GOVERNMENT OF TAMIL NADU

HIGHER SECONDARY FIRST YEAR

VOCATIONAL EDUCATION

Basic Mechanical Engineering

THEORY & PRACTICAL

A publication under Free Textbook Programme of Government of Tamil Nadu

Department of School Education

Untouchability is Inhuman and a Crime

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Government of Tamil Nadu

First Edition - 2018

Revised Edition - 2019

(Published under New Syllabus)

NOT FOR SALE

Content Creation

State Council of Educational Research and Training

© SCERT 2018

Printing & Publishing

Tamil Nadu Textbook and Educational Services Corporation

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PREFACE

This book **"General Machinist"** has been written entirely based on new syllabus framed by TNSCERT. The subject matter is explained in a simple manner and simple language, lightened by sufficient colourful diagrams, illustrations with learning objectives.

In each chapter, Quotes, Activities, "Do you Know" and web search link have been given to enhance the student knowledge. QR Codes, ICT Corner for the tough area of the subject are marked which helps the students to understand the subject further in detail and quickly. Line diagrams as well as 3-Dimension views are given for easy understanding. Model Question has also been included at the end of the last chapter. Case studies are included at the end of this book which focus the importance of this **General Machinist** course and also motivate the students to join and learn in the Engineering fields.

We sincerely convey my thanks to the Director, Joint Director and Staff members whose patronage on this book to come out successfully and the committee of experienced Teachers who beard the responsibility of the book to come out in good shape.

In spite of all our efforts, some errors and mistakes might have crept in. Any error or misprint, if pointed out and any suggestion for the improvement of the book will be thankfully acknowledged.

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HOW TO USE THE BOOK

Learning Objectives: Learning objectives are brief statements that describe what students will be expected to learn by the end of school year, course, unit, lesson or class period.

Chapter Outline — Illustrate the complete overview of chapter

Amazing facts, Rhetorical questions to lead students to Engineering inquiry

Activity — Directions are provided to students to conduct activities in order to explore, enrich the concept.

Infographics — Visual representation of the lesson to enrich learning .

Evaluation — Assess students to pause, think and check their understanding

To motivate the students to further explore the content digitally and take them in to virtual world

Career corner — List of professions related to the subject

References — List of related books for further details of the topic

Web links — List of digital resources

Glossary — Explanation of Engineering terms

Competitive Exam questions — Model questions to face various competitive exams

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CAREER GUIDANCE

AFTER COMPLETION OF 12TH VOCATIONAL GROUP
General Machinist Trade

Higher Education (Vertical Mobility)

1. Directly to Join 2nd year Diploma Engineering in Government and Government Aided and private polytechnics.
2. 10% of the Seats are allotted to Government and Government Aided and Private Engineering colleges to join first year Bachelor of Engineering (B.E).
3. To Distance Education Directly undergo the course AMIE which is equal to Government Engineering Courses.

Arts Group Area

1. +2 Vocational Groups Students are eligible to Join Ist year Diploma Teacher Training Course.
2. Directly Join B.A. Arts Group Except – Physics, Chemistry, Biology major all other Science group.
3. Directly Join B.Sc-Maths Group and B.Sc-Computer Science.

Horizontal Mobility

Employments

1. Directly Join to Reputed Industries as Apprentice Training/Factory Training like
   a) Ashok Leyland (Chennai and Hosur)
   b) TVS Groups (Chennai, Hosur, Madurai, etc.)
   c) Simpson Engineering Groups (Chennai, Hosur, Redhills, etc.)
   d) Hyundai Car Company (Sriperumbudur, Irrungattukotttai, Chennai)
   e) Ford India Ltd. (Maraimalai Nagar, Kanchipuram Dt.)
   f) All Reputed Service centers like TVS, VST and Hyundai, Ford etc.
   g) All Automobile leading manufacturing, repairing and servicing centers.

Self-Employment

1. Vocational Students after getting Apprentice Training Industry Training are eligible to get small scale Industry Loan from Hudco, TIDCO, SIDCO etc.
2. After getting required experience in the field, they are eligible to get minimum loans under the scheme of
   a) **NRY** (Nehru Rozhar Yogana)
   b) PMRY (Prime Minister Rozhar Yogana)
   c) TRYSEM (Training for Rural Youth and Self Employment)
   d) PMK**VY** (Pradhan Mantri Kaushal Vikas Yojana)

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BRIEF CONTENTS

GENERAL MACHINIST

SGURIH

E-book

SGZZW8

Assessment

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DIGI-Links

Lets use the QR code in the text books ! How ?

- Download the QR code scanner from the Google PlayStore/ Apple App Store into your smartphone
- Open the QR code scanner application
- Once the scanner button in the application is clicked, camera opens and then bring it closer to the QR code in the text book.
- Once the camera detects the QR code, a url appears in the screen.Click the url and goto the content page.

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Basic Mechanical Engineering

THEORY

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Chapter

1

WORKSHOP ENGINEERING SAFETY PRECAUTIONS

Learning Objectives

1. To know about workshop, workers, Industries Safety Precaution, Accidents, First Aid and First Aid Materials

Table of Content

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1.1 Introduction

- Now a days technological revolution modern machineries and industries show dramatic development. New techniques lead to new machines. In order to cater to the needs of our daily life, new machines are developed and places in our house, office, commercial plazas, and industry etc., Machines became a part of our life. We can see our daily life begins and ends with machines from water heater, grinder, mixer, refrigerator etc. Giant machines in the factories also fit the bill.
- In order to satisfy the rising demands of the mankind, such machines are manufactured in large number. Machinists involve themselves in the process of mass production and avert any shortfall in the demand special trainings need to be given to machinist to make them aware of modern manufacturing techniques and special skill developing abilities.

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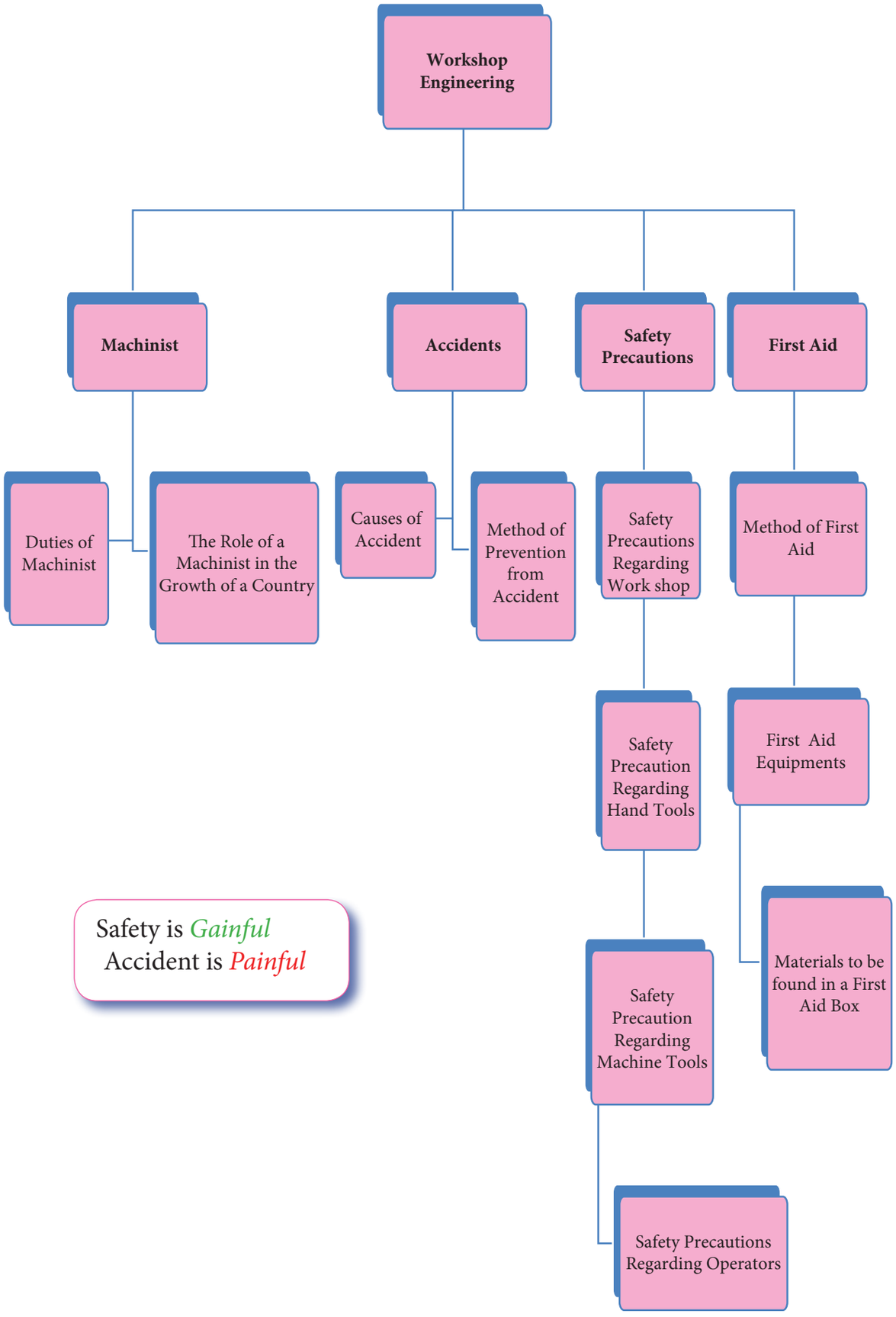

Safety is *Gainful*
Accident is *Painful*

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வருமுன்னர்க் காவாதான் வாழ்க்கை எரிமுன்னர்
வைத்தூறு போலக் கெடும்.

குறள் எண் : 435

His joy who guards not against the coming evil day,
Like straw before the fire shall swift consume away.

(Kural No : 435)

Meanings

The prosperity of him who does not timely guard against faults,

Will perish like straw before fire.

A machine tool is a machine which is used in manufacturing process. An industry or a factory may have many machine tools such as lathes, drilling machines, shaping machines, milling machines and grinding machines. It may also have several types of hand tools and cutting tools involved in the production process.

Industries can be classified as small scale industry, medium scale industry and large scale industry according to the range of investments and production. All such industries need specially skilled machinist in achieving their target in production.

1.2 MACHINIST

A machinist can be defined as a person who has a complete knowledge of operation various machine tools and handling different hand tools. In the process of doing so, he makes components or machine parts of required size and shape from various materials.

1.3 DUTIES OF MACHINIST

- A machinist should have a complete and thorough knowledge of operating different machine tools.

Machinist works in a Lathe

- He should know how to handle various hand tools and instruments.
- He should have a complete knowledge of reading production drawings. He should understand the various notes given in the drawing and different symbols, marked on the drawing. He will then analyse about the size and shape of the component or assembly, the materials used for manufacturing them and method of production.
- He should operate the machine tools in a proper manner providing periodical maintenance.
- He should be able to provide appropriate cutting speed, feed and depth of cut according to the rigidity of the machine, nature of the materials used for manufacturing and the type of cutting tool used.
- He should provide wholesome support to the overall development of the industry he works in.

1.4 THE ROLE OF A MACHINIST IN THE GROWTH OF A COUNTRY

- The industrial growth depends solely on the capacity of qualitative and quantitative production. A machinist should keep this in mind and dedicate himself in achieving this.

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Indian Statistical Report (2017):

Persons those who are not using safety materials while working in their industries met with an accident. As per statistical report nearly 500 workers are suffered or injured in daily life at industries.

- The growth of industry increases the employment opportunities.
- The machinist helps to increase the value of Gross Domestic Product (GDP). Because he helps the nation, and he is the back bone of the economic growth of the nation.
- Any commodity when produced in lesser numbers cost high. Increased production reduces the cost of the item.
- Reduced costs increase the number of consumers is the index of growth of a country on real terms. So it is evident that the growth of industry or a workshop depends on the efficient and skilled machinist.

1.5 ACCIDENTS

Accidents can be called as an unexpected event which takes place suddenly causing damages to human lives and materialistic loss. Accidents may occur to everyone in factories, workplace, on roads and at home. The main reason of accidents can be attributed to carelessness and not correcting some minor faults or deficiencies.

CAUSES OF ACCIDENTS

In industries accidents can be avoided by placing proper attention on the activities that takes place there. Some important causes for accidents are:

- Unnecessary conversation and lack of attention on the work.
- Lack of adequate rest or sleep.
- Not possessing adequate experience in the task to be done.
- Showing sense of urgency in the work.
- Desire of making quick time money.
- Working with poor health.
- Improper handling of hand tools.
- Improper environment
- Inadequate facilities in the workplace.
- Wearing improper clothes.
- Improper holding of work pieces and tools in machines.

1.6 SAFETY

Safety can be defined as an attitude to keep away damages or accidents from happening in a workshop by strictly following the precaution and conducting the activities in a careful manner.

The adventures of new machines are welcome to fulfil our needs. But at the same time they bring dangers and potential of accidents along with them. Accidents take place at a regular basis in industries. Every human life is essential and invaluable. In order to prevent the loss of human lives, safely should be enforced at all costs. Safety is an attitude and working safely is a state of mind. A machinist should accept that safe working habits are important in keeping

- **World Labours Day-May 1**
- **World Industries Safety Day-March 4**

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Safety First. Duty Next.

Safety Materials used while working in workshop

himself and others working alongside him away from accidents.

SAFETY PRECAUTIONS

Safety in a workshop can be classified under four headings. They are:

1. Safety precautions regarding workshop.
2. Safety precautions regarding hand tools.
3. Safety precautions regarding machine tools.
4. Safety regarding operators.

1.7 SAFETY PRECAUTIONS REGARDING WORKSHOPS

- Round and cylindrical objects, sharp articles and tools should not be found in pathways for it may cause injuries to the workers.
- The layout of machines in the workshop should be suitably done considering proper lighting and ventilation.
- Oil and grease should not be found spilled inside workshop.
- Inflammable materials should be kept in safe places with proper precautions.
- Hot object should be kept separately, where in messages like "HOT", "DO NOT TOUCH" are displayed.
- First aid box containing proper medicine and instruments should be kept always ready in a workshop.

1.8 SAFETY PRECAUTIONS REGARDING HAND TOOLS

- Files, hammers and screw drivers with proper handles alone should be put into use.
- When hammers, chisels and punches are put into use, should be taken that any oil, grease or metal chips present on their heads are cleaned completely.
- After use measuring instruments should be kept safely in their respective covers (or) places.
- Measuring instruments should be handled properly to increase their durability.
- Sharp tools and accessories should be kept in their covers or boxes safely.

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Smart Work

- The hand tools should be used for the specific purpose for which they are intended. They should not be placed near machine tool when their usage is not necessary.
- Marking and measuring should not be done on rotating and moving parts.
- Hacksaw blades should not be given under tightening when fitted on hacksaw frames.
- The hand tools should not be placed on electrical equipment.
- Tools like file, try square and hacksaw frames should not be used as a hammer or a screw driver.
- Tools having cutting edges like files, and scrapes should not be grouped with other hand tool when storing.

1.9 SAFETY PRECAUTIONS REGARGING MACHINE TOOLS

- Proper packing pieces should be used while lifting or shifting machine tools.
- Operators should work on machines which they are familiar with. When they choose to work on unfamiliar machines, accident may take place.
- The amount of parameters like feed, cutting speed and depth of cut should be selected according to the strength and rigidity of the machine tools.
- Sharped tools should not be placed on machine tools.
- Sudden failures and defects in the machines should not be corrected or attended by the operator himself. Proper technicians should be called for repair works.
- The machines should be stopped immediately if any abnormal sound comes from them.
- Notice board plate showing the message "The Machine Out Of Order" should be placed near the machines which are breakdown or under repair.
- The operator should not change the speed (or) lubricates when the machine is still functioning.
- While erecting new machine tools their weight, efficiency and speed are assessed and foundation bolts of sufficient strength should be installed.
- The machine tools should be maintained properly. It should be monitored regularly for scheduled maintenance and periodical lubrication.

1.10 SAFETY PRECAUTIONS REGARDING OPERATORS

- Operator should not wear ties and bows while working
- Operator should not wear small towel or clothes around his neck or on shoulders
- Operators should not rest his body on the machines at any time, when working on them
- Operator should wear tight clothing, they should avoid wearing loose dresses
- While operations like grinding, welding and chiselling, the operator should wear safety goggles

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Safety Material Uses

- The operator should wear gloves while handling hot and sharp articles
- Operators should wear only leather footwear
- The operator should prefer working on machines which are familiar to him
- The operator should not touch unsafe and un-insulated electrical wires
- The operator should resist himself from changing the speed, marking or lubricating on functioning machines
- Metal chips should not be cleaned with bare hands but with proper brushes
- The operator should seek the help of others while handling heavy and fragile materials
- Safety plates and equipment should be installed before the machine is set on for operations
- Strict code of discipline should be followed in the workshop. Running, playing and chatting with others are to be avoided in the workshop
- The operator should wear earplug, helmet and mask while performing the machining operations
- The operator should know about the "FIRST AID"

MUST HAVE IN THE WORK SHOP

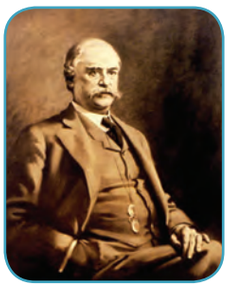
Fire Extinguisher

DO YOU KNOW?

Father of First Aid

Dr. Matthew Shields is known as the "Father of First Aid" in the United States. He was born in Crawfordville, Georgia, on 2nd November 1862.

Founder of First Aid



Robert Wood Johnson I (February 20, 1845–February 7, 1910) was an American industrialist Inventor of First Aid box.

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1.11 FIRST AID

So far we have discussed about various factors to enforce safety and avoid accidents. At some times, the focus on safety may be missing due to some reason or other. In such circumstances, accidents may be happen causing liabilities to the industry as well as to the operator.

First Aid at the time of injury

Accidents may happen at any time in a workshop. The affected or injured person should be provided with immediate medical attention before he is taken to a hospital. This treatment which is given on the spot is known as first aid.

Every industry (or) a workshop should be equipped with a doctor or a first aid assistant. Apart from this, all the operators should be given proper training in first aid.

These measures will avoid heavy losses of lives. Every workshop should have a first aid box always ready with proper medicine and instruments.

1.12 MATERIALS TO BE FOUND IN A FIRST AID BOX

1. Iodine
2. Tincture Benzene
3. Dettol
4. Burnol
5. Boric Powder
6. Meshed Cloth
7. Cotton
8. Plaster
9. Small Scissor
10. Knife
11. Small Wooden Stripes
12. Basin for Washing Eyes
13. Broad Based Beaker for Mixing Medicine

Clear-Cut of First Aid Box

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STRETCHER AND WHEEL CHAIR

The wheel chair and stretchers are also necessary for transferring the injured or affected person to a hospital.

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Stretcher and Wheel Chair

Glossary

1. Revolution – புரட்சி
2. Technique – நுட்பம்
3. Modern – நவீன
4. Accident – விபத்து
5. Safety – பாதுகாப்பு
6. First Aid – முதலுதவி
7. Workshop – பணிமனை
8. Gross Domestic Product (GDP) – உள்நாட்டு மொத்த உற்பத்தி
9. Environment – சுற்றுச்சூழல்
10. Precautions – முன்னெச்சரிக்கை

Activities

1) Make the First Aid Box.
2) How do you give First Aid for burning accident? Explain and give the report.

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QUESTIONS

SHDILS

1 Mark

PART A

I. Choose the correct option :

1) The person who manufactures different parts is
   a) Supervisor
   b) Machinist
   c) Manager
   d) Foreman

2) What kind of safety rule while the operator rest his body on the running of the machine
   a) Workshop safety precaution
   b) Safety precaution for hand tools
   c) Safety precaution for machine tools
   d) Safety precaution for operators

3) First Aid is
   a) a manufacturing process.
   b) safety regarding operators.
   c) immediate treatment given at the spot of accidents.
   d) breakdown of machines.

4) The packing pieces are used at the time of
   a) running of the machine.
   b) while stopping the machine.
   c) while lifting (or) shifting machine tools.
   d) while fitting the machine tools.

3 Marks

PART B

II. Answer the following questions in one or two sentences:

5) How Industries are classified?
6) Who is Machinist?
7) What is safety?
8) What are the classification of safety Precautions?
9) What is known as First Aid?
10) List out the Medicines in a First Aid box?

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PART C

5 Marks

III Answer the following questions in about a page?

11) What are the main causes for accident?

12) List out the safety Precautions regarding hand tools.

13) What are the safety Precautions for machines?

14) List out the safety Precautions regarding for operators.

PART D

10 Marks

IV. Answer the following questions in detail:

15) Explain the duties and important role in development of country of a machinist.

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Chapter

2

HAND TOOLS

Learning Objectives

1. To know about Hand Tools and its types and various instrument used in workshop.

It is foolishness to say empty hand,
While you have ten fingers as capital

- Poet Tharabarathy.

வெறுங்கை என்பது மூடத்தனம்
விரல்கள் பத்தும் மூலதனம்.

– கவிஞர் தாரா பாரதி

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2.12. Scriber – Types of Scriber – Maintenance of Scriber
2.13. V-Block
2.14. Angle Plate
2.15. Tap – Types of Taps
2.16. Dies – Types of Dies

2.1 Introduction

- Tools are useful in assembling or dismantling machine parts or elements. Some other tools are used to measure dimensions, marking size and dimensions and cutting off undesired portions of materials. Different types of tools are used in fabricating various components of a machine tool. All these tools are known as hand tools. These hand tools serve as the nerve centre of the workshop. Hand tools are very much necessary even in a modern workshop which has very accurate and precious machines.

2.2 IMPORTANT HAND TOOLS

1. Vice
2. File
3. Hacksaw Frame
4. Try Square
5. Scriber
6. Punch
7. Hammer
8. Surface Plate
9. V-Block
10. Angle Plate
11. Surface Gauge
12. Parallel Clamp
13. C-Clamp
14. Spanner and Wrench
15. Bearing Puller
16. Scraper
17. Tap Set
18. Tap and Die Holder.

The above tools can be broadly classified under following categories:

1. Measuring Tools
2. Marking Tools
3. Cutting Tools
4. Assembling and Dismantling Tools

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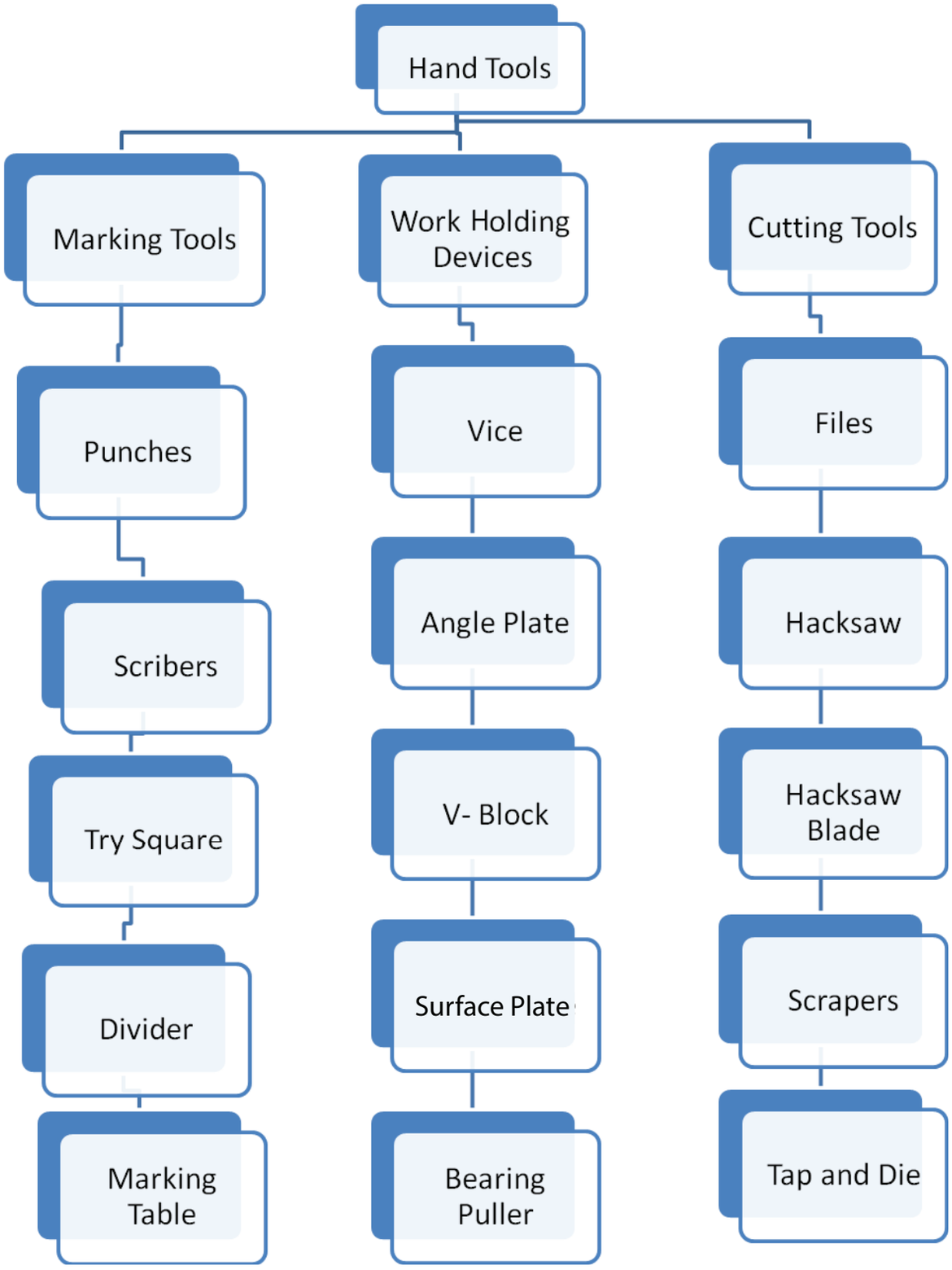
HAND TOOLS



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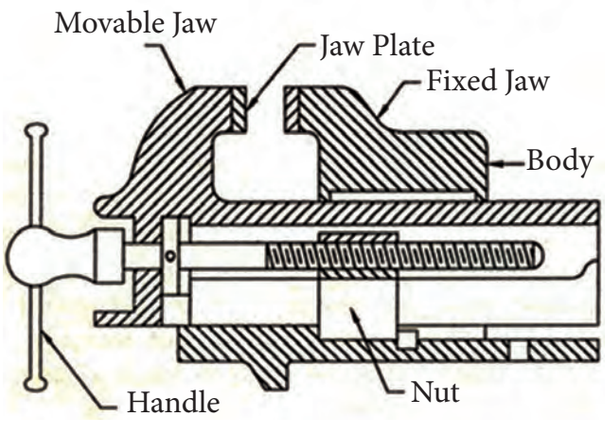
2.3 VICE

Vice is generally used to hold work pieces when operations like drilling, chiselling and hacksaw cutting are performed to them. Vice is a essential tool in a workshop. A workshop is complete only when it has different types of vices available. There are several types of vices used according to the type of work to be performed, the shape, size of the work and the method of holding.



3D and Cut Sectional View of Vice

The types of vice are

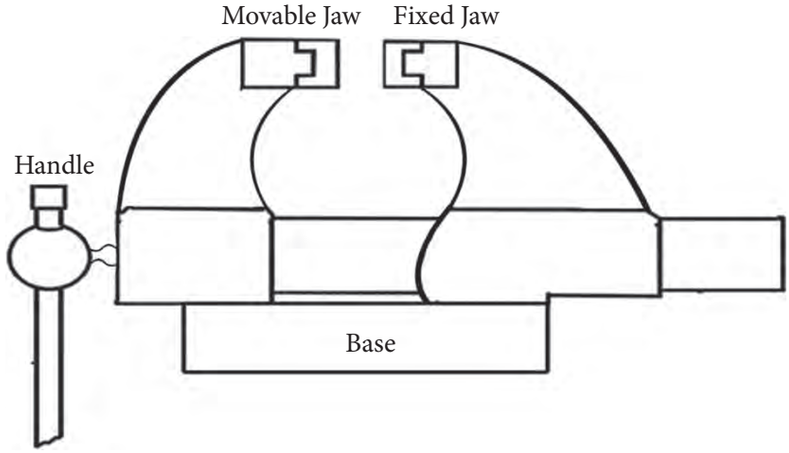
1. Bench vice
2. Hand vice
3. Leg vice
4. Pipe vice
5. Pin vice
6. Universal vice.

BENCH VICE

Bench vice is a work holding device which finds application in all workshops. It is useful in holding work pieces while doing works like filing, chiselling and hacksaw cutting. It is mounted on a bench by means of bolts and nuts. There are two jaws in a vice and they are;

1. Fixed jaw and
2. Movable jaws.

Jaw plates are screwed on the faces of these two jaws. The gripping surface of the jaw plates are knurled for proper holding of the work. The body of the vice is



2D View of Bench Vice

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made of cast iron, and the jaws are made of tool steel. The handle is made of mild steel.

There is a screw arrangement to make the movable jaw more up to a desired point. When the handle is rotated, the screw which passes through a nut in the fixed jaw makes the movable jaw move. The movement is suitably adjusted according to the size of the vice is specified by the maximum distance between the fixed and movable jaw.

HAND VICE

Small objects like screws, rivets. Keys and drills are hold with the help of a hand vice. When the force which needs to be applied is more, hand vices are fitted on benches.

LEG VICE

Leg vice are generally used in a blacksmiths shop or in a foundry. They are useful in holding work pieces when doing works like striking, chiselling and cutting. The body of the leg vice is made of wrought iron and so it holds on to sudden and heavy blows made on it.

PIPE VICE

Pipe vice consists of a base and a column filled on it. A 'V' shaped jaw is fitted on the base. The column is provided with another 'V' shaped movable jaw. Work is done on pipes or round rods fitted between these two jaws.

PIN VICE

The pin vice has three jaws which open or close by equal amount on turning

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a sleeve surrounding the jaws. This movement enables the vice to hold small round objects. Strings and wires of small diameters can be held with a pin vice.

UNIVERSAL VICE

The universal vice can be swivelled in a horizontal plane similar to a swivel vice and can also be tilted in any vertical position for angular cuts.

MAINTENANCE OF VICE

1. Vices should be maintained properly. Care should be taken that the screw of the vice is free from dirt or metal burrs.
2. The screw of the vice should be lubricated with grease for proper sliding of the movable jaws.
3. The top of the vice should not be used as an anvil.

2.4 FILE

File is a hardened steel tool having slanted and parallel rows of cutting edges or teeth on its surface. It is used to cut, smooth or fit metal parts. It is also used on wooden and plastic parts. It cuts all materials expect hardened steel. Small quantities of unrequired metal can be removed with files.

File

Metal burrs left out after chiselling and backsaws cutting are removed with the help of files. It is also used to sharpen the cutting edges of sharp tools like saws. The tang is a pointed part which fits into the handle. The point is the end opposite to the tang. The heel is next to the tang. The face of the file has a slanting row of cutting edges. File is made of high carbon steel.

Files are classified according to the following factors.

1. Effective length
2. Sectional form
3. Cut of teeth
4. Grade

Size of the file

The length of the file is its size. It is measured from the point to the

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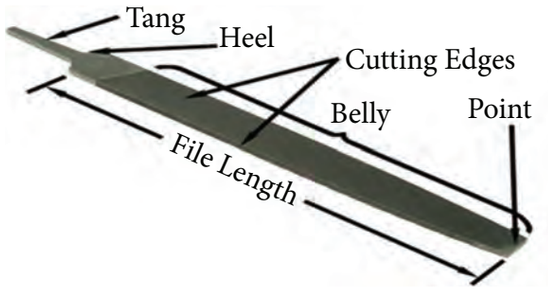
level excluding tang. Generally files are available in size ranging from 100mm to 200 mm. Files upto length of 500 mm are also available to be used for heavy duty work.



Parts of File

The shape of the file is its cross section. Files are made in different forms of a shape. Most common types of files are

1. Hand file
2. Flat file
3. Square file
4. Round file
5. Half round file
6. Triangular file
7. Knife edge file.

HAND FILE

It is similar to the flat file but its only difference is that it has uniform width. It is useful in filing internal square edges.

Hand File

FLAT FILE

It is rectangular in cross section and is the most common form of file. It is always double cut on the faces and single cut on the edges. It is tapered in width towards point. It is used for general work and can be adopted for speed work.

Flat File

SQUARE FILE

It is square in cross section. It is tapered towards the point. It has double cut teeth on all the four faces. It is used for filling square corners, enlarging square and rectangular openings.

Square File

ROUND FILE

Round file is circular in cross section. The diameter of the file is uniform for about two thirds of its length. From it is tapered towards point. It carries single cut teeth all around its surface. It is used for filing curved surfaces and enlarging round holes.

Round File

HALF ROUND FILE

The cross section of a half round file is not a half circle but around 1/3rd of the circle. The width of the file is tapered towards point. It may have single cut teeth on the curved double cut teeth on the curved surface and double cut teeth on the flat surface. It is used to file concave and convex surface as well as other curved surfaces.

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Half Round File

TRIANGULAR FILE

It is also called as three square file and its cross section is a triangle. Each side is inclined at 60° its adjacent side. It is tapered towards point and has single cut or double cut teeth on all its sides. It is used for filing grooves and sharp corners or edges more than 60°.

Triangular File

KNIFE EDGE FILE

The cross section of this file is tapered and looks like that of a knife. It carries double cut teeth on both its faces and single cut teeth on the edge. It is used to file sharp corners, and edges of keyways.

Knife Edge File

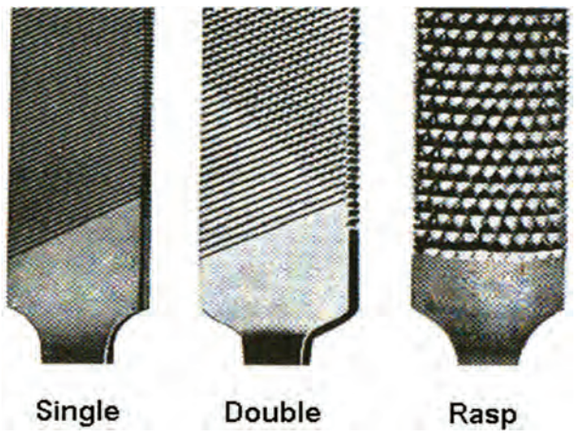
MAINTENANCE OF FILES

During filing, the metallic burns coming out of the filed parts occupies the clearance spaces between the teeth. It prevents efficient cutting. These burns should be removed with brushes having thin metallic wires.

2.5 CUT OF TEETH

Cut of teeth of a file refers to the type of teeth on the faces. Files can be classified according to cut of teeth as

1. Single cut file
2. Double cut file
3. Rasp cut file



Cut of Teeth

SINGLE CUT FILE

In single cut file the teeths are cut in parallel rows on the faces normally inclined at an angle of 50° to 60° with the centre line of the face.

DOUBLE CUT FILE

In double cut file, there are two sets of teeth. One similar to those of a single cut file about an angle of 50°-60°, and another set running diagonally across the first set at an angle of about 70° to 80°, from the other side harder materials are cut with double cut files.

RASP CUT FILE

The cross section of this file is half round. The teeth of the file are triangular in shape and project from the face surfaces. Rasp cut files are used to file soft materials like wood, plastic and hard rubbers.

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GRADE

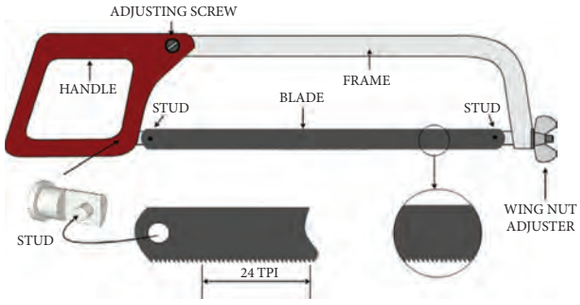
The grade of a file refers to the coarseness or the spacing between the rows of the teeth. It is designated by the number of rows of teeth per inch.

These are five types of files according to its grade. They are,

1. Rough file (R)-20-25 teeth/inch
2. Bastard file (B)-25-30 teeth/inch
3. Second cut file (SC)-35-40 teeth/inch
4. Smooth file (S)-40-60 teeth/inch
5. Dead smooth file (DS)-80-100 teeth/inch.

2.6 HACK SAW FRAME

Hack saw frame consist of a frame, a wooden handle, prongs, tightening screw and a wing nut. It is used for sawing all metals expect hardened steel. Tightening screw with the help of a wing nut is used to stretch the blade is desired.



There are two types of hacksaw namely,

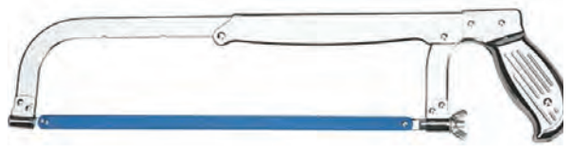
1. Standard or solid hacksaw
2. Adjustable hacksaw

STANDARD HACKSAW

In this type, the distance between the prongs cannot be altered. So it is suitable for a particular length of hacksaw blades only.

ADJUSTABLE HACKSAW

In this type, the distance between the prongs can be adjusted to hold hacksaw blades of different lengths say from 200mm to 300mm.



2.7 HACKSAW BLADES

Hack saw blades are made of high carbon steel, low alloy steel or high speed steel. They are then hardened and tempered. They are made as thin sheet with cutting edges present on one side or on both sides. The size of the blades is specified by the distance between the holes on either sides along the length.

According to the distance between two successive teeth on the blade (pitch), they are classified as coarse, medium and fine path blades. Soft materials like plastics are cut by coarse pitch blades. Medium pitch blades are employed to cut tool steel, hard light alloys, thick sections and tubes. Materials of small thickness are cut accurately by fine pitch blades.

Reason for the breakage of Hacksaw blades,

1. The cutting action may not be of uniform speed and thrust.
2. Improper fitting of blades (improper tightness or looseness)
3. Putting into use new blades on old cuts.

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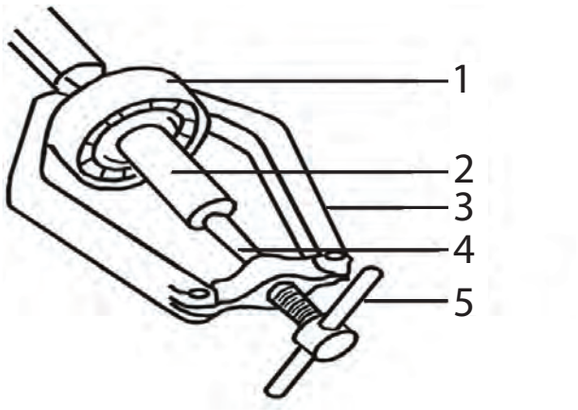
4. Not selecting blades of suitable pitch.
5. Poor workmanship.

Reason for the blunting of hacksaw blades

1. The material being cut is harder than the blades.
2. Improper selection of blades.
3. Application of high thrust and speed.
4. Applying thrust during return stroke also
5. Not applying a coolant.

2.8 BEARING PULLER

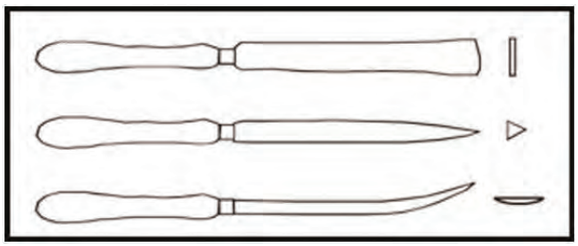
This is a device to remove the bearing from the shaft. It works in the principle of bench-vice. The legs of the puller is widened to hold the bearing and the bottom of the screws of the puller, should touch the face of the shaft, then turned clockwise as shown in the figure. Due to the movement of the screw rod of the puller the bearings is easily pulled out from the shaft. Arbor press is used to fix the bearing in the shafts.



2D and 3D View of Bearing Puller
1. Bearing 2. Shaft 3. Leg 4. Screw 5. Handle

2.9 SCRAPER

Scrapers are used for sharing off or parting off thin slices or flakes of metal to make a fine smooth surface. The materials used for making scrapers is a good quality forged steel and the cutting edge is very hard. Scraping is a process of obtaining a true flat surface which is superior in quality than that can be produced by machining are filing. The top of the surface plate is coated with a thin film of Prussian blue the surface to be scraped is laid on the surface plate and moved back and forth. The high



Types of Scraper

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spot, on the work will be marked with Prussian blue. The high spots are scrapped down by giving the scrapped down by giving the scraper a small circular motion. There are three different types of scrapers according to its shape, they are;

1. Flat Scraper
2. Triangle Scraper
3. Half-round Scraper

FLAT SCRAPER

The flat scraper is the most common type and has the cutting edge at the end. It is used to produce a perfect flat surface. It is available in different lengths ranging from 200mm to 250mm.

TRIANGULAR SCRAPER

The triangular scraper has three cutting edges. It is used to scrape round or curved surfaces and to finish sharp corners free from burrs.

HALF ROUND SCRAPER

The shape of half round scraper is like a half round file. They are used to scrape round or curved surfaces.

MAINTENANCE OF SCRAPERS

1. The cutting edges of the scraper should always be kept sharp.
2. It should be kept in a special case or wrapped in a piece of cloth when not in use.
3. It should be used for no other purposes other than scraping.

2.10 MARKING TOOLS

In addition to the measuring instruments, some tools are used to make marking on the work pieces and to scribe lines on them. They are known as marking tools.

Scribing is a very important action in making a component. Lines are to be drawn on the work piece according to the design. These lines are drawn with reference the contours of the work preferably at right angles or with reference to a certain datum line. The position of these edges or the position of the datum line may be determined from the drawing which is necessary for each job.

Effects of Poor Marking

1. Waste of job material.
2. Wastage of time.
3. Leads to loss because of the production of inaccurate products.
4. Consequent transporting expenditure
5. Earning bad name in the industry.

Guideline of Good Marking

1. Drawing should be correctly understood.
2. Marking tools should be kept ready.
3. Proper marking tools should be used.
4. Scribed lines are checked for correctness before punching.
5. Selection of punches should be done properly.

Types of Marking Tools

Important marking tools are given below

1. Steel Rule
2. Divider
3. Punches
4. Try Square

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5. Scriber
6. Surface Plate
7. Marking Table
8. Surface Gauge
9. V - Block
10. Angle Plate

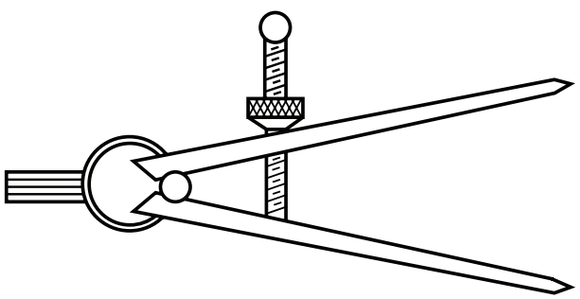
STEEL RULE

Steel Rule

Steel rule is used generally for measuring all kinds of objects. It is also adopted for making and scribing straight lines. It is made of thin steel sheet and hence named so.

DIVIDER

Divider has got two legs having sharpened ends. The two legs are connected at the top by a rivet or by a spring.



Divider

Uses of Divider

1. To scribe arcs and parallel lines on work pieces.
2. To divide straight lines and curved lines into equal parts.
3. To find and check the centre of a round rod.
4. To mark correct dimensions taken from the steel rule on work pieces.

2.11 PUNCHES

Punches are used to make permanent marks on the lines already scribed on the work pieces. The punch marks make the line appear clearly. Punches are also used to make marks on exact locations on the work pieces where drilling is to be performed.

Punch

Punches are made of steel alloys. The punching ends are ground to be a required angle. The body of the punch is knurled to provide gripness.

Types of punches

1. Centre Punch
2. Dot Punch
3. Prick Punch
4. Bell Punch
5. Hollow Punch
6. Pin Punch

CENTRE PUNCH

The angle of the centre punch is 90°. It is used to make marks on the locations, where drilling operations is going to be performed. The marks made by the punches will allow the drill to get seated and rotated at the exact location.

Centre Punch

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DOT PUNCH

Dot punches are used to make marks on the work pieces and to make scribed lines appear clearly. The end of the dot punch is ground to have an angle of 60°. Punch marks are made at regular intervals on the lines (interval may be 6mm for straight lines and 3mm for curved lines).

Dot Punch

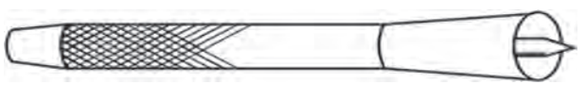
PRICK PUNCH

Prick punches are used in some precison work and on softer materials. The end of the punch carry an angle of 30°.

Prick Punch

BELL PUNCH

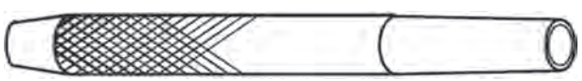
It is useful in marking centres on the faces of round rods.



Bell Punch

HOLLOW PUNCH

The end of the hollow punch is concave inside. It is used to make holes on sheet materials like leather, rubber and cardboard sheets.



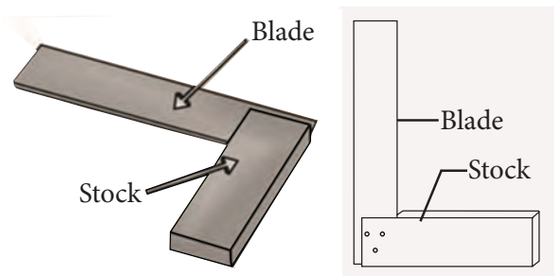
Hollow Punch

PIN PUNCH

Pin punch is used to make small holes on their sheet materials. It is also used insert or remove small pins into or out to holes.

TRY SQUARE

Try square is used to check whether the angular surface of internal or external is 90°. It is also useful in scribing parallel lines perpendicular to a particular surface and to check flatness of surface. Try square consists of two parts namely stock and blade. Stock is made of cast iron or cast steel and blade is made of high carbon steel or stainless steel. All sides of the stock are machined accurately and perpendicular to the adjacent sides.



Try Square

The blade is riveted to the stock such that both of them are absolutely perpendicular (90°) to each other. There will be an undercut on the stock nearer to the bottom of the blade. It will be accommodate burrs on the work piece if any. The blade of the try square may be graduated.

The square should be maintained properly. The blade of the try square should not be used as a screw driver and stock as hammer. It should be oiled properly for avoiding rust formation on its surface.

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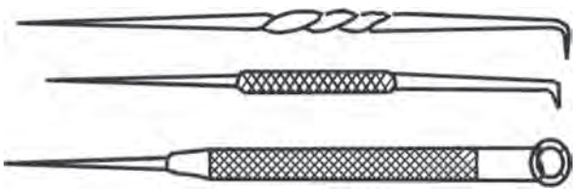
2.12 SCRIBER

A scriber is used to scribe lines on the work pieces it is made of high carbon steel, which is hardened and tempered. The end of the scriber is ground sharp to have an angle of 12° to 15°. The body of the scriber is knurled to provide gripness. It is available in different lengths 150mm, 200mm & 250mm.

There are different types of scribers available. They are,

1. Straight ended Scriber
2. Bent ended Scriber
3. Adjustable Scriber
4. Offset Scriber
5. Knife edge Scriber.



Types of Scriber

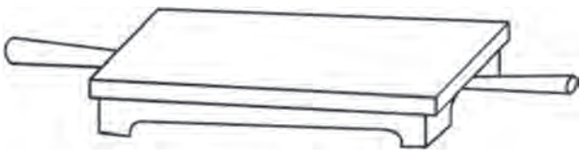
Surface plate is invented by "Hendry Maudslay". He was called as "Father of Machine Tool Technology"

Maintenance of Scribers

1. The point of the scriber should be maintained straight and sharp.
2. Heavy materials should not be placed on it.
3. The scriber point should be kept in a cover which not in use.
4. Scriber should be used after cleaning of moulded area.

SURFACE PLATE

The flatness of a surface of a work can be tested with the help of a surface plate. It is also used for marking-out work.



Surface Plate

Surface plates are made of grey cast iron. The top surface of the surface plate is very accurately machined and scraped for further accuracy. It should be mounted on a bench or on a special stand at an height of about 800mm. They are made in two grades of accuracy A grade and B grade. A grade surface plates are with 0.005mm flatness and B grade with 0.2 mm flatness. It is available in sizes of 150 x 100 mm and 1000 x 750mm care of surface plates

1. The surface plate should be covered when not in use.
2. The top surface should be kept free from rust and dirt.
3. It should be wiped with a clean cloth and smeared with grease or oil after use.
4. Parts having burrs on them should not be rubbed on the top surface of the plate.

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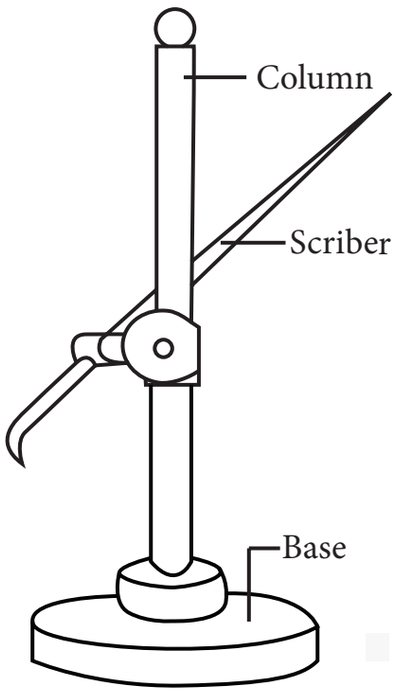
MARKING TABLE

Marking table accommodates surface plates to be mounted on it. It helps in marking and inspection. It is made of mild steel and the top is made of cast iron. It is available in sizes of 900 x 900 x 825mm.

SURFACE GAUGE



Surface Gauge

Surface gauge is also a marking tool. It can also be called as marking block. This instrument is used to scribe straight lines on work surfaces and it can also be used to check the correctness of surface level. In combination with a dial indicator, it is used to line up cutting tool or work pieces for inspection.

The base of the surface gauge is accurately machined and a pillar stands vertically on it. A scriber is attached to the pillar by means of a clip. The scriber can be positioned practically in any position.

There are two types of surface gauges, namely

1. Standard or plain surface gauge
2. Universal surface gauge

STANDARD OR PLAIN SURFACE GAUGE

This is a simple form of surface gauge in which a pillar is filled into a heavy base vertically. A scriber is attached to the pillar by means of a clip. It is adjusted by means of a knurled nut. It is not suitable for precision work.

Before setting the instrument for scribing and checking, the surface plate, the angle plate and the work are cleaned neatly for measuring purposes, the steel rule of the combination set is selected. Angle plate is placed on the surface plate. The steel rule and the work are placed closely on one side of the angle plate. The tip of the scriber is set and adjusted by sliding the clip suitably. The required straight line way be drawn by moving the surface gauge along the work upon the surface plate.

UNIVERSAL SURFACE GAUGE

It has a base having 'V' groove, a spindle and a scriber. The scriber is adjusted by means of knurled nut. The advantage in comparison with pillar type is that fine adjustments can be made by means of an adjusting screw. Pins provided on the base can be pushed down to act as a guide against the top of the surface plate. 'V' groove on the base enable it to be placed on round rods.

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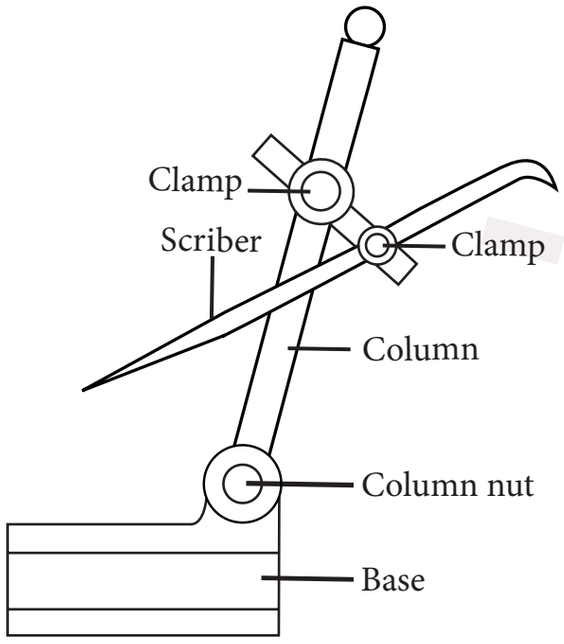


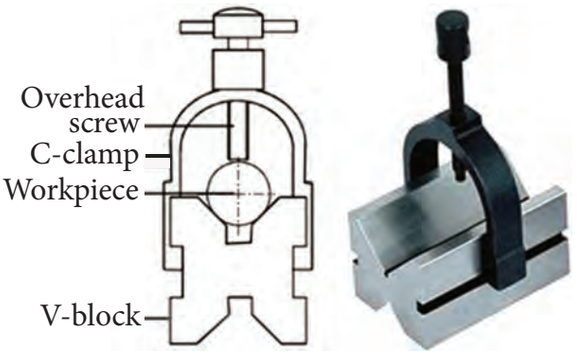
Universal Surface Gauge

Uses of Surface Gauges

1. To find centres of round rods and square rods.
2. To set work pieces aligned to the axis of the lathe while held by chucks.
3. Can be used as a vernier height gauge to draw horizontal lines on work pieces.
4. To check parallelism of opposite sides on machined parts.
5. The scriber of the surface gauges is replaced by a dial indicator and used for alignment of machines tools.

2.13 V BLOCK

'V' block has a 'V' shaped groove and rectangle grooves on it. The angle of the 'V' groove is either 90° to 120°. The face of the 'V' block is square or rectangular in section. It is used to hold cylindrical work pieces when these work pieces are be machined in a drilling machine, shaping machine and milling machine. It is also used to hold round rods when some markings are to be done on it.



2D and 3D V-Block

The usual sizes of a 'V' block are 50mm to 250mm in length and 50mm to 100mm in width and height.

2.14 ANGLE PLATE

It resembles the English alphabet 'L'. It has got two sides absolutely perpendicular to each other. Usually it is made of cast iron. The sides of the angle plate have got slots and holes on it. It is used to hold work pieces on machine tools like lathe,

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drilling machine and milling machine. It is also used to check the perpendicular of the surface either internally or externally. It is also used for marking tools like surface gauge. It is specified by its length, width and height.

2.15 TAP

A tap is a screw like tool which has threads like a bolt and three or four flutes cut across the thread. It is used to cut threads on inside of a hole as in a nut. The tap is used along with the wrench which holds the tap with it. The cutting edges are formed by the flutes on the thread. The lower end of the tap is somewhat tapered so that it can dig into the walls of the hole. The top of the tap has a square shank which helps it to be held by the wrench. Taps are made of either high speed steel or high carbon steel and hardened and tempered.

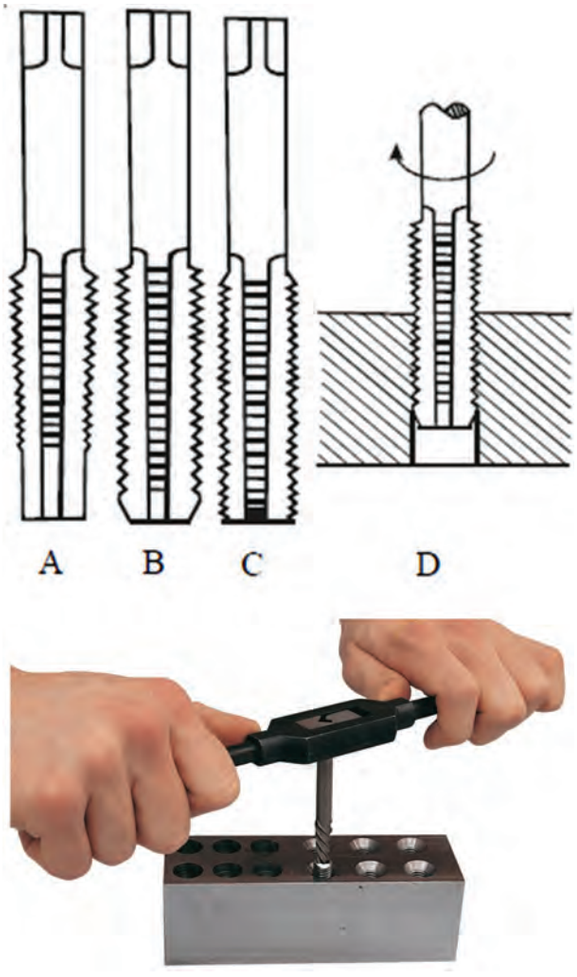
Taps are made in sets of three:

TAPER TAP

The taper tap has about six threads tapered. It allows the tap to dig into the hole easily to form threads gradually as the tap is moved clockwise and anti-clockwise while tapping. Oil is applied into the hole while tapping.

SECOND TAP

It is tapered back from the edge about three or four threads. This is used after the taper tap has been used to cut the thread as far as possible.



A. Taper tap B. Second tap C. Parallel tap D. Tapping

Types of Tap and Uses

PARALLEL TAP

It has threads for the whole of its length. It is used to finish the work prepared by the other two taps.

Important Points to be observed while tapping.

1. Taps should be used in order i.e., from taper tap to Parallel tap through the second tap.
2. It should be ensured whether the tap enters into the hole properly.

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3. Burrs are removed by turning the tap back and forth.
4. High pressure should not be applied on the tap.
5. Proper wrenches should be used to operate the taps
6. Cooling agents should be used while tapping

2.16 DIES

Dies are used to cut threads on a round bar of metal, such as threads on bolt. It is a round or square block of hardened steel with a hole containing threads and flutes which form cutting edges.

2D and 2D Die Types and Uses

There are mainly two types of dies in common use. They are,

1. Solid Die
2. Adjustable Die

SOLID DIE

A solid die is one which has fixed dimensions and cannot be adjusted for larger or smaller diameter. Adjustable means that it can be set to cut on larger or smaller diameter.

ADJUSTABLE DIE

A circular adjustable split die shown in fig is very common. The die is split through one side and a slight adjustment is made by means of the set-screw. This screw is tightened up the die is opened up slightly, whilst unscrewing will cause the die to spring in. Another common type is the two-piece rectangular die in this type the dies are fitted into a special stock and they are closed by means of the adjusting screw. The size of the die is specified by the outer diameter of the thread to be made. The tools for holding and turning the threading die are called a die stock.

Importance Points to be Observed while Die

1. To ensure whether the job is cylindrical shape and the job should not be bigger than die.
2. The front face of the job should be chamfered.
3. To ensure the proper angle of the thread was formed.
4. When you are using the adjustable die, check whether both dies are of same dimensions.
5. Do not apply more pressure on the die.
6. Cooling agents should be used while die.

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Glossary

1. Assembling – ஒன்று சேர்த்தல்
2. Dismantling – பிரித்தல்
3. Vice – பிடிப்பான்
4. Jaw – தாடை
5. Taper – சரிவு
6. Adjacent – அடுத்துள்ள
7. Diagonal – மூலை விட்டம்
8. Edge – முனை
9. Scraper – சுரண்டி
10. Contour – மேடு பள்ளமான (அ) கரடுமுரடான
11. Scribing – கீறி கோடிடுதல்
12. Precision – துல்லியமான
13. Burr – பிசிறு
14. Tempered – பதப்படுத்துதல்
15. Hardening – கடினபடுத்துதல்

Activities

1) Find and list out Latest hand tools using in Industrial field.
2) Make a punch (or) Scriber.

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QUESTIONS

SHWAQ3

1 Mark

PART A

I. Choose the correct option :

1. The vice with 'V' shaped jaws is
   a) Leg vice
   b) Hand vice
   c) Pipe vice
   d) Pin vice

2. The vice which is having many moments
   a) Pipe vice
   b) Pin vice
   c) Leg vice
   d) Universal vice

3. Convex and concave surfaces can be filed with a
   a) Flat file
   b) Square file
   c) Triangular file
   d) Half round file

4. The file used for filing v-shaped grove is
   a. Square file
   b. Triangular file
   c. Half round file
   d. Flat file

5. Grade of a file with 40 to 60 teeth per inch
   a. Round file b. Second cut file
   c. Smooth file d. Dead smooth file

6 Scraper is made up of
   a. Steel
   b. Copper
   c. High carbon steel
   d. Lead

7. The punch used for making holes on sheet materials like leather, rubber and cardboard and sheets is
   a. Bell punch
   b. Prick punch
   c. Hollow punch
   d. Pin punch

8. The angle of scriber is
   a. 120 to 150
   b. 150 to 200
   c. 120 to 180
   d. 120 to 250

9. The device which used for holding cylindrical work pieces is
   a. Chuck
   b. Vice
   c. V-block
   d. Drilling

10. The tool which used for cutting threads on inside of a hole is
    a. Round file
    b. Tap
    c. Die
    d. Scriber

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PART B

3 Marks

II. Answer the following questions in one or two sentences:

11. Mention some hand tools which is used in work shop.
12. What is vice?
13. Write the types of vice.
14. What is file?
15. What is the grade of file?
16. Write the types file as per grade.
17. Mention the types of scriber.
18. Write some types of marking tools.
19. State the types of punch.
20. What is the use of try square?
21. Mention the types of scriber and their uses.
22. What are the uses of surface plate?
23. What is Die? State their two types.

PART C

5 Marks

III Answer the following questions in about a page?

24. Explain the bench vice with neat sketch.
25. State the type of files as per their form of a shape and explain any two of them with neat diagram.
26. What are the reasons for the breakage and blending of hacksaw blades.
27. Mention the type of punches and explain any two of them with neat sketch.
28. Explain the try square with neat sketch.
29. Mention the types of surface gauge and explain any one with diagram.

PART D

10 Marks

IV. Answer the following questions in detail:

30. Draw and explain a bearing puller.
31. State the types of tap and explain with suitable diagrams.

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Chapter

3

MEASURING INSTRUMENTS AND GAUGES

SI2J3T

Learning Objectives

1. Students to know about the measuring instruments and gauges like scales, calipers and Gauges.
2. Students to know how to operate the measuring instruments and gauges and to know about their uses.

Table of Content

3.1 Introduction

- Factories are producing desired products. The quality of the products depends upon its shape, size and surface finish. To measure these features, different types of measuring instruments are required. In this chapter, we discuss about some important measuring instruments.

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3.2 SCALES

Scale is a one of the linear measuring instrument. Scales are used to measure the length, breadth and height of an object and to draw straight lines. It is made up of spring steel or stainless steel are called as 'Steel Rule'. These scales are used in Engineering fields.

