# Foundry Works

# Level-II

Based on March, 2022 Curriculum Version 1

## Module Title: Develop and Manufacture Wood Pattern.

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## Acknowledgments

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## Acronyms

OHS Occupational health safety

PPE Personal protective equipment

TVT Technical and vocational training

TTLM Teaching training learning materials

# Introduction to module

In the field of foundry, Pattern prepares a mould cavity for the purpose of making a casting. It possesses core prints which produces seats in form of extra recess for core placement in the mould. Pattern is made up of wood, plastic, or metal. The selection of a pattern material depends on the size and shape of the casting, and the molding process. Because patterns are used repeatedly to make molds, the strength and durability of the material selected for a pattern must reflect the number of castings that the mold will produce.

This module is designed to meet the industry requirement under the **Foundry Works Level II** occupational standard, particularly for the unit of competency **Develop and manufacture wood pattern.**

This module covers the competence required in developing and manufacturing wood patterns, both regular shaped and split patterns, based on an understanding of casting and moulding principles.

**This module covers the units**:

- Job requirements
- Lay out wood patterns
- Wood patterns

**Learning Objective of the Module**

- Determine job requirements
- Develop and lay out wood patterns
- Manufacture wood patterns

**Module Instruction**

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book to get more knowledge and to-do.

## Unit One: Determine job requirements

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- (OHS) requirements.
- Job instructions and specifications.
- Type of wood patterns.
- Timber/timber composites.

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Adhered Safety (OHS) requirements.
- Interpret Job instructions and specifications.
- Moulding/casting techniques and foundry processes.
- Select appropriate timber/ timber composites.

## 1.1 OHS Requirements.

### 1.1.1. Introduction

Safety is the condition of being safe from undergoing or causing hurt, injury, or loss.

Safety of workers (also known as worker safety and occupational health and safety) refers to the provision of a safe working environment, safe equipment, policies, and procedures in order to ensure workers' health and safety. Workplace safety has become one of the main concerns for many employers

**Characteristics of a Safe Work Environment**

- Identification of Potential Hazards. Every workplace has potential hazards. ...
- Proactive Approach for Injury Prevention. The institution encourages a proactive stance toward preventing injuries.
- Procedures for Incident Reporting.

### 1.1.2. Pattern Shops General safety instructions

- The faculty or staff member in charge of the shop will ensure that all appropriate safety rules are followed.
- Only trained and approved persons will be permitted to use any piece of powered equipment.
- One of the most important safety rules in a foundry is never put water-containing object into melting furnace, explosive power of one pound of aluminium melt is equivalent with 3 pounds of TNT / 7.5 pounds of normal bomb, if water is contacted with the melts accidentally.
- If any part of the equipment fails while being used, report it immediately to your supervisor. Never try to fix the problem yourself because you could further damage the equipment and harm yourself and others in the lab.
- For shops that are intended to be used by students:

- Training is to be done and documented by the designated shop owner (faculty, staff member). Training should consist of both classroom instruction (including reading the Operator's Manual for each piece of equipment) and hands on competency training.
- Training will be documented and record retention will be the responsibility of the department.
- Shops are to be kept clean and orderly.
- Shop safety rules are to be posted.
- Horseplay is forbidden.
- Machines are to be inspected prior to use.
- Machines should ***never*** be used if all guards are not in place.
- Machines should be placed out of service if:
- Guards are missing or damaged
- Machine is damaged or not operating properly
- Power cords are damaged or plug is not properly grounded
- Use the right tool for the job. Do not force a tool or attachment to do a job for which it was not designed.
- Wear proper attire. Do not wear loose fitting, gloves, jewellery, watches, ties, ID badges or anything else dangling that might get caught in a piece of moving equipment.
- Long hair should be in a protective head covering such as a hair net.

### 1.1.3. Common safety in wood work machine shop

There are some general safety precautions to be taken care of while working in carpentry shop. Some of which are discussed as under.

- Before starting any wood working machine, it should be ensured that all the safety guards are in proper places and secured well.
- While working on a circular saw, one should not stand in a line with the plane of the rotating blade and always keep your fingers always away from the reach of blade.

- The wooden pieces should not be fed to the sawing machines faster than the cutting speed of the machine.
- While working on wood lathes, the job should be properly held.
- One should not use defective or damaged carpentry tools while carrying out carpentry work.
- Nails, screws should be properly kept in a box for proper housekeeping.
- Sufficient safety precautions are to be taken for preventing fire in the carpentry shop.
- No carpentry tools should be thrown for saving time in handling.
- Avoid drugs and alcohol
- Wear appropriate clothing
- Use sharp blades and bits while working
- Disconnect power before blade changes when replacing g blades in the power hack saw.
- Always check for nails, screws and other metal on y our wood or work piece.
- Never put your hands anywhere near the moving blade especially when attempting to remove waste or cut-offs.
- Avoid distractions.
- Always listen carefully to the teacher and follow instructions. Ask questions if need be.
- Avoid horse play in the workshop.
- Wear good strong shoes, training shoes are not allowed.
- Bags should not be brought into the workshop as people can trip over them.
- Always be patient, never rush in the workshop.
- Use hand tools carefully, keep both hands behind the cutting edge.
- Report any damage to machines/equipment as this could cause accident.
- Only use woodworking machines that you have been trained to use properly and safely.
- Always wear safety glasses or goggles or a face shield (with safety glasses or goggles).
- Wear hearing protection that is suitable for the level and frequency of the noise you are exposed to in the woodworking area.

- Use gloves to protect hands from splinters when handling wood but do not wear them near rotating blade and other machinery parts where the gloves can be held.
- Make sure the equipment is properly grounded before use.
- Turn the power off and unplug the power cord (or lock out the power source) before inspecting, changing, cleaning, adjusting or repairing a blade or a machine.

All injuries should be assessed and appropriate medical treatment or first aid administered immediately.

### 1.1.4. Personal safety

- Personal cleanness can play a significant role in protecting foundry workers from exposure to hazardous substance.
- This special vital in the corer room area where skin irritation sensitization or dermatitis may cause by prolonged or repeated skin contact with resinous binders.
- Workers /trainees are encouraged to wash their hands or other contaminated parts of the body immediately after skin contact and before eating Smoking to reduce the risk of ingestion or inhalation of toxic material .eg. lead, abrasive skin cleaner and strong alkalis or solvent that defeat the skin should be avoided
- Therefore, wear proper Personal Protective Equipment (PPE
  - ✓ Leather shoes
  - ✓ Fireproof apron
  - ✓ Foot and leg protection
  - ✓ Proper gloves, wire mesh face shield
  - ✓ Safety glasses
  - ✓ Cotton baseball hat.
  - ✓ A leather foundry hat is the best choice.
  - ✓ A long sleeve cotton shirt.
  - ✓ Wear safety glasses as well as the mesh face shield

## 1.2. Job instructions and specifications.

### 1.2.1. Introduction

- ✓ It is customary in pattern shops to furnish the pattern maker with ***a mechanical drawing*** or blue print of the part to be made.
- ✓ This is very important, in fact almost an indispensable part of the work, and yet often this ***drawing*** falls far short as a reliable guide to the pattern maker; for while it may indicate clearly enough the style of casting desired, it may contain no directions or suggestions which will govern or assist the pattern maker in the construction of the pattern.
- ✓ Although the office drawing may be a perfect representation of the casting itself, the pattern maker's drawing should show not only the casting, but also the cores, core prints, etc. and where practicable the pattern maker's drawing should be full size, in order that the dimensions may be taken directly from the drawing with the dividers.
- ✓ The pattern shop should always contain sufficient space to provide for the free and comfort able execution of its greatest volume of production and should be arranged with a view to afford ample room for the advantageous distribution and location of machinery, benches , trestles, clamps , tools, etc.
- ✓ The room should be so arranged that a proper temperature can be maintained in winter to insure the successful gluing of work, as cold destroys the adhesive quality of glue and is detrimental to good work in many ways.
- ✓ The Shop should be equipped with a band saw or at least a jig saw, a pattern lathe and suitable clamps for gluing up material.
- ✓ In large shops a rip saw and wood worker will be found very useful. The highest grade of glued work, such as piano and organ cases, sleeping car bunks and fine furniture generally, is made by using hot glue applied to wood which has been heated to receive it; the work being done in a room heated for the purpose

- ✓ It is recognised that a pattern maker is likely to work in a variety of different roles and this standard allows for the apprentice to demonstrate a full range of skills across a variety of job roles within the occupation.

**Requirements**

- A Furniture Wood Machinist produces components for furniture using a wide range of wood working machinery.
- This includes setting up, operating and maintaining wood working machines such as saws, planers, moulders, lathes, routers and CNC/NC machines.
- Apprentices will take raw materials and produce components to a given specification to be used in the manufacture of furniture.

## 1.3. Types of wood pattern

### 1.3.1. Introduction patterns

The wood is the most common material used for pattern making. Because easily available and very cheap. The main advantage of wood is that it can be easily shaped and it possesses low weight as compared to metal pattern. Wood is optimal for very large casting and small quantity production.

Patterns are used to mold the sand mixture into the shape of the casting and may be made of wood, plastic, or metal. The selection of a pattern material depends on the size and shape of the casting, the dimensional accuracy and the quantity of castings required, and the molding process. Because patterns are used repeatedly to make molds, the strength and durability of the material selected for a pattern must reflect the number of castings that the mold will produce

Patterns may be made of a combination of materials to reduce wear in critical regions, and they usually are coated with a parting agent to facilitate the removal of the casting from the molds.

Patterns can be designed with a variety of features to fit specific applications and economic requirements. One-piece patterns, also called loose or solid patterns, generally are used for simpler shapes and low-quantity production; they generally are made of wood and are

inexpensive. Split patterns are two piece patterns, made such that each part forms a portion of the cavity for the casting; in this way, castings with complicated shapes can be produced.

The pattern is the principal tool during the casting process. It is the replica of the object to be made by the casting process, with some modifications. The main modifications are the addition of pattern allowances, and the provision of core prints. If the casting is to be hollow, additional patterns called cores are used to create these cavities in the finished product. The quality of the casting produced depends upon the material of the pattern, its design, and construction. The costs of the pattern and the related equipment are reflected in the cost of the casting. The use of an expensive pattern is justified when the quantity of castings required is substantial.

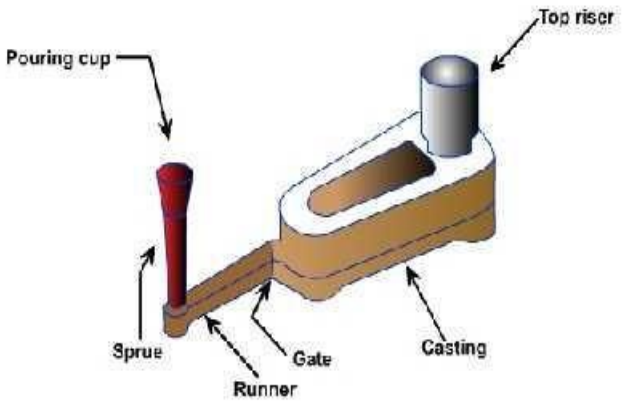



Fig 1.1 a typical pattern attached with gating system

**1.3.2 Functions of the Pattern**

- A pattern prepares a mould cavity for the purpose of making a casting.
- A pattern may contain projections known as core prints if the casting requires a core and need to be made hollow.
- Runner, gates, and risers used for feeding molten metal in the mould cavity may form a part of the pattern.
- Patterns properly made and having finished and smooth surfaces reduce casting defects.
- A properly constructed pattern minimizes the overall cost of the castings.

