LORDS INSTITUTE OF ENGINEERING & TECHNOLOGY (A)

Survey No. 32, Near Police Academy, Appa Junction, Himayath sagar,
Hyderabad, Telangana 500091.

MANUAL

of

Workshop/Manufacturing Practices Lab

B.E I-YEAR I/II SEM

A.Y: 2023-2024

(COMMON TO ALL BRANCHES)

Name: ______________________

Roll No: ____________________

Branch & Section: _____________

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DEPARTMENT OF MECHANICAL ENGINEERING

LORDS INSTITUTE OF ENGINEERING & TECHNOLOGY(A)

Survey No. 32, Near Police Academy, Appa Junction, Himayath sagar,
Hyderabad, Telangana 5000091.

VISION

Lords Institute of Engineering and Technology strives for excellence in professional education through quality, innovation and teamwork and aims to emerge as a premier institute in the state and across the nation.

MISSION

1. **To impart quality professional education that meets the needs of present and emerging techno-logical world.**
2. **To strive for student achievement and success, preparing them for life, career and leadership.**
3. **To provide a scholarly and vibrant learning environment that enables faculty, staff and students to achieve personal and professional growth.**
4. **To contribute to advancement of knowledge, in both fundamental and applied areas of engineering and technology.**
5. **To forge mutually beneficial relationships with government organizations, industries, society and the alumni.**

QUALITY POLICY

To pursue global standards of excellence in all our endeavors namely teaching, research, and consultancy to create quality Engineering professionals in order to meet the emerging industrial and social needs.

Departmental Vision, Mission and PEOs

VISION

To become center of repute for high standards of quality mechanical engineering education, researchand entrepreneurial skills.

MISSION

DM1: Provide an integrated education that blends fundamental knowledge, technical skills,and innovation.

DM2: Enrich the experience of curriculum, hands-on learning, team work, management andmulti-disciplinary skills.

DM3: Make aware of professional responsibilities, ethics, and global demands, with lifelonglearning.

DM4: Design, develop sustainable and cost-effective solutions with research and entrepreneurial focus.

PROGRAM EDUCATIONAL OBJECTIVES

PEO1: To establish themselves as successful professionals with strong fundamental knowledge in basic and engineering sciences to find suitable solutions of technological and real life challenges using innovative tools.

PEO2: To enhance technical competency and problems solving skills through state of art facilities for adequate solutions to technical problems.

PEO3: Acquire high skill-set by continuous training, multi-disciplinary activities, team work, effective communications, Information Technology tools usage and ethics so that students shall acquire good job opportunities and also will help in their higher education.

PEO4: Giving consultancy services to industrial challenges and promoting department-industry interactions, by enhancing technical, managerial, environmental responsibilities and lifelong learning with sustainable development.

PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

	PO's & PSO's
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research in literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
PO3	**Design and development of solutions:** Design solutions for complex engineering problems and design system components or processors that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to access societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of , and need for sustainable development
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and Teamwork:** Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.
PO11	**Project Management and Finance:** Demonstrate knowledge and understanding of the Engineering and Management principles and apply these to once own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.
PO12	**Lifelong Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	**Professional Skills:** An ability to understand the basic concepts in mechanical Engineering and to apply them to various areas, like production, thermal, designing etc., in the design and implementation of complex systems.
PSO2	**Problem-Solving Skills:** An ability to solve complex Mechanical Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

WORKSHOP/MANUFACTURING PRACTICES SYLLABUS

Course code	Course title						Core/Elective
U23ME1L2/ U23ME2L2	**WORKSHOP/MANUFACTURING PRACTICES (COMMON TO ALL BRANCHES)**						**Core**
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
-	L	T	D	P			
	1	-	-	4	50	50	3

Course Objectives:

The Objective of this course is to impart knowledge of

1. Engineering Practices & develop holistic understanding of various Engineering materials and Manufacturing processes.
2. Steel, Plastic, Composite and other materials for suitable applications.
3. Hands on practice on techniques of fabrication, welding, casting, manufacturing, metrology, and allied skills.
4. Productivity, create skilled manpower which is cognizant of industrial workshop components and processes and can communicate their work in a technical, clear and effective way.
5. Engineering Skill development with regard to making components, system integration and assembly to form a useful device.

Course Outcomes – (Laboratory):

After completing this course, the student will be able to

1) Understand about the tools and Fabricate components with their own hands.
2) Get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
3) Understand the Assembling of different components and will be able to produce small mechanisms/devices of their interest.
4) Gain practical skills of carpentry, tinsmithy, fitting, house wiring.
5) Gain knowledge of different Engineering Materials and Manufacturing Methods.
6) Understand trades and techniques used in Workshop and chooses the best material/ manufacturing process for the application.

SYLLABUS:-

A. TRADES FOR EXERCISES

1. FITTING

1. Square fitting
2. Dovetail fitting
3. V- Template fitting

2. CARPENTRY

1. End lap joint
2. T- Bridle joint
3. Dovetail lap joint

3. ELECTRICAL/HOUSE WIRING

1. Two lamps in parallel with 5 Pin 6amp socket and switches.
2. Two lamps in series connection with switches.
3. Staircase wiring.

4. TIN SMITHY

1. Square Tin
2. Rectangular Scoop
3. Conical funnel

5. WELDING PRACTICE

1. Lap Joint
2. V- Butt Joint
3. T-joint

B. TRADES FOR DEMONSTRATION AND EXPOSURE

1. Machining (Lathe & Drilling)
2. Black smithy (Introduction, Round to Square , Square to Octagon)
3. Plumbing (Introduction of tools, joints, couplings, and valves etc)

C. PRESENTATIONS AND VIDEO LECTURES

1. Manufacturing Methods
2. Rapid Prototyping
3. Glass Cutting
4. 3D printing
5. CNC LATHE
6. Injection Moulding
7. Mould Making and casting
8. Basic Electronics lab Instruments

Suggested Readings

1. H S Bawa, "Workshop Practice", Tata Mc Graw Hill Education Private Limited ,New Delhi, Second Edition, 2009.
2. V Ramesh Babu, “Engieering Workshop Practice”, VRB Publishers Pvt Ltd, New Edition, 2009.
3. P. Kannaiah & K. L. Narayana “Workshop manual” 2nd Ed., Scitech publications (I) Pvt. Ltd., Hyderabad.
4. Hajra Choudhury S.K., HajraChoudhury A.K., Nirjar Roy S.K. “Elements of Workshop Technology” Vol-I 2008 &Vol-II 2010 Media Promoters & Publishers Pvt. Limited, Mumbai.
5. B S Raghuwanshi, “A Course In Workshop Technology”, Dhanpat Rai & Co.(P) Ltd, Educational & Technical Publishers, Vol-II, 2011.

Note: At least two exercises from each trade.

Course outcomes: C19– Workshop/Manufacturing Practices

Student will able to:

CO. No.	Description	Bloom's Taxonomy Level
C19.1	Learn basics of Different tools and tools usage, properties.	BTL1
C19.2	Understand the basics of different manufacturing processes, dimensional accuracies and tolerance while doing the practical.	BTL2
C19.3	Remember the techniques used to assemble and disassemble the small models, in trades like fitting , carpentry.	BTL1
C19.4	Demonstrate practical skills in different trades like carpentry, tinsmithy, fitting and welding.	BTL6
C19.5	Develop the small device on their interest with the practical knowledge of welding, plumbing, fitting and carpentry tools.	BTL6
C19.6	Differentiate and Evaluate the techniques used in workshop to choose materials, tools and its applications in day to day life also.	BTL3

Note: Bloom's Taxonomy Levels

BTL1-Remember	BTL2 - Understand	BTL3 –Apply
BTL4-Analyze	BT56 –Evaluate	BTL6–Create

Signature of the Faculty

Course Articulation Matrix: Mapping of Course Outcomes (CO) with Program Outcomes (PO) and Program Specific Outcomes (PSO's):

Course Outcomes (CO)	Program Outcomes (PO)												Program Specific Outcomes (PSO's)	
CO. No.	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**
C19.1	3		2			2					3		3	3
C19.2	3		2		2						3		3	3
C19.3	3		2		2				3		3		3	3
C19.4	3		2		2	2			3		3		3	3
C19.5	3		2		2	2			3		3		3	3
C19.6	3		2			2					3		3	3
C19	**3**		**2**		**2**	**2**			**3**		**3**		**3**	**3**

Level:

1- Low correlation (Low), 2- Medium correlation (Medium), 3-High correlation(High)

PO1: Engineering knowledge, **PO2**: Problem analysis, **PO3**: Design/Development of solutions, **PO4**: Conduct investigations of complex problems, **PO5**: Modern tool usage, **PO6**: The engineer and society, **PO7**: Environment and sustainability, **PO8**: Ethics, **PO9**: Individual and teamwork, **PO10**: Communication, **PO11**: Project management and finance, **PO12**: Life-long learning **PSO1**: Professional Skills, **PSO2**: Problem-Solving Skills

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Workshop/Manufacturing Practices Safety Rules

- When working in the lab, jewelries, loose clothing etc. are must be avoided and long hair must be completely covered.
- Lab coats/overalls and safety boots must be worn by students performing the exercise.
- Ask how to use the tools safely. Immediately notify the workshop supervisor of any faulty or broken equipment.
- No tool may be used or work undertaken unless the technician-in- charge permits.
- Make sure your work piece is fixed securely before work commences.
- Keep clear of any person operating tools and machinery (bumping an operator could cause serious injury to you or the operator)
- Equipment must be cleaned after use. Any materials, tools or equipment used must be tidied away.
- Tools and equipment must be replaced in their appropriate cabinets after each working day.
- Tools and equipment must not be removed from the workshop without permission from the technician-in-charge.
- Eating and drinking in the mechanical workshop is strictly prohibited.

All accidents, cuts and abrasions must be reported to the In-charge & get the required First-Aid.

Instructions to the students:

- No Entry without Apron, ID Card & Shoes.
- Students must carry their records, observation & required stationary (pen, pencil, eraser, etc.) to the lab.
- Students must be regular, punctual and disciplined in the lab.
- The objective of the laboratory is learning. The experiments are designed to illustrate phenomena in different areas of Workshop and to expose you the uses of instruments.
- Conduct the job with interest and an attitude of learning.
- Work quietly and carefully (the whole purpose of experimentation is to make reliable measurements!) and equally share the work with your partners.
- All presentations of job and diagram should be neatly and carefully drawn with pencil. Always display units.
- Students must mark their presence in log resister when they come to laboratory (as per time-table), failing which their attendance will not be considered.
- Students are liable for getting their observations and records corrected on day-to-day basis.

Do’s

1. Teachers expect students to be calm and discipline. Your behavior and attitude in the lab should be excellent. The safety of you and other persons depend on it.
2. There is always plenty to do in the lab, so teachers expect you to arrive on times and to use your time well.
3. Listen to all instructions given by your teacher and follow them carefully.
4. Read your lab assignments before coming to lab. Prepare your pre-lab write-up prior to entering the lab.
5. Familiarize yourself with all lab procedures before doing the lab exercise.
6. Get signature in your observation book from your teacher before leaving the lab.
7. Perform only those experiments which you have been instructed.
8. It is your responsibility to take care of lab equipment, use it only as instructed, and report any damages to your teacher.
9. Clean and dry your lab work area at the close of the lab period. Return all equipment and materials to the proper place.
10. Use ball points pens, not pencils for noting the observations.
11. Be honest. All procedures and experimental data whether you regard them as “good” or “bad” at the time should be recorded in the lab book.
12. Pleases take care your personal stuff with you (Backpacks, purses, calculators, keys, etc.). Do not leave them in the laboratory.

Don’ts

1. Never attempt to touch the equipment or to do the experiment on your own until your teacher demonstrates about it.
2. Don’t eat or drink in the lab room at any time
3. Don’t chew gum or eat candy during lab exercises.
4. Don’t be mischievous in the lab
5. Never remove any pages from the observation notebook & record.
6. Never use electrical equipment around water.
7. Don’t work in the lab alone.
8. Don’t leave the bags and books in the aisles.

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Signature of the faculty

FITTING

Introduction to Fitting

1. Introduction

Machine tools are capable of producing work at a faster rate, but, there are occasions when components are processed at the bench. Sometimes, it becomes necessary to replace or repair component which must be fit accurately with another component on reassembly. This involves a certain amount of hand fitting. The assembly of machine tools, jigs, gauges, etc, involves certain amount of bench work. The accuracy of work done depends upon the experience and skill of the fitter.

The term “bench work” refers to the production of components by hand on the bench, whereas fitting deals which the assembly of mating parts, through removal of metal, to obtain the required fit. Both the bench work and fitting requires the use of number of simple hand tools and considerable manual efforts. The operations in the above works consist of filing, chipping, scraping, sawing, drilling, and tapping.

2. Measuring Tools

Steel Rule

It is a direct reading measuring instrument to read an accuracy of 0.5 mm metric and 1/64 of an inch in British. Steel rules are made from high carbon steel and stainless steel.

Try Square

It is make and checking instrument of right angle of the job as well as levelness of the flat surfaces.

Inside calipers

It is a tool used to checkup the internal dimensions of any job. It is an indirect measuring instrument.

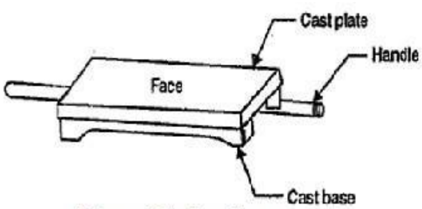
Outside Calipers

It is a tool used to checkup the outer dimensions of any job.

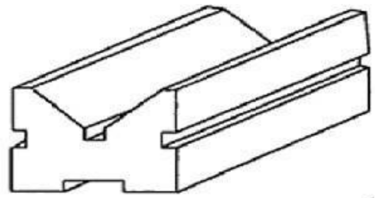
Jenny Caliper or Bent Leg Calipers

It is a tool used in layout work for locating and testing the center of cylindrical job. It is used scribed parallel lines on flat surfaces.

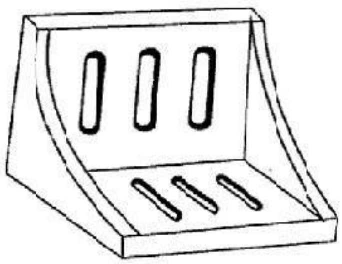
Cutting tools



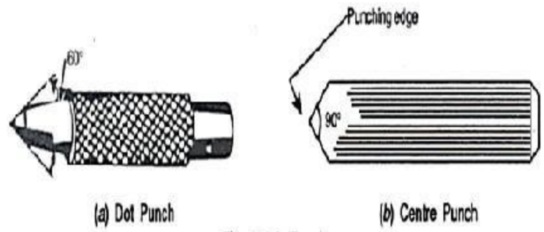
Universal Surface Gauge



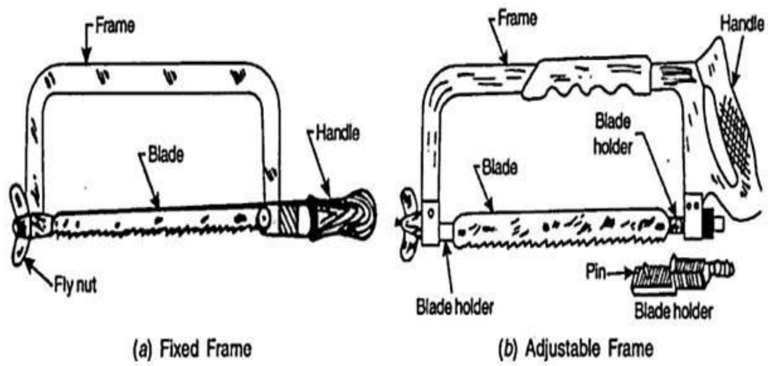
V Block



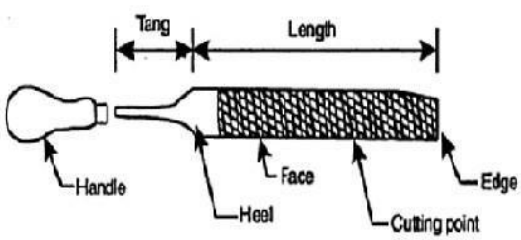
Angle Plate



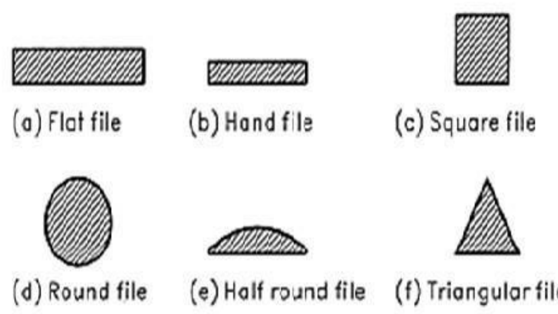
Punches



Hand Hacksaws



Nomenclature of File



Types Of files

Fig No: 01 Fitting (Cutting Tools)

2. Marking Tools

Universal Surface Gauge

It is an instrument having a base, and a scriber. It is a tool used for marking lines on flat surfaces. It is an indirect marking instrument.

V-Block

It is a rectangular or square block having V-shape grooves as such it is called V-block. It is classified by its length, breath and height. It is used to support the job and to mark the round rod center.

Angle Plate

It is made from closed grain cast iron. It is used for marking purpose as well as to checkup the right angles of the job.

Punch

Punch is a cylindrical steel piece. It is a tool used for punching on the marked lines. This operation is called punching. There are three types of punches: 1) Center Punch (90), 2) Dot Punch (60), 3) Prick Punch (30).

3. Cutting Tools

Hacksaw

It is a tool which consists of a frame and a blade. It is a tool used for cutting the surplus metal on the marked lines. This operation is called sawing.

File

File is a cutting used to remove small quantity of surplus metal. Files having cutting points incorporated in the body at equal distance usually on all four faces over the length from tip to shoulder. Files are classified according to their length, grade, section and cuts.

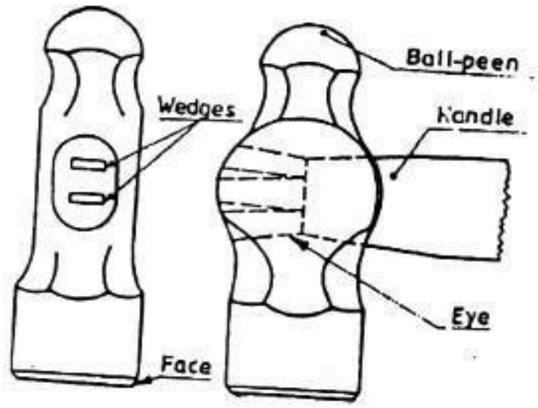
3.2.1 Types of files:

a. Flat file: This file has parallel edges for about two-thirds of the length and then it tapers in width and thickness. The faces are double cut while the edges are single cut.

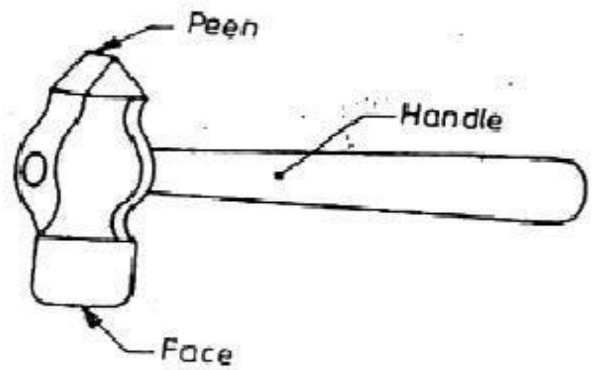
b. Hand file: for a hand file the width is constant throughout, but the thickness tapers as given in flat file. Both faces are double cut and one edge is single cut. The remaining edge is kept uncut in order to use for filing a right-angled corner on one side only.

c. Square file: It has a square cross-section. It is parallel for two-thirds of its length and then tapers towards the tip. It is double cut on all sides. It is used for filing square corners and slots.

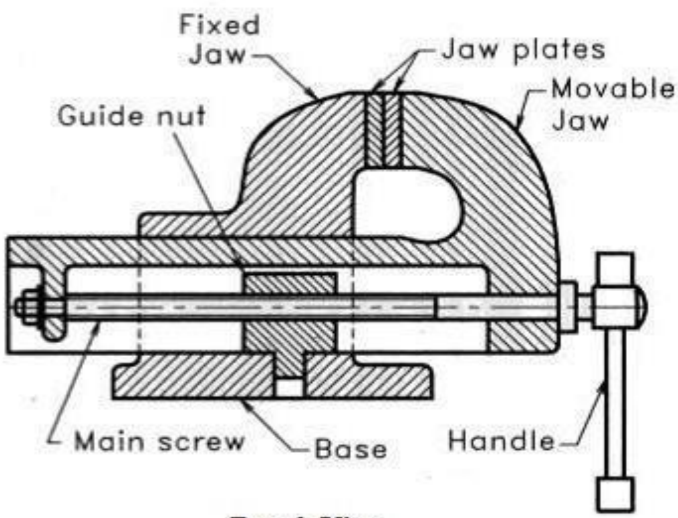
d. Round file: It has round cross-section. It carries single cut teeth all round its surface. It is normally made tapered towards the tip and is frequently known as rat-tail file. Parallel round



Ball Peen Hammer



Cross Peen Hammer



Bench Vice

Fig No: 02 Fitting (Hand Tools)

files having same diameter throughout the length are also available. The round files are used for opening out holes, producing round comers, round-ended slots etc.

e. Half-round file: Its cross-section is not a true half circle but is only about one-third of a circle. The width of the file is either parallel throughout or up to middle and then tapered towards the tip. The flat side of this file is always a double cut and curved side has single cut. It is used for filing curved surfaces.

f. Triangular file: It has width either parallel throughout or up to middle and then tapered towards the tip. Its section is triangular (equilateral) and the three faces are double cut and the edges single cut. It is used for filing square shoulders or comers and for sharpening wood working saws.

4. Hand Tools

Hammer

It is a simple striking tool used to make the job to a required shape either in cold or hot conditions beating directly on the job. There are four types of hammer.

a) Ball- Peen Hammer

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

b) Cross peen hammer

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

c) Straight-Peen Hammer

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

d) Riveting hammer

A hammer having a long head, a flat face, and a narrow peen; used for swaging down rivets or beating sheet metal.

e) Bench-vice:

A device is used to hold the job firmly fixed on a bench is called Bench-vice. It is available according to their length of the jaw plates.

- **Parts of the Vice:**

1) Fixed Jaw, 2) Moveable Jaw, 3) Jaw plates, 4) Spindle, 5) Handle, 6) Box nut,

7) Split pin, 8) Washer It is an instrument used to checkup the manufacture job to know whether it is fit or not. It is made from tool steel hardened and tempered. Gauges are classified according to their nature or work.

Ex. No. 1
Square Fitting

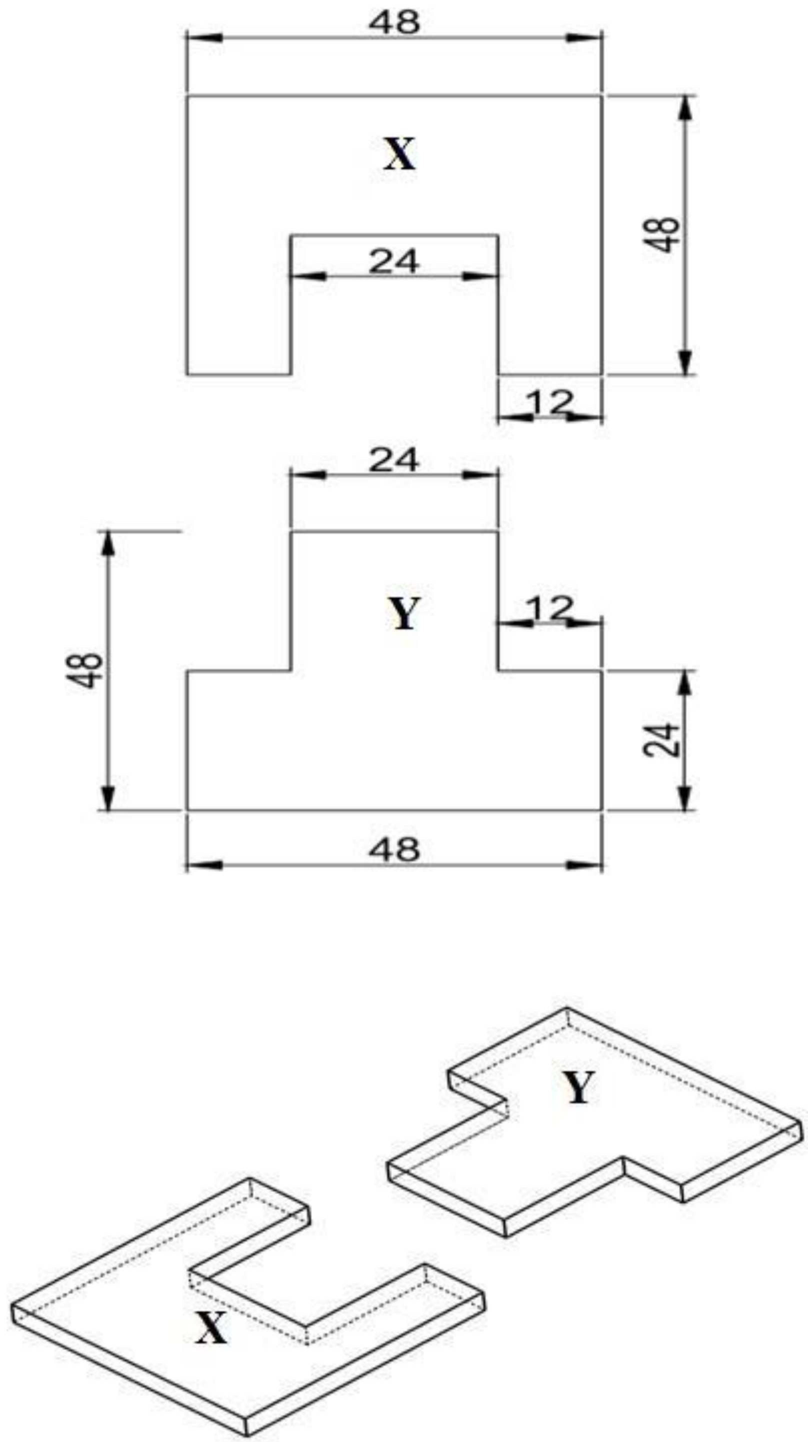


Fig No:03 Square Fitting

All dimensions are in mm

Ex. No. 1

Square Fitting

Aim: To make a Square fitting from the given two M.S pieces.

Material: Two MS Flat pieces of size 50x50x5mm

Tools Required & Equipment:

1. 10" Flat rough file	2. 6" Safe edge file	3. 4" Try square
4. 6" Vernier Calipers	5. 12" Vernier height gauge	6. 4" Angle plate
7. 2" V-Block	8. 12" Hacksaw	9. 4" Dot punch
10. Feeler Gauge	11. 1/2 lb. (half pound) Ball peen Hammer	

Sequence of Operations:

1. Filling 2. Marking 3. Punching 4. Sawing 5. Filling 6. Finishing

Precautions:

1. While sawing use coolant properly.
2. While sawing, Hacksaw should move perpendicular to the job pieces.
3. Should wear Apron, Shoes while entering to the laboratory.
4. Marking is done without parallax error.

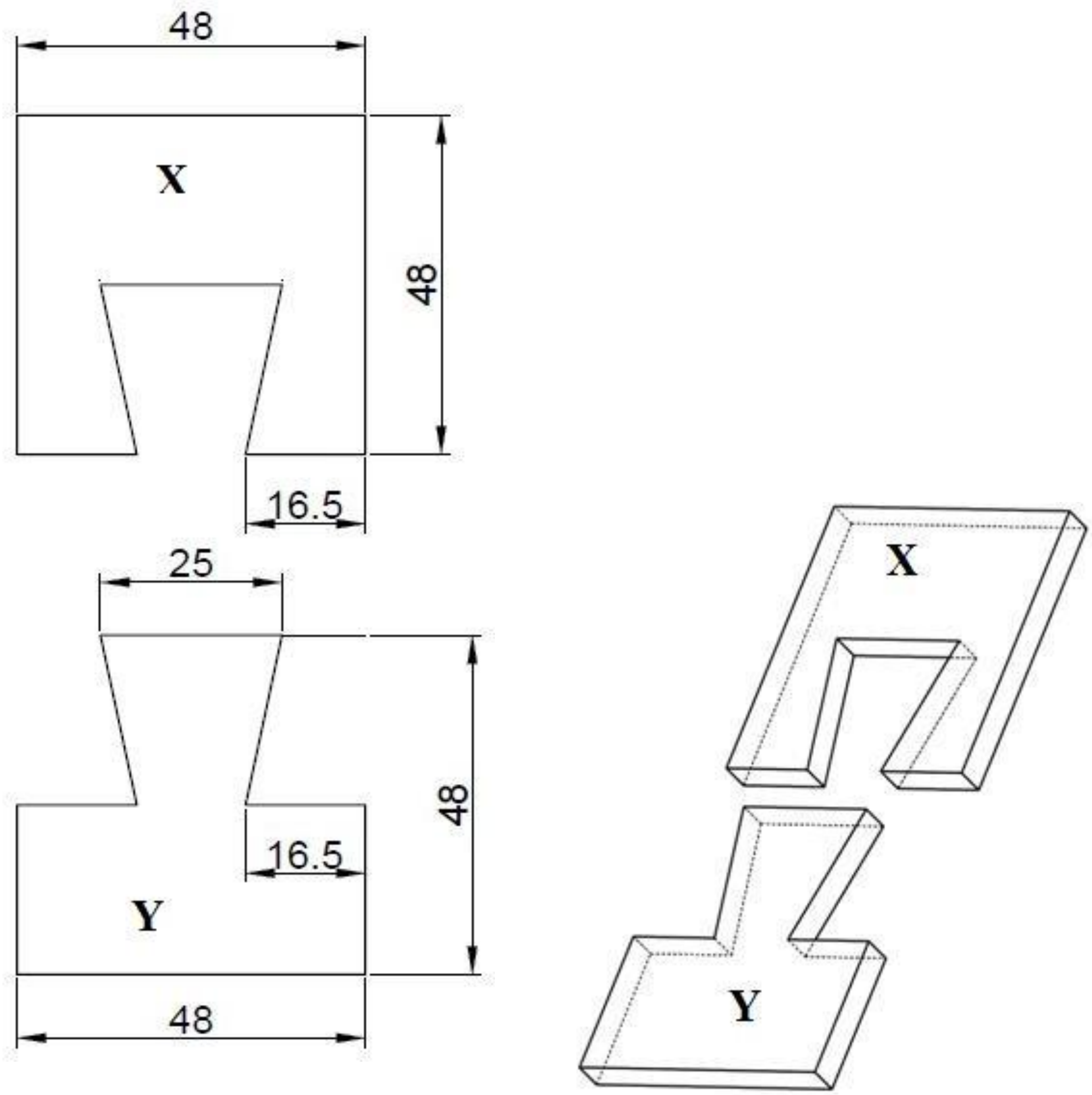
Procedure:

1. The burrs in given materials are removed and the dimensions are checked for 50x50x5mm with steel rule.
2. The pieces are clamped one after the other and outer mating edges are filed and checked for their flatness, with the help of try-square.
3. The side edges of the two pieces are filed such that, they at right angles to each other and widths are exactly 48mm.
4. Wet chalk is applied on surfaces of the two pieces.
5. The given dimensions of the Square fitting are marked, by using steel rule, scriber, and the surface plate.
6. The portion to be removed is then marked.
7. Using dot punch, dots are punched along the above scribed lines.
8. Using the hacksaw, the unwanted portions are removed.
9. Now the potions are filed and burrs are removed by filing on the surfaces of fitted job.