Type of Scales

1. Standard Scale
2. Flexible Scale
3. Narrow Scale
4. Hook Scale
5. Folding Scale
6. Tape Scale

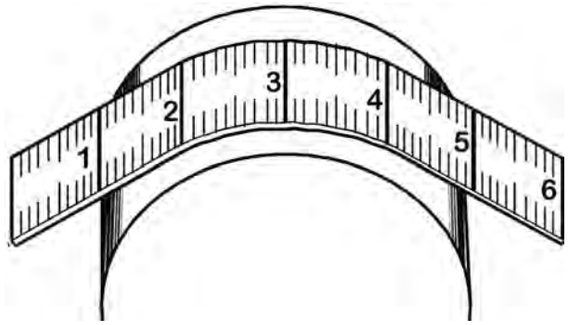
1. Standard Scale

Standard Scale is available in maximum length of 150mm or 300mm in Metric system. It is also available in maximum length of 6 inches or 12 inches in British system. The standard scale measurements are accepted by the world wide.

Standard Scale

2. FLEXIBLE SCALE

This type of scale is flexible in nature because it is made up of narrow thin plate of spring steel. It is useful for taking measurements on irregular and cylindrical surface.



Flexible Steel Rule

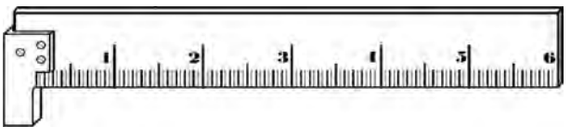
3. NARROW SCALE

The width of the narrow scale is about ¼ inch. This is used to measure the depth of narrow hole.

Narrow Scale

4. HOOK SCALE

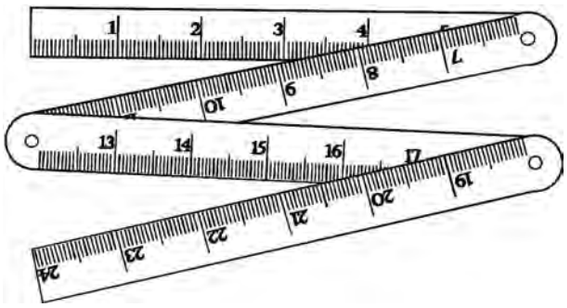
Hook scale has a hook in initial side of the scale. Hook scales are uses to measure from broken or barreled ends. It is used to measure from the inner chamfered surface of gear to the outer surface.



Hook Scale

5. FOLDING SCALE

Folding Scale is having total length of 600 mm or 24 inch. It may be folded or unfolded regarding nature of work.



Folding Scale

6. MEASURING TAPE

The tap is wound inside of a round closed case. It can be pulled out to the required length. The tap is made of steel plate or thick plastic cloth material. This is used to measure the play grounds and house flats.

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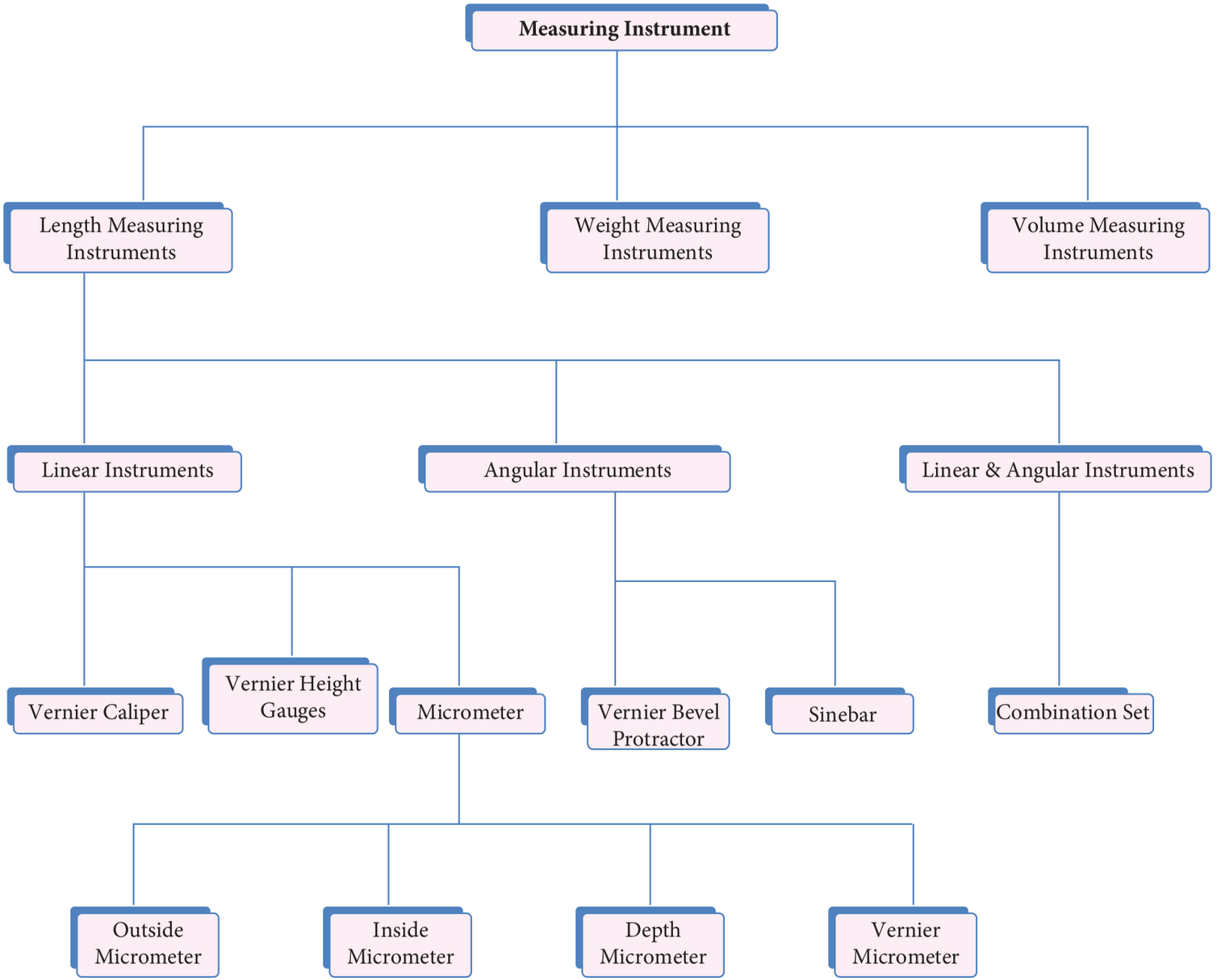

Flow Chart of the Measuring Instruments

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Maintenance of Scales

1. Scales should not be used as wedge or Screw driver.
2. Heavy objects should not be placed on it.
3. Scales should not be used for rough surface.

3.3 CALIPERS

A caliper can be as simple as a compass with inward or outward - facing points. Calipers are used to measure diameters of round circular and objects internal and external dimensions of square or rectangular objects. It does not show the measurements directly, but along with steel rule, They are also used to measure dimensions rotating of and hotter jobs.

Types of Calipers

1. Outside Caliper
2. Inside Caliper
3. Jenny C aliper

Outside Caliper

Outside Caliper is used to measure external dimensions like length and breadth of various objects and diameters of round rods.

Inside Caliper

Inside caliper is used to measure the internal diameter of hole and length of grooving and undercutting of cylindrical jobs.

Jenny Caliper

Jenny caliper is used to find the center of facing side of round rod and to draw parallel lines on work pieces. One of the legs of this type of caliper is straight and other is bent.

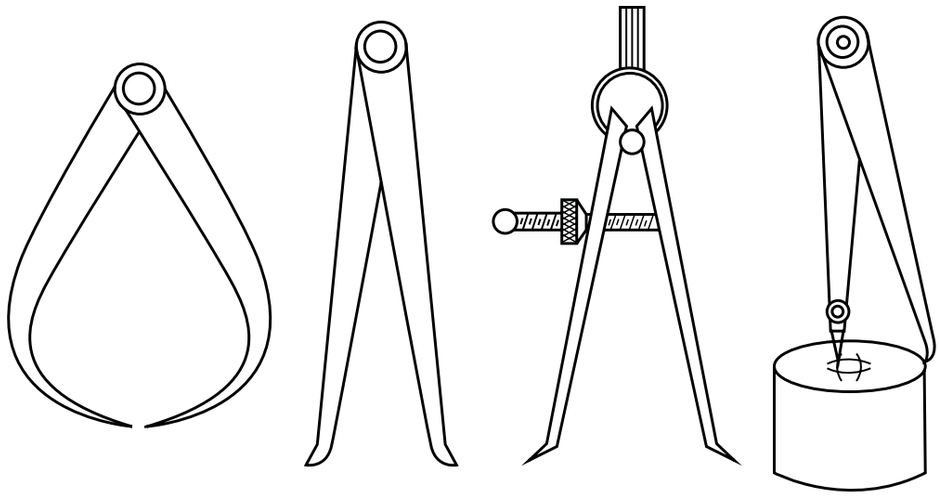
The above calipers' legs are generally joined by either Rivet or Spring.

Rivet Type

The two legs of this type of calipers are connected by rivets at the top. So these type of calipers are called as "RIVET TYPE CALIPERS'

Spring Type

The two legs of this type of caliper are connected by springs at the top. So these



Outside Caliper | Inside Caliper | Inside Caliper Spring Type | Jenny Caliper

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type of Calipers are called as **"SPRING TYPE CALIPERS"**

Maintenance of Calipers

1. It should not be used on hot and rotating parts.
2. Heavy objects should not be placed on it.
3. It should be kept on flat surfaces.

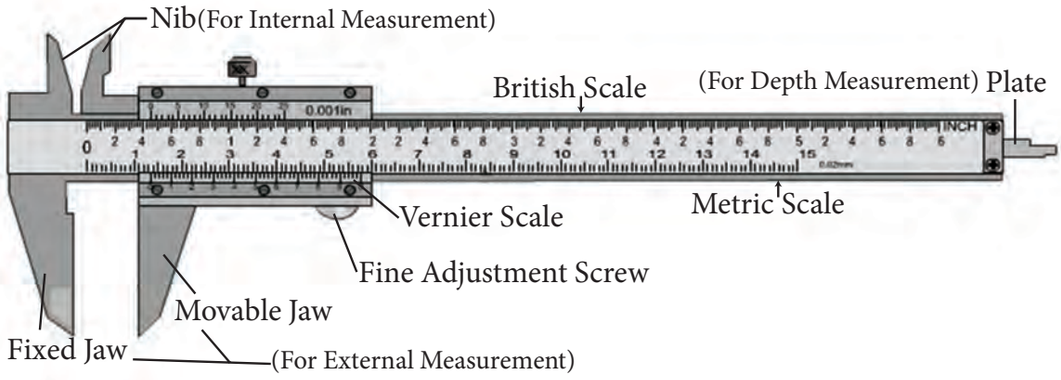
3.4 VERNIER CALIPER

Vernier Caliper is a precision measuring instrument. Vernier caliper was developed by French Mathematician Pierre Vernier in the year 1830 and the instrument is called after his name. Generally the least count of vernier caliper is 0.02 mm. In metric system and 0.01 inches in British System Diameter.

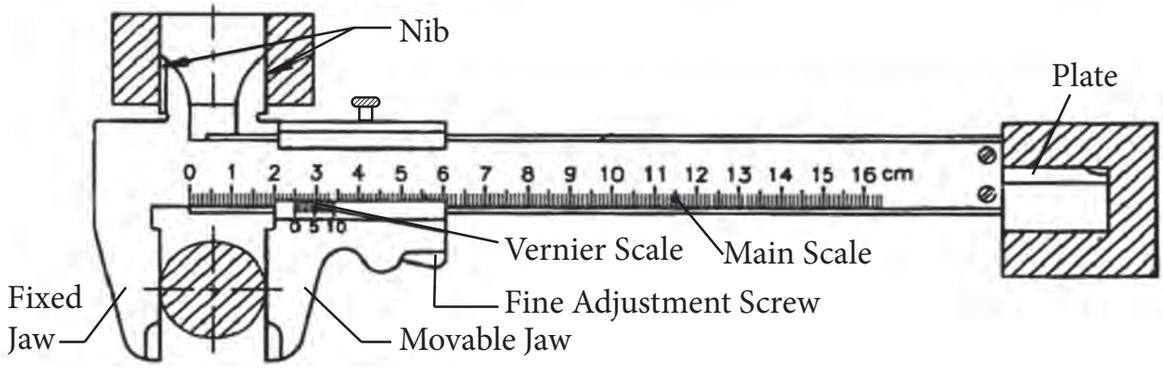
Vernier caliper is useful in measuring outer and inner diameter of hole and depth of holes. There are two important parts one is main scale and other is vernier scale. A fixed jaw is attached to main scale. Vernier Scale with movable jaw is slides over the main scale.

The object to be measured is held between the fixed jaw and movable jaw. The reading on both the main scale and the vernier scale are noted. (Two separate nibs are provided on the top side, for measuring inner dimension of any jobs.)

A narrow slot is provided on the backside for the main scale to accommodate a narrow plate. This plate is made to move along with the vernier scale to measure depth of holes and slots.



Vernier Caliper



***Working Method of Vernier* Caliper**

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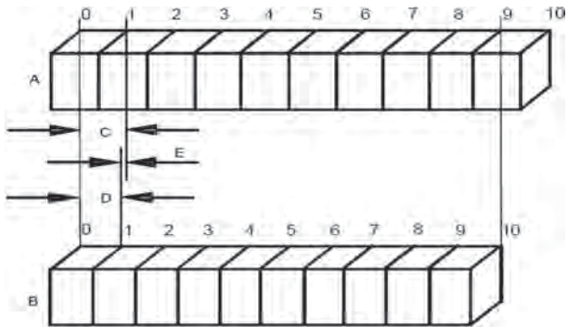


Least Count of Vernier Caliper

Least count: The smallest value that can be measured by the measuring instrument is called least count.

Finding the Least Count of Vernier Caliper

Formula

Least Count of
Vernier Caliper = 1 M.S.D – 1 VSD

(MSD – Main Scale Division, VSD – Vernier Scale Division.)

Problem

The main Scale of Vernier Caliper is marked in Millimeters. 49 divisions of main scale are divided as 50 divisions in Vernier Scale. What is the least Count of that Vernier Caliper?

Value of one division in Main Scale $= 1mm$

Value of one division in Vernier Scale $= \frac{49}{50}$ mm

Formula

$$Least\ \text{Count} = 1\ MSD - 1\ VSD$$

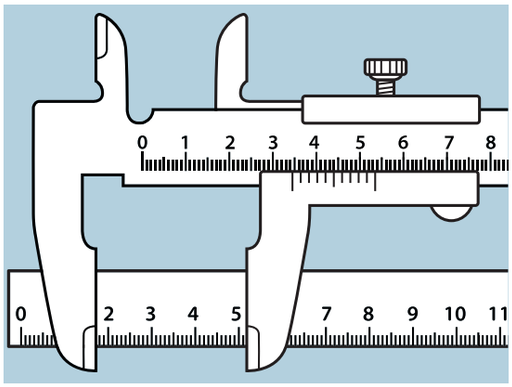
$$= \frac{1 - 49}{50}$$

$$= \frac{50 - 49}{50}$$

$$= \frac{1}{50}$$

Least Count of
Vernier Caliper = 0.02 *mm*

Activity: Find the measurement of Vernier Caliper as shown in figure



DO YOU KNOW?

Pierre Vernier

Pierre Vernier was a French mathematician and instrument inventor. He was inventor and eponym of the vernier scale used in measuring devices. Born: 19 August 1580.

VERNIER HEIGHT GAUGE

Vernier Height Gauge is used to find the height of an object and to draw lines to desired heights accurately. Measurements can be done to an accuracy of 0.02 mm and 0.01 inch.

The base of Vernier height gauge is made up of steel. It is machined accurately.

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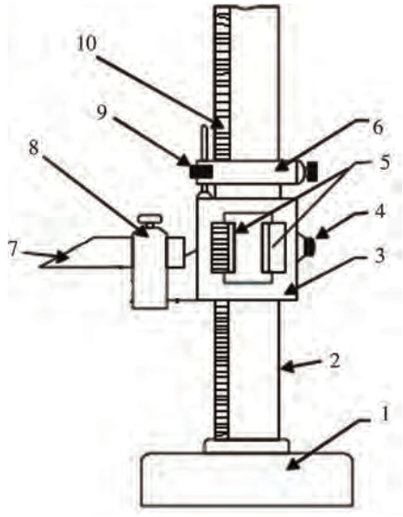
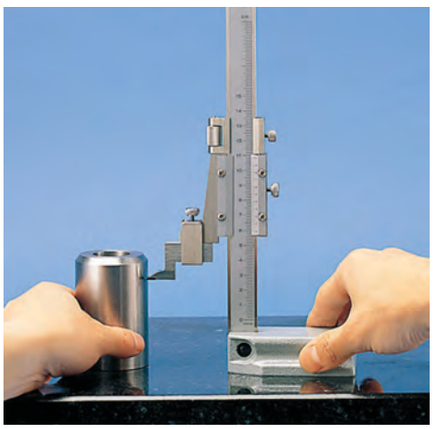


1. Base	**6. Fine Adjustment Clamp**
2. Column	**7. Scriber**
3. Slide	**8. Clamp**
4. Slide Clamp	**9. Fine Adjustment**
5. Vernier Scale	**10. Main Scale**



Vernier Height Gauge

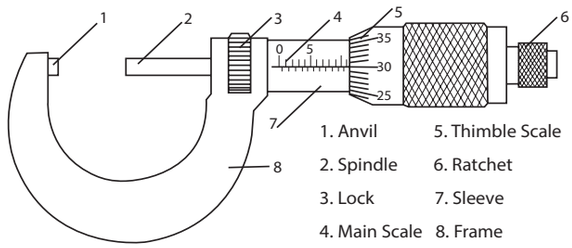
A Graduated main scale is mounted vertically on the base. A movable Vernier scale is fixed on main scale and slides over the fixed on main scale and slider over the main scale up and down. A scriber is fitted to Vernier scale. A clamping screw is fitted on Vernier scale to lock the Vernier scale at the required height.

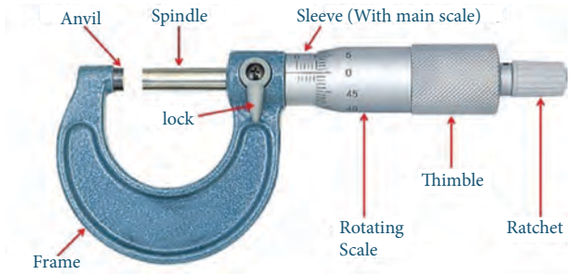
There is a fine adjusting slide fitted on the Vernier scale to with screw which is useful in adjusting the vernier scale accurately. Measurements are made by placing the Vernier height gauge on their surface plate. Opposite to this, objects may be placed in Angle plate.

3.5 MICROMETER

The Micrometer is an extremely precise measuring instrument. It is used to measure length width and thickness of small and medium sized objects and diameter of wires and small rods, to an accuracy of 0.01mm in metric scale and 0.001 inches in British scale. The instrument used measure outside dimensions of objects this micrometer is also called as outside micrometer.

The frame is 'U' Shaped and it is made up of steel. The hardened Anvil is attached to left end of the frame. A graduated barrel having internal thread is called as 'sleeve'. It is attached to the right end of 'U' frame. It is the "Main Scale".





Line Diagram and 3D of Micrometer

The spindle is attached to the thimble and the rotation of thimble will make the spindle to move forward or backward. The beveled edge of the thimble is graduated and called as thimble scale. A ratchet stop' is attached to thimble. It gives 'Click sound when we give more pressure to rotate

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thimble we stop the rotational movement of thimble, when we hear click sound.

Least Count of Metric Micrometer

When we rotate the thimble to one rotation, the distance moved by the spindle is called 'pitch' of the micrometer. Thimble scale is having 50 divisions itself. when we rotate the thimble to one rotation, the spindle moves 0.5mm

Formula

$$\text{Least Count of metric Micrometer} = \frac{\text{pitch}}{\text{Total no of thimble Divisions}}$$

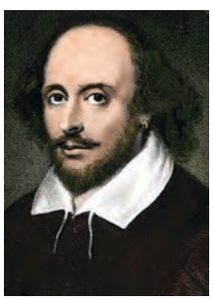
$$= \frac{0.5}{50} = \frac{5}{500} = \frac{1}{100}$$

Least Count of metric Micrometer = 0.01 *mm*

Least Count of British Micrometer

In British micrometer, main scale (Sleeve) is having 40 threads in one inch. When we rotate thimble to one rotation, spindle moves to 1/40 inch. Thimble scale is having 25 divisions itself.

William Gascoigne



William Gascoigne was an English astronomer, mathematician and maker of scientific instruments from Middleton, America Leeds who invented the micrometer.

$$\text{Least Count of metric Micrometer} = \frac{\text{pitch}}{\text{Total no of thimble Divisions}}$$

$$= \left(\frac{1/40}{25}\right)$$

$$= \frac{1}{40} \text{X} \frac{1}{25}$$

$$= \frac{1}{1000}$$

Least count of British Micrometer = 0.001 *inch*

METHOD OF MEASURING IN METRIC MICROMETER

Errors in Micrometer

There are two types of Error

1. Positive Error
2. Negative Error

POSITIVE ERROR

When the micrometer is closed if the zero of the thimble is not touch the zero of sleeve, the error is said to be positive. The number of thimble divisions between the zero of the thimble divisions between the zero of thimble and zero of sleeve is the positive error should be subtracted from the original reading of micrometer.

Problem

When we measure an object, the micrometer shows 15.12 mm. The positive error of the micrometer so 0.03 mm .What is the correct dimension of the object?

Micrometer Reading	=	15.12 mm
Positive Error Reading	=	(–) 0.03 mm
Correct Dimension of Object		15.09 mm

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NEGATIVE ERROR

When the micrometer is closed if the zero of the thimble is crossed over the zero of sleeve, the error is said to be negative. The number of thimble divisions between the zero of thimble divisions between the zero of thimble and zero of sleeve is the amount of negative error. The amount of negative error should be added to the original reading of micrometer.

Problem

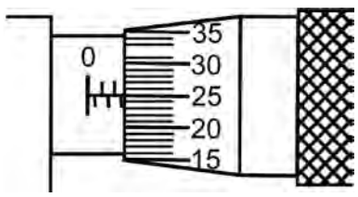
When we measure an object the micrometer shows 9.14 mm. The negative error of the micrometer is 0.04 mm. what is the correct dimension of the object.

Micrometer Reading	=	9.14 mm
Negative error Reading	= (+)	0.04 mm
Correct dimension of object	=	9.18 mm

Correcting the Error in Micrometer

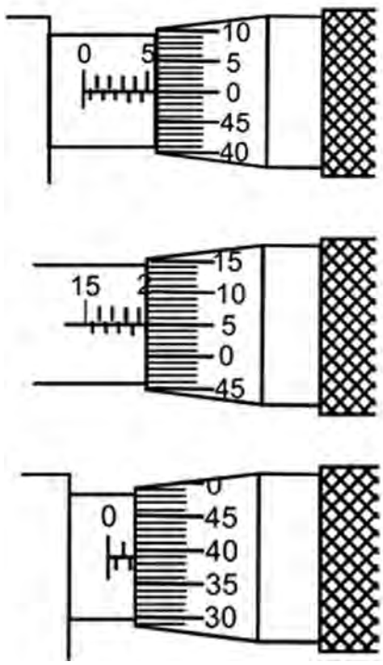
Small C- Shape spanner is given with every micrometer. If there is error (Positive or negative) in micrometer, C-spanner is inserted in a small hole found in sleeve then tight or lose it to correct reading.

Method of Measuring in Micrometer



Main Scale	=	2.50mm
Thimble Scale	=	0.25mm
Total	=	2.75mm

Activity: Find the measurement of Micrometer as shown in figures



INSIDE MICROMETER

The inside micrometer is used to measure the internal dimensions of holes with diameters range from 50mm to 63mm.

Inside Micrometer

Anvil is attached to one end of the graduated sleeve and spindle is attached to

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other side of the sleeve. To measure the holes with a diameter over 63 mm. The extension rod is fitted with micrometer. The sizes of the Extension rods following sizes are in common use: 13, 25, 50, 100, 150, 200 and 600 mm.

DEPTH MICROMETER

Depth micrometer is used to measure the depth of holes in small work pieces and to measure slots and keyways of pulley, gears and etc.

To bottom of the Depth Micrometer is known as 'Head' through which spindle moves down into holes. The bottom of the head is placed on top of the hole and it is perfectly flat to ensure correct seating of the instrument. When the thimble is rotated, spindle moves into holes. After spindle touch the bottom of hole, the Depth micrometer take away from hole to find out the measurement.

Depth Micrometer

Difference between a Vernier Caliper and a Micrometer

Sl.No	Vernier Caliper	Micrometer
1.	External, Internal and depth measurements of an object can be done with a single instrument is called vernier caliper.	External, Internal and depth measurements can be measured with different types micrometers such as outside micrometer, Inside micrometer and depth micrometer.
2.	Generally the least count of varnier caliper in Metric system is 0.02 mm and in British system is 0.01 inch.	Generally the least count of micrometer in metric system is 0.01 mm and in British system is 0.001 inch.
3.	For measuring metric and British system, the mm and inch measures are marked in top and bottom side of main scale in a vernier caliper. So one vernier Caliper is enough to measure both system.	For measuring metric system (mm) metric micrometer is needed for measuring British system (inch), inch micrometer is needed.
4.	The measuring range is more (300 mm, 450mm, 600mm, 1200mm)	The measuring range is less (0.25 mm, 26-50 mm, 51-75 mm)
5.	The movement of spindle is controlled by Ratchet so it is more accurate.	The touch feelings of fixed and movable jaws in the vernier caliper are somewhat difficult to feel. So accuracy may vary slightly.

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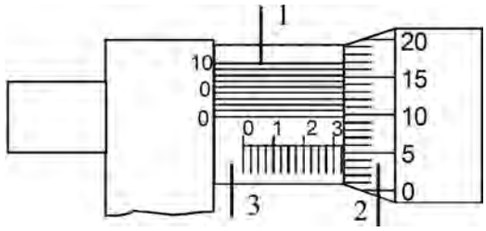
VERNIER MICROMETER

After including Vernier division in the outside micrometer, it is known as Vernier Micrometer. We should add the main scale reading thimble reading and vernier reading. The least count of the vernier micrometer is 0.001 mm.



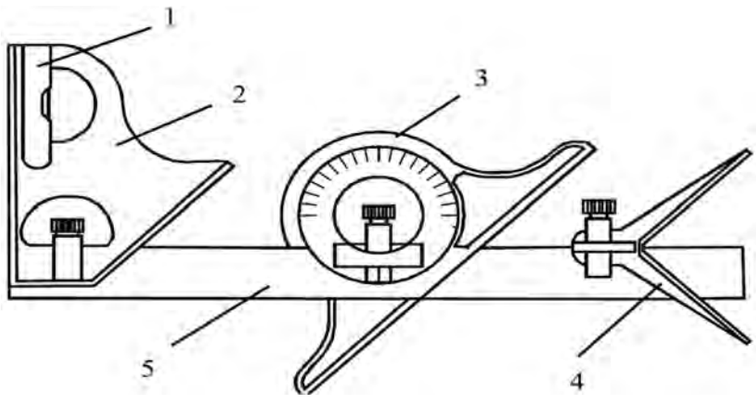
Vernier Micrometer
1. Vernier Scale 2. Thimble Division
3. Main Scale

3.6 COMBINATION SET

Combination set consists of a blade (Steel Rule) a square head, center head and a protractor head. According to nature of work, any one part is attached to blade and find out the measurement.

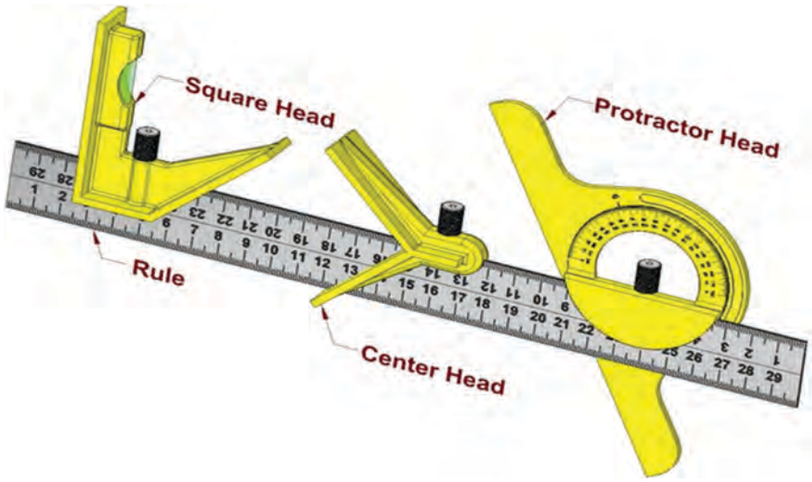
Blade (Rule)

This is looks like standard steel Rule. To attach a square head, center head, or protractor in the backside of the blade.



Layout of Combination Set

1. Sprit Level 2. Square Head 3. Protractor Head 4. Centre Head 5. Steel Rule



Layout of Combination Set

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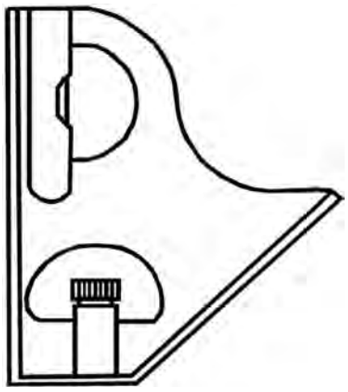
Square Head

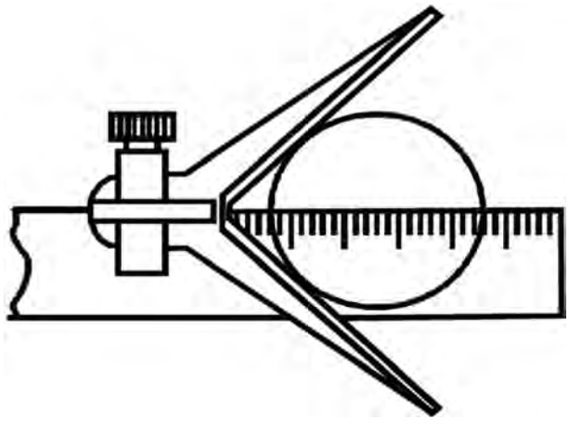
Square head has one of its sides at 90° and other side at 45°, to the base. Square head can be used to scribe and check angle. When used along with steel rule, it serves as depth gauge. It has got a spirit level which can be used to check the levels of surfaces.



Square Head

Center Head

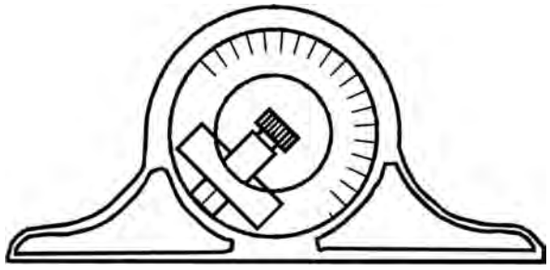
It has two legs at right angles to each other. So it is 'V' shaped with an angle of 90°. When it is attached to Steel Rule ,the angle is bisected. This construction helps in finding the center of round rods. It is also useful in checking 90° (or) 45°.



Center Head

Protractor Head

The bottom side of protractor head is machined smoothly to seat on object. Top-side is circular shape. Angular graduations are marked on the protractor from 0° to 180°. When we used along with steel Rule, straight lines can be scribed at a required angle on the work pieces. It is also useful in checking the levels of angular surfaces.

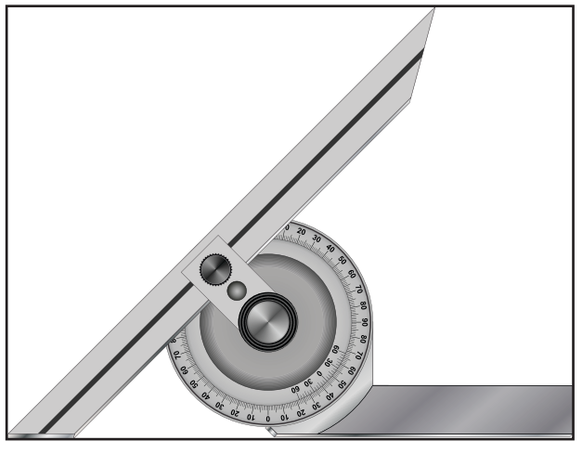


Protractor Head

Vernier Bevel Protractor

Bevel protractor is an measuring instrument used for measuring and testing angles. This is used to measure the angles with the accuracy of 5 minutes. There is a circular dial in which 0° to 180° angles are marked from left to right and right to left both sides.

This is known as 'Main Scale'. Above the circular dial, circular disc with stock is pivoted with one another. The part, Vernier scale is attached to the edge of circular disc.



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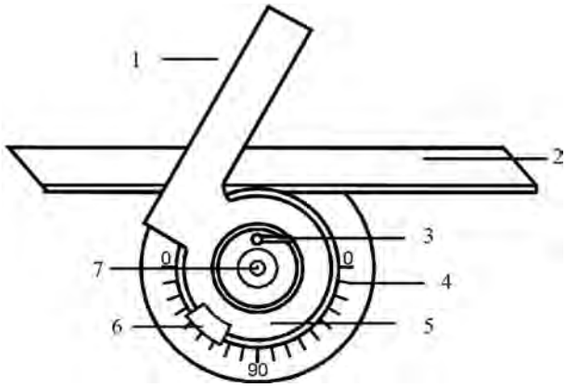


Vernier Bevel Protractor

1. Stock 2. Movable blade
3. Clamp of Blade 4. Main Scale
5. Disc 6. Vernier Scale
7. Locking Screw

Below the disc, blade is fitted and it can be moved lengthwise. The circular disc and blade can be adjusted to measure the angle depends upon the angle of object. Measuring the angle of dead centre of a lathe with the help of vernier Bevel protractor which is shown in figure.

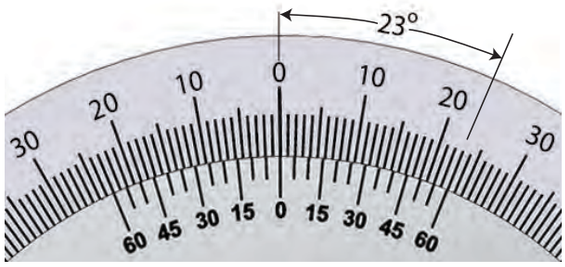
Finding the Least Count of Vernier Bevel Protractor

The value of one division of main scale is one degree. The one side vernier scale has 12 division which is equal to 23^0 in the main scale. The value of one division of vernier scale is $\frac{23^0}{12}$.

Least Count of
Vernier Bevel Protractor = 1 MSD – 1 VSD
LCV Bevel Protractor = One main Scale Division – One Vernier Scale Division

$$= 1 - \frac{23^0}{12}$$

$$= 2 - \frac{23^0}{12}$$



Reading with Vernier Bevel Protractor

(Let us take 1MSD as two Because the 1VSD is greater than 1MSD)

$$= \frac{24 - 23^0}{12}$$

$$= \frac{1^0}{12}$$

$$= \frac{60}{12} \ (1^0 = 60 \text{ minutes})$$

$$= 5 \text{ minutes}$$

3.7 SINE BAR

Measuring instruments like combination set, and vernier bevel protractor are used to measure the angles directly the measuring instrument which is used to measure the angle with the help of sine Formula, so it is called as 'Sine bar'. The least count of Sine bar is one minute.

$$Sin\theta = \frac{Opposite}{Hypotenuse}$$

Sine bar consist of an accurately lapped steel bar and two rollers. The two roller of the same size is fitted with both ends of the sine bar. The size of the sine bar is specified by the distance between the centers of two rollers. Sine bar and slip

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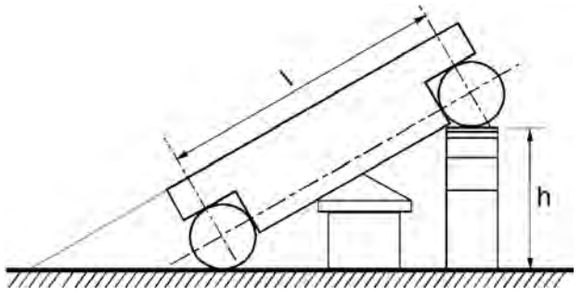

Measuring with Sine Bar

Gauges are used to find the angle in this method firstly sine bar this placed on the surface plate. Now, the sine bar is placed on the taper side of the object. Then slip gauges are arranged one by one upwards till touch the right side of the roller. The remove the object from the sine bar. Now find the total height of slip gauge and length of sine bar (size of sine bar)

$$Sin\theta = \frac{Opposite}{Hypotenuse} = \frac{h}{l}$$

where, h – Total height of slip gauges, l – Length of sine bar

3.8 GAUGES

Gauges are the instruments which are ready made with required size and shape .We use this gauge instantly to find out the Size and shape. There is no graduated part in the gauges. They are made up of alloy steel and heat treated and fine finishing done by grinding process.

Advantage of Gauges

1. The measurements are checked quickly and easily.
2. The cost of gauges is less when compared with precision measuring instruments.
3. A semi skilled operator easily can handle gauges.
4. No Supervision is required.
5. The production is increased.

GRADES OF GAUGES

Gauges are made up of alloy steel they are hardened and tempered and made in following three different grades

1. Workshop Gauge
2. Inspection Gauge
3. Master Gauge

Workshop Gauge: This grade of gauges is used in workshops to check the products manufacture in the shop with low accuracy, the accuracy of workshop gauge is 0.01 inch or 0.025 mm.

Inspection Gauge: Inspection Ganges are deigned to be handled by skilled operators for inspection purpose. It is made with an accuracy of 0.001 inch or 0.0025 mm.

Master Gauge: Master gauge are useful for checking the workshop gauges and inspection gauges. It is also used to check very accurate tools and is made with an accuracy of 0.00001 inch.

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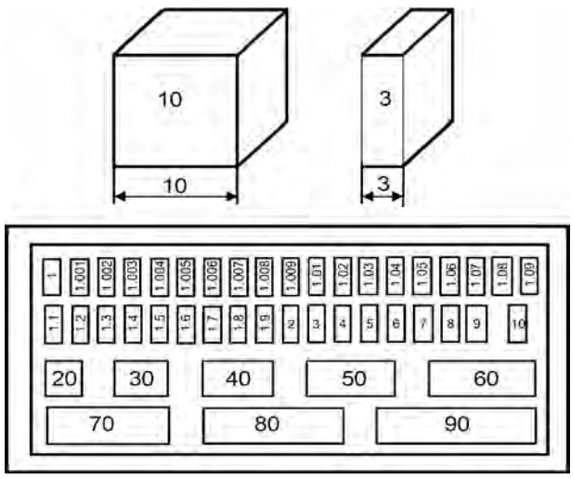
TYPE OF GAUGES

Gauges are classified according to accuracy, shape and the elements to be checked. Some of them are mentioned below

1. Slip Gauge
2. Radius Gauge
3. Depth Gauge
4. Limit Gauge
   a. Plug Gauge
   b. Ring Gauge
   c. Snap Gauge
5. Plate and Wire Gauge
6. Feeler Gauge
7. Telescopic Gauge
8. Template Gauge

1. Slip Gauge



Slip Gauge

Slip Gauges are used with sine bar and dial test indicator to find out tapper angle of an object. This is also known as 'Gauge Blocks', they are made of high speed steel. They are made in different sizes as blocks. After making heat treatment, slip gauges machined accurately and finished to a very high accuracy with grinding and lapping. After use, the slip gauges should be pleased back safely in the box exclusively meant for that.

2. Radius Gauge

The function of radius gauge is to check the radii of curvature of convex and concave surfaces.

Radius Gauge

3. Depth Gauge

This is used to measure and check the depth of hole in given job. The least count is 0.5 mm. If we need more accuracy, we may use vernier Depth gauge and Depth micrometer.

4. Limit Gauge

The gauge which is used to test whether the given job is within the specific limit is called limit Gauge. It is general name. Plug gauge, Ring gauge, Snap gauge are all known as limit gauge.

Plug Gauge: Plug gauge is used to check internal diameter of hole. There are two types of Plug gauge. In first type plug gauge the knurled cylindrical rod has two plugs each at one end. One is 'Go plug and other is 'No Go ' Plug if 'Go 'plug goes into internal diameter of hole it is correct size If 'No Go' plug goes into the internal diameter of hole it is not correct size. In second type plug gauge 'Go plug and 'No Go' plug are attached to one end of the knurled cylindrical rod.

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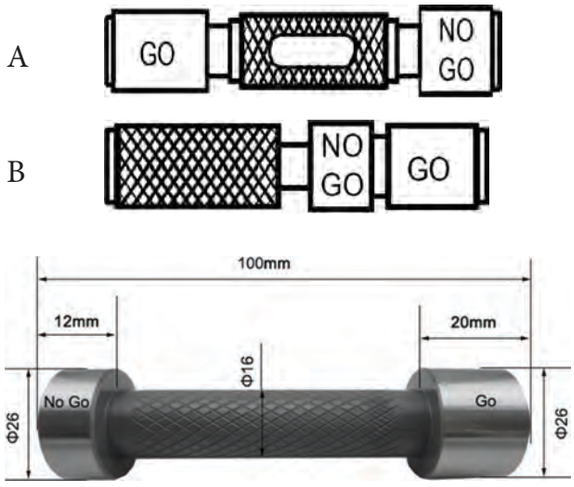
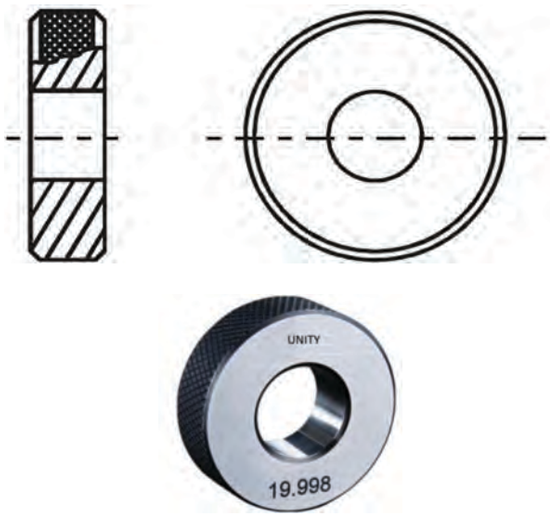


Plug Gauge
A - Double ended plug gauge
B - Progressive plug gauge

Ring Gauge: Ring Gauge is used to check external diameter of cylindrical job. This is in Circular shape. In centre, there is specified hole. Around the circular shape, knurling has done to hold grisly. One side of the hole is 'GO side and other side of the hole is "No Go 'side 'Go 'side is allowed limit and 'No Go' side is not allowed limit.



Ring Gauge

Snap Gauge: Snap gauge is used for checking external divisions there are three types of snap gauge as follows.

1. Caliper Gauge
2. Adjustable Snap Gauge
3. Double ended Solid Snap Gauge

Caliper Gauge: The caliper snap gauge with 'Go' and 'No Go' end is used to measure objects quickly.

Adjustable Snap Gauge: This is made with two fixed anvils in one side and two adjustable anvils in other side. Anvils are adjusted according to size of the job.

Double ended Solid Snap Gauge: This is look like adjustable snap gauge. This is used for measuring specific object only. It measure quickly.

Snap Gauges

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5. Plate and Wire Gauge

The thickness of sheet metal is checked by means of plate gauge and wire diameters by means of wire gauges. The plate gauge is used to check the thickness of plate from 0.23 to 3 mm and the wire gauge is used to check the wire diameter from 0.1 to 10 mm.

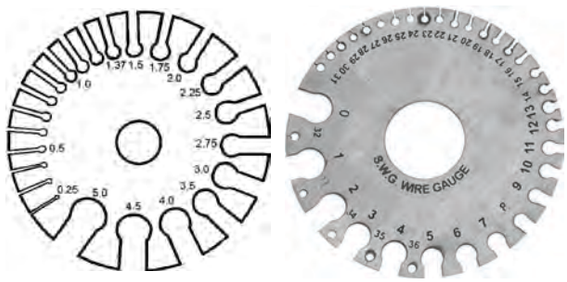
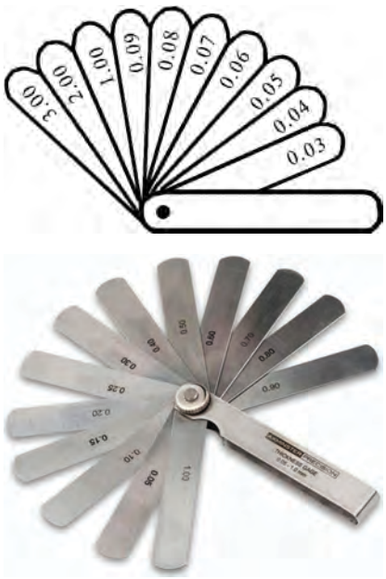


Plate and Wire Gauge

6. Feeler Gauge

Feeler gauge is useful in checking small gaps between mating surfaces. They are made as precision machined blades with different thickness. The thickness ranges from 0.03 mm to 1.0 mm. All the blades are placed in a holder and have indications of their thickness marked on them.



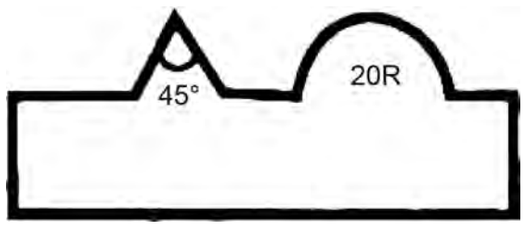
Feeler Gauge

7. Telescopic Gauge

Telescopic Gauge is used for measuring inner dimensions of holes and slots. It consists of handle and two plungers. Generally telescopic gauge are available to measure the range from 12 mm to 150 mm.

8. Template

Template is made from steel. If objects are produced in mass, the model of the object with same shape and size in shell steel is called Template. We measure the completed objects, quickly with template is similar to the gauge.



Example Template

3.9 DIFFERENCE BETWEEN GAUGES AND TEMPLATES

Sl. No	Gauges	Templates
1	This is made up of alloy steel	This is made up of thin steel sheets
2	This is costly	This is cheaper
3	Not used for hot articles	Can be used for all parts
4	Used to check correct size	Used to check size and shape
5	Accuracy is Very high	They are not very accurate

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GLOSSARY

1. Gauge – அளவி
2. Ratchet – ஒரு வழித்தடை பற்சக்கரம்
3. Telescopic– ஒன்றினுள் ஒன்று சொருகப்பட்டு நீளுதல்

ACTIVITIES

1) Find and list out Latest hand tools used in Industrial field.
2) Make a punch (or) Scriber.
3) Make a plate gauge (or) Template by using plastic or thick card board.
4) Find and list out different types of gauges.

QUESTIONS

SIBF5G

1 Mark

PART A

I. Choose the correct option :

1. Measurements on cylindrical surface are done with
   a) Narrow Scale
   b) book Scale
   c) Folding Scale
   d) Flexible Scale.
2. The least count of a vernier caliper is
   a) 0.01 mm
   b) 0.02 mm
   c) 0.001 mm
   d) 0.1 mm
3. Angular measurements are done to an accuracy of 5 minutes with
   a) Sine Bar
   b) Vernier Bevel Protractor
   c) Combination Set
   d) Protractor
4. Anvil and thimble are found in this measuring instrument
   a) Vernier Caliper
   b) Vernier Height Gauge
   c) Micrometer
   d) Combination Set
5. Slip gauges are used in this measuring instrument
   a) Vernier Bevel Protractor
   b) Sine Bar
   c) Combination Set
   d) Micrometer

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PART B

3 Marks

II. Answer the following questions in one or two sentences:

6. List out any three types of scales?
7. How do you measure the depth of a hole using vernier caliper?
8. What is positive error of a micrometer?
9. What is negative error of a micrometer?
10. What are the grades of gauges?

PART C

5 Marks

III Answer the following questions in about a page?

11. A main scale of vernier caliper is marked in millimeter. The Vernier Scale has 50 divisions which is equal to 49 divisions in the main scale. What is the least count of that vernier caliper ?
12. In metric micrometer, if the thimble rotates one rotation, spindle moves 0.5 millimeter. The thimble has 50 divisions totally. What is the least count of metric micrometer?
13. What are the advantages of gauges?
14. What are the various type of gauges?

PART D

10 Marks

IV. Answer the following questions in detail:

15. Describe about vernier height gauge?
16. Draw the Vernier Caliper and explain about it.
17. Explain about the outside micrometer with figure.
18. What are the difference between vernier caliper and micrometer?
19. What are the difference between gauges and templates?
20. Draw the snap Gauge and explain about its types.

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Chapter

4

ENGINEERING MATERIALS

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Learning Objectives

1. Students to know about the various Engineering Materials and their properties and their types.
2. To know about the metals and non-metals and Ferrous and non-ferrous metals, steels and cast Iron.
3. To know, the uses of all Engineering materials.

Table of Content

4.1 Introduction

- In General, material may be anything else. It is consisting of whether pure or impure, single or composite, living or non-living matter. It may be a solid, liquid, and gas. Materials can be classified based on different properties, such as physical and chemical properties, etc.,
- In Industry, Material are inputs for production or manufacturing processes. They may be raw material to produce things in engineering fields. Synthetic materials are used in other fields like Medical, Textile and Home Appliances. Medicines, textile, petrol, fuels, soaps, glass, polymers, cements, etc are synthetic materials.
- The materials are either natural or artificial. Natural materials are air, water, oil, minerals, cereals, metals, wood, rubber, etc.,
- The artificial materials are made from natural things. In the physical sense, materials are studied in material science.

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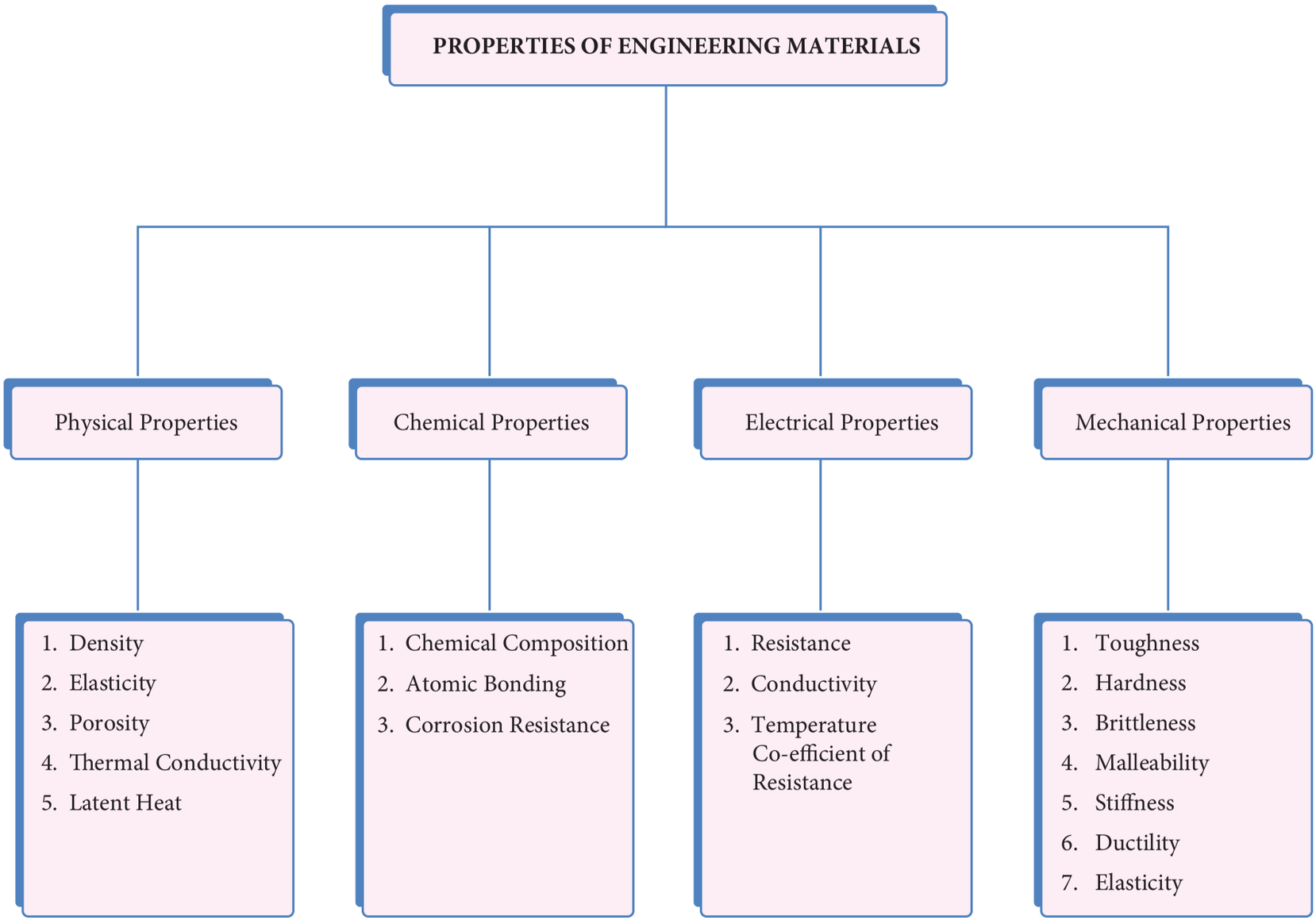

Flow Chart of Properties Engineering Materials

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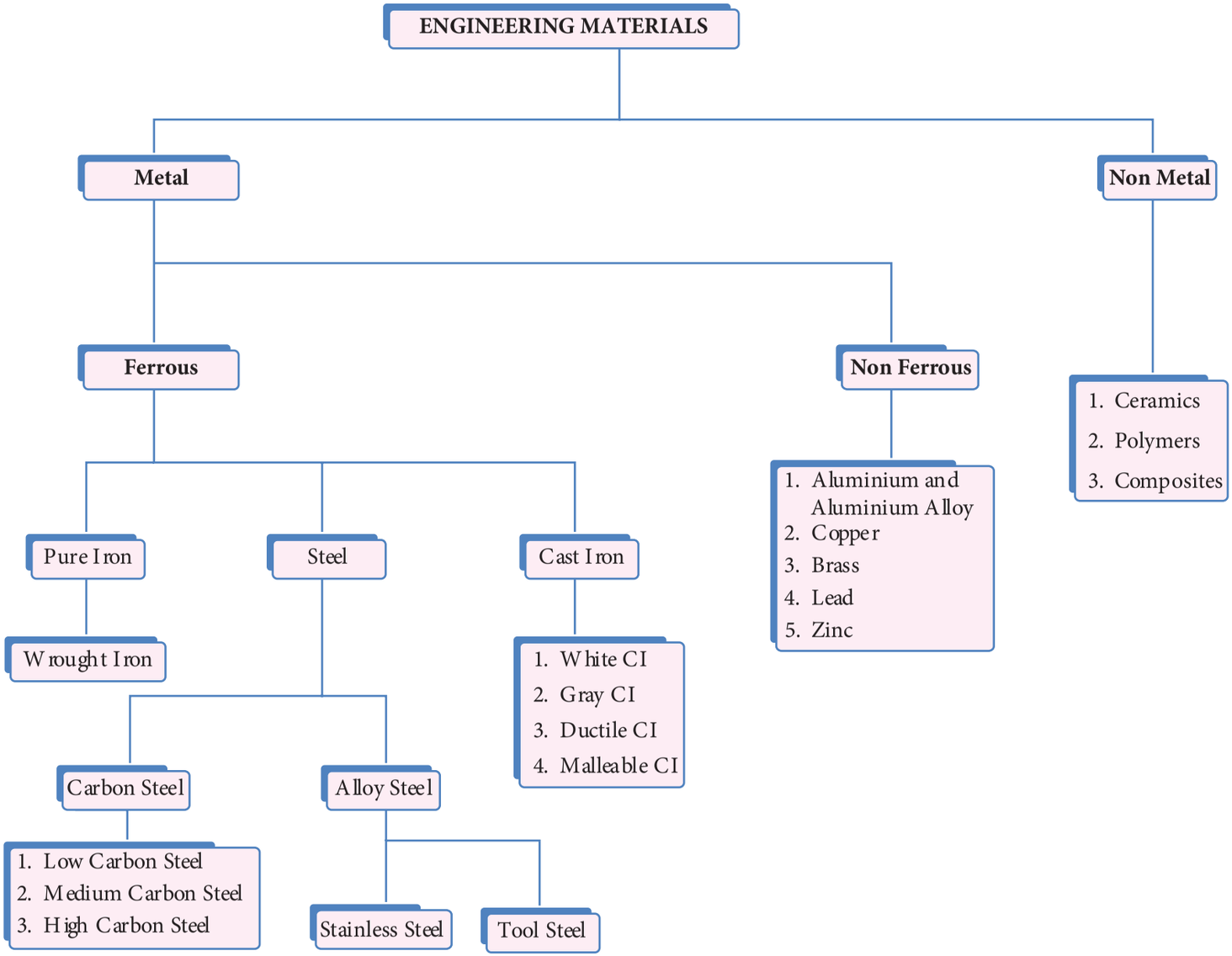

Flow Chart of Engineering Materials

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4.2 ENGINEERING MATERIALS

If we would like to fabricate an engineering part, like a hacksaw blade, we must go in search of material, like high carbon steel high speed steel which possess desirable properties as will permit the blade to perform its function successfully while in use. That is, any tool or cutting materials , should have high strength , high toughness, high hardness and high corrosion resistance.

Tungsten carbide, vanadium carbide, molybdenum steels are used as tool or cutting materials advanced in technology depend increasingly on the development of better materials of corrosion and resistance to heat.

4.3 PROPERTIES OF MATERIALS

The practical application of engineering materials in manufacturing a component, we must have a thorough knowledge of their particular properties under a wide range of conditions. However, the range of properties found in different classes of materials in very large. Some of the very useful properties are,

1. Physical properties
2. Chemical properties
3. Electrical properties
4. Mechanical properties
5. Thermal properties

Physical Properties

Physical properties can be observed or measured without changing the composition of matter.To finalize the material for an engineering product or application, we should have the knowledge of physical properties of materials like the Density, Elasticity, Porosity, Thermal conductivity and Latent heat.

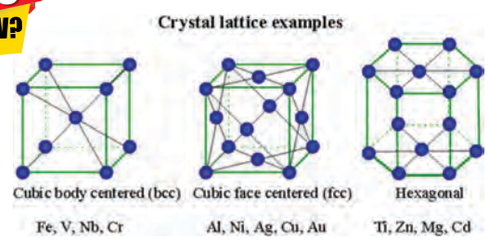
Chemical Properties

Being an Engineer, It is very important to have the knowledge of chemical properties of engineering materials. Because most of the engineering materials contact with other materials and chemically react to each other. Due to this chemical reaction they may suffers from chemical deterioration.

Some of the chemical properties of engineering materials are listed below

1. Chemical Composition
2. Atomic Bonding
3. Corrosion Resistance

DO YOU KNOW?



Crystal Structure - In crystallography, crystal structure is a description of the ordered arrangement of atoms, ions or molecules in a crystalline material.

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Electrical Properties

The Electrical properties of a material are those which determine ability of material to be suitable for a particular Electrical engineering Application. Some of the typical Electrical properties of engineering materials are listed below.

1. Resistivity
2. Conductivity
3. Temperature co-efficient of Resistance
4. Thermoelectricity

Mechanical Properties of Engineering Materials

Being an Engineer, we must have a thorough knowledge of mechanical properties of Engineering Materials, because they are of great importance in the design of tools, machines and structures. The most important and useful mechanical properties are briefly explained below.

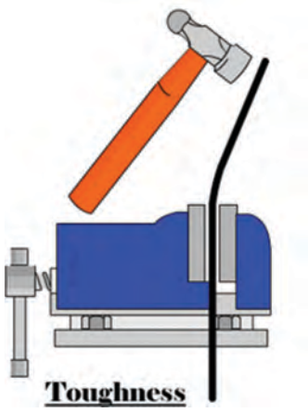
1. Toughness
2. Hardness
3. Brittleness
4. Malleability
5. Stiffness
6. Ductility
7. Elasticity

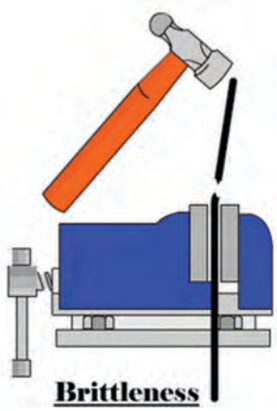
Toughness: Toughness is the ability of a material to withstand sudden external forces. It is the amount of energy absorbed by the material before it develops fracture. Wrought Iron, Mild steel are the examples for the tough materials.

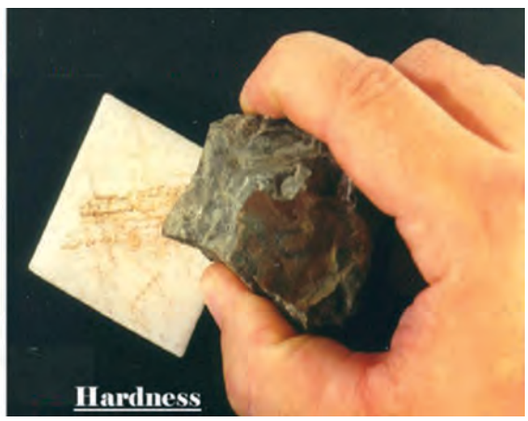
Brittleness: Brittleness of a material indicates that how easily it gets fractured when it is subjected to a force or load.

Example Glass, Cast Iron.

Hardness: Hardness is a fundamental properties which is closely related to the ability of a material the resist to scratching, abrasion, and cutting. High carbon steels and high speed steels have higher hardness. Diamond is the hardest material.







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Malleability: Malleability is a property of solid material which Indicates that how easily a material gets changed in shape under compressive stress. Material can be formed into thin sheet by hammering (or) rolling. Copper, Aluminium and silver are malleable materials.

Ductility: Ductility is a property of solid materials which indicates that how easily a materials get changed in shape under tensile stress. Metals can be pulled into wire by using this property.

Elasticity: The ability of material to regain its original size and shape on removal of the applied forces is known as elasticity. Low carbon steels are having this elastic property. It is used to make spring.