### 1.3.3. Types of Pattern

1 One piece or solid pattern,
2. Two piece or split pattern,
3. Cope and drag pattern,
4. Three-piece or multi- piece pattern,
5. Loose piece pattern,
6. Match plate pattern,
7. Follow board pattern,
8. Gated pattern,
9. Sweep pattern,
10. Skeleton pattern and
11. Segmental or part pattern

**1. Single-piece or solid pattern**

Solid pattern is made of single piece without joints, partings lines or loose pieces. It is the simplest form of the pattern. Typical single piece pattern is shown in Fig. 2.1

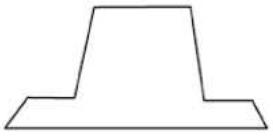


Fig. 1.2 Single piece pattern

**2. Two-piece or split pattern**

When solid pattern is difficult for withdrawal from the mould cavity, then solid pattern is splited in two parts. Split pattern is made in two pieces which are joined at the parting line by means of dowel pins. The splitting at the parting line is done to facilitate the withdrawal of the pattern. A typical example is shown in Fig. 2.2.

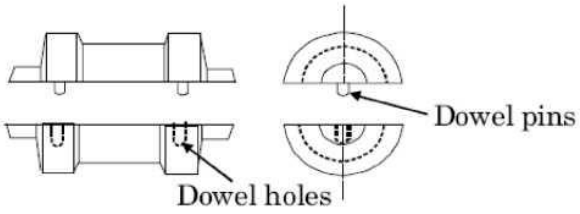



Fig. 1.3 Two piece pattern

**3. Cope and drag pattern**

In this case, cope and drag part of the mould are prepared separately. This is done when the complete mould is too heavy to be handled by one operator. The pattern is made up of two halves, which are mounted on different plates. A typical example of match plate pattern is shown in Fig. 2.3.

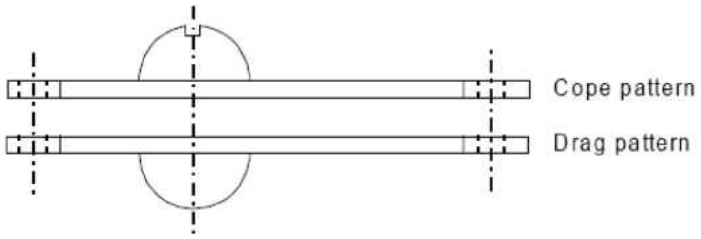



Fig. 1.4 Cope and drag pattern

**4. Three-piece or multi-piece pattern**

Some patterns are of complicated kind in shape and hence cannot be made in one or two pieces because of difficulty in withdrawing the pattern. Therefore these patterns are made in either three pieces or in multi-pieces. Multi moulding flasks are needed to make mould from these patterns.

**5. Loose-piece Pattern**

Loose piece pattern (Fig. 2.4.) is used when pattern is difficult for withdrawal from the mould. Loose pieces are provided on the pattern and they are the part of pattern. The main pattern is removed first leaving the loose piece portion of the pattern in the mould. Finally the loose piece is withdrawal separately leaving the intricate mould.

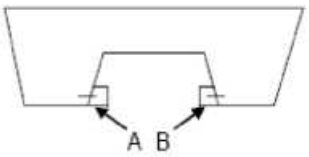



Fig. 1.5. Loose piece pattern

**6. Match plate pattern**

This pattern is made in two halves and is on mounted on the opposite sides of a wooden or metallic plate, known as match plate. The gates and runners are also attached to the plate. This pattern is used in machine moulding. A typical example of match plate pattern is shown

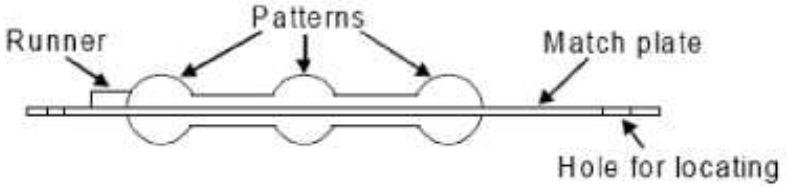



Fig. 1.6. Match plate pattern

**7. Follow board pattern**

When the use of solid or split patterns becomes difficult, a contour corresponding to the exact shape of one half of the pattern is made in a wooden board, which is called a follow board and it acts as a moulding board for the first moulding operation as shown in Fig. 2.6.

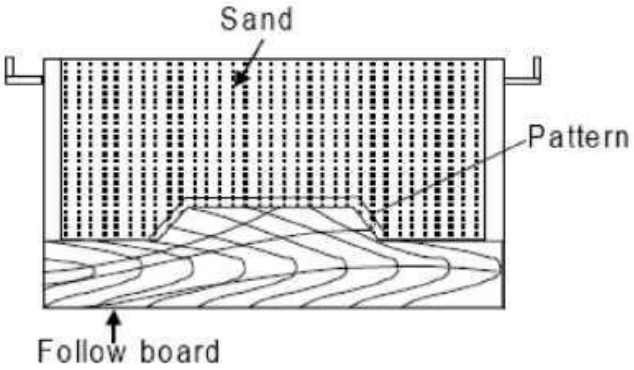



Fig. 1.7 Follow board pattern

**8. Gated pattern**

In the mass production of casings, multi cavity moulds are used. Such moulds are formed by joining a number of patterns and gates and providing a common runner for the molten metal, as shown in Fig. 2.7. These patterns are made of metals, and metallic pieces to form gates and runners are attached to the pattern.

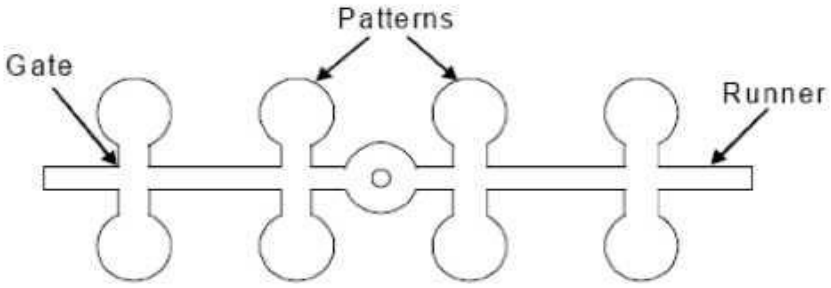



Fig. 1.8 Gated pattern

**9. Sweep pattern**

Sweep patterns are used for forming large circular moulds of symmetric kind by revolving a sweep attached to a spindle as shown in Fig. 2.8. Actually a sweep is a template of wood or metal and is attached to the spindle at one edge and the other edge has a contour depending upon the desired shape of the mould. The pivot end is attached to a stake of metal in the center of the mould.

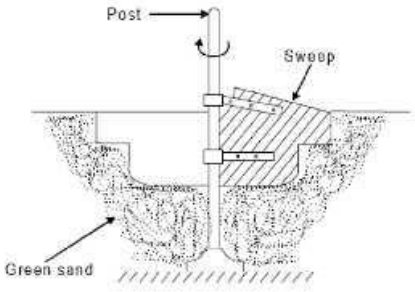



Fig. 1.9 Sweep pattern

**10. Skeleton pattern**

When only a small number of large and heavy castings are to be made, it is not economical to make a solid pattern. In such cases, however, a skeleton pattern may be used. This is a ribbed construction of wood which forms an outline of the pattern to be made.

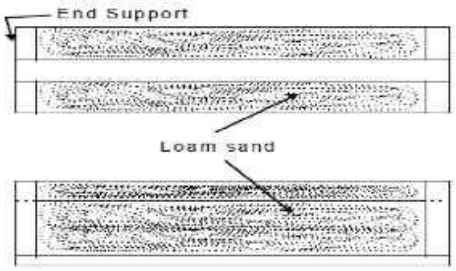



Fig. 1.10 Skeleton pattern

This frame work is filled with loam sand and rammed. The surplus sand is removed by stickle board. For round shapes, the pattern is made in two halves which are joined with glue or by means of screws etc. A typical skeleton pattern is shown in Fig. 1.10.

**11. Segmental pattern**

Patterns of this type are generally used for circular castings, for example wheel rim, gear blank etc. Such patterns are sections of a pattern so arranged as to form a complete mould by being

moved to form each section of the mould. The movement of segmental pattern is guided by the use of a central pivot. A segment pattern for a wheel rim is shown in Fig. 2.10.

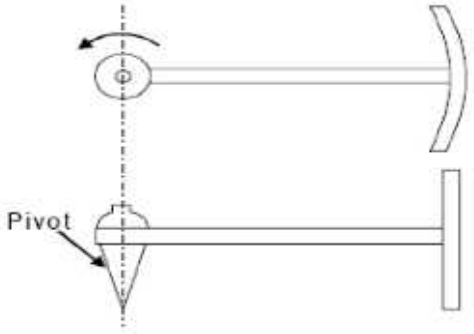



Fig. 1.11 Segmental or part pattern

### 1.3.4. Pattern types (single piece, two piece or multiple piece patterns)

**Core and Core Box**

- Cores are compact mass of core sand that when placed in mould cavity at required location with proper alignment does not allow the molten metal to occupy space for solidification in that portion and hence help to produce hollowness in the casting. The environment in which the core is placed is much different from that of the mold.
- In fact has to withstand the severe action of hot metal which completely surrounds it. Cores are classified according to shape and position in the mold.

There are various types of cores such as;

- Horizontal core,
- Vertical core,
- Balanced core,
- Drop core and,
- Hanging core,

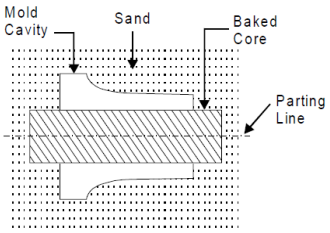



Fig 1.12, Horizontal core


Fig 1.13, Vertical core and Balanced core respectively


Fig 1.14, Drop core and Hanging core respectively

**There are various functions of cores which are given below**

- Core is used to produce hollowness in castings in form of internal cavities,
- It may form a part of green sand mold,
- It may be deployed to improve mold surface,
- It may provide external undercut features in casting,
- It may be used to strengthen the mold,
- It may be used to form gating system of large size mold,
- It may be inserted to achieve deep recesses in the casting.

**Core Box**

- Any kind of hollowness in form of holes and recesses in castings is obtained by the use of cores.
- Cores are made by means of core boxes comprising of either single or in two parts.
- Core boxes are generally made of wood or metal and are of several types.
- The main types of core box are;
- Half core box,

- Dump core box,
- Split core box,
- Stickle core box,
- Right and left hand core box and
- Loose piece core box.

**Half core box**

- This is the most common type of core box.
- The two identical halves of a symmetrical core prepared in the half core box.
- Two halves of cores are pasted or cemented together after baking to form a complete core.

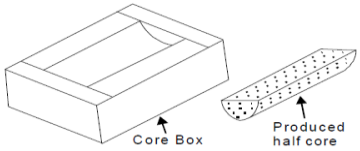



Fig. 1.15, Half core box

**Dump core box**

- Dump core box is similar in construction to half core box.
- The cores produced do not require pasting, rather they are complete by themselves.
- If the core produced is in the shape of a slab, then it is called as a slab box or a rectangular box.
- A dump core-box is used to prepare complete core in it. Generally cylindrical and rectangular cores are prepared in these boxes.

