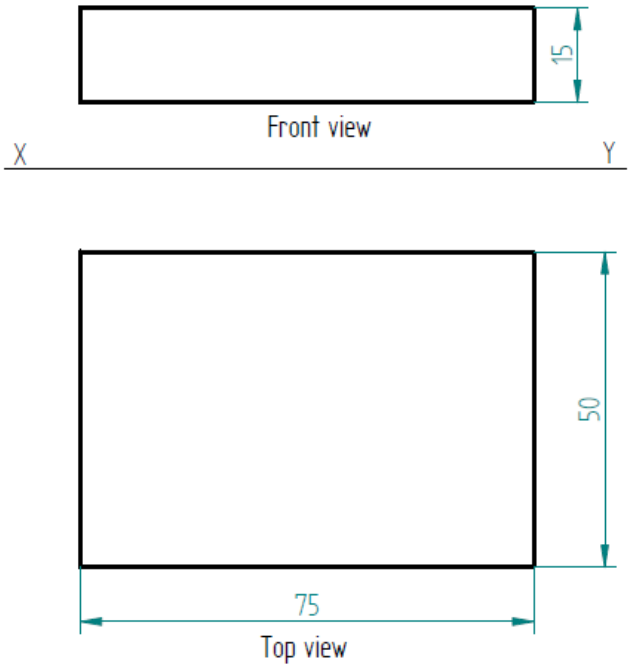


Dovetail Seam Joint

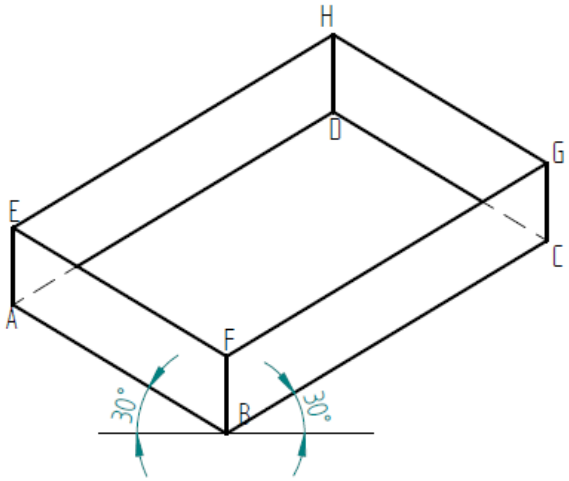
HEMS AND SEAMS

EX.NO :-1.1 RECTANGULAR TRAY

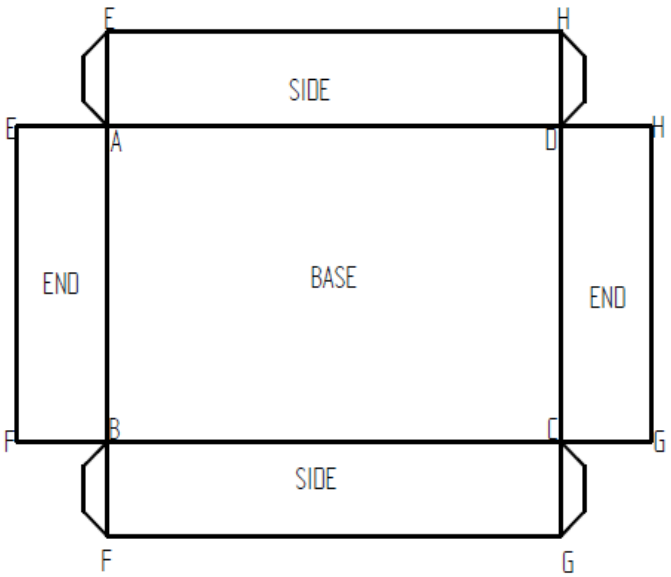
Material : G.P. sheet 28G.
XY Reference line,
Intersection of VP and HP.



2D Drawing



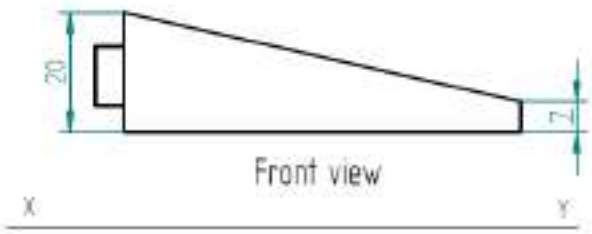
3D Drawing



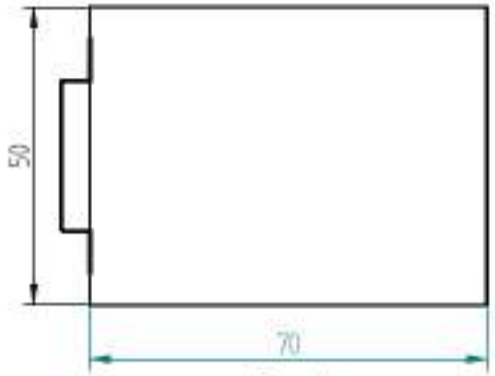
Development (Full Scale)

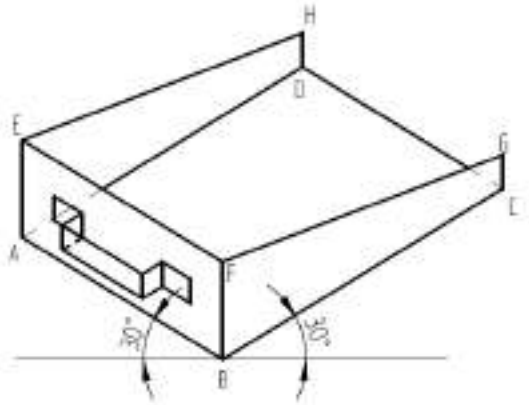
All Dimensions are in mm.

EX.NO:–1.2 DUSTPAN



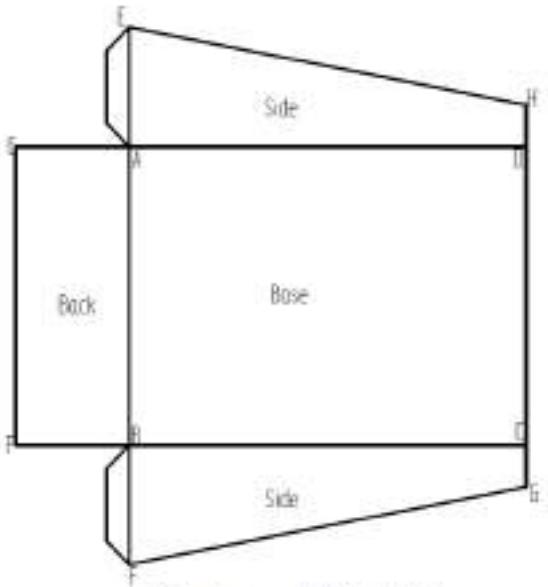
Material – G P Sheet 28G.
XY Reference line,
Intersection of VP & HP





2D Drawing

3D Drawing



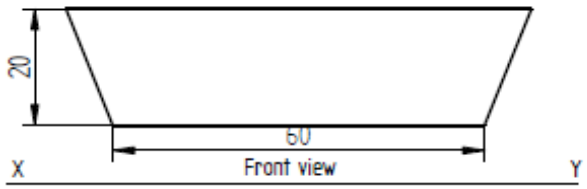
Development (Full Scale)