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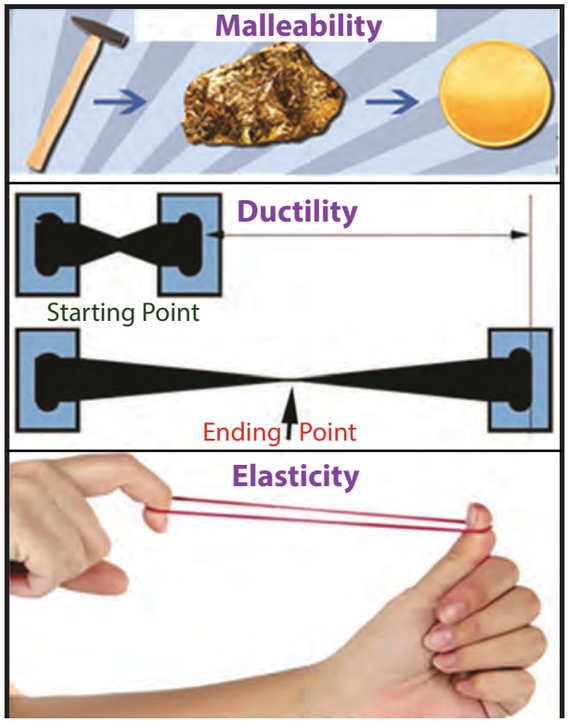

Malleability, Ductility and Elasticity

4.4 METALS

Metals are very useful in Industrial field. They are used to make tools because they can be strong and easy to share. Bridges, buildings or ships are constructed by using Iron and Steel. Most metals are heavy and they melt only when they are heated at very high temperature. Heat and electricity can easily pass through metals. A lump of metals can be beaten into a thin sheet or can be pulled into thin wires. Most of the metals are solid at room temperature except mercury. Mercury is liquid at room temperature.

Metals are classified as ferrous and non-ferrous metals.

Ferrous: Ferrous metals mostly contain Iron. They have small amounts of other metals or elements added, to give the required properties.

Types of ferrous metals

1. Pure Iron
2. Steel
3. Cast Iron

Pure Iron: Iron is a chemical element with symbols Fe and its atomic number is 26. It is an iron alloy with a very low carbon (0.1%) content. It is commercially known as pure Iron. It is relatively soft etc.

Pure Iron
Example Wrought Iron

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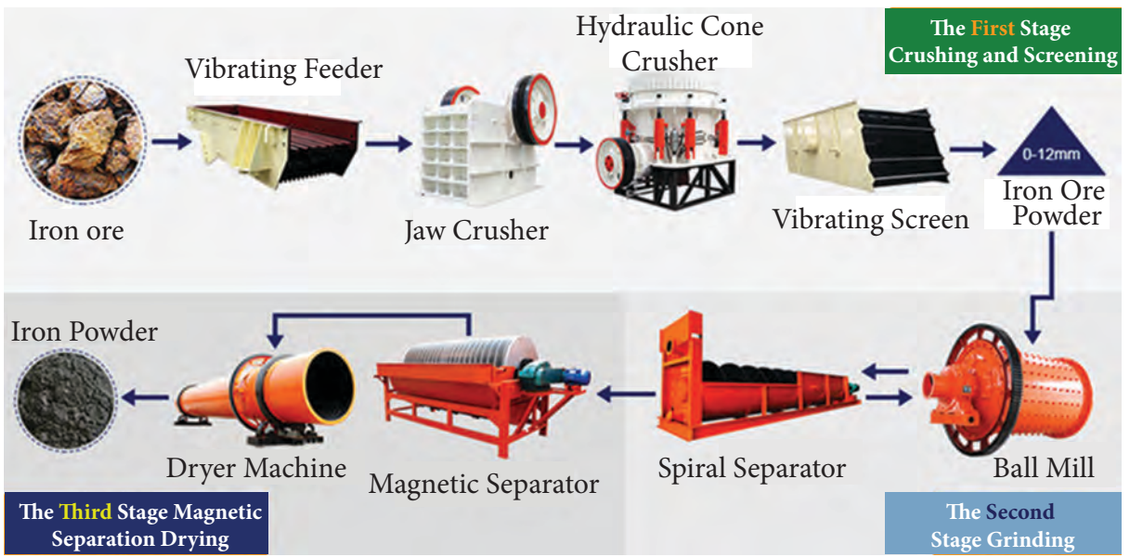
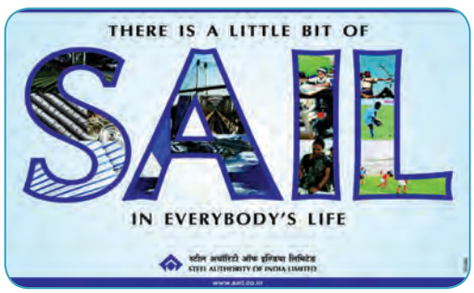
DO YOU KNOW?

How the Iron is extracted from its Ore



Steel: Steel is an alloy of iron, carbon and other elements. It has carbon content range from 0.1% to 0.15%. Because of its high tensile strength and low cost, it is a major component used in buildings, infrastructure, tools, ships, automobiles, machines and weapons.

DO YOU KNOW?



SAIL - *Steel Authority of India Ltd* is the largest steel producer in India with the widest range of steel products. We have steel for all sectors from Infrastructure & Construction, Railways, Defense to space exploration.

TYPES OF STEEL:

Steel can be broadly classified into four groups based on their chemical compositions:

1. Carbon Steel
   a. Low Carbon Steels
   b. Medium Carbon Steels
   c. High Carbon Steels
2. Alloy Steel
   a. Stainless Steel
   b. Tool Steel

Carbon Steel: Carbon steel or steel is a metal alloy. It is a combination of two

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metals. It is a combination of two elements like Iron and carbon. Other elements are present in small qualities. As carbon content rises the metal becomes harder and stronger but less ductile and more difficult to weld. Carbon steels are further classified into three on the basis of percentage of carbon.

1. Low carbon steels or mild steels contain up to 0.3%of carbon.
2. Medium carbon steels contain 0.3% to 0.6% carbon.
3. High carbon steels contain 0.6% to 1.5% of carbon.

Alloy Steels: Alloy steels contain alloying elements (Example Manganese, silicon, nickel, titanium, copper, chromium and aluminum) in varying proportional in order to manipulate the steel's properties, such as it's harden ability corrosion resistance, strength, weldability or ductility.

a) **Stainless Steel:** Stainless steel generally contain 10-20% of chromium as the alloying elements. It is notable for its corrosion resistance, and it is widely used for food handling and cutlery devices.

b) **Tool Steel:** Tool steel contain tungsten, molybdenum, cobalt and vanadium in varying quantities to increase heat resistance and durability, making them ideal for cutting and drilling equipment.

Examples of Tool Steel:

High speed Steel: High speed steel is a cutting tool material used in drilling, milling, turning, threading, boring, gear cutting and many other machining operations. The alloying elements are tungsten, molybdenum, vanadium and chromium.

Tungsten Steel: High speed Tungsten steel is a high carbon tool steel, containing a large dose of tungsten; a typical HSS composition is 18% tungsten, 4% chromium, 1% vanadium, 0.7% carbon and the rest, Iron.

Cast Iron: Cast iron is a group of iron-carbon alloy with carbon content ranges from 2% to 4.5%. This high carbon content makes them excellent materials to use for casting.

Types of cast Iron

1. White Iron
2. Gray Iron
3. Ductile Iron
4. Malleability Iron

Non Ferrous: Non-ferrous metals do not contain Iron, we can also get non-ferrous metals as alloys. Eg, brass is an alloy of copper and Zinc. Non-ferrous metals are specified for structural applications because it has lesser weight, higher strength, higher melting points. They are also used for electronic applications. Some examples of Non-Ferrous metals are given below

1. Aluminium and Aluminium Alloys
2. Copper
3. Brass
4. Lead
5. Zinc

Aluminium: Aluminium is a chemical element with symbol Al and Its atomic number is 13. It is a silvery-white, soft, non-magnetic, ductile metal. Its ore is bauxite. As pure Aluminium has a low melting point(658°C)and it is used for sand casting.

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DO YOU KNOW?

AISI

The *American Iron and Steel Institute* is an association of North American steel producers. Its predecessor organizations date back to 1855 making it one of the oldest trade associations in the United States

Copper: Copper is a chemical element with symbol Cu, and its atomic number is 29. It is a soft, malleable, and ductile metal with very high thermal and electrical conductivity. It is generally extracted from an ore called "pyrites". The impurities are filtered in various stages to obtain pure copper. Its melting point is 1083°C It is used for making electrical wires and vessels.

Brass: Brass is a metallic alloy that is made of copper and zinc. The proportions of zinc and copper can vary to create different types of brass alloys with varying mechanical and electrical properties . Brass is used for coating materials for its bright appearance. It is used in making locks, gears, bearings and valves.

Lead**:** Lead is a chemical element with symbols Pb and its atomic number is 82. It is a heavy metal that is more dense than most common materials. Lead is soft and malleable and has a relatively low melting point(326°C). It is extracted from the ore of (326°C) Galena.

Zinc**:** Zinc is a chemical element with symbols Zn and its atomic number 30. The most common Zinc ore is sphalerite. Zinc is used for coating material in iron and steel parts. The process of coating is known as Galvanizing.

Aluminium, Copper and Brass

Glossary

1. Brittleness – சிதறும் தன்மை
2. Malleability – தகடாக நீளும் தன்மை
3. Ductility – கம்பியாக நீளும் தன்மை
4. Elasticity – மீள்தன்மை
5. Galvanizing – துத்தநாக முலாம் பூசுதல்

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Activities

1) Collect small quantity of any Engineering Materials Like Iron, Copper, Brass,
2) List out the brittleness Materials.

Questions

SINXV1

1 Mark

PART A

I. Choose the correct option :

1. Atomic bonding is
   a) Physical property
   b) Chemical property
   c) Electrical property
   d) Mechanical property

2. Elastic property is
   a) Physical property
   b) Mechanical property
   c) Electrical property
   d) Chemical property

3. Which material has brittleness property?
   a) Steel
   b) Copper
   c) Cast Iron
   d) Aluminium

4. Which material has elastic property?
   a) Steel
   b) Mild Steel
   c) Copper
   d) Spring

5. The atomic number of Pure Iron is
   a) 16
   b) 26
   c) 36
   d) 46

6. Which steel is used for making transformers?
   a) Carbon Steel
   b) Alloy Steel
   c) Tool Steel
   d) High Speed Steel

7. Which kind of steel is used to make milling tools?
   a) Carbon Steel
   b) Tool Steel
   c) Stainless Steel
   d) High Speed Steel

8. The Carbon content in Cast Iron is,
   a) 2% to 3%
   b) 2% to 4%
   c) 2% to 4.5%
   d) 2% to 5%

9. The Atomic Number of Aluminium is
   a) 10
   b) 12
   c) 13
   d) 15

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10. The ore of the Aluminium is
    a) Bauxite
    b) Hematite
    c) Dolamite
    d) Gallena

11. The symbol of Zinc is
    a) Zn
    b) Al
    c) Fe
    d) Pb

12. Which metal is used to make decoration materials?
    a) Copper
    b) Brass
    c) Lead
    d) Zinc

PART B

3 Marks

II. Answer the following questions in one or two sentences:

13. List out some Engineering properties.
14. List out some Electrical properties.
15. What are different types of Steel.
16. What are the three kinds of carbon Steel.
17. What are the metals in Tool Steel.
18. List out the types of Cast Iron.
19. List out the Non-Ferrous materials.

PART C

5 Marks

III Answer the following questions in about a page?

20. What are the properties of engineering materials and write short notes any two of them?
21. Explain the different kinds of Tool Steel
22. Write Short notes:
    a) Aluminium b) Copper

PART D

10 Marks

IV. Answer the following questions in detail:

23. What are the mechanical properties of engineering materials and explain any four?
24. Explain the different types of Steel

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Chapter

5

HEAT TREATMENT

SIU78R

Learning Objectives

1. Students to know about the heat treatment of metals.
2. To know the purpose, methods of heat treatment processes.
3. To know about the various processes and types of heat treatment furnaces.

Table of Content

5.1 Introduction

- Metals and alloys develop important properties by heat which plays an important role in achieving appropriate micro structure that imparts the desires characteristics in given material. Hence the study of heat treatment is of great significance.
- Heat treatment is a process in which a metal is heated to a certain temperature and cooled in a particular manner and speed to alter its internal structure for obtaining desired degree of physical and mechanical properties.

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5.2 PURPOSE OF HEAT TREATMENT

1. Improvement in ductility
2. Relieving internal stresses
3. Refinement of grain size
4. Increasing hardness or tensile strength
5. Improvement in machinability
6. Alteration in magnetic properties
7. Improvement in toughness and development of re-crystallized structure.

5.3 LOWER AND HIGHER CRITICAL TEMPERATURE

While heating a solid metals, their internal structure starts to transform at a particular temperature. This temperature is known as Lower critical temperature of the metal. On further heating, the whole internal structure is transformed at particular temperature. This temperature is called upper critical temperature.

இரும்பை காய்ச்சி உருக்கிடுவீரே...
இயந்திரங்கள் வகுத்திடுவீரே...

—பாரதியார்

Melt the Iron and
Make the Machine

—Bharathiyar

5.4 METHOD OF HEAT TREATMENT PROCESS

1. Annealing
2. Normalising
3. Hardening
4. Tempering
5. Case Hardening
   a. Carburising
   b. Nitriding
   c. Cyaniding
   d. Induction Hardening
   e. Flame Hardening

ANNEALING

Annealing is a process in which a metal is heated to a particular high temperature, held there for a period of several hours or several days, and allowed to cool slowly, by using sand, lime or ashes. This process is mainly applied to produce softening.

Process of Annealing

1. In this process low carbon steel is heated to 30°C to 50°C above the higher critical temperature.
2. Maintain it in the same temperature for a considerable period of time.
3. The metal is slowly cooled by placing in to sand, ashes or lime that insures a slow rate of cooling.
4. Oil fired furnace, gas fired furnace or sintering (Electrical) furnace are used for heating.

The temperatures are monitored by thermo couple.

Purpose of Annealing

1. To soften the steel.
2. To improve machinability.
3. To increase ductility and toughness.
4. To relieve internal stresses.
5. To refine grain size.
6. To improve homogeneity.

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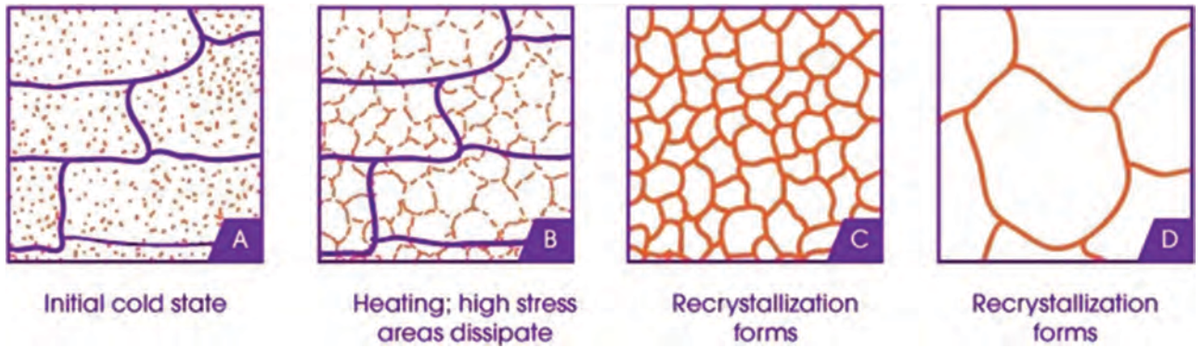
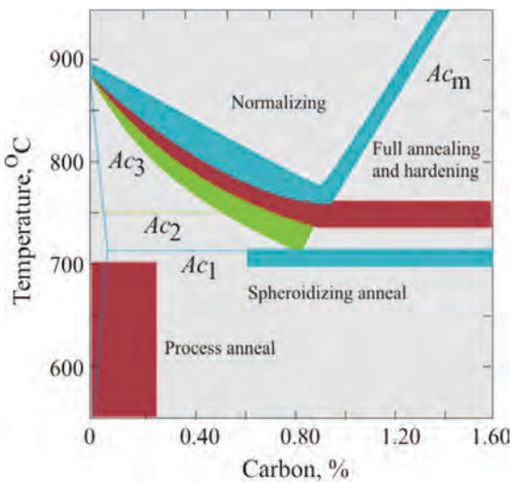


Annealing Process



Normalizing Chart

Harry Brearley was an English metallurgist, usually credited with the invention of "rustless steel".

NORMALIZING

Normalizing is a process in which a steel is heated above the critical temperature, holding for a period of time, and allowed to cool by air. The transformation of Internal structure are occurred during the cooling process.

After forging, rolling and casting, the steel parts are distorted in its structure. In this case, Normalizing is done to rectify the internal structure of the parts to its original position.

Process of Normalizing

1. In this process the steel is heat to 50°C above the higher critical temperature. Holding it at that temperature for approximately 15 minutes.
2. Cooling it in air.

Purpose of Normalizing

1. To refine the grain size
2. To remove internal stresses
3. To improve machinability
4. To improve strength
5. For homogeneous structure

HARDENING

This process makes the material stronger. In the process of hardening, the

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steel is heated to the above critical temperature (from 750°C to 850°C), holding it at the temperature for a considerable period of the time and rapidly quenching it in water, oil or salt bath. Hardness is depending on the following factors,

1) Carbon content
2) Rate of cooling
3) Work size

Purpose of Hardening

1) To increase the hardness of the metal.
2) To resist wear and enable it to cut other metals.
3) To improve strength, elasticity, toughness and ductility.

TEMPERING

Commonly used in steel making, tempering is a heat treatment used to improve hardness and toughness in steel as well as to reduce brittleness. The tempering process creates a more ductile and stable structure. If the steel (or) any tool is very hard it will brittle. So the tempering operation is done to reduce the brittleness.

Process of Tempering

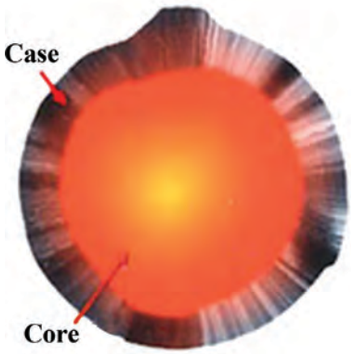
1. The steel is heat at below lower critical temperature after hardening.
2. Holding it for a considerable time.
3. Then cooling it slowly.

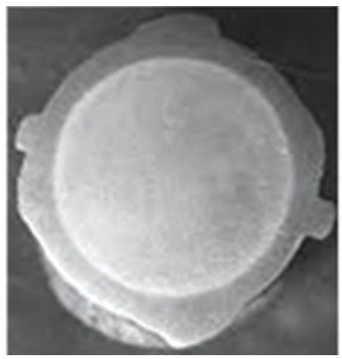
Purpose of Tempering

1. To decrease the brittleness of hardened steel.
2. To achieve the best mechanical properties in metal.
3. To stabilize the structure of metal.
4. To increase the toughness of steel.
5. To improve ductility.

CASE HARDENING

Case hardening is a process that is used to harden the outer surface metal while manufacturing a soft inner metal case. The case hardening process involves infusing addition carbon into the surface layer. In this process, chemical reaction made on the steel.





Case Hardening

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Purpose of case hardening

1. To provide adequate wear resistant on the surface.
2. To improve corrosion resistance
3. To improve heat resistance
4. To increase life of components made from low cost material.

The different processes of case hardening are

1. Carburizing
2. Nitriding
3. Cyaniding
4. Induction Hardening
5. Flame Hardening

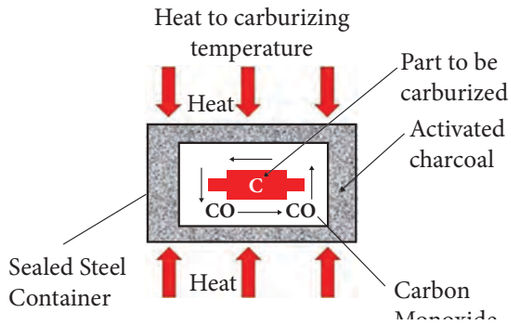
CARBURIZING

There are several techniques for hardening the outer surfaces of steels. These include diffusing carbon into the surface and heat treating the surface without changing the properties of core. This treatment is applied to low carbon steel parts after machining

There are three types of carburizing commonly used:

1. Pack Carburizing
2. Liquid Carburizing
3. Gas Carburizing

Pack Carburizing: In pack carburizing, the components are surrounded by a carburizing medium and placed in a sealed box. The medium is usually wood (or) leather, coke or charcoal mixed with barium carbonate. When the sealed box is kept into the furnace at 925°C and held at the same temperature for considerable time. At that temperature carbon monoxide is produce from the medium and reacts with the iron. It produces iron carbide on the surface. It hardened the surface.



Pack Carburizing

where C Means Carbon on the Surface of the work piece and CO Means Corbon Monoxide gas that is circulated around the work piece.

Disadvantages of Carburizing

1) It is not suitable for mass production.
2) Time taken is more for packing, unpacking, heating and cooling.
3) The amount of hardening cannot be controlled easily.

NITRIDING

Nitriding is one of the case hardening process on alloy steels

In this process nitrogen is added to the surface of steel parts. The steel parts is heated in the presence of Ammonia gas at range of temperature 500°C to 600°C The Ammonia is dissociated as Nitrogen and Hydrogen, the nitrogen reacts with the steel to form nitrides. It develop a very hard case in a component at low temperature. In this process the surface is hardened up to a thickness of 0.25mm.

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Advantages of Nitriding

1. The surface hardness is very high.
2. It increases wear and corrosion resistance.
3. Due to rapid cooling there is no scaling.
4. It is suitable for complicated structures.

CYANIDING

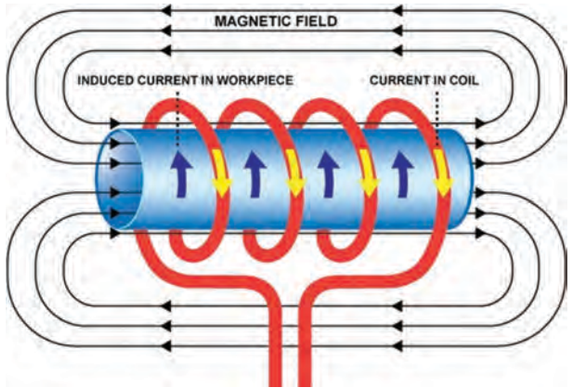
Cyaniding is one of the case hardening process on low carbon and alloy steels. The metal is heated at the range of temperature 800°C to 900°C in contact with molten bath of sodium cyanide, so the surface of the metal absorbs carbon and Nitrogen. Then the metal is quenched in oil or water, depending on the type of material used and the hardness required. In this process the surface is hardened upto a thickness of 0.5mm.

Advantages of Cyaniding

1. It is a rapid process.
2. The exterior will have high lustre.
3. It gives uniform hardening.
4. It increases the ductility.

INDUCTION HARDENING

It is a process used for the surface hardening of steel and other alloy components. The parts to be heat treated are placed in a induction coil. When high frequency alternating current is passed through the coil, the coil produces an alternative magnetic field within the components. So, the outer surface of the part is heated to higher critical temperature. Then the components are quenched in oil or another media, depending upon the types of steel and hardness desired.



Induction Hardening

Advantages

1. It is a rapid process.
2. High rate of change of properties.
3. The exterior surface can be made of high quality.
4. The internal hardening can be controlled.
5. Heat can be controlled in this process.

Disadvantages

1. The cost of the equipment is very high.
2. Low carbon steel cannot be hardened.
3. Maintenance cost of the equipment is more.

FLAME HARDENING

Flame hardening is a process of hardening the surface of the steel. Here, the steel is heated to the above critical temperature by using an oxy-acetylene flame and then it is quenched by spraying water. The result is a hard surface Layer on the steel. In this process the outer surface is hardened 3 to 6mm.

Advantages

1. It is simple and manufacturing cost is less.

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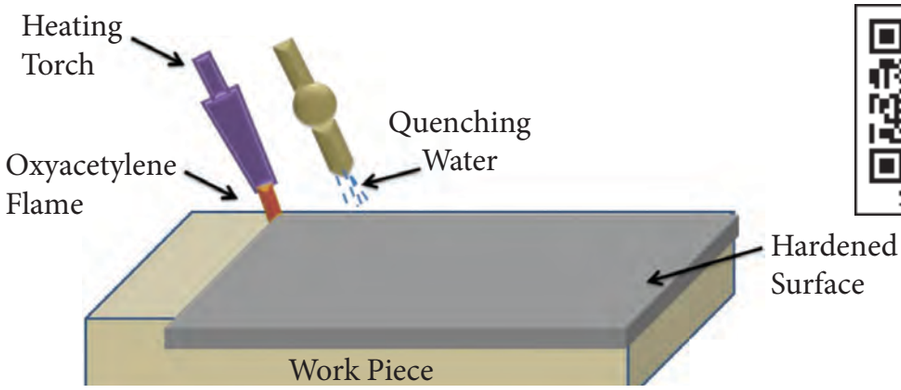

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Flame Hardening

2. It is possible to harden a part which is too large or inconvenient
3. The time required for heating is lesser.

5.5 QUENCHING

Quenching is done as a cooling process after the metal is heated. It is done with the water, oil or high pressure air.

The materials used for quenching are,

1. Sodium Solution
2. Cool Water
3. Salt Baths
4. Grade of Oil
5. Air

DO YOU KNOW?

Daniel Gabriel Fahrenheit

Daniel Gabriel Fahrenheit was a Dutch-German-Polish physicist, inventor, and scientific instrument maker.

DO YOU KNOW?

$$°C = (°F - 32) \times 5/9$$

$$°F = (°C \times 9/5) + 32$$

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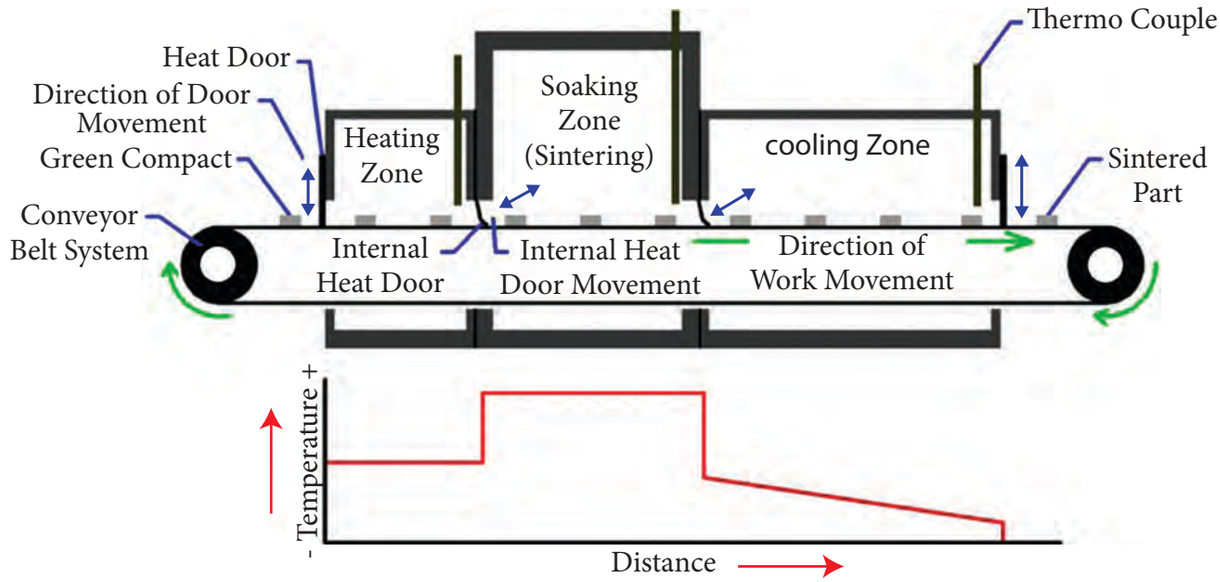

Sintering furnace

5.6 HEAT TREATMENT FURNACES

Some common types of heat treatment furnaces are mentioned below

1. Sintering Furnace
2. Oil fired Furnace
3. Gas fired Furnace
4. Salt bath Furnace

ELECTRIC FURNACE:

Materials to be heated, using electrical equipments are called electric furnace.

SINTERING FURNACE:

Sintering furnace is one of the electric furnace. In this furnace, there are three zones, namely heating zone, soaking zone and cooling zone. Heat is controlled by thermostat and the temperature is measured by thermo couple. Component is placed in the tray which is passed through the furnace by means of iron belt conveyers.

The component is heated in the heating zone, then it is maintained at the sintering temperature in the soaking zone. Finally the component is cooled in the cooling zone. In this process operating, increasing and decreasing of the Iron belt conveyers is controlled by the controlling unit.

Glossary

1. Annealing – மிருதுவாக்குதல்
2. Hardening – கடினப்படுத்துதல்
3. Case Hardening – புறக் கடினமாக்கல்
4. Quenching – விரைவாக குளிரச்செய்தல்
5. Sintering Furnace – மின்சார உலை

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Activities

1. Visit any one of the blacksmith workshop and submit the report. What are the various processes done there?

Questions

SJ7PYB

1 Mark

PART A

I. choose the correct option:

1. Which one is added to the surface of the steel, while nitriding
   a) Carbon and Nitrogen
   b) Nitrogen
   c) Carbon
   d) Hydrogen

2. The purpose of tempering is
   a) to improve corrosion resistance.
   b) to increase the hardness of the metal.
   c) to decrease the brittleness.
   d) to improve machinability.

3. The furnace with three Zone is
   a) Gas fired Furnace
   b) Salt bath Furnace
   c) Sintering Furnace
   d) Oil fired Furnace

4. _____ is a method of case hardening.
   a) Tempering
   b) Annealing
   c) Cyaniding
   d) Hardening

5. The temperature used for pack carburising is at
   a) 925°C
   b) 750°C to 850°C
   c) 30° to 50° above the higher critical temperature
   d) 500°C to 600°C

3 Marks

PART B

II. Answer the following questions in one or two sentences:

6. Define "Heat treatment"?
7. What are the methods of heat treatment?
8. What is lower critical temperature and upper critical temperature?
9. What is "Annealing"?
10. What are the types of furnaces?

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PART C

5 Marks

III. Answer the following questions in about a paragraph:

11. Write any five points about the purpose of Heat Treatment.
12. Mention the different process of Case hardening.
13. Describe about "Nitriding".
14. What are the materials used for quenching?
15. Write down the advantages of "Induction hardening".

f

PART D

10 Marks

IV. Answer the following questions in detail:

16. Explain about the process of "Pack Carburising" with neat diagram.
17. Explain about the process of "Cyaniding" with neat diagram.

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Chapter

6

FOUNDRY

SJCYC2

Learning Objectives

1. Students to know about the Foundry, using materials in Foundry , pattern materials, types of patterns, Moulding tools and Moulding sand.
2. To know about the classification, properties and types of moulding.

Table of Content

6.1 Introduction

Various manufacturing processes are available for producing a component with required shape. Casting is one the processes used for making component of complicated shapes in large numbers. The parts obtained by pouring the moulden metal into the mould cavity and solidification are known as castings. The processes of making required shape in moulding sand with the help of a patterns is known as moulding. The cavity produced by pattern is known as mould or mould cavity. The place where moulding, melting and casting are done is known as foundry.

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Foundry Work

6.2 PATTERN

Pattern is the model of casting. It is made of wood, metal or plastics. Mould is produced in moulding sand by using pattern.

6.3 PATTERN MATERIALS

The following materials are used for making patterns.

- Wood
- Metal
- Plaster
- Plastic
- Wax

Wood: Wood is widely used for making pattern. It is easy to work and readily available. Generally pattern is made from teak wood, mahogany, Pine and rose wood. The surface finish and life can be increased by applying metal coating on the wood pattern.

Metal: Metal pattern is used for producing large number of casting. Metal pattern is made by using a master pattern made of wood. Cast iron, Brass, Aluminium and white metal are commonly used for pattern making. Aluminium is the best metal for pattern making. Brass is suitable for small size patterns. White metal can be used for making patterns for complicated shapes.

Plaster: The gypsum cement is known as plaster. Pattern is made by pouring the mixture of plaster and water into the mould prepared by master pattern. It is used for making small patterns and core boxes.

Plastics: Plastic patterns are producing from a master pattern made of wood. The two types of plastics materials are used for pattern making namely, thermo setting and thermo plastics. Pattern made of thermo plastics used for producing less number of pattern. But Thermo setting plastics are used for large number of pattern.

Wax: Wax patterns are excellent for investment casting process. This pattern is produced from paraffin wax, shellac wax, bees wax, ceresinwax and micro crystalline wax. The liquefied wax is injected into a split die. Then the die is cooled and the wax pattern is taken out.

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6.4 FACTORS FOR SELECTING PATTERN MATERIALS:

The following factors are to be considered for selecting the pattern materials.

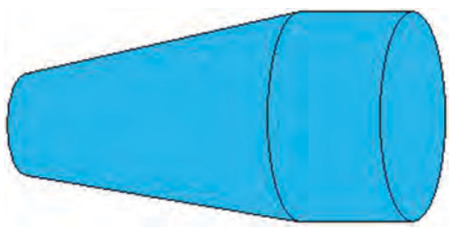
- Number casting to be produced
- Quality of the casting
- Size and shape of the casting
- The method of mould and casting
- Required surface finishing of casting
- Required accuracy of casting

6.5 TYPES OF PATTERNS

The following types of pattern are generally used in foundry.

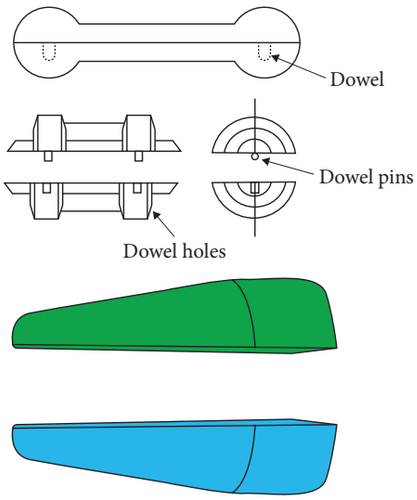
- Single Piece Pattern
- Split Pattern
- Match Plate Pattern
- Loose Piece Pattern
- Sweep Pattern
- Skeleton Pattern
- Segmental Pattern
- Shell Pattern

Single Piece Pattern: The pattern made of single piece without joints is known as solid pattern. This pattern is used for making small casting with simple shape. Solid pattern can be easily removed from the moulding sand.



Single Piece Pattern

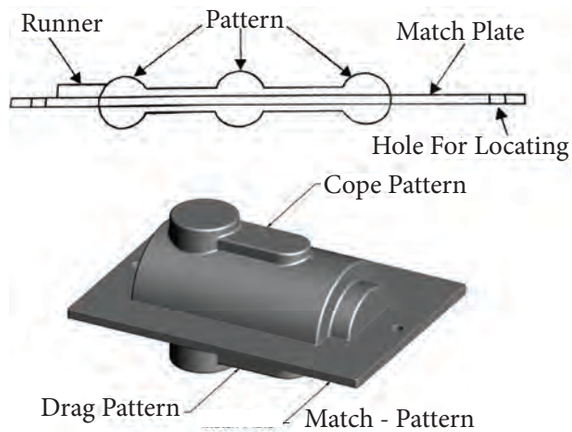
Split Pattern: Some patterns cannot be removed from the mould, if they are made



Split Pattern

in single piece. So, spilt patterns are used in that time. Split patterns are usually made of two parts. One part will make the lower half of the mould and the other part will make the upper half of the mould. These two parts are fixed correctly by dowel pins. Split pattern made in three or four parts are used for producing symmetrical casting such as cylinder, spindles, pipes, shaft etc.

Match Plate Pattern: This pattern has a match plate made of aluminium. split metal patterns are fitted on both sides of the match plate. one half of the pattern is fitted on one side of the match plate. The other half is fitted directly opposite on the other of the match plate.



Match Plate Pattern

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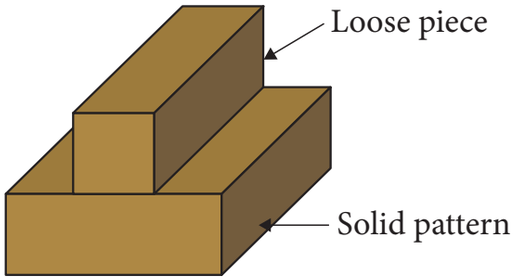
Loose Piece Pattern: Some patterns cannot be removed from the mould as single piece. So loose piece patterns are used with the solid



Loose Piece Pattern:

pattern for the easy removal. After moulding, the solid pattern is removed first, Then the loose pieces are removed without damaging the mould. This pattern is used for producing complicated casting of large size.

6.6 PATTERN MAKING ALLOWANCES

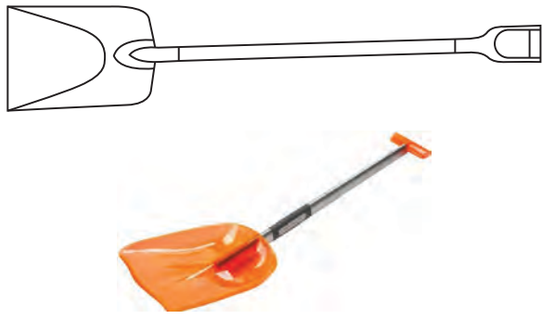
Patterns are made to correct size of the required casting. They are made slightly larger than the required casting. This extra dimension given to the pattern is called allowance. Pattern allowances are given to compensate the metal shrinkage, to avoid metal distortion, to withdraw the pattern easily from the mould.

- Shrinkage allowance
- Machining allowance
- Draft allowance
- Distortion allowance
- Rapping allowance

6.7 MOULDING TOOLS

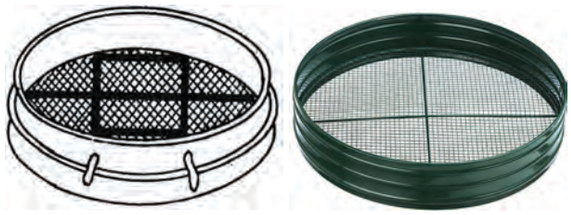
The following moulding tools are used in the foundry.

Shovel: Shovel has a broad metal blade with long wooden handle. It is used for mixing and transferring the moulding sand into moulding box.



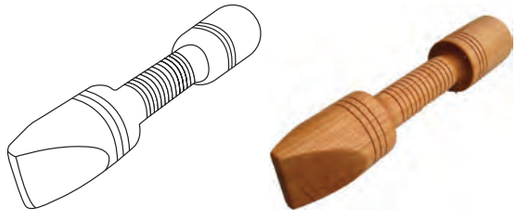
Shovel

Riddle: It has a circular square wooden frame with a wire mesh at the bottom. It is used to clean the mould sand by removing unwanted materials like nails, metal chips, stones, etc.



Riddle

Rammer: Rammer is used for packing or ramming the moulding sand in the moulding box. It is made of wood or cast iron. It has a butt end and a peen end. The butt end is in cylindrical shape and the peen end is in wedge shape.



Rammer

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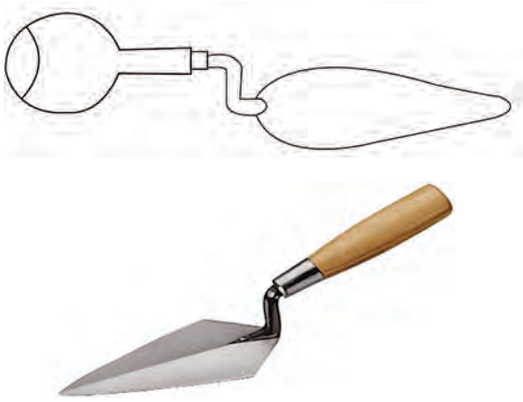
Trowel: It has as a metal blade fitted with a wooden handle. It is used to smoothen the mould surface and to repair the damaged portions of the mould. The end of the blade has square or round shape.

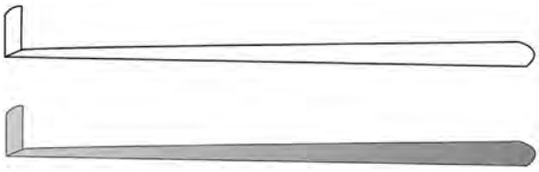


Trowel

Slick: It has two spoon like blades at the ends. It is used for finishing mould surface and for repairing the round corners of the mould.

Slick

Lifter: It is long steel plate with a twisted and bent end It is available with various lengths and widths. It is used to remove the loose sand from the mould and to repair the broken surface of the mould.



Lifter

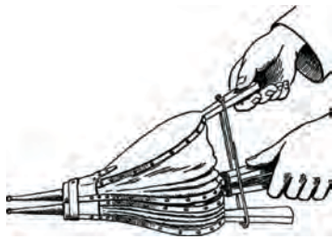
Strike Off Bar: It is made of wood or metal with straight edges. It is used for removing excess sand from the mould after ramming. This makes a leveled surface on the moulding box

Strike Off Bar

Sprue Pin: It is a cone shaped wooden piece. It is used for making holes for runner and riser in the mould. Sprue pins of different sizes are used for different size of mould.

Sprue Pin

Bellows: Bellows are used for blowing off loose sand particles from the mould.



Double Acting Bellows.
Two methods of Coupling shown

Bellows

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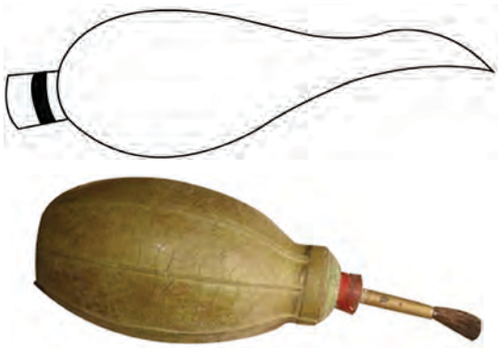
Swab: It is a small brush. It is used for applying small amount of water around the pattern before removing it from the mould. It is also used to give coating on the mould surface.



Swab

Gate Cutter: It is a steel piece with bent end. It is used for cutting gate in the mould. Gate connects the runner hole and the mould cavity.

Gate Cutter

Draw Spike: Draw spike is a long steel rod with a pointed or threaded end. The other end has a ring shaped head. It is used for removing the pattern from the mould.

Draw Spike

Vent Rod: It is a long thin steel wire with handle. It is used for making small holes on the mould. During casting, the steam and gases escape through these holes.

Vent Rod

Mallet: It is a hammer made of wood. It is used to fix the draw spike into the pattern by hammering

Mallet

6.8 MOULDING BOXES

It is also called as moulding flask. Moulding box is used to prepare Sand mould. It is a frame, made of wood or metal. It is box with both the bottom and top surfaces are opened. If the moulding is done with two boxes, the upper box is called cope and the lower box is called drag. The two box are aligned correctly with the help of dowel pin. If the moulding is done with three boxes, the middle box is called cheek.

The two types of moulding flasks are

- Snap Flask
- Tight or Box Flask

Snap Flask: It is used for preparing small size moulds in large number. It has

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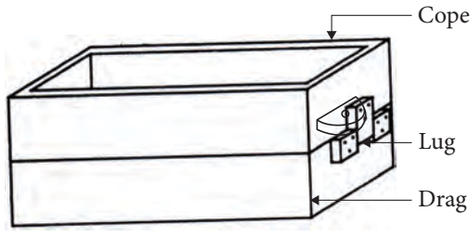
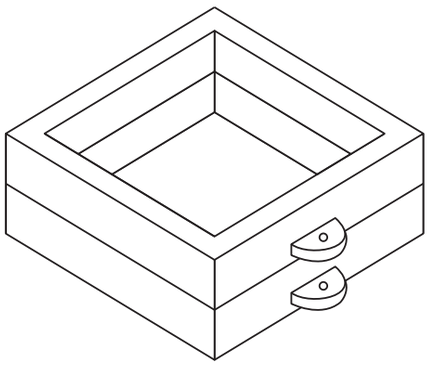
made with hinges and locks to open the flask easily after moulding. Number of moulds can be prepared by using one moulding box.



Snap Flask

Tight or Box Flask: It is used to prepare small and medium size moulds. The box cannot be separated from the mould after moulding. So it is also called permanent flask.



Tight or Box Flask

Moulding: The process of making mould is called moulding. It includes filling of moulding sand around the pattern, ramming, removing the pattern, making runner, riser, gate and vent holes.

Moulding Sand: Moulding sand is an important in foundry. It can withstand the high temperature of molten metal. It does not react with molten metal. It permits the gases and air to escape from the mould when the molten metal is poured. Due to these properties of moulding sand, it is used for casting.

Moulding Sand Ingredients

Moulding sand has the following ingredients

- Sand
- Binder
- Additive

Sand: Sand contains silica, clay and moisture. Sand has 80 to 90% silica which gives refractoriness. Sand contains 5 to 20% clay which gives binding strength. 2 to 3% of water is added with the sand to give moisture.

Binder: Binder is added with the moulding sand to obtain cohesiveness. Binder binds the sand particles together and given strength to the mould. The following three types of binders are used.

Clay Type Binders: Bentonite, Kalvanite are clay type binders.

Organic Binders: Wood, resin, linseed oil dextrin and molasses are organic binder.

Inorganic Binders: Portland cement and sodium silicate are inorganic binders.

Additives: Additives are added with the moulding sand to improve the

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properties like strength, permeability and refractoriness. The following three types of additives are used.

Reducing Agents: This type of additive prevent the formation of oxide. They fill up the fine pores in the mould surface. This improves the surface finish on the casting. Coal dust, fuel oil and sea coal are some reducing agents.

Fibrous Material: This type of additive prevent the formation of dry surface on the mould. It improves the collapsibility of mould. Wood flour, straw, cow dung, asbestos and saw dust are some fibrous materials.

Special Additive: Some special additive are added to improve the dry strength and collapsibility of mould. These additive also prevent quick drying of the mould. Dextrin and molasses are some special additives.

6.9 SAND INGREDIENTS - CLASSIFICATION OF MOULDING SAND

Moulding sand are classified as follows:

1. Natural Sand
2. Synthetic Sand
3. Special Sand

Natural Sand or Green Sand: Natural sand is available at river beds. It contains 80 to 90% silica, 5 to 10% alumina or clay and small amount of lime and magnesia.

Green Sand

Natural sand is used to make casting in ferrous and non-ferrous metals.

Synthetic Sand: Synthetic sand is prepared to obtain required properties by adding some ingredients with the natural

Synthetic Sand

sand. Bentonite, water, iron, oxide, calcium and magnesium are mixed with natural sand. Synthetic sand is used in machine moudling and high pressure moulding.

Special Sand: Special sands are prepared to obtain specific properties such as

Special Sand

refractoriness, high heat conductivity and low expansion. Good quality casting with fine surface finish can be produced by using special sands. The most widely used special sands are given below.

Oilvine Sand: It is in green color. It has medium refractoriness. It is used for producing non-ferrous castings of complicated shapes.

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Ziecon Sand: It is in cream color. It has high heat conductivity, good refractoriness and high density. It is used for making cores required for brass and bronze casting.

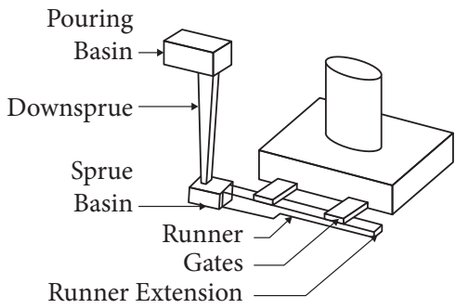
Chromite Sand: It has high heat conductivity and good refractoriness. It is used in chilled casting. It is also used as facing sand.

6.10 PROPERTIES OF MOULDING SAND:

A good moulding sand should have the following properties.

1. Porosity
2. Plasticity
3. Adhesiveness
4. Cohesiveness
5. Refractoriness
6. Collapsibility

6.11 GATING SYSTEM



Schematic diagram of a simple green sand mold together with the gatting system

Gating system consists of pouring cup, sprue, runner, gate and riser.

Pouring Cup: It is the funnel shaped portion on the top of the sprue note. Molten metal is poured easily through this cup.

Sprue: It is the hole which connects the pouring cup to the runner. Molten metal passes through the sprue to the runner.

Runner: Runner supplies molten metal from sprue to different gate.

Gate: It connects the runner and the mould. Molten metal enters the mould through the gate

Riser: It is a hole is the cope portion. After the mould is filling up, the molten metal rises into the riser. It supplies molten metal to the mould during shrinkage of casting and thus correct size casting can be obtained.

6.12 TYPES OF MOULDING:

The various types of moulding are follows:

1. Green Sand Moulding
2. Dry Sand Moulding
3. Loam Moulding
4. Bench Moulding
5. Floor Moulding
6. Pit Moulding
7. Sweep Moulding
8. Plate Moulding
9. Machine Moulding

SJGKZY

floor moulding

Green Sand Moulding: The process of making mould by using green sand is called green sand moulding. After the mould is prepared, the molten metal is poured into the mould for producing casting.

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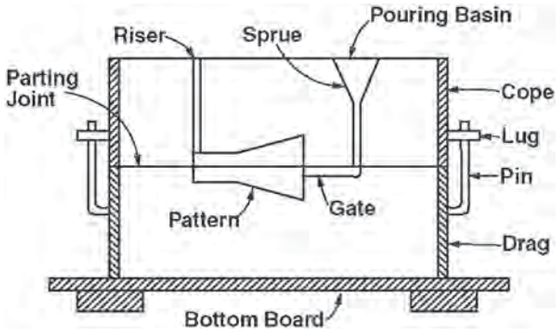

Green Sand Moulding

The following is the step by step procedure of making green sand mould using a split pattern.

1. One half of the pattern is placed on the moulding board.
2. Drag box is placed upside down on the board and parting sand is sprinkled over the pattern.
3. 20mm layer of facing sand is filled around the pattern. Then green sand is filled in the box.
4. Ramming is done uniformly by using rammer.
5. Excess sand is removed and levelled by strike off bar.
6. Vent holes are made. The box is tilted upside down.
7. The cope box and another half of the pattern are placed correctly. Parting sand is sprayed over the pattern.
8. The runner pin and riser pin are placed in the cope box at correct position. Then facing sand and moulding sand are filled.
9. Ramming is done uniformly. Vent holes are made.
10. Runner pin and riser pin are removed and pouring cup is made.
11. Cope and drag boxes are separated so as to remove the pattern.
12. Draw spike is driven into pattern pieces and shaken lightly in all direction. Then pattern pieces are withdrawn slowly.
13. Runner and gate are cut in drag portion.
14. Core is placed in the mould if necessary.
15. The cope and drag boxed are assembled in correct position and weight is placed over the cope. Now molten metal can be poured in the mould for producing casting.

Dry sand Moulding: Dry sand mould is obtained after heating the green sand mould. The procedure for making dry sand mould is same as that of green sand mould. The large moulds are heated by oxy-acetylene flame. Small moulds are heated in ovens.

Machine Moulding: Hand moulding is a slow process. It is suitable only for producing less number of casting. Ramming may not be done uniformly during moulding. Due to this, production time is increased. So machine moulding is best suitable for producing large number of similar castings. Accurate and better quality moulds can be prepared at faster rate by using machine moulding. The production cost is also reduced.

James Oliver
(August 28, 1823 – March 2, 1908) was an American inventor and industrialist best known for his creation of the South Bend Iron Work.

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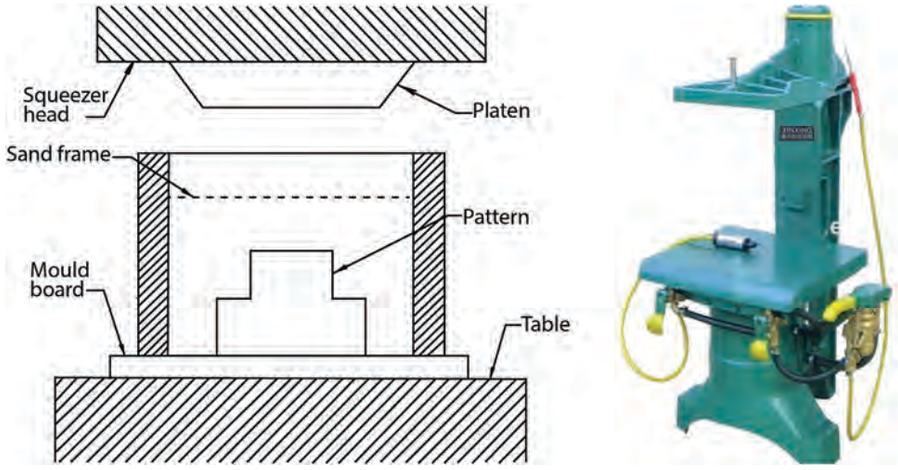

Top Squeezer Machine

Ramming the moulding sand, tilting the moulding box and removing the pattern from the mould are done by moudling machine. Generally, the following types of moulding machines are used.

1. Squeezer Machine
   a. Top Squeezer Machine
   b. Bottom Squeezer Machine
2. Jolt Machine
3. Sand Slinger

Squeezer Machine: In a squeezing machine, the sand in the moulding box is squeezed between the table squeezer machine.

Top Squeezer Machine: A moulding board and moulding box are placed on the table. The pattern is placed inside the moulding box. The sand frame is placed on the upper side of the box. Moulding sand is filled up in the box. The table is lifted up by using a table lifting mechanism. The plate in the squeezer head slightly presses the sand. The table comes to the starting position after the squeezing is over.

This machine is suitable for small moulds. In this method, the sand is rammed more densely on the top of the mould than around the pattern.

GLOSSARY

1. Pattern – மாதிரிவடிவம்
2. Mould – அச்சு
3. Casting – வார்ப்பு
4. Riddle – கம்பிவலை சல்லடை
5. Squeezing – அழுத்துதல்
6. Jolt – குலுக்குதல்
7. Slinger – வீசுதல்

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ACTIVITIES

1. Visit near the foundry and watch how moulding is performed.
2. Use clay and plastic container or box to make a moulded model.

QUESTIONS

SJLUDP

1 Mark

PART A

I. Choose the correct option :

1. This material is most used to making pattern
   a) Wood b) Metal
   c) Wax d) Plastic

2. Material is used to making a long life pattern
   a) Wood b) Thermosetting plastic
   c) Wax d) Casting

3. This instrument is used to clean the mould sand by removing unwanted materials
   a) Shovel b) Bellows
   c) Slick d) Riddle

4. The raw material of the moulding and is
   a) Wax b) Glass
   c) Sand d) Rubber

5. The process used to produce less number of mouldings
   a) Bench Moulding
   b) Floor Moulding
   c) Machine Moulding
   d) Sand Moulding

3 Marks

PART B

II. Answer the following questions in one or two sentences:

6) What are the materials used to make pattern?

7) What are the types of moulding boxes?

8) How do you choose the material used for making 'pattern'?

9) What is the use of 'Rammer'?

10) What are the types of 'Moulding Sand'?

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PART C

5 Marks

III Answer the following questions in about a page?

11) List out the moulding Tools?

12) Explain characteristics of 'Moulding Sand'?

13) List out the types of moulding?

14) What are the raw materials to make the moulding Sand?

15) Explain the parts of the 'gating System'?

PART D

10 Marks

IV. Answer the following questions in detail:

16) List out moulding tools and draw the neat sketch of any two and explain it?

17) Draw any two moulding boxes and give their uses?

18) Explain the methods of green sand moulding?

19) Write the types of moulding machine and explain any one with neat sketch?

20) List out the materials for making patterns and explain any two of it?

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Chapter

7

FASTENERS AND JIGS & FIXTURES

SJQH2L

Learning Objectives

1. Students to know about the fastners like nuts, bolts, washers, screws.
2. To know about threads and types and its uses.
3. To know about the nomenclature of threads.
4. To know about the key and key ways and its uses.
5. To know the design and creation of jigs and fixtures with regarding to job fitted with machine.

Table of Content

7.1 Introduction

- Fastener may be defined as a machine element used for holding or joining two or more parts of a machine or a structure. This process of joining the parts is known as fastening. Machines, vehicles, playthings are made by joining some spare part together.
- Bolt and Nut, screws, rivet, cotters, key and keyways, couplings, welding and soldering are materials which are used to assemble many machines and others.

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Table: Difference between Temporary Fasteners and Permanent Fasteners

Temporary Fasteners	Permanent Fasteners
Parts can be disassembled without damaging.	Cannot be disassembled, parts will be damaged
Parts which are worn can be replaced	Cannot be replaced
Assembling and disassembling are easy	Assembling and disassembling are very tough
Strength of this fastening is limited	Strength of this fastening is very strong
Less cost	More cost

7.2 TYPES OF FASTENERS

The fasteners are classified into two types depends upon whether the assembled parts can be dismantled or not.

1. Temporary Fasteners
2. Permanent Fasteners

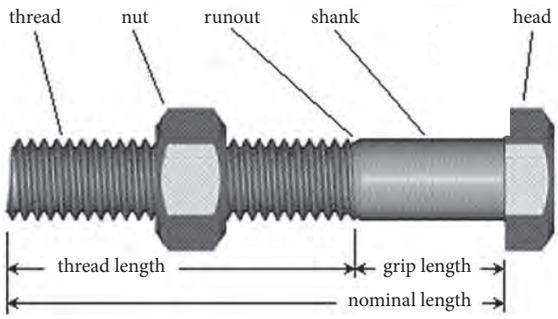
Temporary Fasteners: The temporary fasteners are these fastenings which can be disassembled without any damaging the connecting components.

Screws, bolts, nuts, studs, keys and couplings are some examples of temporary fasteners.

Permanent Fasteners: The permanent fasteners are those fastenings which cannot be disassembled without damaging the connecting components. Welded, riveted joints and soldered are some example for permanent fasteners.

BOLTS

A bolt is a threaded shaft which consists of two parts known as a shank and a head. The shank is cylindrical and is threaded at the tail end to sufficient length. The shape of the bolt head is used depending upon the purpose of the bolts.



Through Bolt

Some important types of bolts are

1. Through Bolt
2. Tap Bolt
3. Stud Bolt

Through Bolt: Through bolts are used to connect two parts which have unthreaded holes on them. The bolt is inserted in to the hole and the other end is tightened with a nut.

Through Bolt

Tap Bolt: A tap bolt differs from an ordinary bolt. The two parts to be connected, one is threaded hole and

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another one is plain hole. The bolt is screwed into a threaded hole without the nut, while it passes freely through a plain hole on the upper part.

Tap Bolt

Stud or Stud Bolt: Bolts that do not have an head is called as stud bolt. The center of the bolt may have a collar or square section. The stud is threaded at both ends. One end of the stud is screwed into a tapped hole of the parts to be fastened, while the other end receives a nut on it. It is used to cover the engine and pump cylinders, valves etc.,

Stud Bolt

NUTS

A element used with a bolt or a stud to join two or more parts together temporarily is known as a nut. Nut is a square or hexagonal shape having a threaded through hole. In order to ensure proper joint of the connection, a cotter pin is inserted into a hole made across the bolt diametrically.

Nuts

WASHER

A circular disc of a metal, having a hole in centre for inserting a bolt is known as a washer. It is placed below a nut to provide a perfect seating for the nut. The washer is generally specified by its hole diameter.

Washer

Uses of Washer

1. To provide perfect seating
2. The pressure applied on the nut is limited
3. If the hole is bigger than the head of the bolt, the washer is used

The washers are classified into two types as follows

1. Plain Washer
2. Spring Washer

Plain washer and Spring Washer

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7.3 THREAD

Threads are first developed by sir Joseph Whitworth of England in the year 1841. Threads are one of the several methods of fastening two or more components temporarily. A thread is a helical groove cut on the cylindrical surface of a round rod or a hole.

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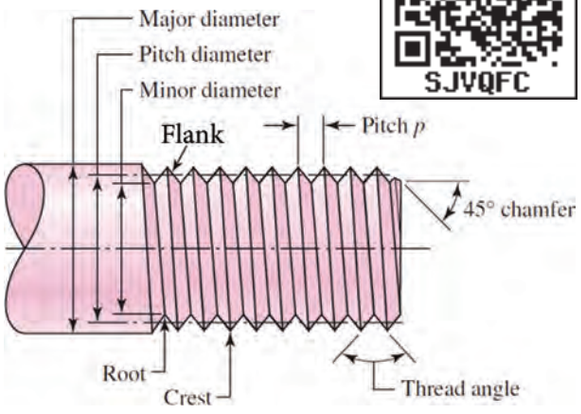


Nomenclature of Thread

Nomenclature of Threads

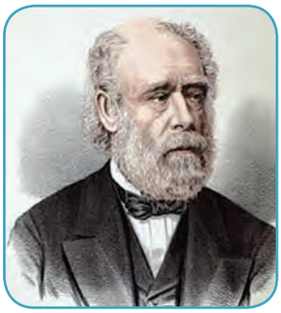
Major Diameter: This is the largest diameter of a screw thread, touching the crests of an external thread or the roots of an internal thread. A screw is specified by its major diameter.

Minor Diameter: This is the smallest diameter of a screw thread, touching the roots or core of an external thread(or) the crests of an internal threads.

Crest: It is the peak edge of the screw thread that connects adjacent the flanks of a thread at the top.

Root: It is the bottom edge of the thread that connects the adjacent flanks of a thread at the bottom.

DO YOU KNOW?



Joseph Whitworth was one of the greatest Victoria Mechanical Engineers. He is master of Screws.

Flank: The inclined flat surface of the thread which connects the crest and the root is called flank.

Depth of Thread: The depth of the thread is the distance between the crest and root which is measured right angle to the axis.

Pitch: Pitch is the distance measured parallel to the axis, between on one thread to the corresponding point on the adjacent screw threads.

TPI: Number of threads per inch in a screw is abbreviated as TPI.

Lead: It is defined as the distance which a screw moves axially in one complete rotation. Lead is equal to 1/TPI and is equal to pitch.

TYPES OF THREADS

Thread are classified into two types V-shape thread and square shape thread.

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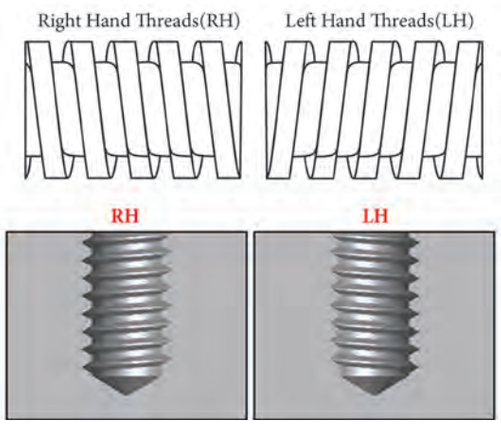
It is further divided into,

1. Right Hand Thread
2. Left Hand Thread
3. Single Start Thread
4. Multi Start Thread
5. External Thread
6. Internal Thread

Right Hand Thread: When the axis of the screw is horizontal, if the slope of the thread lines are towards right hand side, then the thread is called right hand thread. A right hand thread advances into a threaded hole when turned clockwise direction.