Result: The square fitting is thus made by following the above sequence of operations.

EX.NO. 2

Dovetail Fitting



TV **3D VIEW**

Fig No: 04 Dovetail Fitting

All dimensions are in mm

EX.NO. 2

Dovetail Fitting

Aim: To make a dovetail fitting as per the given dimensions.

Material Required: Two MS Flat pieces of size 50x50x5mm

Tools Required & Equipment:

1. 10" Flat rough file	2. 6" Safe edge file	3. 4" Try square
4. 6" Vernier Calipers	5. 12" Vernier height gauge	6. 4" Angle plate
7. 2" V-Block	8. 12" Hacksaw	9. 4" Dot punch
10. Feeler Gauge	11. 1/2 lb. (half pound) Ball peen Hammer	

Precautions

1. While sawing use coolant properly.
2. While doing in step filing use safe edge file.
3. While sawing, Hacksaw should move perpendicular to the job pieces.

Sequence of Operations

1) Filing, 2) Marking, 3) Punching, 4) Sawing, 5) Filing to the given dimensions, 6) Finishing

Procedure:

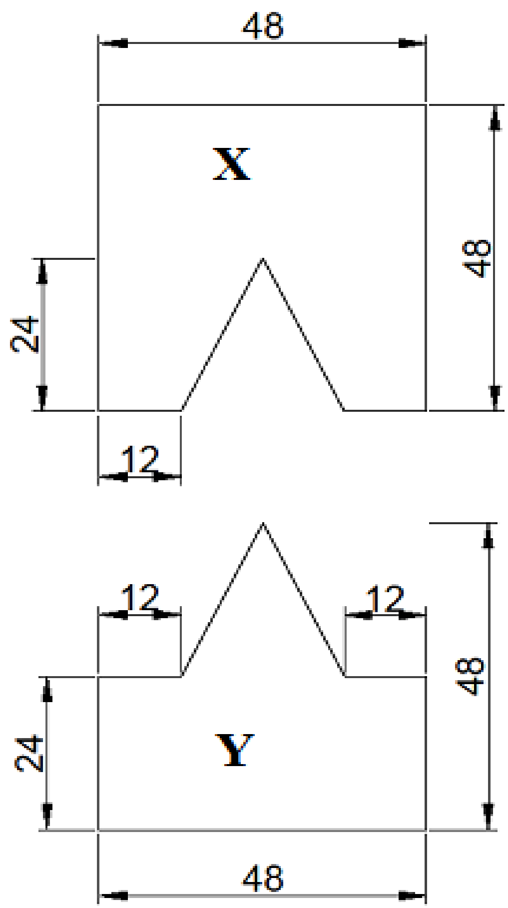
1. The burrs in the pieces are removed and the dimensions are checked with the steel rule.
2. The pieces are clamped one after the other and the outer mating edges are filed and checked for their flatness, with the help of the try-square.
3. The side edges of the two pieces are filed such that, they are at right angle to each other and widths are exactly 48 mm.
4. Chalk is then applied on the surfaces of the two pieces.
5. The given dimensions of the dovetail fitting are marked, by using the Jenny caliper, steel rule and surface plate.
6. Using the dot punch, dots are punched along the above scribed lines.
7. Using the hack saw, the unwanted portions are removed.
8. Using the flat chisel, the unwanted material in the piece Y is removed.
9. The cut edges are filed by the half round file.
10. The corners of the stepped surfaces are filed by using a square or triangular file to get the sharp corners.

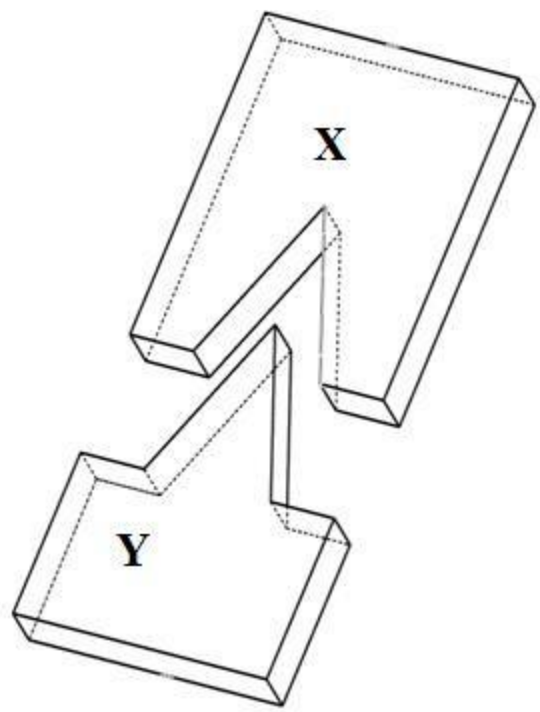
The pieces (X and Y) are fitted together and the mating is checked for the correctness of the fit, any defects noticed, is rectified by filing with a smooth file.

2.7. Result: The required Dovetail fitting is obtained according to the drawing.

Ex. No. 3

V- Template Fitting





TV **3D VIEW**

Fig No: 05 V-Template Fitting

All dimensions are in mm

Ex. No. 3

V- Template Fitting

Aim: To make a V- Template as per the given dimensions.

Material Required: Two MS Flat pieces of size 50x50x5mm

Tools Required & Equipment:

1. 10" Flat rough file	2. 6" Safe edge file	3. 4" Try square
4. 6" Vernier Calipers	5. 12" Vernier height gauge	6. 4" Angle plate
7. 2" V-Block	8. 12" Hacksaw	9. 4" Dot punch
10. Feeler Gauge	11. 1/2 lb. (half pound) Ball peen Hammer	

Precautions

1. While sawing use coolant properly.
2. While doing in step filing use safe edge file.
3. While sawing, Hacksaw should move perpendicular to the job pieces.

Sequence of Operations

1) Filing, 2) Marking, 3) Punching, 4) Sawing, 5) Filing to the given dimensions, 6) Finishing

Procedure

1. The given MS piece is fixed in the bench vice and one of the two surfaces is filed with a 10" flat rough file and checkup the flatness with the help of try square. File two adjacent sides and make it right angle.
2. Apply marking media only on field surface.
3. Marking should be done with the help of a Vernier height gauge as per the given dimensions.
4. After marking, punching should be done with the help of Dot punch & Ball peen hammer as per given dimensions.
5. Sawing the excess material with the help of Hacksaw, filing should be done as per given dimensions with the help of a Flat smooth file & safe edge file.
6. Checkup the dimensions with the help of the Vernier caliper as per the given dimensions.
7. File another surface as per required thickness with the help of the flat smooth file.
8. Finishing should be done with the help of flat smooth file.

Result: V-Template fitting is thus made by following the above sequence of operations

REVIEW QUESTIONS

1. Define the terms „Bench work" and „Fitting‟

Ans: Bench work refers to the production of components by hand on the bench.

2. Name the operations that are normally performed under „Bench work‟ and „ Fitting‟

Ans: Bench work operations are fitting operations are chipping, filing, scarping, marking, measuring angles and sawing.

3. Name the material with which a vice body is normally made of. What are the characteristics of this material?

Ans: it is made of cast iron which is strong in compression, week in tension and so fractures under shocks and therefore should never be hammered

4. What for a C-clamp is used.

Ans: It is used to hold the work against an angle plate or v-block or any other surface

5. Name the measuring tools which are a part of the combination set.

Ans: steel rule, square head, centre head, protractor and spirit level

6. Define „Least count‟‟ of a vernier.

Ans: minimum dimension which can be measured by the device

7. Name the parameters which specify the size of the fallowing.

Surface plate,

Ans: length, width and height

Try square,

Ans; length of the blade

Combination set

Ans: length of its rule

Screw driver

Ans: length of the metal part from handle to tip

8. Classify hacksaw blades.

Ans: a) All hards made of HSS hardened and tempered material

b) Flexible types made of HSS or low alloy steels

CARPENTRY

Table 1: Carpentry tools

S No.	Tools	Specifications
1	Steel Rule	24"
2	Marking gauge	2" x 2"
3	Carpentry vice	8" x 6"
4	Metal jack plane	14"
5	Try square	6"
6	Hand Saw	12"
7	Tenon Saw	12"
8	Rip saw	18"
9	Firmer Chisel	5, 18, 12, 6 mm
10	Bevel edge chisel	12, 18 mm
11	Mortise chisel	12 mm
12	Wooden mallet	4" x 4"
13	Pincer	2" x 2"
14	Wood Rasp File	

Introduction to Carpentry

Introduction:

Carpentry may be defined as the process of making wooden components. It starts from a marketable form of wood and ends with a finished product. It deals with the building work, furniture, cabinet making, etc. Joinery, i.e. preparation of joints is one of the important operations in all wood works. It deals with the specific work of a carpenter like making different types of joints to form a finished product. In this chapter, tools and works associated with joinery are presented.

Specification of wood:

Timber is the name given to the wood obtained from well grown trees. The trees are cut, sawn into various sizes to suit building purposes. The word, „grain", as applied to wood, refers to the appearance or pattern of the wood on the cut surfaces. The grain of the wood is a fibrous structure and to make it strong, the timber must be so cut, that the grains run parallel to the length.

Classification of Timber

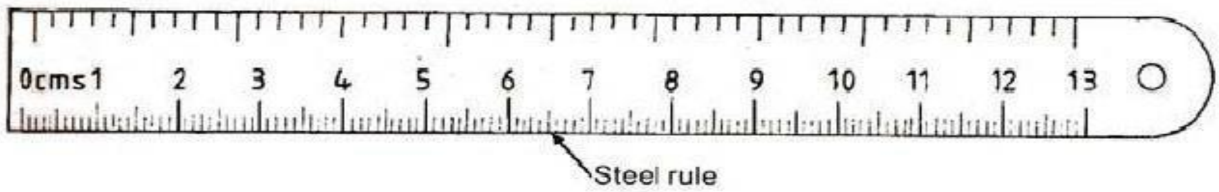
Wood suitable for construction and other engineering purposes is called timber. Woods in general are divided into two broad categories: Soft woods and hard woods.

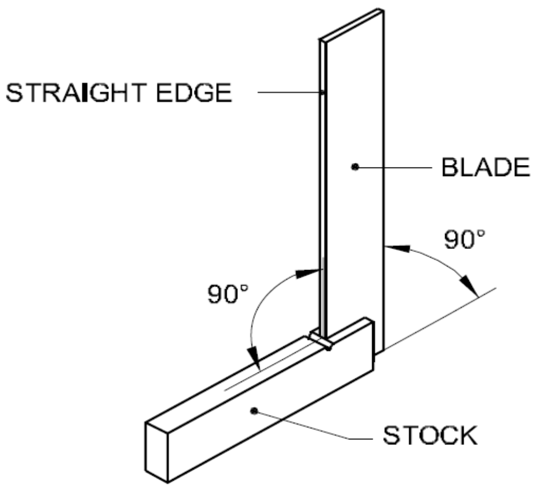
Soft woods are obtained from trees having needle shaped leaves or conifers grown in colder part of the world.

Hard woods are obtained from trees having broad leaves or deciduous trees in hot climate.

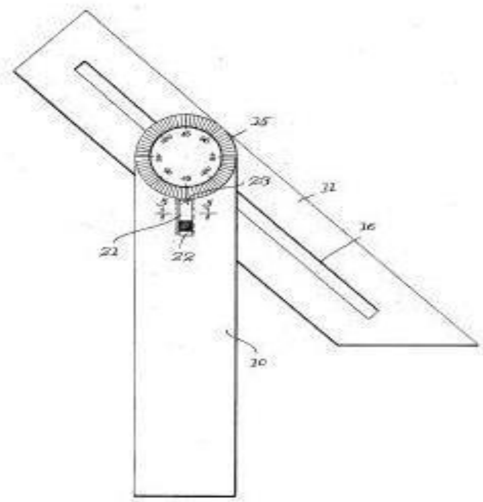
Seasoning of Wood

A newly felled tree contains considerable moisture content. If this is not removed, the timber is likely to wrap, shrink, crack or decay. Seasoning is the art of extracting the moisture content under controlled conditions, at a uniform rate, from all the parts of the timber. Only seasoned wood should be used for all carpentry works. Seasoning makes the wood resilient and lighter. Further, it ensures that the wood will not distort after it is made into an object.





Try Square



Bevel square

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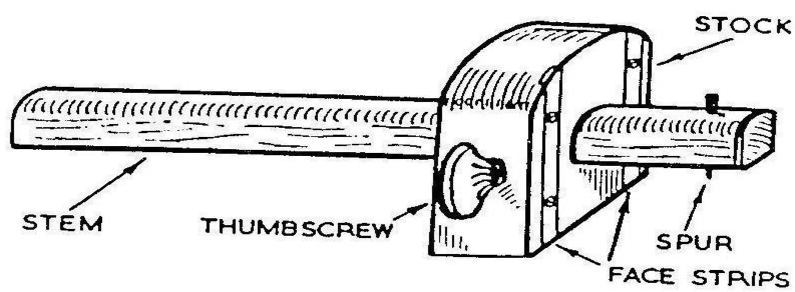
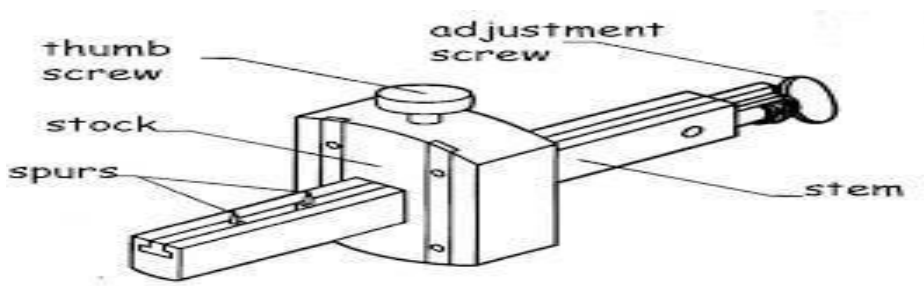


Marking Gauge



Mortise Gauge

Fig No: 06 Marking and measuring Tools

Carpentry Tools

Carpentry involves operations like cutting, shaping, fastening, etc.., which requires a variety of tools. The tools which are used to perform the exercises in the WMP lab are tabulated below.

Classification of Carpentry Tools

Marking and Measuring Tools

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

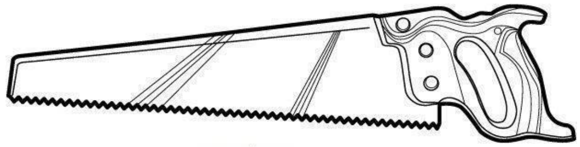
a) **Steel Rule:** Steel rule is a simple measuring instrument consisting of a long, thin metal strip with a marked scale of unit divisions. It is an important tool for linear measurement.

b) **Try Square**: Try Square is used for marking and testing angles of 90^0. It consists of a steel blade riveted into a hard wood stock, which has a protective brass plate.

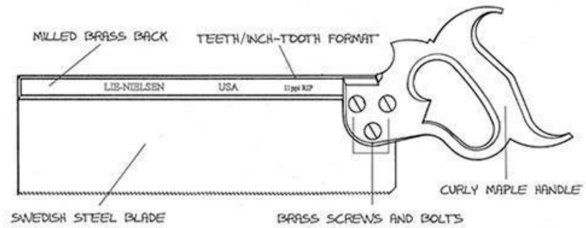
c) **Bevel Square**: The bevel square is similar to the try square but has a blade that may be swiveled to any angle 0 to 180^0. This tool is adjusted, by releasing with a turn screw.

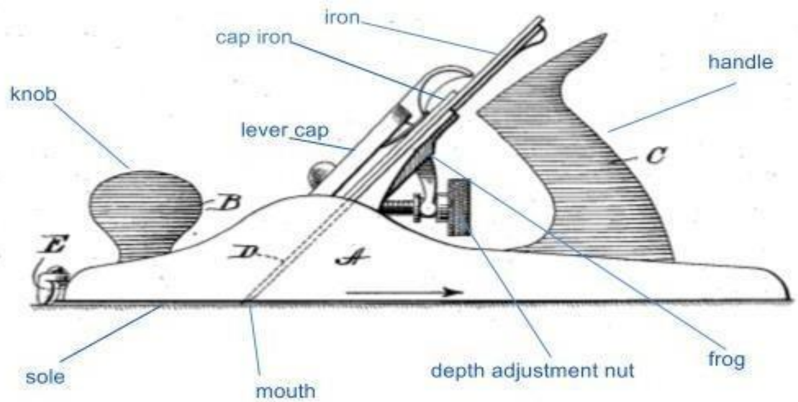
d) **Marking Gauge**: The marking gauge has one marking point. It gives an accurate cut line parallel to the true edge. Usually with the grain.

e) **Mortise Gauge**: Mortise Gauge has two marking points one fixed near to the end of the steam and another attached to the brass sliding bar these two teeth cut two parallel lines called mortise lines.

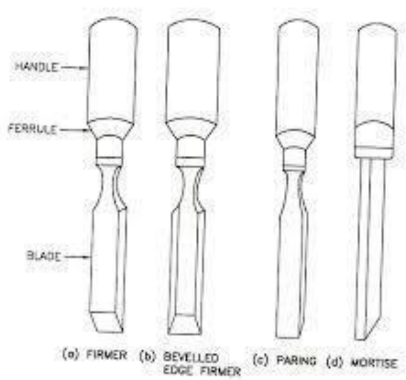


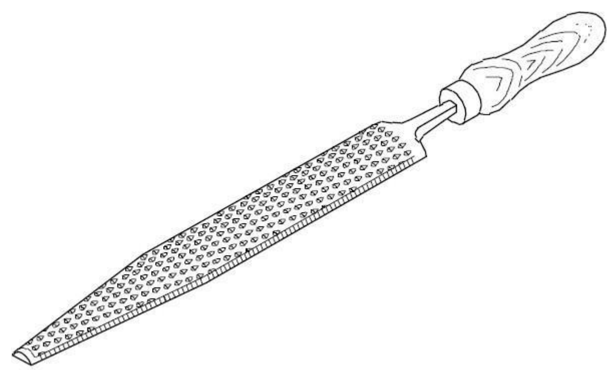
Hand Saw



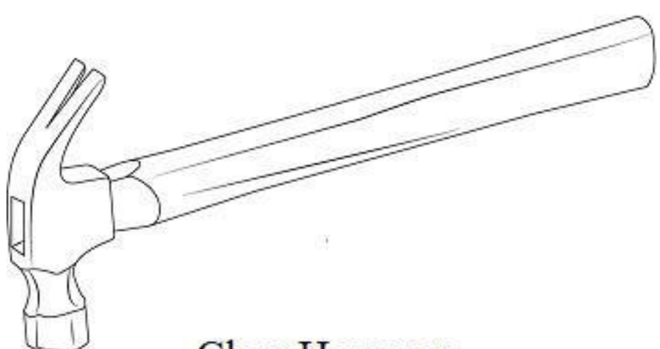


Metal Jack Plane





RASP CUT FILE



Claw Hammer

Mallet

Fig No: 07 Cutting and planning tools

Cutting and planning tools

a) **Rip Saw:** Rip Saw is used for cutting along the grain in thick wood. The blade is made of high grade tool steel and may be either straight or skew backed. It is fitted in a wooden handle. Made of hard wood by meant of rivets or screws.

b) **Hand saw**: Cross cut saws, or hand saws as they are sometimes called are used for cutting across the grain in thick wood.

c) **Tenon Saw**: Tenon Saw is mostly used for cross cutting when a finer and more accurate finish is required the blade, being very thin.

d) **Metal jack plane**: A metal jack plan serves the same purpose as the wooden planes but facilitate a smoother operation and better finish. The body of a metal plane is made from a Grey Iron Casting.

e) **Firmer Chisel**: Firmer Chisel is most useful for general purposes and may be used by hand pressure or mallet.

f) **Bevel Edge Chisel**: Beveled edge chisel is used for more delicate or fine work. They are useful for getting acute angles.

g) **Mortise Chisel**: The mortise chisel is used for chopping out mortises. This chisels are designed to with stand heavy work.

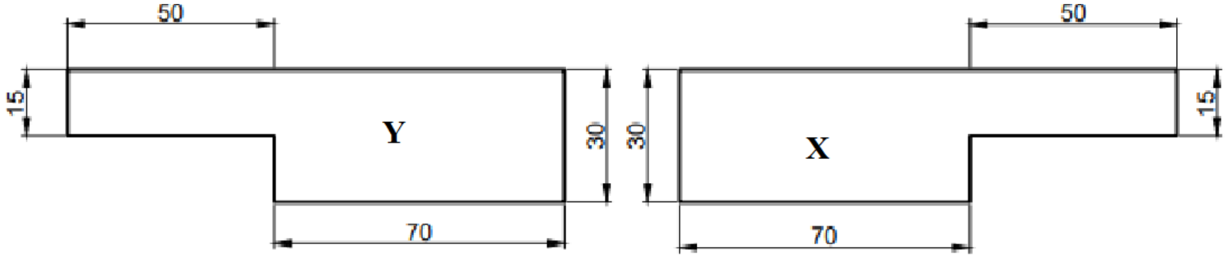
h) **Pincer**: Pincer is mainly used for pulling out nails, tacks etc. It consists of two arms– one area has a ball end and the other arm has end for levering out small tacks

i) **Wood Rasp File:** A rasp is coarse form of file used for coarsely shaping wood, it consists of a generally tapered rectangular, round, or half-round sectioned bar of case hardened steel with distinct, individually cut teeth.

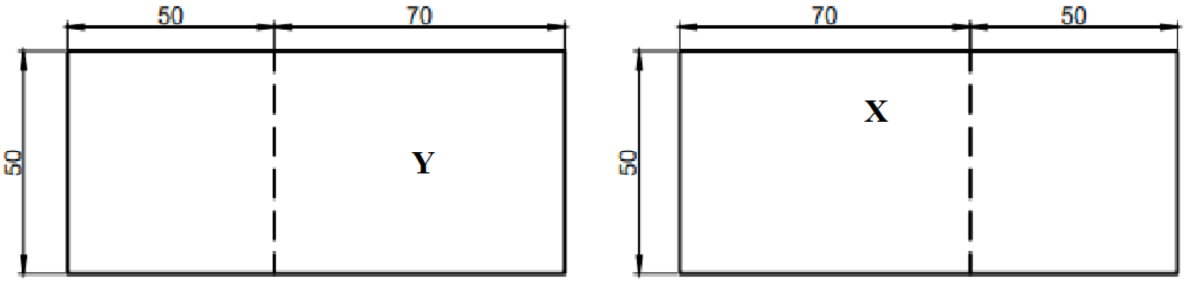
j) **Claw Hammer**: It serves the dual purpose of hammer and as well as pincer. The claw is used for pulling out any nails.

k) **Mallet**: The mallet is woodenheaded hammer of round or rectangular cross section the striking face is made flat to the work

Ex. No. 1
End- Lap Joint



FV



TV

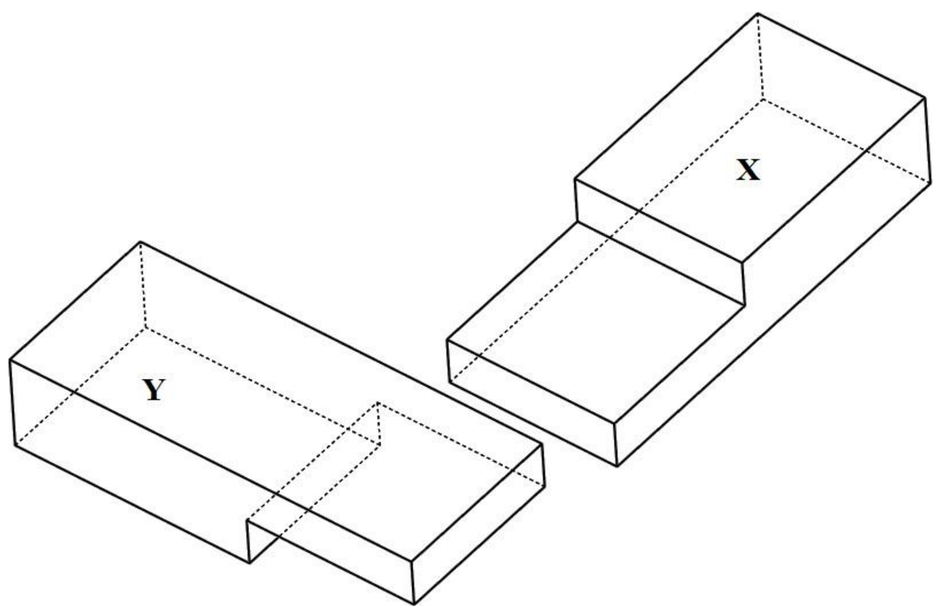


Fig No:08 End Lap Joint

All dimensions are in mm

Ex. No. 1
End- Lap Joint

Aim: To make a End-Lap joint.

Material Required: Soft Wood (250 mm x50 mm x30mm).

Tools required: 1. 300mm Steel rule 2. Metal jack plane 3. Try-square 4. Marking gauge, 2. Hand saw 6. Wooden mallet 7. Wood rasp file 8. Mortise chisel 9.Scriber10.Tenon saw.

Sequence of operations:

1. Planning 2. Marking 3.Sawing 4.Chiseling 5.Filing 6.Finishing.

Procedure:

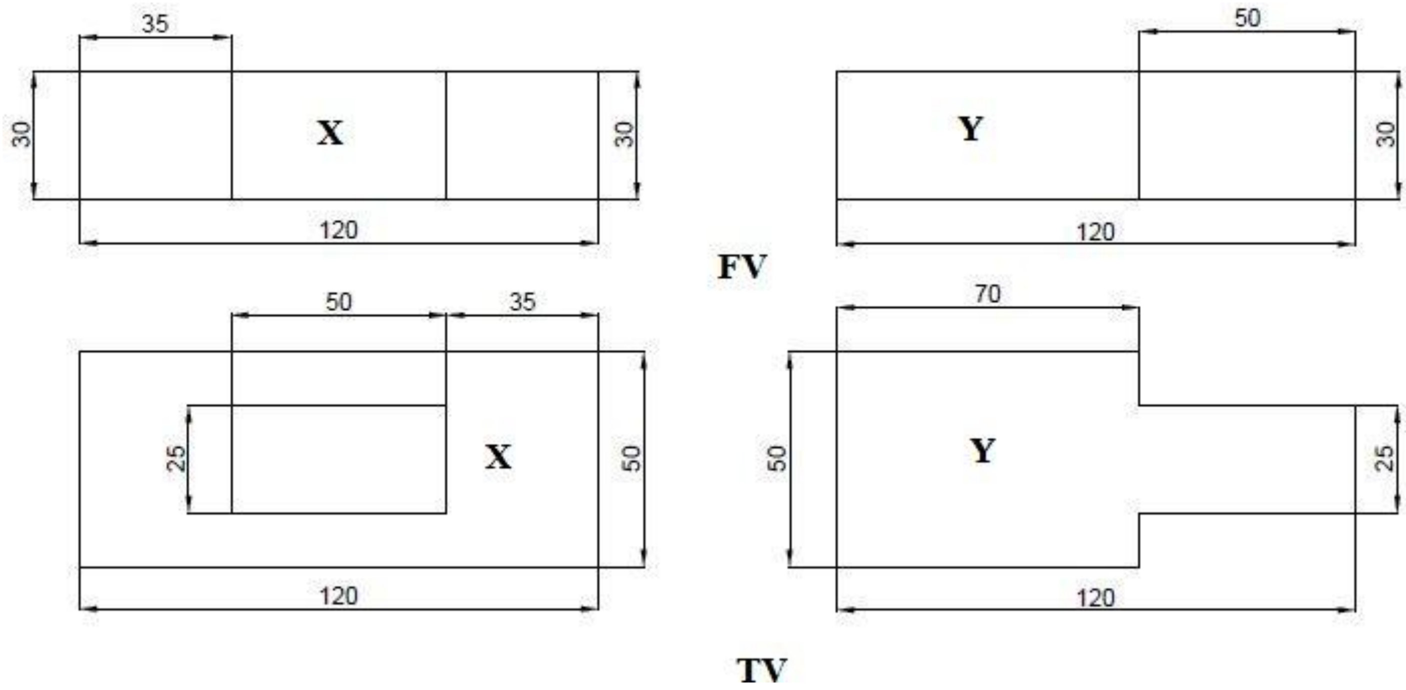
1. The given reaper is checked to for dimension.
2. The reaper is firmly clamped in the carpenters vice and to adjacent faces is planed by the jack plane and the two faces are checked for squareness with the Try-square.
3. Marking gauge is set and lines are draw at 30 and 50mm, to mark the thickness and width of the model respectively.
4. The excess material first chiseled out with firmer chisel and then planned to correct size.
5. The mating dimensions of the parts X and Y are then marked using scale and marking gauge.
6. Using the tenon saw, the portion to be removed or cut in both the pieces, followed by chiseling and also the parts X and Y are separated by cross-cutting, using the tenon saw.
7. The end of both the parts are chiseled to the exact lengths.
8. A fine finishing is given to the parts, if required so that, proper fitting is obtained.
9. The parts are fitted to obtain a slightly tight joint.

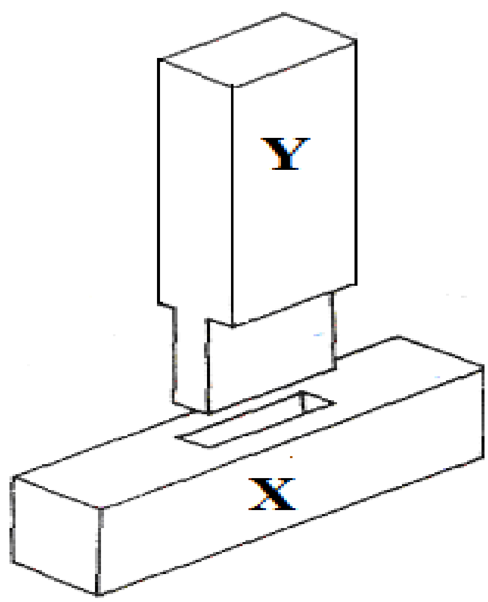
Safety Precautions:

- Loose cloths should be avoided.
- Shoes should be worn.
- The saw teeth should not touch the hard material.
- Work shop should always be kept clean.