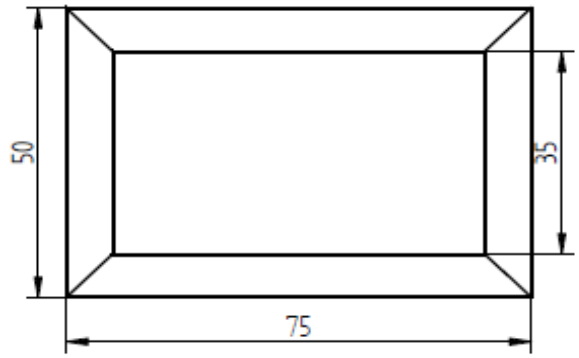
All dimensions are in mm

EX.NO :-1.3

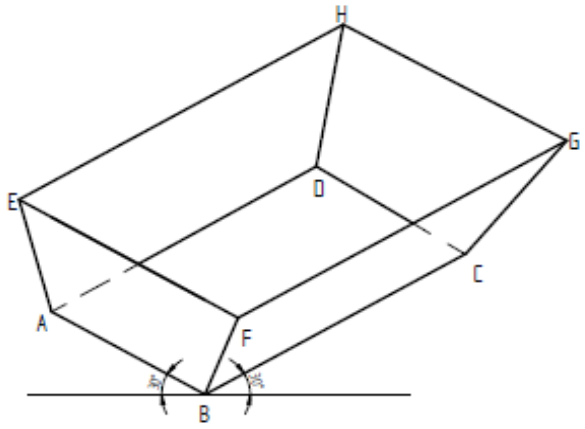
TAPERED TRAY

Material :- G P sheet-28G
XY Referenve line.
Intersection of VP & HP

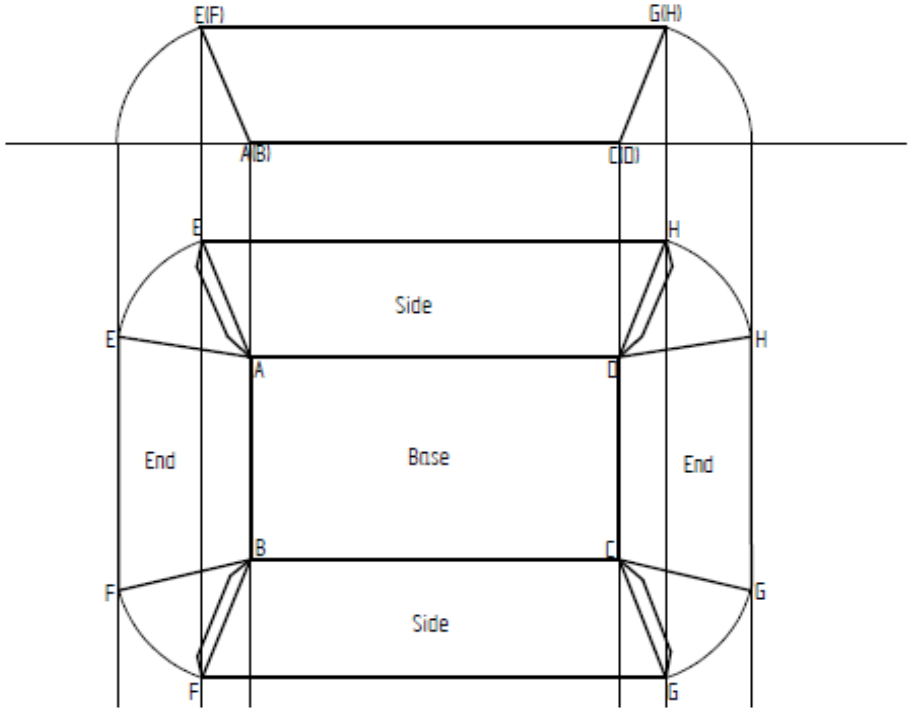




2D Drawing



3D Drawing



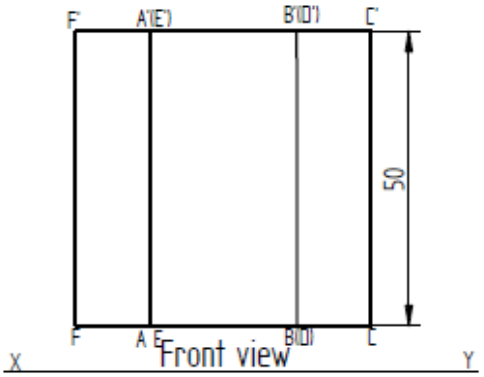
Development (Full Scale)

All Dimensions are in mm

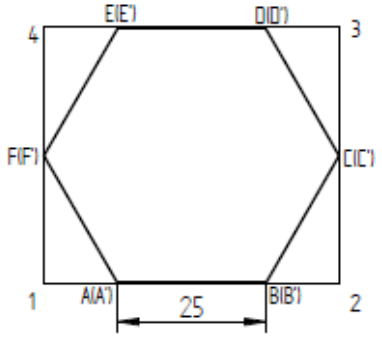
Sequence of operation or Procedure to prepare Trays in Sheet metal.

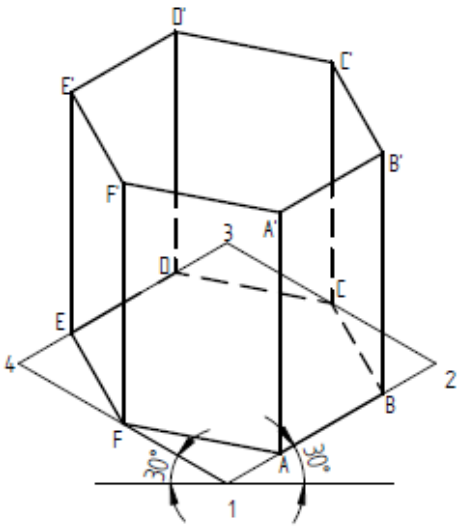
- Draw 2D/ 3D sketches as per scale.
- Draw the development considering all lines must be a " True Length"
- Construct the base of the Tray.
- Construct the two sides of the tray.
- Construct the two ends of the tray.
- Set 5mm extra, allowance on side face for joining the corners by seaming.
- Notch the points to prevent bulging on seaming
- Cut the development shape on lines by using paper cutting scissor
- Place and fix the development on given G.P sheet by using Sticker.
- Punch two points on each bending line.
- Mark the boundary line by using Marking Pen.
- Remove the paper development join the two punch points by a scriber or marking pen.
- Shear the boundary lines by hand snip.
- Flattening the sheet by using mallet on flatter.
- Always bend the seaming line first and remaining lines to get the desired shape by forming.
- Finish the surface keeping on stake to shape.
- Solder the joint.
- Finish surface finishing and complete the Tray.

EX.NO:-2 HEXAGONAL PRISM



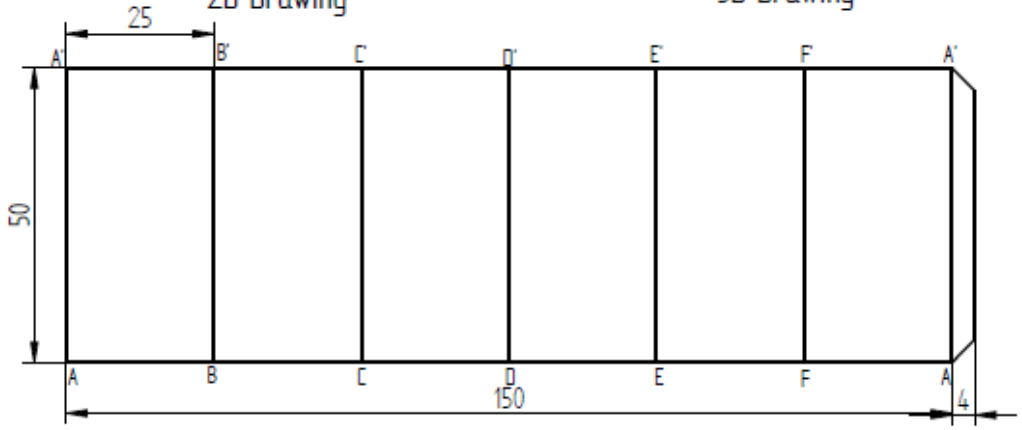
Material:- G.P sheet-28G
XY Referenceline,
Intersection of VP & HP





2D Drawing

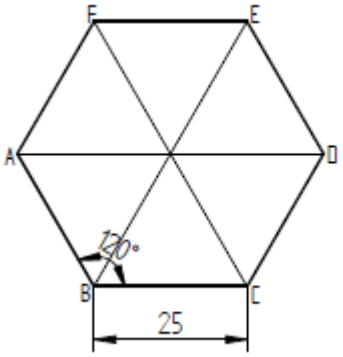
3D Drawing



Development (Full Scale)