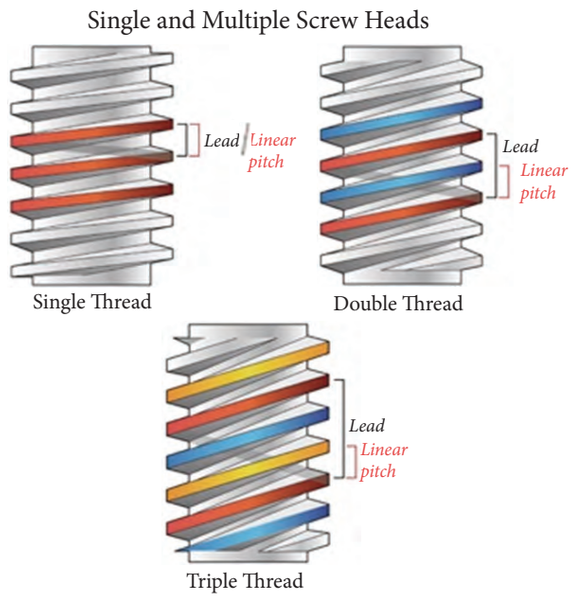
Left Hand Thread: When the axis of the screw is horizontal, if the slope of the thread lines are towards the left hand side, then the thread is called left hand thread. A left hand thread advances into the threaded hole when turned anti clockwise direction.



Right and Left Hand Threads

Single Start Thread: When only one helix forming the threads, run on a surface, it is called a single start thread only one starting point is seen on the beginning of the threaded portion. In a single start thread, the pitch is equal to the lead.

Multiple Start Thread: When two or more helices forming the threads run side by side on the cylindrical surface, it is called multiple start threads. Two or more than two starting points are seen on the beginning of the threaded portion. In double start thread, the lead is twice the pitch.



Single and Multiple Start Threads

USES OF THREADS

Multiple threads are used wherever quick motion is required and application of great force is not allowed.

APPLICATION

It is used in valves, power press screws and vice screws.

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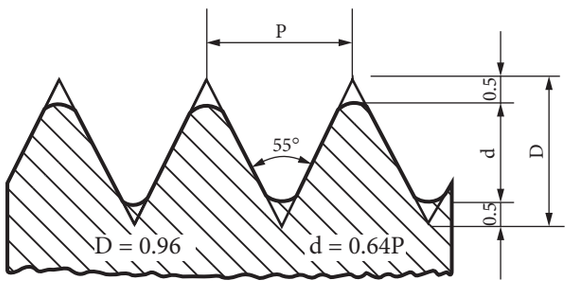
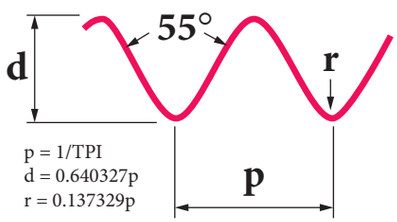
Forms of Threads:

1. British Standard Whitworth Thread (BSW)
2. British Association Thread (BA)
3. Metric Thread

British Standard Whitworth Thread (BSW): This form of thread is used as a Standard thread in Britain. It is the modified form of 'V' thread having angle of 55°. British Standard Fine (BSF) and British Standard Pipe (BSP) threads have the same profile of the BSW threads. It is widely used in machine parts. The British Standard threads with fine pitches (B.S.F) are used where more strength is required.

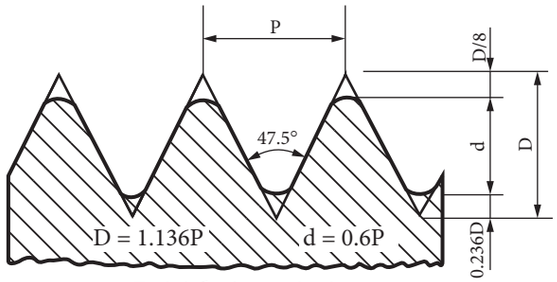


Whitworth Thread Form

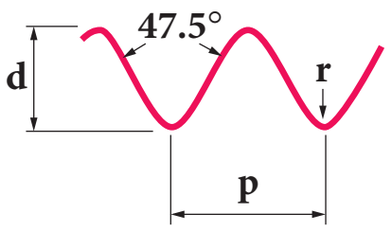


British Standard Whitworth Thread

British Association Thread (BA): The angle of BA thread is 47½°. It has fine pitches. This form of thread is generally used at precious instrument like micrometer and vernier caliper, etc… screw having diameters less than ¼ inch.

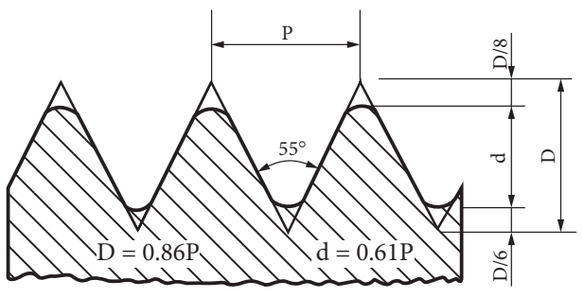


British Association Thread

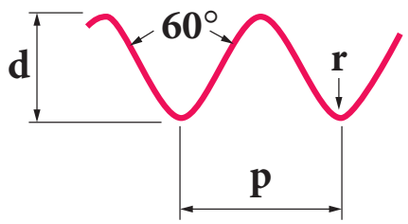


British Association Thread

Metric Thread: The angle of metric thread is 60°. It is an Indian Standard Thread and similar to B.S.W thread. This types of thread is mostly used in industries.



Metric Thread



British Metric Thread

Acme Thread: The angle of the thread is 29°. It is modification of square thread. It is stronger than square thread.

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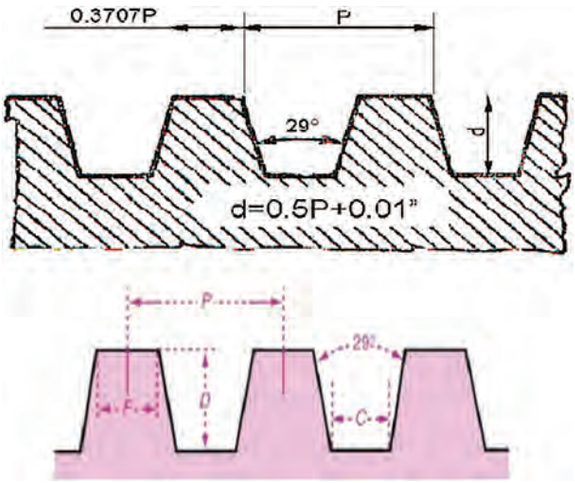


Acme Thread

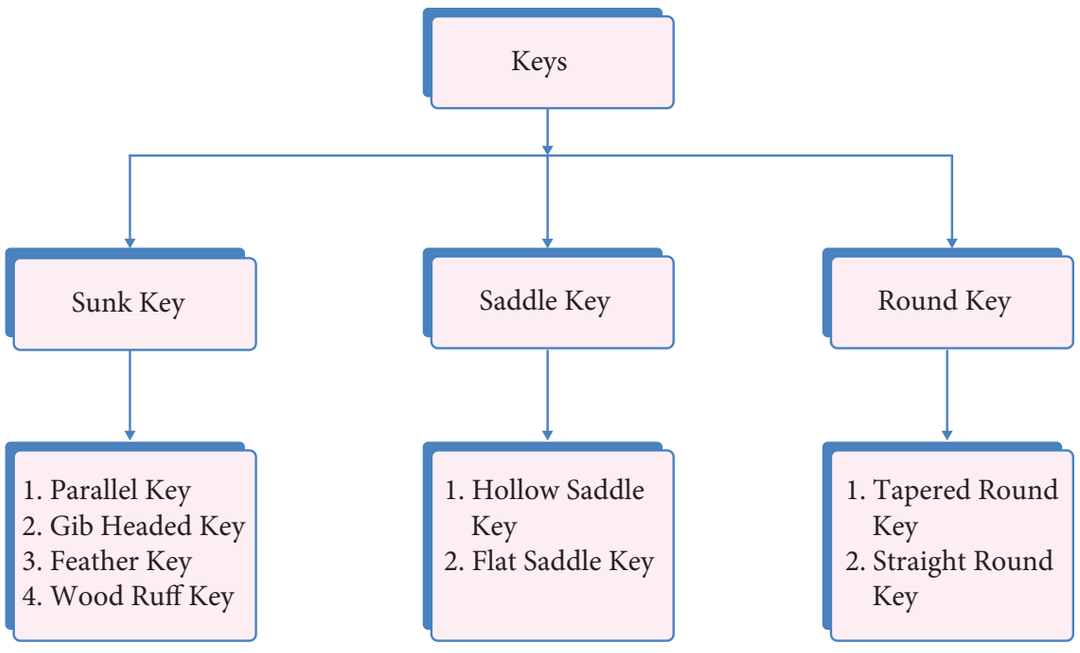
This type of thread is used in lathe lead screws and radial drilling machine etc..,

7.4 KEYS AND KEYWAYS

Keys are machine elements used to connect a shaft and the parts, such as pulleys, gears, couplings etc. so the shaft not only rotates but gears, (or) Flange also rotates which connected with shaft. It is subjected to shearing and torsion stresses, hence it is always made of steel.

Keys and Keyways

MIND MAP



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The groove cut on the shaft and the groove cut inside the pulleys, gears and flange. Which is parallel to their axis then it is called "key way".

Types of Key

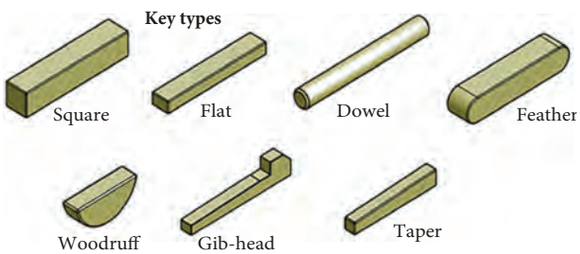
1. Sunk Key
2. Saddle Key
3. Round Key

Sunk Key

This is a standard form of key and it may be either rectangular or square in cross section. The two ends of the key may be square or round.

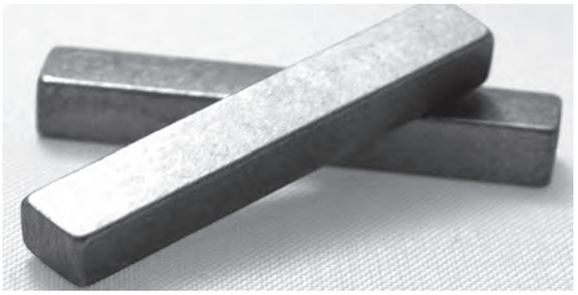
Types of Sunk Keys:

1. Parallel Key
2. Tapper Key
3. Gib Headed Key
4. Feather Key
5. Wood-Ruff Key



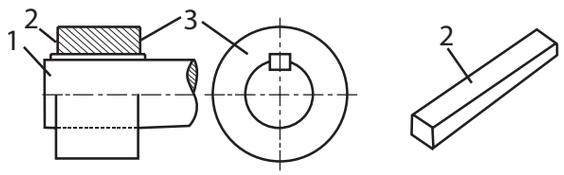
Types of Sunk Keys

Parallel Key: A parallel key is rectangular or square in cross-section and uniform in width and thickness, throughout its length. These keys are generally used where pulleys, gears or other similar parts are secured to the shaft permitting relative axial movement.



Parallel Key

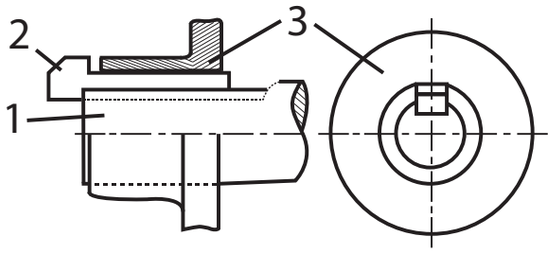
Taper Key: A taper key is uniform in width but tapered in thickness. The bottom surface of the key is flatted and the top surface is tapered. The magnitude of the taper is 1:100.



1. Shaft. 2. Tapper Key 3. Hub

Taper Key

Gib Headed Key: A taper key is generally removed by hammering at its thinner end, when that end is inaccessible. The key is usually provided with a head called gib-head which enable to remove the key. This type of key is used when the connected parts are to be separated occasionally for the purpose of repair.



1. Shaft. 2. Gib headed Key 3. Hub

Gib Headed Key

Feather Key: A Feather key is attached to one member of the pair, screwed to the shaft. Feather keys are parallel keys

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Feather Key

and permit relative axial movement of the pair. It may be rectangular, square, dovetail (or) rounded in cross-section.

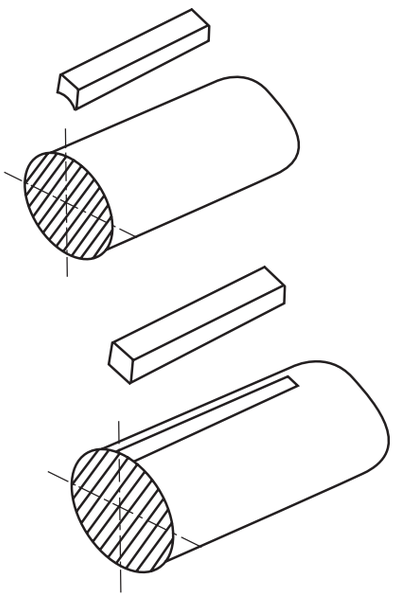
Saddle Key

The top of this key is fixed into the keyway of the hub. The bottom of the key is mounted on the shaft. There is no keyway in the shaft. Saddle keys are used for low power transmission.

There are two types of saddle key

1. Hollow Saddle Key
2. Flat Saddle Key

Hollow Saddle Key: A hollow saddle key has a concave shaped bottom to suit the curved surface of the shaft on which it is used. The keyway is only cut in the hub of the wheel. The relative rotation is prevented by the friction between the key and the shaft.



Hollow and Flat Saddle Key

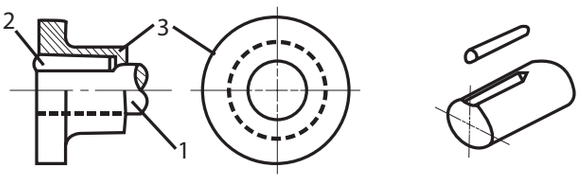
Flat Saddle Key: It is similar to the hollow saddle key except that the bottom surface of it is flat. It fits on the flat surface provided on the shaft. It gives more gripping than a hollow saddle key.

Round Key

Keys of circular cross-section are called rounded keys, usually tapered along the length. A round key fits in the hole drilled partly in the shaft and partly in the hub. It is generally used for light duty transmission of power.

There are two types of round keys.

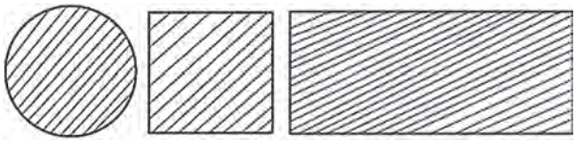
1. Tapered Round Key
2. Plain Round Key



1. Shaft 2. Round Key 3. Hub

Tapered and Plain Round Key

Faces of Keys: There are three types of key faces. The cross-sectional view of the key is as follows



Round Square Rectangle

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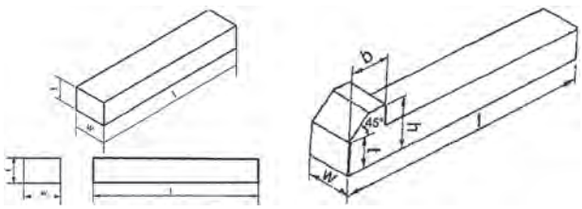
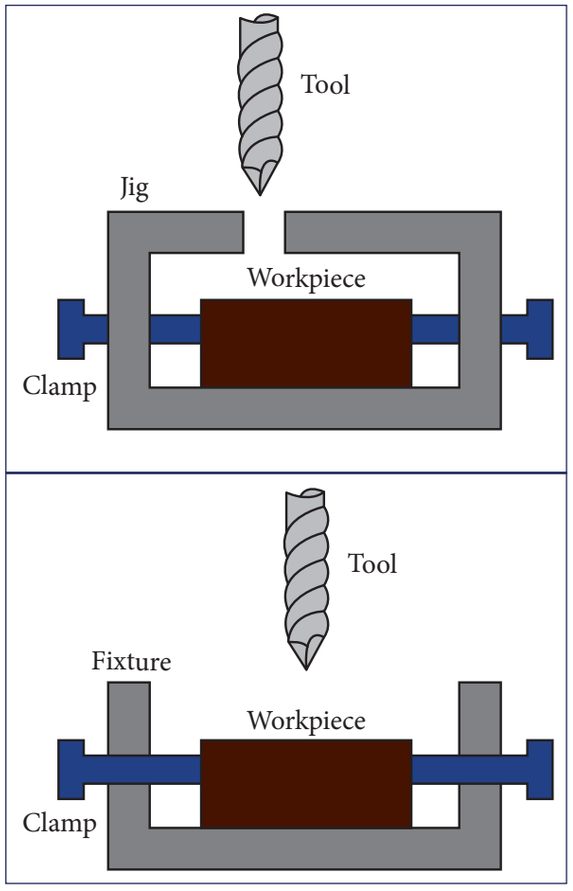
Important Dimension of a key

D - Diameter of the shaft
T - Thickness of the key
W - Width of the key
R - Radius of the key
L - Length of the key
d - diameter of the key
Taper Ratio is 1 : 100.



Dimension of Keys



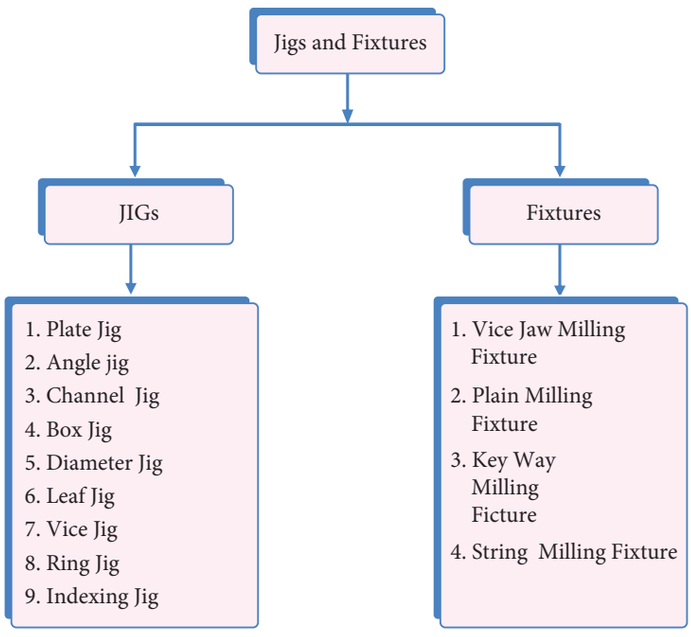
Jig and Fixture

7.5 JIGS & FIXTURES

Introduction

Some machining operations are quite easy. For example, in drilling machines, the job is held in correct position

MIND MAP



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by using vice for simple operations. No other special devices are required to hold and guide the tool for simple operations, but for some special work and production works, the tool must be guided and the job to be held in correct position by of special device. Such special device is called Jigs and Fixtures.

We must understand that the device which holds the job and guides the tool is called jig and the device which holds the job only in correct position is called fixture.

Purpose of Jigs and Fixtures

1. It is to provide repeatability and interchangeability
2. To get accuracy in the manufacturing products
3. To provide interchangeability for alternative parts to another one

JIG

Jig is a special device used to hold the work pieces and guide and Control the tools used in the machining process.

Important Parts of Jig

1. Jig Body
2. Jig Feet
3. Jig bush
4. Bush Plate (or) Jig Plate
5. Locators
6. Clamps

Types of Jig

1. Plate Jig
2. Angle Jig
3. Channel Jig
4. Box Jig
5. Diameter Jig
6. Leaf Jig
7. Vice Jig
8. Ring Jig
9. Indexing Jig

Plate Jig: This is the simplest type of Jig. It is a simple plate made to the shape and size of the work piece, with the required number of holes made on it. This plate Jig is mounted on the work piece and held rigidly. Then the work is drilled rapidly by passing the drill bit through the hole on the plate Jig.

Angle Plate Jig: It resembles as an angle plate. One side of the angle plate is fitted on the machine table. A plate is fixed parallel to the base, on the top of the angle plate. Drill bushes are attached to guide the drills on that plate. The work is

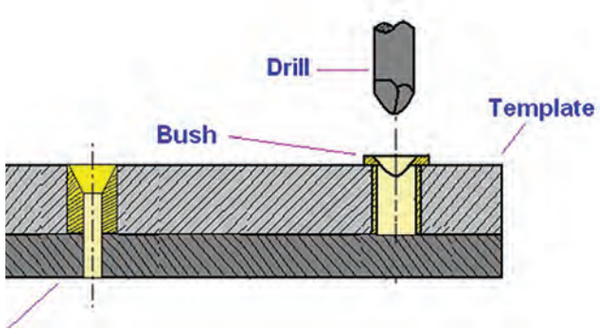

Plate Jig

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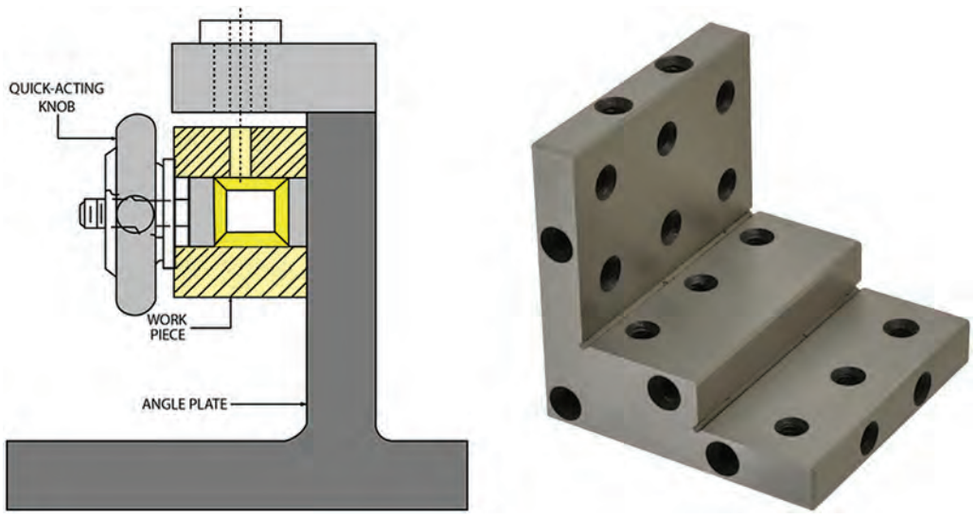
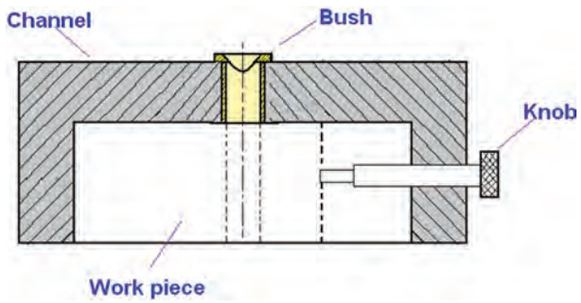


Angle Plate Jig

held and clamped on the vertical side of the angle plate, beneath the bush plate.

Channel Jig: The cut sectional view of this jig looks like a channel. The work is mounted in the channel and held firmly. The drill bit is passed through the drill bush and the work piece is drilled.

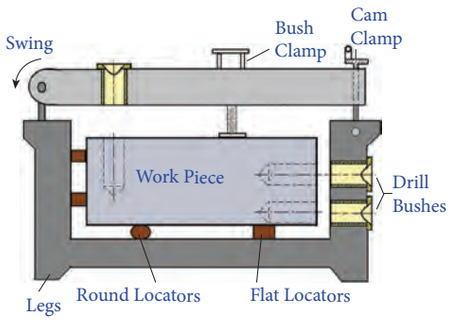


Channel Jig

Diameter Jig: The diameter Jig is hollow cylinder in shape and its top and bottom Surface is flat. This type of Jig is used to drill holes on cylindrical work pieces.

Diameter Jig

Box Jig: It looks like closed box. The work is completely enclosed inside the jig and clamped by using cam. The top of the box is having drill bush at the required locations. Holes are made by feeding the drill bit into the bushings. It is used to drill in small work pieces.



Box Jig

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Fixture: Fixtures are devices which hold and locate the work during inspection or in a production process. It does not guide the tool.

Important Parts of Fixture

1. Base
2. Setting Block
3. T-Bolt
4. Clamps
5. Locators

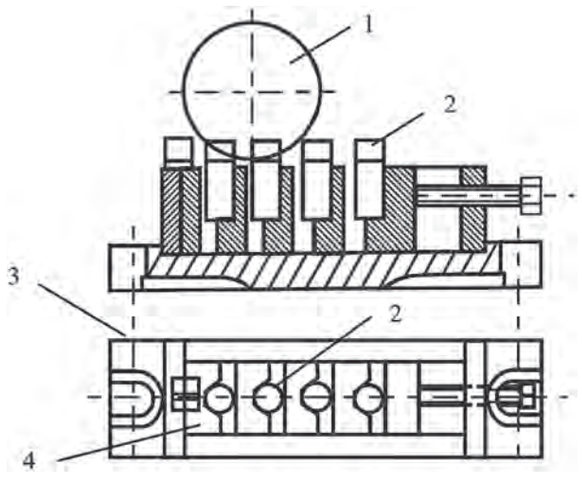
Types of Fixtures

1. Vice Jaw Milling Fixtures
2. Plain Milling Fixtures
3. Keyway Milling Fixtures
4. String Milling Fixtures

KEYWAY MILLING FIXTURES

This type of fixture is used to cut the keyway on cylindrical shaft at required place. The cylindrical shaft is mounted on 'V' block and tightened with the help of clamp. At a time, more than one cylindrical work pieces is fitted on this fixture and more than one milling cutter are fixed in milling machine relative to the work piece and then key way operation may be done on cylindrical work piece.

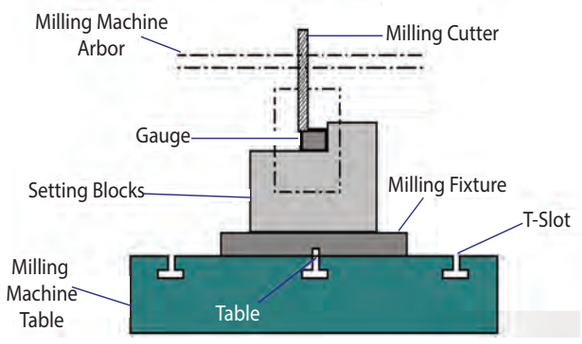
String Milling Fixture: This type of fixture is used to cut slot on the facing side of cylindrical job. Four cylindrical jobs are mounted on four V-blocks at a time in the string Milling fixture. Four slots are cut in facing side of cylindrical jobs by using milling cutters.The milling cutter is mounted with the help of setting block in milling machine.



1. Slot Milling Cutter 2. Work Pieces 3. Base 4. V-Block

String Milling Fixture

TO KNOW HOW TO SET THE CUTTING TOOL IN MACHINE



setting block

7.6 LOCATION AND LOCATORS

When the machining is done, it is necessary to hold and seat, the work piece in correct position on the machine table. The place, where the work piece is tightly fixed by using jigs and fixtures, is called location. The pins which support the work piece are called locators.

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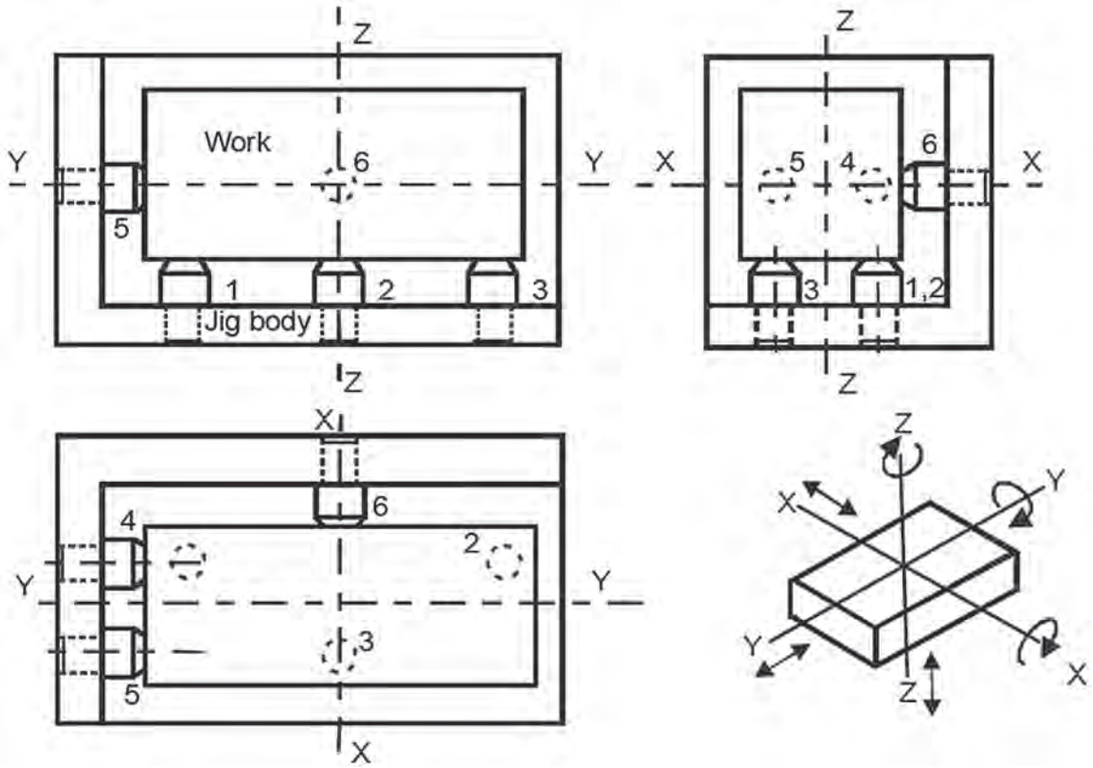

3-2-1 Location

3-2-1 LOCATION

3-2-1 location is also known as "six point location"

Let us consider a rectangular block is free from holding so the rectangular block may be moved into six directions through X-X, Y-Y and Z-Z axes, and it may also be revolved through these axes. Hence the rectangular block must be arrested to avoid these movements and located in correct position.

The rectangular block is fixed in Jigs & Fixtures. The bottom side of block is supported by three pins (1, 2, & 3) and backside by two pins (4, & 5) , and rear side by one pin(6).

The movement of this rectangular block is prevented as follows:

Pins	Prevented Movements	Numbers
1, 2 & 3	Z-Z axis movement Y-Y axis rotation X-X axis rotation	3
4 & 5	Z-Z axis movement Y-Y axis rotation	2
6	X-X axis movement	1
	Total	6 axis Moment

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7.7 DIFFERENCE BETWEEN JIGS AND FIXTURES

Sl. No.	Contents	Jigs	Fixtures
1.	Uses	This is used to hold the job and guide the tool	This is used to hold and locate the job
2.	Weight	This is light in weight	This is heavy in Weight
3.	Application	Jigs are used for Drilling, reaming and tapping operation	Fixtures are used in milling, shapping, grinding, planning and turning operation
4.	Holding Method	This is not fixed on machine table	This is fixed on machine table
5.	Advantages	Even unskilled workers can handle Jigs so handling cost is low	Only Skilled workers can handle the Fixture. So the holding cost is High

7.8 ADVANTAGES OF JIGS AND FIXTURES

1. Jigs and Fixtures are used in mass production with same size and shape.
2. It is not necessary to make marking and punching on every work piece.
3. The mounting time for the work piece is reduced.
4. The accuracy of the product is more because the work piece is located accurately in fixtures.
5. As the size and tolerance on dimensions are within specified limits, there is chance for interchangeability.
6. The cost on quality control becomes less.
7. Machining can be performed even by semi-skilled operator.
8. Due to rigid mounting of work piece in Jigs & Fixtures more cutting speed, feed and depth of cut may be given
9. As the machining process is safer, accidents are avoided
10. Workers are not getting tired, because work load is lesser when using Jigs and Fixtures.

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GLOSSARY

1. Fasteners – இணைப்புப் பொருட்கள்
2. Helical groove – சுருள் பள்ளம்
3. Pulley – கப்பி
4. Shaft – தண்டு
5. Jig – வழிநடத்தும் சாதனம்
6. keyway – சாவிபள்ளம்

ACTIVITIES

1. Collect different types of Bolts, Nuts, Washers, Keys.
2. Visit near machine shop and list out various types of jigs and fixturs used there.

QUESTIONS

SK5LGZ

1 Mark

PART A

I. Choose the correct option :

1. An example for Permanent fastener is
   a) Welded Joint
   b) Screwed Joint
   c) Keyed Joint
   d) Couplings

2. A screw or bolt is specified by its
   a) Major diameter
   b) Minor diameter
   c) Pitch diameter
   d) Pitch

3. The washer is generally specified by its
   a) Outer diameter
   b) Hole diameter
   c) Thickness
   d) Mean diameter

4. keys are made of
   a) Tungston
   b) Steel
   c) Cast Iron
   d) Lead

5. The Jig used to hold cylindrical work-piece is
   a) Box Jig
   b) Channel Jig
   c) Diameter Jig
   d) Angle Jig

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PART B

3 Marks

II. Answer the following questions in one or two sentences:

6. Definition 'pitch' of a thread?
7. Mention the types of sunk keys?
8. Write any three types of Jigs?
9. Mention the angles of following threads.
   a) BSW thread
   b) Metric thread
   c) Acme thread
10. Write any three parts of Jig?

PART C

5 Marks

III Answer the following questions in about a page?

11. Define "Temporary Fasteners" and "Permanent Fasteners" with examples?
12. Define 'Washer' and write its uses?
13. Draw the 'Plate Jig' and indicate the parts?
14. Define "Saddle key" and write its types only?
15. What do you know "Location and Locators"?

PART D

10 Marks

IV. Answer the following questions in detail:

16. Write the difference between Temporary fasteners and Permanent fasteners?
17. Draw and explain about "Box Jig"?
18. Draw any one of assembled view of the keys and explain about it?
19. Draw and mention the nomenclature of threads?
20. Discuss the advantages of Jigs and Fixtures?

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Chapter

8

STANDARDIZATIONS

SK995W

Learning Objectives

1. Students to know about the definition of standardization, interchangeability and fits.
2. To know about ISO, BIS and its activities.

Table of Content

8.1 Introduction

- When we manufacture a machine we need thousands of components. To accomplish this, various materials are used. The required parts are machined in various machines. In the olden days the conventional machine are used like lathe, drilling machine, shaping machine, milling machine, grinding machine etc. But now a days CNC, NC machines are used mostly to reduce the production time and cost with very high accuracy as they needed. Man power has reduced and machine power has increased to achieve the required quality of the components.
- The components accuracy depends on the machine accessories, tool materials and angles. But it is not always possible to keep exact measurement in mass

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production. If sufficent time is given, any operator would work and maintain the sizes with in a close degree of accuracy. Hence, tolerance were introduced, It helps to increase the production and to achieve the required fits. The same standards follow all over world which helps their sales internationally.

For Examples:

Bolts, Nuts, Threads, Keys, Studs, Washers, Tapers, Gears, Bearings and different sizes of plates and wires are available in standard sizes very easily. The production is also increased by reducing the cost. Then only the components are easily available sole everywhere. Trading from one country to another country is also increased.

8.2 STANDARDIZATION

Standardization is the process of implementing and developing technical standards based on the consensus of different parties that include firms, users, interest groups, standard organisations and governments. It helps to maximize compatibility, interperability, safety, repeatability and quality.

If any component is broken or to be changed due to wear and tear, it can be easily replaced by a new components by purchasing it from market. These parts are manufactured by following the quality, the accuracy of size and other standards strictly prescribed by the following organisations like ISO and BIS. This is called Standardization.

8.3 INTERCHANGEABILITY

Interchangeability parts, the ability to select components for assembly at random and fit them together within proper tolerances.The ability that an object can be replaced by another object without affecting code using the object.

In making mating parts in mass production, it is not always possible to maintain the dimensional accuracy of the parts. There are some variations in dimensions in few of the many number of products. Variations of sizes are within certain limits. Certain deviations are allowed to ensure Interchangeability of mating parts.

8.4 ADVANTAGES OF INTERCHANGEABILITY

1. The assembly of mating parts is easier.
2. The rate of waste in mass production becomes less.
3. It reduces assembly time and cheaper by employing unskilled worker.
4. Random assembly of components is possible.It reduces cost of production.

8.5 BASIC TERMINOLOGY IN INTERCHANGEBLE SYSTEM

Shaft: The shaft indicates the outer diameter of a cylinderical profile, but also

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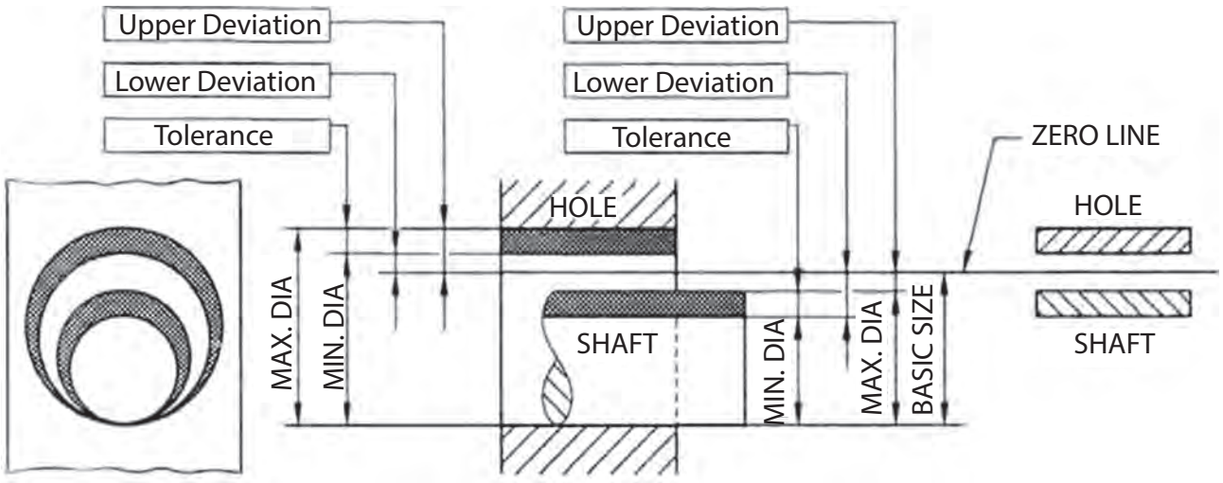

Basic Terminology In Interchangeble System

represents any external dimension of a component.

Hole: The hole indicates the inner diameter of a cylinderical hole but also represent any internal dimensions of a component.

Basic Size: Basic size of a dimension is the size in relation to which all limits of variations are determined. This is fixed up by designer considering its functional aspects without indicating any tolerance.

Actual Size: It is defined as the size of actually obtained by machining. It is found by measurement using measuring instruments.

Limits of Size: Limits are the two extreme permissible sizes of any dimension, the actual size should lies between these two limits of sizes.

Deviation: The algebraic difference between the actual size and its corresponding basic size is called deviation.

Upper Deviation: It is defined as the algebraic difference between the maximum limit of size and the corresponding basic size.

Lower Deviation: It is defined as the algebraic difference between the minimum limit of size and the corresponding basic size.

Zero Line: The deviations are always measured from basic size. Therefore, to represent limits and fits graphically, a straight line is drawn for basic size. This line is called zeroline because the deviation at the basic size is zero.

When zero line is drawn horizontally deviations above this line will be positive and below it will be negative. The sign + is added with positive and the sign – is added with negative deviations.

TOLERANCE

Tolerance is the difference between the maximum limit of size and minimum limit of size.

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There are two basic ways of specifying to tolerance

1. Unilateral Tolerance
2. Bilateial Tolerance

UNILATERAL TOLERANCE

In this system, the tolerance is allowed to only one side of the basic size. Parts manufactured will fall close to the desired dimension but can vary in only one direction.

Example

Component Size	Basic size	Maximum limit	Minimum limit
$20^{+0.02}_{-0.00}$	20.00mm	20.02mm	20.00mm
$20^{+0.00}_{-0.02}$	20.00mm	20.00mm	19.98mm

BILATERAL TOLERANCE

In this system, the tolerance is allowed to both sides of the basic size. One limit will be above basic size and other limit below the basic size.

Example

Component Size	Basic size	Maximum limit	Minimum limit
$35^{+0.02}_{-0.02}$	35.00mm	35.02mm	34.98mm

8.6 FITS

The relation between two parts where one is inserted into the other with a certain degree of tightness or looseness is known as fit.

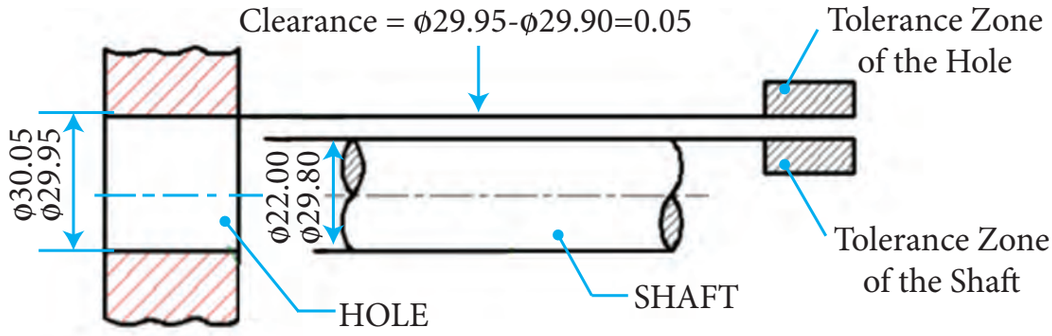
Types of Fits: Depending upon actual limits of the hole and the shaft, fit can be divided into three classes.

1. Clearance Fit
2. Interference Fit
3. Transition Fit

Clearance Fit: If a positive clearance exists between the hole and shaft, then it is called clearance fit. In this type of fit minimum clearance is always grater than zero. Such fits give loose joining and there will be some amount of freedom between the shaft and holes.

Example Bush bearings and channel bearings are fitted with clearance fit.

Interferance Fit: If a negative clearance exists between the hole and shaft, then it is called as "Interferance fit". In this type of fit, the shaft being larger than the hole. There are three grades of interferance fit namely,



Clearance Fit

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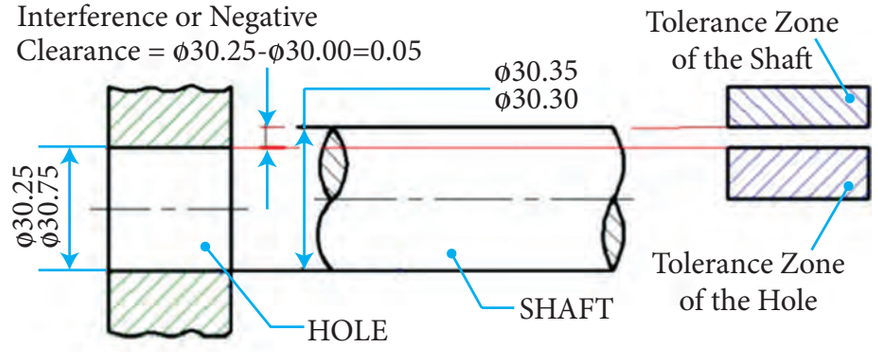


Interferance Fit

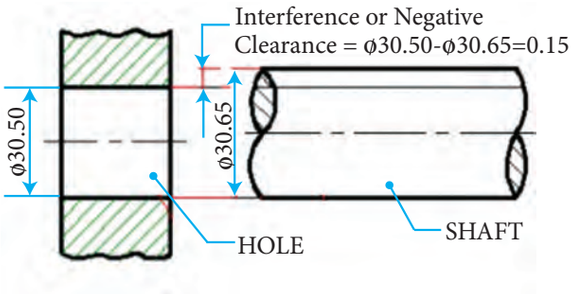
1. Shrink Fit
2. Heavy Driving Fit
3. Light Driving Fit

Shrink Fit: The parts with holes are heated to expand. In this condition, the shaft is inserted into the hole and the joint is rapidly cooled to have a strong fit. This is known as shrink fit.

Heavy Driving Fit: In heavy driving fit, a good amount of force is given to drive the shaft into the hole.

Light Driving Fit: It involves light force employed to insert the shaft into the hole.

Eli Whitney (December 8, 1765 – January 8, 1825) has inventing the idea of interchangeable parts.



Tranistion Fit

Transition Fit: If a positive clearance or negative clearance exists between the hole and shaft, it will be called transition fit. Transition fit may provide either a clearance or an interferance. In this fit tolerance zones of the holes and shaft overlap.

There are four types of transition fits

1. Force Fit
2. Tight Fit
3. Wringing Fit
4. Push Fit

HOLE BASIC SYSTEM

If the system of assembley of shaft and hole is consisting of basic hole, then the type of system is known as Hole basic system. It means for the system of assembly

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Henry Maudslay

(22 August 1771 – 14 February 1831) was a British machine tool innovator, tool and die maker, and inventor. He is considered a founding father of machine tool technology. His inventions were an important foundation for the Industrial Revolution.

of shaft and hole, the zero line will be lying on the minimum diameter of the hole as shown figure. For this system the lower limit size of hole is equal to basic size.

SHAFT BASIC SYSTEM

If the system of assembly of shaft and hole consisting of basic shaft, then that type of system is known as shaft basic system. It means for the assembly of shaft and hole, the zero line will be lying on the maximum size of the shaft as shown figure. For this system the upper limit size of shaft is equal to the basic size.

LIMIT SYSTEM

Limit system is important to keep limits and fits within desired limits. It has to be standardized to be able to produce components with interchangeability.

There are several organisations worldwide to ensure standardization. They are

1. International Standardization for Organisation (ISO)
2. Newall system
3. Indian Standard Institution (ISI)

8.7 INTERNATIONAL STANDARD ORGANISATION (ISO)

ISO is an International Standard setting body composed of representatives from various national standards organisations. It was founded on 23 February 1947. The organisation promotes worldwide proprietary, Industrial and Commerical Standards.

It's headquarters located Geneva at Switzerland.

In this system, Setout in BS 4005 – 1969, allows for 27 types fits and 18 grades of tolerance covering a size ranging from 0 to 3150 mm. In this system 27 possible holes are designated by capital letters A, B, C, D, E, F, G, JS, J, K, M, N,O, P, R, S, T, U, V, X, Y, ZA, ZB and ZC and the shaft by lower case letters, a, b, c, d, e, f, g, js, j, k, m, n, o, p, r, s, t, u, v, x, y, za, zb and zc.

The 18 grades of tolerance are designated by numerals

T01, T0, T1, T2, T3, T4,T5, T6, T7, T8, T9, T10, T11, T12, T13, T14, T15 and T16

For specifying a particular hole or shaft, it is to be written as the letter followed by the numeral.

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For example: H9 for a hole and d6 for a shaft.

8.8 NEWALL SYSTEM

The Newall system provides a range of clearance, transition and interferance fits for sizes upto 12". It is a hole basic system which stipulates two grades of holes, specified with bilateral tolerances, together with 6 grades of shaft tolerance. It has two grades of bilateral holes (A and B), two grades of press fit (F and D) one transition fit (p) and three clearance fits (Z, Y and X). Hole A is having higher accuracy than B and can be produced by precision reamers.

8.9 BUREAU OF INDIAN STANDARDS

The Bureau of Indian Standards (BIS) is the national standard body of India working under the ministry of consumer affairs, Food and public distribution, government of India. It is established by the Bureau of Indian Standard Act, 1986 which came into effect on 23 December 1986. The Bureau of Indian Standards (BIS), the national standard body of India, resolves to be the leader in all matters concerning standardization, Certification and quality in order to attain this.

This system of limits, fits recommended in IS 919 – 1963 comprises 18 grades of fundamental tolerance or grades of accuracy of manufacturing with designations. IT01, IT0, IT1, …….. IT16. The symbol IT denotes recommended standard tolerance. It also recommended 25 types of fundamental deviations indicated by letters, symbols for holes and shafts. Capital letters of A to Z for holes and small letter of "a to zc" for shafts.

Example

Ø40 H7/gb

It indicates

- Basic size is 40mm
- Hole basic system is adopted
- The tolerance grade of the hole is H7
- The tolerance grade of the shaft is gb.

GLOSSARY

1. Interchangeability – ஒன்றுக்கொன்று பொருந்துதல்
2. Tolerance – ஏற்கப்படும் அளவு வேறுபாடு

ACTIVITIES

1) Visit near industry and look out for sometime in the inspection department.
2) Take and assemble the same make and model of pen parts.

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QUESTIONS

SKI57J

1 Mark

PART A

I. Choose the correct option :

1. The system that enables parts of equivalent sizes with dimensional variation within certain limits to be fit operating is
   a) Limits
   b) Unilateral
   c) Deviation
   d) Interchangeability

2. If the size of the shaft is smaller than the hole size, the system of fits is
   a) Interference fit
   b) Clearance fit
   c) Driving fit
   d) Push fit

3. The fit which involves the shaft being driven into the hole with light force
   a) Light driving fit
   b) Heavy driving fit
   c) Shrink fit
   d) Tight fit

4. The algebraic difference between the actual size and its corresponding basic size is called
   a) Maximum limit
   b) Deviation
   c) Tolerance
   d) Minimum limit

3 Marks

PART B

II. Answer the following questions in one or two sentences:

5. Define 'Interchangeability'?
6. What do you mean by limits of size?
7. What is fit?
8. What is 'Basic Size'?
9. Write short notes on the types of deviations?
10. What are the difference limit systems?

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PART C

5 Marks

III Answer the following questions in about a page?

11. What is tolerance?

12. Explain the limit systems?

PART D

10 Marks

IV. Answer the following questions in detail:

13. Explain the terms used in interchangeability?

14. Explain the different types of fits?

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Chapter

9

TRANSMISSION OF POWER

SKNDKA

Learning Objectives

1. Students to know about the Transmission of power.
2. To know about the types of transmission of power like open belt and cross belt.
3. To know about the gear transmission and their types

Table of Content

9.1 Introduction

- A source of power is always needed in workshop processes particularly in cutting and forming of metals. Electricity as a means of conveying power to machinery is widely adopted. The electrical energy is converted into rotational energy by means of an electric motor and the machine converts the input of rotational energy into various forms useful work.
- It is the movement of energy from its place of generation to a location where it is applied to perform useful work.

9.2 Power Transmission

- Power transmission devices are very commonly used to transmit power from one shaft to another. Belt, chains and gears are used for this purpose. When the distance between the shafts is large, belts and ropes are used and for intermediate distance chains can be used. Gear drive is used for short distances.
- When power is transmitted by gears and chain , there is no slip in velocity ratio. It is called positive drive. When power is transmitted by a belt drive, there is always a possibility of some slip between the belt and the faces of the pulleys, so the character of motion transmitted is non-positive.

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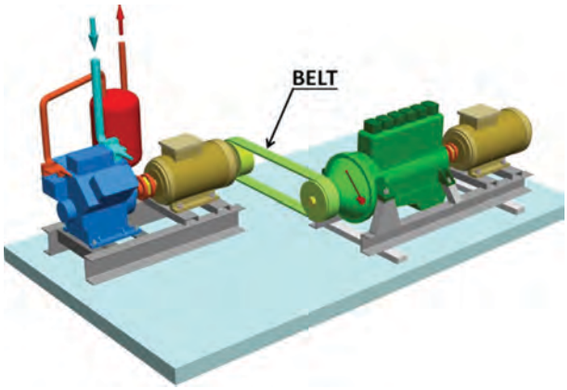


Transmission of Power

9.3 METHODS OF TRANSMITTING POWER

1. Belt drive.
2. Gear drive.
3. Chain drive.
4. Clutch drive.
5. Rope drive.

9.4 BELT DRIVE

Belt drive is one of the common methods of transmitting motion and power from one shaft to another by means of a thin inextensible band running over two pulleys.

In a belt drive arrangement, the shaft which transmits the rotational power is known as the driving shaft. The pulleys mounted on the driving shaft is known as driver (or) driving pulley. The shaft which receives the rotational power is known as driven shaft and the pulley mounted on it is known as follower or driven pulley. The transmission of power becomes possible because of the grip between the pulley and the belt. Belt drive is generally used in mills and factories.

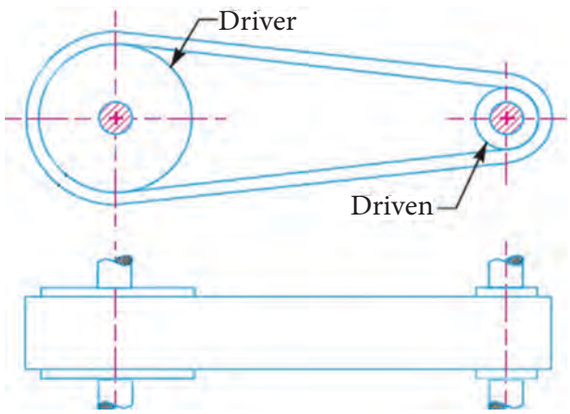
TYPES OF BELT DRIVES

The belt drives are divided into two types.

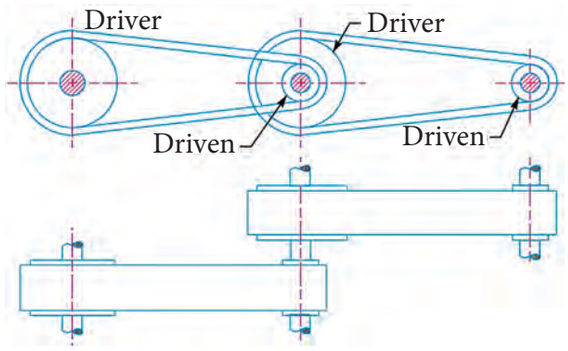
1. Openbelt drive.
   a) Simple belt drive
   b) Compound belt drive
2. Crossed belt drive.

OPEN BELT DRIVE

In this type of belt drive the belt is not crossed. The belt connects the top portions of the pulleys directly. The grip between the belt and the pulley is minimum. The driver and the follower rotate in the same direction.



Simple Belt Drive



Compound Belt Drive

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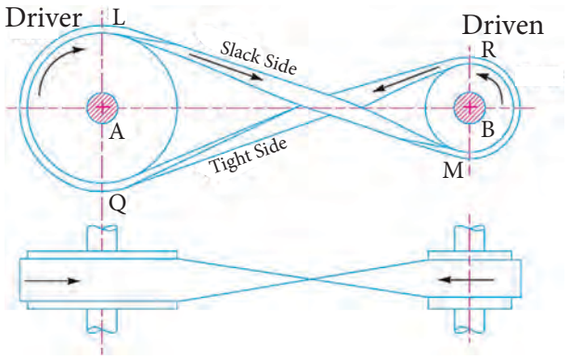
CROSSED BELT DRIVE:

In this type of belt drive, the belt is crossed between the pulleys. The belt connects the top portion of the driver with the lower portion of follower. The grip between the belt and pulley is greater because of the crossed nature of the belt. The pulleys connected by the cross belt arrangement rotate in the opposite directions. If the driver rotates in clockwise direction, the follower will rotate in the anticlockwise direction.

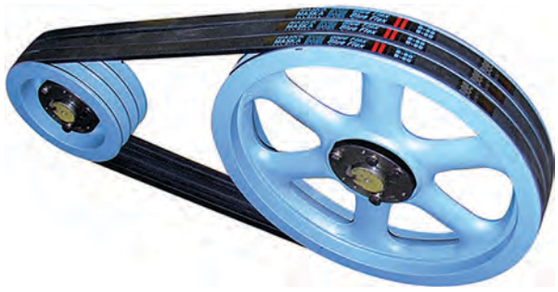


Crossed Belt Drive

TYPES OF BELT

Belt is usually made from leather, rubber and canvas thread in a moulded form. The two ends of a belt are connected by hooks and pins. Generally two forms of belts are used.

1. Flat belt.
2. V – belt



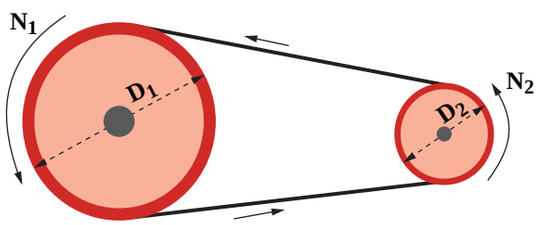
V-BELT

FLAT BELT
1. Cross section thickness 0.75mm to 5mm.
2. Transmission of power is low
3. Flat face pulleys are used
V- BELT
1. Cross section thickness 8mm to19mm.
2. Transmission of power is high
3. V-groove pulleys are used.

VELOCITY RATIO OF A BELT DRIVE:

Velocity ratio of a belt drive is the ratio of number of revolutions of follower to the number of revolutions of driver in a particular time.

If D_1 and D_2 are the diameter of driver and follower and N_1 and N_2 are the number of revolutions per minute of the driver and the follower.



$$\text{Velocity ratio} = \frac{N_2}{N_1} = \frac{D_1}{D_2}$$

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Though the theoretical value of velocity ratio is calculated as above, it differs from it because of the thickness of the belt and belt slip. These factors should also be taken into account in calculating the actual velocity ratio.

The speed of the shaft or the pulley is expressed in RPM (Revolutions Per Minute). If we want to increase the speed of the follower with respect to the driver, the pulley on the driven shaft should be smaller in size (diameter) than the pulley on the driving shaft. If we want to decrease the speed of the follower, the pulley on the driven shaft should be larger in size.

$$D_1N_1 = D_2 N_2$$

EXAMPLE 1

Pulley of diameters 360 mm and 60 mm are connected by a belt drive. Find the velocity ratio.

D_1 = 360 mm

D_2 = 60 mm

Driver pulley speed = N_1

Driven pulley speed = N_2

Driving pulley diameter(D_1) = 360 mm

Driven pulley diameter (D_2) = 60 mm

$$\text{Velocity ratio} = \frac{N_2}{N_1} = \frac{D_1}{D_2} = \frac{6}{1} = \frac{360}{60} = 6{:}1$$

Velocity ratio = 6:1

EXAMPLES 2

Two pulleys of diameters of 500 mm and 250mm are connected by means of a open belt drive. If the larger pulley rotates at a speed of 400 rpm in clockwise direction, find the speed and direction of rotation of the smaller pulley.

D_1 = 500 mm D_2 = 250 mm

N_1 = 400 rpm

Driving pulley diameter (D_1) = 500 mm

Driven pulley diameter (D_2) = 250 mm

Driver pulley speed N_1 = 400 rpm

Driven pulley speed N_2 = ?

$$D_1N_1 = D_2 N_2$$

$$N_2 = \frac{D_1N_1}{D_2}$$

$$= \frac{500 \times 400}{250}$$

N_2 = 800 rpm clockwise direction

EXAMPLE 3

Two shafts are connected by a belt drive. On one of the shafts, a pulley of 200 mm diameter is fitted and it rotates at a speed of 3000 rpm in anticlockwise direction. What should be the diameter of the driven pulley if it is to rotate at a speed of 1500 rpm in clockwise direction? What should be the type of belt driver?

D_1 = 200 mm D_2 = ?

N_1 = 3000 rpm N_2 = 1500 rpm

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Driving pulley diameter (D_1) = 200mm

Driven pulley diameter (D_2) = ?

Driving pulley speed N_1 = 3000 RPM

Driven pulley speed N_2 = 1500 RPM

$$D_1N_1 = D_2 N_2$$

$$D_2 = \frac{D_1 N_1}{N_2}$$

$$= \frac{200 \times 3000}{1500}$$

$$= 200 \times 2$$

D_2= 400 mm

The diameter of the pulley is 400 mm and the belt should be connected in cross belt method.

BELT SLIP

When power is transmitted through belt driver, the follower of the driver will not rotate at the estimated speed. It will rotate at a lower speed only. The main reason for this defect is slackness of the belt.

Belt slip is the difference between the distance covered by a point on the pulley and the distance covered by a point on the belt per minute. Belt slip is always expressed in percentage.

$$\text{Belt slip} = \frac{\text{Estimated speed} - \text{Actual speed} \times 100}{\text{Estimated speed}}$$

If D_1 and D_2 are the diameters of the pulleys and N_1 and N_2 are their speed in rpm and 'S' is the amount of belt slip in percentage.

$$\text{Velocity ratio} = \frac{N_2}{N_1} = \frac{D_1}{D_2} \times \frac{(100 - s)}{100}$$

EXAMPLE 4

A driving pulley of diameter 120 mm rotates at a speed of 400 rpm. The driven pulley of diameter 80 mm connected by a belt drive rotates at speed of 588rpm. Find the percentage of belt slip.

D_1 = 120 mm D_2 = 80 mm

N_1 = 400 rpm N_2 =?

Driving pulley diameter (D_1) = 120 mm

Driven pulley diameter (D_2) = 80 mm

Driving pulley speed N_1= 400 RPM

Driven pulley speed N_2 = ?

$$D_1N_1 = D_2 N_2$$

$$N_2 = \frac{D_1 N_1}{D_2}$$

$$= \frac{120 \times 400}{80}$$

$$N_2 = 600 \text{ RPM}$$

Estimated speed N_2 = 600 RPM

Actual speed N_2 = 588 RPM

The estimated speed of the driven pulley is 600 rpm. But it rotates at 588 RPM.

$$\text{Belt slip\%} = \frac{\text{Estimated speed} - \text{Actual speed} \times 100}{\text{Estimated speed}}$$

$$= \frac{600 - 588}{600} \times 100$$

$$= \frac{12}{600} \times 100$$

$$= 2$$

Belt slip = 2 %

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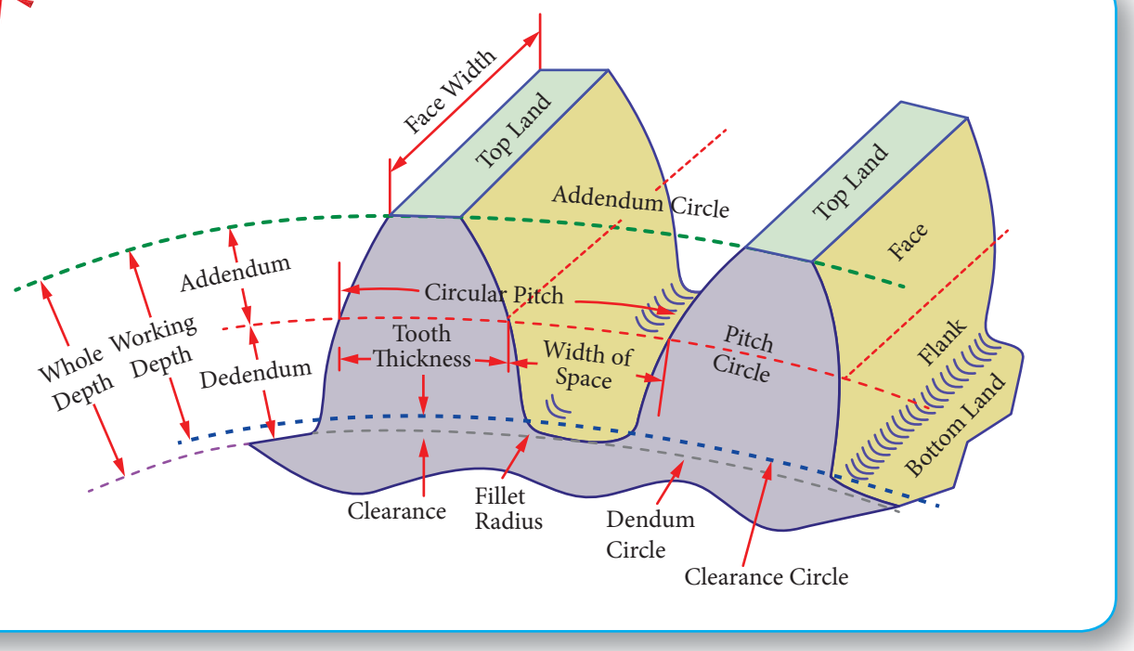
DO YOU KNOW?