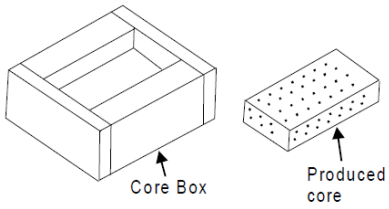



Fig 1.16, Dump core-box

**Split core box:** Split core boxes are made in two parts They form the complete core by only one ramming. The two parts of core boxes are held in position by means of clamps and their alignment is maintained by means of dowel pins and thus core is produced.

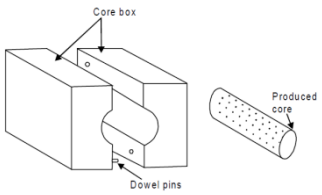



Fig. 1.17, Split core boxes

**Core box allowances**

Materials used in making core generally swell and increase in size. This may lead to increase the size of core. The larger cores sometimes tend to become still larger.

This increase in size may not be significant in small cores, but it is quite significant in large cores and therefore certain amount of allowance should be given on the core boxes to compensate for this increase the cores.

It is not possible to lay down a rule for the amount of this allowance as this will depend upon the material used, but it is customary to give a negative allowance of 5 mm /m.

**Core Prints**

When a hole blind or through is needed in the casting, a core is placed in the mould cavity to produce the same. The core has to be properly located or positioned in the mould cavity on pre-formed recesses or impressions in the sand.

To form these recesses or impressions for generating seat for placement of core, extra projections are added on the pattern surface at proper places.

- These extra projections on the pattern (used for producing recesses in the mould for placement of cores at that location) are known as ***core prints***. Core prints may be of
- Horizontal,
- Vertical,
- Balanced,
- Wing and Core types.

- Horizontal core print produces seats for horizontal core in the mould.
- Vertical core print produces seats to support a vertical core in the mould.
- Balanced core print produces a single seat on one side of the mould and the core remains partly in this formed seat and partly in the mould cavity, the two portions balancing each other. The hanging portion of the core may be supported on chaplets.
- Wing core print is used to form a seat for a wing core.

**1.3.5. Procedure: Mould Making**

1. First a bottom board is placed either on the molding platform or on the floor, making the surface even.
2. The drag molding flask is kept upside down on the bottom board along with the drag part of the pattern at the center of the flask on the board.
3. Dry facing sand is sprinkled over the board and pattern to provide a non-sticky layer.
4. Freshly prepared molding sand of requisite quality is now poured into the drag and on the pattern to a thickness of 30 to 50 mm.
5. Rest of the drag flask is completely filled with the backup sand and uniformly rammed to compact the sand.
6. After the ramming is over, the excess sand in the flask is completely scraped using a flat bar to the level of the flask edges.
7. Now with a vent wire which is a wire of 1 to 2 mm diameter with a pointed end, vent holes are in the drag to the full depth of the flask as well as to the pattern to facilitate the removal of gases during casting solidification. This completes the preparation of the drag.
8. Now finished drag flask is rolled over to the bottom board exposing the pattern.
9. Using a slick, the edges of sand around the pattern is repaired
10. The cope flask on the top of the drag is located aligning again with the help of the pins of the drag box.

11. Sprue of the gating system for making the sprue passage is located at a small distance of about 50 mm from the pattern. The sprue base, runners and in-gates are also located as shown risers are also placed. Freshly prepared facing sand is poured around the pattern.
12. The moulding sand is then poured in the cope box. The sand is adequately rammed, excess sand is scraped and vent holes are made all over in the cope as in the drag.
13. The sprue and the riser are carefully withdrawn from the flask
14. Later the pouring basin is cut near the top of the sprue.
15. The cope is separated from the drag any loose sand on the cope and drag interface is blown off with the help of the bellows.
16. Now the cope and the drag pattern halves are withdrawn by using the draw spikes and rapping the pattern all around to slightly enlarge the mould cavity so that the walls are not spoiled by the withdrawing pattern.
17. The runners and gates are to be removed or to be cut in the mould carefully without spoiling the mould.
18. Any excess or loose sand is applied in the runners and mould cavity is blown away using the bellows.
19. Now the facing paste is applied all over the mould cavity and the runners which would give the finished casting a good surface finish.
20. A dry sand core is prepared using a core box. After suitable baking, it is placed in the mould cavity.
21. The cope is placed back on the drag taking care of the alignment of the two by means of the pins.
22. The mould is ready for pouring molten metal. The liquid metal is allowed to cool and become solid which is the casting desired.

**Result**: The required mould cavity is prepared using the given Single /solid Pattern.

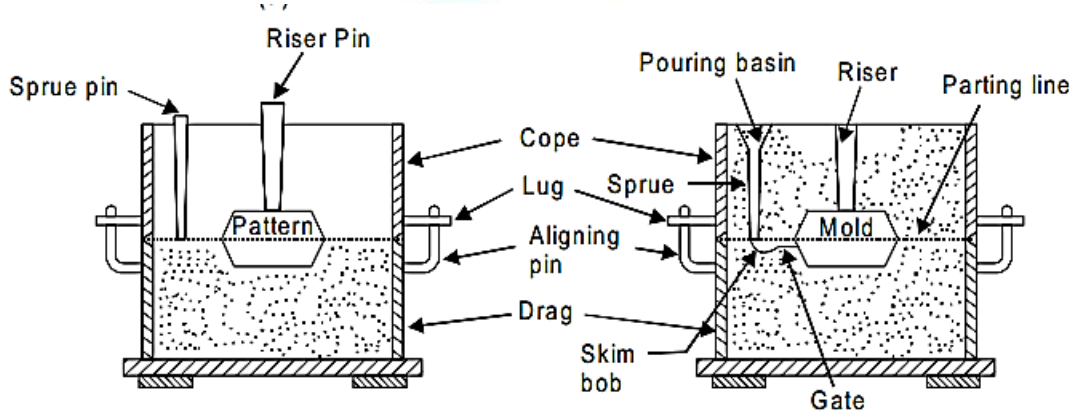



Figure 1.18 Mold Making

## 1.4. Timber composite

### 1.4.1. Common Pattern Materials

- The common materials used for making patterns are wood, *metal, plastic, plaster, wax or mercury*.

**I. Wood**

- Wood is the most popular and commonly used material for pattern making.
- It is cheap, easily available in abundance, repairable and easily fabricated in various forms using resin and glues.
- It is very light and can produce highly smooth surface.
- Wood can preserve its surface by application of a shellac coating for longer life of the pattern.
- But, in spite of its above qualities, it is susceptible to ***shrinkage*** and ***warp-age*** and its life is short because of the reasons that it is highly affected by moisture of the molding sand.
- After some use it warps and wears out quickly as it is having less resistance to sand abrasion.
- It cannot withstand rough handily and is weak in comparison to metal. In the light of above qualities, wooden patterns are preferred only when the numbers of castings to be produced are less.

- The main varieties of woods used in pattern-making are shisham, kail, deodar, teak and mahogany.

**A. Shisham**

- It is dark brown in color having golden and dark brown stripes.
- It is very hard to work and blunts the cutting tool very soon during cutting.
- It is very strong and durable.
- Besides making pattern, it is also used for making good variety of furniture, tool handles, beds, cabinets, bridge piles, plywood etc.

**B. Kail**

- It has too many knots.
- It is available in Himalayas and yields a close grained, moderately hard and durable wood.
- It can be very well painted.
- Besides making pattern, it is also utilized for making wooden doors, packing case, cheap furniture etc.

**C. Deodar**

- It is white in color when soft but when hard, its color turns toward light yellow.
- It is strong and durable.
- It gives fragrance when smelled.
- It has some quantity of oil and therefore it is not easily attacked by insects.
- It is available in Himalayas at a height from 1500 to 3000 meters.
- It is used for making pattern, manufacturing of doors, furniture, patterns, railway sleepers etc.
- It is a soft wood having a close grain structure unlikely to warp.
- It is easily workable and its cost is also low.
- It is preferred for making pattern for production of small size castings in small quantities.

**D. Teak Wood**

- It is hard, very costly and available in golden yellow or dark brown color.
- Special stripes on it add to its beauty.
- It is very strong and durable and has wide applications.
- It can maintain good polish.
- Besides making pattern, it is used for making good quality furniture, plywood, ships etc.
- It is a straight-grained light wood.
- It is easily workable and has little tendency to warp.
- Its cost is moderate.

**E. Mahogany**

- This is a hard and strong wood.
- Patterns made of this wood are more durable than those of above mentioned woods and they are less likely to warp.
- It has got a uniform straight grain structure and it can be easily fabricated in various shapes.
- It is costlier than teak and pine wood, It is generally not preferred for high accuracy for making complicated pattern.
- It is also preferred for production of small size castings in small quantities.
- Used for pattern making are deodar, walnllt, kail, maple, birch, cherry and shisham.

**Advantages of wooden patterns**

- Wood can be easily worked,
- It is light in weight,
- It is easily available,
- It is very cheap,
- It is easy to join,
- It is easy to obtain good surface finish,
- Wooden laminated patterns are strong,
- It can be easily repaired.

**Disadvantages**

- It is susceptible to moisture,
- It tends to warp,
- It wears out quickly due to sand abrasion,
- It is weaker than metallic patterns.

### 1.4.2. Pattern Materials Used in Carpentry:

Basic materials used in pattern making shop are ***timber and plywood***. Auxiliary materials used are ***nails, screws, adhesives, paints, varnishes,*** etc.

- **Timber:**

Timber is the name given to wood obtained from exogenous (outward growing) trees.

In these trees, the growth is outward from the centre, by adding almost concentric layers of fresh wood every year known as annual rings.

After the full growth, these trees are cut and sawed to convert into rectangular sections of various sizes for engineering purposes.

Timber is available in market in various shapes and size. The common shapes and sizes an: given below:

- ✓ **Log:** This is the trunk of die tree which is tree from branches.
- ✓ **Balk:** This is the log after sawing roughly to square cross section.
- ✓ **Deal:** This is the log after sawing into rectangular cross section of width about 225 mm and thickness up to 100 mm.
- ✓ **Plank:** This is the timber piece having width more than 275 mm and thickness 50 lo 150 mm.
- ✓ **Board:** This is the timber piece below 50 mm in thickness and above 125 mm in width,
- ✓ **Batten:** This is the timber piece below 175 mm in width and thickness between 30 mm to 50 mm in thickness.
- ✓ **Scantlings:** These are timber pieces of various assorted and nonstandard sizes other than the types given above

- **Classification of Wood**
  - ✓ The timber used for commercial purposes can he divided into two classes as soft wood and hard wood
- **Soft wood**
  - ✓ A soft wood is light in weight and light colour.
  - ✓ They may have distinct annual rings but the medullar rays (radial lines) are not visible and the colour of the *sap wood* (outer layers) is not distinctive from the heart wood (inner layers).
  - ✓ These woods cannot resist stresses developed across their fibres; hence, not suitable for wood working.
- **Hard wood**

In this type of wood the annual rings are compact and thin and the medullar rays (radial lines} are Visible in most cases. Hard woods are nearly equally strong both along and across the fibres.