Result: The End-Lap joint is thus made by following the above sequence of operations.

Ex. No. 2
T-Bridle Joint





3D VIEW

Fig No:10 T-Bridle Joint

All Dimensions in mm

Ex. No. 2
T-Bridle Joint

Aim: To make T-Bridle Joint as per given dimensions.

Material Required: Soft Wood (250 mm x 50 mm x 30 mm).

Tools required: 1. 300mm Steel rule 2.Metal jack plane 3.Try-square 4.Marking gauge 5. Hand saw 6.Wooden mallet 7.Wood rasp file 8.Mortise chisel 9.firmer chiesel.

Sequence of Operations:

1. Planning 2. Marking 3.Sawing 4.Chiseling 5.Filing 6.Finishing.

Procedure:

1. The given reaper is checked for dimension.
2. The reaper is firmly clamped in the carpenter's vice and one of its faces are planned by the jack plane and checked for straightness.
3. The adjacent face is then planed and the faces are checked for squareness with the try square.
4. Marking gauge is set and lines are drawn at 30 and 50 mm, to mark the thickness and width of the model respectively.
5. The excess material is first chiseled out with the firmer chisel and then planned to correct size.
6. The mating dimensions of the parts X and Yare then marked using the scale and marking gauge.
7. Using the tenon saw, the portions to be removed in part Y (tenon) is cut, followed by chiseling.
8. The material to be removed in part X (mortise) is carried out by using the mortise and firmer chisels.
9. The parts X and Yare separated by cross-cutting with the tenon saw.
10. The ends of both the parts are chiseled to exact lengths.
11. Finish chiseling is done wherever needed so that, the parts can be fitted to obtain a near tight joint.

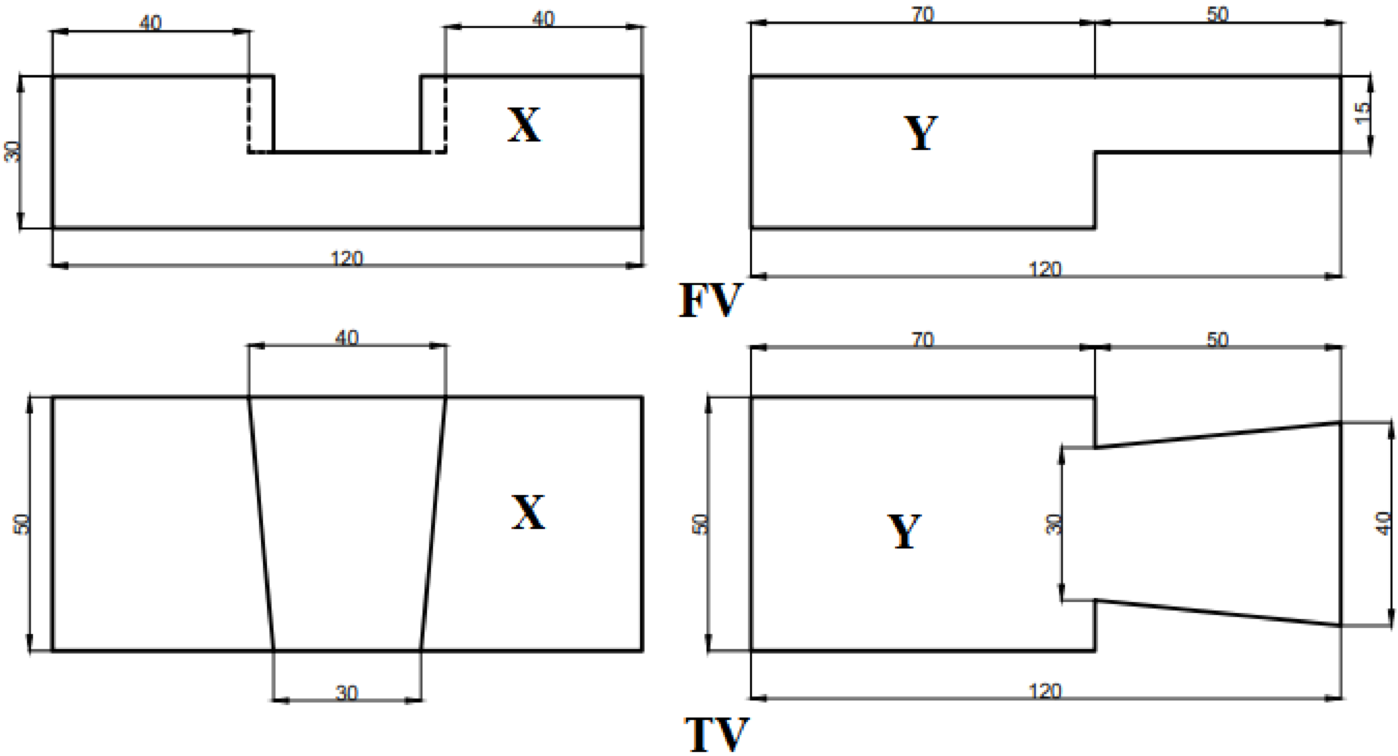
Safety Precautions:

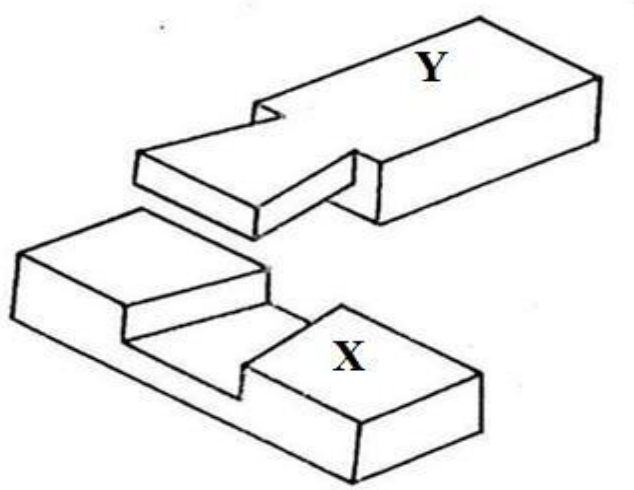
- Loose cloths should be avoided.
- Shoes should be worn.
- The saw teeth should not touch the hard material.
- Work shop should always be kept clean.

Result:

The T- Bridle joint is thus made by following the above sequence of operations.

Ex. No. 3
Dovetail Joint





3D VIEW
Fig No:11 Dovetail Joint

All dimensions are in mm

Ex. No. 3
Dovetail Joint

Aim: To make dovetail lap joint as per dimensions.

Materials required: Soft Wood (250 mm x50 mm x30mm).

Tools required: 1.300mm Steel rule 2.Metal jack plane 3.Try-square 4.Marking gauge 5. Hand saw 6.Wooden mallet 7.Wood rasp file 8.Mortise chisel 9. Scriber 10. Tenon Saw

Sequence of operations:

1. Planning 2. Marking 3.Sawing 4.Chiseling 5.Filing 6.Finishing.

Procedure:

1. The given wood is checked for dimensions.
2. One side is planned with metal jack plane and checked for trueness by try-square.
3. The four sides are also planned.
4. The excess material is cut by tenon saw.
5. Now the portions for lapping portion are marked.
6. After sawing remove the waste material by firmer chisel.
7. If the material is still remained in 2 or 3 mm, the remove by filing by wood rasp file.

<u>Note:</u>

Dovetail joint is widely used simple and effective joint. Generally an angle of 1:6 ratios is adopted. It is partially used in joint between the sides and back of drawers.

Safety Precautions: -

- Loose cloths should be avoided.
- Shoes should be worn.
- The saw teeth should not touch the hard material.
- Work shop should always be kept clean.

Result:

The dovetail lap joint is thus made by following the above sequence of operations.

REVIEW QUESTIONS

1. **Name the commonly available shapes of timber in the market.**

Ans: - log, balk, post, plank, board, batten, scantlings or reapers

2. **Classify the planning tools.**

Ans: - to regulate the depth of cut, to straighten the blade so that it produces flat surfaces

3. **Name the different type of chisels**

Ans: - firmer chisel, dove tail chisel, mortise chisel

4. **On what parameters, the strength of the joint depends.**

Ans: - the strength of joint depends upon the amount of contact area

5. **Name the various joinery materials used in carpentry.**

Ans: - nails, screw, bolts, nuts and dowels

ELECTRICAL/ HOUSE WIRING

Introduction to Electrical/House Wiring

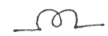
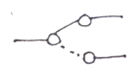
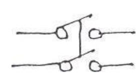
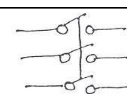
INTRODUCTION

Power is supplied to domesticate installations through a phase and neutral, forming a single phase AC 220v two 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.

Safety Precautions

- ✓ Always be careful.
- ✓ Don"t tamper unnecessarily with any live electrical gear.
- ✓ Don"t disconnect any plug by pulling the flexible cable.
- ✓ Before replacing a blown fuse, always remember to put the main switch off.
- ✓ Safety demands good earthing. Here always keep earthing connections in good conditions.
- ✓ While handling on electrical appliance like Table Fan, Iron heaters etc., be sure that they are disconnected from the supply. Switches off is not enough. Leaky insulation may give serious shock.
- ✓ Live wires should always be connected through the switch.
- ✓ Do not put a share edge tool in your pocket.
- ✓ In case of electric wire, do not throw water on line conductor and equipment as it is dangerous. The best remedy is to disconnect the electrical supply immediately and then throw sand (or) dust on fire.
- ✓ Do not tie wire with the electric pole on which clothes are dried (or) hanged.

Table No:2 Signals and Symbols

Signs and Symbols:		
1.	Alternate current	
2.	Direct current	
3.	Lamp	
4.	Fuse	
5.	Earthing	
6.	One way switch	
7.	Two way switch	
8.	Double pole iron clad switch	
9.	Triple pole iron clad switch	

CONNECTION OF RESISTANCE

1. Series connections   2. Parallel connection   3. Combined connections

1. Series Connections

The R1 ending is connected to R2 starting and R2 ending is connected to R3 starting like 50 is known as series connections. The characteristics of the series connection the total voltage divided into number of lamps, 50 numbers of lamps. This connection is generally used for decoration purpose.

2. Parallel connections

All the resistance starting terminals are connected at one end and all the ending terminals are connected at another end is known as parallel connections. The characteristics of the parallel connection are voltage same and current will divide. The number of lamps time which is depend upon supply system. This connection can be used for domestic purpose. i.e., House, Factories, Street lights etc.

3. Combined connections:

The combined of series and parallel connection is known as combined connection

CIRCUITS

There are three types of circuits.

1) Open circuit   2) Short circuit   3) Closed circuit

1. Open Circuit:

When we put on the switch the lamp does not glow due to the loose connections of conductors (or) damage of the conductor is known as open circuit.

2. Short Circuit:

When phase and neutral conductors are touching together before the high resistance, the short circuit is occurred when the short circuit is occurred immediately the fuse will blow off when we provide rating of fuse wire i.e., 5A, 10A, 15A etc.

3. Closed Circuit:

When we put on the switch the lamp glow is known as closed circuit. Our circuits are closed circuit and connections are all parallel.

4. Consumption of power: No. of lamps x watts x hours x days

1 x 100 x 5 x 30 = 15000 wh = 15
kwh One unit cost Rs. 1.50
= 15 x 1.50 = Rs. 22.50 p

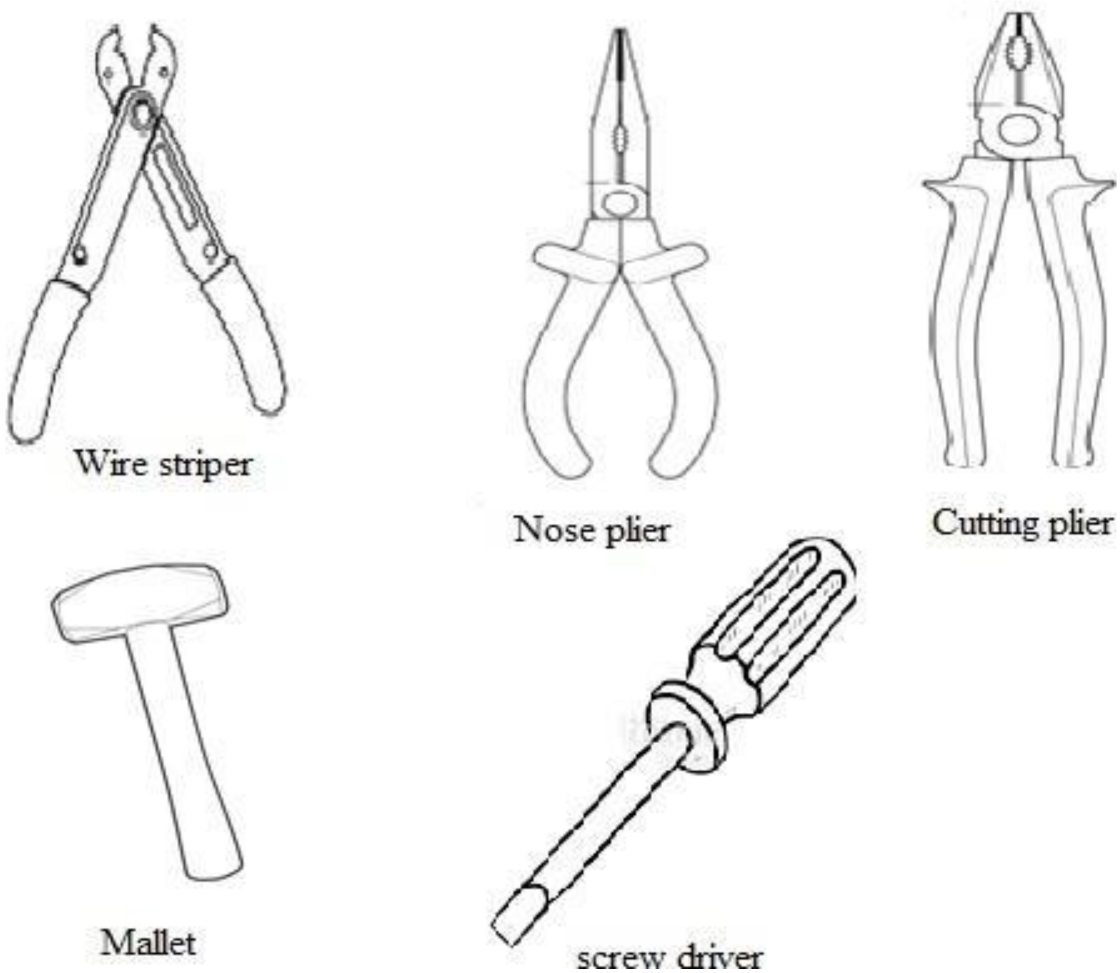


Fig No: 12 Electrical Tools

2. TOOLS AND USES

1. Cutting Pliers

Cutting is a tool used for cutting & nipping purpose. It is used for cutting both insulator and conductor at once. It is available 8” and 6”

2. Nose Pliers

It is a tool used for cutting the conductors and insulators at very narrow places. Whole cutting plier cannot be used because of its width.

3. Screw Driver

Screw driver of different way this and of different sizes of screws. It is used for loosing and fitting the screw. It is available 12”, 8”, 6” & 4” etc.

4. Poker

It is used to make pilot holes on wooden boards.

5. Wire stripper

It is used to remove the insulation.

6. Hammer (1/2 lb.)

It is used for reverting purpose. The iron part of this hammer weighs ½ lb.

EX.NO. 1

Two Lamps in Parallel with 5 pin 6amp socket and switches

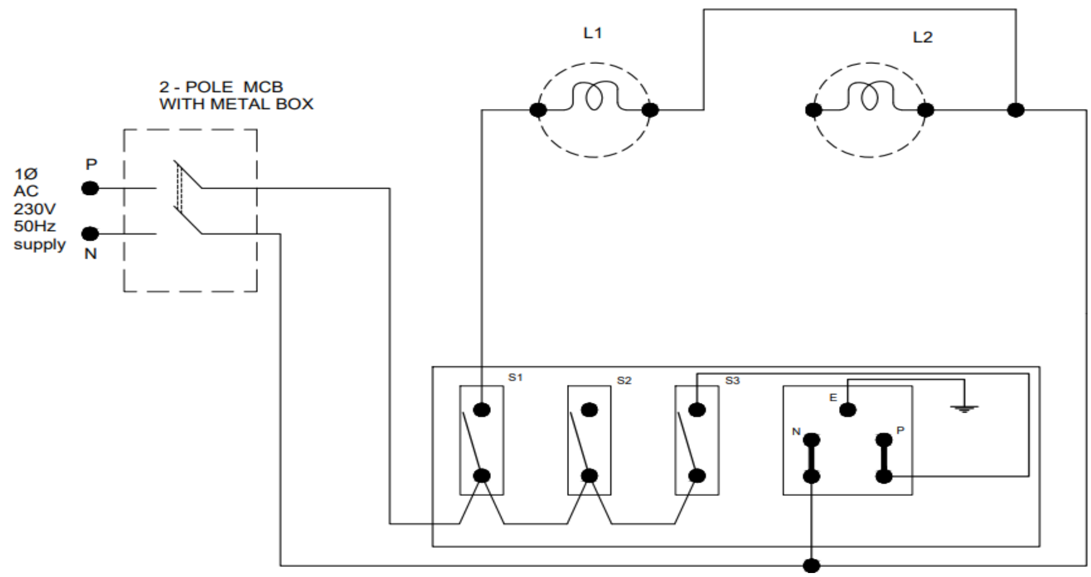
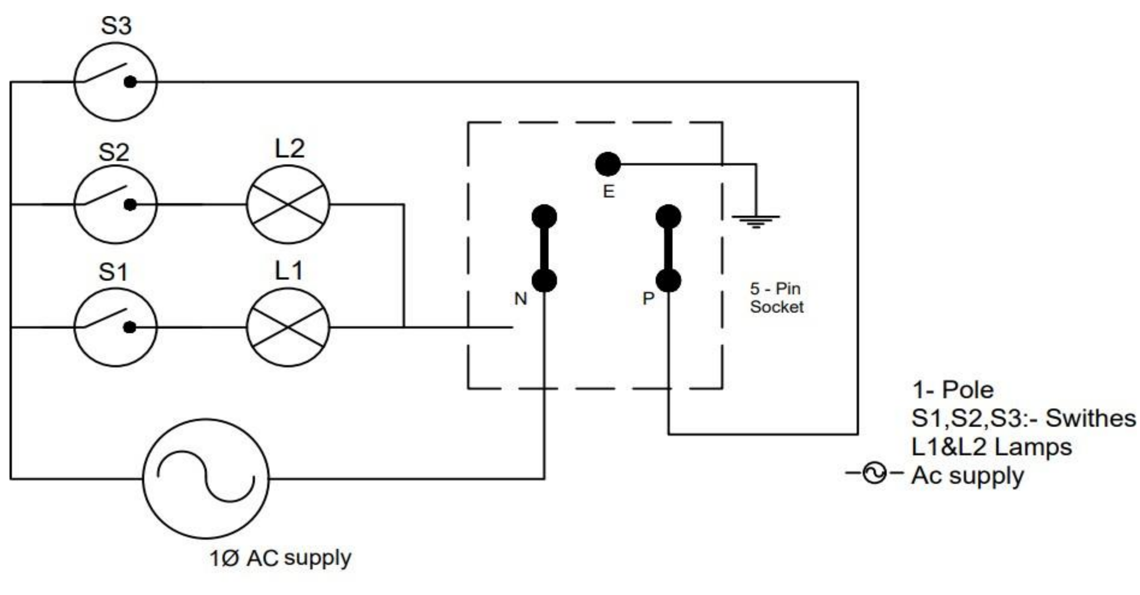


Fig No:13 Connection Diagram (Parallel Connection)



TWO LAMPS WITH 5 - PIN POCKET

Fig No:14 Circuit Diagram(Parallel Connection)

EX.NO. 1

Two Lamps in Parallel with 5 pin 6amp socket and switches

Aim: To connect two lamps in parallel connection with controlling one-way switch with 5pin , 6amp socket.

Material Required:

1. 3 way junction box 3/4
2. Saddle ¾”
3. Square block
4. Round block wooden
5. PVC wire 1/18
6. Screws 12 mm &60 mm
7. PVC pipe ¾”
8. Socket 5pin, 230V, 6amp 1 Nos.
9. switches (1way) 3 No,s
10. Two Lamps

Tools Required:

- Screw Driver 12" 1 No.
- Screw driver 8" 1 No.
- Screw Driver 4" 1 No.
- Cutting plier 8" 1 No.
- Poker 8" 1 No.
- Hammer ½Ib 1 No.
- Wire Stripper 6" 1 No

Index:

1. Hammer ½Ib 1 No. 1 &2 Lamp Holders
2. Wire Stripper 6" 1 No.3 One-Way Switch

Precautions:

1. Avoid loose connections.
2. Avoid short circuit.

Procedure:

1. Make “T” frame with the help of 3-way junction box and fix with help of saddles.
2. Take PVC wire and give connection as per circuit diagram such that a phase wire connected incoming of one-way switch and another wire connected outgoing of one-way switch to the bottom wire which was connected to bottom of L1 and L2 ends. Neutral wire is connected to L1 and L2 second terminal and 5 pin socket second terminal.
3. Fix one-way switch square block.
4. Fix round blocks and the top of the round blocks are connected to lamp holders.

Result: Two lamps are connected in parallel connection with controlling one-way switch.

Ex. No. 2

Two Lamps in Series Connection with switches

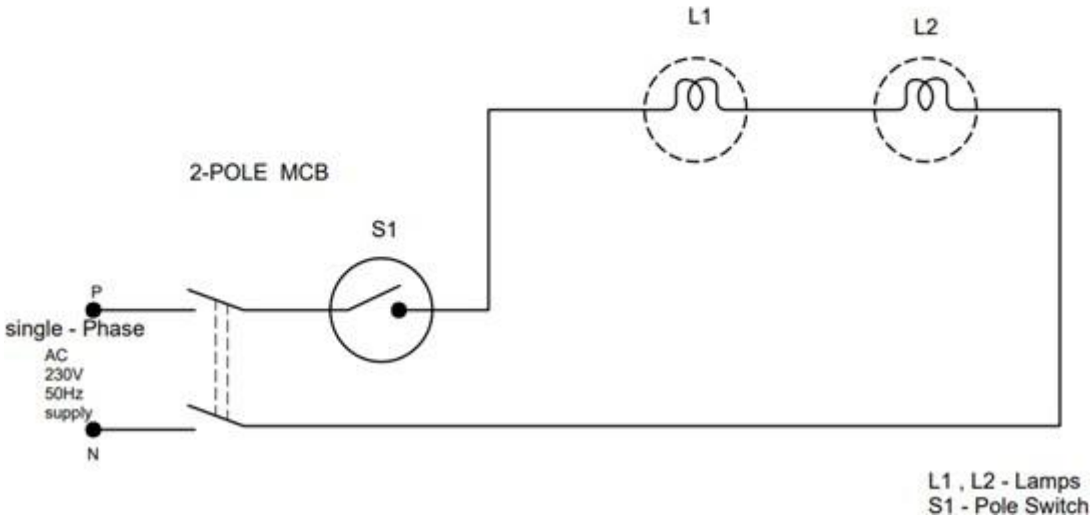


Fig No:15 Connection Diagram(Series Connection)

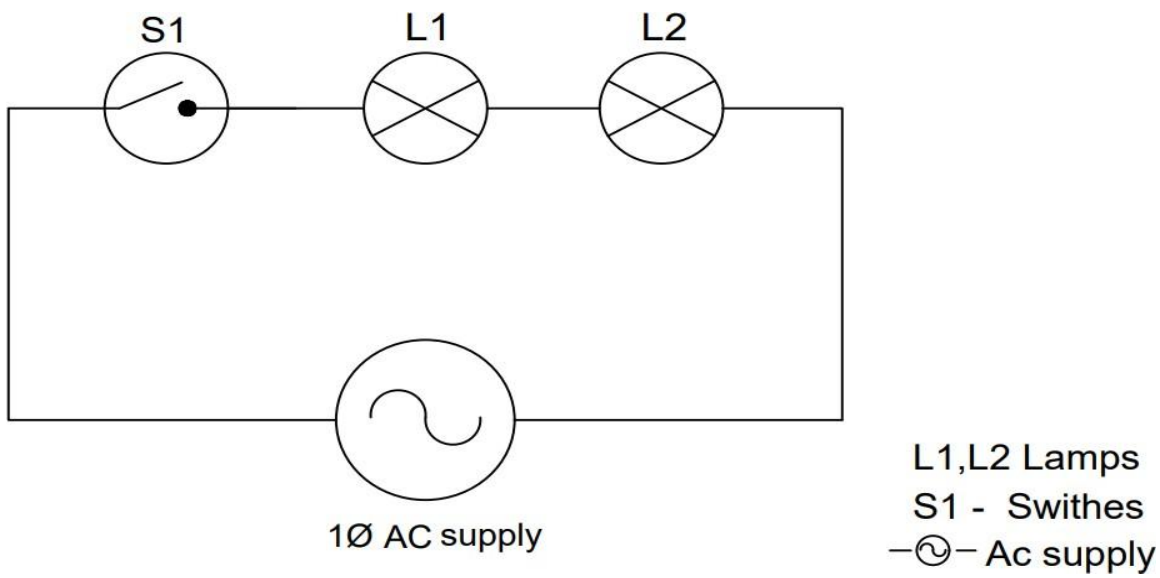


Fig No:16 Circuit Diagram(Series Connection)

Ex. No. 2

Two Lamps in Series Connection with switches

Aim: To connect two lamps in series connection with switches.

Material Required

1. Two lamps 250 volts 6 amp
2. Two lamp holder's 250 volts 6 amp
3. PVC Pipe ¾"
4. One way Switch 2 No. 250 volts 6 amp
5. One Square block
6. Two Round blocks Wooden
7. PVC Wire 1/18

Tools Required

1. Screw Driver 12" 1 No.
2. Screw driver 8" 1 No.
3. Screw Driver 4" 1 No.
4. Cutting plier 8" 1 No.
5. Poker 8" 1 No.
6. Hammer ½ Ib. 1 No.
7. Wire Stripper 6" 1 No

INDEX

- 1 &2 Lamp Holders
- One-Way Switch

PRECAUTIONS

1. Avoid loose connections.
2. Avoid short circuit

PROCEDURE:

1. Make "T" frame with the help of 3-way junction box and fix with help of saddles.
2. Connection such that a phase wire connected incoming of one-way switch and another wire connected to outgoing one-way switch to the one end of L1 bottom lamp holder. Neutral wire is connected to another end of L2 lamp holder. Finally L1 L2 top of ends points are connected with a wire.
3. Fix one-way switch square block.
4. Fix round blocks and the top of the round blocks are connected to lamp holders

Result: Two lamps are connected in series connection

Ex No: 3
Stair-Case Connection

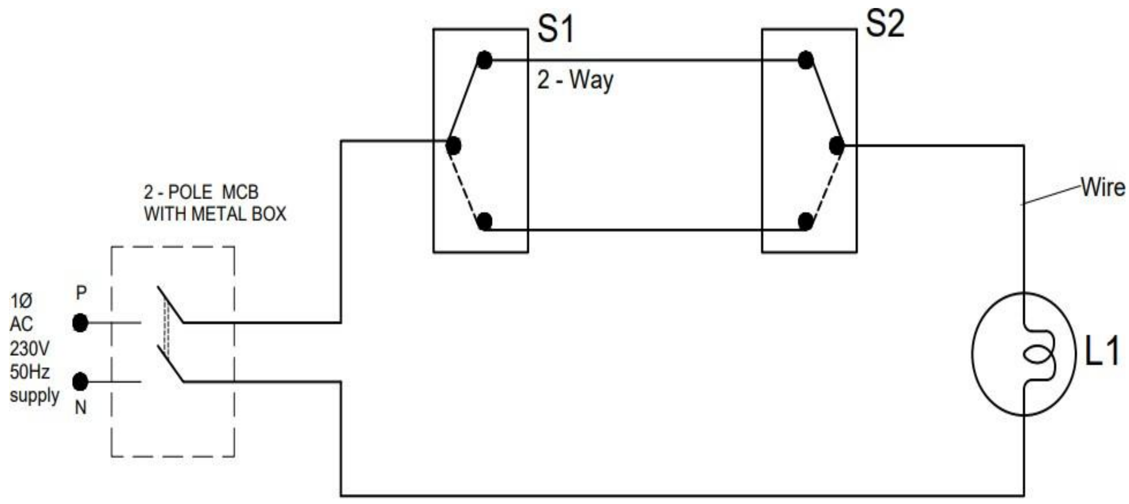


Fig No:17 Connection Diagram (Stair-Case Connection)

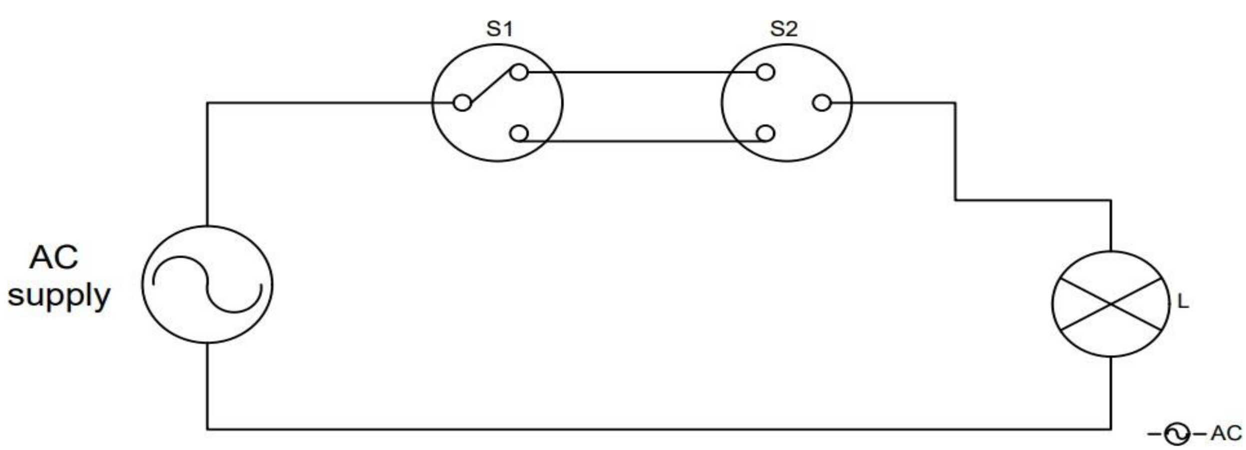


Fig No:18 Circuit Diagram (Stair-Case Connection)

Ex No: 3

Stair-Case Connection

Aim: To give connection to one light controlled by 2 two way switches.

Material Required:

1. Wooden wiring board.
2. One way switch.
3. Wooden round blocks.
4. Batten lamp holders.
5. Wires, wire clips.
6. Bulbs.
7. Nails.