Belt drive advantages and disadvantages

Advantages

1. Absorbs noise and vibrations
2. Protects from overload
3. Needs little maintenance
4. Allows misalignment (Parallel shafts)

Disadvantages

1. Speed ratio is not constant (Slip & Stretch)
2. Speed limited- 2000 m/min
3. Endless belts needs special attention to install
4. Belt may slip from Pulley while rotate

9.5 GEARS

Gears are used to transmit power between rotating parts to operate various machines. The power transmission is achieved without any slip. It is also advantageous in the sense that higher velocity ratio can be achieved in limited space. Only parallel shafts are connected by belt drive whereas parallel non-parallel and perpendicular shafts are connected by means of gears to transmit power.

FORMS OF GEARS

There are different forms of gears namely:

1. Spur gear.
2. Helical gear.
3. Bevel gear.
4. Rack and pinion gear.
5. Worm and worm gear.

1. SPUR GEAR

Spur gears have their teeth elements parallel to the rotating shafts. These gears are used to transmit power between parallel shafts. A small sized gear is called pinion.

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Spur Gear

2. HELICAL GEARS

If the teeth elements are twisted or helical, they are known as helical gears . These gears may be used for connecting shafts that are at an angle in the same plane or in different planes. They are smooth acting because there will always be more than one tooth in contact. Depending upon helix , the helical gears are classified as right hand type or left hand type.

Helical Gear

3. BEVEL GEARS

The power is transmitted between two shafts which are at right angles through bevel gears. It is in the shape of a truncated cone having all the teeth elements on the conical surface.

Bevel Gears

4. RACK AND PINION GEARS

This type of gear is used to convert rotary motion into linear motion or vice versa. The rack gears are straight and flat and have no curvature. This type of gear is used in lathe and drilling machine.

Rack And Pinion Gear

5. WORM AND WORM GEARS

Worm and worm gear are used to transmit power between two perpendicular shafts. Worm may be single threaded or multi threaded. The worm gear resembles

Worm and Worm Gear

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a spur gear. In this gearing the worm will always be the driver. This gearing is used where a large speed reduction is desired. It is useful in indexing head, rotary table and in the feed rod of lathe.

9.6 GEAR TRAIN

Gear drive is used where moderate to large amount of power is to be transmitted at constant velocity ratio. If the driving gear rotates in the clockwise direction, the follower will rotate in the anti- clockwise direction. The velocity ratio of a gear drive depends on the number of teeth present on the driving gear and the driven gear.

VELOCITY RATIO OF GEAR DRIVE

Velocity ratio of a gear drive is the ratio of number of revolutions of driven shaft or driven gear to the number of revolutions of driving shaft or driving gear in a particular time.

If N_1 and N_2 are the number of revolution of driver and follower and T_1 and T_2 are the number of teeth on the driving gear and the driven gear.

$$\text{Velocity ratio} = \frac{N_2}{N_1} = \frac{T_1}{T_2}$$

EXAMPLE 5

If a gear having 48 teeth rotates at a speed of 600rpm. In clock-wise direction, what will be speed and direction of rotation of a gear having 72 teeth which is in mesh with the first one ?

T_1 = 48 teeth T_2 = 72 teeth

N_1 = 600 rpm N_2 = ?

Number of teeth on the driving gear (T_1) = 48 teeth

Number of teeth on the driven gear (T_2) = 72 teeth

Number of rotational of driving gear (N_1) = 600 rpm.

Number of rotational of driven gear (N_2) = ?

$$\frac{T_1}{T_2} = \frac{N_2}{N_1}$$

$$N_2 = \frac{T_1 \times N_1}{T_2}$$

$$= \frac{48 \times 600}{72} = 400 \text{ rpm}$$

N_2 = 400 rpm Anti clock wise direction

SIMPLE GEAR TRAIN

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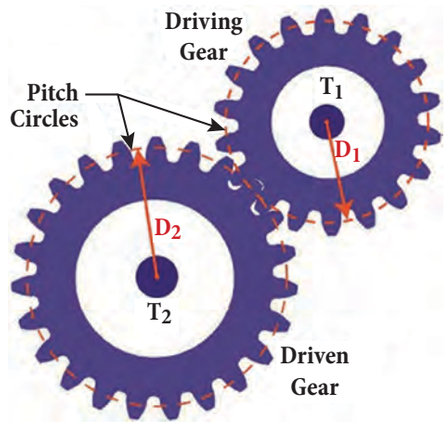
If a gear train is arranged by keeping only one gear on a shaft, it is called simple gear train. The net velocity ratio of the gear drive is determined by the number of teeth present on the first and the last gears of the drive. The intermediate gears of the drive using only to fill the gap between the driving shaft and the driven shaft, is called



Simple Gear Train

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Idle gear. It is also useful in changing the direction of rotation of the follower with out changing the speed.

In simple gear train, if the total number of gears are in odd number then the first and last gear rotates in the same direction

Example 6

Gears A,B,C and D are connected by a simple gear train. The number of teeth on them are 75, 45, 60 and 50. If the gear D rotates at a speed of 360 rpm in clock-wise direction, what will be the speed of the gear A.

T_1 = 75 teeth T_2 = 45teeth
T_3 = 60 teeth T_4 = 50teeth

Number of teeth on the driving gear (T_1) = 75 teeth

Number of teeth on the ideal gear (T_2) = 45 teeth

Number of teeth on the ideal gear (T_3) = 60 teeth

Number of teeth on the driver gear (T_4) = 50 teeth

Number of rotational of driven gear N_4 = 360 rpm

$$T_1 N_1 = T_4 N_4$$

$$N_1 = \frac{T_4 \times N_4}{N_1}$$

$$N_1 = \frac{50 \times 360}{75}$$

$$N_1 = \frac{2 \times 360}{3} = 240 \text{ rpm}$$

N_1 = 240 RPM Anti clock wise direction

COMPOUND GEAR TRAIN

If the gear drive is arranged by keeping more than one gear on a shaft , it is called compound gear train. The net velocity ratio of the gear drive is influenced by the intermediate gear also, so it is possible with a compound gear train to attain a higher velocity ratio in limited space. The direction of rotation of the follower with respect to the driver is determined by a number of intermediate gears on separate shafts.

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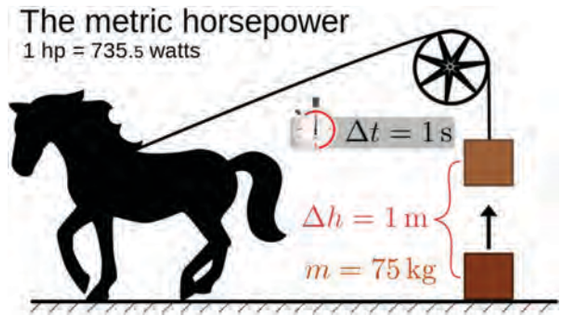
DO YOU KNOW?

Mechanical Horse Power
1 HP= 745.7 Watts



Horse power (hp) is a unit of measurent of power (the rate at which work is done). Two common definitions being used to day are the mechanical horse power or emperial horse power, which is 745.7 watts, and the metric horse power, whcih is apprximately 735.5 watts.

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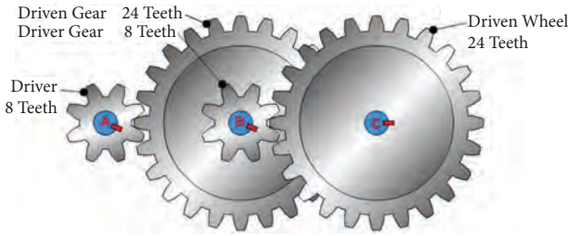


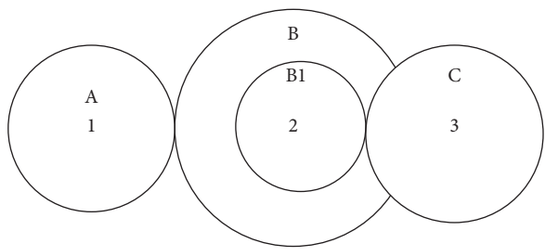
Compound Gear Train

Two gears mounted in the same shaft. So rotational speed are same. ($N_2 = N_3$)

Velocity ratio: $\frac{N_4}{N_1} = \frac{T_1}{T_2} \times \frac{T_3}{T_4}$

EXAMPLE 7

A compound gear train is arranged in which the driving shaft 1 and shaft 3 through intermediate shaft 2. The gear A on shaft 1 has 40 teeth which rotates at 900 rpm in clock wise direction. It meshes with a gear B of 80 teeth on shaft 2. This shaft has another gear with 50 teeth which meshes with a gear, C on shaft 3. what is the speed and direction of rotation of the gear on shaft 3 which has 60 teeth?



T_A = 40teeth T_B = 80teet T_C = 60teeth

N_A = 900rpm T_{B1} = 50teeth

Number of teeth on the driving gear (T_A) = 40 teeth

Number of teeth on the intermediate shaft gear (T_B) = 80 teeth

Number of teeth on the intermediate shaft gear (T_{B1}) = 50 teeth

Number of teeth on the driver gear (T_C) = 60 teeth

Number of rotational of driving gear (N_A) = 900 rpm

$$N_B = \frac{T_A N_A}{T_B}$$

$$N_B = \frac{40 \times 900}{80}$$

N_B = 450 RPM

Two gears (N_B and N_{B1}) mounted in the same shaft. So rotational speed are same.

$N_B = N_{B1}$ = 450 RPM

$$N_C = \frac{T_{B_1} \times N_{B_2}}{T_c}$$

$$= \frac{50 \times 450}{60}$$

= 375 RPM

N_C = 375 RPM Anti clock wise direction

Advantages of gears

1. By using gear train, large velocity ratio can be obtained with minimum space
2. Gears are mechanically strong, So higher loads can be lifted
3. They are used for positive drive, so its velocity ratio remains constant.
4. Gears require only lubrication, hence less maintenance is required.

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Disadvantages of gears:

1. They are not suitable for large velocities.
2. They are not suitable for transmitting motion over a large distance.
3. They have no flexibility
4. Gear operation is noisy.

ABSTRACT OF TRANSMISSION OF POWER

1. Methods of transmitting power	1. Belt drive 2. Chain drive 3. Gear drive
2. Transmitting motion of Belt drive	1. Belt Slip 2. Belt are used to distance between the connected shafts is high.
3. Transmitting power, chain and gears	1. No slip in velocity ratio 2. Chains are used to connect small gab between the shafts.
4. Velocity ratio without slips	Positive drive (Chain drive, Gear drive)
5. Velocity ratio with slip	Non – Postive Drive(Belt drive)
6. Shaft which transmits the rotational power is connected with electric motor. pulley	Driving PULLEY
7. Shaft which receives theRotational power is Known as driven shaft and Pulley mounted on it is Known as	FOLLOWER (or) DRIVEN PULLEY
8. The_____ between the Belt and the pulley	Grip
9. Open belt drive	The driver and the follower Rotate in the same direction
10. Cross belt drive	1. The driver and the follower rotate in opposite direction. 2. The grip between the belt and pulley is greater
11. Types of belt	1. Flat belt 2. V–belt
12. The thickness of a flat belt	0.75mm to 5mm
13. The efficiency of the flat belt	98%

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14. The thickness of the V_belt	8mm to 19mm
15. The efficiency of the V_belt	70% to 98%
16. Velocity ratio of a belt drive	$\frac{N_2}{N_1} = \frac{D_1}{D_2}$ D_1, D_2 are the diameter of driver and follower. N_1, N_2 are the number of revolutions perminute of the driver and follower.
17. Velocity ratio depends on	1. Thickness of the belt 2. Slip of the belt.
18. Belt slip (%) (s)	$S = \frac{\text{Estimated speed} - \text{Actual speed}}{\text{Estimated speed}} \times 100$
19. Velocity Ratio with considering slip	$\frac{N_2}{N_1} = \frac{D_1}{D_2} \times \left(\frac{100 - s}{100}\right)$
20. Spur gears	1. Gear teeths are parallel to the shaft axis. 2. These gears are used to Transmit power between Parallel shafts.
21. Helical gears	1. The teeth are inclined to the snaft axvis 2. They are smooth acting Because there will always engage More than one tooth in contact
22. Bevel gears	1. The teeth elements on The conieal surface. 2. The power is transmitted Between two shafts Which are at right angles Though bevel gears.
23. Rack and pinion gears	1. The rack gears are straight and flat and pinion are rotate. 2. This type of gear is used to convert rotary motion into linear motion or Vice versa
24. Worm and worm gears	1. worm may be single threaded or multi threaded. 2. This gearing is used where a large speed reduction. 3. Worm and worm gear are used to transmit power between two perpendicular (90°) shafts.
25. Two gears are rotates with each other	1. Driving gear rotates in the clockwise direction 2. The follower will rotate in the anti-clock wise direction.

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26. Velocity ratio of gear rive	$\frac{N_2}{N_1} = \frac{T_1}{T_2}$ T_1 and T_2 are the number of teeth on the driving gear and the driven gear. N_1 and N_2 are the number of revolutions of driver and follower
27. Simple gear train	1. If a gear train is arranged by keeping only one gear on a shaft 2. If the total number of gears are in odd number then the first and the last gear & rotates in the same direction.
28. Compound gear train	1. If the gear drive is arranged by keeping more than one gear on a shaft. 2. The net velocity ratio of the gear drive is influenced by the intermediate gear also.

GLOSSARY

1. Spur gear – நேர்பல்லிணை
2. Helical gear – நெளிவுப் பல்லிணை
3. Bevel gear – சரிவுப் பல்லிணை
4. Rack & Pinion – தட்டை மற்றும் சிறு பல்லிணை

ACTIVITIES

1. Make a open belt drive, cross belt drive and chain drive by using scrab material.

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QUESTIONS

SL1WAU

1 Mark

PART A

I. Choose the correct option :

1. Power is transmitted between shafts at moderate distance by
   a) belt drive
   b) gear drive
   c) chain drive
   d) frietion drive

2. The diameter of the driving pulley is 200 em. The velocity ratio of the drive is 4. The diameter of the driven Pulley is
   a) 100cm
   b) 25cm
   c) 40cm
   d) 50cm

3. Velocity ratio of a gear drive is
   a) $D_1N_1 = D_2N_2$
   b) $\frac{N_T - N_A}{N_T} \times 100$
   c) $\frac{T_1}{T_2} = \frac{N_2}{N_1}$
   d) RPM

3 Marks

PART B

II. Answer the following questions in one or two sentences:

4 Expand r.p.m

5. What are the types of belt drive?

6. Mention any two forms of gear?

7 What is an idle gear?

8 What is a bevel gear?

9. What are methods by which power can be transmitted?

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PART C

5 Marks

III Answer the following questions in about a page?

10. Explain velocity ratio?
11. Draw a simple gear train and explain.
12. Draw a compound gear and explain.
13. Explain power transmission by a belt drive.
14. Explain velocity ratio.
15. Draw a simple gear and explain.
16. Draw a compound gear and explain.

PART D

10 Marks

IV. Answer the following questions in detail:

17. Explain open belt drive with a diagram.
18. Crossed belt drive_draw and explain.

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Chapter

10

ELECTRICITY

SLASCH

Learning Objectives

1. To know about the basic electricity and Faraday's laws and Flemming Rules.
2. To know about the direct current and alternative current.
3. To know about the motor and starter and their types.

Table Of Content

10.1 Introduction

Electricity is a form of energy. Benjamin Franklin discovered about the electricity. Later on Thomas Alva Edison invented the electric light bulb and world has been brighten in 1879. It is used in Electric Lamp. Electric Cooker, Refrigerator, Air conditioner and Machines etc.

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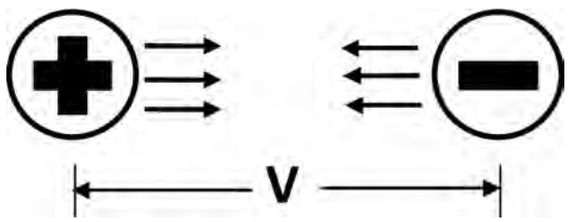
10.2 BASICS OF ELECTRICITY?

Electricity is one type of energy. All matters whether solid, liquid or gaseous consist of minute particles known as Atom. According to modern research electric current means electrons movement only.

Voltage

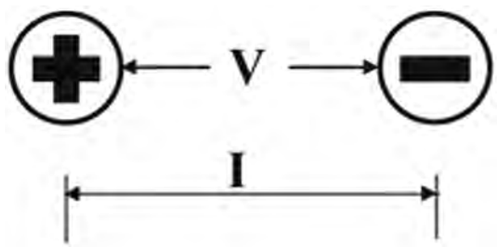
The electric pressure which is used to move electrons from one end to another end is called voltage. It is represented by the letter 'V' and the unit is volts. It is measured by voltmeter. Similarities to voltage are volt, emf, potential and potential difference.



Voltage

Current

Flow of Electron in a conductor is called current. It is represented by the letter 'I' and the unit is called ampere(A). Current can be measured by ammeter.



Current

Resistance

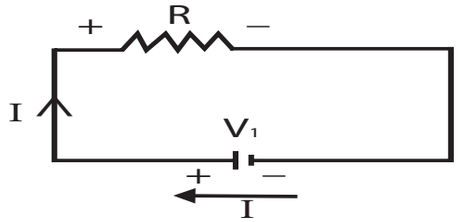
Resistance may be defined as the property of a substance which opposes the flow of current flowing through it. It is represented by the letter R and the unit is ohm(Ω). It is measured by ohm meter. Mega ohms value is measured by using meggar

Example: when compare gold to iron, gold has less resistance value. Resistance depends upon materials.

Also the resistance depends on the temperature of co-efficient of the material.

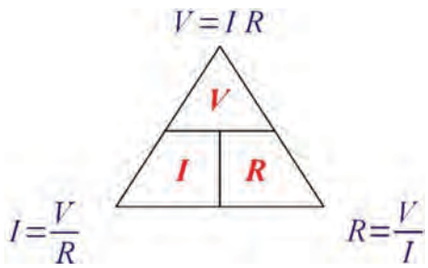
OHM'S LAW

Ohm's law states that, "In any closed circuit the current is directly proportional to the voltage applied and inversely proportional to the resistance of the circuit at a constant temperature".



i.e: I α V and I α 1/R from this

V= I × R and R=V/I



Where,

I = current,

V = voltage,

R = resistance.

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ELECTRIC CIRCUIT

The circuit is defined as the current flows from the supply points through the load to complete the path.

Types of circuits:

1. Series circuit
2. Parallel circuit

Series Circuit

When a circuit is made up of two or more resistance it is connected in series, it is known as series circuit.

$$V = V_1 + V_2 + V_3$$

$$R = R_1 + R_2 + R_3$$

I = same for all elements.

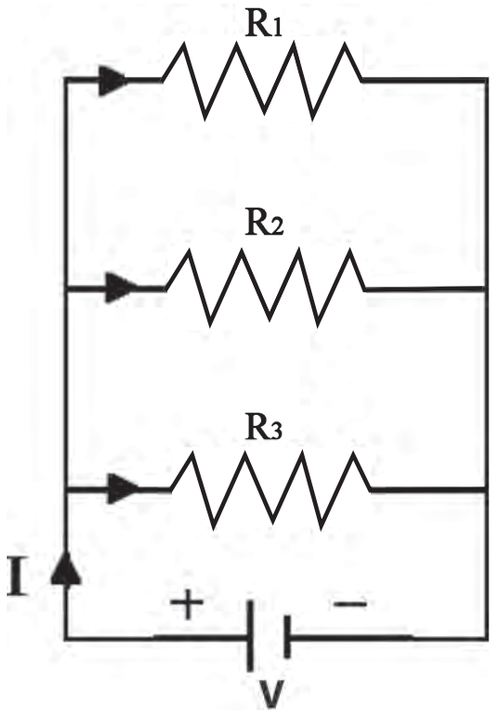
Parallel Circuit

When two or more resistances are connected parallelly to each other with same starting and ending points, this circuit is known as parallel circuit.

$$V = V_1 = V_2 = V_3$$

$$I = I_1 + I_2 + I_3$$

$$1/R = 1/R_1 + 1/R_2 + 1/R_3$$

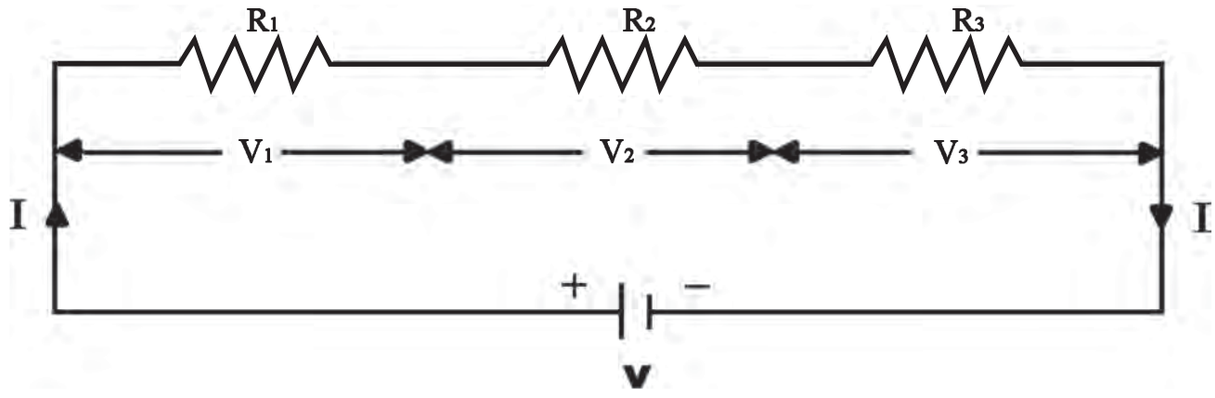


Parallel Circuit

10.3 MAGNETISM

Magnetism is a force field that acts on some materials. Physical device which possesses this force is called Magnet.

The force to attract iron is known as Magnetism. The substance which possesses magnetism is called Magnet. The materials attracted by magnet is known as Magnetic materials.



Series Circuit

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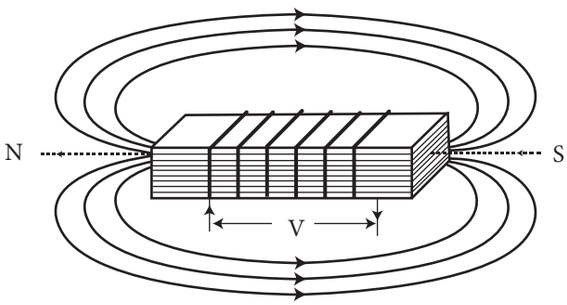
Electromagnetism

When a current is passed through a coil of wire, a magnetic field is setup around the coil. If soft iron bar is placed inside the coil of wire carrying current, the iron bar becomes magnetized. This process is known as electro magnetism.



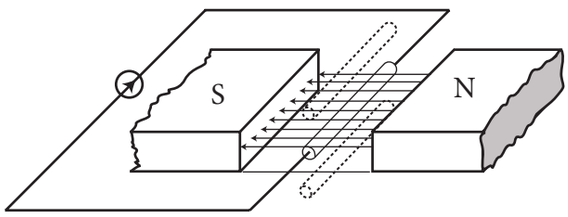
Magnetic Flux

Magnetic Flux

Magnetic flux is a group of lines of force crossing the space of a magnetic field. It is denoted by Ø. The unit of magnetic flux is weber in M.K.S system and Maxwell in C.G.S system.

Electro Magnetic Induction

The current is induced in a conductor when it is cut by a magnetic flux, it is known as Electro Magnetic induction. The current induced is known as Electro Motive Force (E.M.F). The e.m.f induced in the conductor depends upon the strength of the magnetic flux and the speed at which the conductor cuts the flux.



Faraday's Laws

10.4 FARADAY'S LAWS OF ELECTROMAGNETIC INDUCTION

First Law

Whenever any conductor is made to rotate in a magnetic field and hence to cut the magnetic lines of force or the flux, an electro motive force (e.m.f) will be induced in that conductor.

Second Law

The magnitude of the induced e.m.f is directly proportional to the rate of change of flux linked with the conductor.

Direction of E.M.F

The relation between the directions of the motion of conductor, the induced e.m.f and the magnetic flux can be explained by Flemming's right hand and left hand rules.

10.5 FLEMMING RULES

Flemming's Right Hand Rule

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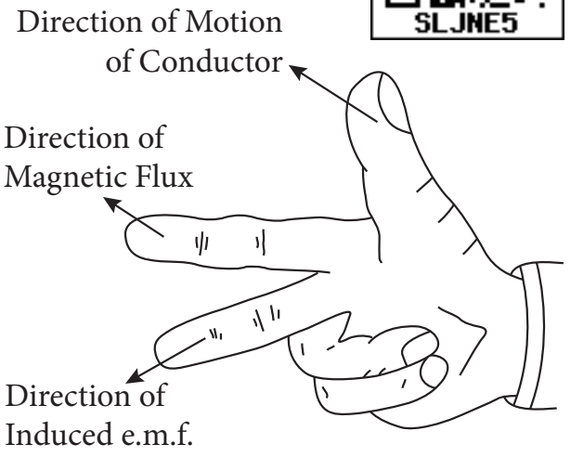

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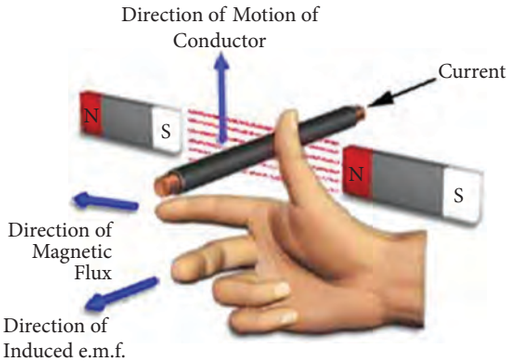

Flemming's Right Hand Rule

If we stretch the thumb, forefinger and the middle finger of the right hand mutually at right angles to each other and the thumb indicates the direction of motion of the conductors and the fore finger in the direction of the magnetic flux, then the middle finger indicates the direction of induced e.m.f.

Flemming's Left Hand Rule

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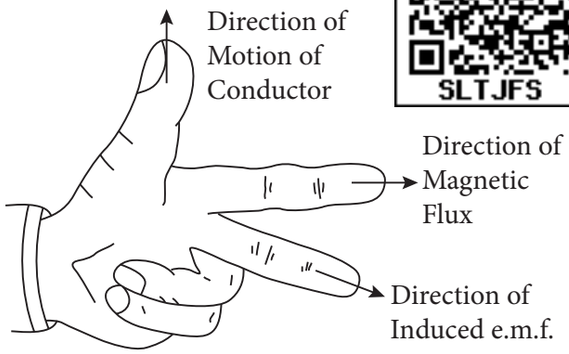
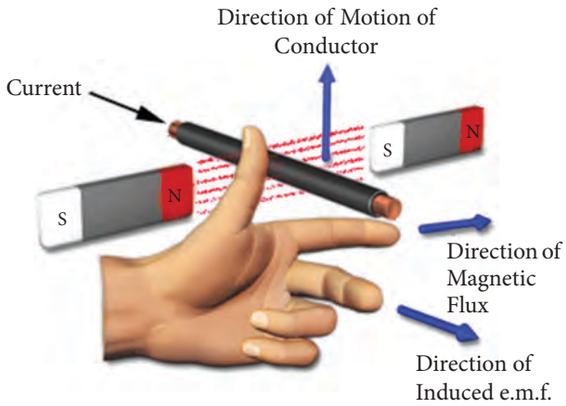




Flemming's Left Hand Rule

If we stretch the thumb, fore finger and the middle finger of the left hand mutually at right angles to each other and the forefinger indicates the direction of the magnetic flux and the middle finger is in the direction of induced e.m.f then the thumb indicates the direction of motion of the conductors.

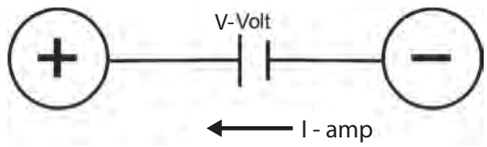
CURRENT

Types

1. Direct Current (D.C)
2. Alternative Current (A.C)

D.C FUNDAMENTALS

D.C means direct current and it is available from positive terminal (anode) and negative terminal (cathode). Current flows as electrons from negative potential to positive potential. D.C is generally produced by chemical processes as in batteries. D.C generators are used for generation of high capacity current. The current flows only in positive direction.



D.C Current

A.C FUNDAMENTALS

A.C means alternative current. Magnitude, direction of current and voltage alternate continuously. The flow of current changes direction periodically.

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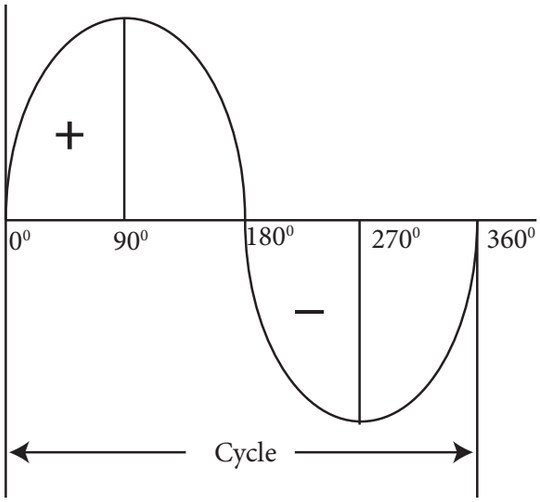

A.C Current

Differences Between D.C and A.C Systems

D.C systems	A.C systems
(+) ⊣⊢ (–)	P ~ N
• The voltage increases from "0" to higher potential	it has instantaneous potential referred to V_m and instant of phase angle with RMS.
• It is direct current system	It is alternating current system
• There is no frequency	It has the frequency in the system
• The current will be spend only when connected to load	It has the reactive load with resistance, inductance and capacitance (RLC load)
• It is only one voltage system	It has multiple phase system with three phase star, three phase delta and single phase system.
• It has the polarity system	There is no polarity in the system.

10.6 ELECTRICAL EQUIPMENTS

Introduction

Electricity is a form of energy. It occupies an important place in our daily activities in life and business. One cannot see electricity but can feel the effects of it. One should not have a direct contact with it as it may cause damages.

Electricity is being used for everything from providing light and other facilities to our household to latest space research. The contributions made by American scientists like Benjamin, Thomas Alwa Edison and Michael Faraday of England are immeasurable.

10.7 MOTOR

A motor is a device used to convert electrical energy into mechanical energy. Different types of motors are used according to their usage and the place in which they are used.

Types of Motor

1. D.C Motor (Direct current Motor)
2. A.C Motor (Alternative Current Motor)

A.C Motor

1. Three phase induction motor
   a) Squirrel - gauge induction motor
   b) Slip ring induction motor
2. Single phase induction motor
   a) Split phase induction motor
   b) Capacitor induction motor
   c) Repulsion motor
   d) Shaded pole motor.

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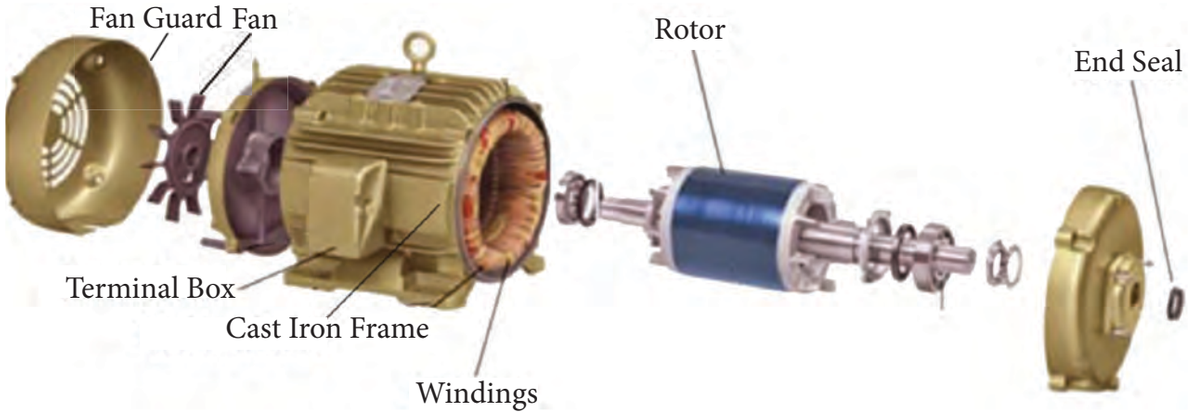
Parts of electrical induction motor



Parts of Electrical Induction Motor

Three phase induction motors-the principle of working

When the three phase supply is supplied to three phase windings placed 120° apart inside the stator of an induction motor, a constant rotating magnetic field is induced.

It induces e.m.f in the conductors of the rotor known as armature. According to Lens' law, we know that when an e.m.f is induced in a circuit electromagnetically, the current setup always opposes the motion or change in the current which produces it

Construction of a Induction Motor

The main parts of a induction motor are

1. Stator
2. Rotor.

Construction of a Induction Motor

Stator

It is made of thin sheets arranged as tube. The laminated core has slots cut longitudinally on it parallel to the axis. It is wound for two, four, six, and eight poles depending on the required speed.

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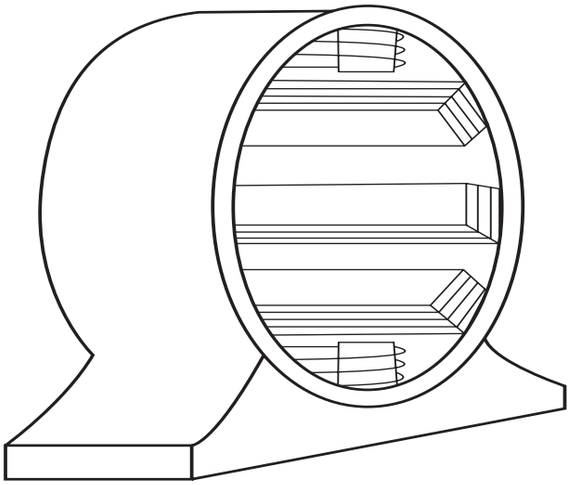
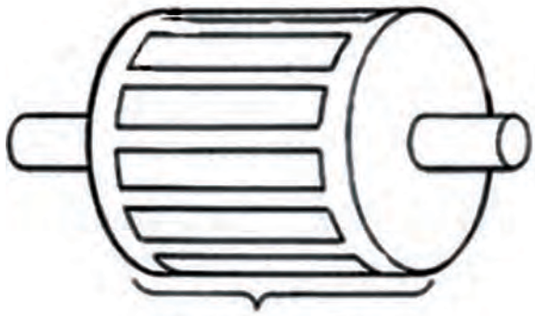


Stator



Rotor

Rotor

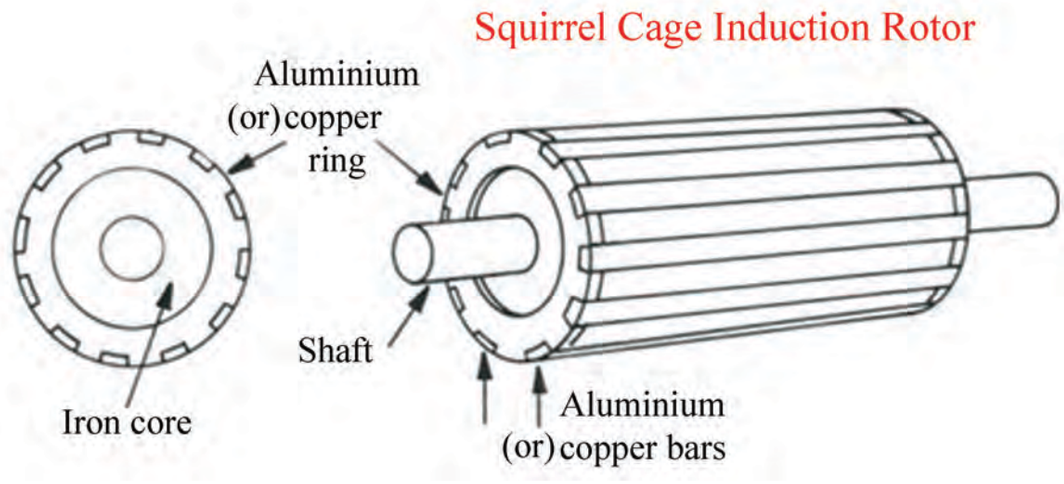
Based on the construction of the rotor, the three phase induction motor can be classified as

1. Squirrel cage induction motor
2. Slip ring induction motor

Construction of a Squirrel Cage Induction Motor

The rotor of a squirrel cage motor is made of cylindrical laminated core with small openings. These openings receive insulated conductors. The openings are formed parallel to the axis. So, the motor starts to run with a uniform rotating torque. Humming is reduced to a great extent. One bar is placed in each slot and all the bars are short circuited by two end rings. This makes a complete squirrel cage rotors.

There are two types of squirrel gauge induction rotors,



Squirrel Cage Induction Rotor

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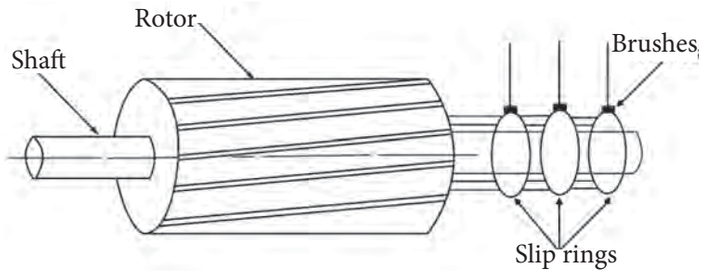

Slip Ring Induction Rotor

1. Single squirrel cage induction rotors-it has only one winding in the rotor.
2. Double squirrel cage induction rotors-it has two windings in the rotor.

Construction of a Slip Ring Induction Motor

The rotor of the slip ring motor is actually wound for three phase windings connected in star formation. These windings are placed in insulated rotor slots and the ends are brought out and connected to the three slip rings mounted on the shaft.

Brushes mounted on the slip rings connect the rotor windings to external resistance for the purpose of starting.

This motor is started with full additional resistance in the rotor circuit to ensure less starting current and more starting torque. The external resistance is reduced gradually and the required speed is obtained by short-circuiting the three slip rings. The rotor winding will have the same number of poles found in the stator. This motor is also known as "wound rotor induction motor".

Difference between a Squirrel Cage Induction Motor and a Slip-Ring Induction Motor:

Squirrel Cage Induction Motor	Slip Ring Induction Motor
1. Simple in construction	Construction is complicated because rotor is also wound with insulated wire.
2. Low cost	The cost is high
3. Operates at high efficiency	Efficiency is not high
4. There is no chance of sparks and hence it is explosion proof.	Sparking risk is there because of slip rings and the brushes riding on them.
5. Requires the least maintenance.	Maintenance is trouble some
6. Starting arrangements are simple.	Requires costly starters.
7. Starting torque is less.	High starting torque.
8. Speed control is not easily possible.	Speed can be changed easily.

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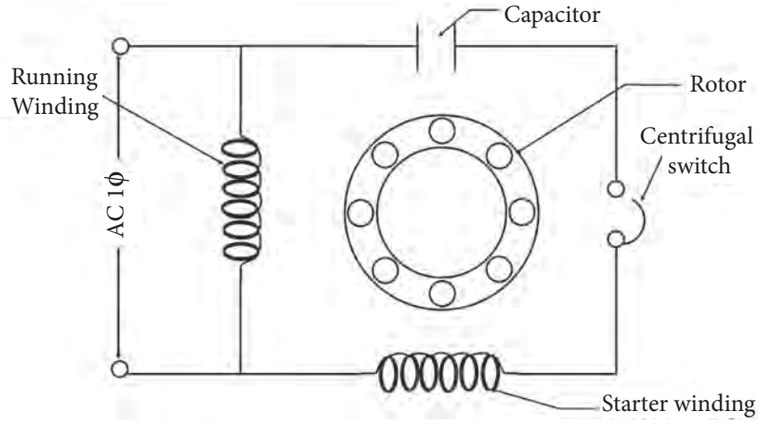

A.C Single Phase Capacitor Start Motor

A.C Single Phase Capacitor Start Motor

The stator of a A.C single phase capacitor start motor has two windings- running winding & starting winding. A capacitor and centrifugal switch are connected in series with the starting winding. A squirrel cage rotor is fitted in this motor. Capacitor creates 90° phase difference between the two windings.

Single phase current is supplied and the development of rotating magnetic field makes the rotor to rotate. When the rotor attains 70% of the total speed, the centrifugal switch disconnects the starting winding, this motor has high starting torque. The direction of rotation can be changed by just changing the connection of terminals of anyone of the windings. The motors find extensive use in wet grinders, small grinding machines, drilling machines, compressed motors used for air-conditioners and refrigerators.

10.8 STARTERS FOR INDUCTION MOTORS

Need of Starters

When induction motors are directly switched on to supply, it takes about five to six times of full load current. This initial excessive current causes damages to the motor and supply wires. Starters are used to limit the inrush of starting line current and full current is supplied when the motor picks up speed. It consists of

DO YOU KNOW?

Georg Simon Ohm (16 March 1789 – 6 July 1854) was a German physicist and mathematician. As a school teacher, Ohm began his research with the new electrochemical cell, invented by Italian scientist Alessandro Volta. Using equipment of his own creation, Ohm found that there is a direct proportionality between the potential difference (voltage) applied across a conductor and the resultant electric current.

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protective elements like "no volt coil" and "over load relays."

Different Types of Starters for Induction Motors

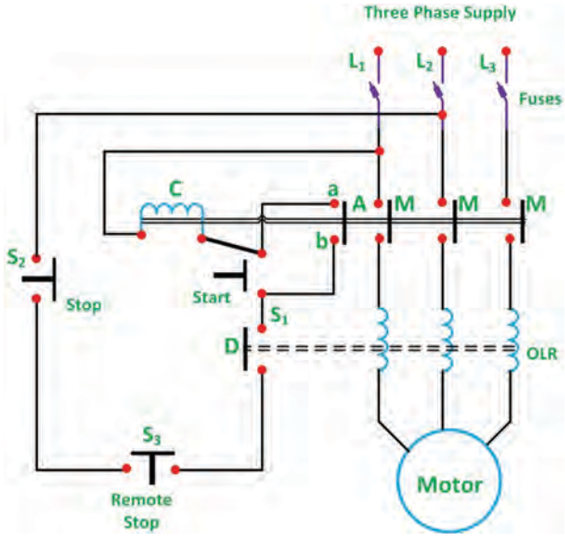
There are different types of starters used for induction motor.

1. Direct-on-line starter (D.O.L)
2. Star-delta starter
3. Auto transformer starter
4. Rotor resistance starter(for slip ring motor)

Direct-on-Line (D.O.L) Starter

It is simple in construction when compared with other starters. It permits the motor to start up with full voltage on. It has protective elements to safeguard the motors against over loading and single-phasing. Single-phasing means operation of motor with one line cut of accidentally. When the start button is pressed, the "no volt coil circuit" energises. The contacts are pressed against spring tension to connect motor terminals to three-phase supply. The motor starts running.

Even if the pressing of 'start' button is stopped, the circuit is closed through the fourth conductor and the



Direct-on-Line (D.O.L) Starter

motor continues to run. When the motor is overloaded, the temperature of the heating elements becomes high to heat the bimetallic strip. This makes overload relay (OLR) to press a lever to open the no volt coil for a moment to switch off the supply to stop the motor.

If the "off" button is pressed, the supply to the no volt coil is disconnected and the motor is stopped. Direct-on-line starters are used for motors with capacity up to 5 hp.

Star-Selta Starter

This starter has two positions 'start' and 'run'. When the handle is pressed

Michael Faraday was an English scientist who contributed to the study of electromagnetism and electrochemistry. His main discoveries include the principles underlying electromagnetic induction, diamagnetism and electrolysis.

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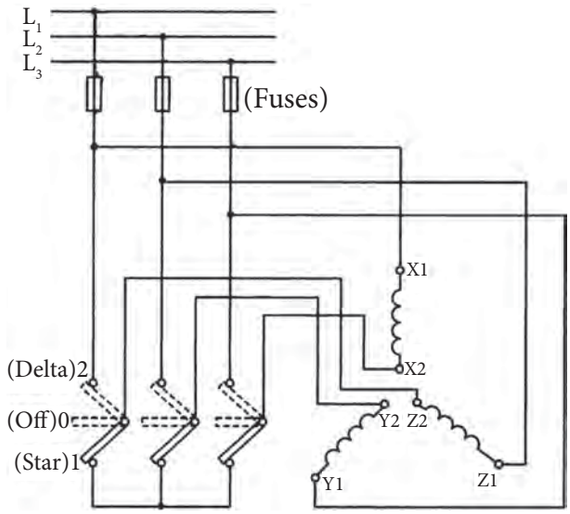

Start-Delta Starter

to 'start' the three motor windings are connected in star formation. Each phase windings gets only 58% of the line voltage. So the starting line current to the motor is reduced. As the motor picks up speed and attains nearly 80% of normal r.p.m, the starter handle is pushed to 'run' position. In this run position, the three winding get connected in delta formation so that each winding gets full supply voltage and full line current.

This starter is provided with usual protective devices such as overload relay, no volt coil release and single phase prevented. Star-delta starter is used for motors of capacity 5 hp to 15 hp.

Auto Transformer Starter

An auto transformer is fitted in this starter and so it is costlier. Star connected transformers with 40, 60 and 80% tapings, allows specific voltage to be pressed against the motor windings.

When the starter handle is thrown to start position-reduced voltage is supplied to the motor windings and the motor starts with reduced line current and reduced torque. When the starter handle is pushed to run position, full line voltage is applied to motor windings and the auto transformer is isolated from the circuit. This starter is provided with usual protective devices such as overload relay and no volt coil. This type of starter is intended for starting three phase induction motors of capacity more than 15 hp.

Rotor Resistance Starter

Slip ring motors are always started with a resistance in series with each rotor phase in this starter, full line voltage is applied across starter windings. Full value additional resistance is added in series with each phase of the rotor windings. These resistances are immersed in oil. As the rotor starts up, the handle is rotated slowly until the entire resistance is out. The motor then runs normally. At this stage, rotor windings are short- circuited eliminating the resistance. Now the motor runs like a squirrel cage motor.

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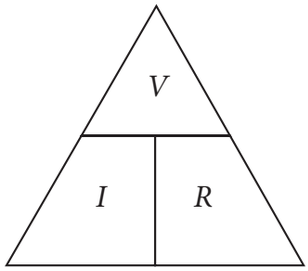
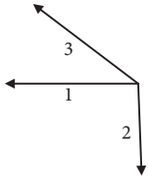
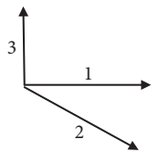
ABSTRACT

Title	Description
1. Voltage (V)	Voltage (V) volt meter
2. Current	Current I ammeter
3. Resistance	$R = \rho L/A$ ρ = specific resistivity in ohm-meter L = length of material in meter A = area of the material in m^2.
4. Ohm's law	 1. $I = \frac{V}{R}$ 2. $V = I.R$ 3. $R = \frac{V}{I}$
5. Series circuit	$V = V_1+V_2+V_3$ $R = R_1+R_2+R_3$ I = same for all elements.
6. Parallel circuit	$V = V_1 = V_2 = V_3$ $I = I_1 + I_2 + I_3$ $1/R = 1/R_1 + 1/R_2 + 1/R_3$
7. Flemming's right hand rule	
8. Flemming's left hand rule	
9. Direct current (DC)	
10. Alternative current (AC)	
11. AC 3 phase system (3Ø phase)	360°/3 = 120° 120° in Each phase
12. Three wire joint type	RYB DELTA Red, yellow, blue
13. Four wire joint type	RYNB Red, yellow, blue, neutral

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14. 3Ø phase Line voltage (V_L) V-voltage L-line	$V_L=V_{RY}=V_{YB}=V_{RB}$ Voltage between any two phases of the system.
15. Line current (I_L) I=current L=line	$I_L=I_R=I_Y=I_B$
16. Phase voltage (V_p) V=Voltage P=Phase	Voltage between any one of the phases and the NEUTRAL terminal
17. Phase current (I_p) I=current P=phase	Current flowing through anyone of phase winding is called as phase current.
18. Delta system RYB system	$V_L=V_P=V_{PY}=V_{YB}=V_{RB}$ $I_P=I_R=I_Y=I_B$ $I_P=I_L\sqrt{3}$
19. Star system RYNB system	$I_P=I_L=I_R=I_Y=I_B$ $V_P=V_L\sqrt{3}$ $V_{RN}=V_{YN}=V_{BN}=V_P$
20. Direct on line starter (DOL starter)	Used for motors with capacity up to 5 Hp.
21. Star-delta starter	Used for motors with capacity 5Hp to 15 Hp.
22. Auto transformer starter	Used for motors of capacity more than 15 Hp.
23. Rotor resistance starter	a. Full line voltage is applied across starter windings b. Full value additional resistance is added in series with each phase of the rotor windings c. These resistance are immersed in oil.
24. 1 H.P One horse power	746 wattes 0.746 kilo wattes.

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GLOSSARY

1.Voltage – மின்னழுத்தம்
2. Resistance - மின்தடை
3. Current – மின்னோட்டம்
4. Electric Circuit – மின்சுற்று
5. Series Circuit – தொடர் மின்சுற்று
6. Parallel Circuit – பக்க மின்சுற்று
7. Electro Magnet - மின்காந்தம்

ACTIVITIES

1) Construct Parallel and Series Circuit connection by using battery.
2) Collect resistors for the following Typical values 220Ω , 330Ω, 1K Ω, 1.1KΩ, 2KΩ, 2.4KΩ, 2.7KΩ

QUESTIONS

SM3FHF

1 Marks

PART: A

I. Choose the correct option :

1. The unit of current is
   a. Volt c. Ampere
   b. Watt d. Ohm

2. The unit of voltage is
   a. Watt c. Volt
   b. Weber d. Gilbert

3. The unit of resistance is
   a. Meter c. Watt hour
   b. Ohm d. Coulomb

4. The unit of power is
   a. Volt
   b. Ampere
   c. Watt
   d. Ohm

5. The frequency of A.C current is
   a. 50 c/sec c. Coulomb
   b. Volt d. Meter

6. The device is used to convert electrical energy into mechanical energy
   a. Generator
   b. Electric motor
   c. Starter
   d. Transformer

7. Starter used for motors of capacity up to 5Hp is
   a. Star-delta starter
   b. Direct-on-line starter
   c. Auto transformed starter
   d. Rotor resistance starter

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PART: B

3 Marks

II. Answer the following questions in one or two sentences:

8. What is electric current?
9. What do you mean by Electric resistance?
10. State ohm's law
11. State Faraday's first law
12. State Faraday's second law
13. List out the types of electrical motors
14. What are the types of starters used in induction motors?
15. What are the safety devices fitted in starters to protect the induction motors?
16. What is the need of a starter in a electric motor?

PART: C

5 Marks

III Answer the following questions in about a page?

17. Series circuit, parallel circuit-explain with neat sketch
18. Explain Flemming's Right Hand Rule with illustration
19. Explain Flemming's Left Hand Rule with illustration
20. Compare D.C with A.C

PART: D

10 Marks

IV. Answer the following questions in detail:

21. Differentiate between squirrel cage induction motor and a slip ring induction motor?
22. Explain a D.O.L starter with neat sketch?
23. Explain a neat diagram of a star-delta starter.
24. Explain a A.C single phase capacitor start motor with a neat sketch.

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Chapter

11

INDUSTRIAL MANAGEMENT

SMCBJ3

Learning Objectives

1. To know about the industrial management and the types of management and industries.
2. To know about the important factors considered in selecting a plant location.
3. To know about the production and productivity and quality control.
4. To know about the F.W.Taylor and Hendri Fayol management and their principles.

Table of Content

11.1 Introduction

- Factory is a place of required resources are collected in one place to manufacture materials in correct size and correct shape. The resources are trained men, raw materials, machines etc.

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11.2 PLANT LOCATION

Plant location is important exercise of selecting a suitable site and area of establishing a new plant or for expanding a existing plant. This is very essential as it decides the operational and capital cost of the product.

11.3 IMPORTANT FACTORS TO BE CONSIDERED IN SELECTING A PLANT LOCATION

1. The plant should be located as near as possible to the place where the raw materials are available. This will reduce the cost involved in transportation of the raw materials.
2. The location should be conveniently connected by highways and railways.
3. The availability of adequate labour is an important factor.
4. The topography of geography, area of available land, shape of the site and drainage facilities should be suitable to the needs of the plant. The location should not be prone to floods and earthquakes.
5. Sufficient quantity of quality water should be available near the plant location.
6. The atmosphere of the plant should provide adequate lighting and ventilation facilities.
7. Electrical power of adequate strength and necessary fuel should be available at the plant location
8. Location of the plant should be selected to avail maximum tax concessions, loan facilities and low power tariff.
9. Proper housing facilities for the employees, presence of hospitals, educational institutions, banks, markets and recreational facilities should also be considered while selection locations.
10. Presence of related industries near the location is preferable.

11.4 PLANT LAYOUT

The physical arrangements of buildings, machinery, equipments, workplaces and other facilities for the manufacturing process is known as plant layout.

ADVANTAGES OF A GOOD PLANT LAYOUTS

1. Handling of materials and transportation becomes minimum.
2. The rate of production increases because of effective use of man and machines.
3. Workers feel comfortable with less movement inside the plant.
4. The available space is economically and efficiently used.
5. Investments on equipments becomes minimum.
6. Simple, easy and effective supervision is possible.

11.5 WORK STUDY

Work study is a technique to increase the productivity. It is used to find out the reasons for shortfall in the efficiency of the human work and set guidelines for improvement. By increasing production, the cost is reduced and the product reaches more people. Work study aims on the above objective.

Work study is a combination of two techniques namely

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1. Method study and
2. Work measurement.

Work study= Method study + Work measurement

Method Study

Method study is a systematic recording and critical analysis of the method of doing a work. It also proposes a new method of doing the same work in a easy and effective manner to reduce costs.

Work Measurement

Work measurement is a technique to find out the time taken for a qualified worker to finish a specified work at a particular level of performance.

11.6 PRODUCTION AND PRODUCTIVITY

Production can be defined as a process of manufacturing the required end product from the available raw materials.

Raw material → production → products

Productivity can be defined as a ratio between the output in a quartum of wealth and the input resources of production.

$$\text{Productivity} = \frac{\text{Production Output}}{\text{Input of Resources}}$$

11.7 PRODUCTIVITY BASED ON DIFFERENT RESOURCES- PRODUCTIVITY OF LAND

Let us assume an agriculturist spends ₹5000/- to plant casuarina saplings in his land of 1 acre and earns yields worth ₹10,000/-.

$$\text{Productivity} = \frac{\text{Production Output}}{\text{Input of Resources}}$$

$$= \frac{10000}{5000} \times 100$$

$$\text{Productivity} = 200\%$$

we consider another case where the same agriculturist spend. ₹6000 for better saplings and better methods of cultivator in the same area and earns yields worth ₹15,000/-.

$$\text{Productivity} = \frac{\text{Production Output}}{\text{Input of Resources}}$$

$$= \frac{15000}{6000} \times 100$$

$$= 250\%$$

In this case, the productivity is increased by 50%.

PRODUCTIVITY OF MEN

We consider a case of machinist who works on a milling machine and makes 40 gears a day. By improved methods of work, the same machinist is able to machine 50 gears in a day. The increase in productivity can be calculated as,

$$\text{Increase in Productivity} = \frac{\text{Change in Production}}{\text{Original Production (Input)}}$$

$$= \frac{50 - 40}{40} \times 100$$

$$= 25\%$$

Increase in Production = 25%

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PRODUCTIVITY OF MACHINE

Let us consider a case where an operator works on a drilling machine for 8 hours to make drills on 100 identical work pieces. With the same machine, the operator is able to make drills on 140 work pieces by using jigs and drills with high cutting speeds.

$$\text{Increase in Productivity} = \frac{\text{Change in Production}}{\text{Original Production (Input)}}$$

$$= \frac{140 - 100}{100} \times 100$$

$$= 40\%$$

INCREASING PRODUCTIVITY METHODS

Some important methods of increasing the productivity are given below,

1. By improving the working conditions.
2. By improving the process involved in production
3. By reducing the non-productivity time by work measurement
4. By providing suitable incentives to the workers.
5. By proposing better plant maintenance programmes.
6. Old and worn out machines should be corrected to make them function as before.
7. Men, Machine and Materials should be maintained at the required quantum.
8. By providing the operators with new and proper training.
9. Layout of the plant and equipments should be improved.

11.8 PRODUCTION PLANNING AND CONTROL (PPC)

Production planning is a process of scheming the production procedures to get the finished products of required quality from the raw materials with in a prescribed time frame economically.

Production control is a process of making specific arrangements to carry out the procedures outlined by production planning. It should also over see corrective measures in case of failures in the production process.

11.9 FUNCTION OF PPC

1. **Pre-planning:** It involves the decisions of the preparatory functions in the production process.
2. **Route plan:** It is the plan arranging various activities that take place from the stage of raw material to the finished product.
3. **Scheduling:**Scheduling is the preparation of a time table to show the time of starting and the time of completing of operations involved in production of each component.
4. **Despatching**: It is the process of ordering different departments to carry out production process as per the route plan and scheduling,
5. **Controlling**: It is the process of getting reports from all departments regarding production and taking correcting actions, if necessary.

IMPORTANCE OF PPC

Guideline is very important to all departments. It must be clear and correct.

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DO YOU KNOW?

Frederick Winslow Taylor was an American mechanical engineer who sought to improve industrial efficiency. He was one of the first management consultants.

PPC does this guideline to every industry. So PPC is the "Brain of the Industry".

The important task of arranging specific instructions to the workers to carry out specific tasks, at specific time, frame with specific materials at specific quantity and quality on specific machines.

If the PPC does not work in right way, the industry affects. So every industry needs skilled PPC.

11.10 QUALITY CONTROL

The quality of product is the fitness of the product regarding its intended purpose. In production process, it is not always possible to maintain the quality for all the number of products.

The quality may vary with each piece of the product. It depends on the product. It depends on the machine on which it is produced, the tools used, the methods holding tools used work pieces etc. This variation in quantity is unavoidable. However the variations should be within desired limits.

By ensuring quality control, we can look forward to quality productions in future. It can be said that the quality control cannot do anything with the past production. So the action plan deviced to control the quality of the product before the production process is known as quality control.

11.11 PRINCIPLES OF MANAGEMENT

In twentieth century, industries were developed. The field of production had increased. Competition and confusion were the results of new methods of trade. In order to resolve these issues, a new west up in governing process was required. For that new principles of management were created, by experienced experts.

MANAGEMENT

Management is a process of achieving the objectives of an organisation by directing and controlling the various activites of the involved man power.

Frederick W. Taylor

Ferderick W. Taylor is called as the father of scientific management. He started his carrer as a labour in Midvale steel company of USA in the year 1878. He held different positions in the company and later become the chief engineer in 1884. He wrote many management books related to industries. 'The principle of Scientific Management' is one of the important management books written by F.W. Taylor.

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DO YOU KNOW?

The product life cycle is an important concept in marketing. It describes the stages a product goes through from when it was first thought of until it finally is removed from the market. Not all products reach this final stage.

According to F.W.Taylor, Scientific Management involves the following procedures.

1. Observation
2. Measurement
3. Experimented Comparison
4. Formulation of Procedure.

HENDRI FAYOL

Henri Fayol was a French industrialist. He was a graduate in mining engineering. He joined as an engineer in a coal mining company in the year 1860. Later, he becomes the managing director of the company. He retrieved the company from near bank ruptcy to set it as a leading coal mining company in France.

Based on his hand work and a successful managing experience, he wrote a book titled "General and Industrial Management". It contained his general management principles. He categorized all the activities of industrial undertakings into six groups. They are,

1. Technical activities (production related)
2. Financial activities (Capital related)
3. Commercial activities (buying material and selling products)
4. Security activities (protection of properties)
5. Accounting activities (Statistics and Stock Taking)
6. Managerial activities (plan and control)

11.12 ORGANISATION

The process of organizing in a industry involves the identification and establishment of its objectives and co-ordination of the capital, raw material, machines and people to reachout the set objectives. The institution which involves the process is known as an organisation.

Types of Organisation

1. Line organisation
2. Taylor's functional organisation
3. Line and staff organisation
4. Line and functional staff organisation
5. Committee organisation.