Hand wood is the material used for wood working

- **Classification of timber**
  - ✓ According to the manner of growth of trees, timber can be classified as
  - ✓ Exogenous or out ward growing ) Endogenous or in ward growing
- **Exogenous or out ward growing**
  - ✓ In exogenous trees the growth take place from the centre by the addition of concentric layers of fresh wood every year, known as annual rings.
  - ✓ These varieties of trees are suitable for building and other engineering uses the exogenous trees are again classified as
- **Conifers or ever green trees**
  - ✓ The conifer give soft woods and the deciduous gives hard wood common example of hard wood are Sal, teak, rose wood, sandal, shisham, oak beach, ash ebony, mango, neem, babool, etc., soft wood include kail pine, deodar chair, walnut seemal etc.
- **Endogenous or in ward growing timber**

- ✓ These trees grow in wards i.e. .every fresh layer of sap wood is added inside instead of outside cane, bamboo, coconut

- **Seasoning**
  - ✓ Seasoning of wood carried out for removing the sap and reducing the moisture content the presence of sap and moisture will render the wood unsuitable for engineering works due to uneven shrinkage, crack, wrapping and decay.
- **Different methods of seasoning**
  - ✓ Air seasoning or Natural seasoning
  - ✓ Water seasoning
  - ✓ Electrical seasoning
  - ✓ Kiln seasoning
- **Ply wood**
  - ✓ Thick sheet formed by pasting veneers of wood is called ply.
  - ✓ Three or more ply joined by glues is called plywood.
  - ✓ The grains of adjacent layers are kept at right angle to each other in order to get better strengthening both directions the outer layer are called facing ply and good hard wood veneers are used for this inner ones are called core ply and low quality wood is used for this the ply wood is made by either cold pressing or hot pressing.

## 1. Measuring and Layout Tools

1. Wooden or steel scale or rule
2. Dividers
3. Calipers
4. Try square
5. Caliper rule
6. Flexible rule
7. Marking gauge
8. T-bevel
9. Combination square

## 2. Sawing Tools

1. Compass saw
2. Rip saw
3. Coping saw
4. Dovetail saw
5. Back saw
6. Panel saw
7. Miter saw

## 3. Planning Tools

1. Jack plane
2. Circular plane
3. Router plane
4. Rabbet plane
5. Block plane
6. Bench plane
7. Core box plane

drills

7. Bit gauge

## 5. Clamping Tools

1. Bench vice
2. C-clamp
3. Bar clamp
4. Hand screw
5. Pattern maker's vice
6. Pinch dog

## 6. Miscellaneous Tools

1. Screw Driver
2. Vaious types of hammers
3. Chisel
4. Rasp
5. File
6. Nail set
7. Screw driver
8. Bradawl
9. Brad pusher
10. Cornering tool

**Self-Check -1 True false item**

**Part I:**

**Direction - Write true if the statement is correct and false if the statement is not correct on separated answer sheet.**

1. _____ wearing Leather shoes, fireproof apron and Safety glasses are grouped under shop safety
2. _____Personal cleanness can play a significant role in protecting foundry workers from exposure to hazardous substance.
3. _____One of the most important safety rules in a foundry is put water containing object into melting furnace.
4. _____When starting wood work machine operation the advisable work procedure is removing safety guards and perform any operation.
5. _____ Using any wood working machines that you have been not trained properly and safely is not safe work.
6. _____In the process of operation never put your hands anywhere near the moving blade especially when attempting to remove waste or cut-offs.
7. _____Inspecting changing, cleaning, adjusting or repairing a blade on a machine is performed with the machine is turn on.

**Part II: Matching**

**Direction Match column A with column B. Select the letter of the correct answer from column B**

| **Column A** | **column B** |
|---|---|
| 1. _____Shine | A. Industrial kitchens and washing bays |
| 2. ____ Set in order | B. 1st of the five components of 5S |
| 3. ____ Sort | C. Deciding the place for necessary items, arrange them to keep easy access |
| 4. ____Anti-slip flooring | D. cleaning equipment, facilities and floor space in the workplace |

| **Operation Sheet 1** | Determining job requirements |
|---|---|

**Procedures**

1. Wear personal protective equipment
2. Prepare  working drawing for pattern making
3. Select and prepare materials to be used for pattern making
4. Identify machines and check its performance for specific work

| | |
|---|---|
| **LAP Test** | **Practical Demonstration** |

Name: _____ Date: _____

Time started: _____ Time finished: _____

**Instructions:** Given necessary templates, tools and materials you are required to perform the following tasks within 4 hour.

Task1. Wear proper personal safety cloth.

Task 2.idenify and select proper raw materials and machines.

# Unit Two: Develop and Lay Out Wood Patterns

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Pattern parameters.
- Lay out Patterns.
- Jigs and fixtures.

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Calculate Pattern parameters
- Show Pattern is laid out
- Manufacture Jigs and fixtures

## 2.1. Pattern parameters.

Pattern parameter is a numerical or other measurable factor forming one of a set that defines a system or sets the conditions of its operation.

### 2.1.1 Parameters for the Selection of Pattern Materials

After getting comprehensive information about the Pattern and the materials used to make it, it's time to get acquainted with the different essential parameters that are pretty effective while selecting the pattern materials.

The following are some of the factors that define the selection of pattern materials:

- The shape and size of the object to be cast.
- The quantity or volume of production.
- Precision, dimensional accuracy and surface finish are adjudged.
- The need or possibility of design alteration.
- The method used in the molding.
- The cost associated with the pattern material.
- The attributes of a good pattern.
- Number of castings to be produced. Metal pattern are preferred when castings are required large in number,
- Type of mould material used,
- Kind of molding process,
- Method of molding (hand or machine),
- Degree of dimensional accuracy and surface finish required,
- Minimum thickness required,
- Shape, complexity and size of casting

The above points specifically clear the core points on which we can choose effective pattern material, but some of the core features of pattern materials make them reasonably practical. Those are as follows:

- Cost-effective
- Lightweight and water-resistant
- Rigidity and long-lasting

- The simplistic design and repairable attributes as per the industry standard

Apart from these, some ambiguities make the patterning process quite rugged. The structural problems can be mending with different allowances such as Draft Allowances, Shake allowances, shrinkage allowances, distortion allowances, etc. in addition to these, and the following attributes can also help in choosing the types of patterns:

- Attributes of the specific casting process
- Quantity of castings that are to be created
- Physical specifications such as dime sin of the casting

## 2.2 Lay out pattern

**Pattern allowances**

Pattern allowance is a vital feature as it affects the dimensional characteristics of the casting. The selection of correct allowances greatly helps to reduce machining costs and avoid rejections. The allowances usually considered on patterns and core boxes are as follows:

1. Shrinkage or contraction allowance
2. Machining or finish allowance
3. Draft or taper allowance
4. Rapping or Shake allowance
5. Distortion or camber allowance
6. Mould wall Movement Allowance

**1. Shrinkage or Contraction Allowance**

All most all cast metals shrink or contract volumetrically on cooling. The metal shrinkage is of two types:

i. **Liquid Shrinkage**: it refers to the reduction in volume when the metal changes from liquid state to solid state at the solidus temperature. To account for this shrinkage; riser, which feed the liquid metal to the casting, are provided in the mould.

ii. **Solid Shrinkage:** it refers to the reduction in volume caused when metal loses temperature in solid state. To account for this, shrinkage allowance is provided on the patterns.

The rate of contraction with temperature is dependent on the material. For example steel contracts to a higher degree compared to aluminum. To compensate the solid shrinkage, a shrink rule must be used in laying out the measurements for the pattern.

A shrink rule for cast iron is 1/8 inch longer per foot than a standard rule. If a gear blank of 4 inch in diameter was planned to produce out of cast iron, the shrink rule in measuring it 4 inch would actually measure 4 -1/24 inch, thus compensating for the shrinkage. The various rate of contraction of various materials are given in Table 2.1.

**Table 2.1: Rate of Contraction of Various Metals**

| **Material** | **Dimension** | **Shrinkage allowance** (inch/ft) |
|---|---|---|
| Grey Cast Iron | Up to 2 feet | 0.125 |
| | 2 feet to 4 feet | 0.105 |
| | over 4 feet | 0.083 |
| Cast Steel | Up to 2 feet | 0.251 |
| | 2 feet to 6 feet | 0.191 |
| | over 6 feet | 0.155 |
| Aluminum | Up to 4 feet | 0.155 |
| | 4 feet to 6 feet | 0.143 |
| | over 6 feet | 0.125 |
| Magnesium | Up to 4 feet | 0.173 |
| | Over 4 feet | 0.155 |

### 1. Machining Allowance

It is a positive allowance given to compensate for the amount of material that is lost in machining or finishing the casting. If this allowance is not given, the casting will become undersize after machining. The amount of this allowance depends on the size of casting, methods of machining and the degree of finish. In general, however, the value varies from 3 mm. to 18 mm.

### 2. Draft or Taper Allowance

- Taper allowance is also a positive allowance and is given on all the vertical surfaces of pattern so that its withdrawal becomes easier.
- The normal amount of taper on the external surfaces varies from 10 mm to 20 mm/mt. On interior holes and recesses which are smaller in size, the taper should be around 60 mm/mt.
- These values are greatly affected by the size of the pattern and the molding method. In machine molding its, value varies from10 mm to 50 mm/mt.

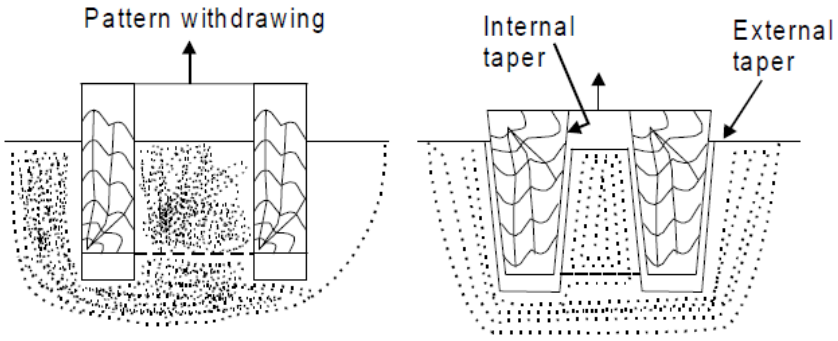



Fig 2.1, Draft allowance

### 3. Rapping or Shake Allowance

- Before withdrawing the pattern it is rapped and thereby the size of the mould cavity increases.
- Actually by rapping, the external sections move outwards increasing the size and internal sections move inwards decreasing the size.

- This movement may be insignificant in the case of small and medium size castings, but it is significant in the case of large castings.
- This allowance is kept negative and hence the pattern is made slightly smaller in dimensions 0.5-1.0 mm.

**4. Distortion Allowance**

- This allowance is applied to the castings which have the tendency to distort during cooling due to thermal stresses developed.
- For example a casting in the form of U shape will contract at the closed end on cooling, while the open end will remain fixed in position. Therefore, to avoid the distortion, the legs of U pattern must converge slightly so that the sides will remain parallel after cooling.

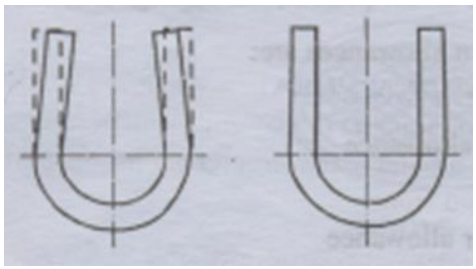


Fig 2.2 Distortion Allowance

**5. Mould wall Movement Allowance**

Mould wall movement in sand moulds occurs as a result of heat and static pressure on the surface layer of sand at the mould metal interface. In ferrous castings, it is also due to expansion due to graphitization. This enlargement in the mould cavity depends upon the mould density and mould composition. This effect becomes more pronounced with increase in moisture content and temperature.