All dimensions aew in mm

Construction of regular hexagon of size 25mm with two of the edges horizontal & locate it centre



a. Draw a line BC equal to 25mm
b. From B & C draw lines at 120º to AB and CD

$\Theta = 180º - 360º/6$

$= 180-60 = 120º$

c. Draw arcs from B & C with radius equal to 25 on them to get A &D Respectively
d. From 'D' draw a parallel to AB and cut the arc of radius 25mm on it to get 'E'
e. From 'E' draw a line parallel BC and cut an arc of radius 25mm on to get 'F' join AF and complete the Hexagon.
f. Locate the centre by joining any two diagonals say CF & BE

Sequence of operation or procedure for preparing Hexagonal prism

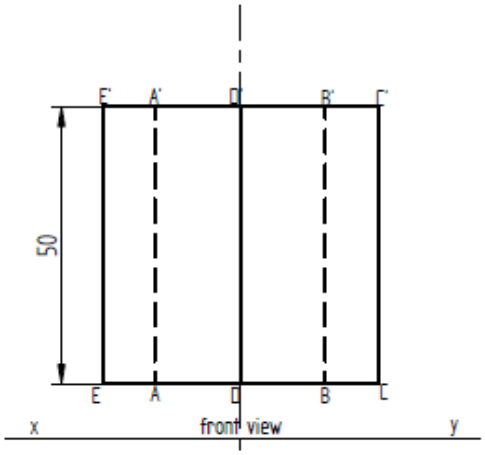
- Draw the top and front view of the prism of the given dimensions
- Equal to six sides of the prism 25 X 6 =150 mm
- Draw a stretch out line AA and mark off the sides of the base along this line i.e AB, BC, CD & DE, EF and FA.
- Erect perpendiculars through these points and mark the edges AA' B B' CC' DD' FF' and AA' height of the prism 50mm.
- Add 5mm extra adjacent to AA' for seam joint.

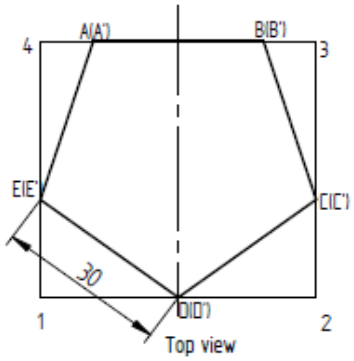
Note: (i) Stretch out line is drawn in line with the base in the front view to complete the development quickly.
(ii) Generally the lateral surfaces of the solid are developed and the bases are omitted.
(iii) All the lines on the development should be present the true length.

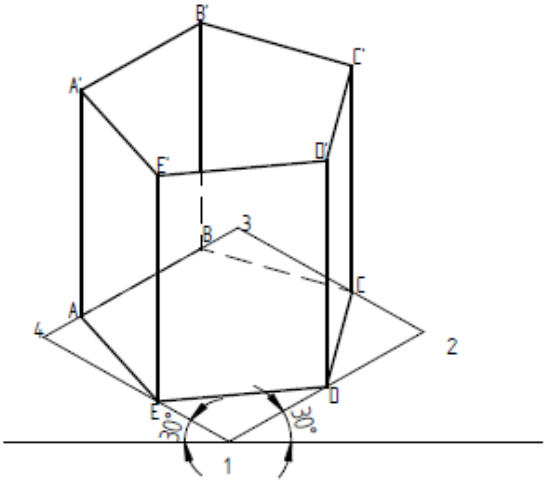
- Cut the development to shape on lines by using paper cutting scissor.
- Place and fix the development on gives G.P sheet by using sticker.
- Punch two points on each bending lines.
- Mark the boundary line by using marking pen .
- Remove the paper development join the two point by scriber or marking pen.
- Shear the boundary lines by hand snip.
- Flatter the sheet by using mallet on flatter.
- Always bend the seaming line first and then the remaining lines to get desired shape.
- Finish the surface keeping on stake to shape.
- Solder the joint.
- Finish the surface finishing and complete the job.

EX.NO:-3 PENTAGON PRISM

Material:- G P Sheet- 28G.
XY Reference line,
Intersection of VP & HP.

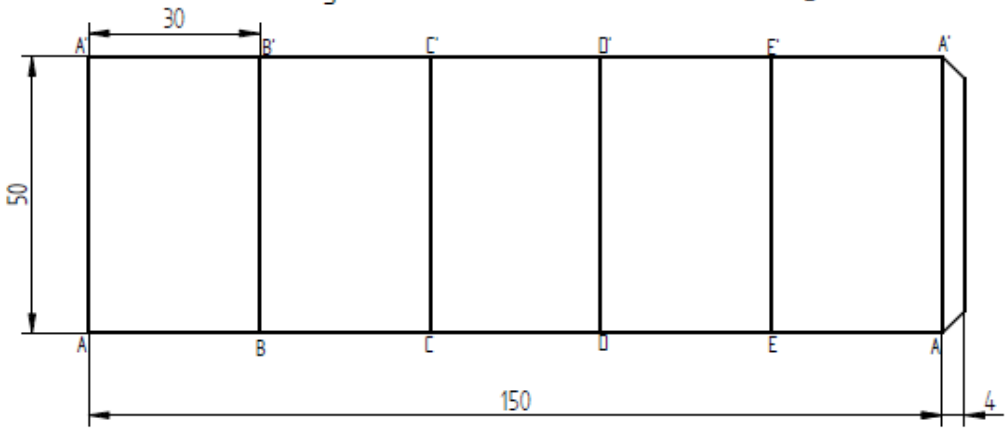






2D Drawing

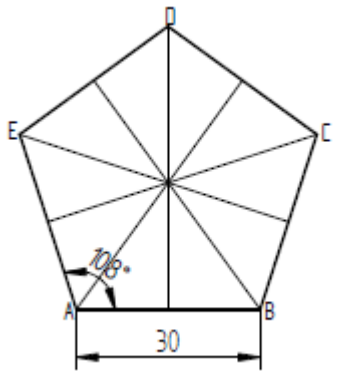
3D Drawing



Development (Full Scale)

All dimensions are in mm

Construct a regular pentagon of side 30mm with one of its sides horizontal and locate the centre.



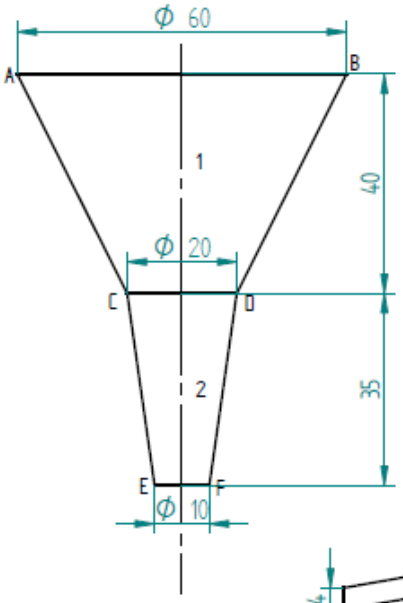
2. Draw a line AB equal to 30mm
3. From A & B draw lines at 108º to AB (Θ = 180º-360º/5=72
   180º-72º= 108º
4. With centers A & B and radius 30mm, draw arcs to get C & E
5. With centre C & E and radius 30mm draw arcs to get the intersection point D
6. Join the lines C D and DE to complete the pentagon.
7. From any two corners draw perpendicular to opposite side.
8. The intersection point locates the centre.

Sequence of operations or procedure for preparing Pentagonal Prism.