Organisation Chart

Organisation chart is a graphical representation of various steps of organisational structure

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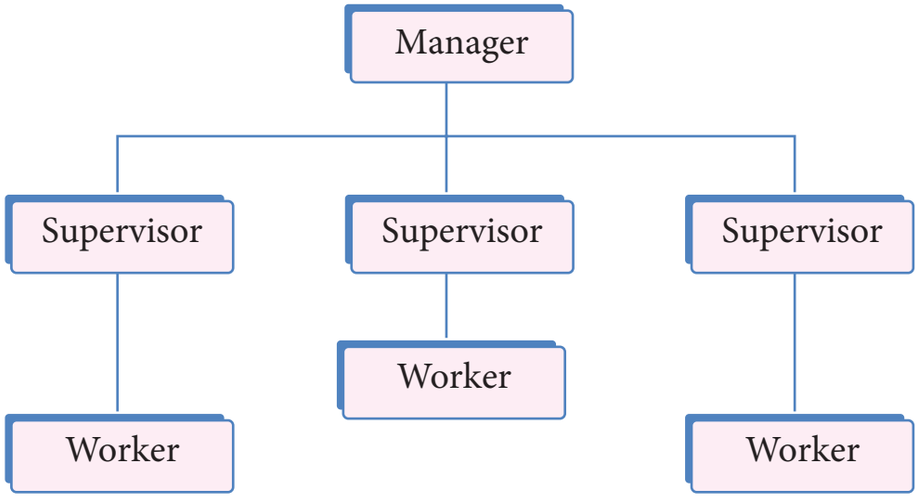
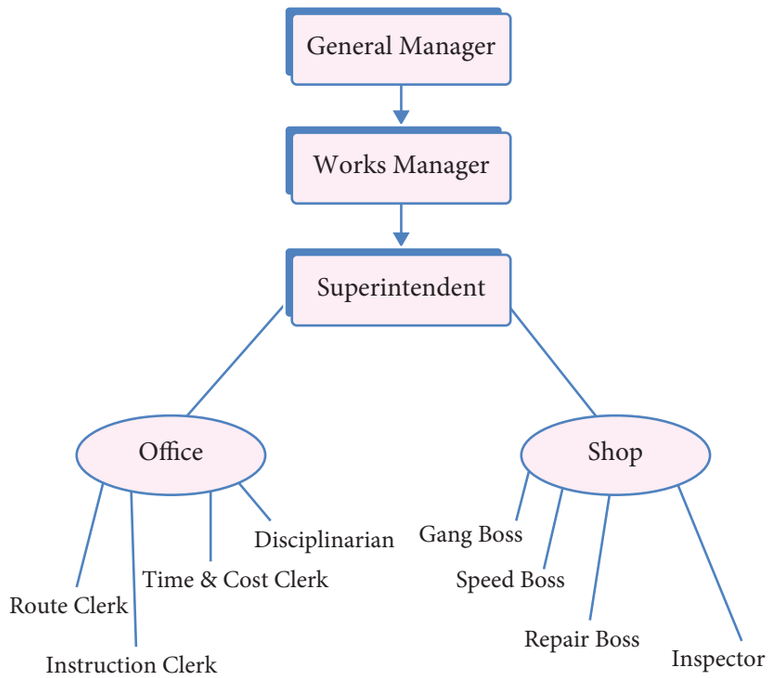


MIND MAP

Functional Organization



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GLOSSARY

1. Location – அமைவிடம்
2. Layout – அமைவிட வரைபடம்
3. Organization – நிறுவனம்

ACTIVITIES

1) Visit any organization (Bank, workshop, EB office, Post office etc.,) near school and collect the following details
   a. Name of the organization
   b. Number of workers working in that organization.
   c. Name the various designation of the workers, and their nature of work.

QUESTIONS

SML7KQ

1 Mark

PART A

I. Choose the correct option :

1. Work study is
   a. Method of plant layout
   b. A technique of increasing production
   c. Method study
   d. Work measurement

2. Production planning is
   a. Productivity of men
   b. Productivity of land
   c. Scheming of productivity procedures
   d. Quality control.

3. Father of 'scientific management' is
   a. Henry Fayol
   b. Pierre Vernier
   c. F.W.Taylor
   d. Faraday

4. The book "general and industrial management " was written by
   a. Faraday
   b. Henry Fayol
   c. F.W.Taylor
   d. Pierre Vernier

5. The book "the principles of scientific management" was written by
   a. Pierre Vernier
   b. F.W.Taylor
   c. Faraday
   d. Henry Fayol

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PART B

3 Marks

II. Answer the following questions in one or two sentences:

6. What do you know about "Plant Location"?
7. What do you know about "industrial management"?
8. Define "work study"?
9. Define "method study"?
10. Define "work measurement"?

PART C

5 Marks

III Answer the following questions in about a page?

11. What are the advantages of a good plant location?
12. What are the functions of PPC? (production planning and control)
13. Explain about "Quality control"?
14. How many groups are there in industrial undertakings categorized by Henry Fayol?
15. Write "Types of organisations"?

PART D

10 Marks

IV. Answer the following questions in detail:

16. List out the important to be considered in selecting a plant location?
17. What are the increasing productivity methods?
18. Explain about the productivity of men and productivity of machine?
19. Draw a simple organisation method?
20. Draw a functional organisation chart?

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Chapter

12

COST ESTIMATION

SMMTAJ

Learning Objectives

1. Students to know and learn about the basics of cost estimation of an Industry.
2. To know about the cost of raw material, machining charges, wages for the workers.

Table of Content

12.1 Introduction

- Cost estimation can be defined as the estimation of expenditure for the entire manufacturing process of an object producing in a factory.
- Cost estimation can be classified by the following points.

1. Cost of raw materials
2. Machining charge
3. Wages, paid for the worker.
4. Cost for making accessories like jigs and fixtures.
5. Administrative expenditure
6. Profit.

12.2 COST OF RAW MATERIALS

The cost of raw materials includes the price of the material required, import tax, labour charges paid for loading and unloading and transportation charges.

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12.3 MACHINING CHARGES

A part or component obtained only after it is subjected to several operations performed on different machine tools. The machining charges are calculated by the duration of machining on each of these machine tools involved in manufacturing the particular component. The machining charges differ for different type of machine tools.

The table prepared here is approximately for calculating the machinery charges. The charges may vary according to the cost of the machine, capacity and accuracy of the machine tool.

MACHINE	DURATION	RATE PER HOUR
Drilling machine	1 hour	₹100.00
Lathe	1 hour	₹150.00
Shaping machine	1 hour	₹200.00
Milling machine	1 hour	₹250.00
Grinding machine	1 hour	₹300.00

12.4 WAGES FOR THE WORKER

This includes the amount of wages paid to the workers employed for operating the machine tools and the expenditure for miscellaneous operations performed on the workpieces. Charges for hacksaw cutting, filing, fitting, and assembling are counted under this head.

12.5 COST FOR MAKING ACCESSORIES LIKE JIGS AND FIXTURES

If the production process involves the usage of jigs and fixtures, (used to hold and guide the job) the cost paid for manufacturing or purchasing the same should be taken into account.

12.6 ADMINISTRATIVE EXPENDITURE

The administrative expenditure can also be called as 'overhead charges'. It includes:

1. Depreciation (wear and tear on machine tools and other tools)
2. Repairs and maintenance of the machine tools.
3. Expenditure on fuels and electricity.
4. Rent and maintenance paid for the building of the manufacturing unit.
5. Salary paid to the administrative staff and expenses for purchasing office records.
6. Salary paid to the supervisors, storekeepers and watchman.
7. Expenditure for advertising, travel and postage.
8. Amount spend for the Welfare of the workers, and contribution to the employee's fund (it includes medical insurance and their child education fund)
9. Interest on capital.

12.7 PROFIT

Profit is calculated in the range of 10% to 30% of the total cost of estimation.

The profit percentage is varies for each factory according to their capital invested.

Example Problems

100 Nos. of spur gears are required with the following specifications.

No. of teeth	=	60
Module	=	3 mm
Width of the gear	=	30 mm
Diameter of the stock	=	40 mm

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Name of the machine	operation	Total time taken for 100 gears		Rate per hour	Total (₹)
		In minutes	In hours		
Lathe	24 minutes are required for turning both sides of the casting gear block (for 1 gear)	2400	40	150	6000
Slotting machine	24 minutes are required for slotting (for 1 gear)	2400	40	200	8000
Milling machine	48 minutes are required for milling (for 1 gear)	4800	80	250	20000
	Total machining charges		160		34000

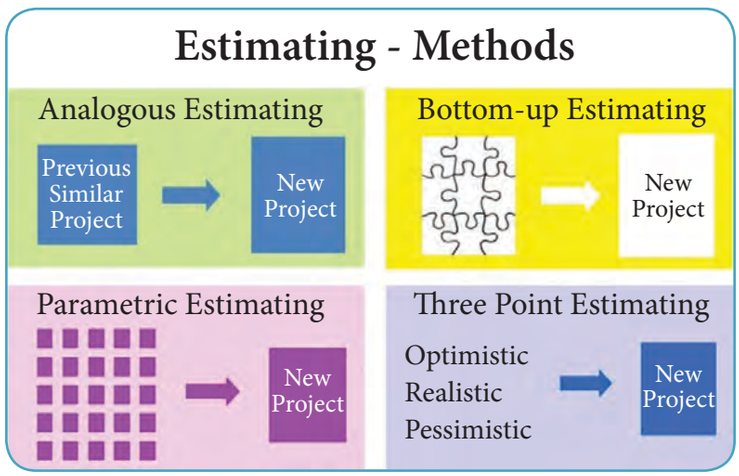
Find the total cost of estimation and the cost of estimation and the cost of single gear, if the cost of the casting material is ₹55 per kg and the weight of a gear is 1kg.

Cost of raw material

(As the gears are to be cast, the cast material should be ordered.)

Weight of a single gear = 1kg
Weight of a 100 gear = 100kg

DO YOU KNOW?



The goal of each *cost estimation method* is to estimate fixed and variable costs and to describe this estimate in the form of Y = f + vX. That is, Total mixed cost = Total fixed cost + (Unit variable cost × Number of units).

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Cost of 1kg of cast material	=	₹55
Cost of 100 kg of cast material	=	55 × 100
	=	₹5500
Loading charge	=	₹200
Transportation (freight)	=	₹400
Unloading charge	=	₹200
Cost of raw materials	=	5500+200+400+200
	=	₹6300

Machining Charges

Total machining time	=	160 hours
Total working days	=	160/8
	=	(1 day = 8 hours)
	=	20 days.

WORKERS WAGES

Workers wages for 1 day	=	₹500
Workers wages for 1 day	=	500 × 20
	=	₹10000

ADMINISTRATIVE EXPENDITURE

Total administrative charges = ₹1000

Total cost estimation=cost of raw materials + machining charges + worker's charges+ administrative expenditure

	=	6300+34000+10000+1000
Total estimation cost	=	₹51,300
Profit percentage	=	15%
Profit for total cost	=	51300 × 15%
	=	51300 × 15/100
	=	₹7695
Cost of 100 gears = total cost estimation + profit		
	=	51300+7695
Cost of single gear	=	58995/100
	=	₹589.95
Cost of a single gear	=	₹590.

GLOSSARY

1. Raw Materials – கச்சா பொருட்கள்
2. Expenditure – செலவினம்

ACTIVITIES

1) To visit any workshop and collect the Cost Estimation of the following process.
   a) Lathe Work (turning, Thread cutting)
   b) Drilling
   c) Welding

And collect the name the machines to perform the above process.

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QUESTIONS

SMV3MD

1 Mark

PART A

I. Choose the correct option:

1. The expenditure on the maintenance of the machines are
   a) Administrative expenditure
   b) Worker's Wages
   c) Cost of raw material
   d) Tax

2. Charges for hacksaw cutting, filing, fitting and assembling in workshop are counted under this head
   a) Cost of raw material
   b) Tax
   c) Worker's Wages
   d) Administrative expenditure

3. Considering the total time for machining and calculate one hour expense is
   a) Tax
   b) Cost of raw material
   c) Administrative expenditure
   d) Machining Charges

4. Cost of Accessories which is used to hold and guide the job are
   a) Administrative expenditure
   b) Jigs and Fixtures cost
   c) Workers Wages
   d) Cost of raw material

3 Marks

PART B

II. Answer the following questions in one or two sentences:

5. Define , "Cost estimation"
6. Define ,"Cost of raw material
7. What is Workers Wages?
8. What is Machining Charges?

5 Marks

PART C

III Answer the following questions in about a page

9. What points should be taken into account for "Cost estimation"?
10. Name some machines and write machining charges for one hour approximately?

10 Marks

PART D

IV. Answer the following questions in detail:

10. Write and Explain the "Administrative Expenditure"?

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1 Case Study of Old Student

M.KRISHNAMOORTHY

Email : mkrishm@yahoo.com
No. 12, Rosaa Block,
DAE Township, Anupuram,
Kancheepuram Dist - 603127

EDUCATIONAL QUALIFICATION

- I completed my Higher Secondary Education in the **General Machinist Vocational Group** in the year 1990 securing 86% marks in **Government Boys Higher Secondary School, Vandavasi**.
- **BACHELOR OF ENGINEERING** in **MECHANICAL ENGINEERING** branch in the year 1994 with First Class securing 70 % marks in Government College of Engineering, Guindy , Anna University, Chennai.
- **MASTER OF ENGINEERING** in the branch of **COMPUTER AIDED DESIGN AND MANUFACTURING** in the year 2012 securing First Class with Distinction (CGPA 8.89) in sathyabama University, Chennai.

PROFESSIONAL EXPERIENCE

- Worked as "**Engineer Trainee**" in **M/s. Balaji Biotech Limited**, Nellore, Andhra Pradesh for a period of one year (1994 – 1995).
- Worked as "**Production Engineer**" in **M/s. Ashok Leyland**, Ennore, Chennai for a period of four years (1995 – 1999).
- Joined in Department of Atomic Energy, **Indira Gandhi Centre for Atomic Research**, Kalpakkam as "**Scientific Officer/C** " in the year 1999 and worked at various capacities. In the year 2014 promoted to **Scientific Officer / F**". Since, then, I am shouldering the responsibility as Head, Fabrication Section, Central Workshop Division and Continuing.

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SKILL MATRIX

- Hands on experience in state of the art manufacturing technology.
- Presented more than 15 technical contributory papers in the National and International Welding Conferences/Seminars.
- Co – authored two journal papers in the leading technical magazine.
- Member in the Department Standing Selection Committees.
- Member in the Board of Examiners in All India Apprentices Examination.
- Organized Quality Circle Annual Meets and Welding Courses in the capacity of Convener/ Secretary.
- Served as Honorary Secretary of IIW – India, Chennai Branch for three years consecutively.

AREA OF INTEREST

Fabrication of Pressure Vessels, Nuclear Components and Latest Welding Processes.

DECLARATION

I hereby declare that all the details provided above are true to the best of my Knowledge and belief, and I will perform my duties with dedication and enthusiasm.

Yours truly,

[M. KRISHNAMOORTHY]

Place : **Anupuram**

Date : 01 – 03 – 2018

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2 Case Study of Old Student

SAKTHIVEL. S

104. 7th Street, Sri Bharathi Nagar,
Vellanur, Avadi, Chennai-600062.
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Office: Ministry of Defence, Heavy Vehicles Factory,
Avadi, Chennai-600054.
Phone: 044-26843744
E.Mail:shaktil176@yahoo.co.in

EDUCATION

- **HSC (Vocational)- General Machanist**, March **1994**, with **83.25%** at @ Govt.Boys Hr.Sec. School, Vandavasi, Thiruvannamalai District.
- Passed the Diploma in Mechanical Engineering (DME) in First Class with Honours in April 1997 with 79.16% @ Central Polytechnic, Tharamani, Chennai-600113.
- **AMIE (Mechanical Engineering) M.A**

EXPERIENCE

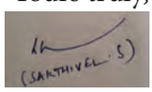
Previous

- Technical Apperentice Training from 27.04.2000 to 26.04.2001 in **B**harat **H**eavy **E**lectrical **L**imited, Tiruchirappalli-620014.
- Office clerk (PB). Sr.DPO/O/MAS. Southern Railway, Chennai Division from 25/07/2006 to 03/05/2008. Technical registration accepted for taking up a new post of Charegeman Gr-II/ Tech at **HVF** and relived from Railway service on 03/05/2008(A/N). Jointed duty at **HVF** as Charegeman Gr-II/Tech (OP) on 05/05/2008 (F/N) since 04/05/2008 Being Sunday Holiday.

Present

- **Junior Works Manager**/ Tedchnical (Mechanical) Group-'**B**' Gazetted Officer, Ministry of Defence , **H**eavy **V**echicles **F**actory, Avadi. Chennai-600054.

Yours truly,



(SAKTHIVEL. S)

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3 Case Study of Old Student

N. KRISHNA MURTHI

No: 182, B12 – Kendriya Vihar,
Avadi Main Road,
Paruthipattu,
Chennai – 600071.
Mobile: 9840532277 / 99410 82488
Email: krishnamurthi@benir.in via yahoo.com

EDUCATIONAL QUALIFICATION

- I completed my Higher Secondary Education in the **General Machinist Vocational Group** in the year 1992 securing 86% marks in **Government Boys Higher Secondary School, Nattrampalli**.
- **BACHELOR OF ENGINEERING** in **MECHANICAL ENGINEERING** branch in the year 1993 - 1997 in **Vellore Engineering College**, Vellore.

PROFESSIONAL EXPERIENCE

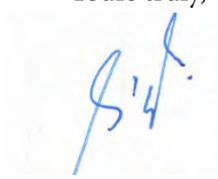
I have been working as a **General Manager** in Manufacturing Unit of **Bailley Water** (Parle Benir e-Store Solutions Private Limited, No. 18/2, Avadi Main Road, Senneerkuppam, Poonamallee, Chennai - 600056.

DECLARATION

I hereby declare that all the details provided above are true to the best of my Knowledge and belief, and I will perform my duties with dedication and enthusiasm.

Place : Vellore

Yours truly,



[N. KRISHNA MURTHI]
General Manager - Chennai Plant

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MODEL QUESTION PAPER

GENERAL MACHINIST THEORY

Time: 2.30 hours **Marks : 90**

PART A

Choose the correct answer **15×1=15**

1. The person who manufactures different parts is
   a) Supervisor b) Machinist c) Manager d) Proprietor
2. The least count of a vernier caliper is
   a) 0.01 mm b) 0.02 mm c) 0.001 mm d) 0.1 m
3. Slip gauges are used in this measuring instrument
   a) Vernier Bevel Protractor b) Sine Bar
   c) Combination Set d) Micrometer
4. Anvil and thimble are found in this measuring instrument
   a) Vernier Caliper b) Vernier Height Gauge
   c) Micrometer d) Combination Set
5. Which material has brittleness property?
   a) Steel b) Copper c) Cast Iron d) Aluminium
6. The Atomic Number of Aluminium is
   a) 10 b) 12 c) 13 d) 15
7. The purpose of tempering is
   a) to improve corrosion resistance.
   b) to increase the hardness of the metal.
   c) to decrease the brittleness.
   d) to improve machinability.
8. The process used to produce less number mouldings
   a) Bench Moulding
   b) Floor Moulding
   c) Machine Moulding
   d) Sand Moulding
9. The washer is generally specified by its
   a) Outer Diameter b) Hole Diameter c) Thickness d) Mean Diameter

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10. keys are made of
    a) Tungsten b) Steel c) Cast Iron d) Lead
11. If the size of the shaft is smaller than the hole size, the system of fits is
    a) Interference Fit b) Clearance Fit c) Driving Fit d) Push Fit
12. Power is transmitted between shafts at moderate distance by
    a) Belt Drive b) Gear Drive c) Chain Drive d) Friction Drive
13. The unit current is
    a) Volt b) Watt c) Ampere d) Ohm
14. Work study is
    a) Method of plant layout b) A technique of increasing production
    c) Method study d) Work measurement
15. Cost of Accessories which is used to hold and guide the job are
    a) Administrative expenditure. b) Jigs and Fixtures cost.
    c) Workers Wages. d) Cost of raw material.

PART B

Answer any ten questions in not exceeding four lines: **10 × 3 = 30**

16. Who is Machinist?
17. Name five types of files in accordance with the "grade".
18. What are the grade of gauges?
19. What is positive Error in Micrometer ?
20. What are the three kinds of carbon steels?
21. Define "Heat treatment".
22. What are the types of moulding box?
23. Write any three types of Jigs?
24. Write short notes on the types of deviations?
25. What are the types of belt drive?
26. State ohm's law.
27. Define "work measurement".
28. What do you understand about "wages for the workers" ?

PART C

Answer the following questions in about a page. **5 × 5 = 25**

29. Write any five types of vice.
30. A main scale of Vernier caliper is marked in millimeter the Vernier scale
    a) Divisions which is equal to 49 divitions in the main scale what is the least count of that Vernier caliper?
31. Mention the different process of Case hardening?
32. List out any five types of moulding?

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33. Draw the 'Plate Jig' and indicate the parts?
34. Draw and explain velocity ratio with formula.
35. Explain Kirchhoffs first law with illustration.

PART D

Answer the following questions in details. **2×10=20**

36. (a). What are the safety precautions regarding operators?

(or)

(b). Draw the Vernier Caliper and explain about it?

37. (a). Draw and explain the sintering Furnace.

(or)

(b). Write the difference between Temporary fasteners and Permanent fasteners?

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2. "Elements of workshop Technology" by S.K.Hajra Choudhury and A.K. Hajra Choudhury and Nirjhar Roy Media Promoters & Publishers pvt. Ltd, Reprint – 2014. Heat Treatment
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GLOSSARY

SMWPC7

Chapter 1

1. Revolution – புரட்சி
2. Technique – நுட்பம்
3. Modern – நவீன
4. Accident – விபத்து
5. Safety – பாதுகாப்பு
6. First Aid – முதலுதவி
7. Workshop – பணிமனை
8. Gross Domestic Product (GDP) – மொத்த உள்நாட்டு உற்பத்தி
9. Environment – சுற்றுச்சூழல்
10. Precautions – முன்னெச்சரிக்கை

Chapter 2

1. Assembling – ஒன்று சேர்த்தல்
2. Dismantling – பிரித்தல்
3. Vice – பிடிப்பான்
4. Jaw – தாடை
5. Taper – சரிவு
6. Adjacent – அடுத்துள்ள
7. Diagonal – மூலை விட்டம்
8. Edge – மூனை
9. Scraper – சுரண்டி
10. Contour – மேடு பள்ளமான (அ) கரடுமுரடான
11. Scribing – கீறி கோடிடுதல்
12. Precision – துல்லியமான
13. Burr – பிசிறு
14. Tempered – பதப்படுத்துதல்
15. Hardening – கடினபடுத்துதல்
16. Tapping – மரையிடுதல்

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Chapter 3

1. Gauge – அளவி
2. Ratchet – ஒரு வழித்தடை பற்சக்கரம்
3. Telescopic – ஒன்றினுள் ஒன்று சொருகப்பட்டு நீளுதல்

Chapter 4

1. Brittlness – சிதறும் தன்மை
2. Malleability – தகடாக நீளும் தன்மை
3. Ductility – கம்பியாக நீளும் தன்மை
4. Elasticity – மீள்தன்மை
5. Galvanizing – துத்தநாக முலாம் பூசுதல்

Chapter 5

1. Annealing – மிருதுவாக்குதல்
2. Hardening – கடினப்படுத்துதல்
3. Case Hardening – புறக்கடினமாக்கல்
4. Quenching – விரைவாக குளிரச்செய்தல்
5. Sintering Furnace – மின்சார உலை

Chapter 6

1. Pattern – மாதிரிவடிவம்
2. Mould – அச்சு
3. Casting – வார்ப்பு
4. Riddle – கம்பிவலை சல்லடை
5. Squeezer – அழுத்துதல்
6. Jolt – குலுக்குதல்
7. Slinger – வீசுதல்

Chapter 7

1. Fasteners – இணைப்பு பொருட்கள்
2. Helical Groove – சுருள்பள்ளம்
3. Pulley – கப்பி
4. Shaft – தண்டு
5. Jig – வழிநடத்தும் சாதனம்
6. keyway – சாவி பள்ளம்

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Chapter 8

1. Interchangeability – ஒன்றுக் கொன்று பொருந்துதல்
2. Tolerance – ஏற்கப்படும் அளவு வேறுபாடு

Chapter 9

1. Spur Gear – நேர்ப் பல்லிணை
2. Helical Gear – நெளிவுப் பல்லிணை
3. Bevel Gear – சரிவுப் பல்லிணை
4. Rack & Pinion – தட்டை மற்றும் சிறு பல்லிணை

Chapter 10

1. Voltage – மின்னழுத்தம்
2. Resistance – மின்தடை
3. Current – மின்னோட்டம்
4. Electric Circuit – மின்சுற்று
5. Series Circuit – தொடர் மின்சுற்று
6. Parallel Circuit – பக்க மின்சுற்று
7. Electro Magnet – மின்காந்தம்

Chapter 11

1. Location – அமைவிடம்
2. Layout – அமைவிட வரைபடம்
3. Organization – நிறுவனம்

Chapter 12

1. Raw Materials – கச்சா பொருட்கள்
2. Expenditure – செலவினம்

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Basic Mechanical Engineering

PRACTICAL

PART – I - ENGINEERING DRAWING PRACTICAL

PART – II - FITTING

CONTENTS

INTRODUCTION - ENGINEERING DRAWING

PRACTICALS PART – I

ENGINEERING DRAWING PRACTICAL

PRACTICALS PART – II

FITTING

1 – 6 Fitting Practicals

INTRODUCTION
ENGINEERING DRAWING

1 INTRODUCTION - ENGINEERING DRAWING

INTRODUCTION

The oldest form of communication among human beings is sharing of ideas through some sort of graphical language. They might have put into use a peculiar equipment to make out images.We can even imagine that ancient men used a stick to scratch messages on sand. Early Egyptians used paint and brushes to make pictures to be used as a form of communication. In the field of Engineering drawing, some special equipment (or) tools are required to make images. At present we use pencil, sketch pad and even computer controlled plotting devices for making drawings.

ENGINEERING DRAWING

Engineering drawing is an effective method of communication between engineers belonging to various disciplines of engineering.All necessary features of an objects are mentioned on the drawing with proper dimensioning and important remarks, The entire community of engineers can analyze the object for its correctness , accuracy of the object's design and modifications .As all the production related remarks and instructions are graphically expressed in the drawing, it is easy for the production process to be carried out .

Engineering drawing is the language engineers. This language is spoken , read and written in its own way. It is used as a means of communicating ideas , concepts and designs to all the others involved in the process of production. Engineering drawing is drawn by an engineer having engineering knowledge for engineering purposes. Engineering drawing is the starting point for all engineering disciplines- Mechanical, Automobiles, Production, Civil, Architectural,Computer,Science, Communication, Instrumentation, Aeronautical, Marine, Agricultural, Mining, Chemical, ,Textile etc.

The view of an objects are drawn initially on a tracking paper and this drawing is known as **original drawing.** Additional copies of the original drawings are taken according to the need and they are called as **Blue prints or Ferro prints .**

Importance of Engineering drawing

It is not possible to explain all the details of objects orally irrespective of the size of the object (very small to large). Some of the details may be left out, misrepresented or misunderstood.

There may be some difficulty in understanding oral communication because of the languages spoken by the individuals. Considering such difficulties, drawings are used to communicate with people from different levels in the field of engineering (from engineers to workers). The can understand the drawing and help manufacture new components. Another distinct advantage is that the details are protected for further reference.

As there is a define grammar for a language and rules and regulations for games and sports, there is definition for a drawing.

Each and every symbol , line , letter and numbers has its unique meaning. Drawing should be made with these definitions in mind. Same methods are to be followed in making drawings for them to be accepted and understood all over the world.

2 DRAWING INSTRUMENTS

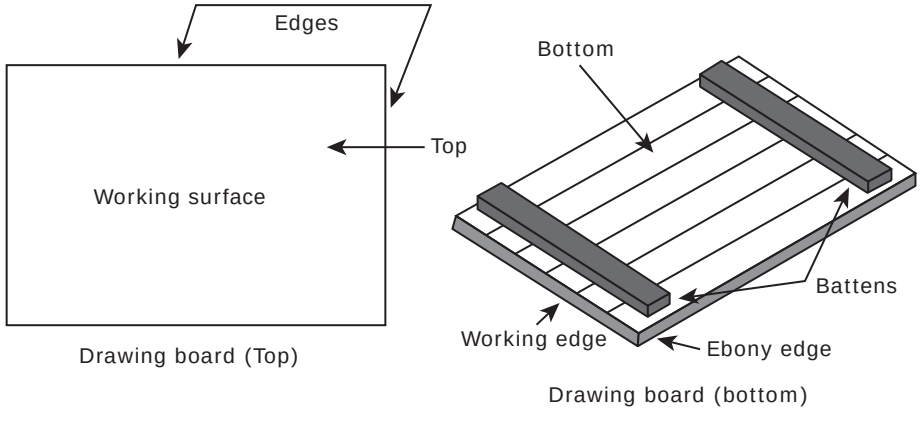
INTRODUCTION

The necessity of proper equipments and instruments for making drawings was discussed in the previous lesson.Good quality of drawing instruments are needed to make accurate drawings. However, these instruments should be handled correctly and accurately. Following are the instruments required for preparing drawings.

1. Drawing board
2. T - square
3. Drafter
4. Pencils and pencil leads
5. Scales
6. Set squares
7. Protractor
8. French curves
9. Instrument Box
   a) Compass
   b)Divider
   c)Inking pen
   d)Lengthening bar
10. Drawing sheets

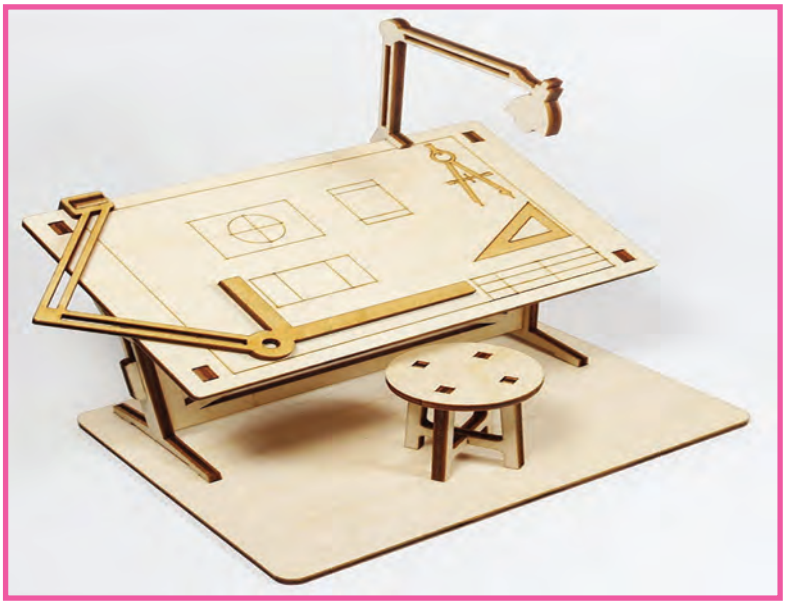
DRAWING BOARD

A drawing board is made of four or five strips of soft wood with approximate thickness of 20mm. The wood should be well-seasoned and soft and made of Pine, Oak or Fir. The strips are cleated at the back by battens with screw to prevent them from warping.



A straight ebony strip is fitted on the left edge of the board . This enables the the movements of T - square on the board. The drawing board is illustrated in figure.

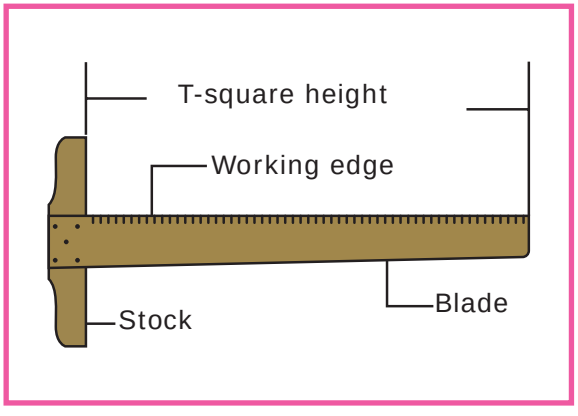
The top surface of the drawing board should be flat and smooth and the thickness uniform B.I.S(Bureau of Indian Standards) has standardized the sizes of drawing board as follows.



SI.NO	Designation	Size in mm L X W X T	Size of sheet
1	D_0	1500 X 1000 X 25	A_0
2	D_1	1000 X 700 X 25	A_1
3	D_2	700 X 500 X 15	A_2
4	D_3	500 X 350 X 15	A_3

T - SQUARE

T–square is made of hard quality of wood like teak or mahogany. There are two parts of a T –square namely stock and blade. The working edge is formed by an ebony piece attached to the blade. The stock slides along the abony piece attached to the drawing board. These two parts are connected at right angles to each other by means of screw or dowel pins. The working length of the T –square is approximately equal to the length of the drawing board. T - square is illustrate in figure



SI.No	Designation	Length of the working edge of the blade in mm
1	T_0	1500 x 10
2	T_1	1000 x 10
3	T_2	700 x 5
4	T_3	500 x 5

T -square are used to draw horizontal lines parallel to each other. When used along with set-square, it is used as a base to draw various angles.

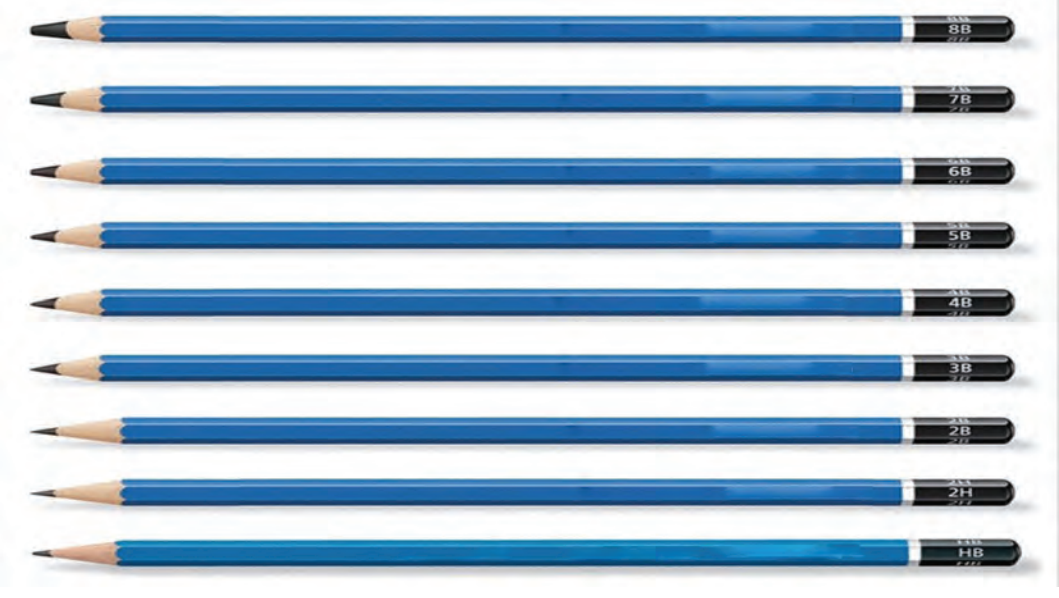
DRAFTER

It comprises of a pair of steel strips hinged at the center .At one end, a clamp is provided . This clamp is useful in clamping the drafter at the left side top corner of the drawing board .The other end is known as working end which consists of the two perpendicular scales and circular base. The perpendicular scales are graduated in millimeters whereas circular scale is graduated in degrees up to 360°.The working end can be oriented to any angle and fixed at the position with help of knob.

When the clamping end is fitted to the drawing board, the working end can be made to slide over the board. After the perpendicular scales are set at the desired angle , parallel or perpendicular lines can be drawn. Taking reference from the circular scale, line at any desired can also be drawn drafter is illustrated in figure.

PENCILS

Pencils are used for making drawings on drawing sheets. The quality of the pencil determines the accuracy and appearance of the drawing. The grades of pencil are designated by marking made on each of them . The grade of pencil describes the hardness of the graphite lead used . The grades of pencil range from 9H to 7B, where 9H is the hardest and 7B is the softest. Hard pencils such as 2H, H are used for making engineering drawing and for lettering and dimensioning , softer pencils like HB pencils are used, also used for making freehand sketches .

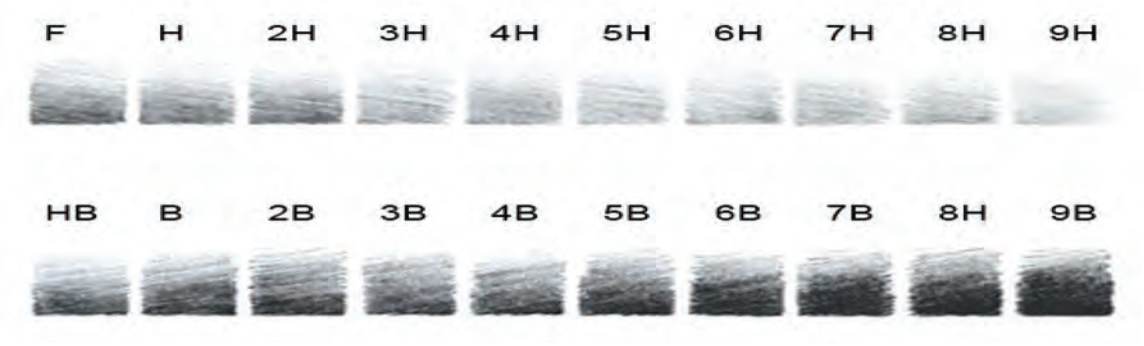


The grades of the pencil may be categorized as

Soft 7B to 2B

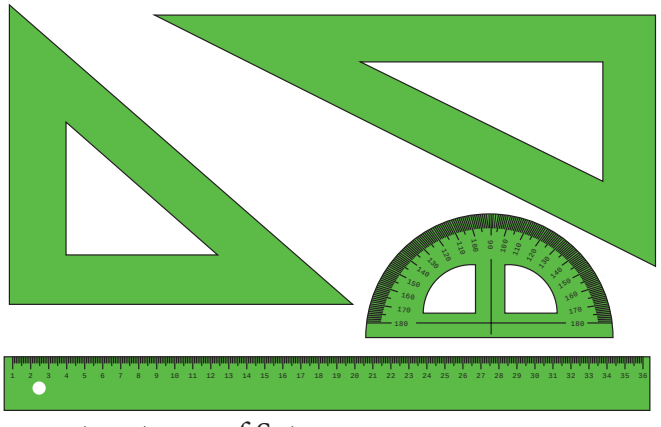
Medium B to 3H

Hard 4H to 9H



SET-SQUARE

Set-square are useful in drawing perpendicular lines and lines at 30°, 45°, 60° and 90° to the horizontal lines drawn with T-square. By the combined use of two Set-square, we can also draw lines at 15°, 75° and 105° to the horizontal line.



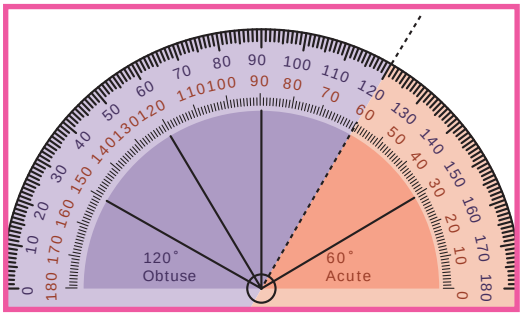
There are two types of Set-square

1. Thirty – Sixty(30°-60°)
2. Forty five (45°)

30°-60° Set-square has edges having 30 degree and 60 degrees apart from an edge which is right angled. The 45° Set-square also has a right angled edges besides two edges having 45° and is the form of an isoscales triangle. They are made of transparent celluloid to enable us to see the lines underneath them Figure illustrates Set-squares.

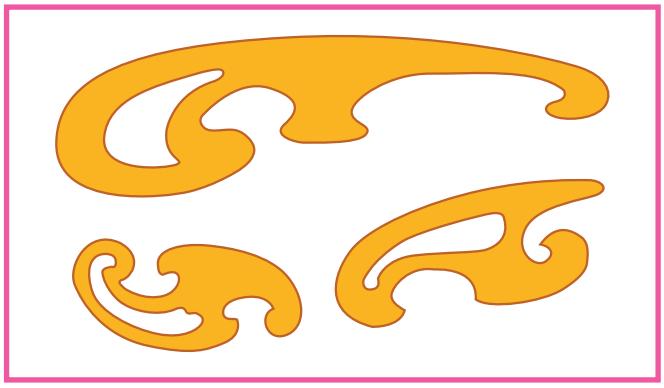
PROTRACTOR

Protractor are used to measure or construct angles which cannot be done by Set-square . The shape of the protractor may be circular or semi- circular. They are made of celluloid , wood or ivory.



FRENCH CURVES

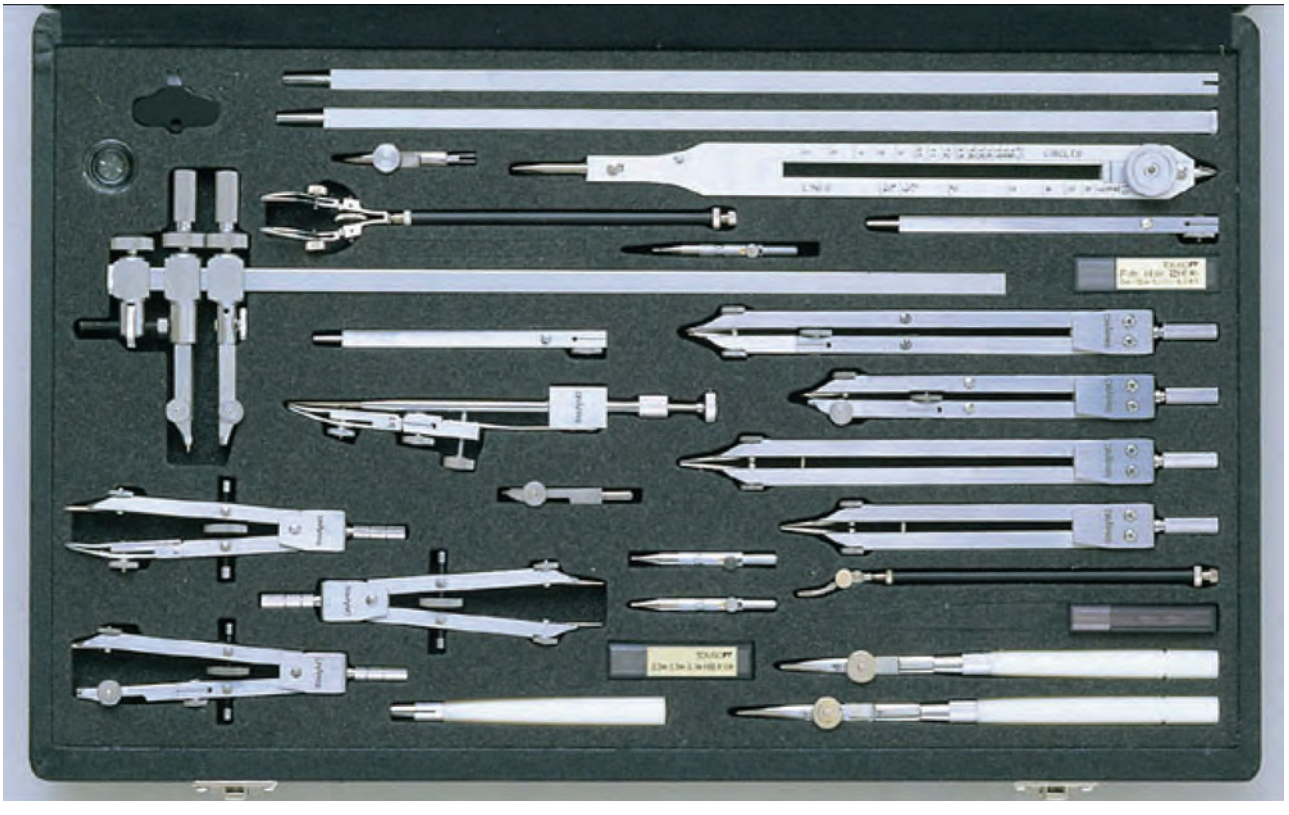
French curves are the templates made of plastic or celluloid sheet. Profiles and contours of different shapes and sizes are cut on the edges of French curves. Curve lines and circular arcs which cannot be drawn with a compass can quickly be drawn with French curve. Figure illustrate French curves



INSTRUMENT BOX

The instrument box contains different drawing instruments for drawing different types of drawings. The instruments are

1. Large Size Compass
2. Small Bow Compass
3. Small Ink Bow Compass
4. Large Size Divider
5. Small Bow Divider
6. Lengthening Bar
7. Inking Pen
8. Pin Point
9. Ink Pot
10. Lead Case



COMPASS

Compass are used for the drawing circles and arcs of required sizes. It has two metals legs joinded at the top with help of a knee joint. One of the two legs is fitted with a adjustable needle. The other leg has an attachment which can hold an inking device (or) a pencil lead tip.

DIVIDER

Straight lines or curved lines are divided into required number of equal parts with help of dividers .(Divider is also useful in transferring dimensions from a part to another part in the drawing and set off given distances from the scale to the drawing) It is very similar in construction to a compass but for the fact that both the legs of the divider are provided with steel points.

Inking pen is used to draw straight lines and curved lines in ink. It consist of a metal nib fitted to an ivory or metal holder. **Pin point** and **ink point** are used as attachment to a large compass. Lead case is useful in holding lead sticks of different grades.

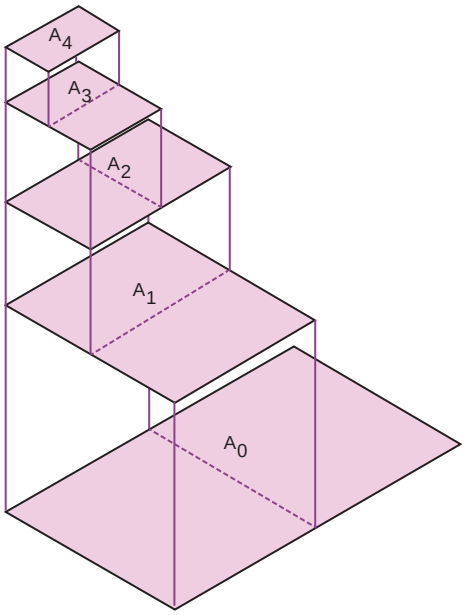
DRAWING SHEETS

Drawing Sheet: Standard size

- Trimmed paper of a size A_0-A_4.
- Standard sheet size

A_4	210 x 297
A_3	297 x 420
A_2	420 x 594
A_1	594 x 841
A_0	841 x 1189

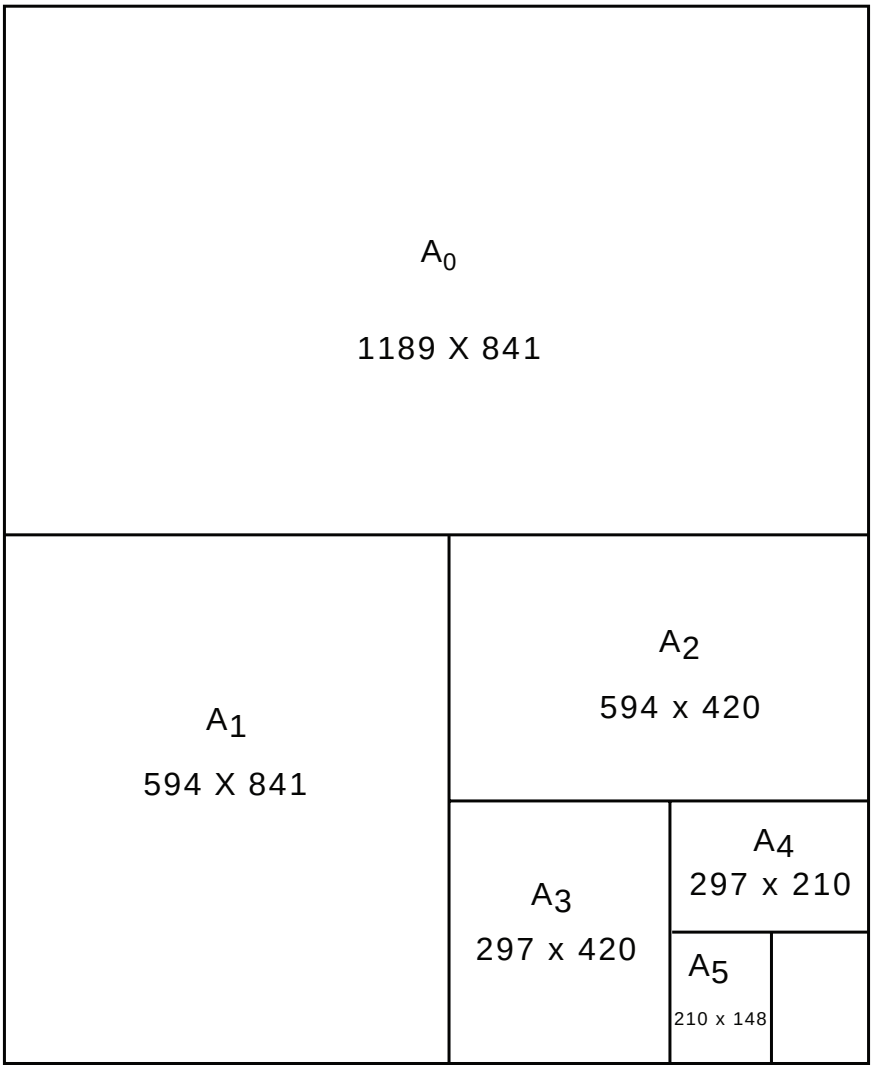
(Dimensions in millimeters)



Different qualities of drawing sheets used for making drawings. The quality of the sheet depends upon the nature of drawing . It should be tough, strong and uniform thickness. The effect of erasing should not be felt and ink should not spread out. The smooth side of the sheet should always be used for drawing.

The standards sizes of trimmed drawing sheets recommended by ISO (International Organisation for Standardization) and adopted by BIS (Bureau of Indian Standards)- BIS: 10711-1983 are as follow.

Different sizes of drawing sheet



3 BUREAU OF INDIAN STANDARDS (BIS)

INTRODUCTION

The field of engineering and Technology is fast evolving day by day to set newer trends in the world community. The arrival of foreign technologies , technical tie –ups between different countries, and exchange of new technologies have made it mandatory to set specific international standards in the field . This need is most felt in preparing and understanding of engineering drawing . **Indian Standards Institution (ISI)** established in the year 1947, formulated the code of practice for general engineering drawing in the year 1955. ISI was taken over and renamed as **Bureau of Indian Standards(B.I.S.)**in the year 1987 by an Act in the IndianParliament.

In the year 1987 , B.I.S. has adopted the standards of **ISO (Indian Standards Organization for Standardization)**in full. The following are the topics adopted by B.I.S in the field Engineering drawing(latest version)

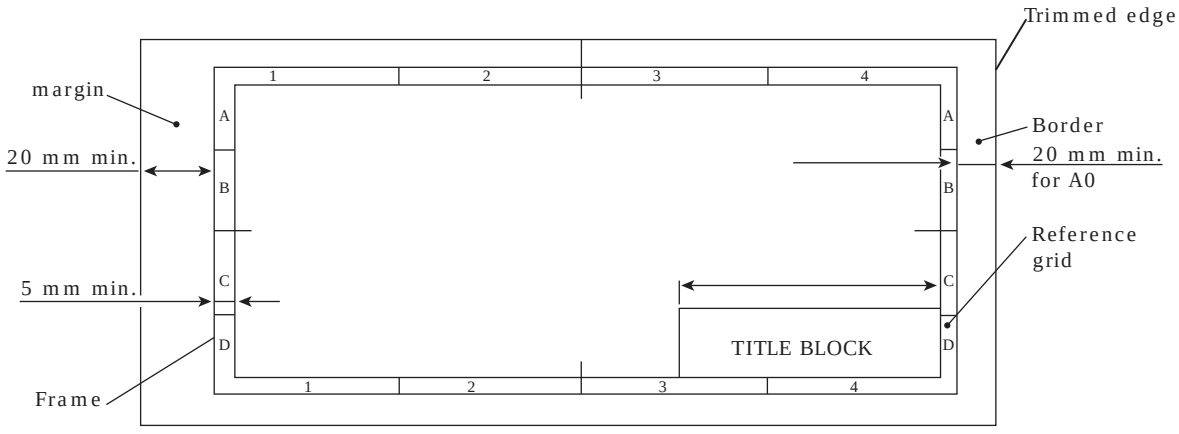
SI.No	Standard	Indian Status	Corresponding ISO standard
1	Drawing sheet(sizes, layout etc.)	IS: 10711-2001	ISO:5457-1999
2	General principles of presentation of Technical Drawing (Lines etc.)	IS: 10714-2001	ISO:128-1996
3	Lettering on Technical Drawing	IS: 9609-2001	ISO:3098-1997
4	Methods of Dimensioning	IS: 10718-1993	ISO:3040-1990

(**Note :** In the standards mentioned above, either the whole topic or certain parts(s) of the topic may have been withdrawn and new standards introduced)

LAY OUT OF DRAWING SHEET

The Lay out of drawing sheets make it easy for the readers to locate all important references of the drawing. For this a standard arrangement should be followed in which all the informations are included . The **Lay out of drawing** sheet should have the following features.

1. Margin
2. Title block
3. Parts list
4. Revision panel
5. Zone system
6. Folding marks



Lay out of drawing sheet

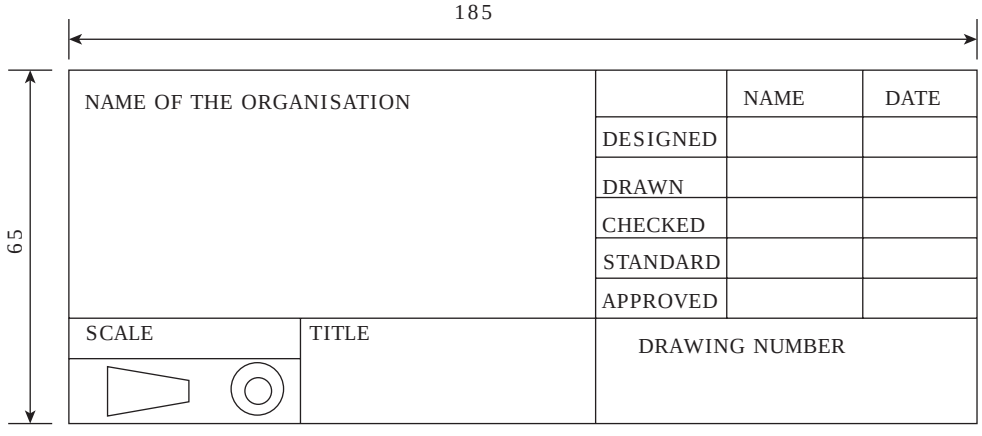
Margin

Margin is provided in a drawing sheet to enable it to be trimmed. After trimming, the sizes of the standard drawing sheets should be equal to the sizes of trimmed sheets recommended by B.I.S.

Apart from margins, border lines are drawn to get a complete working space. Drawing of border lines should also facilitate easy filing or binding.

Title Block

Provision of title block in a drawing in necessary as it gives all informations regarding the drawing. It is placed at the bottom right hard corner of the drawing sheet. B.I.S has recommended the size of the title block to be 185mm x 65mm. The size is the same for all designated sizes of the sheet (ie.from A0-A5). The title block should contain the followinginformations. A_0-A_5 A sample title block is given below:



TITLE OF DRAWING

1. Drawing Number
2. Title of the Drawing
3. Projection
4. Material Details
5. Scale of Drawing
6. Surface Finish
7. Tolerance

4 LETTERING & DIMENSIONING

INTRODUCTION

Lettering is an important feature in Engineering drawings. Writing of titles and subtitles of drawings , dimensioning the parts of the objects drawn, writing the scale and other details is called dimensioning . As the use of instrument for lettering will consume more time, it is very essential to do lettering free hand with speed, neatness, and beauty of form.

The requirements of lettering, namely types and sizes of letters and techniques of lettering are specified in IS 9609- 1983(Lettering for technical Drawings)

IMPORTANCE OF LETTERING

Neatness , legibility, uniformity, suitability for microfilming and photocopying are the main feature of lettering . Poor lettering will spoil the appearance of a drawing and lead to wrong results. Lettering is the talk of the drawing and so it very important that it is done correctly to finish the drawing completely.

PROPORTIONS OF LETTERING

There is no specified proportions for each letter of alphabets lettering. Considering uniformity, a proportions between the height and the width is to be followed. There are three proportions by which lettering can be done best. They are

1. NORMAL LETTERING
2. CONDENSED LETTERING
3. EXTENDED LETTERING

Normal lettering will have normal height and width and finds application in general use. Condensed lettering has shortened width with respect to its height and is used where space available is limited. Extended lettering will have more width and normal height.

SPACING OF LETTERS

The distance left between two adjacent letters while lettering is known as spacing of letters. Equal spaces have to be left between letters for better appearance. Spacing is judged by observation and done by practice.

A distance equal to the 3/5th of the height of the letters has to be left between two successive words. The space between two lines should be equal to 1 ½ times the height of the letters.

SIZE OF LETTERS

The size of letters in engineering drawing is the height of the letters. B.S.I recommends standard sizes of lettering for various features and they are listed below

SI. No	Features	Size(Height in mm)
1	Drawing Numbers, Letters indicating cutting plane section	10, 12
2	Title of the drawing	6, 8
3	Sub-titles and headings	3, 4, 5 & 6
4	Material List, Dimensioning, Schedules , notes	3, 4 & 5
5	Tolerances Alteration entries	2 & 3

TYPES OF LETTERS

The lettering in which the alphabets are written with uniform thickness is known as Gothic lettering . Gothic lettering may be done on single stroke and double stroke. Double stroke letters are thicker than single stroke letters.

ITALIC PRINTING IS

free hand gothic

OR ROMAN LETERING

Types of letters

1. Vertical letters
   a) Upper case letters (capital)
   b) Lower case letters

2. Inclined letters
   a) Upper case letters (capital)
   b) Lower case letters

Vertical Letters

If the direction of alphabets and numerals is vertical, the letters are know as vertical letters, Both upper case and lower case letters are written in this fashion.

Inclined Letters

When the letters are written inclined to the horizontal line, they are called inclined letters. The angle of inclination is approximately 75° from right to left.

Vertical Upper Case Letters

A B C D E F G H I J K L M N

O P Q R S T U V W X Y Z

I II III IV V VIVII VIII XI X

Vertical Lower case Letters

a b c d e f g h i j k l m n

o p q r s t u v w x y z

1 2 3 4 5 6 7 8 9 0

Inclined Upper case letters

A B C D E F G H I J K L M N

O P Q R S T U V W X Y Z

I II III IV V VIVII VIII XI X

Inclined lower case letters

a b c d e f g h i j k l m n

o p q r s t u v w x y z

1 2 3 4 5 6 7 8 9 0

DIMENSIONING

Drawings are made to represent the actual shape and size of the objects to be produced. So it is necessary to place proper dimensions and related informations regarding different parts of the object. In case the dimensioning is not done properly, there will be great loss in materials, labour and time.

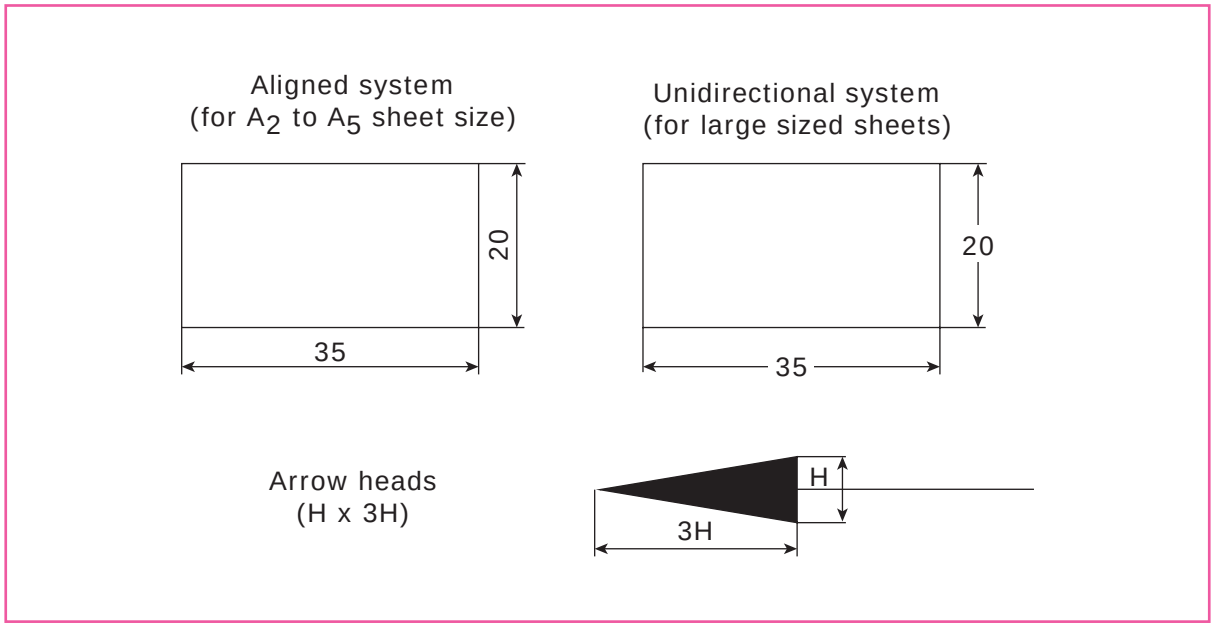
Dimensioning is known as the method of writing various sizes (or) measurements of an object and other important informations such as tolerances on a finished drawing. It should be done with great care that no information is left out in describing the object completely.

TYPES OF DIMENSIONS

System of Dimensions

According to B.I.S., there are two system of placing dimensions on drawing and they are

1. Aligned system
2. Unidirectional system



Alinged system

In this system, the dimensions are placed in a manner to read them from the bottom or from the right side of the drawing. All the dimensions are placed above the dimension lines. Alinged system dimensioning is commonly used in engineering drawing.

Unidirectional system

In this system , the dimensions are placed so that they may be read from the bottom of the drawing only. The dimensions are placed approximately at the middle of the dimension line by breaking it .There is no restriction in controlling the direction of the dimension lines.

Notation of dimensioning

The dimension lines, extension lines , leader lines, arrow head, dimension figures, notes and symbols make up the notation of dimensioning .

Dimension line

Dimension lines are used to indicate the measurement in numbers at a space above them or at a space created by breaking them approximately at their center. Dimension line is drawn as thin continuous line.