Pattern may be made from wood or metal and its color may not be same as that of the casting. The material of the pattern is not necessarily same as that of the casting.

- Pattern carries an additional allowance to compensate for metal shrinkage.
- It carries additional allowance for machining. It carries the necessary draft to enable its easy removal from the sand mass.

- It carries distortions allowance also. Due to distortion allowance, the shape of casting is opposite to pattern.
- Pattern may carry additional projections, called core prints to produce seats or extra recess in mold for setting or adjustment or location for cores in mold cavity. It may be in pieces (more than one piece) whereas casting is in one piece.
- Sharp changes are not provided on the patterns. These are provided on the casting with the help of machining.
- Surface finish may not be same as that of casting.

The size of a pattern is never kept the same as that of the desired casting because of the fact that during cooling the casting is subjected to various effects and hence to compensate for these effects, corresponding allowances are given in the pattern.

These various allowances given to pattern can be enumerated as,

- Allowance for shrinkage,
- Allowance for machining,
- Allowance for draft,
- Allowance for rapping or shake,
- Allowance for distortion and
- Allowance for mould wall movement.

**6. Shrinkage Allowance**

- In practice it is found that all common cast metals shrink a significant amount when they are cooled from the molten state.
- The total contraction in volume is divided into the following parts:
- ***Liquid contraction***, i.e. the contraction during the period in which the temperature of the liquid metal or alloy falls from the pouring temperature to the liquidus temperature,
- Contraction on cooling from the ***liquidus to the solidus temperature***, i.e. solidifying contraction,
- Contraction that results thereafter until the temperature reaches the room temperature. This is known as ***solid contraction.***

- The first two of the above are taken care of by proper gating and risering. Only the last one, i.e. the solid contraction is taken care by the pattern makers by giving a positive shrinkage allowance.
- This contraction allowance is different for different metals.
- The contraction allowances for different metals and alloys such as Cast Iron 10 mm/mt.. Brass 16 mm/mt., Aluminium Alloys 15 mm/mt., Steel 21 mm/mt., Lead 24 mm/mt. In fact, there is a special rule known as the pattern marks contraction rule in which the shrinkage of the casting metals is added.
- It is similar in shape as that of a common rule but is slightly bigger than the latter depending upon the metal for which it is intended.

**7. Machining Allowance**

- It is a positive allowance given to compensate for the amount of material that is lost in machining or finishing the casting.
- If this allowance is not given, the casting will become undersize after machining.
- The amount of this allowance depends on the size of casting, methods of machining and the degree of finish. In general, however, the value varies from 3 mm. to 18 mm.

**8. Pattern draft**

**Draft** means the taper provided by the pattern maker on all vertical patterns. Drafts help to remove the patterns from the mold without tearing or breaking sides of the mold;

- The draft gives to the pattern light clearance as it is lifted up;
- When the pattern is removed from the mold without difficulty, the draft is said to be positive;
- If it is difficult to remove the pattern from the mold , the draft is negative draft( commonly does not used or if used only the rivers one) ;
- When the sides of the pattern is straight the draft is zero draft;
- In expendable mold casting, purpose of draft is to facilitate removal of pattern from mold (1° for sand casting);

- In permanent mold casting, purpose is to aid in removal of the part from the mold (2° to 3° for permanent mold processes);
- Similar tapers should be allowed if solid cores are used.

***Draft allowances depend on:***

- The length of the vertical side of the pattern to be extracted;
- The intricacy of the pattern;
- The method of molding;
- On an exterior surfaces the draft is about 10-20mm per meter and for interior surfaces like hole it should be from40-50mm per meter; For small size patterns 1.6-3.2mm draft is used;

**2.2.1 Life expectancy of patterns**

The life of patterns and core boxes can be expressed in terms of the number of moulds or cores that can be produced. The material of the pattern, type of construction, method of moulding and core-making, care with which patterns are handled, and type of storage affect the life expectancy. Table 2.2 gives the expected life of patterns for guidance purposes.

Table 2.2 Life expectancy of patterns

| **SL. *No.*** | **Method of Using Pattern** | **Pattern Material** | **Type of Construction** | **Expected Life in Number of Moulds** |
|---|---|---|---|---|
| 1. | Loose | Soft wood | Skeleton | 10 |
| 2. | Loose | | Segmental, disc, box, etc. | 50 |
| 3. | Loose | Hard wood | Ring, tongue and groove, header and stave, disc, box and composite | 200 |
| 4. | Mounted | | | 1000 |
| 5. | Mounted | Epoxy resin | Cast in plaster or plastic moulds | 2000 |
| 6. | Mounted | Epoxy resin with filler | Gel coat, lamination with glass fibre | 5000 |
| 7. | Mounted | Aluminium pressure cast | As cast artd cleaned | 3000-5000 |

| | | | | |
|---|---|---|---|---|
| 8. | Mounted | Aluminium, sand cast | Machined all over and polished | 30,000 |
| 9. | Mounted | Brass, SG iron, grey iron, steel | Machined all over | 50,000 |

**Pattern storage and repair**

In order to be able to use the patterns for a long time, it is essential to give due consideration to storage and repair requirements. It is advisable that the patterns, after use in the foundry, are carefully inspected for any breakage or loss, adequately repaired, and sent for safe storage. Similarly, when a pattern is requisitioned by the foundry, it should be obtained from storage, inspected, repairs, if any, carried out, and then issued to the foundry.

It is also desirable to maintain a complete history of each pattern by recording, date-wise on a card, the issue and return of patterns to and from the foundry, number of moulds produced, inspection carried out, and nature of repairs done.

The principal factors governing space requirements for pattern storage are

- Quantity and volume of patterns
- Rate of acquisition of new patterns to be added to storage
- Types Of Patterns
- General rate of obsolescence due to changes in casting design, or design of product.

Pattern-storage areas should be so designed that they are weather-proof and fireproof, with adequate arrangements for extinguishing fires. For expensive patterns, it is also desirable to have temperature and humidity controls. Separate areas or floors should be earmarked for light, medium and heavy patterns. Small patterns are kept in racks, and large ones are placed on the floor with proper identification marks.

Repair of patterns is often required for various reasons. It is relatively easier to manufacture new patterns than repair old ones. It needs skill, hard work and experience to correctly repair the pattern equipment. Pattern repair may be required due to normal wear and tear during use, breakage during transportation and handling, careless moulding work, falling of slag or molten

metal, seasonal effects, improper placement when not in use, use of sub-standard material, wrong designs and weak construction.

In case of foundries with a large turnover of patterns, it is preferable to have a repair section attached to the storage area and separate from the main pattern shop. A properly organized pattern-repair facility can help improve the technological discipline amongst patternmakers, keep a constant check on undesirable and careless practices during manufacture, and even guide in improving moulding and core-making practices.

## 2.3. Jigs and fixture

### 2.3.1 Definition

A **jig** is a work-holding devic**e** that holds, supports, and locates the work piece and guides the one or more tools to perform a specific operation**.** A jig controls and guides the cutting tool to work at a predefined location on a work piece. Fixtures are used for supporting and locating a work piece. Fixtures do not guide the tool on a work piece like a jig.

A jig and fixture are work holding devices used in **machining operations** as an agent of support. They secure, support or mount a work piece correctly. They are very important since they aid smoother manufacturing operations, productivity among other advantages.

The main purpose of a jig is to provide repeatability, accuracy, and interchangeability in the manufacturing of products.

**Some important points to remember about Jigs:**

- It is used in uni-dimensional machining processes like drilling, tapping, and reaming, etc.
- This system is found to be light and has a complex shape.
- Gauge blocks are not necessary and the cost of jigs is higher.
- Jigs are not fixed to the machine table until a large operation has to be performed.

### 2.3.2. Fixture

Fixtures are the work holding device, which holds, supports and locates the work piece but not guides the cutting tool to perform a specific operation. In other words, the fixtures are only the

work holding device that holds, supports and locates the work piece in the desired position to perform any operation.

The main purpose of the fixtures is to hold and locate the work piece during any machining operation and to provide repeatability, accuracy, and interchangeability in the manufacturing of products.

Some important points about fixtures:

- Fixtures are used in multi-dimensional machining like milling, grinding, turning, etc.
- This system found to be heavy in weight, have simple designing.
- Gauge blocks provided for effective handling and the cost is average.
- Fixtures are having specific tools that use particularly in the milling machine, shapers and slotting machines.
- Fixtures are fixed to the machine table.

**Compare Jigs and Fixtures:**

Both the jigs and the fixtures are used to reduce the nonproductive time of any mass production process. The jig is used for guiding the cutting tool (like a drill bit), and for doing so, jigs have components like a bush, which comes in contact with the cutting tool. The other hand, a fixture never comes into direct contact with the cutting tool. Fixtures assure the position and alignment of the work pieces for getting the required machining operation done.

**Types of Jigs and Fixtures:**

There are several types of Jigs and Fixtures available in the market. Also, you can create a Jig and Fixture by yourself to do an operation easily. it is up to you. Although these are some available Jigs and Fixtures in the market.

Types of Jigs:

Here are some simple drill jigs:

- Template jig
- Plate jig
- Diameter jig
- Channel jig
- Ring jig
- Box jig
- Leaf jig
- Angle plate jig

**2.3.3 Methods of jigs and fixture**

The art of metalworking has a primary concern, locating the part to be machined relative to the platform. A CNC machine starts machining at a specific point corresponding to the fixture and proceeds from there. Therefore, the preciseness with which a job is machined is dependent on the accuracy that holds in the fixture. The accurate location of every part loaded into the fixture is essential. Any deviation in part location adds to the dimensional tolerance that must be assigned to the finished pieces. Furthermore, improper supporting and securing the part in the fixture affects surface finishes by temporarily or permanently deforming it. Hence, techniques for supporting, clamping, and locating must be considered together to assure repeatability from part to part.

**Basic principles of Jigs and Fixtures design**

**Locating points:** Locating the work is a prime necessity and requires suitable facilities. The correct setup ensures smooth insertion of a work piece in the proper position and removing a work piece from a jig without operational hassles or time consumption. The work piece position needs to be precise with the guiding tool in the jig or setup pieces in the fixture.

**Foolproof:** A foolproof design of jigs and fixtures does not permit a tool or work piece to be placed in any other way other than the intended one.

**Reduction of idle time:** Jigs and Fixtures must be designed in such a way that ensures smooth loading, clamping, machining, and unloading of a

**Weight of jigs and fixtures:** A jig and fixture must be compact, easy to handle, and low cost regarding the number of materials used without giving up stiffness and rigidity.

**Jigs provided with feet:** Some jigs require feet so that they can be placed on the table firmly.

**Materials for jigs and fixtures:** Jigs and Fixtures are usually created with hardened materials to resist wear & tear and avoid frequent damage—for example, Mild steel, Cast iron, Die steel, High-speed steel, Cesium.

**Clamping device:** A suitable clamp is rated for its strength. It should be able to hold a work piece firmly in its position while bearing the strain of the cutting tool simultaneously, without springing.

### 2.3.4. Broad rules of Jigs & Fixtures Design

- Compare the production cost of work between the existing tools and the tool to be made and see if the manufacturing price is not more than the expected gain.
- Determine location points and outline clamping arrangement.
- Make sure the clamping and binding pieces are as quick to act & efficient as possible.
- Make the jig and fixture foolproof.
- Make sure the locating points are adjustable.
- Do avoid intricate clamping arrangements.
- Round all corners.
- Make sure the operator has handles to make handling tasks easier.
- Provide ample amount of clearance.
- Provide holes for chips to escape.
- Systematically locate clamps to resist the pressure of the cutting tool while machining.