- Draw the Top & Front view of the prism to the given dimensions.
- Draw a stretch line AA & mark of the sides of the base along this line is equal to five sides of the prism is 30×5 =150.
  i.e. AB BC CD DE & EA
- Exact Perpendicular to these points and mark the edges AA' BB' CC' DD' & EE' height of the prism 50mm.
- Add 5mm extra adjacent to AA'
- Cut the development to the shape of the line by using paper cutting scissor
- Place & fix the development to the given GP sheet by using sticker.
- Punch the two points on each bending lines
- Mark the boundary line by using marking pen.
- Remove the paper development; join the two points by scriber or marking pen.
- Shear the boundary line by hand snip.
- Flatten the sheet by using mallet on flatter.
- Always bend the seaming line first and then the remaining lines to get desired shape.
- Finish the surface keeping the stake to correct shape
- Solder the joints
- Finish the surface finishing and complete the job

EX. No: - 4

FRUSTUM OF CONE / FUNNEL

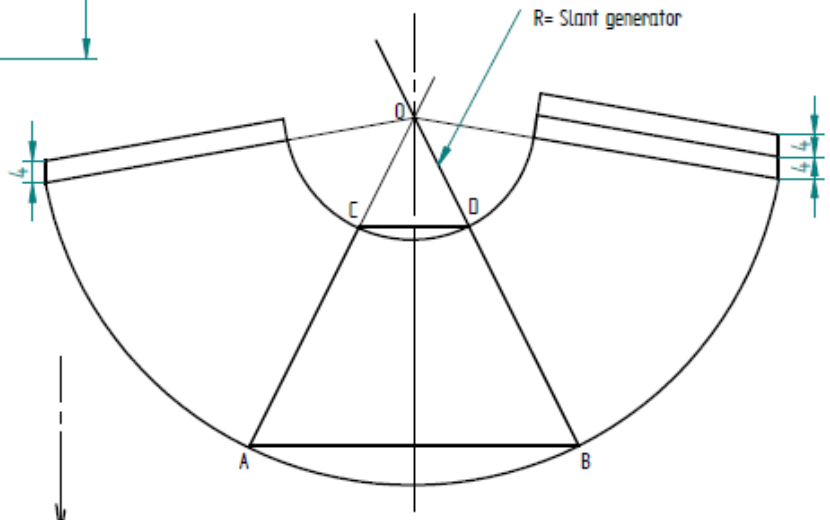


Material:- G.P sheet-28G

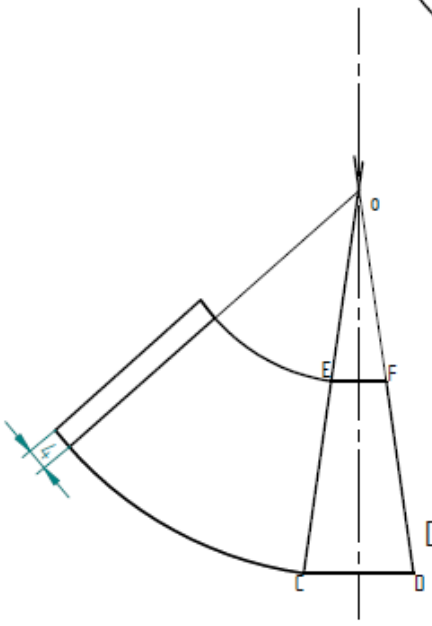
where,

$$\theta = \frac{360 X\ r}{R}$$

θ= Angle Substended to cut the arc.
r = Base radins of the cone.
R= Slant generator of the cone.



Development (Full scale)
Part 1



Development (full scale)
Part-2

All Dimensions are in mm.

Procedure for prepare a funnel

Part -I

I. Draw the front view of the right circular cone OAB of base dia. Is 60mm. A section plane cuts perpendicular to the axis of the cone at 40mm height at CD above the base.
II. With 'O' as center and radius equal to slant generator length (OA or OB) draw an arc. With the same center 'O" radius equal (OC or OD) draw another arc.

III. Find ø = 360X r / R =360 X Radius of the base circle of the cone/ Length of slant generator of the cone

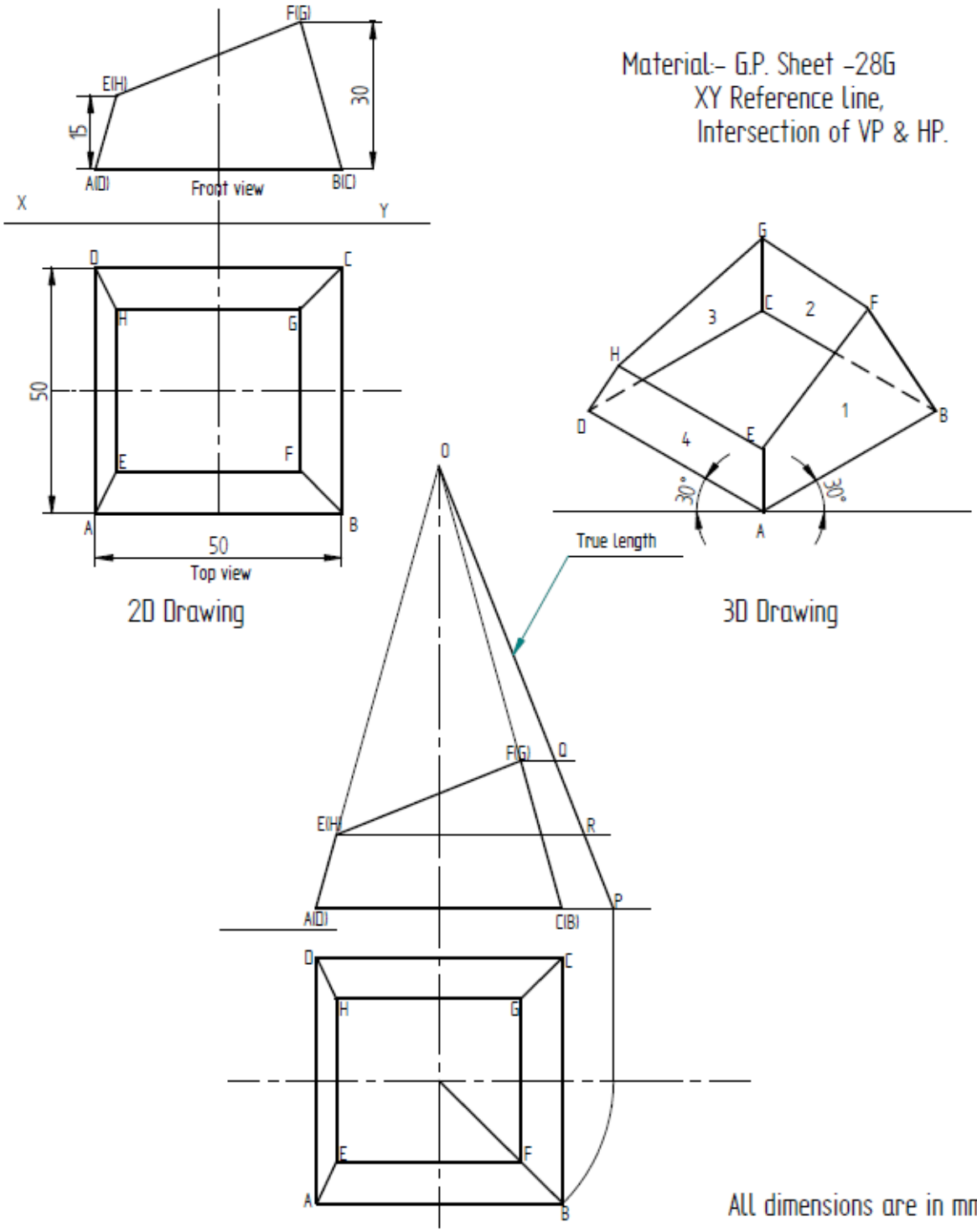
Where ø = Angle subtended to cut the arc.