Tools used:

1. Connector screw driver.
2. Poker.
3. Wire stripper.
4. Nose plier.
5. Cutting plier.
6. Pincer.

Precautions:

1. Avoid loose connections.
2. Avoid short circuit.

Sequence of operations:

- ✓ The outline of the wiring diagram is marked on the wooden wiring board.
- ✓ Clips are nailed the board, following the wiring diagram.
- ✓ Wires are stretched and clamped with clips.
- ✓ Wires are connected to the holders and switch, which are then screwed onto the wiring board.
- ✓ Bulbs are fitted to the holders.
- ✓ The wiring connections are then tested, by giving power supply.

Result: The electrical circuit, for one light controlled by 2 way switches is thus made.

Review Questions and Answers

1. Define electrical wiring?

Ans: a wire is defined as a bare or insulated conductor consisting of one or several stands.

2. Name the three types of electrical circuits?

Ans: Open circuit, series circuit and parallel circuit.

3. What is single phase system?

Ans: There will be only one phase, i.e the current will flow through only one wire and there will be one return path called neutral line to complete the circuit.

4. What is three phase system?

Ans: The three phase system can be used as three single phase line so it can act as three single phase system.

5. What is the unit of power?

Ans: Watt

6. What is the function of the electrical switch?

Ans: An electrical switch is any device used to interrupt the flow of electrons in a circuit. Switches are essentially binary devices: they are either completely on ("closed") or completely off ("open").

7. Name the different methods of earthlings?

Ans: plate earthing, pipe earthing, rod earthing, earthing through the waterman.

8. The intensity of the glow of an indicator lamp is a measure of voltage/current level. Ans: voltage

9. How do protect the circuits?

Ans: by installing fuse or circuit breaker.

TIN SMITHY

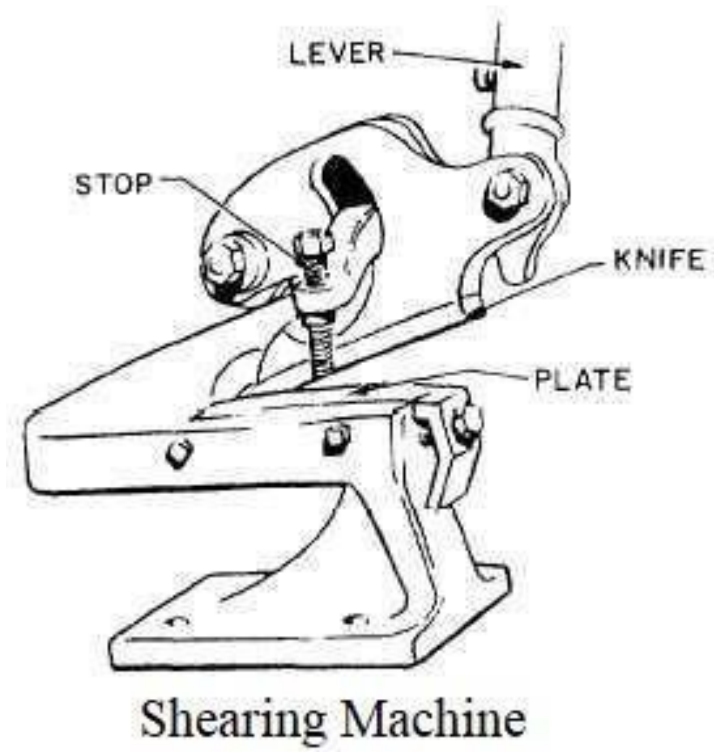


Fig No:19 Shearing Machine

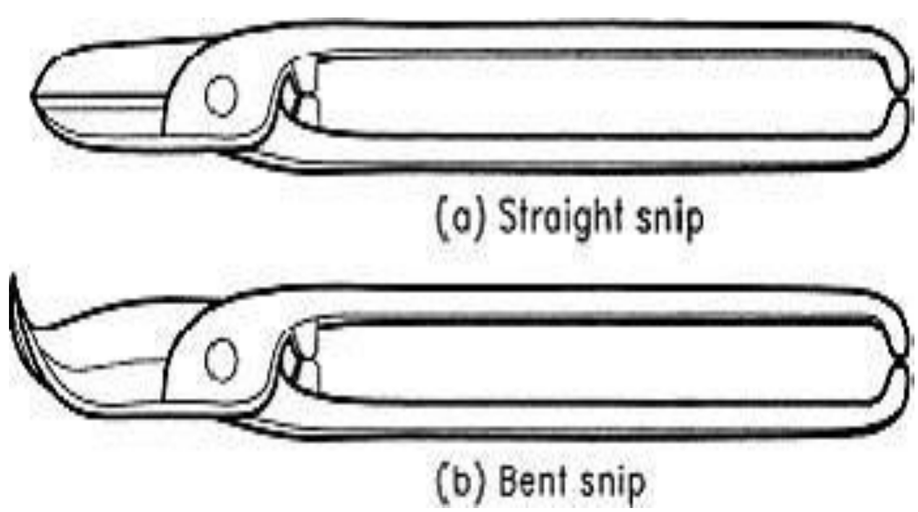


Fig No: 20 Snips

Introduction to Tin Smithy (Sheet Metal Working)

1. Introduction

The sheet metal work section deals working with metallic sheets using hand tools. Sheet metal works such as making a tray, box, funnel, chimney, air duct, fabricate boiler shells and pipe joints from thin or thick plates, etc. are few examples of its application and the process is also known as Tin Smithy. To make any object from sheet metal, knowledge in engineering drawing and development of surfaces is required. As per drawing the sheet is cut and folded to form the required shape of the article. The edge of the article is then secured through welding, brazing, soldering, riveting etc. Allowance should be given in the drawing stage for folding and bending. This allowance depends on the radius of the bend and thickness of the sheet metal.

Sheet Metals Used in Metal Work:

A wide variety of metals, in the form of sheet are used in sheet metal workshop. The most commonly used are explained below.

- **Galvanized Iron (G.I.) Sheet**

  It is a sheet of soft steel coated with zinc. GI sheet is one of the least expensive metals used in sheet metal shop. It is used for making pans, buckets, gutters, tanks, boxes etc. Generally GI products are very suitable for corrosive environment because zinc coating protects the iron form corrosion.

- **Copper**

  It has reddish colour and is used for water pipes, roofing, gutters and other parts of the building. Copper products are used where thermal resistance is the criterion along with corrosion resistance. But copper is expensive.

- **Tin Plate**

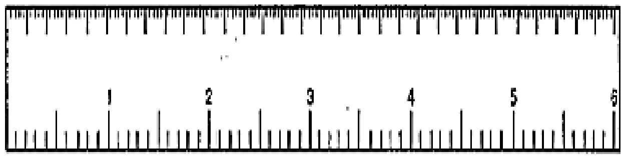
  Tin plate is the iron or steel coated with pure tin. It has bright silvery appearance and is used for containers, dairy equipment‟s, furnace fittings, cans, trays and pans.

- **Stainless Steel**

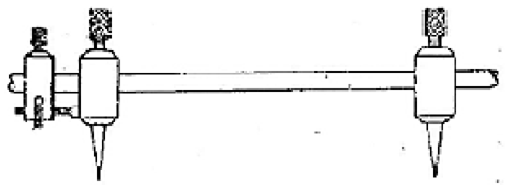
  The 18-8 type steel is used in sheet metal work from the available different type of stainless steel. The products like food containers, dairy equipment‟s and kitchen wares are prepare from 18-8 steel.

- **Black Iron**

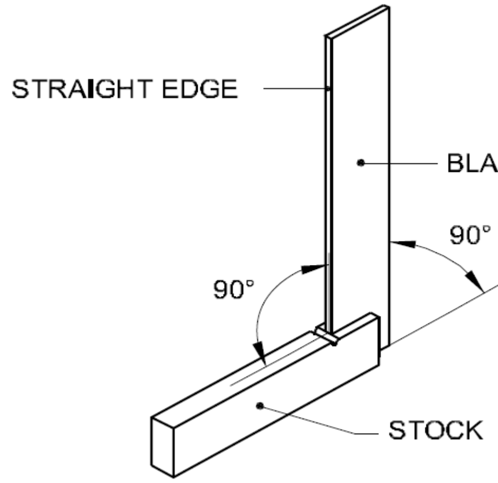
  It is an uncoated sheet of metal with bluish appearance. The black iron sheet is used for the products, which are having no restrictions on painting after its preparation.



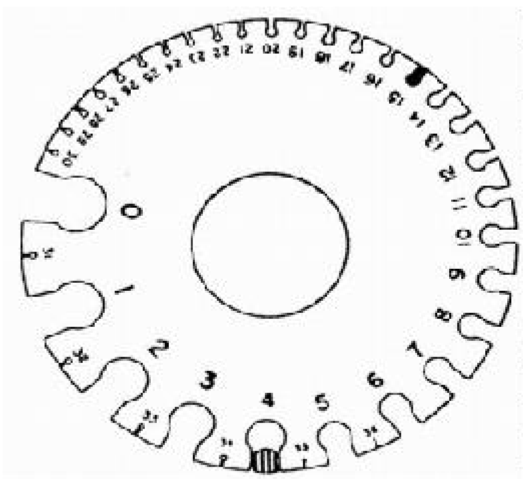
Steel Rule



Trammel point



Try Square



Galvanized Steel Gauge Chart		
Gauge Number	Inches	MM
8	.1681	4.269
9	.1532	3.891
10	.1382	3.510
11	.1233	3.1318
12	.1084	2.753
14	.0785	1.9939
16	.0635	1.6129
18	.0516	1.310
20	.0396	1.005
22	.0336	.853
24	.0276	.701
26	.0217	.551
28	.0187	.474
30	.0157	.398

Divider

Fig No: 21 Marking and Measuring Tools

2. Marking and Measuring Tools

Marking and measuring tools are used to produce objects to an exact shape and size. The commonly used tools are given below:

2.1. Steel Rule

It is used to measure and mark dimensions. It is graduated on both sides in millimeters and centimeters or inches. Its length varies from 15 cm (6 inches) to 30 cm (12 inches).

It is used to mark or scribe lines on the metal sheet. Its length varies from 150 mm to 300 mm and has diameter which varies from 3 to 5 mm.

2.2 Wire Gauge

A gauge is a traditional, non-linear measurement. The most commonly used sheet metal sizes range from 30 gauge (thinner) to 7 gauge (thicker). A sheet metal gauge tool is used to measure metal thickness, and show both the gauge number as well as the thickness of the metal in thousandths of an inch.

Divider

It is used to mark the dimensions from scale to the work piece. It is also used to scribe arcs and circles on the sheets. It is similar to the compass and is used for more accurate marking.

Try-square

It is used for marking and checking right angles. It consists of a steel blade riveted at right angles. It is used to mark square corners.

Trammel points

It is used to draw large circles and arcs. The trammel has two removable pointed legs and mounted on separate holders. The holders slide on a beam which can be easily adjusted for the required length.

3. Cutting Tools

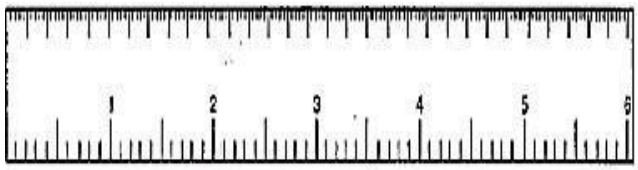
Snips are used to shear or cut the metal sheets to the required size and shape. Snips are used to cut thin sheet metals. The following snips are used in sheet metal work.

Straight snip

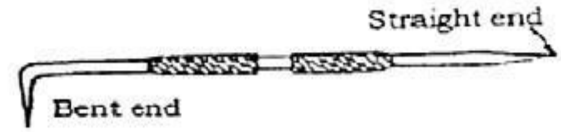
It is used to cut or trim along a straight line. The blades in this snip are straight.

Bent Snip

It is used to trim or cut along inside curves. The blades in this snip are curved back from the cutting edge, which permits the sheet to slide over the top blades while cutting.

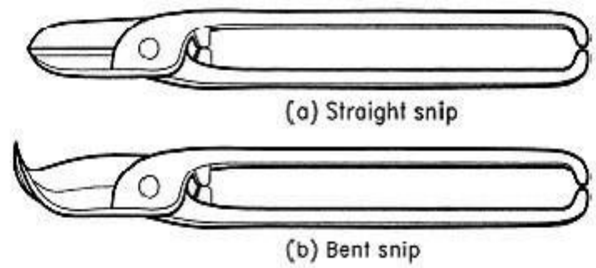


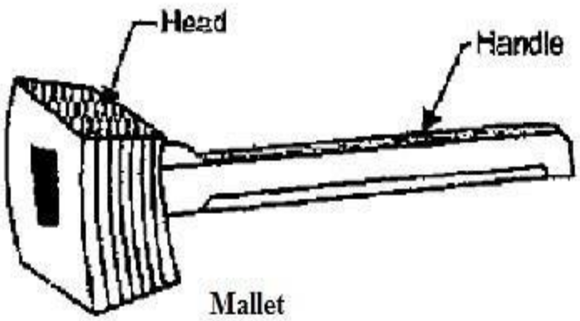
Steel Rule



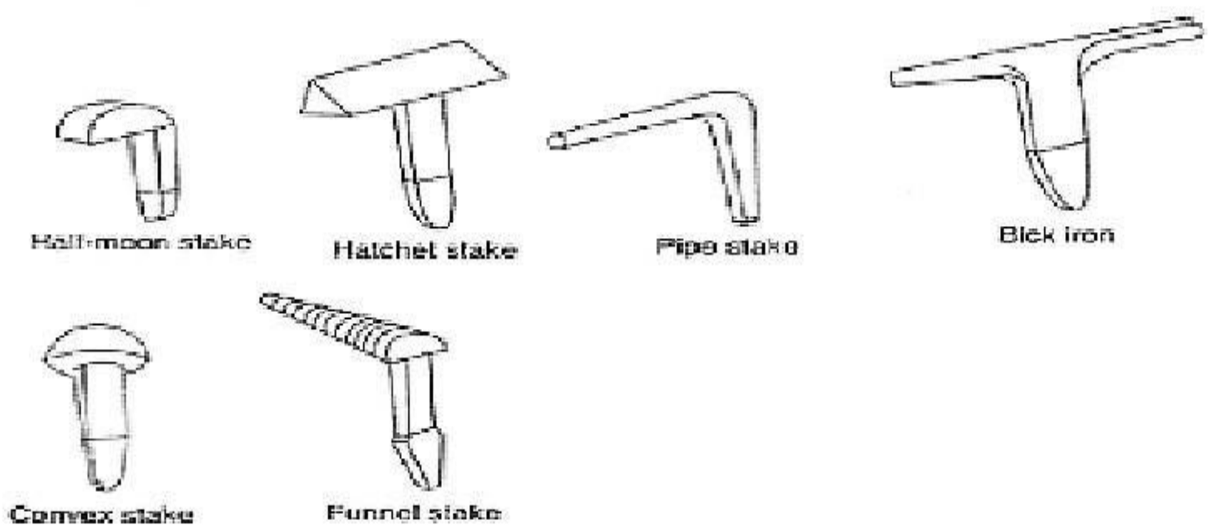
Scriber

Trammel point





Mallet



Different types of Stakes

Fig No:22 Different Types of Stakes

Shearing machine

The simple shearing machine is used to shear the sheet metal using a compound lever. The shearing machine has a fixed bottom blade and a top shearing blade which is operated by a lever. It is used to shear metal plates which can't be cut or trim by snips.

4. Forming Tools

Shaping of the sheet metal such as folding, bending, curling, etc., is done by using the following types of forming tools.

Stakes

Stakes are the sheet metal anvils used for bending, seaming and forming by using a hammer or mallet. They work as the supporting tool as well as the forming tools. They are made in different sizes and shapes depending upon the job requirement. Commonly used stakes are:

a) **Rectangular Stake:** It is used to form / bend the sheet metal to 90^0 and the face of the stake can be used to form square shape.

b) **Hand Stake**: It is used for pressing the inner sides of straight joint in the sheet. It has a flat surface with two straight edges, a concave edge and a convex edge.

c) **Half-Moon or Half Round Stake**: It is used to form a round seam joint on the inner side of the job.

d) **Horse Stake**: It has two square holes for holding one or two stakes to carry out different operations on the job.

e) **Taper Stake**: It is used to form a conical or tapering job.

Hammers and mallet

The hammer is a striking tool. It has a handle and a head. Hammers are classified into four types.

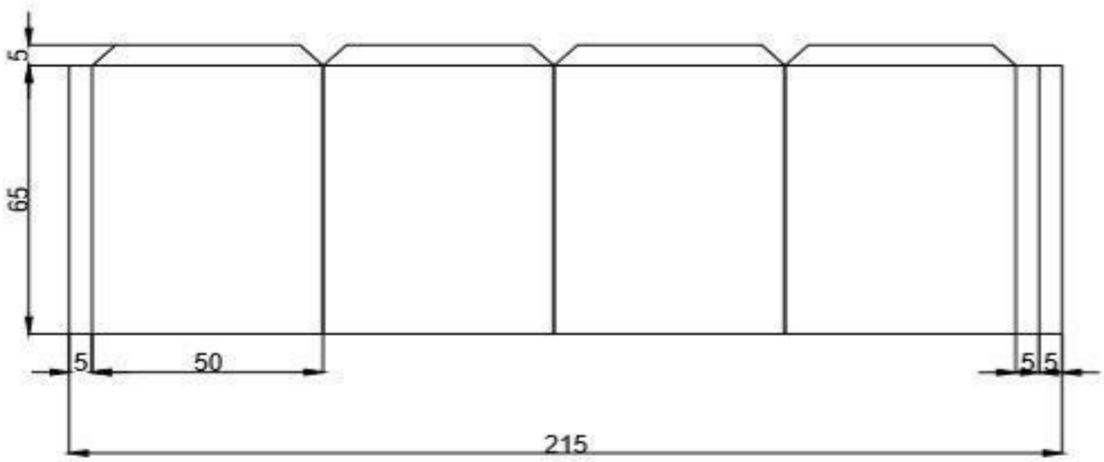
- Ball peen hammer
- Cross pen hammer
- Straight peen hammer
- Riveting hammer

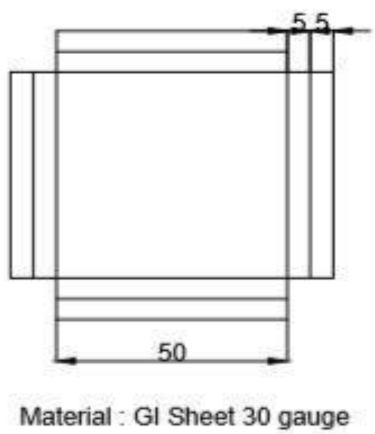
The ball peen hammer is a general purpose hammer which has a slightly curved face and a round head. The cross peen and straight peen hammers are used for folding the sheet and to work in the corners of the object.

Mallet: It has a striking face which is used to give light blows to sheets. It is used to smoothen/ flatten the surface of the sheet without spoiling it. Mallet is made of hard wood and is round or rectangular in cross-section.

Ex. No. 1

Square Tin





Material: GI sheet 30 gauge

Fig No:23 Square Tin

All dimensions in mm

Note: Sketches should be drawn with pencil neatly

Ex. No. 1

Square Tin

1.1. Aim: To make a square tin having separate base and top open.

. Tools Required & Equipment:

1. Steel rule, 2. Straight Snip, 3.Mallet, 4.Scriber, 5.Stakes, 6.Try square,
7. Ball peen hammer½ lb.

Materials Required With Dimensions

G.I sheet, 30-Gauge- 215mm x 70 mm, and 70 mm x 70 mm.

Precautions:

- Wear apron and shoes while doing the job.
- Dimensions have to be marked carefully.
- Dimensions are to be measured carefully.
- The cut portion must not be felt by hand while cutting with snip.
- Cutting has to be done carefully without hurting the fingers.
- Do not let sheet metal slip through your hands. Most cuts from sheet metal result from allowing it to slide through the hands.

Sequence of operation:

1) Measuring 2) Marking 3) Cutting 4) Folding 5) Bending 6) Hammering.

Procedure:

1: The given metal sheet is smoothened using mallet.

2: Draw the development of surface of square tin of required dimensions.

3: (i) 215 mm x 70 mm (ii) 70 mm x 70 mm and mark required dimensions with the help of steel rule and scriber.

4: After marking, unwanted material is removed with the help of steel rule and straight snip.

5: Now bending is to be done by placing sheet on stakes. After bending as per requirement, two pieces are assembled and joined with the help of stakes and mallet. Thus the required square tin is obtained

1.7 Result: Square tin of required size is obtained.

Ex. No. 2
Rectangular Scoop

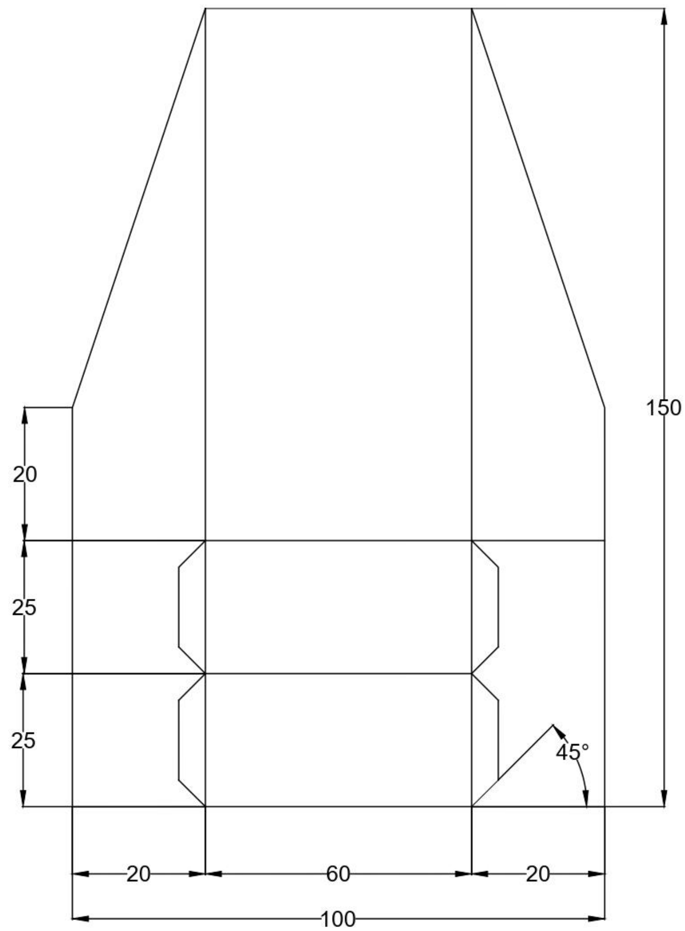


Fig No:24 Rectangular Scoop

All dimensions are in mm

Ex. No. 2

Rectangular Scoop

Aim: To make a Rectangular scoop using the given sheet metal

Tools required:

1. Steel rule, 2. Straight Snip, 3.Mallet, 4.Scriber, 5.Stakes, 6. Try square, 7. Ball peen hammer ½ lb.

Materials Required With Dimensions

G.I sheet, 30-Gauge- 100x120mm

Precautions:

1. Do not try to hold the sheets with bare hands.
2. Be sure that the fingers are away from the shearing bend.
3. Markings should be done carefully.
4. Cutting should be done carefully to avoid cross cutting.

Sequence of operation

1) Measuring 2) Marking 3) Cutting 4) Folding 5) Bending 6) Hammering.

Procedure:

1. The size of given sheet is checked with the steel rule.
2. The layout of the scoop is marked on the given sheet.
3. The layout of the scoop is cut by using the straight snip as shown in development.
4. Single hemming is made on the four sides of the tray.
5. The two sides of the scoop are bent to 90°.

Note:

The single hemmed vertical edges of the scoop can either be riveted or soldered to ensure stability of the joints.

Result:

The rectangular scoop is thus made, from the given sheet metal.

Ex. No. 3

Conical Funnel

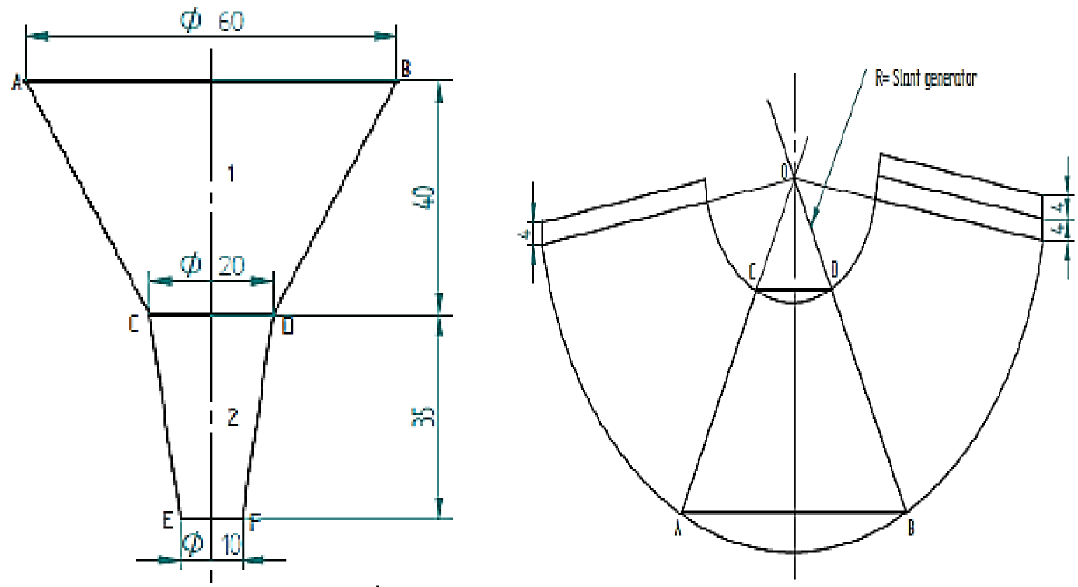


Fig No:25 Conical Funnel

All dimensions are in mm

Where,

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

$\theta = Angle\ substended\ to\ cut\ the\ arc.$

r= base radius of the cone.

R= slant generator of the cone

Ex. No. 3

Conical Funnel

Aim: To make a conical funnel using the given sheet metal.

Tools required:

1. Steel rule, 2. Straight Snip, 3.Mallet, 4.Scriber, 5.Stakes, 6. Try square, 7. Ball peen hammer ½ lb.

Materials Required With Dimensions

G.I sheet, 30-Gauge- 60 mm x 75 mm

Precautions:

1. Do not try to hold the sheets with bare hands.
2. Be sure that the fingers are away from the shearing bend.
3. Markings should be done carefully.
4. Cutting should be done carefully to avoid cross cutting.

Sequence of operation

1) Measuring 2) Marking 3) Cutting 4) Folding 5) Bending 6) Hammering.

Procedure

1. 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.
2. 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.
3. 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.
4. 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.
5. The development of the part-II is in a concept of frustum of cone is just same as Right circular Cone.
6. Trace the development part-I and II on a given G.I sheet 28G (Galvanized Plain sheet0.38mm thick). Mark all the necessary lines.
7. Cut the sheet along the line according to shape of the development.
8. Fold 4 mm extra allowance in clockwise and anti-clockwise directions by keeping hacksaw blade thickness and pressed.
9. Remove the hacksaw blade, Bend the main body using the cone stake and lock the end joint lock.
10. Repeat the same for Part-Ii. Solder the two parts with electric soldering.

3.7 Result: **The funnel is thus made, from the given sheet metal.**

Review Questions and Answers

1. What is straight peen hammer?

Ans: this is similar to cross-peen hammer, but its peen is -line with hammer handle it is used for swaging, riveting in restricted places and stretching‟s metals.

2. What are the types of hammers are there?

Ans: ball peen hammer, cross peen hammer, straight peen hammer.

3. What is scriber?

Ans: It is used to marking on timber and sheet metal. It is made of steel, having one end pointed and the other end formed into a sharp cutting edge.

4. What are the supporting tools in tin smithy?

Ans: trammel, bench shear, snip, stakes,

5. A sheet of steel, which is coated with molten zinc, is known as ------?

Ans: GI sheet

6------- **are used to support the sheet while shaping**

Ans: Stakes

7. Difference between straight snip and bent snip?

Ans: Straight snip is used for cutting along outside curves and bent snip is for trimming along inside curves.

8. What are stakes?

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

9. What is scriber?

Ans: It is used to marking on timber and sheet metal. It is made of steel, having one end pointed and the other end formed into a sharp cutting edge.

10. What is tin smithy?

Ans: Many engineering and house hold articles such as hoppers, guards, covers boxes, cans, fanners, ducts etc., are made from a flat sheet or metal; the process being known as tin smithy.

WELDING PRACTICE

INTRODUCTION TO WELDING

1. Introduction:

Welding is a process of joining two or more parts of material(s) by heating them to above melting point of the base metal.

Welding processes are classified as (i) Autogeneous welding and (ii) Heterogeneous

Autogeneous Welding: In this process the two pieces are fused together without using a filler rod (or an electrode)

Heterogeneous Welding: In this process the two parts are joined together with the help of a filler rod (or an electrode)

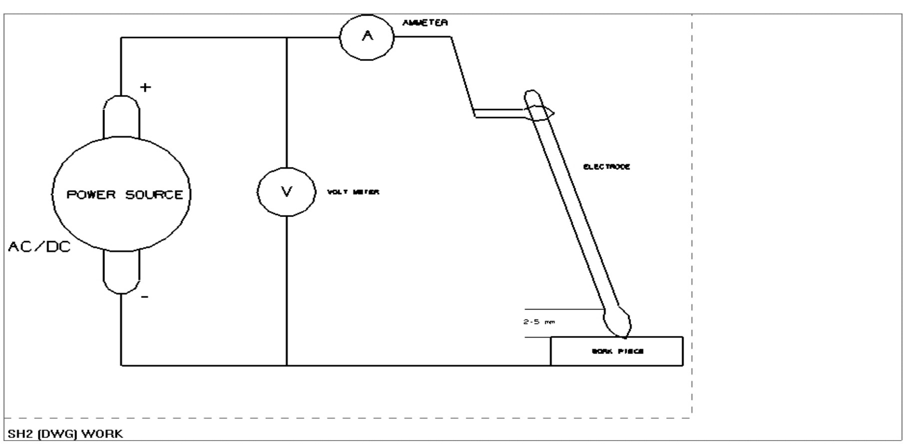
The arc welding processes are again classified as follows:

- Carbon Arc Welding (CAW)
- Shielded Metal Arc Welding or (SMAW) Manual metal arc welding (MMAW)
- Gas Tungsten Arc Welding (GTAW)
- Gas metal Arc Welding (GMAW)
- Plasma Arc Welding (PAW)
- Atomic Hydrogen Arc Welding (AHAW)
- Electro-gas Welding (EGW)

However, SMAW and Oxy-Acetylene Welding processes are the general purpose processes with a wide range of applications.

Some of the typical applications of welding include the fabrication of ships, pressure vessels automobile bodies, off-shore plat forms, storage tanks, bridges, welded pipes, sealing of nuclear fuel and explosives etc.