- To avoid springing action, place all clamps in proximity opposite to the bearing point of the work piece.
- Test the jigs before putting them in a shop.

**The 3-2-1 principle**

Locating a part to be machined involves mainly three steps: **Supporting, Positioning, and Clamping.**

Two main intentions when placing a job on a jig/fixture are:

- Precisely positioning the part at the desired coordinates.
- Curbing all six degrees of movement so that the part cannot budge.

An extensively used method for obtaining these objectives is the **3-2-1 principle** or **six degrees of freedom for part location.**

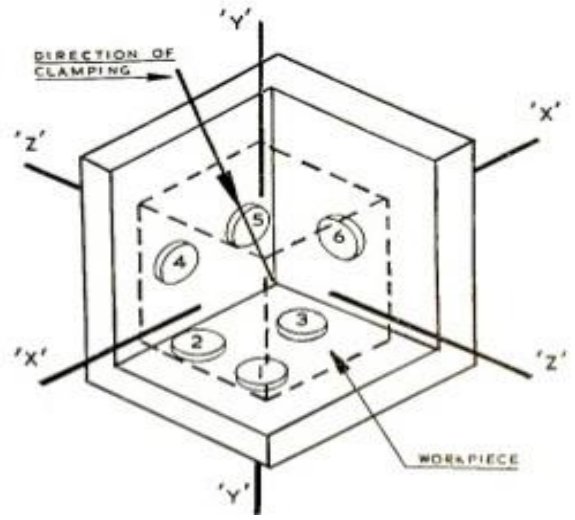



**Figure 2.3 The 3-2-1**

The 3-2-1 method is a work-holding principle where three pins are located on the 1st principle plane, i.e., XY, YZ, and ZX. And two pins are located on the 2nd plane perpendicular to the 1st plane, and at last, one pin on the plane is mutually perpendicular to the 1st and 2nd planes. The aim is to constrain the movement of the work piece along all three axes.

**Design objectives of Jigs and Fixtures**

Before sitting down to design jigs/fixtures, the designer must consider the following points:

- The tool must be foolproof to prevent any mishandling or accidental usage by the operator.
- Easy to operate for increasing efficiency.
- Easy to manufacture using the lowest costs.
- Its ability to weather the tool life instead of appropriate materials.
- Must be consistent at producing high-quality parts.
- Must be safe and secure to use.

The designer must know the basics of the process and the tools associated with it for which the jig/fixture is designed. Overall objectives to look out for a while developing such tools are:

- Cycle time.
- Type of Jig/Fixture.
- Part Assembly sequence or machining locations.
- Joining or machining process.
- Clamping method and clamping sequence.
- Required output accuracy.
- Type of equipment to be used with the jig.
- Method of ejecting finished output and transferring it to the next. Platform, whether the manual or automatic mode.
- The type of material, recommended weight, number of spots involving welding.

**Self-Check -2**

**Part I**

**Direction: Choose the best answer**

**1.** Which one of the following function is jig and fixture is designed to:

A. Part Assembly sequence or machining locations.

B. Joining or machining process.

C. Clamping method and clamping sequence.

D. Required output accuracy.

**2.** 3-2-1 principle Locating a part to be machined involves mainly three steps:

A. Supporting
B. Positioning
C. Clamping
**D.** All

**3.** factors that define the selection of pattern materials

A. Kind of molding process,

B. Method of molding (hand or machine),

C. Degree of dimensional accuracy and surface finish required,

D. Minimum thickness required,

**Part II**

**Direction: Give short answer**

**1.** Parameter is numerical or other measurable factor forming one of a set that defines a system or sets the conditions of its operation

**2.** Jig is to assure the position and alignment of the work pieces for getting the required machining operation done

**3.** Drafts help to remove the patterns from the mold without tearing or breaking sides of the mold;

**Part III**

**Direction: Give short answer**

1. Write basic principles of Jigs and Fixtures?
2. List down Types of Jigs?
3. What is the definition of fixture?

# Unit Three: Manufacture wood patterns

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- OHS procedures and measures.
- Marking out Materials.
- Wood pattern making techniques.
- Hand and handheld power tools.
- pattern components
- Color coding Patterns.
- Performing Housekeeping...

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Observe OHS procedures
- Develop construction Materials
- Produce wood pattern making techniques
- joined or fixed pattern component parts
- Tag/ mark colour coded Pattern.
- Perform Housekeeping procedures.

## 3.1 OHS procedures and measures.

### 3.1.1 Common safety in pattern shop

The field of occupational health and safety sets standards to mandate the elimination, mitigation, or substitution of jobsite hazards. OHS programs also include processes and procedures to

minimize the consequences of workplace incidents. Occupational health and safety is a very broad umbrella.

Workplace safety is an important part of any job and requires that everyone in the company adhere to the safety guidelines and policies in place. Carefully following appropriate safety guidelines can go a long way toward preventing workplace injuries. Here are some ways you can work to stay safe on the job.

**Be Aware**

Always be alert to what's happening in your surroundings; remember that your safety is your responsibility. Understand the particular hazards related to your job or workplace, and keep clear of potentially hazardous areas or situations. Be awake and attentive on the job, and be particularly aware of machinery. Avoid going to work under the influence of alcohol or drugs, which can compromise your concentration, coordination, judgment, motor control and alertness.

**Maintain Correct Posture**

Use correct posture to protect your back while at work. If you sit at a desk, keep your shoulders and hips in line and avoid hunching over. Use correct form when lifting objects and avoid twisting and stooping. The following tips provide information about lifting correctly:

- Use both hands to lift or carry a heavy object.
- Adopt a proper lifting stance by putting the strain on your legs, keeping your back straight and not bending at the waist.
- Wear a back brace for heavy work.
- Test the weight before picking up the item.
- Lift items smoothly and slowly.
- Move your feet instead of your back when traveling or turning with a heavy object.
- Hold the load close to your body.
- Ask for help to move loads that are too heavy for you.

**Take Breaks Regularly**

Feeling tired and burned out makes you less likely to be aware of your surroundings and is a common cause of workplace injuries. Regular breaks help you stay fresh and alert on the job. It is particularly important to take short breaks when you have a task that requires repetitive movements over a long period of time.

**Use Equipment Properly**

Always take the proper precautions when operating machinery or using tools. Taking shortcuts is a leading cause of workplace injuries. Use the appropriate tool for the job, and use it in the right way. When using tools and machinery, put safety first with the following tips:

- Only use machinery you are trained and authorized to use.
- Keep tools clean and in good working order.
- Organize tools and always return them to their proper place.
- Make sure the machine operator sees you; don't approach from a blind spot or from behind.
- Only perform tasks you have been properly trained to perform.
- Never leave machinery unattended while it is running.
- Always obey operating instructions.
- Never remove or tamper with safety guards.
- If something seems wrong, immediately stop the machine and get assistance.
- Communicate with those around you.
- Never walk in front of heavy equipment.
- Read and follow all labels and instructions.
- Don't tamper with hazardous items, including cords, switches and electric controls.
- Wear appropriate and compact clothing; loose, billowing clothing and accessories can easily get caught in moving parts.
- Never place fingers or other objects into moving machinery.

- Turn off equipment before moving, cleaning, adjusting, oiling or un-jamming.

**Locate Emergency Exits**

Always know where emergency exits are located and keep the path to them clear. You should also have clear access to emergency shutoffs on machinery.

**Report Safety Concerns**

If you notice a potential safety hazard or risk, report it to your supervisor immediately so they can address the situation. Keep communication lines open and work as a team to create a safe working environment.

### 3.1.2. Practice Effective Housekeeping

Maintain a clean and organized workplace environment. Make housekeeping an ongoing project that everyone is involved in and keep these tips in mind:

- Prevent trips, slips and falls by keeping all floors clean and dry.
- Eliminate fire hazards by removing combustible materials and storing flammable materials away from sources of ignition.
- Control dust accumulation.
- Avoid tracking materials and cross contamination by keeping mats clean and having separate cleaning protocols for different areas.
- Use appropriate procedures to prevent falling objects.
- Keep the workplace clutter free.
- Store all materials and equipment properly.
- Regularly inspect tools and personal protective equipment to make sure they are in good working order.

**Make Use of Mechanical Aids**

Take the extra time to obtain a wheelbarrow, crank, conveyor belt, forklift or other mechanical aid to assist you in lifting heavy objects. Attempting to lift something that is too heavy can cause injuries that could have been avoided.

**Reduce Workplace Stress**

Stress can contribute to difficulty concentrating and depression, which make it hard to be alert at work. There are many causes of stress at work including conflicts with others, heavy workloads, long hours and job insecurity. If you are experiencing workplace stress, talk to your supervisor about ways to address your concerns.

**Use Appropriate Safety Equipment**

It is important to use the proper safety equipment for a task to help protect yourself from injury:

- Wear appropriate clothing and shoes for your job.
- Know the location of fire extinguishers and first aid kits.
- Use a hard hat if there is a risk of falling objects.
- Wear gloves when handling toxic substances or sharp objects.
- Wear goggles when there is a hazard to your eyes.
- Use safety harnesses if there is a danger of falling.
- Wear non-skid shoes when working on slippery surfaces or lifting heavy objects.
- Wear a breathing mask.
- Use all protective equipment intended for your task including seat belts, protective headgear or clothing and safety glasses.

Creating an environment that is safe is the responsibility of everyone; do your part by following safety guidelines and policies. If you are injured on the job, notify your supervisor immediately and get assistance. Avoid taking risks when it comes to safety, be aware and do your part to maintain a safe workplace environment. If you've been injured on the job, call to schedule an

appointment to see how our team of specialists can help to get you feeling better and back to work!

### 3.2. Marking out Materials.

**Types of tools and their use**

- **Tools for wood working**

The principle hand tools used in a carpentry/pattern/ workshop can be classified into

- ✓ Marking and measuring tool
- ✓ Cutting tool
- ✓ Planning tool
- ✓ Boring tool
- ✓ Striking tool
- ✓ Holding tool

- **Marking and measuring tool**

- ✓ Rules are used for measuring dimensions. For measuring and setting out dimensions various types of rules are used in carpentry shop. Steel Rule, Stainless Steel Rule of length 30cm and 60cm.
- ✓ Flexible Measuring Rule- for measuring large dimensions as well as curved or angular surface dimensions.

- **Straight Edge and Squares**

This is a machined flat piece wood or metal having perfectly straight and parallel edges.

- **Steel Tape:** It is used for large dimensions, such as marking on boards and checking the overall dimensions of the work.
- **Gauges** are used to mark lines parallel to the edges of a wooden piece.
- It mainly consists of a wooden stem sliding inside a wooden stock. The stem carries a steel point for marking lines. The stock position on the stem can be varied and fixed rigidly by tightening the thumb screw.