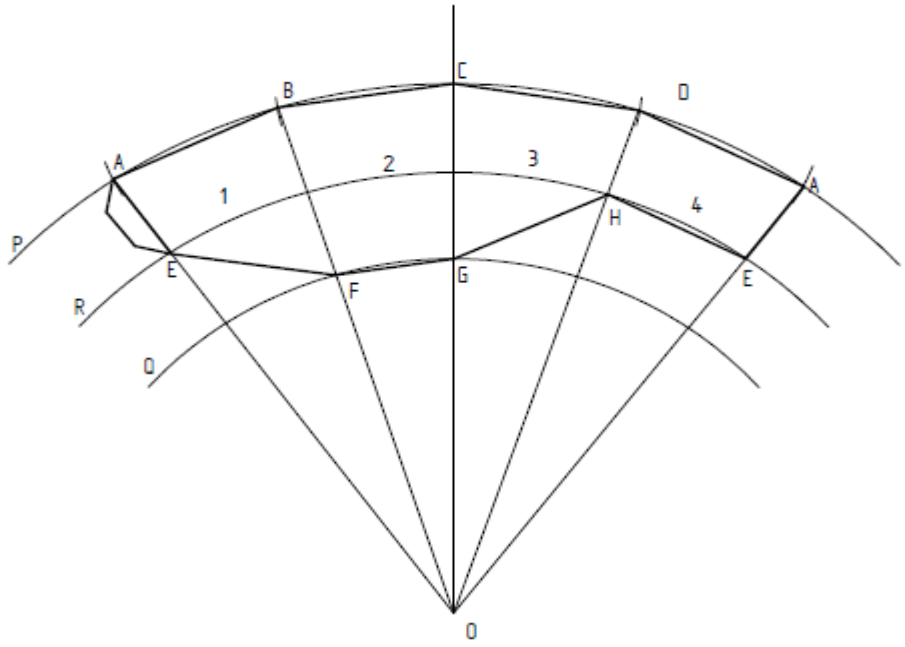
IV. Set an angle ø = _____? At the point of vertex it cut the arc at the points EFGH. Set off 4 and 5+4 mm extra for seam joint.

Part – II

V. The development of the part-II is in a concept of frustum of cone is just same as Right circular Cone.
VI. Trace the development part-I and II on a given G.P sheet 28G (Galvanized Plain sheet 0.38mm thick). Mark all the necessary lines.
VII. Cut the sheet along the line according to shape of the development.
VIII. Fold 4 mm extra allowance in clockwise and anti clockwise directions by keeping hacksaw blade thickness and pressed.
IX. Remove the hacksaw blade, Bend the main body using the cone stake and lock the end joint lock.
X. Repeat the same for Part-Ii. Solder the two parts with electric soldering.

EX.NO:-5 TRUNCATED SQUARE PYRAMID





Development (full Scale)

All dimensions are in mm.

Sequence of operation to prepare truncated square pyramid.

- Draw the front view of the Truncated Pyramid as per dimensions.
- Extend the outer slant edges to mark apex ‘O’.
- Project and get the top view of the pyramid and the apex O is marked at the center.
- Consider O as center and radius OB draws an arc OB’ parallel to XY and project it on to the front view to get ‘P’.
- Join O’P to get the true length of the slant edge.
- With O’ as centre and radius OP describe an arc.
- Transfer the true length of top face edges 50mm each on the arc AB BC CD and DA. Join them with straight line.
- With same ‘O’ as centre radius equal to OR and OQ strike other two arc.
- Section points are marked on the development by measuring their true distances from O on the true length of slant edge in front view.
- Join the sections and draw dark lines to set the development of the surface of the remaining portion of the pyramid.
- Set 5mm extra for seam joint.
- Continue the same procedure of marking, bending, forming and soldering as per standard procedure as explained in the previous jobs.
-

WELDING

It is a process of joining two pieces of metal by heating them to a suitable temperature with additions of filler metal or with application of pressure is called welding.

Practical application of welding:

Welding is extensively used in the following fields

1) Automobile industries
2) Aircraft industries
3) Railway Industries
4) Ship building industries
5) Machine tool industries, structural works, Repair works, thermal power plants, fabrication of metal structures etc.

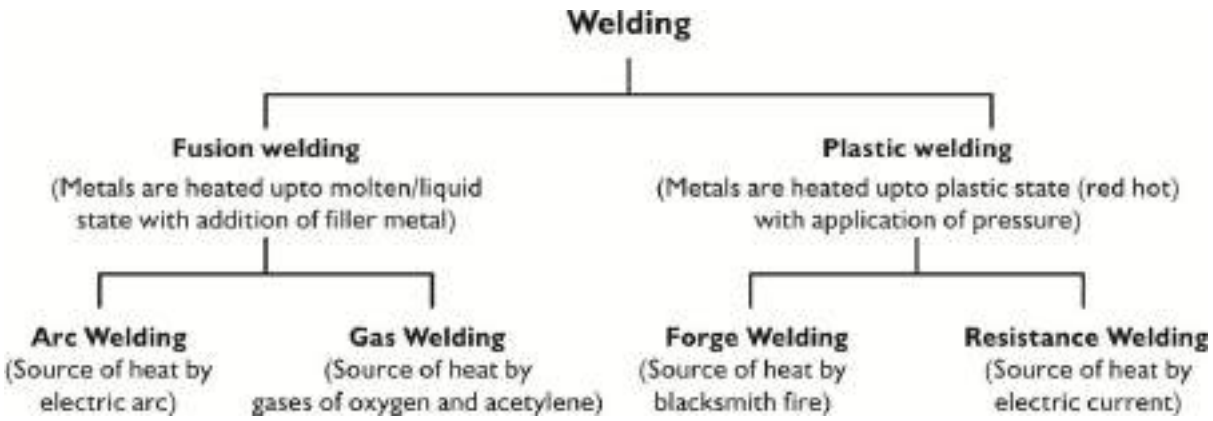
Now a day there is no industry which is not using welding process in the fabrication of its products in some form or the other.

Advantage of welding process when comparing with other process of manufacturing.

Welding is the most acceptable method of fabrication for the following reasons

1. This is the most rapid and easiest way of fabrication and assembly of metal parts.
2. 10 to 40% material can be saved and weight reduction.
3. This process having more than 100% strength of the joint.
4. Greater flexibility in fabrication and erection.
5. Repair and maintenance is easier.
6. Better integrity of components.

Classification of welding:



1. **Fusion welding**: The pieces of metals to be joined are heated to molten/liquid state with addition of filter metal used during welding process and allowed to solidity. Eg. Arc welding, Gas welding.

2. **Plastic welding** :The pieces of metal to be joined are heated to plastic// red hot! state with application of pressure. E.g. Forge welding, Resistance welding.

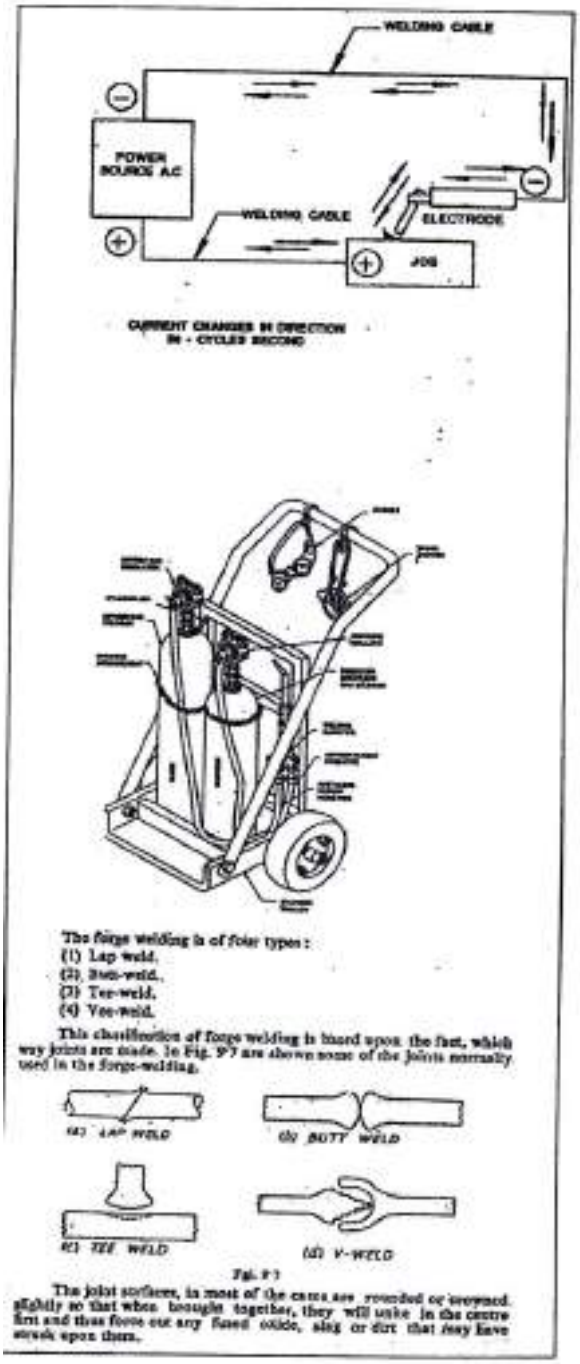
ARC WELDING: The pieces of metal to be joined are heated to molten or liquid state by an electric arc with using flux coated consumable electrode. The intense heat of the electric arc will melt the work pieces and electrode. This molten pool will make a welding joint after solidification. This process of is mostly used for welding ferrous metals.