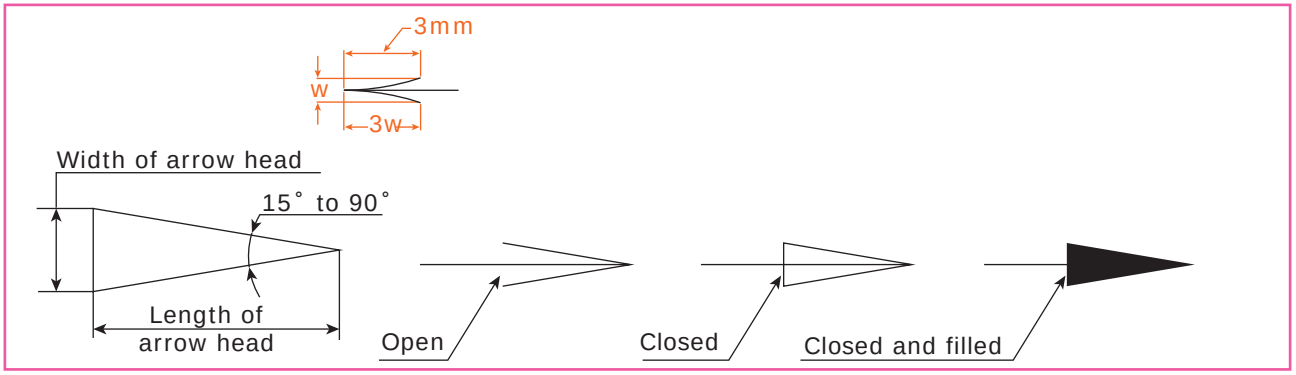
Extension line

It is the line that extends from the outline of the object on a drawing . It is a continuous thin line extending atleast about 2mm beyond the dimension line.

Leader line

When some notes are to be made regarding a specific feature of a drawing , leader lines are used. They extended from where the notes have to be applied to a point where the notes are actually written. Leader line has an arrow at one end which touches the particular feature . It is drawn at any convenient angle between 30° to 60°

Arrow head



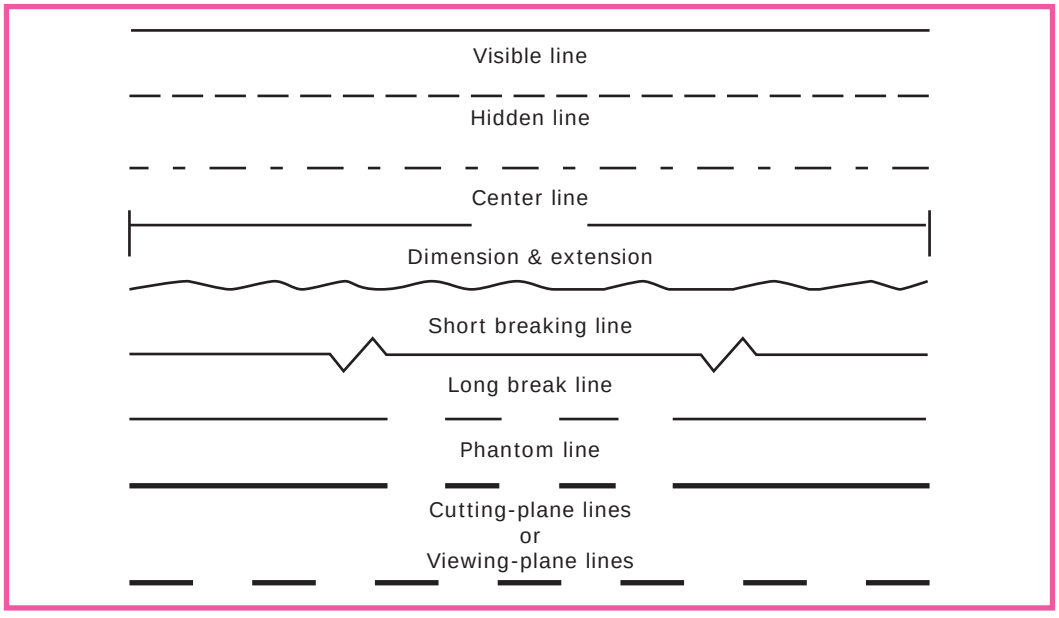
Arrow head are placed at both ends of a dimension line. They touch the extension lines drawn from the outline of the part and indicates the extend of a dimension . The length and width of the arrow should be in the ratio 3:1

Dimension figure

The size of a specific feature is indicated by the dimension figure either as a numerical or as symbols like Ø, R followed by numerals.

TYPES OF LINES

Engineering drawing is made by the combination of different types of lines. Each line shown in the drawing is meant to represent a separate meaning. So it necessary to understand the types of lines and their meaning to make or read a drawing successfully.



Continuous thick line

A continuous thick line in a drawing represents a visible edge or outline. It is drawn with a H or HB grade pencil.

Continuous thin line

Continuous thin lines are used for construction of a drawing. These lines are also used for drawing dimension lines, extension lines, leader lines, and sectional lines(hatching line). When used as construction lines, they do not appear on the finished drawing. But in geometrical drawings, they are removed. Continuous thin lines are drawn with 2H pencils.

Short dashes

Short dashes represent hidden features or outlines in a drawing . The dashes should be of uniform length and the spacing equal. They are drawn with H pencils.

Long chain (thin)

Long chain lines are drawn as an alternative combination of a long dash and a short dash. The lengths of both long dashes, short dashes are to be maintained uniform and they are equispaced . They represent centre lines, extreme positions movable parts and pitch circles in drawings. This types of line is drawn with a 2H pencil.

Long chain(Thick at ends)

It is very similar to a long chain line expect that the terminal long dashes are drawn thick. Cutting plane lines are represented by this type of line. The terminal dashes are drawn with H pencil and others with 2H pencils.

Long chain(Thick)

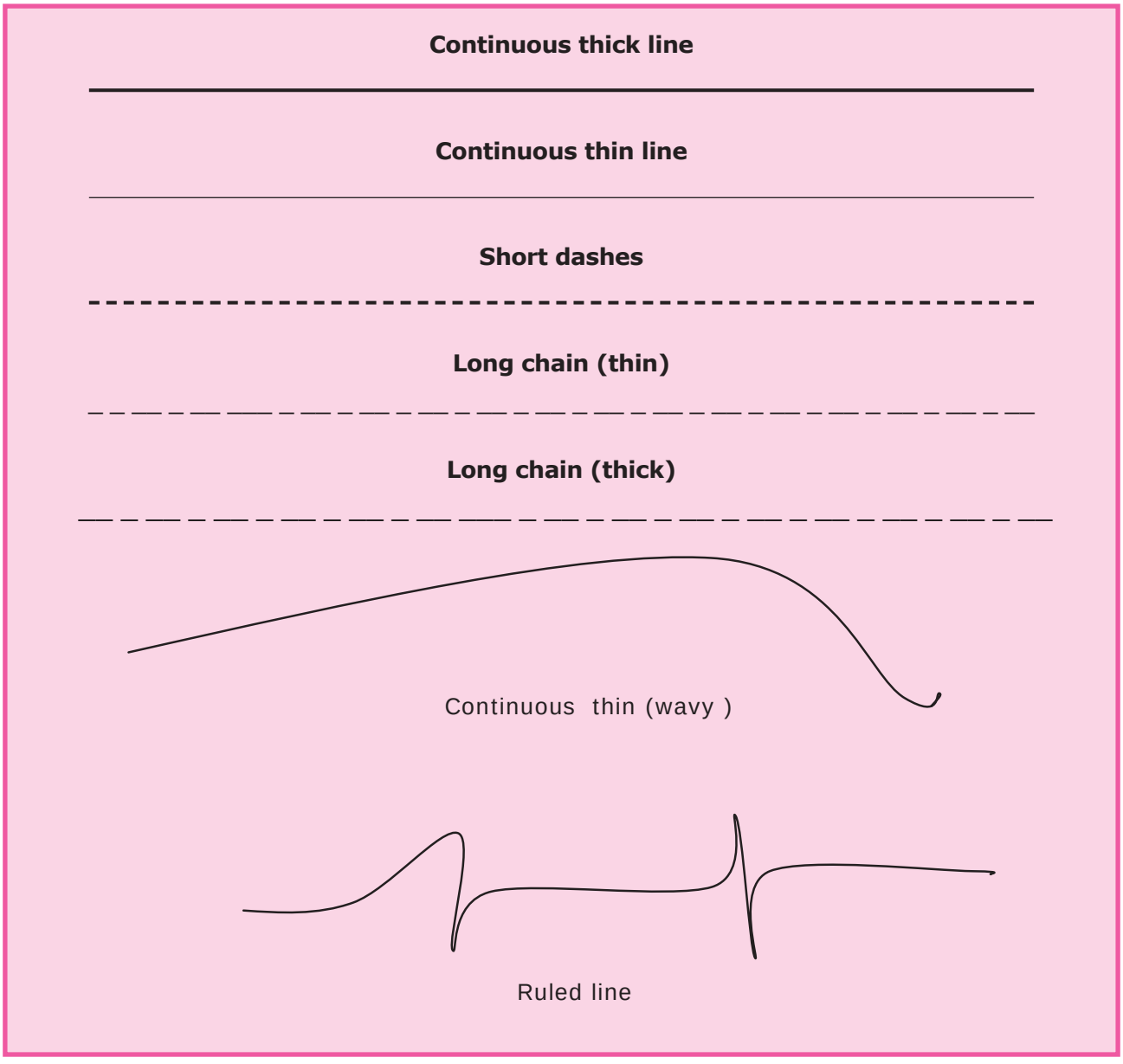
A long chain line is drawn thick completely for this type of line. The surfaces which are to receive additional treatment are represented by a long chain (thick) line. It is drawn with a HB pencil.

Continuous thin(Wavy)

Irregular boundary lines and short break lines are drawn as wavy continuous thin lines. They are with 2H pencils.

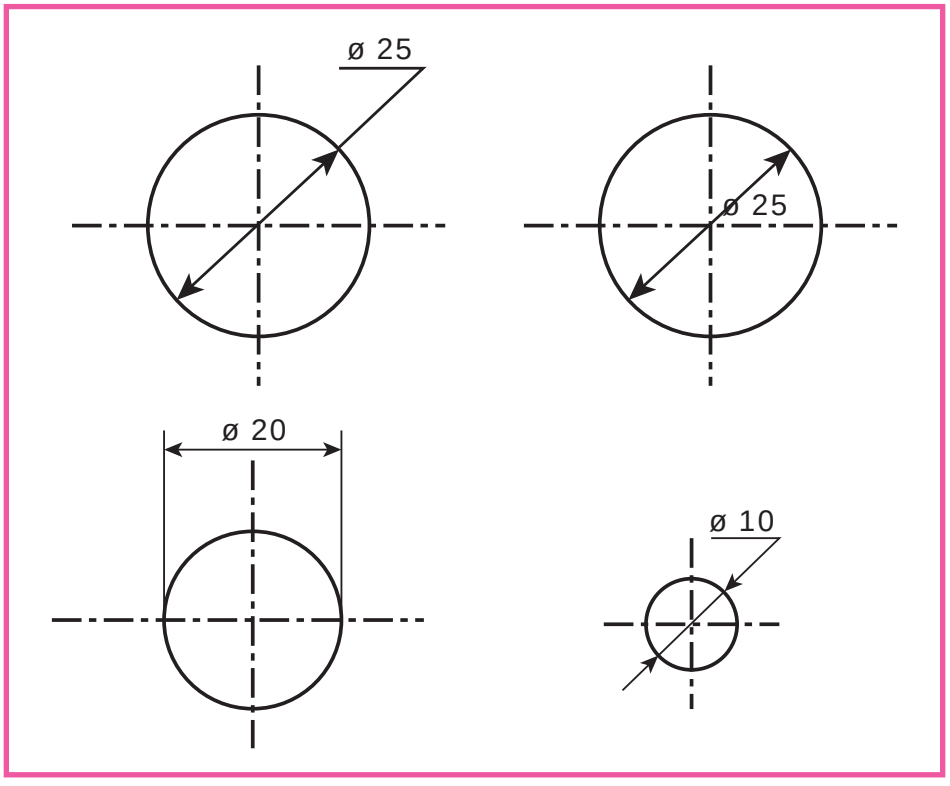
Ruled line and short zigzag(thin)

These lines indicate long break lines. When a long structure of uniform shape is to be shown on a drawing, its view is intercepted by this line and it is drawn with 2H pencil.

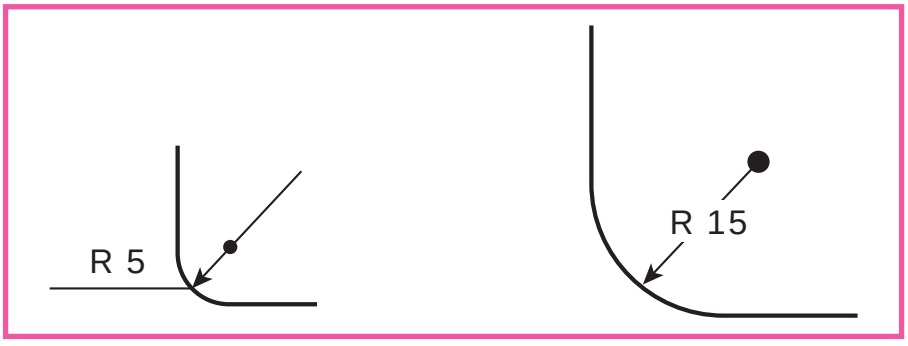


General rules for dimensioning

1. Dimension should be placed outside the view as far as possible.
2. Dimension lines should not intersect each other.
3. Dimension lines should not be placed cutting an extension line.
4. Dimension lines should be given on the view which shows the relevant feature most clearly.
5. Dimension should never be crowded. If the spaces is not sufficient , arrow heads may be replaced by dots or inclined lines.
6. The distance between the outline of the object and first dimension line should be at least 10mm.
7. A distance of atleast 8mm should be kept between two adjacent dimension lines.
8. The extension line should not project beyond 2mm from the dimension line.
9. Leader lines should be constructed at an angle to the horizontal(30°, 45° and 60°)
10. Center lines should not be used as dimension line.
11. Dimensions with smaller sizes should be placed near the drawing than those with bigger sizes.
12. Dimensions marked in one view need not be repeated in other views.
13. While dimensioning angles, their values are placed outside the view.
14. Remarks , instructions and foot notes should be written horizontally.
15. Dimensions of part which are not drawn to scale should be underlined. If the whole drawing is not drawn to scale , a note should be made in the drawings as 'NOT TO SCALE'.
16. When all the dimensions are in same unit, there is no need to mention the unit. Instead a foot note should be written as 'ALL DIMENSIONS ARE IN mm'.
17. The size of the datum plane should be written within brackets.
18. While dimensioning external threads , the type , size and length should be marked.
19. The size of the arcs should be indicated by its radius.
20. The diameter of the circle is always specified as follows

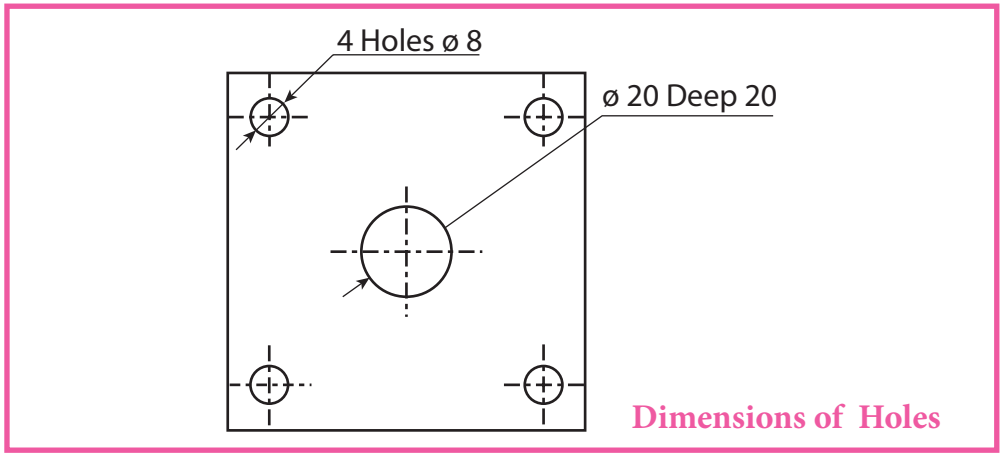


21 While marking the dimension of an arc, the dimension should be proceeded by a mark 'R'.



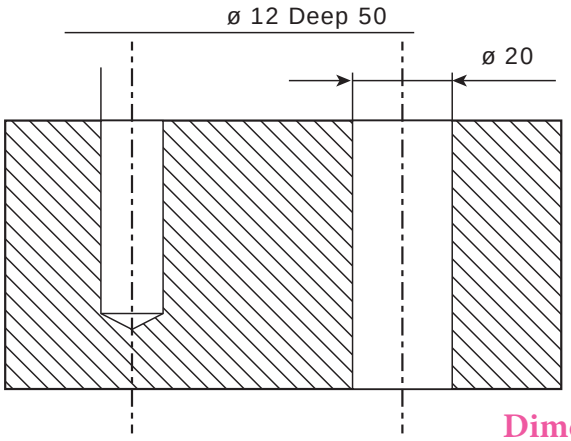
22. The dimensions of holes may be made in the following methods

(i) It should be understood that the four holes are of 8mm diameter. The hole at the centre is 20 mm deep and the diameter is 20 mm.



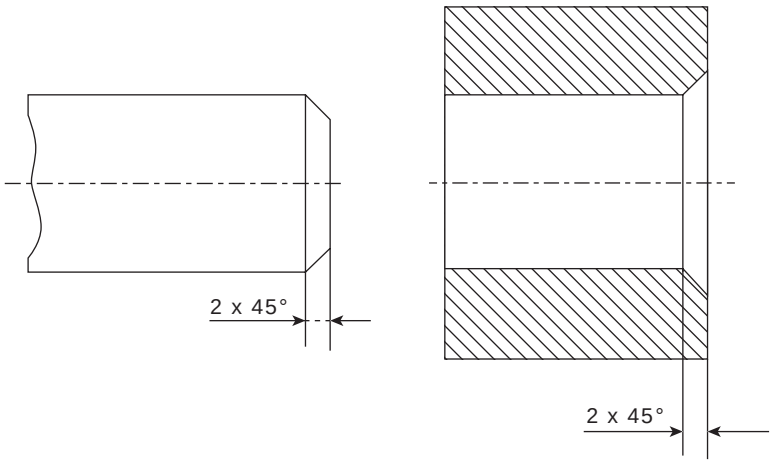
Dimensions of Holes

(ii) The hole on the left is 50 mm deep and is of diameter 12 mm. The other hole is a through hole of diameter 20 mm



Dimensions of Holes

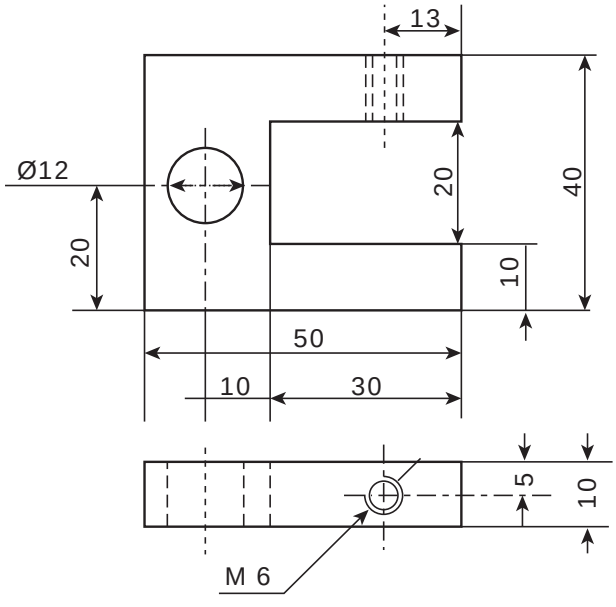
Chamfering is done at the ends of cylindrical parts and parts having cylidnrical holes chamfering is dimensioned as shown following diagrams



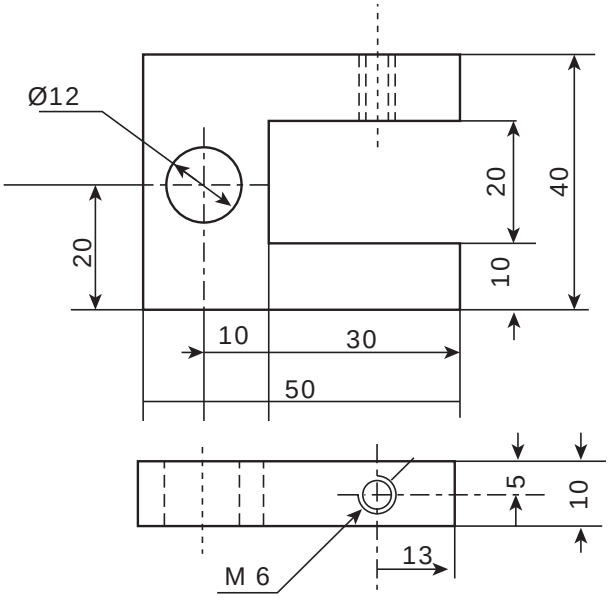
Incorrect and correct methods of dimensioning

In the previous section, guidelines are given regarding proper dimensioning of some important profiles. However, there are chances that dimensions may not be represented in a correct way. Some examples are given in the next few pages to highlight the situations where dimensions are misrepresented frequently and to correct them.

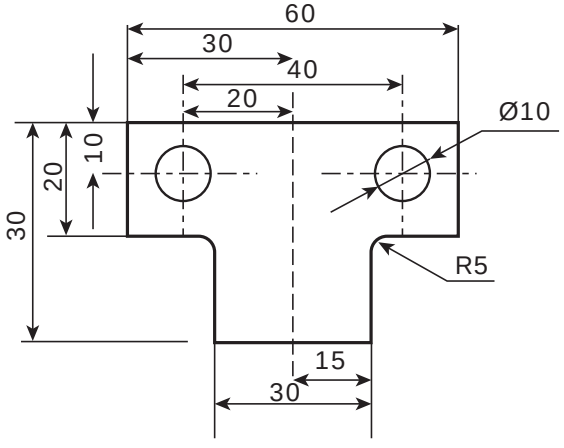
Incorrect



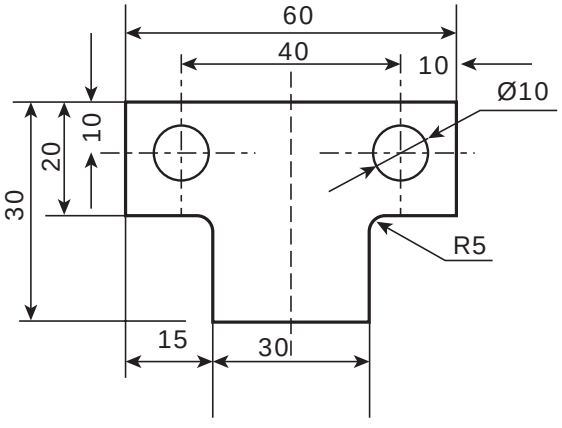
Correct



Incorrect



Correct



5 SCALE OF DRAWING

INTRODUCTION

It is now our knowledge that drawings are made to show all the details of objects clearly. But, it is not always possible to show the objects on a drawing sheets in actual sizes. For example, large machine parts cannot be represented on a drawing sheet in its original size. Hence, it is necessary to reduce the size of the object in affixed proportion to show it in a drawing. At the same time, it is necessary to increase the size of the object in some cases to give a clear description of the object.

In both cases, a proportion is used either to reduce or increases the dimensions of the object. So the proportion by which the actual size of the object is reduced or increased on a drawing is known as **Scale of a drawing.**

Scales are usually made of celluloid, card board, wood or metal. They are actually rulers on which different proportions are represented to make drawings of objects having different range of dimensions. As far as possible, standard scales are adopted in making drawings. The standard scales are designated asM1, M2, M3 ---------- M8. When standard scales are not suitable for making a particular drawing, scales in required proportion can be constructed.

Uses of Scales

The important uses of scales are

1. Scales are useful in making reduced size and enlarged size drawings.
2. The dimensions of various parts can be measured directly.

Types of Scales

There are three types of scales according to the proportions made on them.

1. Full size scale
2. Reducing scale
3. Enlarging scale

Full size scale

When the dimensions of objects are shown on a drawings in its actual sizes, the scale used in the drawings is full size scale. *Full size scale is indicated as 1:1*

Reducing scale

When the size of the object is too large to be accommodated on a drawing sheet, the dimensions of the object are reduced in a particular proportion and represented in the drawing. This scale is known as reducing scale. Eg :*1:2, 1:5, & 1:10*

Enlarging scale

When the size of the object to be shown on the drawing sheet is very small to give clear description about the object, the dimensions of the object are enlarged in a particular proportion. This scale is called enlarging scale.Eg :*2:1, 5:1, 10:1.*

Full size scale	Reducing scale	Enlarging scale
1:1	1:2 1:5 1:10 1:20 1:50 1:100 1:200	10:1 5:1 2:1

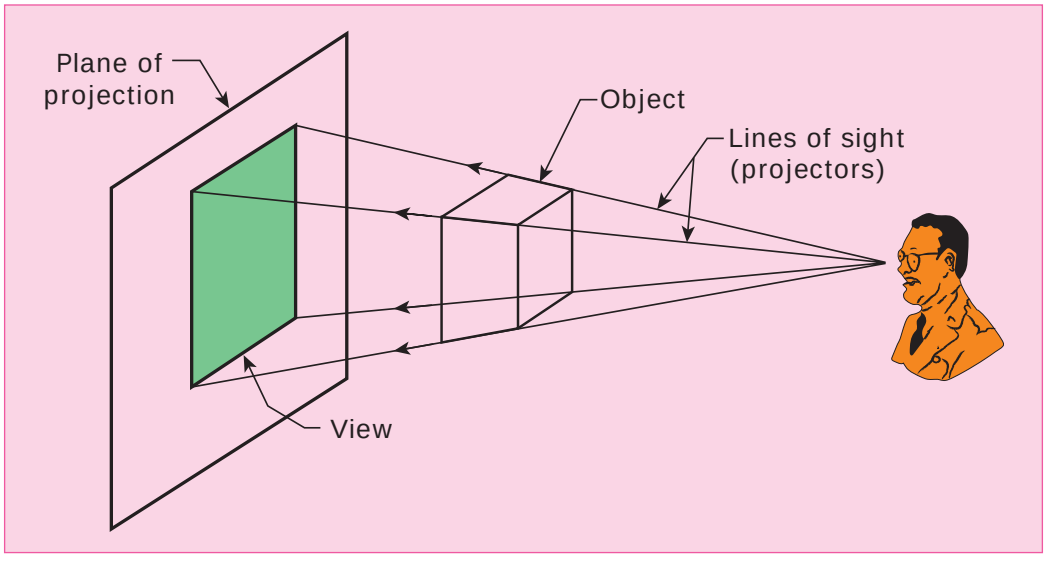
6 PROJECTION

INTRODUCTION

In the introductory chapter, it was explained that the need of the drawing is to communicate the ideas and informations regarding an object between a number of engineers and operators in the field of designing, developing, manufacturing and marketing. As regards to solid geometric drawing, there is the necessity of presenting the informations about a three dimensional object on a two dimensional plane of paper. In overcoming this difficulty, the views of the objects are represented pictorially. Apart from pictorially. Apart from pictorial drawings, the information about the object can be represented in more than one view arranged in a specified order. In general, obtaining the views of the object on a drawing sheet is known as **Projection** and procedures and rules involved in the process are known as **Theory of projection**.

Theory of projection

In the engineering drawing, the exact shape and size of an object should be shown on a two dimensional plane and paper. For doing so, the object is imagined to be located between the observer and the plane on which the view is going to be obtained. Straight lines are drawn from different points on the contour of the object to meet the plane of paper. The points obtained on the sheet of paper are joined in proper sequence to form the image or view of the object.



Pictorial projection

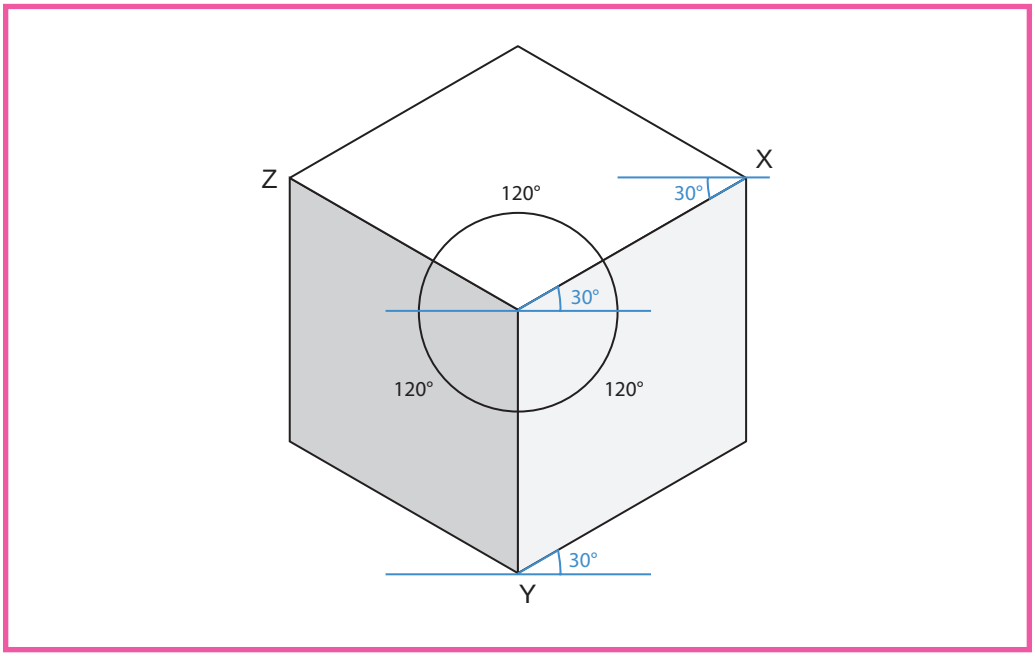
Pictorial projection is a projection in which the description of the object is presented completely in one view. These projections give an immediate impression of the general shape and details of the object. But the exact size of the object is not exhibited.

Isometric View

If the length, breadth and height of an object are drawn and shown in a single view which is called Isometric view.

The method of drawing of Isometric View

Isometric projection is the representation of an object in pictorial form. In isometric projection, there are three pictorial axes namely X,Y and Z which are 120^0 apart. The length, breadth and height of the object are drawn on these axes.



Oblique projection

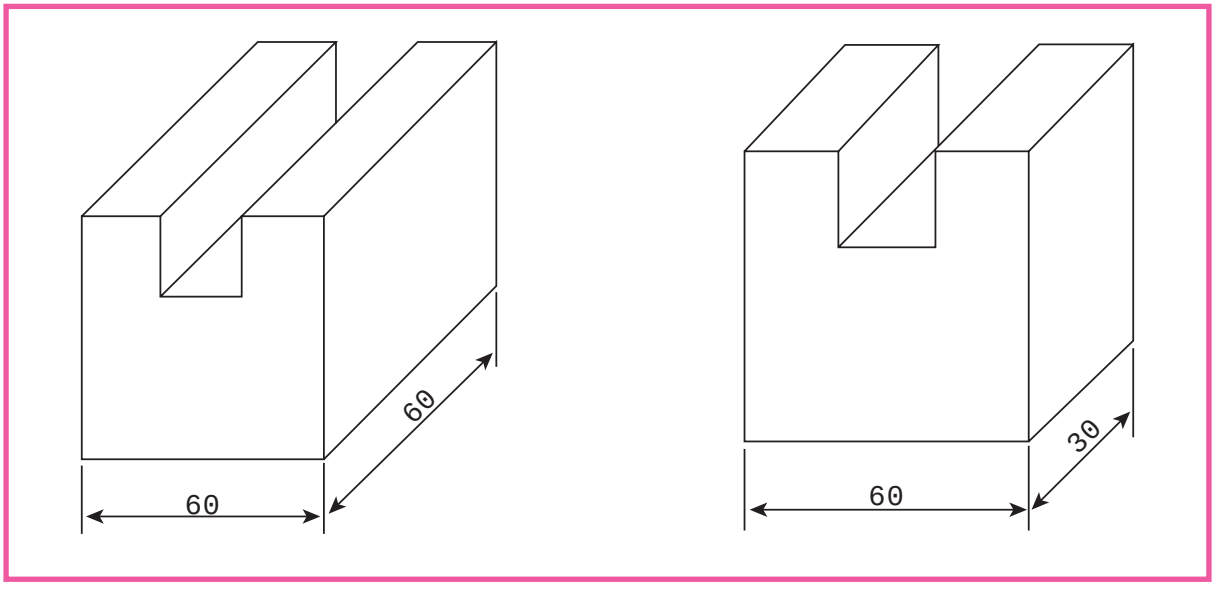
It is the projection of an object on a plane when one face of the object is kept parallel to the plane and the other adjacent face is inclined at 45^0 to the plane , i.e. the projectors make an angle of 45^0 with the plane of projection. Here two axes are perpendicular to each other. But the third axis is drawn either at 30^0 or at 45^0 to the horizontal. The main types of oblique drawings are

1. Cavalier Drawing
2. Cabinet Drawing

Cavalier Drawing

In this type of drawing, two axes are drawn perpendicular to each other and the third is inclined at 45^0. It is made of the exact dimensions of the object. However, in many instances, this projections makes the view appear distorted.

Cavalier Drawing **Cabinet Drawing**



Cabinet Drawing

To reduce distortion, the dimensions of the object along the receding axis is drawn to half scale. The resulting view is called cabinet drawing.

Perspective projection

It is the projection of an object obtained on a plane when the projectors converge to a point. This projection does not represent the actual size of the object.

Orthographic Projections

It is the projection in which different views of an object are obtained on planes of projection when the projectors are parallel to each other and perpendicular to the plane on which the view is projected.

There are some assumptions to be made for obtaining orthographic projection:

1. The observer looks at the object from an infinite distance.
2. The lines drawn from various points on the contour of the object (projectors) are parallel to each other.
3. On projection from the object, these lines meet the plane (of projection) at right angles (the Projectors are perpendicular to the plane of projection)
4. The plane of projection is transparent.

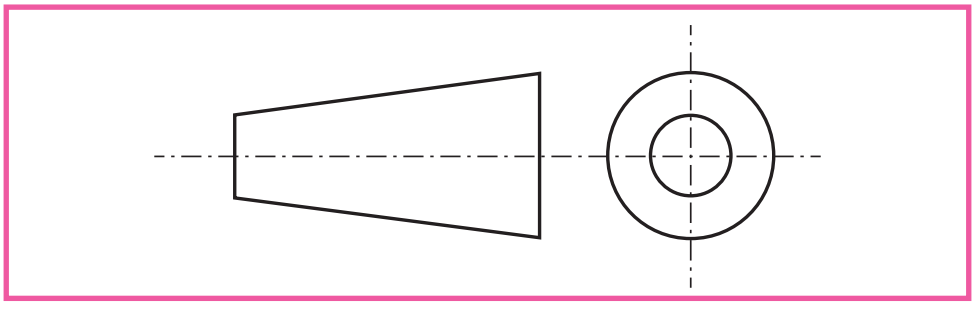
Types of orthographic projection

The object can be placed in any of the four quadrants to obtain the projections (or) views. In convention. The practice of getting views by placing the object either in the first or in the third quadrant is followed. So, the types of orthographic projections are

1. First angle projection
2. Third angle projection

First Angle Projection

When the object is placed in the first quadrant in front of the vertical plane and above the horizontal plane, the method of obtaining the projections on these planes is called **First Angle Projection.**



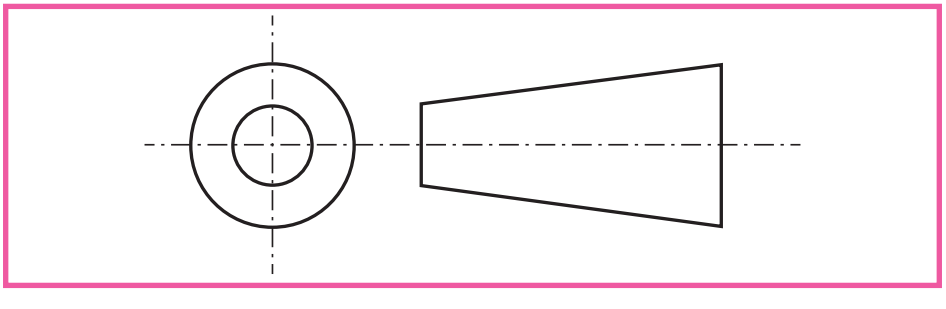
In this method of projection, the object lies between the observer and the planes of projection. The front view is obtained above the ground line (or) reference line and the top view is obtained below the ground line. When the horizontal plane and auxiliary vertical plane are rotated after obtaining the projections, the views will be arranged as follows:

1. The top view is placed below the front view
2. The left side view is placed at the right side of the front view
3. The right side view is positional at the left side of the front view.

Third Angle Projection

The method of obtaining projections on vertical plane and above the horizontal planes by placing the object in the third quadrant is known as **Third Angle Projection.**Here, the object is placed behind the vertical plane and below the horizontal plane.

In this method of projection, the planes of projection lie between the observer and the object. The front view is obtained below the ground line and the top view is obtained above the ground line.



When the horizontal plane and auxiliary vertical plane are rotated after obtaining the projections, the views will be arranged as follows:

1. The top view is placed above the front view
2. The left side view is placed at the left side of the front view
3. The right side view is placed at the right side of the front view.

Views obtained in orthographic projection

Different views are obtained on different planes in orthographic projection. They are

1. Front View (or) Elevation
2. Top view (or) Plan
3. Right Side View
4. Left side View
5. View from Below
6. View form the Rear
7. Cut Section View
8. Auxiliary view

Front view: when the object is viewed from its front, the projection (or) view of the object obtained on the vertical plane, is known as front view. It is also known as Elevation. The details of length and height are found in this view.

Top view : when the object is viewed from its top, the projection (or) view of the object obtained on the horizontal plane, is known as top view. It is also known as Plan . Length and width details of the object are found in this view.

Side view: When the object is viewed from its side, the projection (or) view of the object obtained on the auxiliary vertical plane is known as side view. It can also be called as **side elevation.**

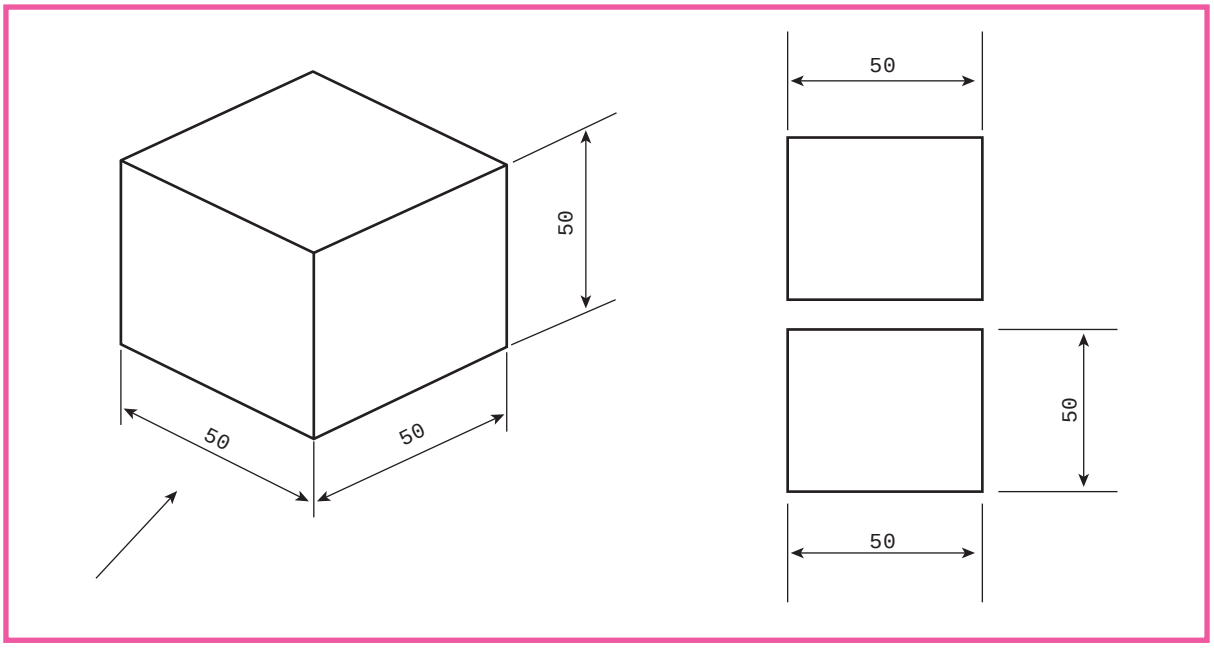
Auxiliary view: when the object is viewed from a direction which is not parallel to any of the three major axes, the projection (or) view obtained on a auxiliary plane is known as auxiliary view. When a specific detail which cannot be shown in any of the above three views is necessary to be shown, it is done so on auxiliary view.

Making orthographic projection from isometric view

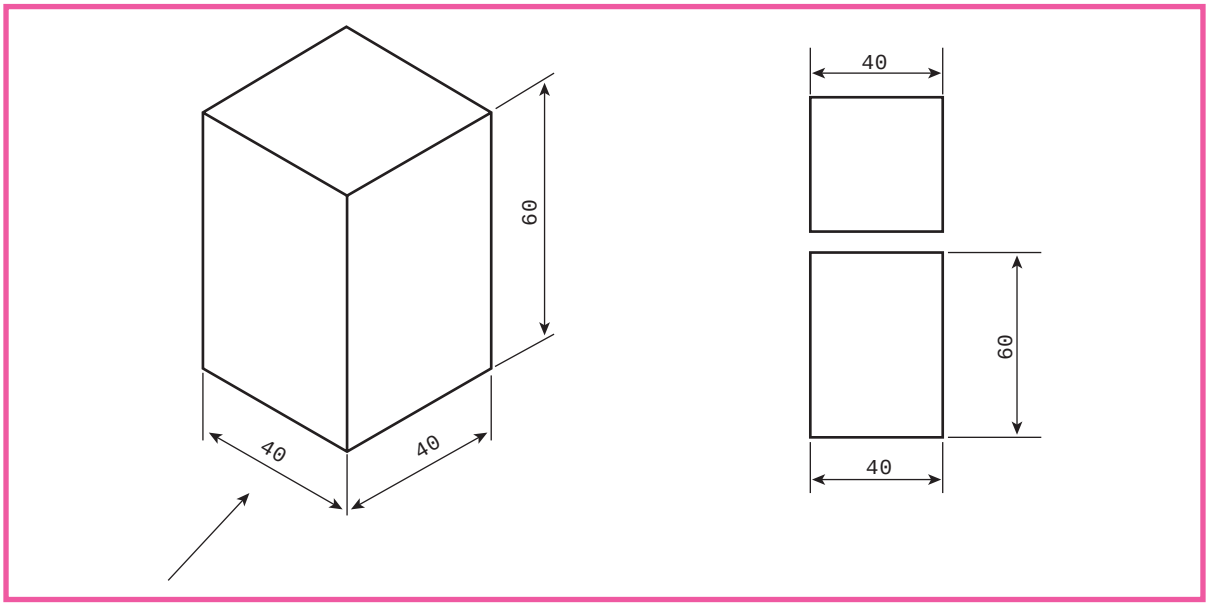
The isometric view helps us in understanding the shape of the object but does not give the dimensional and inner details of the object. But these details are necessary for designing and manufacturing purposes. So, the need of orthographic projection becomes essential.

The object is viewed from the direction of arrow to obtain the front view. If the arrow is not given, the most prominent views is taken as front view. The other views are obtained by viewing the object in direction that are perpendicular to the one utilized for front view.

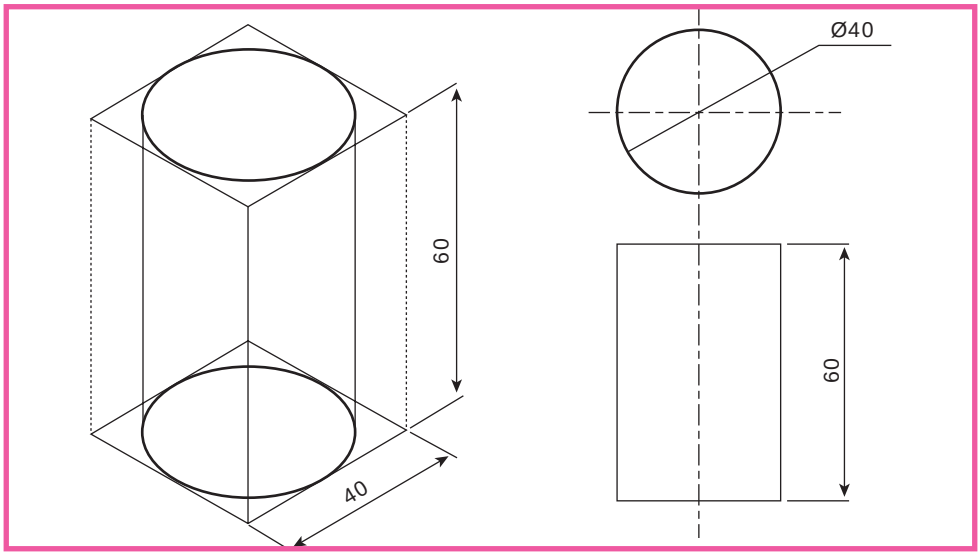
The following illustrations are given to make orthographic projections from the given isometric views.



Isometric views **Orthographic Projections**

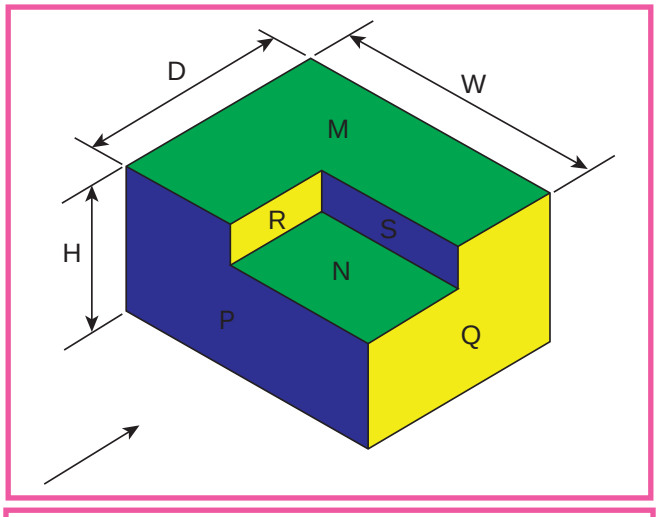


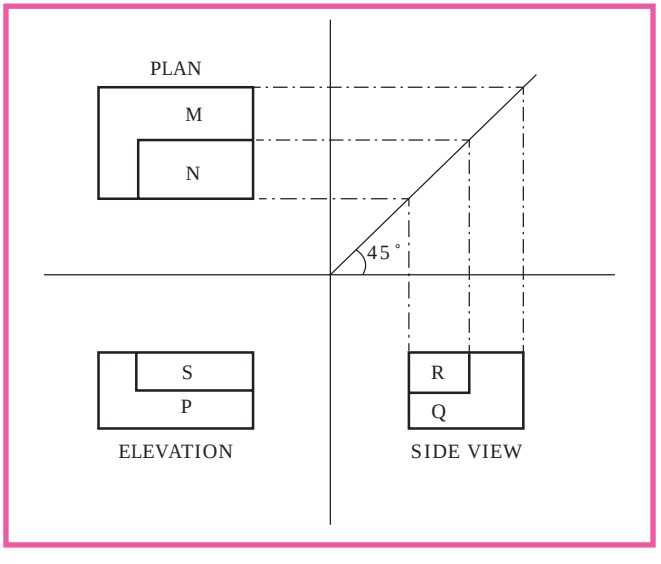
Isometric views **Orthographic Projections**



The following illustrations are given to make Orthographic Projections from the given Isometric Views.

Isometric view

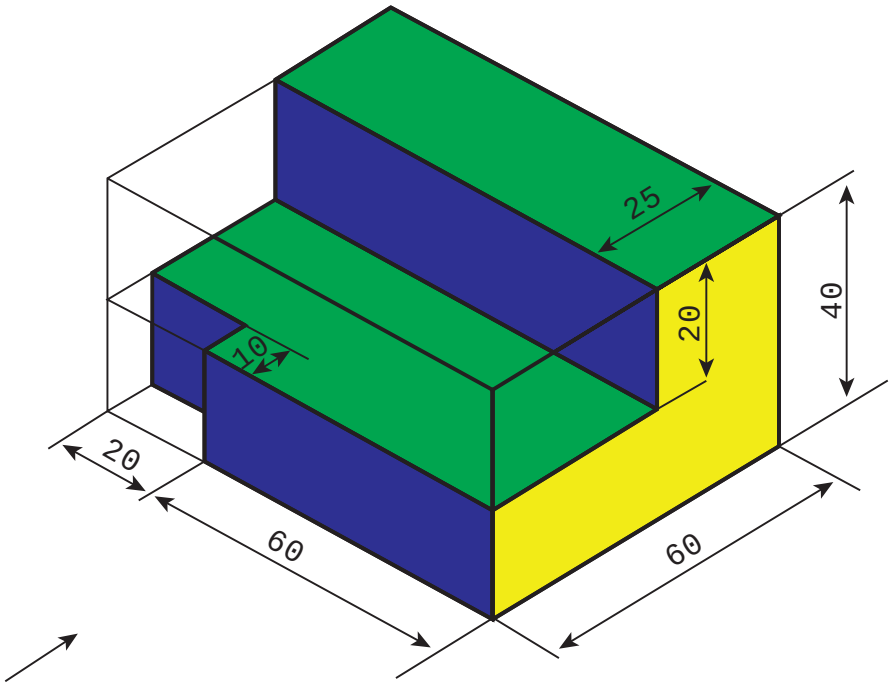




PRACTICAL - I
ENGINEERING DRAWING PRACTICAL

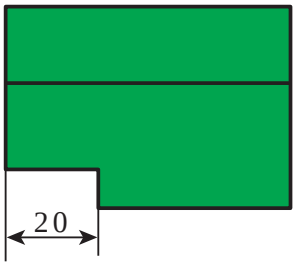
PRACTICAL 1

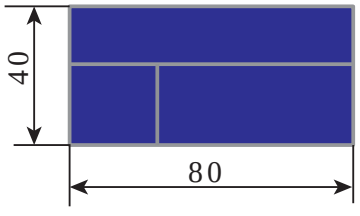
ISOMETRIC VIEW



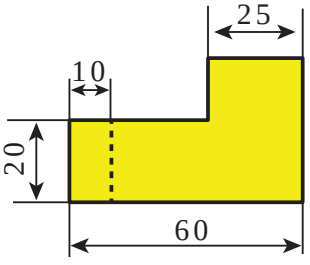
ORTHOGRAPHIC PROJECTION

PLAN





ELEVATION

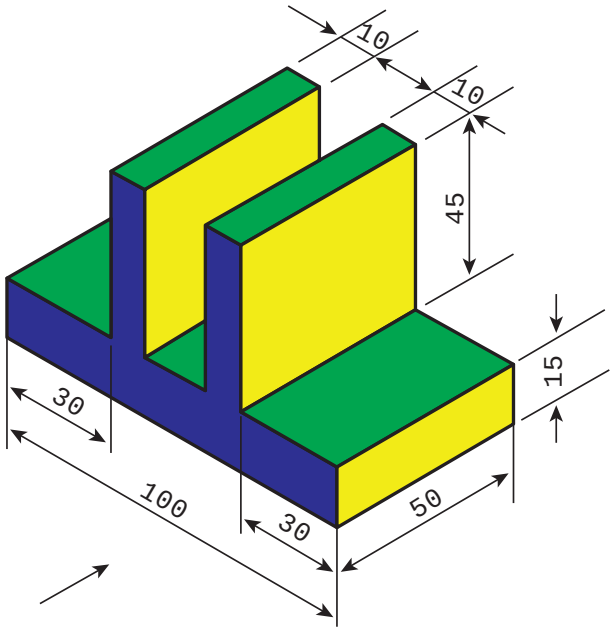


SIDE VIEW

ALL DIMENSIONS ARE IN mm.

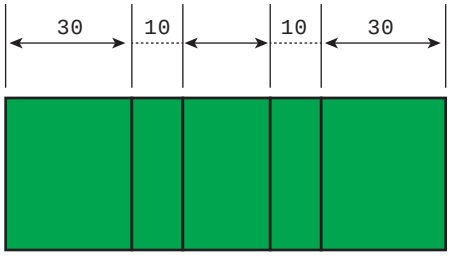
PRACTICAL 2

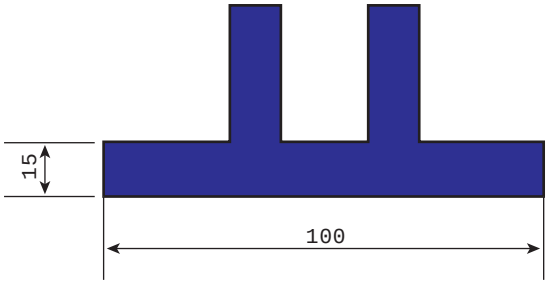
ISOMETRIC VIEW



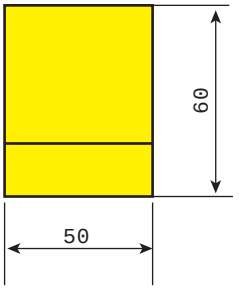
ORTHOGRAPHIC PROJECTION

PLAN





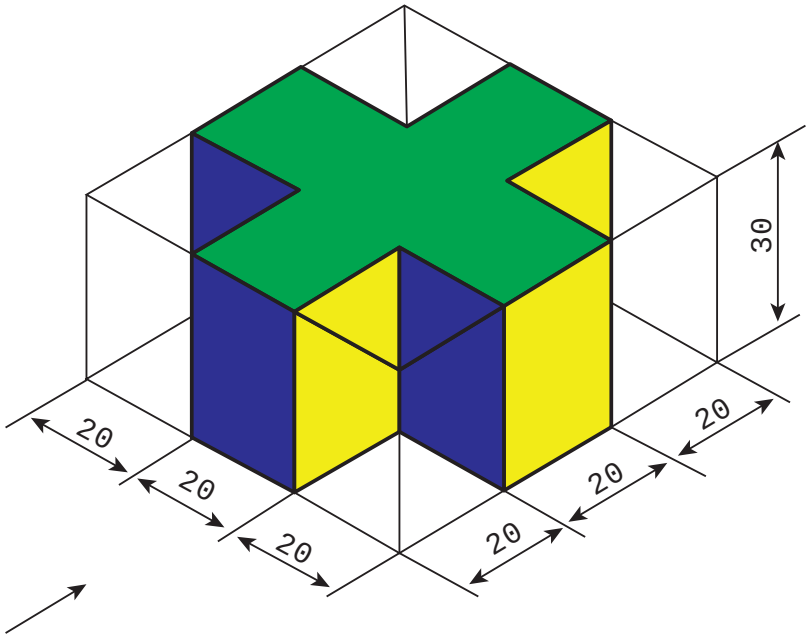
ELEVATION



SIDE VIEW

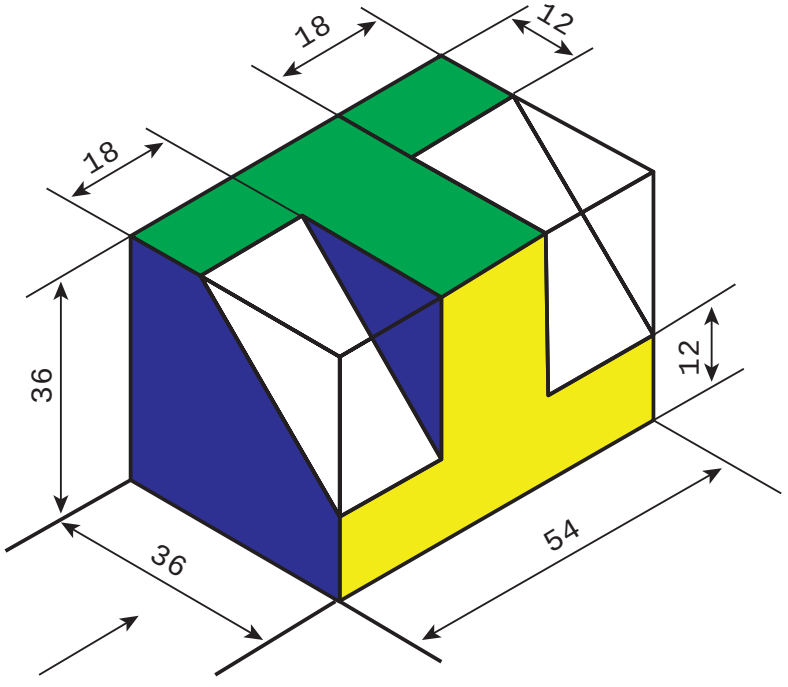
ALL DIMENSIONS ARE IN mm

PRACTICAL 3



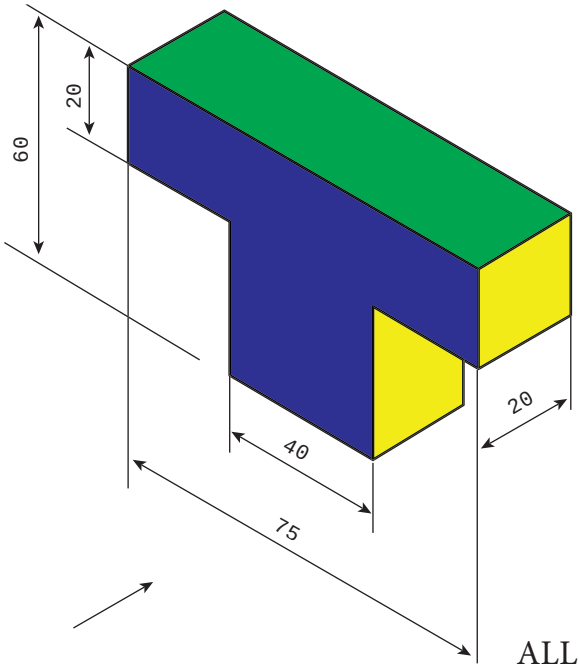
ALL DIMENSIONS ARE IN mm

PRACTICAL 4



ALL DIMENSIONS ARE IN mm.

PRACTICAL 5

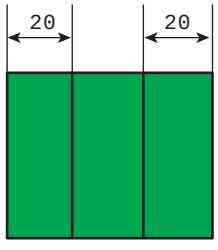


ALL DIMENSIONS ARE IN mm.

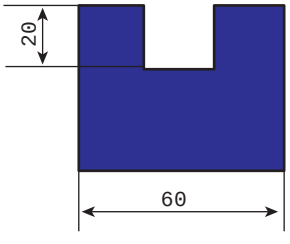
PRACTICAL 6

The following illustrations are given to make Isometric Views from the given Orthographic Projections.

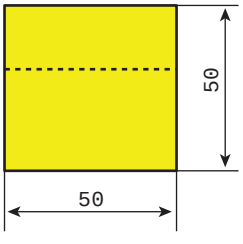
PLAN



ALL DIMENSIONS ARE IN mm.



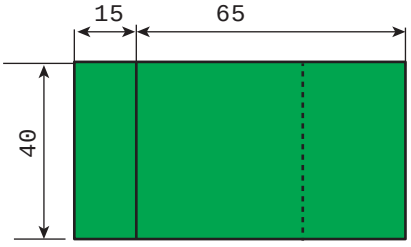
ELEVATION



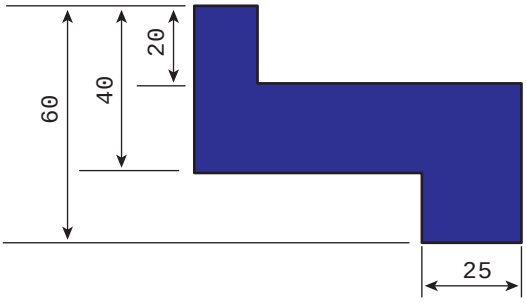
SIDE VIEW

PRACTICAL 7

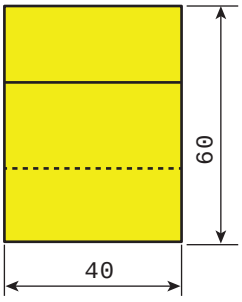
PLAN



ALL DIMENSIONS ARE IN mm.



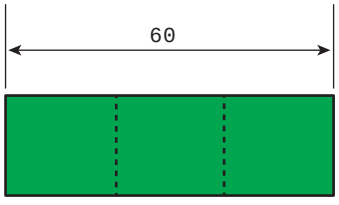
ELEVATION



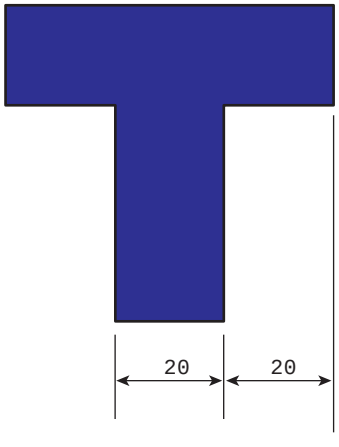
SIDEVIEW

PRACTICAL 8

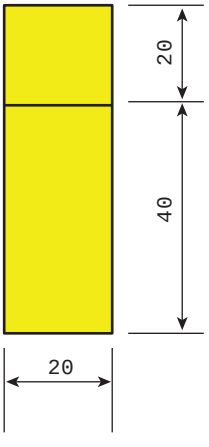
PLAN



ALL DIMENSIONS ARE IN mm.



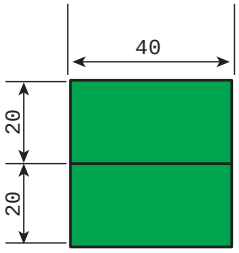
ELEVATION



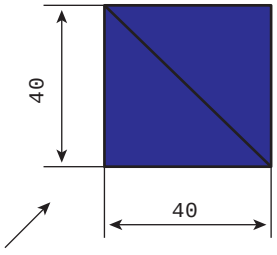
SIDE VIEW

PRACTICAL 9

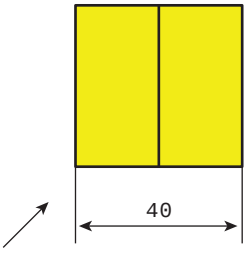
PLAN



ALL DIMENSIONS ARE IN mm.



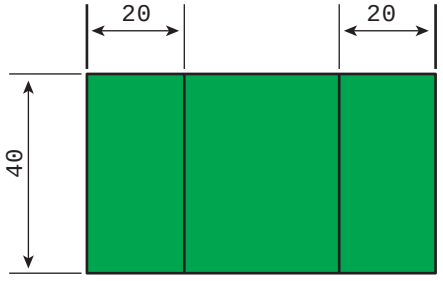
ELEVATION



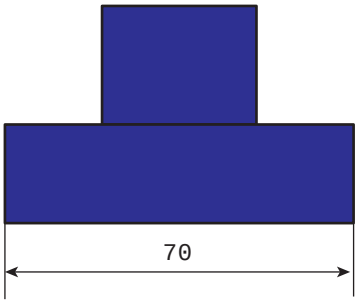
SIDE VIEW

PRACTICAL 10

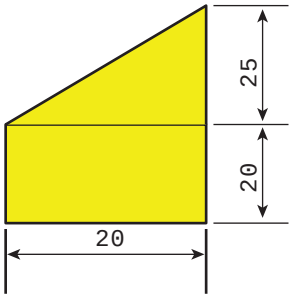
PLAN



ALL DIMENSIONS ARE IN mm.