To mark a line parallel to an edge the gauge stock is held freely against the edge and pushed along it, pressing the steel points to the surface

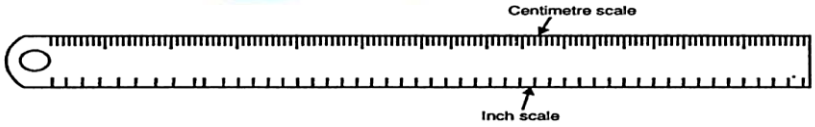



Fig. 3.1 steel rule

Fig.3.2 measuring steel tape

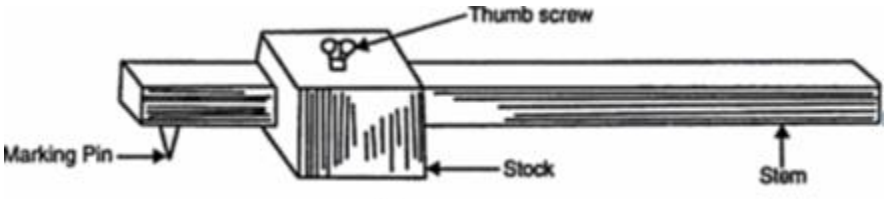



Fig.3.3 marking gauge

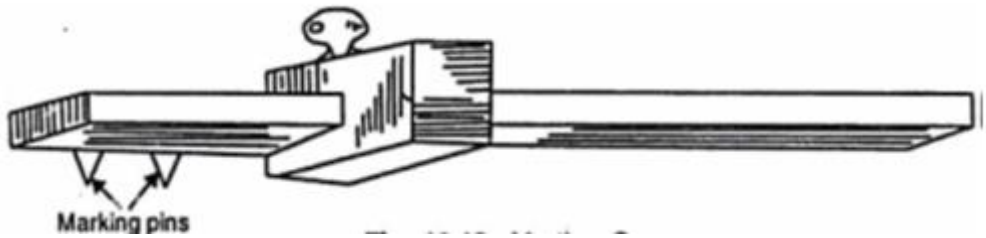



Fig.3.4. mortise gauge

- **Try square**

Try square consists of rectangular steel blade fixed rigidly to cast iron stock. The length of blade varies from 150mm to 300mm.

- **Marking Knife or Scriber**

Marking Knives are used to convert the pencil lines drawn on the wooden surface into deep scratch lines on the surface. They are made of steel with a sharp point at one end and flat blade at the other end.

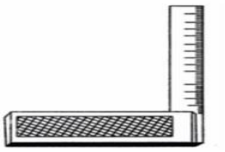
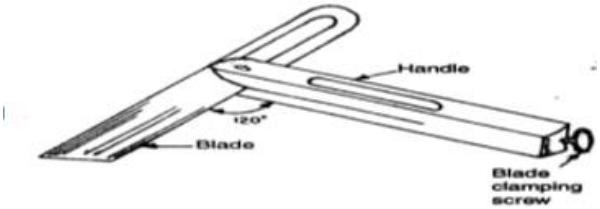


Fig.3.5 try square

Fig3.6 Marking knife




Fig, 3.7 Bevel square

**Holding tools**

- **Work Bench**

This is a table of having size and raised construction made of hard wood. The size ranges from 50- 80 cm in length and about 90cm in width. Two or four carpenters can work at a time on the work bench.

- **Carpenters Bench Vice**

It consists of jaw fixed on the table side and movable jaw kept in position by means of screw and handle. The body of vice is made of cast iron or steel. The jaws are lined with hard wood which can be removed when it is damaged.

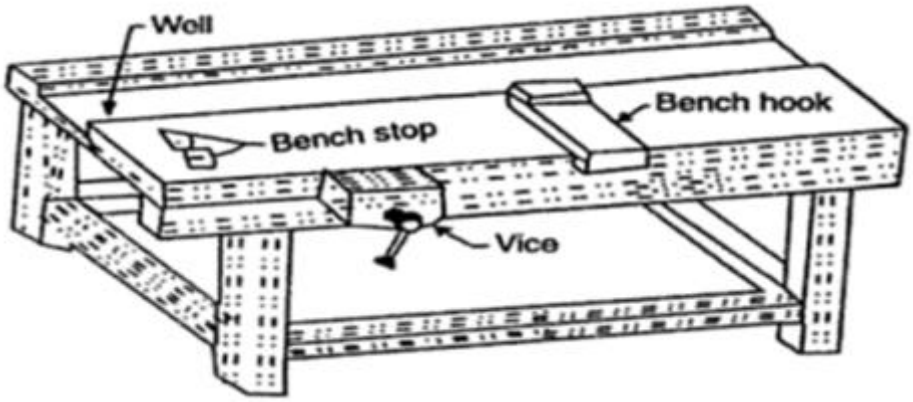



Fig. 3.8 Work bench with bench hook

The screw moves inside the fixed half nut which can be engaged or disengaged by operating the lever. This is made up of a bar of steel. The work is clamped between jaws by rotating the screw using the handle. It is used for clamping glued pieces or holding the work piece of larger size together for various operations.

- **C Clamp:** The clamp of the shape of letter C or G is used to clamp short pieces together as the bar clamp. These clamps are available is sizes varying from 70 mm to 800 mm. it is used for holding the planks after gluing.

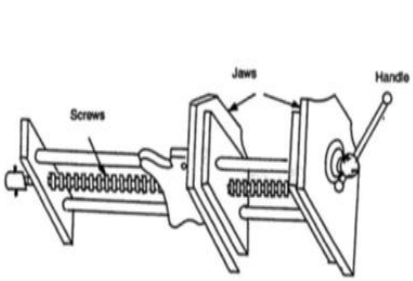



Fig3.9 .Carpenter vice

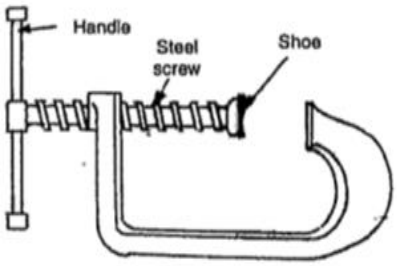



Fig 3.10 C-clap

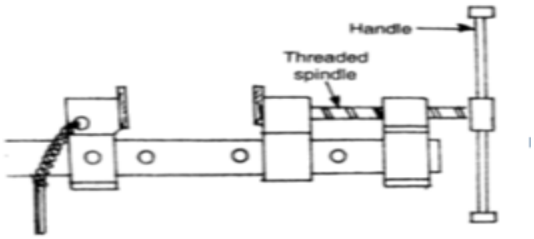



Fig. 3.11 Bar or T-clap

1.1. **Cutting tools**

- **Saws**

Saw is a cutting tool which has teeth on one edge and cutting is affected by reciprocating motion of the edge relative to the work piece. Cutting occurs during the forward motion; such a saw is called push type saw, the cutting occurs during the backward motion.

I. Hand saw- This saw is used for short straight cuts. It has a blade of 25-40cm length 6- 10cm width. The number of teeth per cm length ranges from 3-5.

II. Tenon Saw (Back saw) - It has a parallel blade of 25-40cm length and 6-10cm width. The number of teeth per cm length ranges from 5-8.

- **Chisels**

The common type of chisels used is briefly explained below.

- **Firmer Chisels**- they are most common and general purpose chisel used by a carpenter. They have flat blade of 15-50mm width and 125mm length.
- **Dove Tail Chisel** (bevelled edge firmer chisel) - These chisels are used for fine and delicate works as well as for cutting corners.
- **Mortise chisel** – These chisels are used for heavy and deep cut to remove large quantity of wood. These chisels have width of about 15mm but the blade thickness may range from 6- 15mm.

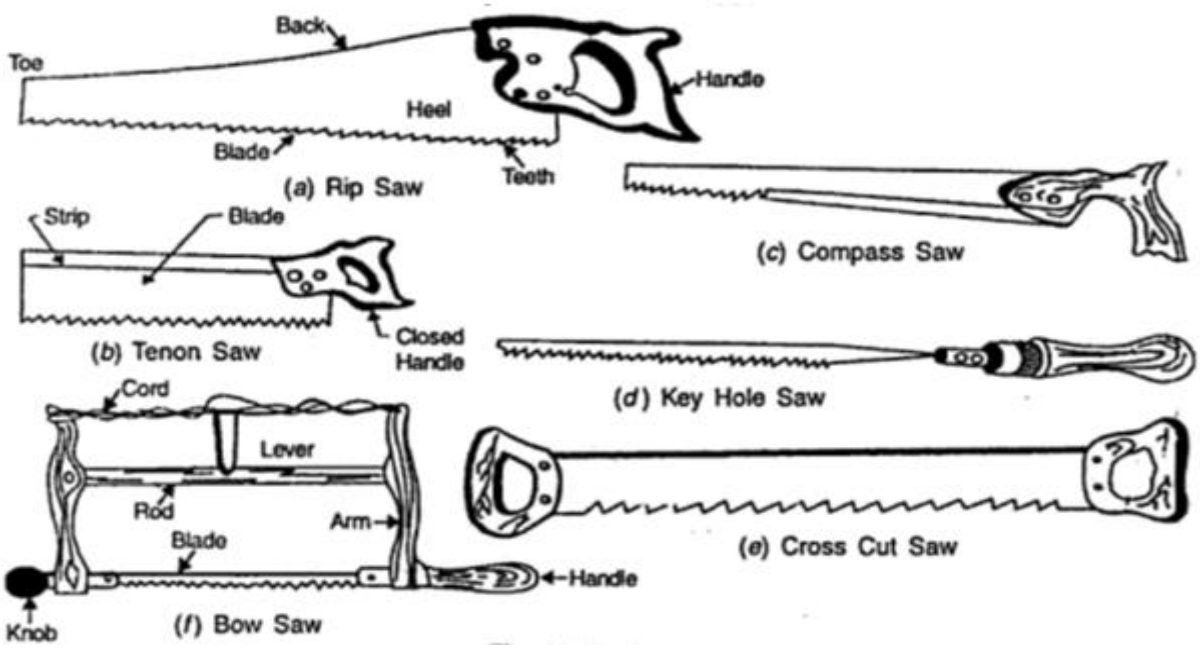



Fig 3.12 Saws

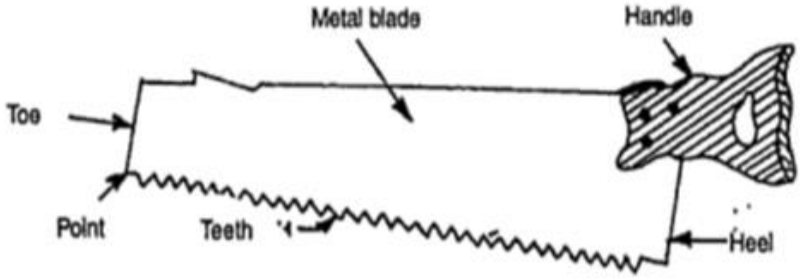



Fig 3.13. parts Rip saw

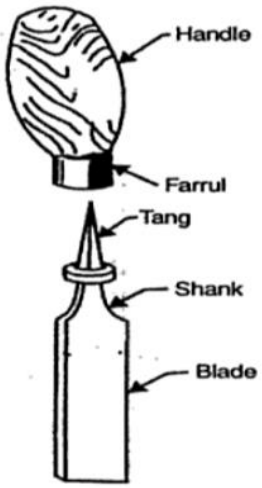



Fig 3.14: Parts of chisel

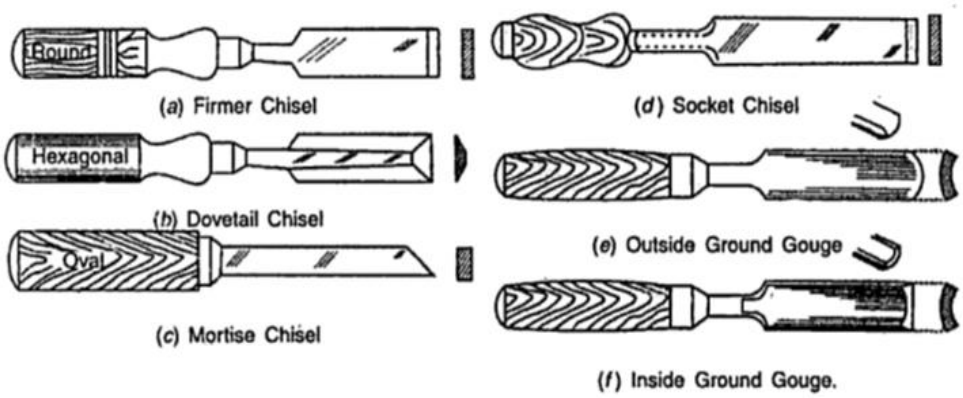



Fig 3.15: types of chisels

- **Claw Hammer**

This is a hammer having steel head and wooden handle. The flat face of the head is used to drive nails and claw portion for extracting nails out of the wood.