GAS WELDING: The pieces of metal to be joined are brought to melting temperature from OXY-acetylene flame and then weld is completed by addition of filler metal (Gas welding rods). The process of welding is used for joining non-ferrous metal and small / thin sections.

FORGE WELDING: The pieces of metal to be joined are heated to plastic state from coal/leco/charcoal/ in hearth or forge then pressing together by hand power hammering.

This is the oldest method of welding.

This process is used in block smith shop for joining wrought iron and low Carbon Steel.



RESISTANCE WELDING:

In resistance welding a heavy electric current is passed through the metal to be joined over a limited area causing them to be locally heated up to. Plastic state and weld is completed by the application of pressure for a prescribed period of time. No addition of filler metal is required.

Resistance welding is employed mainly for mass production. This is the only process where heat can be controlled and which permits a pressure action at the weld. The operation is extremely rapid and simple. E.g. Spot welding, Butt Welding, Seam welding etc.

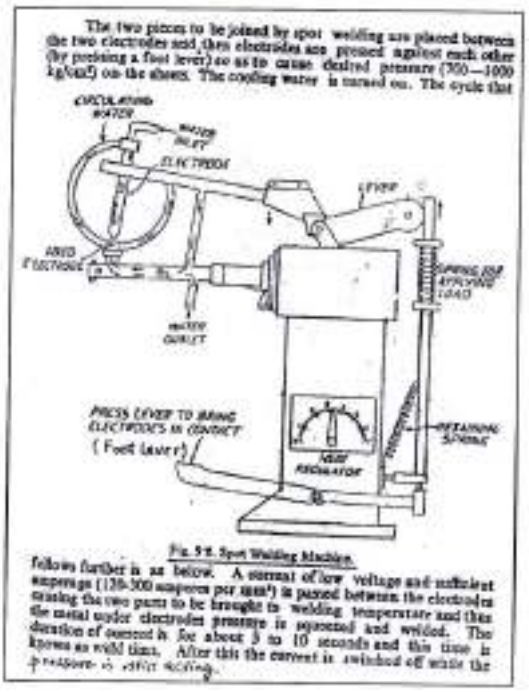


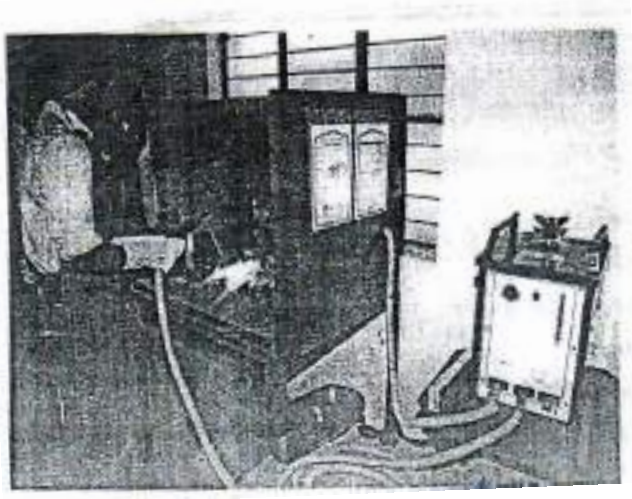
Fig. 5.1. Spot Welding Machine.

Arc Welding and its equipments:

When two conductor of an electric circuit of very high current and low voltage (approximately 200 amps, 20 Volts) are connected with one to flux coated consumable electrode and other one to work piece are brought nearer touch and separated in a small distance of about 4 mm an electric arc is formed. The electric arc is protected from out side atmosphere with gaseous shield around the arc from flux-coated electrode. The temperature of arc is about 3000 to 4000°C. The heat of an electric are will melt the work pieces and electrode. This molten pool will make a welding joint after solidification from the atmosphere. Ensure safety apparel is worn.

Arc welding equipments:

1) AC or DC machines
2) Welding cable and its connectors
3) Electrode holder
4) Earthling clamps
5) Face shield or helmet
6) Goggles and spectacles.
7) Leather hand gloves.
8) Apron.
9) Chipping hammer and wire brush
10) Tongs.



Safety precautions in Arc Welding:

Because of the intensity of heat and light rays from the electric arc the operator hands, face, and eyes are to be protected while the arc is in use. Leather hand gloves are ‘worn and a hand shield or a helmet with a window of colored glass should be used to protect the face and eyes from the glaring effect of the arc rays. Also the space for the electric arc welding should be screened off from the rest of the building to safe guard other workmen from the glare of arc.

Related applications of AC and DC welding:

AC Welding	DC Welding
Ac welding is a low cost efficient performance and popular to weld heavy gauge steel finds maximum use.	DC welding is best suitable for thinner, sheet metals and non-ferrous metals.
Best suitable for flat and horizontal position of welding	DC welding has a greater use in overhead and vertical position.
The biggest advantages in AC welding i) Complete absence of magnetic arc blow (deflection arc is called arc blow) ii) Arc is forceful and produces good penetration. (Pierce or deep in sight)	TIG and MIG welding etc. It is easier to strike and maintain a stable arc. Polarity can be changed to +ve and -ve to electrode Base wire and light coated electrode can be Easily used.

Skill Information required to perform various functions in an Electric Arc Welding to produce good Arc welding joints.

1. Setting of arc welding plant.

2. Setting of welding current and selection of electrode according to plate thickness.

3. Strike and maintain the arc.

i. Scratching method.
ii. Tapping method

4. To deposit straight bead in a flat position.

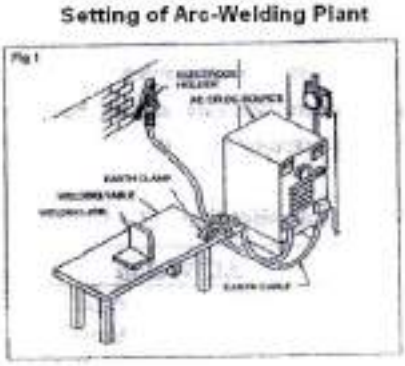
i. Electrode position.
ii. Depositing straight beads by maintaining;
a. Correct arc length.
b. Correct travel speed.
c. Correct angle of electrode.

5 Clean the weldment and inspect for faults.

i. Remove the slag using chipping hammer and wire brush.
ii. Inspect the deposited bead.

1. Setting of arc welding plant.

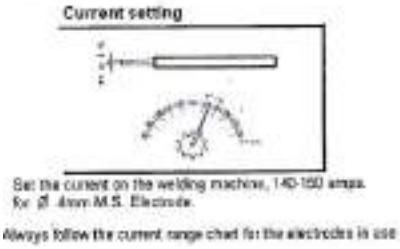
- Check the working of power source for the welding machine.
- Remember electricity is a good servant but a bad master.
- Call an electrician for solving any electrical problems.
- Connect the welding cables with the welding machines.
- Ensure that the cable connections are clean, dry, tight and are attached to the proper terminals of the machine.
- Attach tightly the earth cable with the welding table at the proper place.
- Keep the electrode-holder at a safe place.
- If the machine is on D.C. power connect the cables in correct polarity.
- Polarity means changing of +ve and -ve to the electrode is called polarity.