Fig No: 26 Shielded Metal Arc Welding (SMAW)



In SMAW an emf is applied between the electrode and the work piece and suitable current proportional to the diameter of the electrode is passed through the circuit. An arc is struck between the electrode and the plate and the heat produced is utilized for melting both the work piece and the electrode. The flux around the electrode melts and forms a shielding gas to protect the molten weld pool from the ill effects of atmospheric gases. The temperature in the core of the arc ranges between 6000-7000C. The radiations originating from the welding arc can damage the eye thus necessitating the use of protective shield.

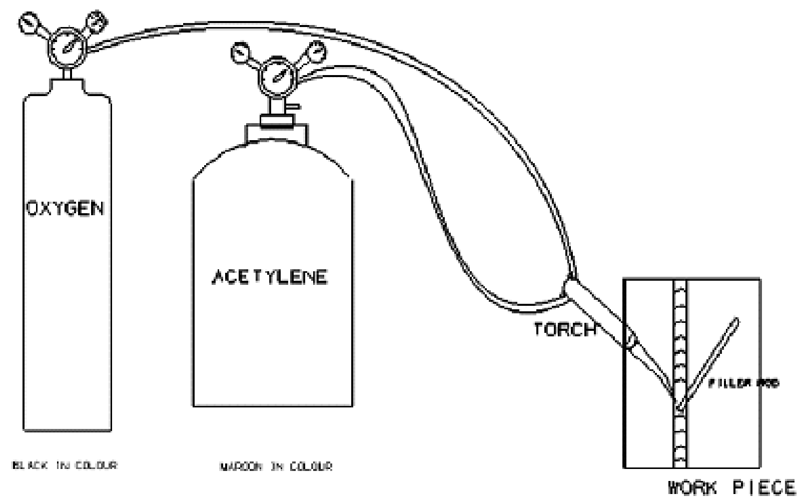


Fig No: 27 Oxy-Acetylene Welding (Gas Welding)

In this process acetylene (C_2H_2) is mixed with oxygen in the welding torch and is then burnt at the torch tip to give a flame with a temperature of about 3300C which can melt most of the ferrous and non-ferrous metals in common use.

Oxygen and Acetylene are easily available in cylinders at pressures of 1500 N/cm^2 or 150 bars and 170 N/cm^2 or 17 bars respectively.

These are connected to the welding torch through hoses and are mixed and burnt to get different types of flames viz., neutral, oxidizing and corburising. The nature of the flame depends upon the ratio of the two gases. The neutral flame is most often used for the welding of most of the materials like low carbon steels, cast steel, cast iron etc.

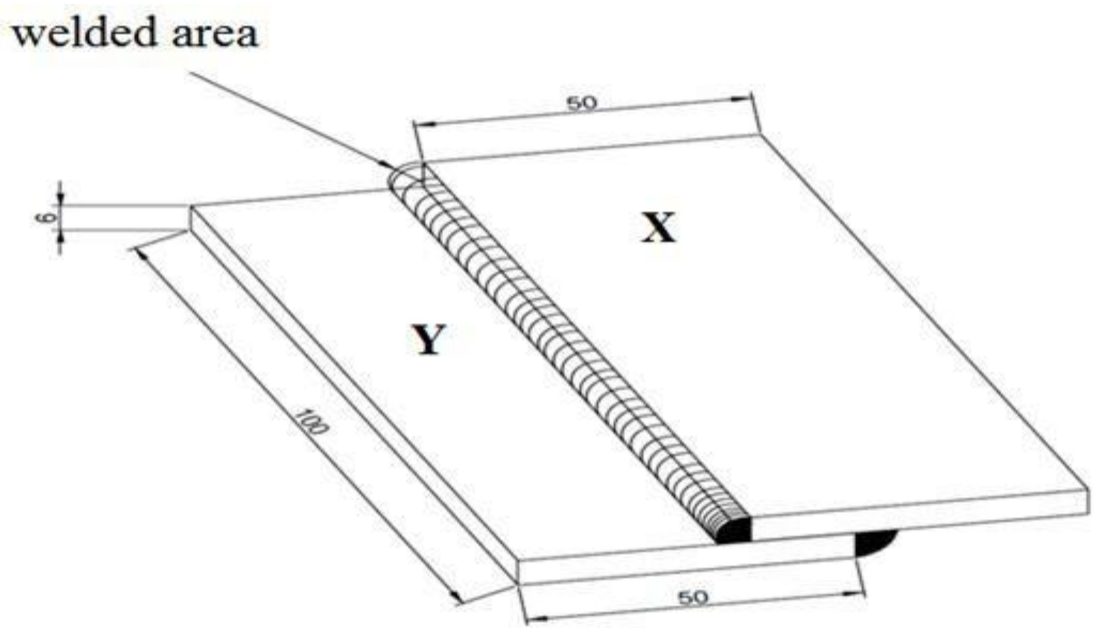
It is quite common to use filler material with gas welding though if need be, the process can be used without filler as well.

1.1 Tools and equipment used in gas and arc welding process

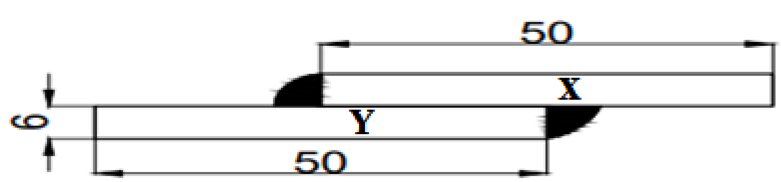
1. Welding machine. (AC transformer, DC generator or AC, DC Rectifier.
2. Welding cables (Copper or Aluminium)
3. Electrode Holder (400 mps or 600 Amps) and Earth clamp
4. Types of Electrodes and Filler rod.
5. Welding Helmet or Hand Screen.
6. Ball peen hammer and Chisel
7. Chipping Hammer and Steel Wire Brush.
8. Tong
9. Steel Rule (12")
10. Leather Hand Gloves and Leather Apron.
11. Oxygen Cylinder and Regulator with hose pipe.
12. Acetylene Cylinder and Regulator with hose pipe.
13. Welding Blow pipe and Nozzle.
14. Cutting Blow pipe and Nozzle.
15. Spindle Key and Adjustable spanner.
16. Spark Lighter and Goggles.

EX.NO. 1

Making Joint on Plate by Shielded Metal Arc Welding (Lap Joint)



3D VIEW



FV

Fig No:28 Lap Joint

All Dimensions are in mm

EX.NO. 1

Making Joint on Plate by Shielded Metal Arc Welding (Lap Joint)

Aim: To make a lap joint on MS plates

Material required:

MS plate on MS flat (100 mm x 50 mm x 6mm thickness (2 Nos)

Tools required:

1. Welding Transformer (AC Transformer, DC generator or AC / DC Rectifier)
2. Welding Cables
3. Electrode holder and Earth clamp
4. Metallic work table
5. MS electrodes
6. Hand Screen
7. Leather apron and Leather hand gloves
8. Chipping hammers
9. Steel wire Brush
10. Tong
11. Ball peen Hammer
12. Chisel
13. Bench grinding machine

Precautions:

- Always use welding hand screen while doing welding.
- While doing welding wear protective items i.e. leather apron, leather hand gloves.
- While doing welding, short arc i.e. (1mm) gap should be maintained.

Sequence of Operation:

1. Marking
2. Cutting
3. Edge preparation (Removal of rust, scale etc.) by filling
4. Try square leveling
5. Tacking
6. Welding
7. Cooling
8. Chipping
9. Cleaning

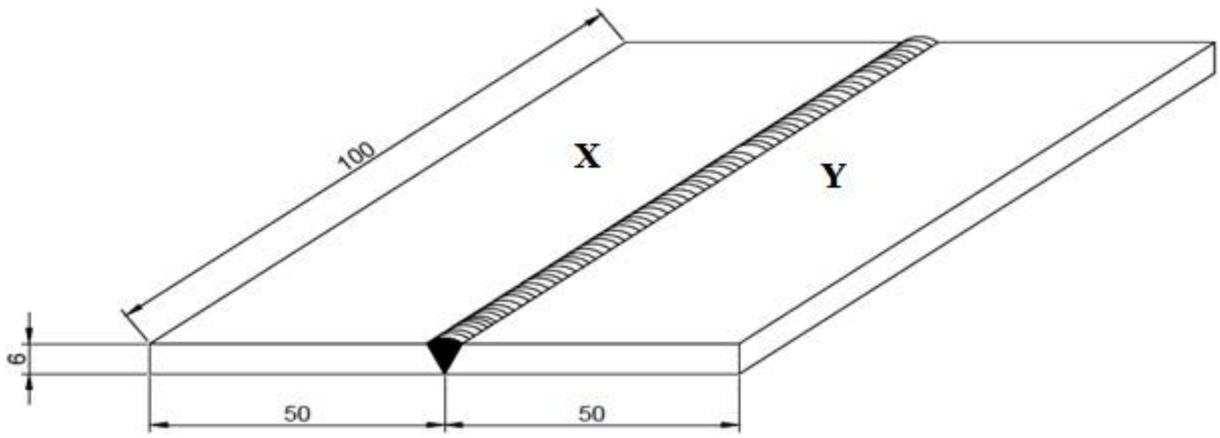
Procedure:

1. Take the given MS plate (100 mm x 50 mm x 6 mm thick) and clean the surfaces from rust and dust particles with the help of steel wire brush.
2. After cleaning the plates grind all sides lightly and one of the edges of both the plates should be ground more like as „V" grove using the bench grinding machine.
3. After grinding, set the plates overlap (overlap length is 25 mm) to each other on the work table.
4. Take 3.15 mm (dia) or 10 gauge electrodes fix into the electrode holder and slightly bend the electrode in the tip side.
5. Set current of the transformer rating to 66 volts i.e. open circuit voltage and 100 Amps i.e. welding current.
6. Firstly, strike the electrode on the scrap plate for 2, 3 times and do tack welding of 2 plates on 4 sides and do full welding carefully.
7. After completing full welding cool the job with water and remove the slag and clean it. The job is over.

Result: Lap joint is done on MS plates

EX.NO. 2

Laying Joint on Plate by Shielded Metal Arc Welding (Butt joint)



3D VIEW

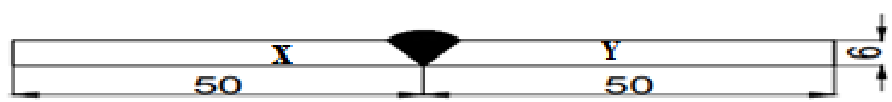


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Fig No:29 Butt Joint

All Dimensions are in mm

EX.NO. 2

Laying Joint on Plate by Shielded Metal Arc Welding

(Butt joint)

Aim: To make a butt joint on MS plates

Material Required:

MS plate on MS flat (100 mm x 50 mm x 6 mm thickness (2 Nos))

Tools Required:

1. Welding transformer (AC Transformer, DC generator or AC / DC Rectifier)
2. Welding Cables
3. Electrode holder and Earth clamp
4. Metallic work table
5. MS electrodes
6. Hand Screen
7. Leather apron and Leather hand gloves
8. Chipping hammers
9. Steel wire Brush
10. Tong
11. Ball peen Hammer
12. Chisel
13. Bench grinding machine

Sequence of Operation:

1. Marking
2. Cutting
3. Edge preparation (Removal of rust, scale etc.) by filling
4. Try square leveling
5. Tacking
6. Welding
7. Cooling
8. Chipping
9. Cleaning

Precautions:

- Always use welding hand screen while doing welding.
- While doing welding wear protective items i.e. leather apron, leather hand gloves.
- While doing welding, short arc i.e. (1mm) gap should be maintained.

Procedure:

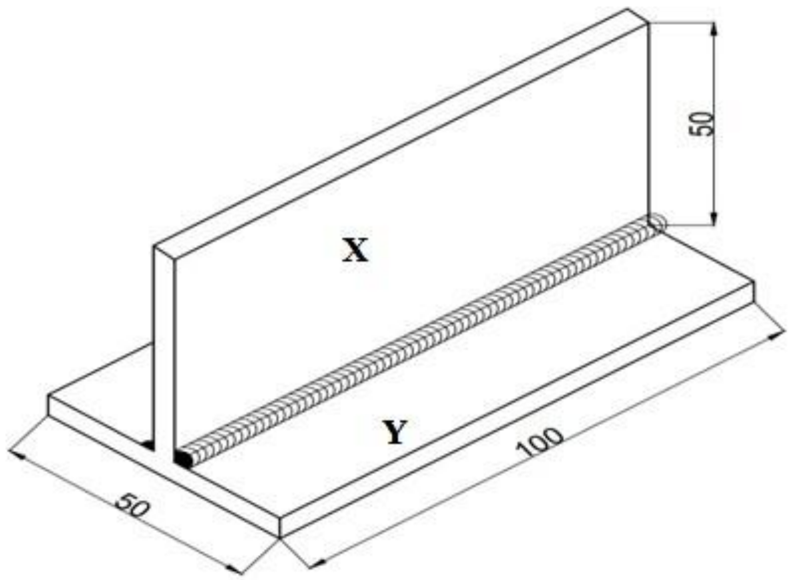
1. Take the given MS plate (100 mm x 50 mm x 6 mm thick) and clean the surfaces from rust and dust particles with the help of steel wire brush.

2.After cleaning the plates grind all sides lightly and one of the edges of both the plates should be ground more like as „V" grove using the bench grinding machine.

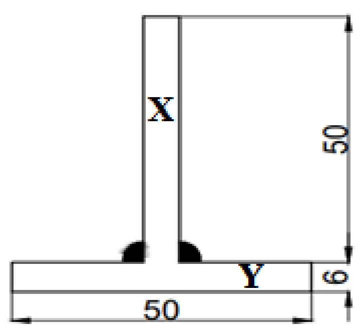
3. After grinding, set the plates on the work table and set parallel to each other and 1 mm gap should be maintained between the two plates.
4. Take 3.15 mm (dia) or 10 gauge electrodes fix into the electrode holder and slightly bend the electrode in the tip side.
5. Set current of the transformer rating to 66 volts. i.e. open circuit voltage and 100 Amps i.e. welding current.
6. Firstly, strike the electrode on the scrap plate for 2, 3 times and do tack welding of 2 plates on 4 sides and do full welding carefully.
7. After completing full welding cool the job with water and remove the slag and clean it. The job is over.

Results: Butt joint is done on the given MS plates

EX.NO. 3
T-Joint



3D View



FV

Fig No:30 T-Joint

All Dimensions are in mm

EX.NO. 3
T-Joint

Aim: To make a butt joint on MS plates

Material Required: MS plate on MS flat (100 mm x 50 mm x 6 mm thickness (2 Nos))

Tools Required:

3. Welding transformer (AC Transformer, DC generator or AC / DC Rectifier)

4. Welding Cables
3. Electrode holder and Earth clamp
4. Metallic work table
5. MS electrodes
6. Hand Screen
7. Leather apron and Leather hand gloves
8. Chipping hammers
9. Steel wire Brush
10. Tong
11. Ball peen Hammer
12. Chisel
13. Bench grinding machine

Precautions:

- Always use welding hand screen while doing welding.
- While doing welding wear protective items i.e. leather apron, leather hand gloves.
- While doing welding, short arc i.e. (1mm) gap should be maintained.

Sequence of Operation:

1. Marking
2. Cutting
3. Edge preparation (Removal of rust, scale etc.) by filling
4. Try square leveling
5. Tacking
6. Welding
7. Cooling
8. Chipping
9. Cleaning

Procedure:

1. Take the given MS plate (100 mm x 50 mm x 6 mm thick) and clean the surfaces from rust and dust particles with the help of steel wire brush.
2. After cleaning the plates grind all sides lightly and one of the edges of both the plates should be ground more like as „V" grove using the bench grinding machine.
3. After grinding, set the plates on the work table and set parallel to each other and 1 mm gap should be maintained between the two plates.
4. Take 3.15 mm (dia) or 10 gauge electrodes fix into the electrode holder and slightly bend the electrode in the tip side.
5. Set current of the transformer rating to 66 volts. i.e. open circuit voltage and 100 Amps i.e. welding current. Firstly, strike the electrode on the scrap plate for 2, 3 times and do tack welding of 2 plates on 4 sides and do full welding carefully.
6. After completing full welding cool the job with water and remove the slag and clean it. The job is over.

Results: T- Joint is done on the given MS plates.

PRE LAB QUESTIONS:

1. What gases are used in gas welding?

Ans:

1. Shielding gases such as carbon dioxide, argon, helium, etc.
2. fuel gases such as acetylene, propane, butane, etc.
3. oxygen, used with fuel gases and also in small amounts in some shielding gas mixtures.

2. What is reverse polarity and forward polarity?

Ans: In case of DC polarity, current flows only in one direction; whereas, in case of AC, current flow direction reverses in every cycle (number of cycles per second depends on the frequency of supply). Now, in arc welding, base metals are connected with one terminal and the electrode is connected with other terminal.

3. What are the rays generates during welding processes which effect on eyes?

Ans: Exposure to infrared light can heat the lens of the eye and produce cataracts over the long term. Visible light from welding processes is very bright and can overwhelm the ability of the iris of the eye to close sufficiently and rapidly enough to limit the brightness of the light reaching the retina.

4. What is the electrode coating material?

Ans: Electrode coatings are composed of a mixture of minerals, organic material, ferro-alloys and iron powder bonded with sodium or potassium silicate.

5. Welding is a permanent or non permanent joint?

Ans: Permanent Joint

6. What is the angle between electrode and work piece?

Ans: With wire welding, hold the gun at a 10° to 15° angle into the direction you are pushing the weld. With stick welding, maintain a 20° to 30° lead angle in the dragging direction. With a fillet (tee) weld, hold the rod or wire (regardless of weld process) at a 45° angle between the two pieces of metal.

7. What is the minimum gap is required to perform the welding process?

Ans: 1/16" inch

PRE LAB QUESTIONS:

1. **What is Arc Welding?**

   Ans: Arc welding is a type of welding process using an electric arc to create heat to melt and join metals. A power supply creates an electric arc between a consumable or non-consumable electrode and the base material using either direct (DC) or alternating (AC) currents.

2. **What is Gas Welding?**

   Ans: Gas Welding • Gas welding is a welding process that melts and joins metals by heating them with a flame caused by a reaction of fuel gas and oxygen.

3. **What is spot welding?**

   Ans: Spot welding (or resistance spot welding) is a type of electric resistance welding used to weld various sheet metal products, through a process in which contacting metal surface points are joined by the heat obtained from resistance to electric current.

4. **What is AC & DC current?**

   Ans: Alternating Current (AC) is a type of electrical current, in which the direction of the flow of electrons switches back and forth at regular intervals or cycles. Direct current (DC) is electrical current which flows consistently in one direction.

5. **What is electrode?**

   Ans: As per the definition of the electrode, it is any substance that is a good conductor of electricity and these substances usually connect non-metallic parts of a circuit for example semiconductors, an electrolyte, plasmas, vacuum or even air. ***The term was first coined by*** William Whewell and derived from Greek words Elektron, which means "amber" and hodos which translates to "a way."

6. **What is the melting temperature of M.S plate?**

   Ans: Typically, mild steel has a melting point of 1350^{o}C-1530^{o}C (2462^{o}F-2786^{o}F) depending on the grade of the steel as dictated by the amount of carbon it contains.

7. **Define the following joints?**

i) Lap Joint, ii) Butt joint, iii) T-Joint and iv) Corner joint.

Ans:

i) **Lap Joint**: A joint made by halving the thickness of each member at the joint and fitting them together.

ii) **Butt joint**: A joint formed by two pieces of wood or metal united end to end without overlapping.

iii) **T-Joint** : A tee joint refers to the welded point of two metallic materials that are joined in the same plane at a 180° combined angle with a 90° angle

iv) **Corner joint**: A joint between two elements located approximately at right angles in the form of L.

B. TRADES FOR DEMONSTRATION AND EXPOSURE

MACHINING
(LATHE & DRILLING)

Machine shop (Lathe & drilling machine)

1. Introduction

In a machine shop, metals are cut to shape on different machine tools. A lathe is used to cu and shape the metal by revolving the work against a cutting tool. The work is clamped either in a chuck, fitted onto the lathe spindle or in-between the centres. The cutting tool is fixed tool is fixed in a tool post, mounted on a movable carriage that is positioned on the lathe bed. The cutting tool can be fed into the work, either lengthwise or cross-wise. While turning, the chuck rotates in counter-clockwise direction, when viewed from tail-stock end

- **Lathe:-**

  A lathe is a versatile machine useful to cut and shape the material by revolving the work against cutting edge of a cutting tool. The work is clamped either in a chuck or face plate fitted on the lathe spindle or between the centre. The cutting tool is fixed in a tool post, mounted on a movable carriage that is positioned on the lathe bed. The cutting tools can be fed into the work either length wise or crosswise.

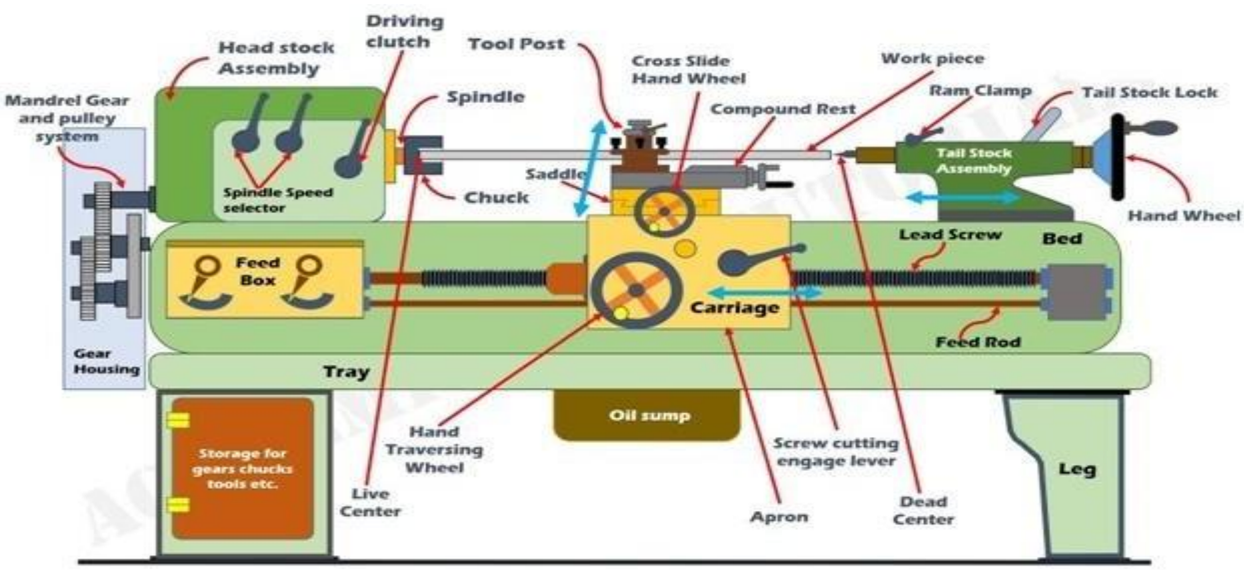


Fig: 31 Lathe Machine

Principal Parts of Lathe:-

Bed: Bed is an essential part of lathe, which must be strong, rigid and free from vibrations. It carries all parts of the machine and resists the outing forces. The carriage and the tailstock move along the guide ways provided on the bed. It is made of grey cast iron because it has the above properties.

Head stock: It contains cone pulleys, V-pulleys or gears to provide necessary range of spindle speeds. Headstock provides the speed gearbox, which rotates the main spindle at selected revolutions per minute depending on the cutting speed (m/mt) recommended for a particular operation.

Tail stock: It is used to support the right hand end of a long work piece. It may be clamped in any position along the lathe bed. The tailstock spindle has an internal Morse taper to receive the dead center to support the work. Drills, reamer, taps etc. may also be fitted in the tailstock spindle for performing operations such as drilling, reaming, and taping.

Carriage or Saddle: Saddle is used to control the movement of cutting tool. The carriage assembly consists of longitudinal slide, cross slide, compound slide and the apron. The cross slide moves across the length of the bed and perpendicular to the axis of spindle. This movement is used for facing and to provide necessary depth of cut while turning. The apron, which is bolted to the saddle, is on the front of the lathe and contains longitudinal and cross slide controls both manual and automatic.

Compound rest: compound rest supports the tool post. By swiveling the compound rest on the cross slide, short tapers may be turned to desired angles. Material is cut by moving the compound slide. The length of the taper is limited to the travel to the compound slide.

Tool post: The tool post holds the tool or the tool holder, which may be adjusted to any working position. It may be a single tool post that can hold the tool at a time or square tool post with provision to hold four tools. In some lathes quick-change tool posts are also provided.

Feed gear box: It is also called Norton gear box. It is connected to the lathe spindle through change gears and tumbler gears to provide automatic rotation to the feed rod or lead screw.

Lead screw (feed rod): It is a long threaded shaft located in front of carriage, running from the head stock end to the tailstock. It is connected to the spindle through the feed gearbox and change gears for providing movement of tool either for automatic feeds or of cutting threads. In some lathes fed rod and lead screw are separated. The thread of the lead screw is made of ACME type for easy engagement of half nut.

Centers: There are two types of Centre known as dead center and live Centre. The dead Centre is fixed in the lathe tailstock spindle and the live Centre in the headstock spindle. During turning between centers the dead Centre does not revolve with the work, while the live Centre revolves with the work.

Working Holding Devices:-

Three jaw chucks: It is a work holding device having three jaws which will close or open with respect to the chuck Centre, Centre line or the spindle Centre. It is used for holding regular objects like round bars, hexagonal rods, etc. a three jaw chuck is provided with a set of external jaws also.

Four jaw chuck: In a four chuck, all jaws have independent movement. It is used for holding, octagonal or irregular shaped works.

Fig No :32 3-Jaw Chuck And 4-Jaw Chuck

Face plate: It is a plate of large diameter used for turning operations. Certain types of works that cannot be held in chucks are held on the face plate with the help of various accessories or fixtures.

Lathe dogs and driving plate: These are used to drive a work piece that is held between centers. These are provided with no opening to receive and clamp the work piece and dog tail. The tail of the dog is carried by the pin provided in the driving plate fixed on the spindle nose and rotates along with it.

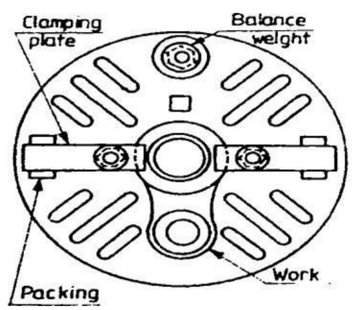


Fig No:33 Face Plate

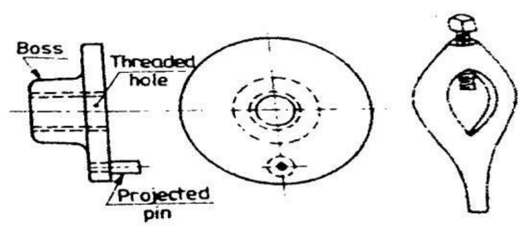


Fig No:34 Lathe Dog And Driving Plate

Cutting Parameters:-

Cutting speed: Cutting speed is defined as the speed at which the material is removed and it is specified in meters per minute. It depends on the work piece material, tool material, feed and depth of cut, type of operation such as rough turning, finish turning, threading etc, and many other cutting conditions. For example the cutting speed recommended for turning operation on mild steel with high speed steel tool is 25m/mt. If instead of HSS tool, carbide tool is used the cutting speed recommended is about 75m/mt.

On the other hand, instead of mild steel the work material is aluminum say with the HSS tool the cutting speed recommended is 150m/mt. The cutting speeds recommended for various combinations are given in table.

Knowing the cutting for a particular operation and the diameter of the work, the spindle speed in revolutions per minute is calculated from the relations.

Introduction to Drilling Machine

1. Introduction

The drilling machine is one of the most important machine tools in a workshop. As regards its importance, it is second only to the lathe. In a drilling machine holes can be drilled quickly and at low cost. The hole is generated by the rotating edges of a cutting tool known as the drill which exerts large force on the work clamped on the table. As the machine tool exerts a vertical pressure to originate a hole it is loosely called a drill press. Drilling machines are made in many types and sizes, each is designed to handle a class of work or specific jobs to the best advantage.

Types of drilling machines:

1. Portable drilling machine
2. Sensitive drilling machine
3. Upright drilling machine
4. Radial drilling machine
5. Gang drilling machine
6. Multiple spindle drilling machine
7. Automatic drilling machine
8. Deep hole drilling machine

2. Sensitive Drilling Machine

It is a small machine designed for drilling small holes at high speeds in light jobs. It may be bench or floor mounted. It consists of a base, a vertical column, horizontal table, a head supporting the motor and driving mechanism and a vertical spindle for driving and rotating the drill. Total drilling operation is manually controlled. The machine is capable of drilling holes from 1.5 to 15mm diameter.

3. Upright Drilling Machine

The upright drilling machine is designed for handling medium sized work pieces. In an upright drilling machine a large number of spindle speeds and feeds may be available for drilling different types of work. The table of machine also has different types of adjustments. There are two general classes of upright drilling machine:

(1) Round column section or pillar drilling machine
(2) Box column section

4. Round column section or pillar drilling machine

The round column section upright drilling machine or pillar drilling machine consists of a round column that rises from the base which rests on the floor, an arm and a round table assembly, and a drill head assembly.

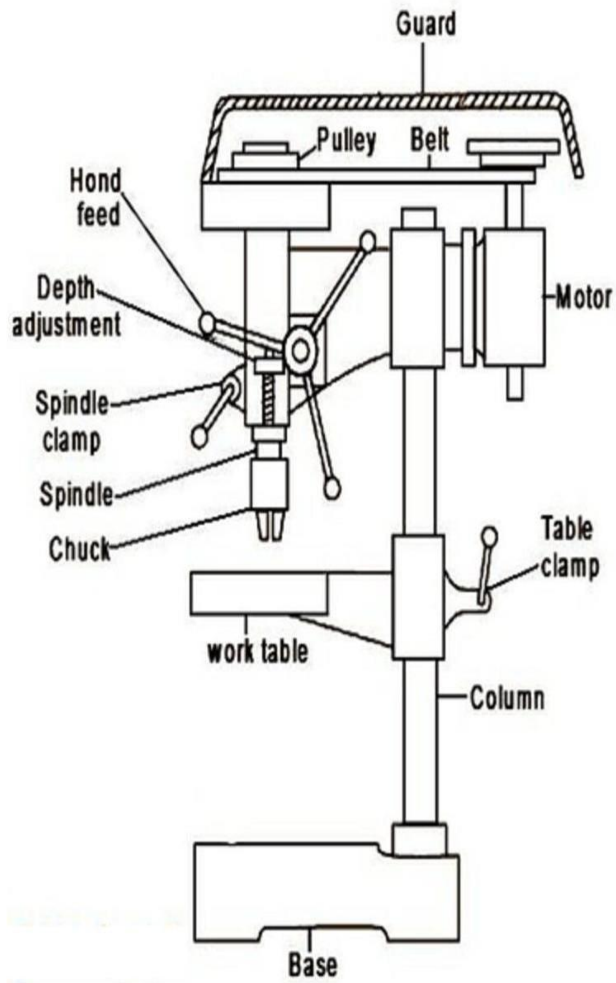


Fig No :35 Vertical Drilling Machine

The arm and the table have three adjustments for locating work pieces under the spindle. The arm and the table may be moved up and down on the column for accommodating work pieces of different heights. The table and the arm may be moved in an arc up to 1800 around the column and may be champed at any position. This permits setting of the work below the spindle.