ELEVATION



SIDE VIEW

7 BLUE PRINT READING

Blueprint is the common name given to the copies taken from an original drawing. The name has nothing to do with the colour of the paper or the colour of the drawing lines.

Blue print reading is an essential skill for any technical persons to perform his job in industry satisfactorily for manufacturing a component accurately and correctly. Proper interpretation of the drawing is essential. Blue print reading involves the following aspects.

1. Visualization of the object from the given orthographic views.
2. Interpretation of the dimensions, notes and symbols.

For blue print reading, one must have a through knowledge of principles of drawing and orthographic projections & also various manufacturing processes.

ABBREVIATIONS FOR MATERIALS

FERROUS MATERIALS		
SI.No.	**Ferrous material**	**Abbreviation**
1	Cast Iron	CI
2	Cast Steel	CS
3	Forged Steel	FS
4	Mild Steel	MS
5	Spring Steel	Sp.S

NON – FERROUS MATERIALS		
SI. No.	**Non – ferrous Material**	**Abbreviation**
1	Aluminium	Al
2	Brass	Br.
3	Bronze	Bronze
4	Copper	cpr
5	Gun Metal	GM
6	White Metal	WM
7	Zinc	Zn

DRAWING ABBREVIATIONS

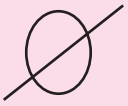
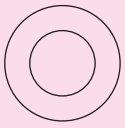
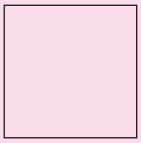
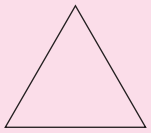
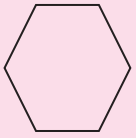
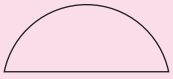
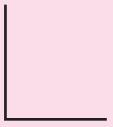
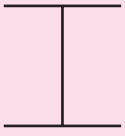
SI.No.	Term	Abbreviations
1	Across corners	A/C
2	Across flats	A/F
3	Alteration	Alt
4	Approved	APPD
5	Approximate	AAPROX
6	Assembly	Assy.
7	Auxiliary	AUX
8	Centimeter	cm
9	Centres	CRS
10	Centre line	CL

SI.No.	Term	Abbreviation
11	Centre to centre	C/C
12	Checked	CHD
13	Circular pitch	CP
14	Connected	CONN
15	Continued	CONTD
16	Counterbore	C' BR
17	Countersink	CSK
18	Cylindrical	CYL
19	Diameter	DIA
20	Diameter pitch	DP
21	Dimension	DIM
22	Drawing	DRG
23	External	EXT
24	Figure	FIG
25	Ground level	GL
26	Hexagon	HEX
27	Horizontal	HORZ
28	Inspected	INSP
29	Inside diameter	ID
30	Internal	INT
31	Kilogram	kg
32	Kilometer	km
33	Left hand	LH
34	Machine	M/C
35	Manufacturing	MFG
36	Maximum	MAX
37	Metres per second	m/s
38	Mechanical	MECH

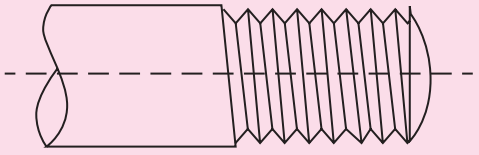
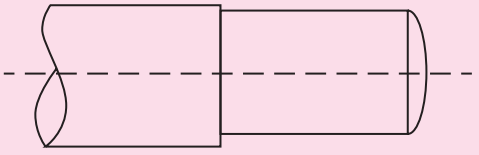
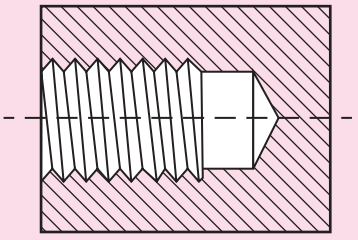
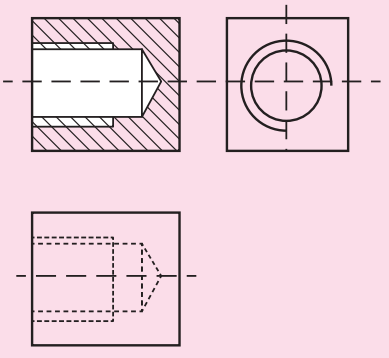
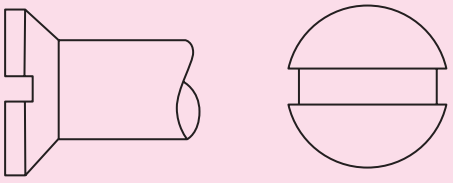
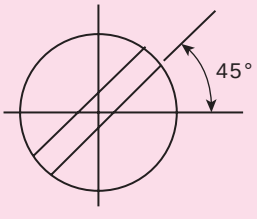
SI.No.	Term	Abbreviation
39	Millimetre	mm
40	Minimum	MIN
41	Miscellaneous	MISC
42	Module	m
43	Nominal	NOM
44	Not to scale	NTS
45	Number	No.
46	Opposite	OPP
47	Outside diameter	OD
48	Pitch circle diameter	PCD
49	Pitch circle	PC
50	Quantity	QTY
51	Radian	rad
52	Radius	R
53	Reference	REF
54	Required	REQ
55	Right hand	RH
56	Serial Number	SL.NO.
57	Specification	SPEC
58	Spherical	SPHERE
59	Spot face	SF
60	Square	SQ
61	Symmetrical	SYM

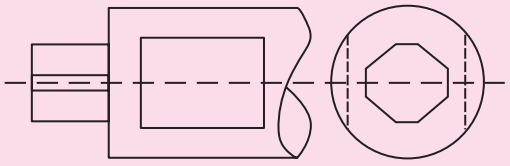
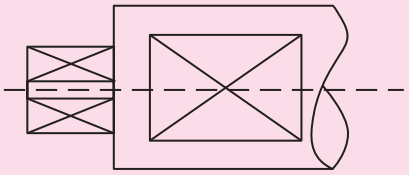
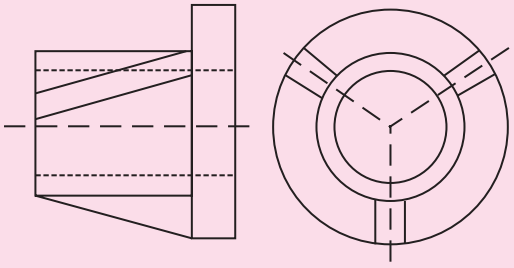
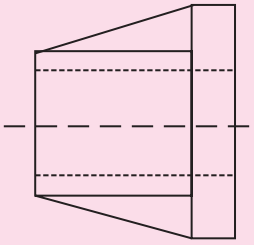
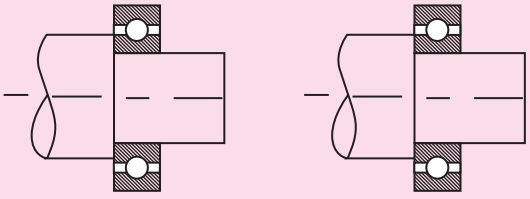
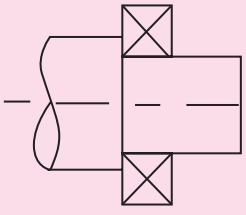
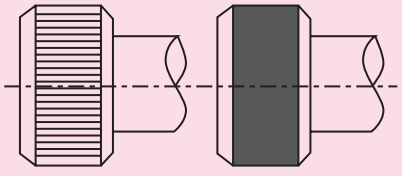
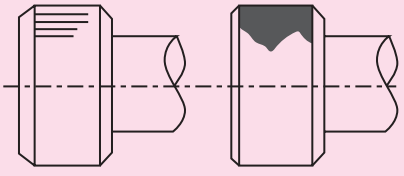
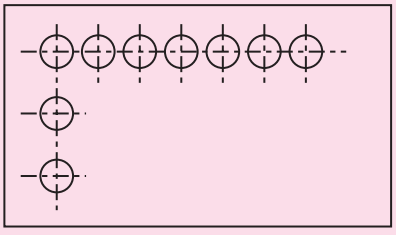
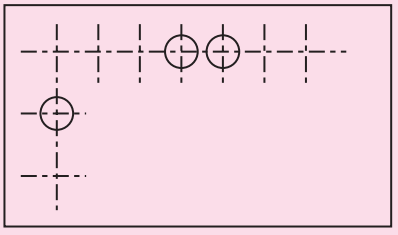
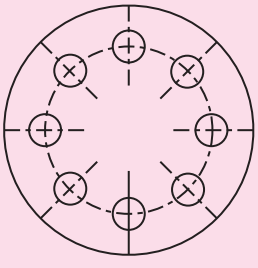
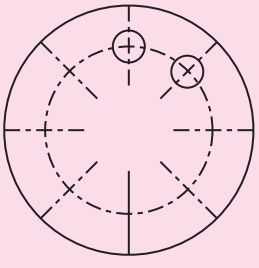
REPRESENTATION OF VARIOUS FEATURES IN DRAWINGS

Title	Actual Projection/Section	Convention
External Threads		
Internal Threads		
Slotted Head		
Square End and flat		
Radial Ribs		
Bearing		
Knurling		
Holes on Linear Pitch		
Holes on Circular Pitch		
Leaf Spring		
Ratchet and Pawl		
Splined Shaft		
Springs		
Repeated Parts		

SI.No.	Description	Symbol	Specified Dimensions	
01.	Round section		**d**	
02.	Tube		**d x t**	
03.	Square section		**s**	
04.	Triangular section		**a**	
05.	Hexagonal section		**s**	
06.	Half round section			
07.	Rectangular section		**w x t**	
08.	Angle section	 	**A x B** **A x B**	
09.	T section		**h x b** **h x b**	
10.	I – beam section		**h**	
11.	Channel section		**h**	

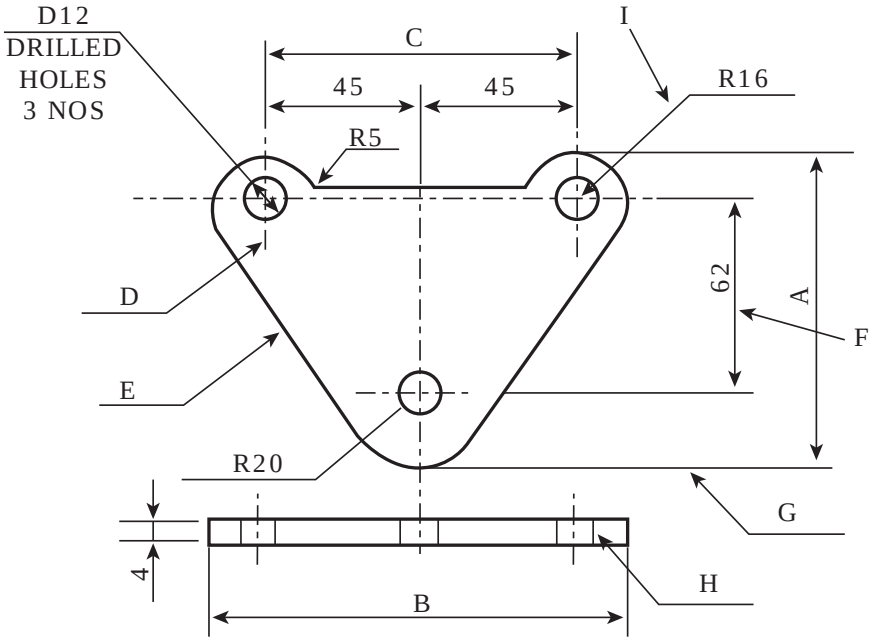
SI.No.	Description	Symbol	Specified Dimensions	
12.	Z section			
13.	Rail section			
14.	Bulb Angle section		**h**	
15.	Bulb plate section		**h**	

Title	Actual Projection/Section	Convention
External Threads		
Internal Threads		
Slotted Head		

Title	Actual Projection/Section	Convention
Square End and Flat		
Redial Ribs		
Bearing		
Knurling		
Holes on Linear Pitch		
Holes on Circular Pitch		

Some drawing are given as exercises to read them correctly and answer the questions given below each of them

FIG 1



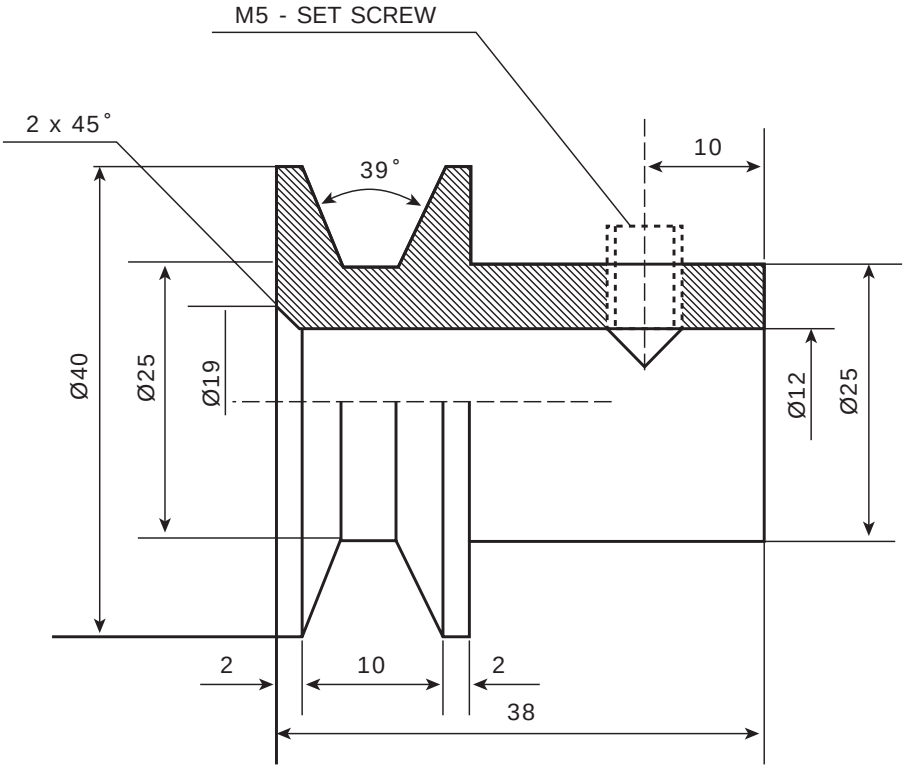
Answer the questions given below with reference to the above diagram

1. What are the two views drawn in the diagram?
2. What are the types of lines indicated by the letters E,F,G,H, & I ?
3. What is the total width of the part (B) ?
4. How many holes are there in the part ?
5. What is the thickness of the plate ?
6. What are the diameters of the holes?
7. What is the radius of the arc in the top of the object ?
8. What is the distance between the top two holes (C) ?

Answers

1. **Plan, Elevation**
2. **D-Center Line, E-Visible Outline, F-Dimension Line, G-Extension Line, H-Dotted Line I-Leader Line**
3. **122 mm**
4. **3 Holes**
5. **4 mm**
6. **12 mm**
7. **16 mm**
8. **90 mm**

FIG 2



Answer the given questions with reference to the diagram

1. What is the name of the part ?

2. Mention the use of the part

3. What is the outer diameter of the part ?

4. What is the length of the part ?

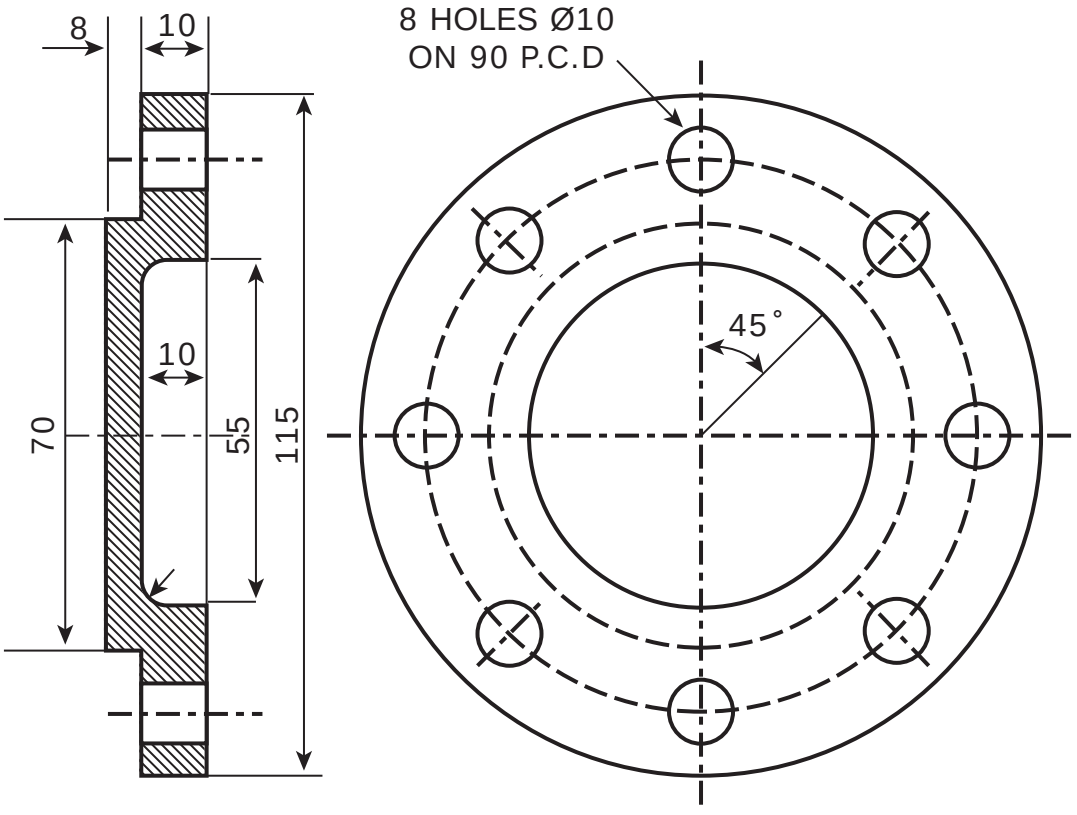
5. What is the size of the thread ?

6. What is the angle of the V – groove ?

7. What is the diameter of the central hole ?

8. What is the depth of the V – groove ?

FIG 3



Answer the given questions with reference to the diagram

1. What is the name of the part ?

2. What is the pitch circle diameter?

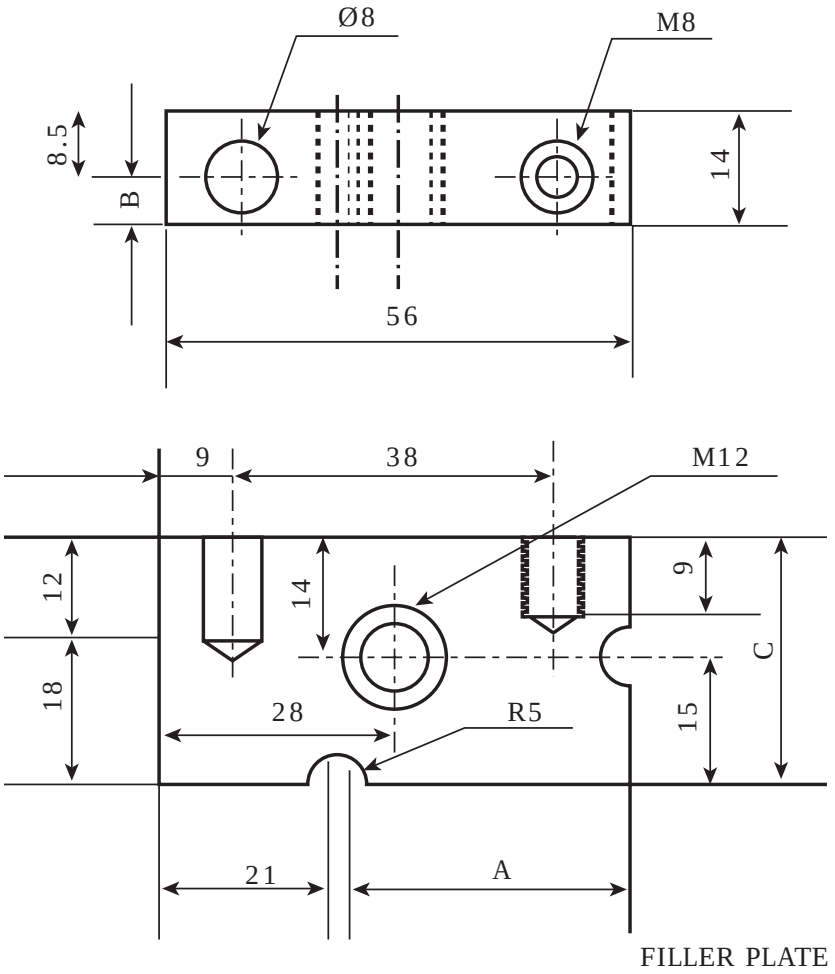
3. How many holes are there in the part ?

4. What is the outer diameter of the part ?

5. What is the thickness of the part ?

6. What is the angle between two adjacent holes ?

FIG 4



FILLER PLATE

Answer the questions given below with references to the above diagram

1. What is the name of the part ?

2. How many holes are tapped ?

3. What is the radius of the groove ?

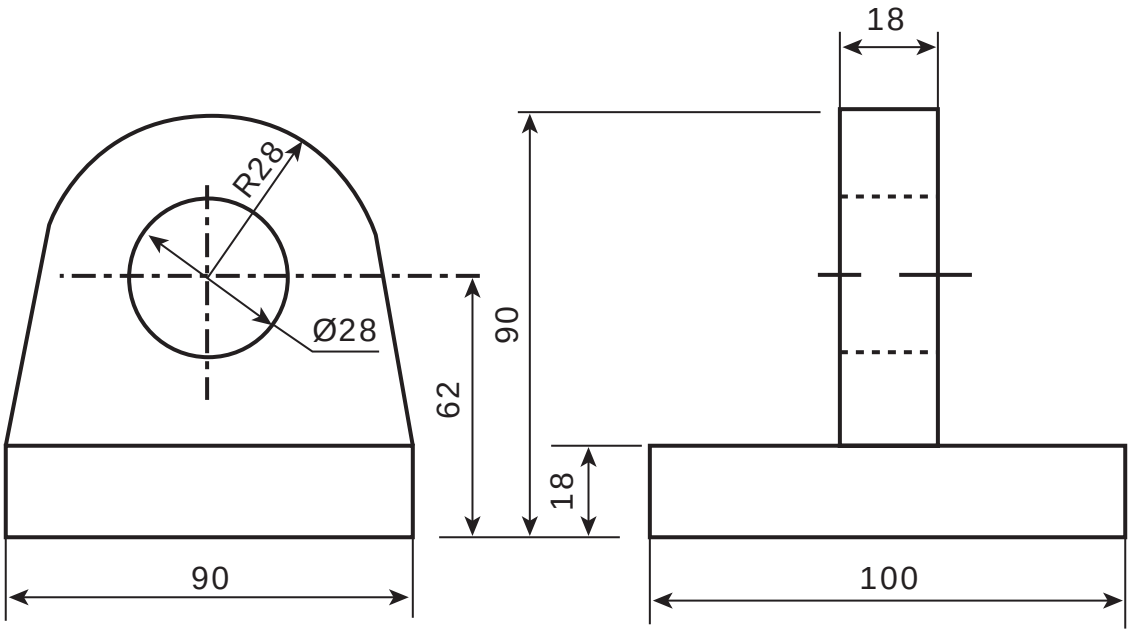
4. What is the length of the part ?

5. What is the width of the part ?

6. What is the height of the part ?

7. What are the dimensions represented by A,B& C ?

FIGURE 5



Answer the questions given below with reference to the above diagram

1. What are the overall dimensions of the bracket shown ?

2. What is the shape and size of the base of the bracket ?

3. What is the size of the hole in the bracket ?

4. What is the radius of the curved top ?

PRACTICAL PART II
FITTING

GENERAL GUIDELINES FOR FITTING WORK

In this modern era, automatic machines are used for manufacturing in small, medium and heavy industries. But fitting and bench work finds an important place in completing and finishing a job to the desired accuracy. Some components that come out after machining processes require some minor operations to be performed by hand tools. Fitting work is an important method in doing this. Fitting is the assembling of parts together and removing them for necessary fit. Both these types of work require many number of hand tools, devices and equipments.

Fitting of parts are made with different kinds of fits. It may be arranged where the fit is tight, loose or very loose. The parts may be arranged to move together with no relative movement or rotational and sliding relative movement.

OBSERVATION EXERCISE FOR STUDENTS

We happen to see various machine tools in engineering shops. We see the sliding and rotating parts are made to fit into each other by Dovetail joints, T – joints, L – joints triangular joints and as holes and shafts. These joints should be closely watched to understand their nature and their respective uses.

For example, in a lathe – the parts of the assembly of carriage – saddle, cross – slide and compound slide. Observe these joints for their shape and purpose.

Observe the top of the table of a shaping machine – What is the shape of the slots made on it? What is its purpose ?

Again in the shaping machine, the ram reciprocates on the column. Observe the joint between the top of the column and bottom of the ram for their shape and purpose.

Observe the method of joining of the parts column, Knee, Saddle and table of a milling machine. These parts are joined by different methods of joining and for different purposes.

Likewise different parts of different machine tools are joined by different methods for obtaining different utilities.

We can also observe some house – hold articles are also joined by different methods.

1. The cap and the body of the bottles that we use daily. How are they joined ?
2. The tiffin – carrier. How are the set of dishes held together ?
3. Hot – cases. How is the lid joined with the base ?
4. The base vessel and the lid of the pressure cooker. What are the methods by which they are joined ?Why ?
5. The regulator of the L.P.G cylinder. How is it fitted with the cylinder ?
6. The frames and the doors of the windows. How are they fitted ?

7. Day – to day usages of waist belts, pen caps, cell phone panels and wrist watch straps. Observe how they are fastened ?
8. Observe the domestic water line taps. How are they opened and closed ?
9. The water pipelines made out in our localities for distribution. How are they connected ?
10. The drums and the tyres of automobiles. How are they fitted ?

By observation we find that different parts are connected or fitted or joined by different methods. Taking these examples in mind we should realise that the manufacturing processes involve joining of various components to accomplish different purposes.

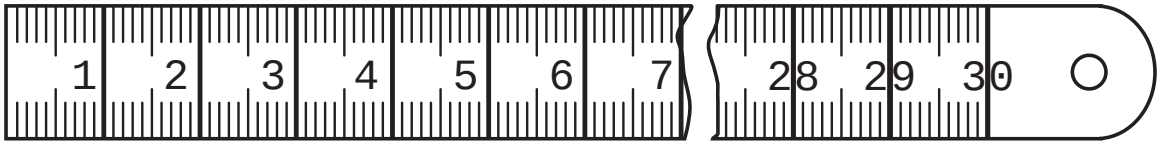
TOOLS USED IN FITTING WORKSHOP

There are different types of tools used in fitting shop and they are classified as

1.	**Marking tools**	Steel rule, protractor, divider, trammel, punches, try square, surface gauge etc..,
2.	**Measuring devices and instruments**	Different types of Gauges, Vernier caliper, Micro Meter, Combination Set, Sine Bar etc....,
3.	**Holding and supporting tools**	Different types of vices, V block, marking table, surface plate etc..,
4.	**Striking tools**	Different types of hammers
5.	**Cutting tools**	Files, Scrapers, Chisels and hacksaw blades
6.	**Tightening tools**	Pliers, spanners and wrenches.

Some of the tools used in fitting shop are illustrated here:

1. STEEL RULE

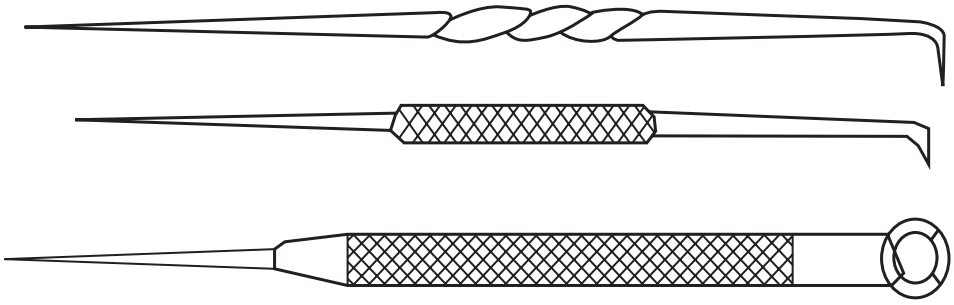


It is one of the most useful tools in a workshop for taking linear measurements and scribing straight lines.

2. SURFACE PLATE

The flatness of a surface of a work can be tested with the help of a surface plate. It is also used for marking-out work.

3. SCRIBERS



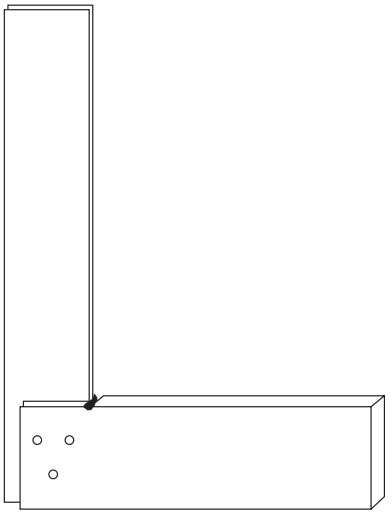
Scribers are used to mark dimensions and to scribe lines on the workpieces .

4. PUNCHES

Punches are used to make permanent marks on the lines already scriber on the workpieces. The punch marks make the line appear clearly. Punches are also used to make marks on exact locations on the workpieces where drilling is to be performed . Punch marks are made at regular intervals on the lines(interval may be 6mm for straight lines and 3mm for curved lines).

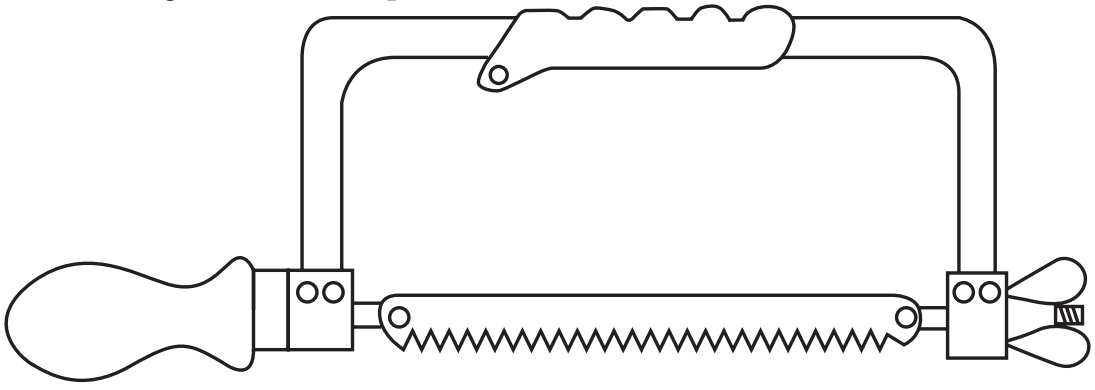
5. TRY SQUARE

Try square is used to check the perpendicularity of surfaces (both external and internal) It is also useful in scribing parallel lines perpendicular to a particular surface and to check flatness of surfaces.

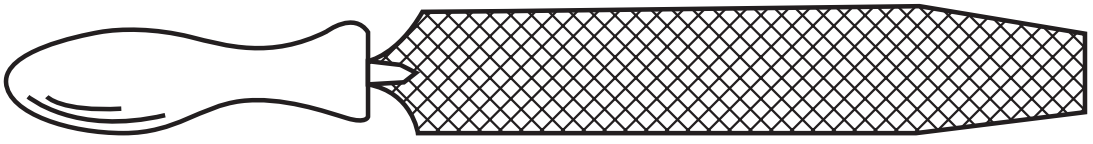


6. HACKSAW

It is used for sawing all metals except hardened steel. It consists of a frame and a blade.



7. FILES

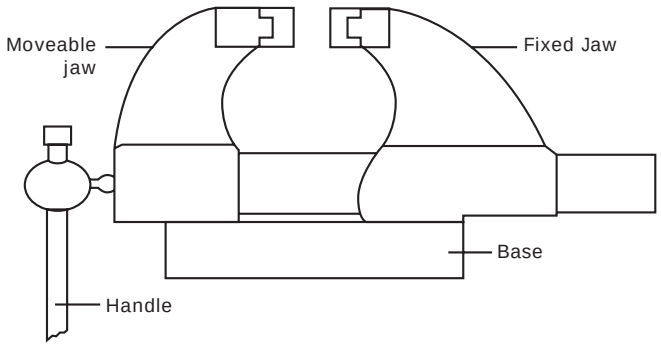


A files is a hardened steel tool having slanted and parallel rows of cutting edges or Teeth on its surfaces. It is used to cut, smooth or fit metal parts. It cuts all materials except hardened steel. Small quantities of unrequired metal can be removed with files. Metal burrs leftout after chiseling and hacksaw cutting are removed with the help of files.

8. VICE

Vice is generally used to hold workpieces when operations like drilling, filing, chiseling and hacksaw cutting are performed on them.

The different types of vices used in shop are Bench vice, Hand vice , Leg vice , Pipe vice, Pin vice , Tool maker 's vice, Machine vice , Swivel vice , Universal vice.



GENERAL WORKSHOP SAFETY PRECAUTIONS

1. The layout of machines in the workshop should be suitably done considering proper lighting and ventilation.
2. First-aid box containing proper medicine and instruments should be kept always ready in a workshop.
3. Inflammable materials should be kept in safe places with proper precautions.
4. Round and Cylindrical objects , sharps articles and tools should not be found in pathways for it may cause injuries to the workers.
5. Oil and grease should not be found spilled inside the workshop.
6. Hot objects should be kept separately wherein message like "HOT", " DO NOT TOUCH" are displayed

SAFETY PRECAUTIONS REGARDING OPERATORS

1. Operators should wear tight clothings. They should avoid wearing loose dresses.
2. Operators should not wear ties and bows while working.
3. The dress code of the operator does not allow him to wear small towel or clothes around his neck or on shoulders .
4. Operators should wear only leather footwear.
5. While performing operations like grinding, welding and chiseling, the operator should wear safety goggles.
6. Metal chips should not be cleaned with bare hands but with proper brushes.
7. Safety plates and equipments should be installed before the machine is set on for operation.
8. Operators should wear gloves while handling hot and sharp articles.
9. The Operators should resist himself from changing the speed , marking or lubricating on functioning machines.
10. Then Operators should seek the help of others while handling heavy and fragile materials.
11. Strict code of discipline should be followed in the workshop . Running, playing and chatting with others are to be avoided in the workshop.
12. The Operators should not rest his body on the machines at any time , when working on them.
13. The Operators should prefer working on machines which are familiar to him.
14. The Operators should not touch unsafe and un-installed electrical wires.

AIM :

To perform the operation of filing, marking and punching

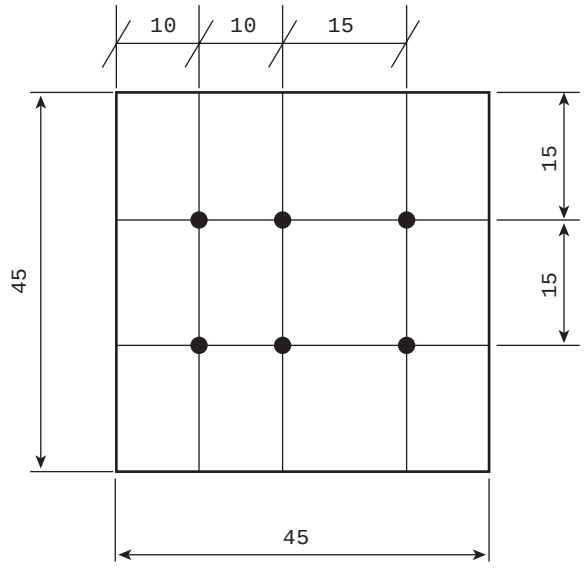
Tools required:

1. Bench vice
2. Try square
3. Hacksaw frame
4. Scriber
5. Steel rule
6. Punches
7. Flat file-rough
8. Flat file-medium
9. Flat file-smooth
10. Triangular file
11. Hammer
12. Divider
13. Chalk paste
14. Vernier caliper
15. Surface plate

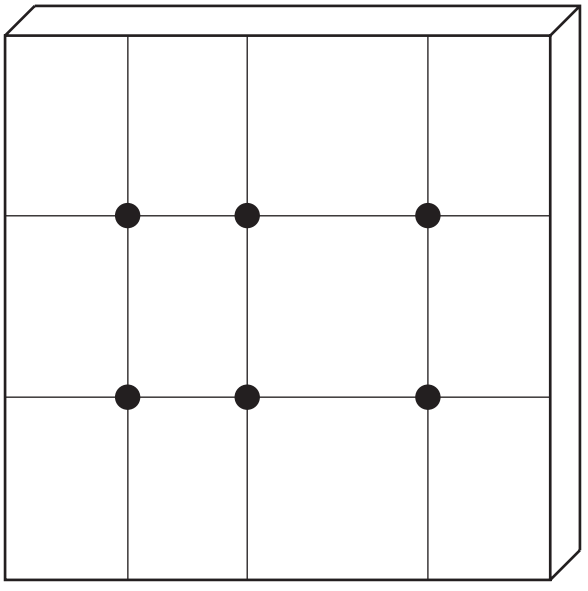
PROCEDURE

1. The design of the given model is studied completely to understand the features like its size and shape.
2. The given piece of metal is checked for size whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations.
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness (The angle between adjacent sides=90 degrees). The same is checked with help of a try- square .
6. The piece of work is checked for 90° on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece .
8. Chalk is allowed to dry.
9. The given design is scribed on the chalked surface using steel rule, divider and scriber.
10. Punch marks are made at required points on the surface using dot punch and a hammer.
11. Punch marks are made by keeping the punch inclined 60° so that they are filed off later.

GIVEN DESIGN OF THE JOB



FINISHED WORKPIECE



CONCLUSION

The operations of square filing, marking and punching are performed according to the given design on the given M.S plate.

HACKSAW CUTTING 1

AIM

To perform the hacksaw cutting on the given M.S plate according to the given design

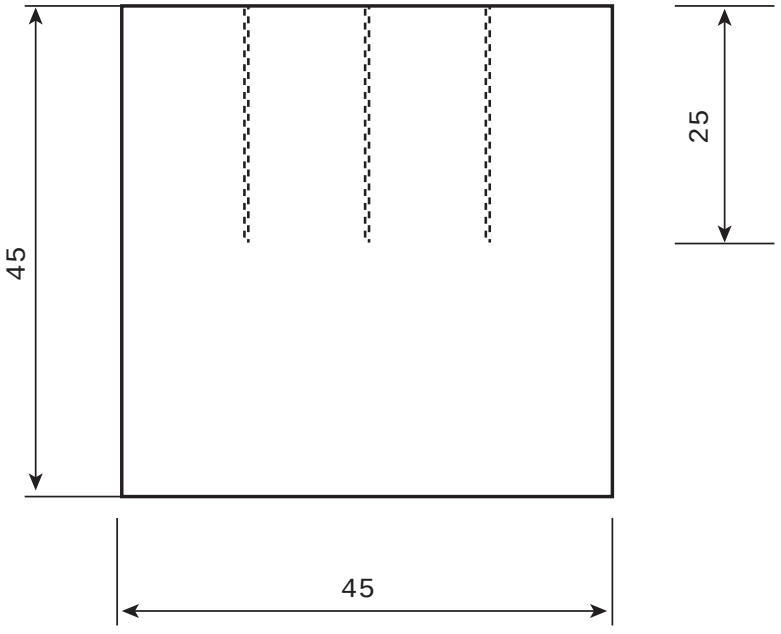
Tools required

1. Bench vice
2. Try square
3. Hacksaw frame
4. Scriber
5. Steel rule
6. Punches
7. Flat file-rough
8. Flat file-medium
9. Flat file-smooth
10. Triangular file
11. Hammer
12. Divider
13. Chalk paste
14. Vernier caliper
15. Surface plate

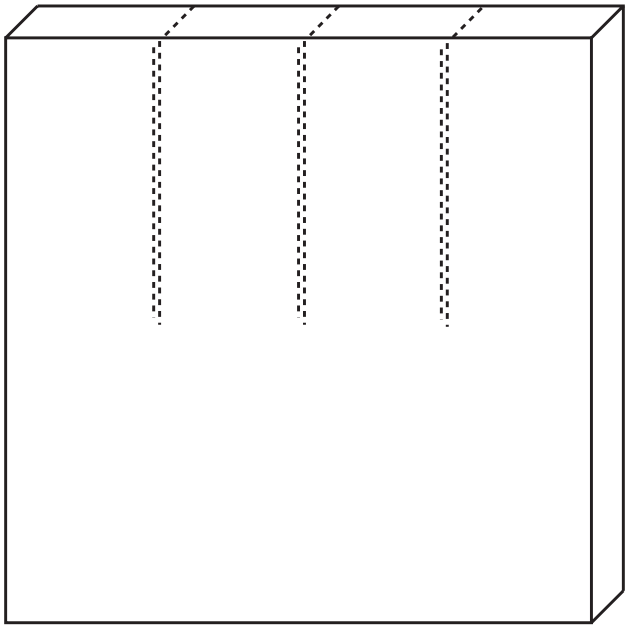
PROCEDURE

1. The design of the given model is studied completely to understand the features like its size and shape
2. The given piece of metal is checked for sizes whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness (The angle between adjacent sides=90 degrees). The same is checked with help of a try- square .
6. The piece of work is checked for 90° on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece .
8. Chalk is allowed to dry.
9. Lines are scribed on the chalked surface using steel rule, divider and scriber.
10. Punch marks are made at required points on the surface using dot punch and a hammer.
11. Punch marks are made by keeping the punch inclined 60° so that they are filled off later.
12. The spacing between adjacent punch marks should be at least 6mm
13. Hacksaw cuts are made on the metal piece at marked locations.
14. The cuts should be made by making the hacksaw frame stroke for the full length at a medium speed.

GIVEN DESIGN OF THE JOB



FINISHED WORKPIECE



Conclusion

The operations of square filing, marking and punching and hacksaw cutting are performed according to the given design on the given M.S plate.

'L' CUTTING 2

AIM

To perform 'L' cutting on the given M.S plate according to the given designs.

Tools required

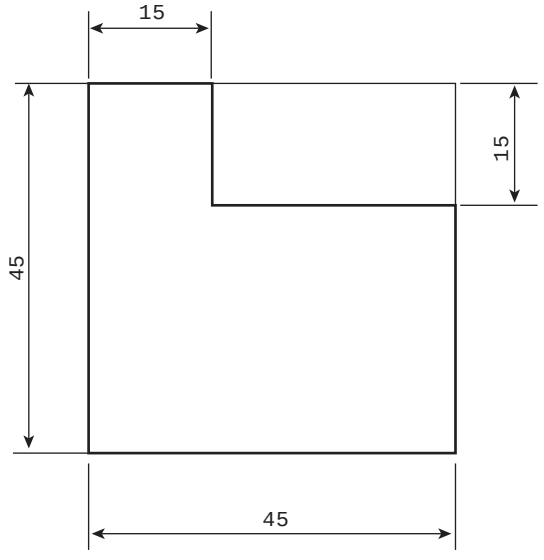
1. Bench vice
2. Try square
3. Hacksaw frame
4. Scriber
5. Steel rule
6. Punches
7. Flat file-rough
8. Flat file-medium
9. Flat file-smooth
10. Triangular file
11. Hammer
12. Divider
13. Chalk paste
14. Vernier caliper
15. Surface plate

PROCEDURE

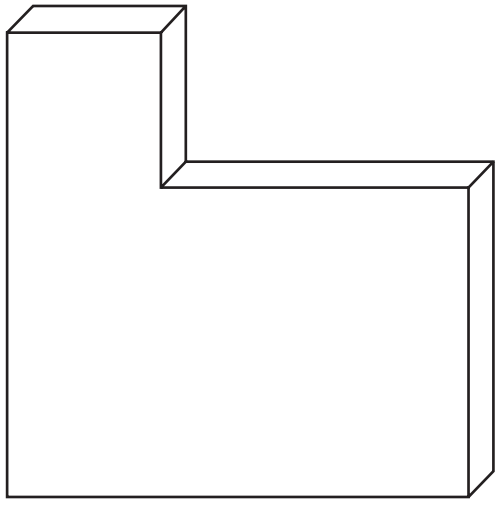
1. The design of the given model is studied completely to understand the features like its size and shape
2. The given piece of metal is checked for sizes whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness (The angle between adjacent sides=90 degrees). The same is checked with help of a try- square .
6. The piece of work is checked for 90° on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece .
8. Chalk is allowed to dry.
9. The design for 'L' shape is clearly scribed on the flat chalked surface with the help of steel rule, divider, try square and scriber as per the given dimensions.
10. Punch marks are made at required points on the surface using dot punch and a hammer.
11. Punch marks are made by keeping the punch inclined at 60° so that they are filed off later.
12. The spacing between adjacent punch marks should be at least 6mm
13. Thin auxiliary lines are made at a distance 1.5mm from the punched line.
14. Hacksaw cuts are made on these auxiliary lines . The unwanted portion of the metal piece is removed.
15. The remaining portion of the metal piece is fitted on the bench vice . The rough surface resulting from hacksaw cutting is filed with the help of flat files(rough, medium, and smooth)

16. When filling , care is taken that half of the punch mark is retained on the work-piece.
17. The sharp corner of the 'L' shape is filed with the help of triangular file.
18. The edge surface of the workpiece are checked frequently for perpendicularity and parallelism with the help of a try-square.

GIVEN DESIGN OF THE JOB



FINISHED WORKPIECE



Conclusion

The operations of square filing, marking and punching and hacksaw cutting and finish filing (for 'L' shape) are performed according to the given design on the given M.S plate.

'T' CUTTING 3

AIM

To perform 'T' cutting on the given M.S. plate according to the given design.

Tools Required :

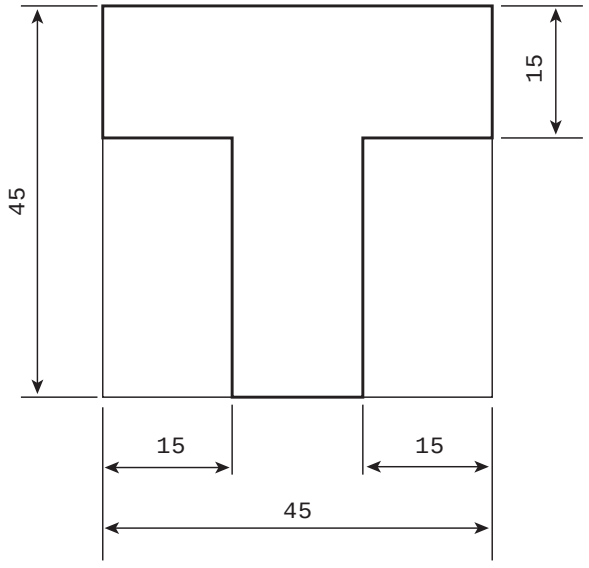
1. Bench vice
2. Try square
3. Hacksaw cutting
4. Scriber
5. Steel rule
6. Punches
7. Flat file – Rough
8. Flat file – medium
9. Flat file – smooth
10. Triangular file
11. Hammer
12. Divider
13. Chalk paste
14. Vernier caliper
15. Surface plate

PROCEDURE

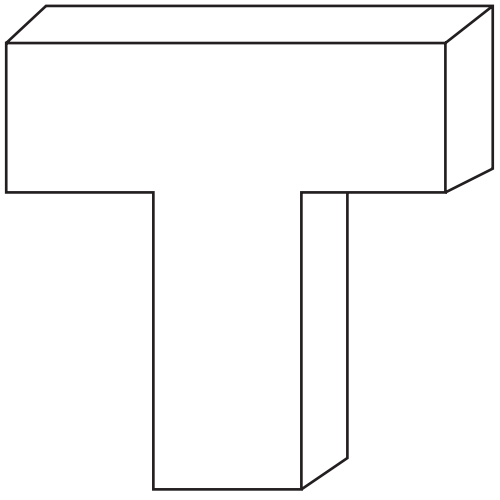
1. The design of the given model is studied completely to understand the features like its Size and shape.
2. The given piece of metal is checked for sizes whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations.
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness(The angle between adjacent sides = 90 degrees). The same is checked with the help of a try – square).
6. The piece of work is checked for 90^0 on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece.
8. Chalk is allowed to dry.
9. The design for 'T' shape is clearly scribed on the flat chalked surface with the help of steel rule, divider, try square and scriber as per the given dimensions.
10. Punch marks are made at required points on the surface using a dot punch and a hammer.
11. Punch marks are made by keeping the punch inclined at 60^0so that they are filed off later.
12. The spacing between adjacent punch marks should be at least 6mm.
13. Thin auxiliary lines are made at a distance of 1.5mm from the punched line.
14. Hacksaw cuts are made on these auxiliary lines. The unwanted portion of the metal piece is removed.

15. The remaining portion of the metal piece is fitted on the bench vice. The rough surface resulting from hacksaw cutting is filed with the help of flat files (rough, medium and smooth)
16. When filing, care is taken that half of the punch mark is retained on the workpiece.
17. The sharp corner of the 'T' shape is filed with the help of triangular file.
18. The edge surfaces of the workpiece are checked frequently for perpendicularity and parallelism with the help of a try- square.

GIVEN DESIGN OF THE JOB



FINISHED WORKPIECE



Conclusion

The operation of square filing, marking, punching hacksaw cutting and finish filing (for 'T' shape) are performed according to the given design on the given M.S plate.

STEP CUTTING 4

AIM

To perform 'V' cutting on the given M.S. plate according to the given design.

Tools Required :

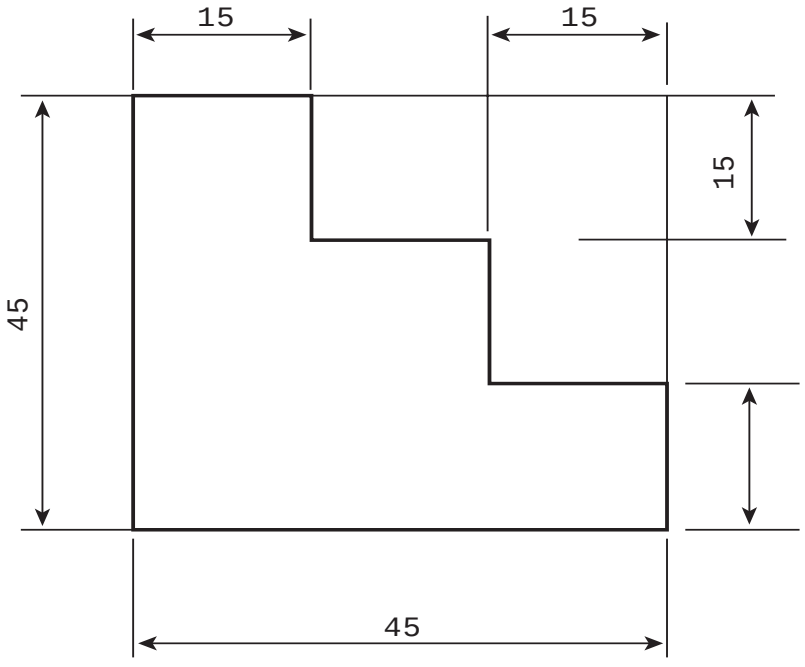
1. Bench vice
2. Try square
3. Hacksaw cutting
4. Scriber
5. Steel rule
6. Punches
7. Flat file – Rough
8. Flat file – medium
9. Flat file – smooth
10. Triangular file
11. Hammer
12. Divider
13. Chalk paste
14. Vernier caliper
15. Surface plate

PROCEDURE

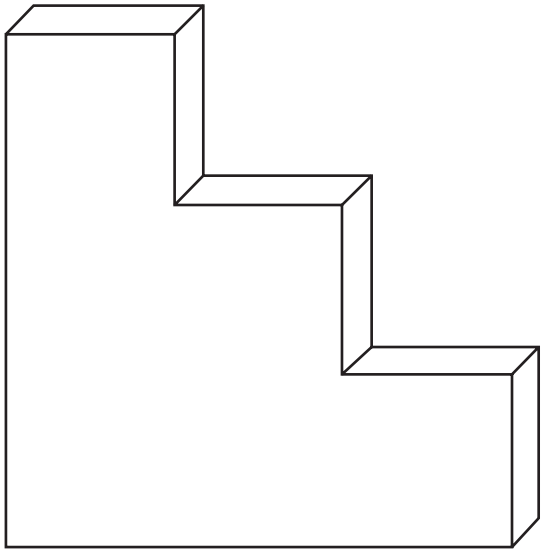
1. The design of the given model is studied completely to understand the features like its Size and shape.
2. The given piece of metal is checked for sizes whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations.
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness(The angle between adjacent sides = 90 degrees). The same is checked with the help of a try – square.
6. The piece of work is checked for 90^0 on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece.
8. Chalk is allowed to dry.
9. The given design in the form of steps is clearly scribed on the flat chalked surface with the help of steel rule, divider, try square and scriber as per the given dimensions. The angular lines are scribed with the help of the protractor head of a combination set.
10. Punch marks are made at required points on the surface using a dot punch and a hammer.
11. Punch marks are made by keeping the punch inclined at 60^0so that they are filed off later.
12. The spacing between adjacent punch marks should be at least 6mm.
13. Thin auxiliary lines are made at a distance of 1.5mm from the punched line.
14. Hacksaw cuts are made on these auxiliary lines. The unwanted portion of the metal piece is removed.
15. The remaining portion of the metal piece is fitted on the bench vice. The rough surface resulting form hacksaw cutting is filed with the help of flat files (rough, medium and smooth)

16. When filing, care is taken that half of the punch mark is retained on the workpiece.
17. The sharp corners of the steps are filed with the help of triangular file.
18. The edge surfaces of the workpiece are checked frequently for perpendicularity and parallelism with the help of a try- square.

GIVEN DESIGN OF THE JOB



FINISHED WORKPIECE



Conclusion

The operation of square filing, marking, punching hacksaw cutting and finish filing (for step cutting) are performed according to the given design on the given M.S plate.

‘ V ’ CUTTING 5

AIM

To perform ‘V’ cutting on the given M.S. plate according to the given design.

Tools Required :

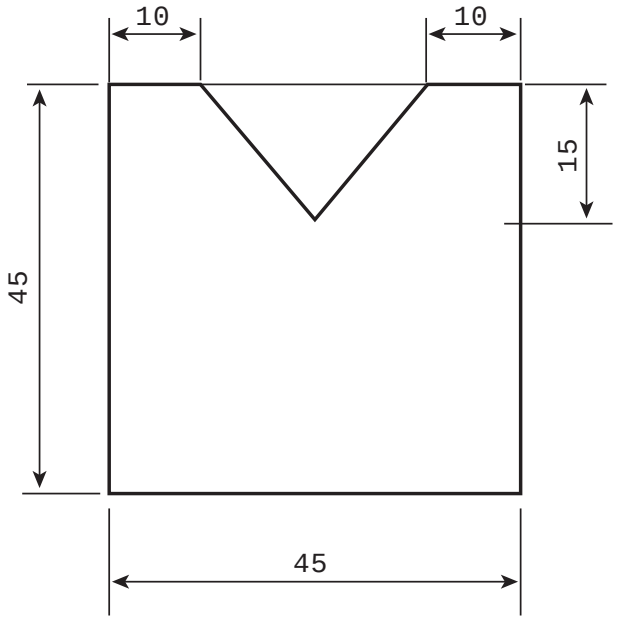
1.	Bench vice	7.	Flat file – Rough	13.	Chalk paste
2.	Try square	8.	Flat file – medium	14.	Vernier caliper
3.	Hacksaw cutting	9.	Flat file – smooth	15.	Surface plate
4.	Scriber	10.	Triangular file	16.	Combination Set
5.	Steel rule	11.	Hammer		
6.	Punches	12.	Divider		

PROCEDURE

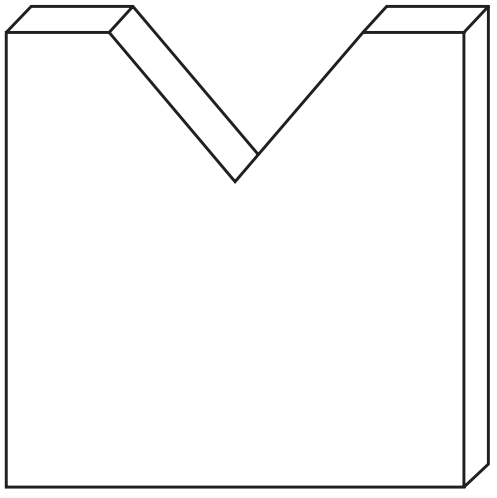
1. The design of the given model is studied completely to understand the features like its Size and shape.
2. The given piece of metal is checked for sizes whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations.
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness. (The angle between adjecent sides = 90°) The same is checked with the help of a try – square.
6. The piece of work is checked for 90^0 on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece.
8. Chalk is allowed to dry.
9. The design for ‘V’ shape is clearly scribed on the flat chalked surface with the help of steel rule, divider, try square and scriber as per the given dimensions. The angular lines are scribed with the help of the protractor head of a combination set.
10. Punch marks are made at required points on the surface using a dot punch and a hammer.
11. Punch marks are made by keeping the punch inclined at 60^0so that they are filed off later.
12. The spacing between adjacent punch marks should be at least 6mm.
13. Thin auxiliary lines are made at a distance of 1.5mm from the punched line.
14. Hacksaw cuts are made on these auxiliary lines. The unwanted portion of the metal piece is removed.
15. The remaining portion of the metal piece is fitted on the bench vice. The rough surface resulting form hacksaw cutting is filed with the help of flat files (rough, medium and smooth)

16. When filing, care is taken that half of the punch mark is retained on the work-piece.
17. The sharp corner of the 'V' shape is filed with the help of triangular file.
18. The edge surface of the workpiece are checked frequently for perpendicularity and parallelism with the help of a try- square.

GIVEN DESIGN OF THE JOB



FINISHED WORKPIECE



Conclusion :

The operation of square filing, marking, punching hacksaw cutting and finish filing (for 'V' shape) are performed according to the given design on the given M.S plate.

DOVE TAIL CUTTING 6

AIM :

To perform Dovetail Cutting on the given M.S. plate according to the given design.

Tools Required :

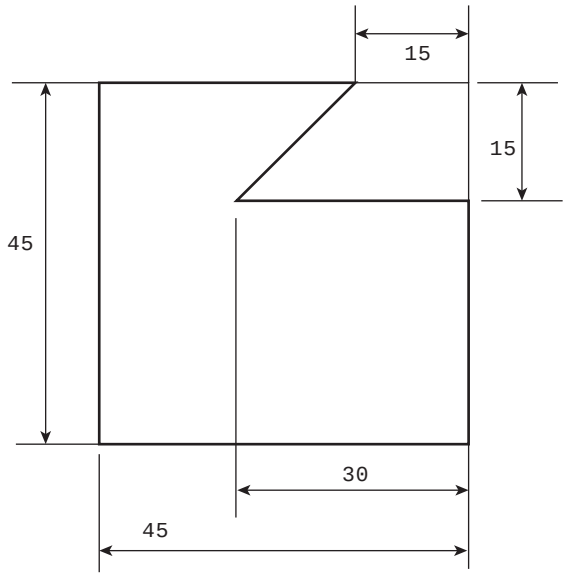
1. Bench vice
2. Try square
3. Hacksaw cutting
4. Scriber
5. Steel rule
6. Punches
7. Flat file – Rough
8. Flat file – medium
9. Flat file – smooth
10. Triangular file
11. Hammer
12. Divider
13. Chalk paste
14. Vernier caliper
15. Surface plate
16. Protractor
17. Combination Set

PROCEDURE

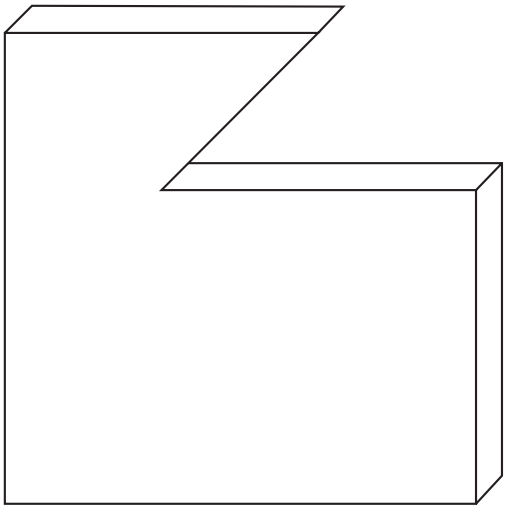
1. The design of the given model is studied completely to understand the features like its Size and shape.
2. The given piece of metal is checked for sizes whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations.
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness (The angle between adjacent sides = 90 degrees). The same is checked with the help of a try – square.
6. The piece of work is checked for 90^0 on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece. Chalk is allowed to dry.
8. The design of dovetail cutting (Single side) is clearly scribed on the flat chalked surface with the help of steel rule, divider, try square and scriber as per the given dimensions. The angular lines are scribed with the help of a protractor or the protractor head of a combination set.
9. Punch marks are made at required points on the surface using a dot punch and a hammer.
10. Punch marks are made by keeping the punch inclined at 60^0so that they are filed off later.
11. The spacing between adjacent punch marks should be at least 6mm.
12. Thin auxiliary lines are made at a distance of 1.5mm from the punched line.
13. Hacksaw cuts are made on these auxiliary lines. The unwanted portion of the metal piece is removed.
14. The remaining portion of the metal piece is fitted on the bench vice. The rough surface resulting form hacksaw cutting is filed with the help of flat files (rough, medium and smooth)

15. When filing, care is taken that half of the punch mark is retained on the workpiece.
16. The sharp corner of the dovetail cutting (single side) is filed with the help of triangular file.
17. The edge surfaces of the workpiece are checked frequently for perpendicularity and parallelism with the help of a try- square.

GIVEN DESIGN OF THE JOB



FINISHED WORKPIECE



Conclusion :

The operations of square filing, marking, punching hacksaw cutting (for dovetail cutting – single side) are performed according to the given design on the given M.S plate.

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This book has been printed on 80 G.S.M.
Elegant Maplitho paper.

Printed by offset at:

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