2. Current setting & selection of electrode according to the thickness of plate to be joined.

- Set the welding current and select the electrode as per the thickness of the metal to be welded ref table.
- Use alternative electrodes of nearest size in the case of non-availability of the exact size of electrodes.
- The electrode diameter should not be more than the thickness of the metal to be welded.
- Set the current on the welding machine 120-130 amps for 3.15mm M.S. electrode. If the thickness of metal to be welded is 5mm. Always follow the current range chart for the electrodes in use.

Plate thickness in mm	Electrode size ϕ mm	Current range amperes
1.6	1.6	40 – 60
2.5	2.5	50 – 80
4.0	3.2	90–130
6.0	4	120–170
8.0	5	180–220
25.0	6	300–400



3. Striking and maintaining an Arc.

Striking an arc is a basic operation in arc welding. It will occur every time the welding is to be started. It is an essential basic skill to learn in arc welding.

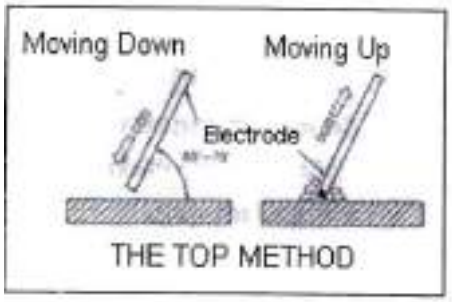
i) Scratching method:

- Hold the electrode about 25 mm above the job piece at one end perpendicular to surface
- Bring the welding screen in front of your eyes.
- Ensure safety apparatus is worn.
- Strike the arc by dragging the electrode quickly and softly across the welding job, using wrist movement only.

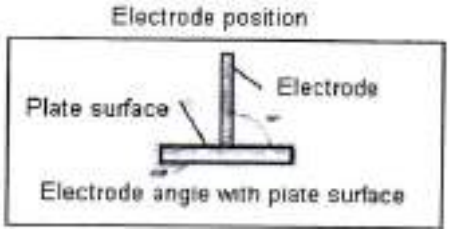


- Withdraw the electrode approximately 6 mm from the surface for a few seconds and then lower it to (approximately) 4mm distance.
- If the arc has been properly struck, a burst of light with a steady sharp crackling sound will be produced.

ii) Tapping method:



- Strike the arc by moving the electrode down to touch the job surface lightly.
- Move the electrode slowly up approximately 6mm for a few seconds and then lower it to approximately 4 mm from the surface.
- The tapping method is generally recommended as it does not produce pit marks on the job surface



4. To deposit straight bead in a flat position.

i. Job setting
 * Set the job in a flat position on the welding table.
 * Ensure there is good electrical contact between the job and the welding table.

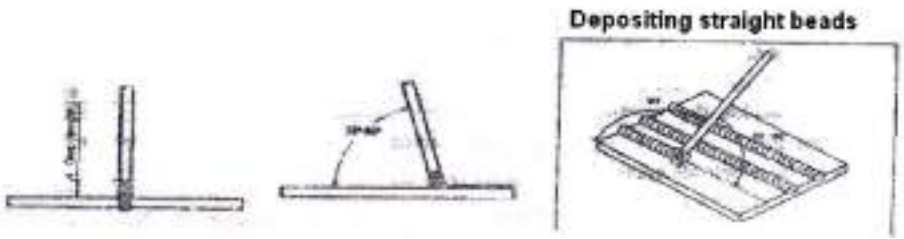
ii. Electrode position
 * Hold the electrode at an angle of 70^{o}-80^{o} with the weld line and 90^{o} with the adjoining plate surface.

4. Depositing straight beads.

Deposit straight bead by following the punched line and maintain a;

- Correct arc length: 4 mm
- Correct travel speed: approximately 150 mm per mm.
- Correct angle of electrode: 70° to 80° to the line of weld.

Note: I ensure that the welding screen lens is clean, so that you can see the arc and the weld line.
ii. Replace the plain glass. If spattered.



Why Electrodes are coated?

During welding, the work pieces melts and at the same time, the tip of electrode also melts. As the globules of molten metal pass from the electrode to the work piece, they absorb Oxygen and Nitrogen from the atmospheric air. This causes the formation of some non-metallic constituents that are trapped in the solidifying weld metal thereby decreasing the strength of the welded joint. In order to avoid this, a flux is coated on the metallic wire. During welding, the flux vaporizes and produces a gaseous shield around the molten weld pool. The flux also performs a variety of functions depending on the constituents from which it is made.

Advantages of coated electrodes:

1 Stabilizes the arc.
2. Prevents oxidation of molten metal
3 Helps in removal of oxides and other undesirable substances present on the surface of the work piece.
4. Chemically reacts with the oxides and forms a slag. The slag floats and covers the top portion of the molten metal thereby preventing it from rapid cooling.
5. Reduces weld metal porosity.
6. Helps to produce minimum spatter adjacent to the weld

Comparison of Basic Jointing Processes

	WELDING	BRAZING	SOLDERING
Definition	It is a process of jointing two or more pieces of similar or dissimilar metals by heating them to a suitable temperature with or without addition of filler metal	It is a process of joining two or more pieces of metal with the help of some fusible alloy known as 'spelter' having its melting point above 600°C but lower than the melting point of the parts to be joined	It is a process of joining two or more pieces of metal with the help of lower melting point alloy known as 'solder' which has lower melting point than the metals being jointed.
Melting temperature	Both base metal and filler metal having the same melting temperature above 1200°C	Melting temperature of spelter is from 600°C to 850 °C	Melting temperature of solder is from 150°C to 350°C
Filler metal	Electrode (Mild steel, cast Iron, stainless steel, carbon etc.)	Spelter An alloy of copper and zinc 60% and 40% An alloy of silver copper and zinc, 34%, 50% and16%.	Solder. An alloy of lead and tin 50% and 50%
Source of heat	Electric arc, gas and chemical reaction etc.	By torch, furnace, electric resistance, immersion etc.	By electric current, coal fire, gas etc.
Fluxes	Minerals, lime stone or calcium carbonate, wood pulp, sugar starch, ball clay, asbestos, iron powder, Ferro manganese, mica etc.	Borax	Zinc chloride Ammonium chloride
Practical application	1. Automobile industries 2. Aircraft Industries 3. Railway Industries 4. Ship Industries 5. Machining tool industries 6. Repair works 7. Structural works	1. Evaporator coils 2. Motor cycle parts 3. Aircraft propellers 4. Joining of dissimilar metals 5. Joining of pipes	1. Sheet metal works and tin containers (biscuit, cake, oil, kerosene, paint tins etc.) 2. Electrical junctions 3. Joining of electronic parts etc.