This is particularly intended for lighter work. The maximum size of hole that the machine can drill is not more than 50 mm.

4.1. Box column section upright drilling machine:

The upright drilling machine with box column section has the square table fitted on the slides at the front face of the machine column. Heavy box column gives the machine strength and rigidity. The table is raised or lowered by an elevating screw that gives additional support to the table. These special features permit the machine to work with heavier work pieces, and holes more than 50 mm in diameter can be drilled through this machine.

5. Radial Drilling Machine

The radial drilling machine is intended for drilling medium to large and heavy work pieces. The machine consists of a heavy, round, vertical column mounted on a large base. The column supports a radial arm which can be raised and lowered to accommodate work pieces of different heights. The arm may be swung around to any position over the work bed. The drill head containing mechanism for rotating and feeding the drill is mounted in a radial arm and can be moved horizontally on the guide-ways and clamped at any desired position. These three movements in a radial drilling machine when combined together permit the drill to be located at any desired point on a large work piece for drilling the hole.

Plain radial drilling machine

Ina plain radial drilling machine provisions are made for vertical adjustment of the arm, horizontal movement of the drill head along the arm, and circular movement of the arm in horizontal plane about the vertical column.

Semi universal machine

Ina semi universal machine, in addition to the above three movements, the drill head can be swung about a horizontal axis perpendicular to the arm. This fourth movement of the drill head permits drilling hole at an angle to the horizontal plane other than the normal position.

Universal machine

Ina universal machine, in addition to the above four movements, the arm holding the drill head may be rotated on a horizontal axis. All these five movements in a universal machine enable it to drill on a work piece at any angle.

Gang Drilling Machine

When a number of single spindle drilling machine columns are placed side by side on a common base and have a common work-table, the machine is known as the gang drilling machine.

In this machine four to six spindles may be mounted side by side. This type of machine is specially adapted for production work. A series of operations may be performed on the work by simply shifting the work from one position to the other on the work-table. Each spindle may be set up properly with different tools for different operations.

6. Multiple – Spindle Drilling Machine

The function of a multiple-spindle drilling machine is to drill a number of holes in a piece of work simultaneously and to reproduce the same pattern of holes in a number of identical pieces in a mass production work. Such machines have several spindles driven by a single motor and all the spindles holding drill are fed into the work simultaneously. Feeding motion is usually obtained by raising the work-table.

2. Drilling Operations

The operations that are commonly performed on drilling machines are

1. Drilling,
2. Reaming,
3. Boring,
4. Counter-boring,
5. Counter-sinking,
6. Spot-facing

1. Drilling: This is the operation of making a circular hole by removing a volume of metal from the work piece by a cutting tool called drill.

2. Reaming: This is the operation of sizing and finishing a hole already made by a drill. Reaming is performed by means of a cutting tool called reamer having several cutting edges. Reaming serves to make the hole smoother, straighter and more accurate in diameter. Reamer may be classified as solid reamer and adjustable reamer.

3. Boring: This is the operation of enlarging a hole by means of adjustable cutting tools with only one cutting edge. A boring tool is employed for this purpose.

4. Counter-boring: This is the operation of enlarging the end of a hole, as for the recess for a counter-sunk rivet. The tool used is known as counter-bore.

5. Counter-sinking: This is the operation of making a cone-shaped enlargement of the end of a hole, as for the recess for a flat head screw.

6. Spot – facing: This is the operation of removing enough material to provide a flat surface around a hole to accommodate the head of a bolt or a nut. A spot-facing tool is very nearly similar to the counter-bore.

REVIEW QUESTION

1) What is the purpose of cone pulley provided in the headstock of a lathe?
A) To provide the necessary range of speeds and feeds

2) What is the purpose of tail stock in a lathe?
A) It is used to support the right hand end of long work piece

3) Name the parts that are associated with carriage or saddle in a lathe?
A) It is consist of longitudinal slide, cross slide, and the compound slide and apron

4) What is the purpose of the lead screw in a lathe?
A) It is geared to the spindle and controls the movement of the tool either for automatic feeding or for cutting threads

5) Define cutting speed and on what it depends?
A) It is defined as the speed at which the material is removed and is specified as in metre per minute

6) Name the possible lathe operations?
A) Turning, facing, taper turning, eccentric turning, drilling, knurling, threading and centre gauge

7) Why lathe is named as entre lathe?
A) Because of the fact that work pieces are held by the centre

8) While turning the chuck rotates in which direction, when viewed from the tail?
A) Counter clock wise direction

PLUMBING

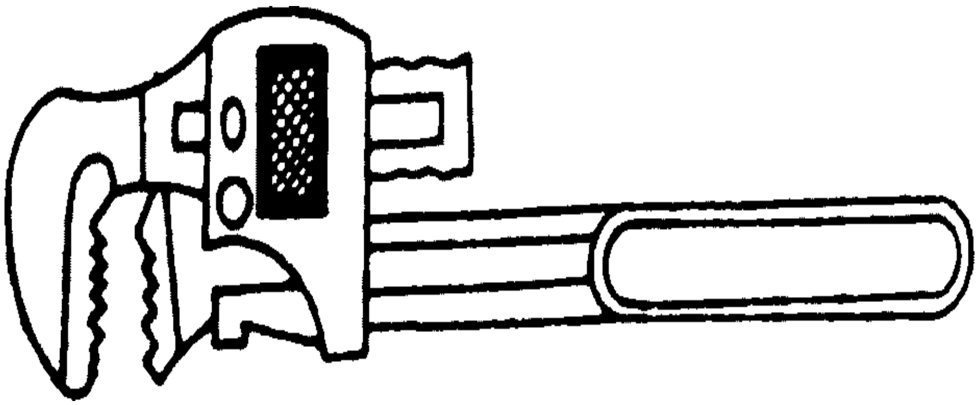


Fig No : 36 PIPE WRENCH

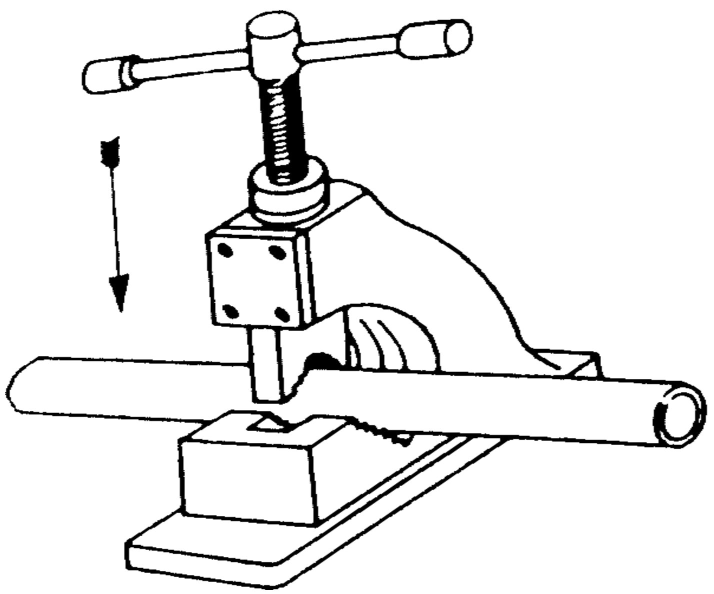


Fig No: 37 PIPE VICE

Plumbing

1. Introduction:

Plumbing deals with the laying of pipe lines. Pipe lines provide the means of transporting the fluid. It is obvious that laying out the pipe line requires a number of joints to be made and a number of valves incorporated, while connecting different length of pipes.

Plumbing work does not require many tools except pipe wrenches, hacksaw, pipe cutter, threading equipment and a pipe vice.

Plumbing Tools

Pipe wrench

Pipe wrenches are used for holding and turning the pipes, rods and machine parts. Wrenches of size 300 mm and 450mm are more useful. The adjustable wrench shown in fig consists of a fixed jaw and a movable jaw. The movable jaw facilities the adjustment of the opening between the jaws. The jaws are serrated inside, to enable a firm grip over the pipes.

Pipe vice

The use of a regular pipe vice is advisable, though ordinary bench vice can serve the purpose in most of the occasions. The pipe vice is fitted on the work bench. It holds the pipe in position during cutting, threading and fitted of bends, couplings etc. fig shows a pipe vice. It consists of two jaws for holding the work, which are serrated to ensure firm grip..

Pipe cutter

For and occasional pipe work, a hacksaw is quite satisfactory. Pipe cutter is also used where considerable amount of pipe work is involved. The pipe cutter mainly consists of three wheels, which are hardened and with sharp cutting edges along their periphery. Of these three wheels, one can be adjusted to any desired distance from the other two fixed wheels, to accommodate different sizes of pipes. After adjusting the cutter on a pipe, it is turned around the pipe so that the cutter wheels cut the pipe along a circle. Fig shows a pipe cutter

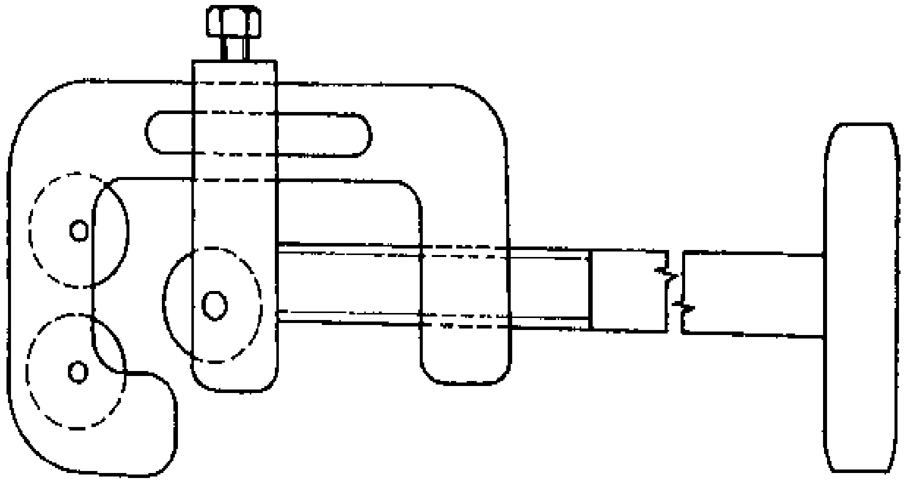


Fig No: 38 PIPE CUTTER

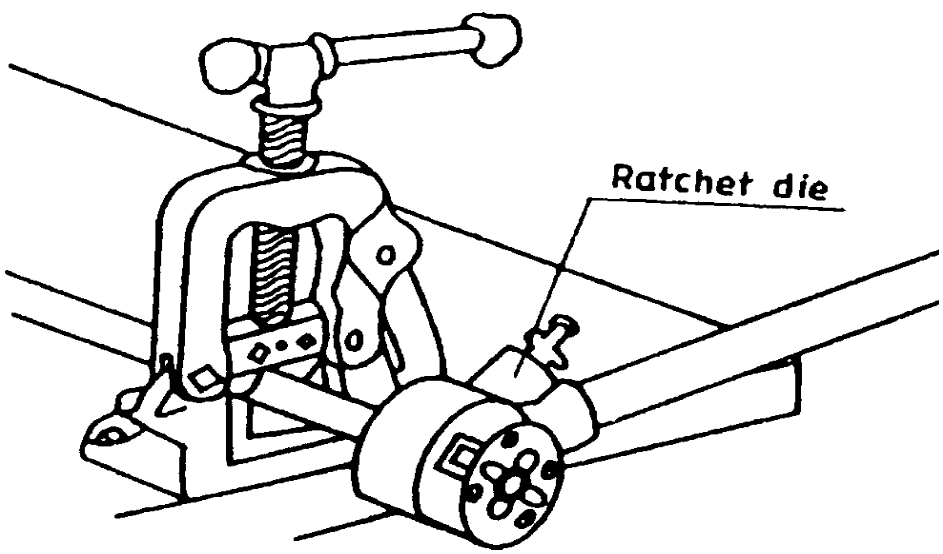


Fig N: 39 DIES

Pipe bending machine

While laying he pipeline, sometimes a part of a pipe may have to be bent to the required curvature. For this, a pipe bending machine is used. It is mounted on a tripod stand and can swivel about a vertical axis to any desired angle, to cover the required range for the operation. The unit consist s of number of bending block and dolly block to obtain any desired curvature at the bend.

Dies

A pipe is used for cutting external threads on pipes. One or two pieces dies are used in the die stock. It is a hand operated tool, which may be considered as a hardened steel nut, having flutes cut along its inside surface. These flutes serve the same purpose as in a twist drill. In case of two piece die, the two pieces are set at a desired distance and secured in position by means of a set screw.

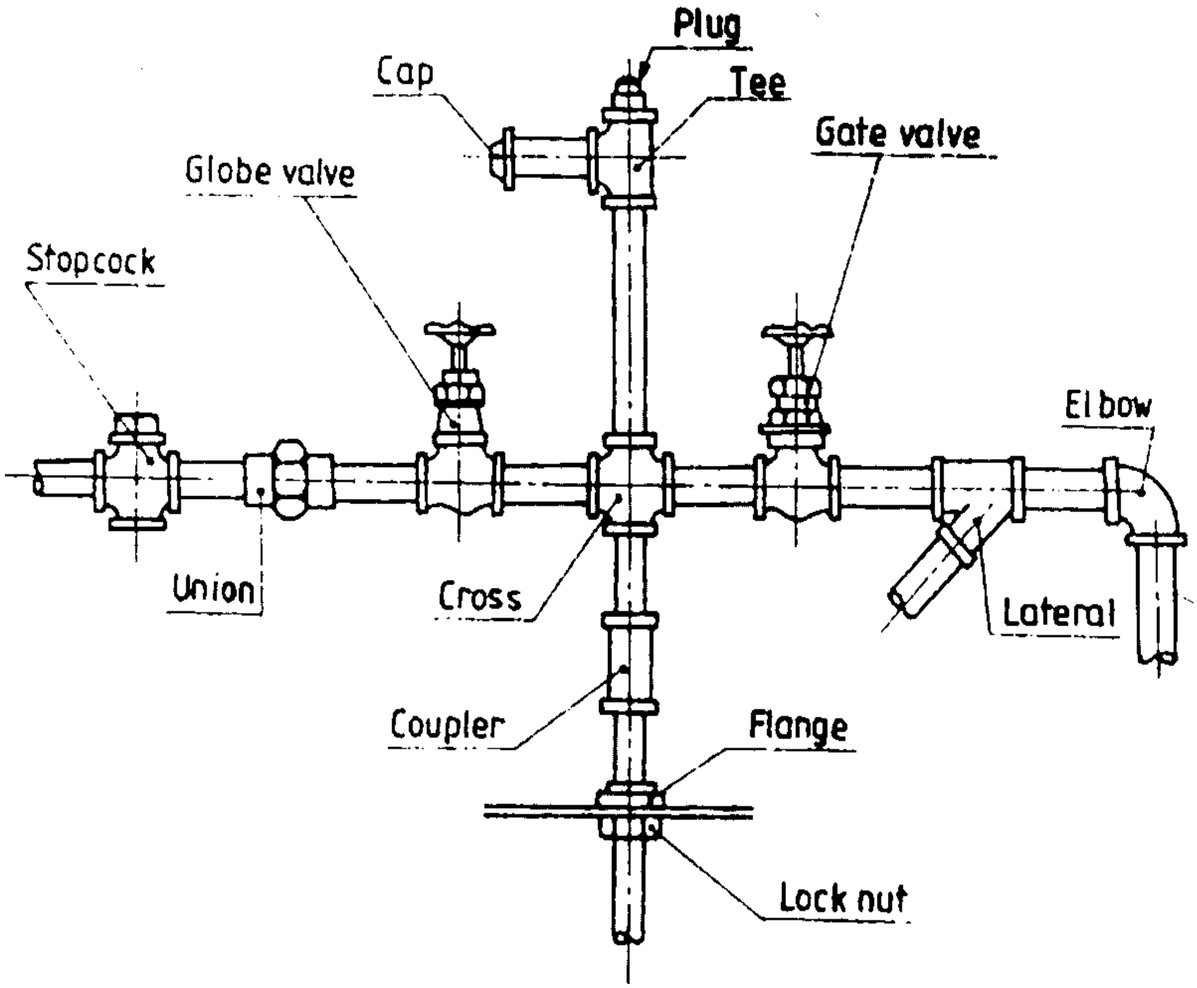


Fig No: 40 GI PIPE LAYOUT

PIPE FITTINGS

The pipe fittings are used to join adjacent lengths pipes. They are also frequently used to provide changes in direction, to provide branch connection at different angles or to effect a change in size. The various screwed fittings commonly used with malleable iron and steel pipes are as follows:

1. **Tee:** It is a threaded T-Shaped component used for distributing the supply of water at right angles to direction of flow.
2. **Elbow:** It is a threaded fitting used for joining two pipes at right angle, while bend is used for any angle
3. **Cross:** It is used to connect four pipes at right angles to each other.
4. **Socket:** It is used to connect two pipes of same diameter.
5. **Increaser or Reducer:** It is a threaded pipe fitting having one of its ends larger than the other. It is used for joining the pipes of different diameters.
6. **Nipple or coupler:** it is a. small length pipe having outside threads at ends. It is used to get extra length of the pipe, by screwing it with the two pipes having internal threads.
7. **Union:** it is used to connect two pipes and can be disconnected easily when desired.
8. **Plug:** it has external threads and is used with Tee or Cross to close the opening of the pipe which is left for further use.
9. **Cap:** it has internal threads and is used to close the threaded end of the pipe.

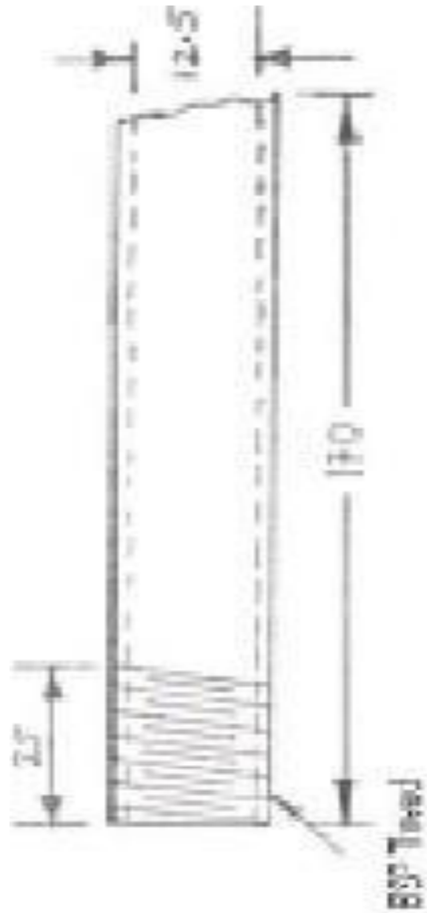


Fig No: 41 Thread Cutting

Ex No: 1

Thread Cutting on G.I. Pipe

Aim: A thread cutting on G.I. pipe

Tools required: pipe vise, pipe wrench, threading die.

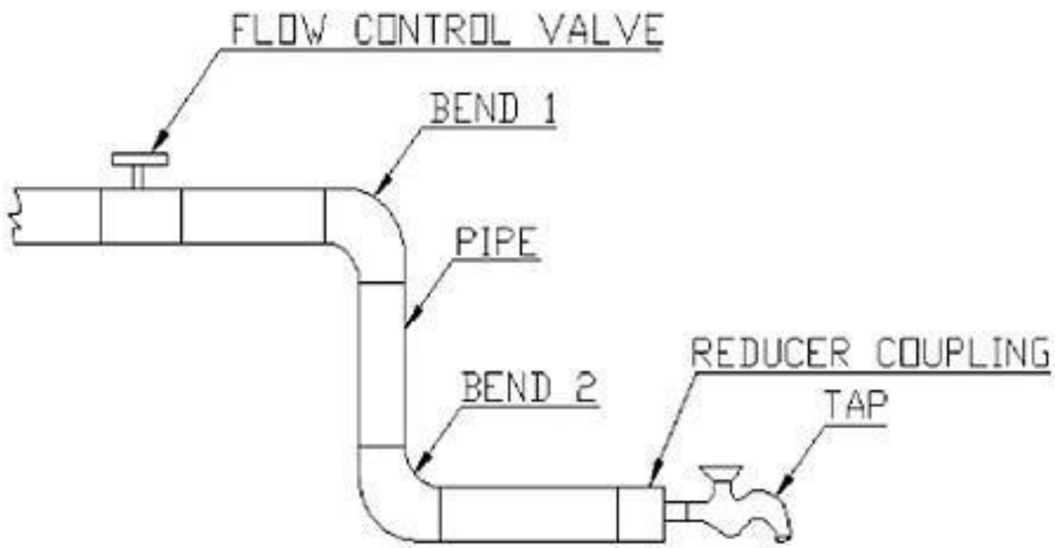
Raw material: GI Pipe

Procedure:

- ✓ First you'll need to measure, mark, and cut the pipe to length.
- ✓ Measure twice, cut once.
- ✓ Be sure about cutting square, don't have to be absolute about it but some care makes the threads come out better and makes work easier.
- ✓ Lubricate the blade of the hacksaw, it makes it much easier to cut, the lard beautifully adheres and doesn't drip (try finding cutting oil which will do that). Also, the lard won't stay solid as people may think; it sort of liquefies on contact with metal.
- ✓ After you cut, take down the edges with a file and make up for any imperfections in the cut

Result: a thread cutting on given G.I pipe is done.

Fig No: 42 Basic Connection Involving PVC/GI Pipe Fitting



Exp. No: 2

Basic Connection Involving PVC/GI Pipe Fitting

Aim: To connect the PVC/GI pipe fitting like valves, bends and tap.

Components required: 1. Pipes different length 2. Gate valve 3. Tap 4. Elbows 5. Reducer

Tools required: pipe wrench, hacksaw, die set, hammer, screw driver, measuring tape

Sequence of operation:

1. Selection of pipe
2. Threading of pipe
3. Connection of the pipes with the fitting

Procedure:

1. The required pipe connection layout is drawn
2. Two pipes of required length are taken and the ends are threaded using die set.
3. The gate valve which is internally threaded is connected to the elbow for vertical extension.
4. A third pipe with external threads is connected to the elbow for vertical extension.
5. To this pipe another elbow is attached at free end
6. The free end of the second elbow is connected with another pipe for horizontal extension.
7. A reducer coupling with internal threads is connected to the horizontal pipe.
8. A tap is connected properly to the end of the reducer coupling.

Result: hence the required connection is obtained using required pipes and pipe fittings.

REVIEW QUESTIONS

1) With what kind of work, the term "plumbing", deals?
A) Plumbing deals with the laying of pipe lines

2) Name the various plumbing tools?
A) Pipe wrench pipe wise pipe cutter, pipe bending machine, dies.

3) What are the jaws of a pipe wrench are serrated inside?
A) Movable jaws

4) When a pipe cutter is used instead of hacksaw, cutting pipes?
A) It is used when considerable amount of pipe work is involved

5) What is a pipe die?
A) A pipe die is used for cutting external threads on pipes

6) A pipe die is used for cutting either external/ internal threads on pipes?
A) External threads

7) Pipe die produces straight/tapered threads?
A) Tapered threads

BLACK SMITHY

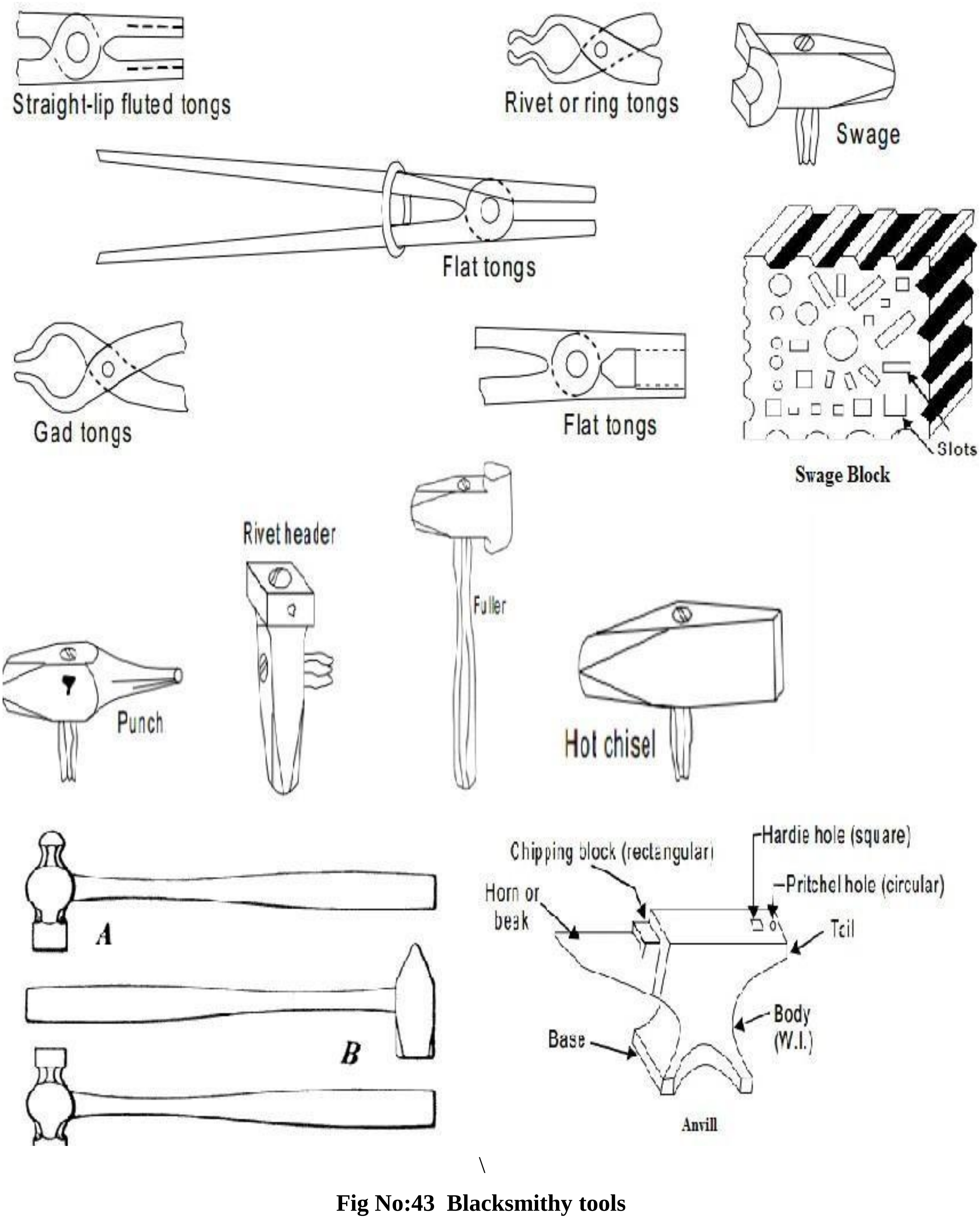


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Fig No:43 Blacksmithy tools

Introduction to Black Smithy

1. Introduction

Black smithy or Forging is an oldest shaping Process used for the producing small articles for which accuracy in size is not so important. The parts are shaped by heating them in an open fire or heat, by the blacksmith and shaping them through applying compressive forces using hammer.

Thus forging is defined as the plastic deformation of metals at elevated temperatures into a predetermined size or shape using compressive forces exerted through some means of hand hammers, small power hammers, die, press or upsetting machine. The shop in which the various forging operations are carried out is known as the smithy or smith‟s shop.

Applications of Forging:

Almost all metals and alloys can be forged. The low and medium carbon steels are readily hot forged without difficulty, but the high-carbon and alloy steels are more difficult to forge and require greater care. Forging is generally carried out on carbon alloy steels, wrought iron, copper-base alloys, aluminum alloys, and magnesium alloys. Stainless steels, nickel-based super alloys, and titanium are forged especially for aerospace uses.

Forgeability

The ease with which forging is done is called forgeability. The forgeability of a material can also be defined as the capacity of a material to undergo deformation under compression without rupture.

2. Common Hand Forging Tools

For carrying out forging operations manually, certain common hand forging tools are employed. These are also called blacksmith‟s tools, for a blacksmith is one who works on the forging of metals in their hot state. The main hand forging tools are as under

a) Tongs

The tongs are generally used for holding work while doing a forging operation. Various kinds of tongs are shown in Figure.

- Straight-lip fluted tongs are commonly used for holding square, circular and hexagonal bar stock.
- Rivet or ring tongs are widely used for holding bolts, rivets and other work of circular section.
- Flat tongs are used for mainly for holding work of rectangular section.
- Gad tongs are used for holding general pick-up work, either straight or tapered.

b) . **Flatter**

It is commonly used in forging shop to give smoothness and accuracy to articles which have already been shaped by fullers and swages.

c) **Swage**

Swage is used for forging work which has to be reduced or finished to round, square or hexagonal form. It is made with half grooves of dimension to suit the work being reduced. It consists of two parts, the top part having a handle and the bottom part having a Square shank which fits in the hardier hole on the anvil face.

d) **Fuller**

Fuller is used in forging shop for necking down a forgeable job. It is made in top and bottom tools as in the case of swages. Fuller is made in various shapes and sizes according to needs, the size denoting the width of the fuller edge.

e) **Punch**

Punch is used in forging shop for making holes in metal part when it is at forging heat.

f) **Rivet header**

Rivet header is used in forging shop for producing rivets heads on parts.

g) **Chisels**

Chisels are used for cutting metals and for nicking prior to breaking. They may be hot or cold depending on whether the metal to be cut is hot or cold. A hot chisel generally used in forging shop. The main difference between the two is in the edge. The edge of a cold chisel is hardened and tempered with an angle of about 60°, whilst the edge of a hot chisel is 30° and the hardening is not necessary. The edge is made slightly rounded for better cutting action.

h) **Hand hammers**

There are two major kinds of hammers are used in hand forging:

- The hand hammer used by the smith himself and
- The sledge hammer used by the striker.

Hand hammers may further be classified as

(a) Ball peen hammer. (b) Cross peen hammer.
(c) Straight peen hammer.

Sledge hammers may further be classified as

(a) Double face hammer. (b) Cross peen hammer.
(c) Straight peen hammer.