Sequence of operation and methods for preparing Electric Arc Welding joints, (Step by Step Procedure)

SI. No.	Sequence of Operation	Method/ System adapted	Tools/ Equipments required to perform the operation
1	Sketching / Drawing	Orthographic : 2D Isometric : 3D	Using all conventions, notations and symbolic representations.
2	Set the Arc welding plant	i) connect one cable to workable it proper place ii) Another cable for electrode holder	i) A.C. step down transformer (air cooled) or D.C. generator I rectifier. (connect the cable to correct polarity) ii) Welding cable, iii) Electrode holder iv) Earthling clamp.
3	Set welding current and selection of electrode according to plate thickness	i) set the current on welding machine ii) Select electrode fit with electrode holder	Ref to Chart for selection of current range in amperes and electrode size. Ex.: 6 mm thick plate / 90 — 130 amps I 3.2 mm
4	Clean and set the work pieces for tack weld Tack the pieces at both ends by holding by 'C' clamp	Obtain the arc by Scratching or tapping method	i) Use suitable tack weld fixture as available. ii) 'C' clamp iii) Face shield and spectacles iv) Chipping hammer v) Wire brush and tong vi) Use safety apparels
5	Check the alignment and reset if necessary. Place the tack weld joint in a fixture in flat position provided on the worktable		Select suitable fixture for fun bead weld. (Butt, Lap, 'T' and 'L' joint)
6	Deposit full bead with correct arc length, electrode angle, travel speed and movement	i) Arc length: 4 mm ii) Electrode Angle: 70° - 80° iii) Travel Speed: 150 mm / mm Movement: more uniform and consistency to your end	Use all safety apparels
7	Reverse the joint, deposit full bead if necessary .	i) Arc length: 4 mm ii) Electrode angle:70°-80° iii) Travel Speed: 150 mm/mm Movement: more uniform and consistency to your end	Use all safety apparels
8	Chip off all slag, remove spatters, clean the bead by brushing		Tong, chipping hammer, wire brush, white glass spectacles, chisel and hammer.
9	Inspect the wd:	i) To ensure uniform and correct reinforcement ii) To ensure that weld face is free from porosity, Slag inclusion, unfilled creator, over lap, insufficient throat	

Experiment No: - 1

Butt Joint

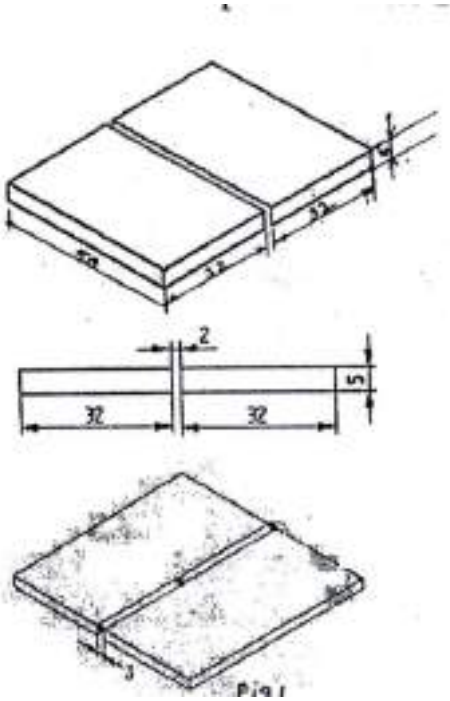


Fig 1

Tack welding

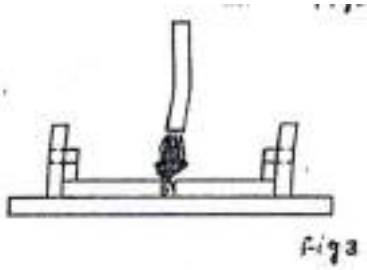
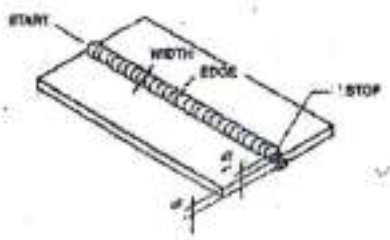


Fig 2

Full bead welding



Experiment No: - 2

Lap Joint

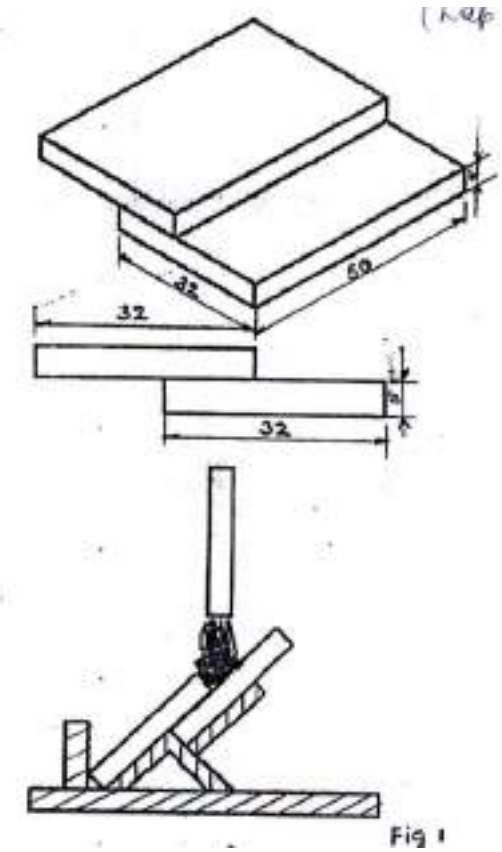


Fig 1

Tack welding

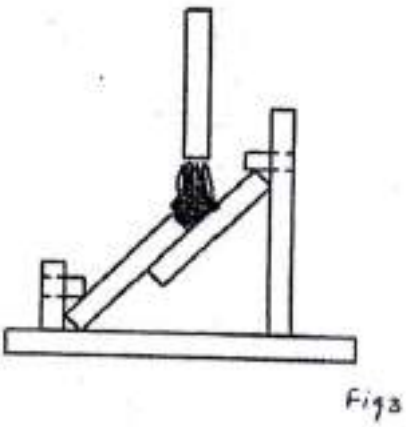
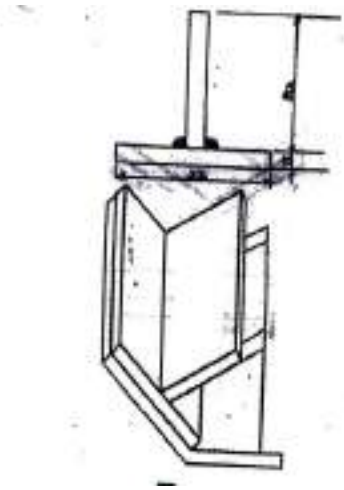


Fig 2

Full Bead Welding

Experiment No: - 3

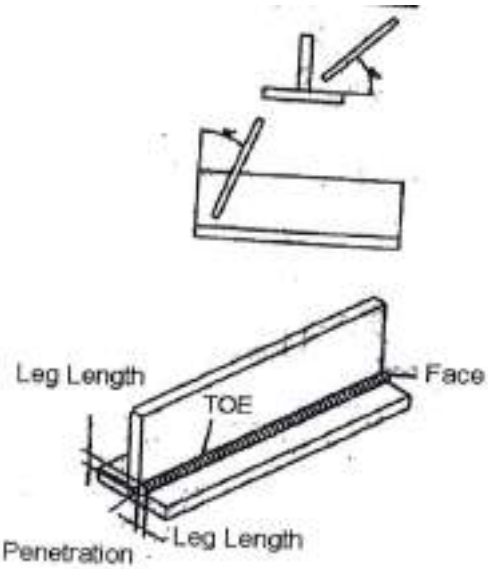
Tee Joint



Tack Welding

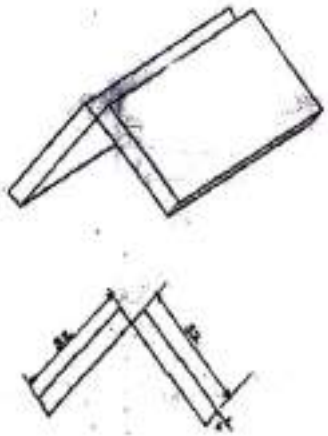


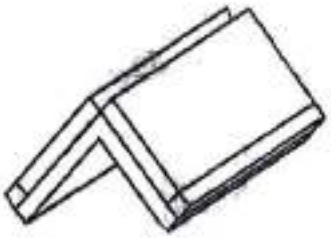
Full bead welding



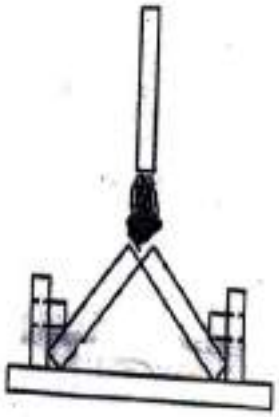
Experiment No:-4

V Joint





Tack Welding



Full Bead Welding