Hammer heads are made of cast steel and, their ends are hardened and tempered. The striking face is made slightly convex. The weight of a hand hammer varies from about to 2 kg whereas the weight of a sledge hammer varies from 4 to 10 kg.

i) Anvil

An anvil is a most commonly tool used in forging shop which is shown in. It acts as a support for blacksmith's work during hammering. The body of the anvil is made of mild steel with a tool steel face welded on the body, but the beak or horn used for bending curves is not steel faced. The round hole in the anvil called pitcher hole is generally used for bending rods of small diameter, and as a die for hot punching operations. The square or hard i.e. hole is used for holding square shanks of various fittings. Anvils in forging shop may vary up to about 100 to 150 kg and they should always stand with the top face about 0.75 mt. from the floor. This height may be attained by resting the anvil on a wooden or cast iron base in the forging shop.

j) Swage block

Swage block generally used in forging shop is shown in figure. It is mainly used for heading, bending, squaring, sizing, and forming operations on forging jobs. It is 0.25 mtr or even more wide. It may be used either flat or edgewise in its stand.

3. Forging Operations

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

a) Drawing-down

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

b) Upsetting

It is a process of increasing the area of cross-section of a metal piece locally, with a corresponding reduction in length. In this, only the portion to be upset is heated to forging temperature and the work is then struck at the end with a hammer. Hammering is done by the smith (student) himself, if the job is small, or by his helper, in case of big jobs, when heavy blows are required with a sledge hammer.

c) Fullering

Fullers are used for necking down a piece of work, the reduction often serving as the starting point for drawing. Fullers are made of high carbon steel in two parts, called the top and bottom fullers. The bottom tool fits in the hard i.e. hole of the anvil. Fuller size denotes the width of the fuller edge.

d) Flattering:

Flatters are the tools that are made with a perfectly flat face of about 7.5 cm square. These are used for finishing flat surfaces. A flatter of small size is known as set-hammer and is used for finishing near corners and in confined spaces.

e) Swaging:

Swages like fullers are also made of high carbon steel and are made in two parts called the top and swages. These are used to reduce and finish to round, square or hexagonal forms. For this, the swages are made with half grooves of dimensions to suit the work.

f) **Bending:**

Bending of bars, flats, etc., is done to produce different types of bent shapes such as angles, ovals, circles etc. Sharp bends as well as round bends may be made on the anvil, by choosing the appropriate place on it for the purpose.

g) **Twisting:**

It is also one form of bending. Sometimes, it is done to increase the rigidity of the work piece. Small piece may be twisted by heating and clamping a pair of tongs on each end of the section to be twisted and applying a turning moment.Larger pieces may be clamped in a leg vice and twisted with a pair of tongs or a monkey wrench. However, for uniform twist, it must be noted that the complete twisting operation must be performed in one heating.

h) **Cutting (Hot and Cold Chisels):**

Chisels are used to cut metals, either in hot or cold state. The cold chisel is similar to fitter‟s chisel, except that it is longer and has a handle. A hot chisel is used for cutting hot metal and its cutting edge is long and slender when compared to cold chisel. These chisels are made of tool steel, hardened and tempered.

NOTE: *The forging produced either by hand forging or machine forging should be heat treated. The following are the purposes of heat treatment:*

- *To remove internal stresses set-up during forging and cooling.*
- *To normalize the internal structure of the metal.*
- *To improve much inability.*
- *To improve mechanical properties, strength and hardness.*

4. SAFE PRACTICES:

- Hold the hot work downwards close to the ground, while transferring from the hearth to anvil, to minimize danger of burns; resulting from accidental collisions with others.
- Use correct size and type of tongs to fit the work. These should hold the work securely to prevent its bouncing out of control from repeated hammer blows.
- Care should be exercised in the use of the hammer. The minimum force only should be used and the flat face should strike squarely on the work; as the edge of the hammer will produce heavy bruising on hot metal.
- Water face shield when hammering hot metal.Wear gloves when handling hot metal.
- Wear gloves when handling hot metal wear steel-toed shoes.
- Wear steel-toed shoes
- Ensure that hammers are fitted with tight and wedged handles.

Ex. No. 1

Round to Square

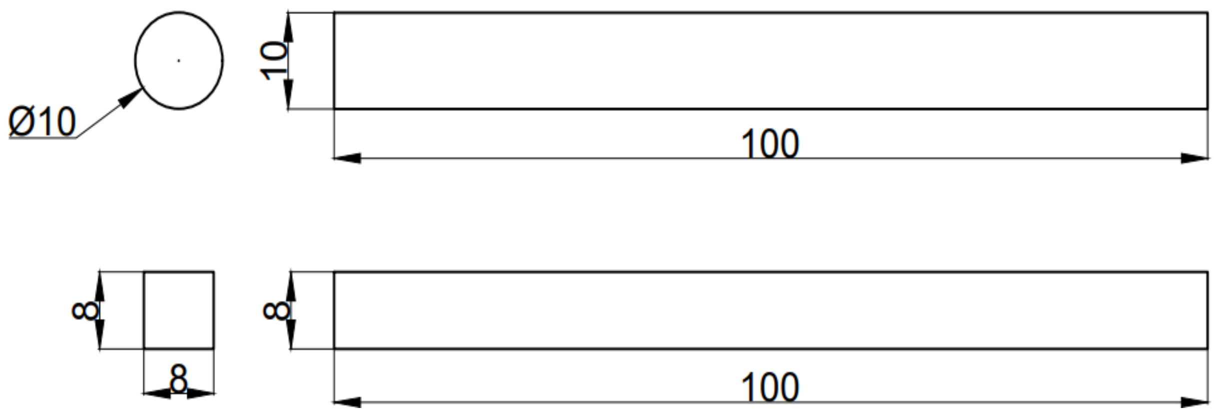

Fig No: 44 Round To Square

All Dimensions are in mm

Ex. No. 1

Round to Square

Aim: To make a Square rod from a given round rod, by following hand forging operation.

Tools required:

1. Smith's forge
2. Anvil.
3. Ball-peen hammers
4. Flatters
5. Swage block.
6. Half round tongs.
7. Pick-up tongs.
8. Cold chisel.

Procedure:

- ❖ Take the raw material from stock i.e., mild steel 10 mm round shaped, cut the length of 100 mm.
- ❖ Handle specimen with round tong and heat in blacksmith‟s forge up to the part appears as red cherry color.
- ❖ The required piece heated up to it gets the recrystallization temperature.
- ❖ The part is taken out from the forge and blow with sledge hammer for obtaining the square shape on all edges.
- ❖ The hammering is done on the anvil.
- ❖ The above mentioned all steps are repeated, till the specimen in required shape is obtained.
- ❖ Check the dimensions after cooling the job by quenching process.

NOTE: In-between the above stage, the bar is heated in the smith‟s forge, to facilitate forging operations.

Precautions:

- Hold the job carefully while heating and hammering
- Job must be held parallel to the face of the anvil.
- Wear steel-toed shoes.
- Wear face shield when hammering the hot metal
- Use correct size and type of tongs to fit the work.

Result: The ***square rod*** is thus made from the given round rod.

Ex. No. 2

SQUARE TO OCTOGON

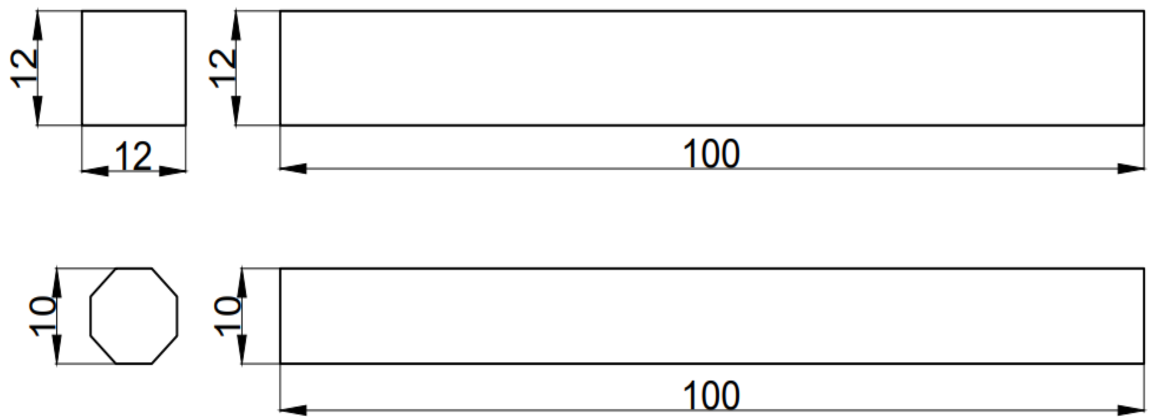

Fig No: 45 Square To Octogon

All Dimensions are in mm

Ex. No. 2

SQUARE TO OCTOGON

Aim: To make an S-hook from a given round rod, by following hand forging operation.

Tools required:

1. Smith's forge
2. Anvil.
3. Ball-peen hammers
4. Flatters
5. Swage block.
6. Square tongs.
7. Pick-up tongs.
8. Cold chisel.

Procedure:

- ❖ One end of the bar is heated to red hot condition in Black smith's forge for the required length.
- ❖ Using the pick-up tongs; the rod is taken from the forge, and holding it with the square tongs, the heated end is forged into a tapered pointed end.
- ❖ The length of the rod requires for Octagon is estimated and the excess portion is cut-off, using a cold chisel.
- ❖ One half of the rod towards the pointed end is heated in the forge to red hot condition and then bent into Octagon shape as shown.
- ❖ The other end of the rod is then heated and forged into a tapered pointed end.
- ❖ Using the flatter, the Octogon shape is made as above, is kept on the anvil and flattened so that, the shape of the Octogon is proper.

Note: *In-between the above stage, the bar is heated in the smith's forge, to facilitate forging operations*

Precautions:

- Hold the job carefully while heating and hammering
- Job must be held parallel to the face of the anvil.
- Wear steel-toed shoes.
- Wear face shield when hammering the hot metal
- Use correct size and type of tongs to fit the work.

Result:

The **Octagon** is thus made from the given square rod; by following the stages mentioned above.

Review questions

1. What is meant by smithy?

Ans: Black smithy or Forging is an oldest shaping process used for the producing small articles for which accuracy in size is not so important. The parts are shaped by heating them in an open fire or hearth by the blacksmith and shaping them through applying compressive forces using hammer.

2. What are the applications of forging?

Ans: Almost all metals and alloys can be forged. The low and medium carbon steels are readily hot forged without difficulty, but the high-carbon and alloy steels are more difficult to forge and require greater care. Forging is generally carried out on carbon alloy steels, wrought iron, copper-base alloys, aluminum alloys, and magnesium alloys. Stainless steels, nickel-based super alloys, and titanium are forged especially for aerospace uses.

3. What are the uses of anvil in block smithy?

Ans: An anvil is a most commonly tool used in forging shop which is shown in. It acts as a support for blacksmith‟s work during hammering. The body of the anvil is made of mild steel with a tool steel face welded on the body, but the beak or horn used for bending curves is not steel faced. The round hole in the anvil called pritchel hole is generally used for bending rods of small diameter, and as a die for hot punching operations.

4. What are the tools required for the forging operation?

Ans: anvil, chisel, tong, fuller, hammer, press, die, flatter, punch and drift, swage, swage block, clamping vice, and hearth.

5. What is meant by red hot temperature?

Ans: Red-hot metal or rock has been heated to such a high temperature that it has turned red.

C. PRESENTATION & VIDEO LECTURING

1. MANUFACTURING METHODS

INTRODUCTION

Manufacturing is the backbone of any industrialized nation. Manufacturing and technical staff in industry must know the various manufacturing processes, materials being processed, tools and equipments for manufacturing different components or products with optimal process plan using proper precautions and specified safety rules to avoid accidents. Beside above, all kinds of the future engineers must know the basic requirements of workshop activities in term of man, machine, material, methods, money and other infrastructure facilities needed to be positioned properly for optimal shop layouts or plant layout and other support services effectively adjusted or located in the industry or plant within a well planned manufacturing organization.

The complete understanding of basic manufacturing processes and workshop technology is highly difficult for any one to claim expertise over it. The study deals with several aspects of workshops practices also for imparting the basic working knowledge of the different engineering materials, tools, equipments, manufacturing processes, basic concepts of electromechanical controls of machine tools, production criteria's, characteristics and uses of various testing instruments and measuring or inspecting devices for checking components or products manufactured in various manufacturing shops in an industrial environment. It also describes and demonstrates the use of different hand tools (measuring, marking, holding and supporting tools, cutting etc.), equipments, machinery and various methods of manufacturing that facilitate shaping or forming the different existing raw materials into suitable usable forms. It deals with the study of industrial environment which involves the practical knowledge in the area of ferrous and non ferrous materials, their properties and uses. It should provide the knowledge of basic workshop processes namely bench work and fitting, sheet metal, carpentry, pattern making, mould making, foundry, smithy, forging, metal working and heat treatment, welding, fastening, machine shop, surface finishing and coatings, assembling inspection and quality control. It emphasizes on basic knowledge regarding composition, properties and uses of different raw materials, various production processes, replacement of or improvement over a large number of old processes, new and compact designs, better accuracy in dimensions, quicker methods of production, better surface finishes, more alternatives to the existing materials and tooling systems, automatic and numerical control systems, higher mechanization and greater output.

Manufacturing Methods/Manufacturing Process:

Manufacturing process is that part of the production process which is directly concerned with the change of form or dimensions of the part being produced. It does not include the transportation, handling or storage of parts, as they are not directly concerned with the changes into the form or dimensions of the part produced.

2. RAPID PROTOTYPING

1. INTRODUCTION:

Prototyping or model making is one of the important steps to finalize a product design. It helps in conceptualization of a design. Before the start of full production a prototype is usually fabricated and tested. Manual prototyping by a skilled craftsman has been an age- old practice for many centuries. Second phase of prototyping started around mid-1970s, when a soft prototype modeled by 3D curves and surfaces could be stressed in virtual environment, simulated and tested with exact material and other properties. Third and the latest trend of prototyping, i.e., Rapid Prototyping (RP) by layer-by-layer material deposition, started during early 1980s with the enormous growth in Computer Aided Design and Manufacturing (CAD/CAM) technologies when almost unambiguous solid models with knitted information of edges and surfaces could define a product and also manufacture it by CNC machining. The historical development of RP and related technologies is presented in table.

1.1 BASIC PRINCIPLE OF RAPID PROTOTYPING PROCESSES

RP process belong to the generative (or additive) production processes unlike subtractive or forming processes such as lathing, milling, grinding or coining etc. in which form is shaped by material removal or plastic deformation. In all commercial RP processes, the part is fabricated by deposition of layers contoured in a (x-y) plane two dimensionally. The third dimension (z) results from single layers being stacked up on top of each other, but not as a continuous z-coordinate. Therefore, the prototypes are very exact on the x-y plane but have stair-stepping effect in z-direction. If model is deposited with very fine layers, i.e., smaller z-stepping, model looks like original. RP can be classified into two fundamental process steps namely generation of mathematical layer information and generation of physical layer model. Typical process chain of various RP systems is shown in figure.

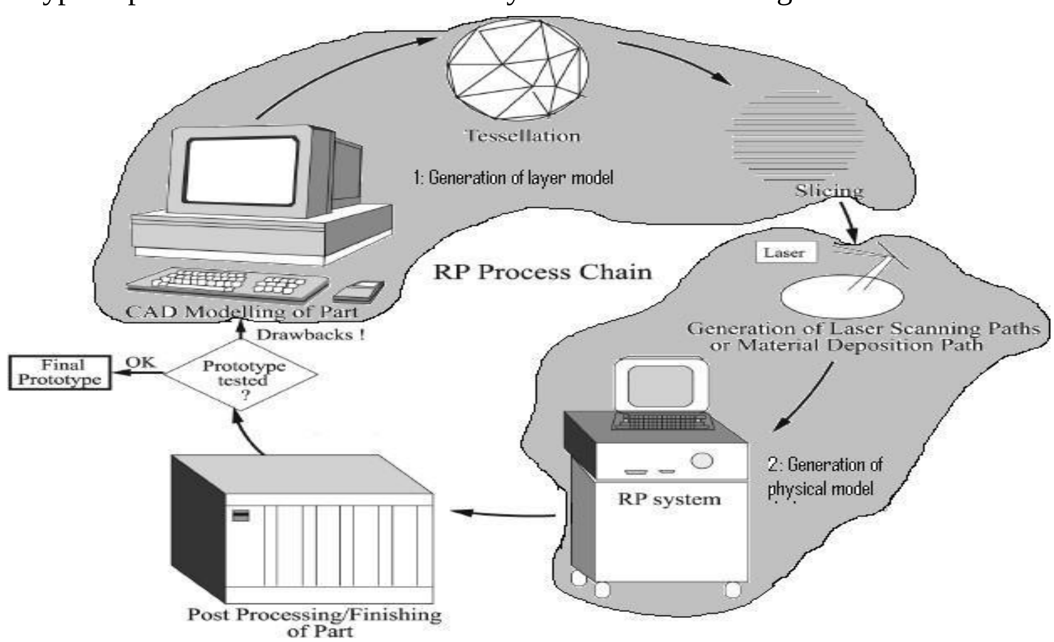

Fig No: 46 Rapid Prototyping Process Chain

It can be seen from figure that process starts with 3D modeling of the product and then STL file is exported by tessellating the geometric 3D model. In tessellation various surfaces of a CAD model are piecewise approximated by a series of triangles (figure 2) and co-ordinate of vertices of triangles and their surface normals are listed. The number and size of triangles are decided by facet deviation or chordal error as shown in figure 2. These STL files are checked for defects like flip triangles, missing facets, overlapping facets, dangling edges or faces etc. and are repaired if found faulty. Defect free STL files are used as an input to various slicing softwares. At this stage choice of part deposition orientation is the most important factor as part building time, surface quality, amount of support structures, cost etc. are influenced. Once part deposition orientation is decided and slice thickness is selected, tessellated model is sliced and the generated data in standard data formats like SLC (stereolithography contour) or CLI (common layer interface) is stored. This information is used to move to step 2, i.e., generation of physical model. The software that operates RP systems generates laser-scanning paths (in processes like Stereolithography, Selective Laser Sintering etc.) or material deposition paths (in processes like Fused Deposition Modeling). This step is different for different processes and depends on the basic deposition principle used in RP machine. Information computed here is used to deposit the part layer-by-layer on RP system platform. The generalized data flow in RP is given in figure .

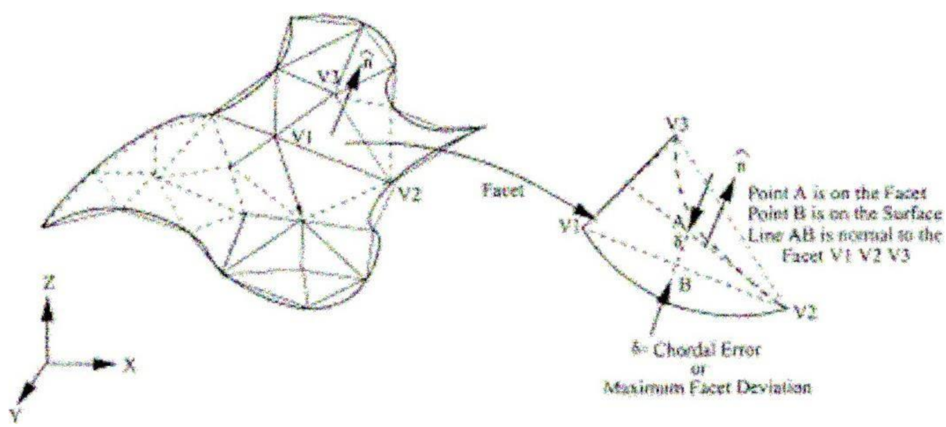

Fig No: 47 Rapid Prototyping Process System

3. GLASS CUTTING

1. INTRODUCTION

Glass is a non-crystalline amorphous solid that is often transparent and has widespread practical, technological, and decorative usages in the industry. In this article, we will discuss on Glass Cutting Process along with its Introduction, Properties, Types, Advantages, Disadvantages, and Applications**.**

HOW GLASS IS MADE?

- The glass is made by heating ordinary sand (which is mostly made up of silicon dioxide) until it melts and turns into a liquid. Sand melts at a high temperature of 1700°C (3090°F).
- In a glass plant, sand is mixed with waste glass, limestone (calcium carbonate), and soda ash (sodium carbonate) heated in a furnace.
- The soda reduces the sand's melting point, which helps to save energy and time during the manufacturing process, but it has a drawback that it produces a kind of glass that would dissolve in water and that (dissolving in water) can be eliminated by adding Limestone to the mixture.
- The end product is called **soda-lime-silica glass** and it is the ordinary glass that we are using in our domestic applications.

Properties of Glass:

These are some of the properties of Glass

- It is amorphous.
- These are affected by alkalis.
- It is very brittle.
- Possesses high compressive strength and since it doesn't have any crystalline structure.
- It Softens on heating
- Light in weight because it has a homogeneous internal structure similar to liquids.
- It can absorb, transmit, and reflect light.
- It is a good electrical insulator.
- Glass is not affected by air, water, etc. But, it is soluble in HF which converts into SiF_4.

Glass Cutting Tools:

1. **Wheel Cutting or Glass Cutter**
2. **CO2 Laser Cutting**

1. **Wheel Cutter or Glass Cutter:** In the Middle Ages, glass was cut with a heated and sharply pointed rod of iron.

   a. The **Diamond** can also act as cutting material for glass. Nowadays we used different methods to cut the glass.

b. **Wheel:** It is a small wheel attached to the glass cutter whose role is to cut the glass plate w.r.t. the dimensions easily. The glass after cut by cutting wheel has sharp corners. So, care must be taken during operation. A glass cutter more commonly uses a small cutting wheel made of hardened steel or **Tungsten Carbide** of **4–6 mm** in diameter with a **V-shaped profile** called a "hone angle" is used. The greater the hone angle of the wheel, the sharper the angle of the V, and the thicker the piece of glass it is designed to cut. The **honing angle** on most hand-held glass cutters is **120°**.
c. **Holders or Grips:** After marking the glass with the cutting wheel, the glass cutter has to be inserted into the corners of glass and tilt it so that it can break w.r.t the mark made.
d. **Ball:** The ball attached at the end of the glass cutter is used for tapping the glass piece if any irregularities are present at the corners of glass after the cut.

This is the explanation of the "wheel cutting" tool in a detailed way which is one of the Glass Cutting tools. So, let's see the detailed explanation of CO2 Laser cutting process in a detailed way.

2. **CO2 Laser Cutting Process:** Cutting the glass with conventional methods (Wheel Cutting) as stated above uses the principle of ***Scribe and Break***. In the sense, you need to scribe on the surface of the glass w.r.t. the dimensions and Break that particular part. By doing so, relatively low scribing quality results in the formation of micro-cracks and that leads to the damage of glass. In addition to that, various time-consuming processes like grinding, masking, and etching are necessary to remove the damage that had been introduced by mechanical processes (Conventional Methods). Using a laser for the glass cutting process avoids all the limitations stated above. By this laser cutting, the **Straight, angled, curved, and chamfered contours** are possible.

The laser beam is used to cut different materials like **metal, wood, rubber, glass, plastics,** etc. Laser cutting machines are equipped with computer-controlled programming that helps to do the work more efficiently and easily. By this, a high degree of accuracy is maintained. This is the detailed explanation of two types of cutting tools used in Glass Cutting Process. ***Let's*** see the advantages, disadvantages of the Glass Cutting Process along with its applications.

Applications of Glass Cutting Process:

3. Small scale industries use wheel cutter to cut the glass for their regular usage. Apart from that, it is also used in labs in colleges for doing experiments on the cutting processes.
4. As Large Scale industries require faster production and accuracy, Laser cutting is used to avoid the breaking of the glass at frequent intervals.
5. Glass is used as decorative items or window panes etc.

4. 3D PRINTING

1. INTRODUCTION

General explanation of 3D Printing:

A method of manufacturing known as ‘Additive manufacturing’, due to the fact that instead of removing material to create a part, the process adds material in successive patterns to create the desired shape.

3D Printing uses software that slices the 3D model into layers (0.01mm thick or less in most cases). Each layer is then traced onto the build plate by the printer, once the pattern is completed, the build plate is lowered and the next layer is added on top of the previous one. Typical manufacturing techniques are known as ‘Subtractive Manufacturing’ because the process is one of removing material from a preformed block. Processes such as Milling and Cutting are subtractive manufacturing techniques. This type of process creates a lot of waste since; the material that is cut off generally cannot be used for anything else and is simply sent out as scrap. 3D Printing eliminates such waste since the material is placed in the location that it is needed only, the rest will be left out as empty space.

How does 3d printing work?

The working principle of 3D printing is the same as that of traditional printers. It’s just that 3D print does not spray ink, but printing materials such as liquid or powder.

The rapid prototyping device that uses light curing and paper stacking technology superimposes the printing materials layer by layer through computer control and finally becomes real.

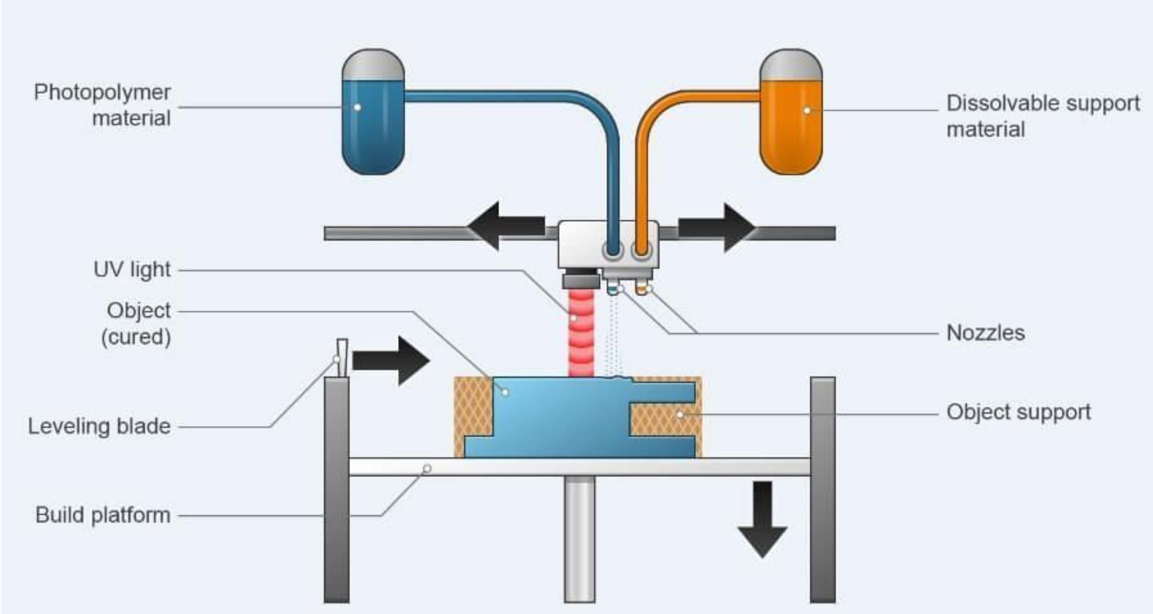

Fig No: 48 3D Printing Principle

2. Advantages and Limitations:

1. Layer by layer production allows for much greater flexibility and creativity in the design process. No longer do designers have to design for manufacture, but instead they can create a part that is lighter and stronger by means of better design. Parts can be completely re-designed so that they are stronger in the areas that they need to be and lighter overall.

2. 3D Printing significantly speeds up the design and prototyping process. There is no problem with creating one part at a time, and changing the design each time it is produced. Parts can be created within hours. Bringing the design cycle down to a matter of days or weeks compared to months. Also, since the price of 3D printers has decreased over the years, some 3D printers are now within financial reach of the ordinary consumer or small company.

3. The limitations of 3D printing in general include expensive hardware and expensive materials. This leads to expensive parts, thus making it hard if you were to compete with mass production. It also requires a CAD designer to create what the customer has in mind, and can be expensive if the part is very intricate.

4. 3D Printing is not the answer to every type of production method; however its advancement is helping accelerate design and engineering more than ever before. Through the use of 3D printers designers are able to create one of a kind piece of art, intricate building and product designs and also make parts while in space.

5. We are beginning to see the impact of 3D printing many industries. There have been articles saying that 3D printing will bring about the next industrial revolution, by returning a means of production back within reach of the designer or the consumer.

Applications of 3D Printing:

1. Biomedical Engineering
2. Aerospace and Automobile Manufacturing
3. Construction and Architecture
4. Product Prototyping

Designing of 3D Printing:

All the parts created using a 3D printer need to be designed using some kind of CAD software. This type of production depends mostly on the quality of the CAD design and also the precision of the printer. There are many types of CAD software available, some are free others require you to buy the software or have a subscription. Deciding what type of CAD software is good for you will depend on the requirements of what you are designing. However for beginners, that simply want to learn CAD and create basic shapes and features, any of the free CAD software packages will do.

When designing a part to be 3D printed the following points need to be kept in mind:

1. The part needs to be a solid, that is, not just a surface; it needs to have a real volume.
2. Creating very small, or delicate features may not be printed properly, this depends greatly On the type of 3D printer that is going to be used.
3. Parts with overhanging features will need supports to be printed properly. This should be

taken into account since after the model needs to be cleaned by removing the supports. This may not be an issue unless the part is very delicate, since it might break.

4. Be sure to calibrate the 3D printer before using it, it is essential to ensure that the part sticks properly to the build plate. If it does not, at some point the part may come loose and ruin the entire print job.
5. Some thought should be given to the orientation of the part, since some printers are more precise on the X and Y axes, then the Z axis.

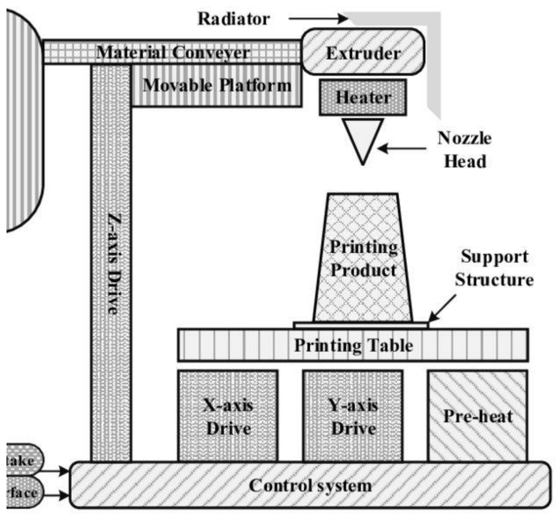

Fig No:49 3D Printing Machine

5. CNC LATHE

1. INTRODUCTION:

CNC machining plays a huge role in shaping today's advanced industrial development. We are now capable of developing most complex of parts and products with absolute perfection, and with minimum of effort. Whether it's about creating 3D, 4D or 5D machined parts, CNC technology has provided us with a sure shot way to convert our 'mechanical fantasies' into a tangible reality! Now, there are multiple types of CNC machining process. All of them have different functionalities and operations; CNC turning uses a helix path to cut through the material, while CNC milling uses rotary cutters to remove excess material. All of them require specific machining tools that enable the workpiece to work do the desired work. CNC lathe is one such important tool. In fact, the lathe is seen as the pioneer for being the machine for metal cutting. Sounds interesting, right? Let's delve deep into the functioning, properties, and types of CNC lathe machine.

A lathe machine is typically used for shaping the material into the desired form by removing the excess material from a given workpiece (generally cylindrical). Apart from serving as cutting and facing machine, a lathe is also used to perform complex operations such as knurling, deformation, metal spinning, woodturning, thermal spraying, metalworking and more.

According to machine historians, the manual lathe was first used by the reformers in the Ancient Egypt and Greece. The European nation widely utilized two-person lathe variety, with the former turning the workpiece (wood) and the latter cutting off the excess material with a single point cutting tool. With the Industrial Revolution came the modern lathe; advanced, fast, and better.

Parts of CNC lathe Machine.

Main Parts of a CNC Lathe Machine Before moving on to the functioning of a lathe machine, let's quickly go through the primary components of a lathe machine:

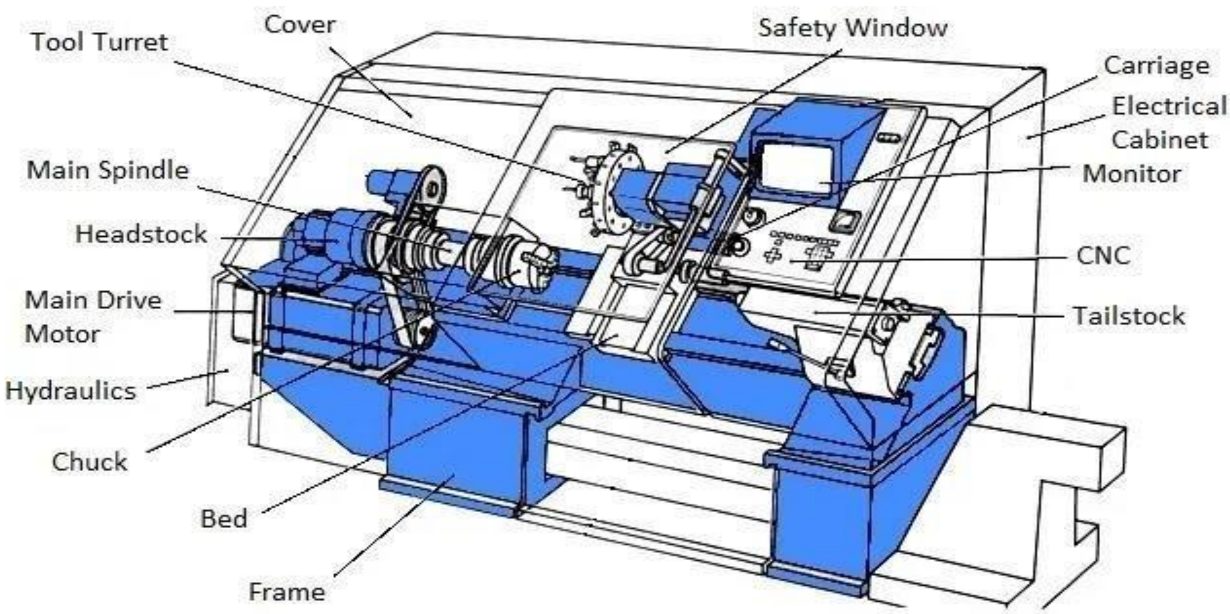

Fig No:50 CNC Lathe Machine

1. **Bed:** As the name suggests, the bed of a lathe serves as the base of the whole machine where the different components are mounted. Generally heavily rigid in structure, the lathe beds are made from a 9:1 combination melting of toughened cast iron (semi-steel) and steel scrap. This method helps lathe bed to perform a sliding action easily. While single-bed lathe machines are quite popular, we also get two-three pieced beds, pieces bolted together to meet the desired length. The beds have a high damping capacity to absorb the vibrations produced by the working machine.

2. **Carriage:** Used for mounting and moving the cutting tools, a carriage moves the tool horizontally and vertically on the bed for a smooth cutting process. PDF is created by Machining Design Associated Ltd

3. **Chuck:** A chuck is responsible for holding the workpiece. This component is attached to the spindle that rotates both the chuck and workpiece.

4. **CNC Control Panel:** The storage center of the machine, CNC control panel stores all the CNC programs and instructions. The CNC expert operates the machine by controlling the keys on the panel, instructing the machine to produce the desired results.

5. **Headstock:** This part functions as a holding device for the other components of the lathe like gear chain, spindle, driving pulley and more.

6. **Main Spindle**: The main feeding center of the machine. Stock is fed via the headstock.

7. **Main Drive Motor:** The drive motor helps rotate the chuck, thus driving the entire machine.

8. **Tailstock:** A tailstock is usually used to conduct drilling operations and support the system.

9. **Tool Turret**: A tool turret is used a tool carrier for the machine. The shape and the size of the turret is determined by the number of tools that'll be mounted on them.

CNC Lathe Machine: How Does It Work?

As discussed in the last part, a typical lathe comprises of a bed, headstock, tailstock, chuck, tool turret, carriage and a spindle for feeding purposes.

The following steps define how this particular machine works:

1. **First Step:** After checking the machine for the working faults, a cylindrical workpiece is attached to the chuck. Its position can differ as per requirement.
2. **Second Step:** We now set the spindle on the desired speed, thus rotating the chuck and the workpiece. Major attention needs to be paid on the spindle speed as any discrepancy can cause cutting errors. Check if the workpiece is turning properly.
3. **Third Step:** Now locate the cutting tool at the desired feed by moving the tool turret and carriage. Pay special attention to feeding speed.
4. **Fourth Step:** Remove all the excess metal by moving the carriage to get the finished CNC products.

Types of Lathe Machines

Just like every other machine, a lathe machine also has different varieties that are used to fulfill different work requirements. Let's have a look at the major types of the CNC lathe machine:

1. **Engine Lathes** Pretty popular amongst manufacturers, an engine lathe perfectly suitable for low-power operations. But that doesn't mean that it cannot be used for high-power operations. This device is very reliable and versatile, operating on a wide range of speed & feed ratios. This type is perfect for manufacturers looking for a machine that works with different metals.
2. **Centre Lathe** Centre lathe is a lathe type where the spindle speed is managed via a set of gears that are operated by using a lever. Gap Bed Lathe This type of lathe machine contains a removable bed section to accommodate the larger diameter of a workpiece, hence the name gap bed lathe. Generally, the part next to the headstock is removable. Speed Lathes A simpler version of a lathe machine, the speed lathe only has a headstock, tailstock, and tool turret. This type is generally used for light machine work as it can only operate in three or four speeds.
3. **Bench Lathe** Smaller in size, a bench lathe can be mounted on a workbench for conducted lighter jobs.
4. **Tool room lathe** is highly versatile, working in a number of speeds and feeds.
5. **Turret Lathes** A turret lathe is ideal for quick and sequential workings. With the tool holder in the vicinity, performing multiple operations on a single workpiece becomes several folds easier.
6. **Special Purpose Lathes** These special purpose lathes are used to perform heavy-duty production of identical parts. Some of the popular special purpose lathes include automatic lathes, crankshaft lathes, bench-type jewelers' lathes, duplicating lathes, and multi-spindle lathes.

6. INJECTION MOULDING

1. INTRODUCTION:-

Injection moulding is the most widely used polymeric fabrication process. This paper describes Injection moulding process in detail along with its process parameters and their effects on the moulding component. Runner system is playing the major role in the quality of the moulded part. Each injection molding method works when a plastic material flows from the sprue into the runner system, and then through a gate into the mold cavity. Basically runner system is of two types, Hot runner and cold runner system, both having some advantages and disadvantages of each. This paper describes in details about effectiveness of hot runner over cold runner. Although hot runner gives better quality of product, many of the industries uses cold runner due to high cost and complexity of design. The paper also deals with the illustration of mould defects related to the process parameters and the need of its optimization.

Injection moulding is a manufacturing process for producing parts from both thermoplastic and thermosetting plastic materials. It is the most widely used polymeric fabrication process which is evolved from metal die casting. However unlike molten metals, polymer melts have a high viscosity and cannot simply be poured into a mould. a large force must be used to inject the polymer into the hollow mould cavity. More melt must also be packed into the mould during solidification to avoid shrinkage in the mould. Thus the injection moulding process is primarily a sequential operation that results in the transformation of plastic pellets into a moulded part. Identical parts are produced through a cyclic process involving the melting of a pellet or powder resin followed by the injection of the polymer melt into the hollow mould cavity under high pressure.

Moulding machine

Most commonly used machines are hydraulically powered in-line screw machines. The various components of the injection moulding machine are illustrated in the following fig.

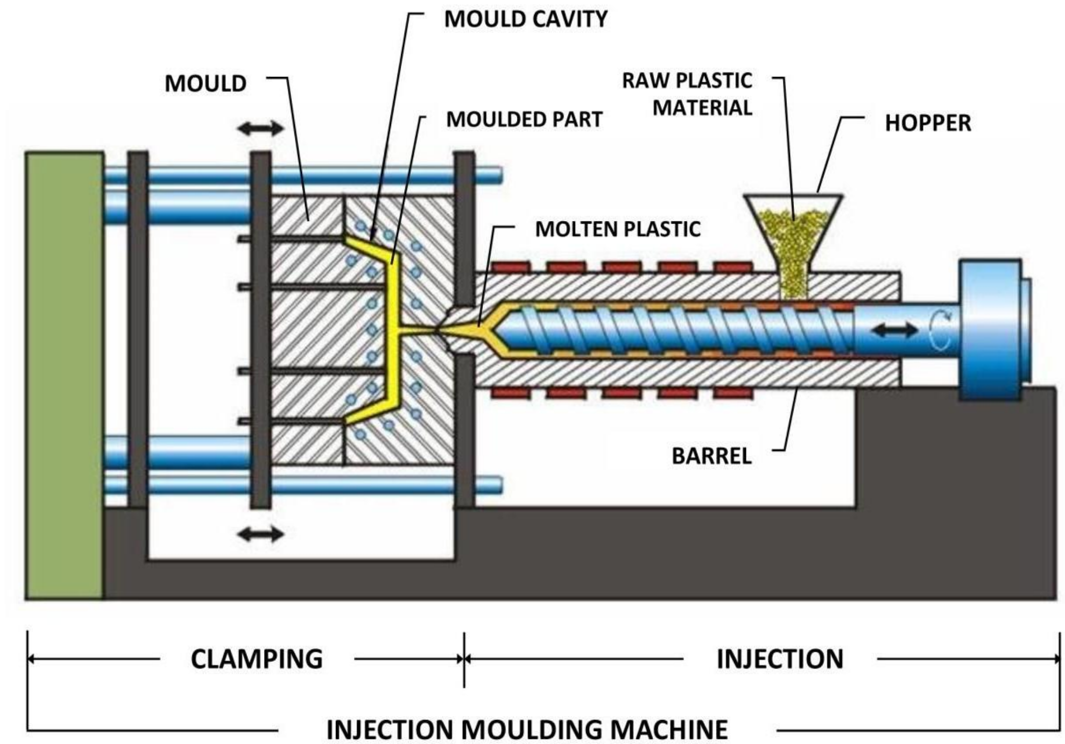

Fig No:51 Injection Moulding Machine

The main units of a typical injection moulding machine are the clamping unit, the plasticizing unit, and the drive unit; as shown in Fig.1. The clamping unit holds the mould. It is capable of closing, clamping, and opening the mould. Its main components are the fixed and moving plates, the tie bars and the mechanism for opening, closing and clamping. The injection unit or plasticizing unit melts the plastic and injects it into the mould. The drive unit provides power to the plasticizing unit and clamping unit. Injection moulding machines are often classified by the maximum clamp force that the machine can generate. This is the force that pushes the two mold halves together to avoid opening of the mould due to internal pressure of the plastic melt in the mould. The clamping force of typical injection moulding machines range from 200 to 100,000 kN.

The runner system

A mould basically consists of properly designed sprue, runner, gate, and cavity. The sprue is the channel, cut in the stationary platen that transports the melt from the plasticator nozzle to the runner. Once the plastic melt enters the mould, it flows through a distribution system, called the runner system, and then through the gates into the mould cavities. The gate connects the runner to the actual part. The cross section of the gate is usually small so that the runner can be easily removed from the part and does not leave a large gate mark on the part. The runner system is the most important part of injection moulding machine as it has a major role in moulding process. Two different types of molding systems can be used in the injection molding process—cold runner molds and hot runner molds. Each injection molding method works when a plastic material flows from the sprue into the runner system, and then through a gate into the mold cavity.

1.2.1 A) Cold Runner Molds

In this system, the runners are kept at the same temperature as the molds. The cold runner system consists of either two or three plates within the mold. The two plate system is the simplest, but requires an ejection system to remove both the runner and the part from the mold. The three plate system enables the part to be ejected separately from the runner, since the runner is on a separate plate from the rest of the part. The three plate molds allow for flexibility in the design. In a cold runner system, a new runner is moulded in each moulding cycle and the runner is ejected together with the moulded parts. The plastic of the runner can often be reprocessed and moulded again. In the design of the runner system the objective is to have the plastic reach to all gates at the same time. This is an important issue in multi-cavity moulds. In a rectangular runner system, the number of cavities is a multiple of two. In a circular runner any number of cavities can be used. In the cold runner system, it is important that the dimension of the runner be larger than the part. This will ensure that the material fills the part properly and that the mold is not under filled

1.2.1 B) Hot Runner Molds

Hot runner molds are made up of two plates, which are heated using a manifold system. There are two types of hot runners, externally heated and internally heated. Externally heated molds are better for materials that are sensitive to heat, while internally heated molds provide better flow control. There are several methods that can be used to heat the runners, including coils, heating rods, and heating pipes. The hot runner system ensures that the material remains molten throughout the runner process until it enters the mold cavity.

7. MOULD MAKING AND CASTING

1. INTRODUCTION

Foundry practice deals with the process of making castings in molds, formed in either sand or some other material. The process involves the operations of pattern making, sand preparation, molding, melting of metals, pouring in molds, cooling, shake-out, heat treatment, finishing, and inspection.

- **Pattern**

Pattern is the principal tool during the casting process. It may be defined as a model of anything, so constructed that it may be used for forming an impression called would in damp sand or other suitable material. When this mold is filled with molten metal and the metal is allowed to solidify it forms a reproduction of the pattern and is known as casting. The process of making pattern is known as pattern making.

- **Mold**

Mold is cavity formed by the pattern. It is similar in shape and size to that of the actual casting plus some allowances for shrinkage, machining etc. Molds are classified as temporary and permanent. Temporary molds are made of refractory sand and other binding materials and may be produced either through hand molding or machine molding.

- **Molding Sand**

Sand is the principal material used in foundry. The principal ingredients of molding sands are: Silica sand, clay, moisture, and miscellaneous materials. Silica sand withstands very high temperatures and doesn‟t react with the molten metal.

Clay imparts the necessary bonding strength to the molding sand. Moisture in requisite amount furnishes the bonding action of clay. Miscellaneous materials that are formed in addition to silica and clay penetrate the mixture and forms a microfilm which coats the surface flake shaped clay particles. Natural molding sand is available in river beds or dug from pits. They possess an appreciable amount of clay and are used as received with addition of water. Synthetic sands are prepared by adding clay, water and other materials to silica sand so that desired strength and bonding properties are achieved which are not possessed by natural sands.

- **Properties of Molding Sand:**

The essential requirement of good molding sand is that it should produce sound castings which are free from defects. For producing sound castings, molding sand or mold should possess the following properties; to quote a few:

- **Porosity or Permeability**

When molten metal is poured into a mold, gases and steam are passed through it. If they are not removed, casting defects such as blow holes will be formed.

- **Flowability**

Flow ability of molding sand refers to its ability to its ability, under externally applied forces (ramming), into deeper sections of the pattern and uniformly fill the flask. Flowability increases as clay and water content increase.

- **Collapsibility**

Collapsibility is the property of sand that permits it to collapse (break) easily during its knockout from the castings. This property is particularly important for cores. This property depends on amount of the sand, clay and type of binder used.

- **Adhesiveness**

Adhesiveness is the ability of a moulding sand to stick on the surface of molding boxes. It is due to this property that the sand mass can be successfully held in a molding box and it does not fall out of the box when it is removed.

- **Cohesiveness or Strength**

This is the ability of sand particles to stick together. Insufficient strength may lead to a collapse in the mold or its partial destruction during conveying, turning over or closing.

- **Refractoriness**

The sand must be capable of withstanding the high temperature of the molten metal without fusing.

Types of Molding Sand:

Molding sands are classified according to their use into a number of varieties. These are described as follows:

Green Sand

It is a mixture of silica sand with 18 to 30 % clay having a total water of 6 to 8 %.

Dry Sand

Green sand that has been dried or baked after the mold is made is called dry sand.

Loam Sand

Loam sand is high in clay, as much as 50 %.

Facing Sand

Facing sand forms the face of the mold. It is used directly next to the surface of the pattern and it comes into contact with the molten metal when the mold is poured. It is made of silica sand and clay, without the addition of used sand.

Baking Sand

Baking sand or floor sand is used to back up the facing sand and fill the whole volume of the flask. Old repeatedly used molding sand is mainly employed for this purpose. The baking sand is sometimes called black sand because of the fact that old, repeatedly used molding sand is black in color due to the addition of coal dust and burning on coming in contact with molten metal.

Parting Sand

Parting sand is used to keep the green sand from sticking to the pattern and also to allow the sand on the parting surface of the cope and drag to separate without clinging. This is clean clay free silica sand which serves the same purpose as parting dust.

Core Sand

The sand used for making cores is called as core sand and sometimes it is called as oil sand. This is silica sand mixed with core oil which is composed of linseed oil. Resin light mineral oil and other binding materials.

Pattern Materials:

- The selection of pattern materials depends primarily on the following factors.
- Service requirement
- Type of production of castings and the type of molding process
- Possibility of design changes
- Number of castings to be produced.
- Easily worked, shaped, and joined
- Light in weight
- Strong, hard, and durable.
- Dimensionally stable in all situations
- Easily available at low cost
- Repairable and reused
- Able to take good surface finish

The wide variety of pattern materials which meet these characteristics are wood and wood products; metal and alloys; plasters; plastics and rubber; and waxes.

Types of Patterns:

Single Piece or Solid Pattern

In a simple solid pattern, one side is made flat which serves as a parting surface. In this case, the mold cavity will be entirely in the drag, and requires the more number of manual operations such as cutting the gating system and repairing of the mold. The shape of the single piece pattern is exactly same as that of casting. Single piece patterns are inexpensive and best suited for limited production

Split Pattern

Split pattern is made in two parts. One part producing the mold in drag and the other in cope. They are kept in position by dowel pins, and the split is usually arranged along the parting line to draw the pattern easily out of the mold before pouring of molten metal. Split piece patterns are used for intricate castings or castings of unusual shapes.

Multi Piece Pattern

Pattern with three or more parts is used for more complex castings. This type of pattern is known as multi piece pattern. It requires molding box with three parts. The middle one is called cheek.

Loose Piece Pattern

Loose piece pattern is used to produce the castings having projections in the sides. Such design makes impossible to draw the pattern from the mold. It is therefore necessary to make such projection in loose piece and fastened to main pattern by means of anchor pin.

Match Plate Pattern

In this case, pattern in two halves is attached on opposite side of wooden or metal plate (match plate). Production efficiency and dimensional accuracy of castings can be generally improved by the use of these patterns. Several patterns for small castings (need not be same) can be mounted on one match plate. These are mostly used in machine molding as well as for producing large number of small castings by hand molding.

Sweep Pattern

It is not a true pattern, but a template made of wood or metal revolving around a fixed axis in the mold shapes the sand to the desired contour. This eliminates the need for a large three dimensional pattern. It is suitable for producing simple symmetrical castings such as wheels, rims, and bell shapes.

Runner:

Runner is a horizontal channel that receives molten metal from the sprue base, and distributes to the in gates which carries metal to the mold. Runners are usually made trapezoidal in cross section. They are generally located in cope and in gates in the drag. This ensures that the slag and dross are trapped in the upper portion of runner and only molten metal enters into the mold.

Runner Extension:

The runner is often extended beyond the last in gate to retain inclusions and various refractory materials that may have been washed along the stream of molten metal. Also, it absorbs kinetic energy causing a smooth flow of metal into the mold cavity.

Gates or In gates:

Gates or in gates are openings through which molten metal directly enters into the mold cavity. The gates should be designed such that the molten metal can flow steadily and quietly into the mold cavity. They should be easily removed from the casting after solidification.

Tools and Equipment:

Molding Board

A molding board is a smooth wooden board on which the flask and pattern are placed when the mould is being made.

Molding Boxes

Sand moulds are prepared in specially constructed boxes called flasks. The purpose of flask is to impart the necessary rigidity and strength to the sand in molding. They are usually made in two parts, held in alignment by dowel pins. The top part is called the cope and the lower part the drag. These flasks can be made by wood or metal depending upon the size required and the purpose the flask must serve.

Shovel

A shovel is used for mixing and tempering molding sand and for moving the sand from the pile to the flask.

Riddle

A riddle sometimes called a screen consists of a circular or square wooden frame fitted with a standard wire mesh at the bottom as shown in figure below. It is used to remove coarse sand particles and other foreign material from the foundry sand.

Rammer

A hand rammer is used for packaging or ramming the sand into the mould. One of its ends, called the peen end, is wedge shaped and is used for packing sand in spaces, pockets and corners, in the early stages of ramming. The other end called the butt end, has a flat surface and is used for compacting the sand towards the end of molding as shown in below figure.

Strike Edge or Strike-Off Bar

It is a piece of metal or wood with straight edge as shown in below figure. It is used to remove excess sand from the mould after ramming, to provide a level surface.

Riser Pin

It is a straight wooden pin used to make a hole in the cope over the mold cavity for the molten metal to rise-in and feed the casting to compensate the shrinkage that may take place during solidification.

1.6.8. Sprue Pin

It is a tapered wooden pin, as shown in below figure. It is used to make a hole in the cope through which the molten metal is poured into the mould.

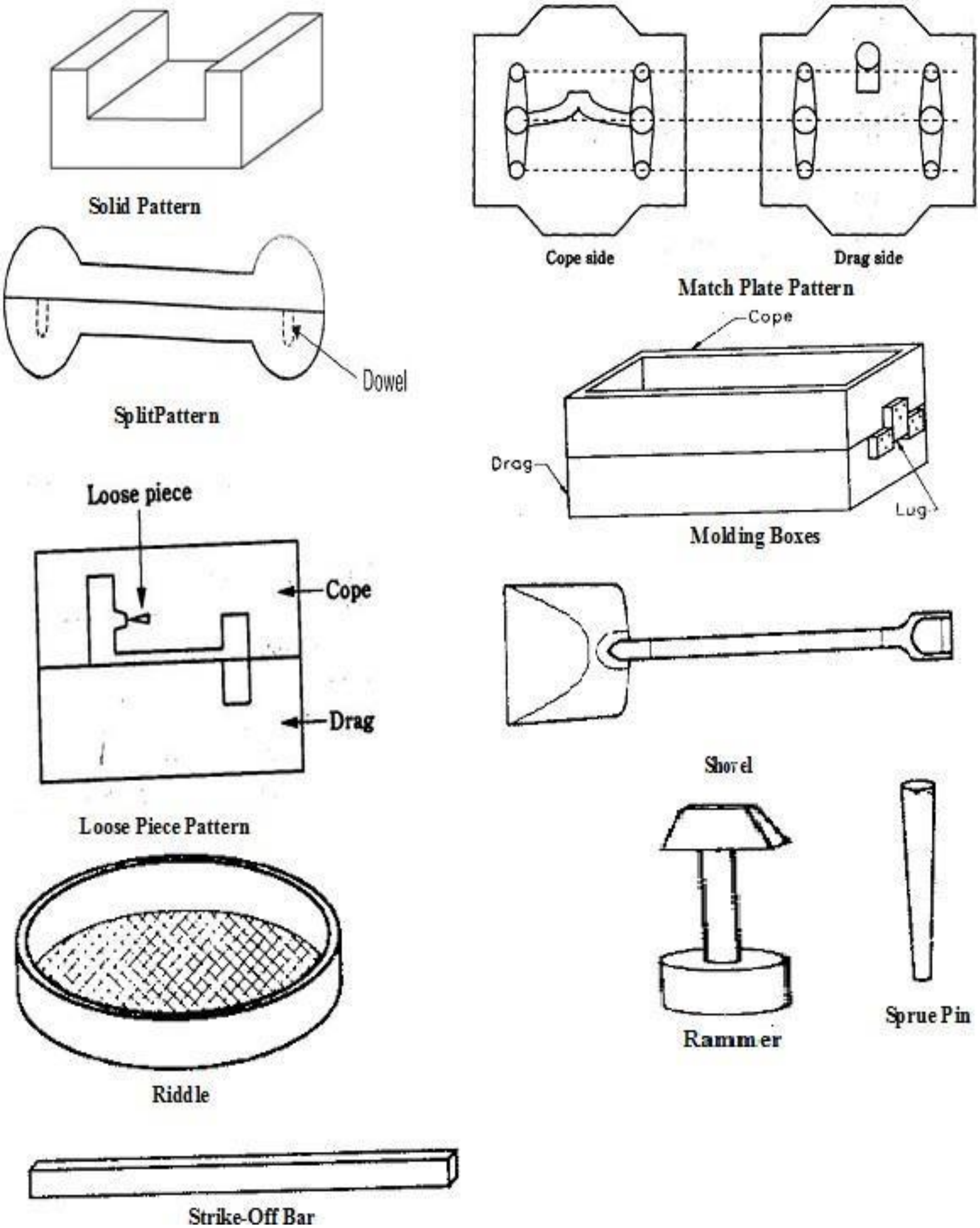

Fig No: 52 Mould Making Tools

8. BASIC ELECTRONICS LAB INSTRUMENTS

1. INTRODUCTION

In the world of mechanical devices today, most measurements are made by electronic instrumentation, not the crude mechanical devices of the past. Most of these newer devices are actually a modern combination of a mechanical device and electronic sensing element. Many of the measurements a mechanical engineer makes are done with specialized calibrated equipment, but some are still made with basic electronic instruments, and the readings interpreted by the operator. This mini-lab is designed to introduce you to some of the more common basic instrumentation and its use. It will also allow you to conduct some measurements and familiarize yourself with these instruments.

Multi-Meter:

The multi-meter is the most common electronic instrumentation in use. It is a combination meter thatis capable of measuring, resistance, voltage (AC and DC) and usually current. In addition some meters are capable of measuring capacitance, frequency and other variables. An example of one of these meters is the Fluke 189 hand held multi-meter.

Fig No: 53 Fluke 189 Multi Meter

This type meter is very common in most shops and is portable and easily used. This meter is capable of measuring AC and DC Voltage (down to 0.000001 Volts and as high as 1000 Volts), Resistance, Capacitance, Temperature, Current (Down to 0.000001 Amps and as high as 10 Amps). In addition it is capable of catching maximum and minimum values and saving them in memory. A versatile meter like this is most commonly used by service personnel, but can easily be used by anyone. In addition this meter is a ***True RMS*** meter, which will be explained in more detail later.

Frequency Counter:

A second common instrument found in any well used instrumentation shop is the Frequency counter or meter. In its most simple form the meter measures the amount of time it takes from one positive going pulse to the next positive going pulse, and the result is displayed as a number of cycles per second or Hertz. This function is built into some higher end hand held multi-meters, but there are many more sophisticated bench top frequency meters available. Most of these meters let you control exactly how you look at the signal being measured. Common settings are weather the signal is triggered going positive or going negative, and at what level this happens. They may also let you look at the pulse period, positive going portion or negative going pulse time, duty cycle and other more advanced configurations involving two input signals, such as time from the pulse on one channel to the pulse on the other channel. All these abilities can be useful when investigating how a particular mechanism or system if functioning. In this course we will only use the simple functions of frequency and period.

Function Generator:

Function or frequency generators are a class of instrument that are useful for creating a repetitive signal of a various form. In the mechanical world this is most commonly used to generate signals to drive test apparatus. As an example, a vehicle chassis may be connected to a large shaker assembly, and this assembly is vibrated and moved in a motion that simulates going down a bumpy road. In this way a vehicles durability can be tested and its motion analyzed, without the need to actually drive it down the road. This might be important if your job is to prove that it will last 100,000 miles of rough road. Your test drivers will certainly appreciate that the machine can spend 24/7 bouncing the truck around instead of the truck spending those miles bouncing their kidneys around.

Fig No: 54 Sweep Function Generator

Oscilloscope:

The basic premise of an oscilloscope is similar to that of a chart recorder, with the pen no longer being an ink device, but a beam of electrons, and the paper being a glass tube with a phosphor coating. When the beam of electrons strike the phosphor, it glows. The beam of electrons is deviated from left to right with time, and up and down with voltage. The resulting image is a small "page" of voltage vs. time. Unfortunately the beam must continue to "paint" this image for it to remain so you could see it. This was only good for repetitive signals, however, it had the advantage that it was extremely accurate for signals that were too fastfor the chart recorder. By installing a triggering section to display the same portion of the wave form over and over at the same point in time, the device became a standard and useful tool. Over time "persistent" phosphors were created that allowed a recording of only a single sweep of the electron beam. With the advent of the computer age, it soon became more cost effective to use a small processor to record the image to memory and display it on a small computer screen.

Spectrum analyzer:

While the oscilloscope is a wonderful tool, there are times when it is valuable to view a waveform in the frequency domain, rather than the time domain. One common application is when working with vibrations of structures. Where the oscilloscope displays a wave form of voltage vs. time, the spectrum analyzer displays a waveform of voltage vs. frequency. This data can be obtained from a specialized instrument, such as the HP 3582, shown below, or from more general purpose tools such as an FFT module in a digital oscilloscope, or a computer data acquisition system running a virtual instrument. Many people have trouble with the concept of the spectrum analyzer. The simplest model for how one of these systems works, is that there are lots of individual frequency filters. Each filter being set to one specific frequency. If the incoming signal has a component that matches this frequency, the analog voltage level of that component is displayed.

Web Links for Video Lectures topics:

Sl. No	Topic	Web link	Remarks
1.	Manufacturing Methods	https://youtu.be/mLakJ77O4_s	
2.	Rapid Proto typing	https://youtu.be/NkC8TNts4B4	
3.	Glass Cutting	https://youtu.be/oAlrlFyEAt4	
4.	3D Printing	https://youtu.be/kNz-TM4zPkE	
5.	CNC Lathe	https://youtu.be/B7MM5M7DzpM	
6.	Injection Moulding	https://youtu.be/QxZ54WgYhnA	
7.	Mould Making and Casting	https://youtu.be/_Pcjz9bOsPs	
8.	Basic Electronics Lab Instruments	https://youtu.be/w8Dq8blTmSA	