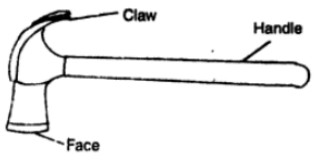



Fig3.16. Claw hammer

- **Wood rasp files:** it is a finishing tool used to make the wood surface smooth, remove sharp edges, and finish fillets and other interior surfaces. Sharp cutting teeth are provided on its surface for the purpose. This file is exclusively used in wood work.

Fig 3.17 .Rasp file

- **Common Drill Bits**

Drill bits are available in many shapes and sizes for various functions.

Besides basic hole drilling bits, there are specialized bits such as countersink bits for recessing screw heads or screwdriver bits for driving and removing screws.

The two basic types, based on the back of the bit or shank, are the round- or straight-shank bits and square-shank bits.

The latter have a tapered square tang on the end.

The round-shank bits are used in hand drills and portable electric drills, whereas the square-shank bits are used in braces.

Some of the common bits (auger, expansive, Forester, spade, and twist drills) are discussed below.

See Figure 1.17 Note that the auger, expansive, Forester, and spade drill bits are available in both square and round shanks for use in braces and portable power drills.

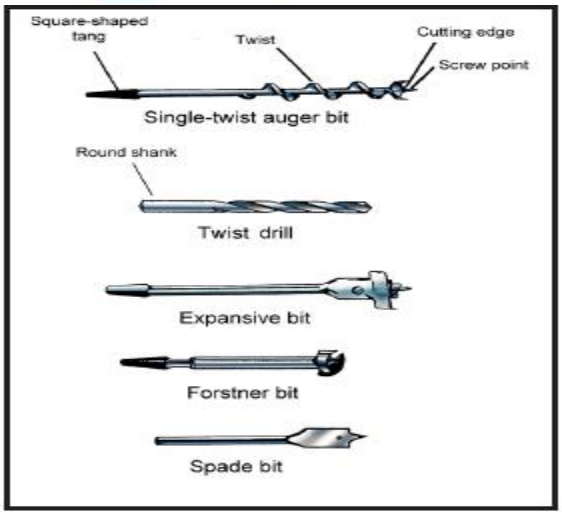



Figure 3.18 - Common Types of Drill Bits

## 3.3. Wood pattern making techniques.

### 3.3.1. Pattern Making

A pattern is a form made of wood, metal, plastic, or composite materials around which a molding material (usually prepared sand) is formed to shape the casting cavity of a mold. Most patterns are removed from the completed mold halves and used repeatedly to make many duplicate molds.

**Expendable patterns** of such materials as **wax or expanded polystyrene** are made in quantity and are used only once to produce an individual mold.

The pattern equipment (tooling) needed to make a casting includes the pattern and may also include one or more core boxes. Core boxes are used to make refractory inserts or cores that are placed within a mold cavity to form internal cavities or passageways within the casting.

The selection of the type of pattern equipment used to make a casting depends on

- Number of castings to be produced,
- the size and shape of the casting,
- the molding or casting process to be used, and
- Other special requirements such as the dimensional accuracy required.

**Pattern making begins with;**

- The dimensions of the casting required; however, the design and dimensions of the resultant pattern equipment must incorporate other features and take into account various pattern allowances.
- Patterns must be oversized to correct for the contraction of the metal upon cooling and any extra metal to be removed from the machined surfaces of a casting.
- A mold parting line must be selected and taper or draft must be included on the vertical faces of the pattern to permit the removal of reusable patterns from the mold.
- Patterns also incorporate provisions for gating and risering (rigging), which facilitate the flow (feeding) of metal into the mold cavity.
- For castings to be made with cores, the pattern and core boxes must include projections called core prints, which are used to support and locate the cores in the mold cavity. The cost of pattern equipment for a given casting can vary greatly, depending on;

- Pattern material,
- type of pattern, and
- Sometimes the dimensional accuracy required.

  However, because the pattern equipment is only a part of the mold making process, the least expensive pattern is not necessarily the most economical.

- Additional pattern cost and quality often lead to lower end costs by a reduction in molding costs and pattern repair costs and by an improvement in overall casting quality.

  **A pattern** is a model or the replica of the object (to be casted). It is embedded in molding sand and suitable ramming of molding sand around the pattern is made.

- The pattern is then withdrawn for generating cavity (known as mold) in molding sand.
- Pattern can be said as a model or the replica of the object to be cast except for the various al1owances a pattern exactly resembles the casting to be made. So the pattern is the replica of the casting.
- A pattern prepares a mold cavity for the purpose of making a casting. It may also possess projections known as core prints for producing extra recess in the mould for placement of core to produce hol1owness in casting.

- It may help in establishing seat for placement of core at locating points on the mould in form of extra recess.
- It establishes the parting line and parting surfaces in the mold. It may help to position a core in case a part of mold cavity is made with cores, before the molding sand is rammed.
- It should have **finished** and **smooth** surfaces for reducing casting defects. **Runner, gates** and **risers** used for introducing and feeding molten metal to the mold cavity may sometimes form the parts of the pattern.

**The first step in casting is pattern making**.

- The **pattern** is a made of suitable material and is used for making cavity called mould in molding sand or other suitable mould materials. When this mould is filled with molten metal and it is allowed to solidify, it forms a reproduction of the, pattern which is known as casting.

### 3.3.2. Objectives of a Pattern

- Pattern prepares a mould cavity for the purpose of making a casting.
- Pattern possesses core prints which produces seats in form of extra recess for core placement in the mould.
- It establishes the parting line and parting surfaces in the mould.
- Runner, gates and riser may form a part of the pattern.
- Properly constructed patterns minimize overall cost of the casting.
- Pattern may help in establishing locating pins on the mould and therefore on the casting with a purpose to check the casting dimensions.
- Properly made pattern having finished and smooth surface reduce casting defects.

**Proper construction of pattern and its material may reduce overall cost of the castings.**

### 3.3.3. Factors Effecting Selection of Pattern Material

The following factors must be taken into consideration while selecting pattern materials.

- Number of castings to be produced. Metal pattern are preferred when castings are required large in number,
- Type of mould material used,
- Kind of molding process,
- Method of molding (hand or machine),
- Degree of dimensional accuracy and surface finish required,
- Minimum thickness required,
- Shape, complexity and size of casting.

### 3.3.4. Pattern Plans/ Mechanical drafting/ drawing

**Pattern Allowances**

- Pattern may be made from wood or metal and its color may not be same as that of the casting. The material of the pattern is not necessarily same as that of the casting.
- Pattern carries an additional allowance to compensate for metal shrinkage.
- It carries additional allowance for machining. It carries the necessary draft to enable its easy removal from the sand mass.
- It carries distortions allowance also. Due to distortion allowance, the shape of casting is opposite to pattern.
- Pattern may carry additional projections, called core prints to produce seats or extra recess in mold for setting or adjustment or location for cores in mold cavity. It may be in pieces (more than one piece) whereas casting is in one piece.
- Sharp changes are not provided on the patterns. These are provided on the casting with the help of machining.
- Surface finish may not be same as that of casting.

The size of a pattern is never kept the same as that of the desired casting because of the fact that during cooling the casting is subjected to various effects and hence to compensate for these effects, corresponding allowances are given in the pattern.

The pattern design must be consider various allowances given to pattern can be enumerated as,

- Allowance for shrinkage,
- Allowance for machining,
- Allowance for draft,
- Allowance for rapping or shake,
- Allowance for distortion and
- Allowance for mould wall movement.

### 3.3.5. Pattern Materials (wood, plastics, clay, metals)

**Common Pattern Materials**

- The common materials used for making patterns are wood, metal, plastic, plaster, wax or mercury.

**1. Wood**

- Wood is the most popular and commonly used material for pattern making.
- It is cheap, easily available in abundance, repairable and easily fabricated in various forms using resin and glues.
- It is very light and can produce highly smooth surface.
- Wood can preserve its surface by application of a shellac coating for longer life of the pattern.
- But, in spite of its above qualities, it is susceptible to **shrinkage** and **warp-age** and its life is short because of the reasons that it is highly affected by moisture of the molding sand.
- It cannot withstand rough handily and is weak in comparison to metal. In the light of above qualities, wooden patterns are preferred only when the numbers of castings to be produced are less.
- The main varieties of woods used in pattern-making are shisham, kail, deodar, teak and mahogany.

**9. Shisham**

- It is dark brown in color having golden and dark brown stripes.

- It is very hard to work and blunts the cutting tool very soon during cutting.
- It is very strong and durable.
- Besides making pattern, it is also used for making good variety of furniture, tool handles, beds, cabinets, bridge piles, plywood etc.

**10. Kail**

- It has too many knots.
- It is available in Himalayas and yields a close grained, moderately hard and durable wood.
- It can be very well painted.
- Besides making pattern, it is also utilized for making wooden doors, packing case, cheap furniture etc.

**11. Deodar**

- It is white in color when soft but when hard, its color turns toward light yellow.
- It is strong and durable.
- It gives fragrance when smelled.
- It has some quantity of oil and therefore it is not easily attacked by insects.
- It is available in Himalayas at a height from 1500 to 3000 meters.
- It is used for making pattern, manufacturing of doors, furniture, patterns, railway sleepers etc.
- It is a soft wood having a close grain structure unlikely to warp.
- It is easily workable and its cost is also low.
- It is preferred for making pattern for production of small size castings in small quantities.

**12. Teak Wood**

- It is hard, very costly and available in golden yellow or dark brown color.
- Special stripes on it add to its beauty.
- It is very strong and durable and has wide applications.
- It can maintain good polish.

- Besides making pattern, it is used for making good quality furniture, plywood, ships etc.
- It is a straight-grained light wood.
- It is easily workable and has little tendency to warp.
- Its cost is moderate.

**13. Mahogany**

- This is a hard and strong wood.
- Patterns made of this wood are more durable than those of above mentioned woods and they are less likely to warp.
- It has got a uniform straight grain structure and it can be easily fabricated in various shapes.
- It is costlier than teak and pine wood, It is generally not preferred for high accuracy for making complicated pattern.
- It is also preferred for production of small size castings in small quantities.
- Used for pattern making are deodar, walnllt, kail, maple, birch, cherry and shisham.

**Advantages of wooden patterns**

- Wood can be easily worked,
- It is light in weight,
- It is easily available,
- It is very cheap,
- It is easy to join,
- It is easy to obtain good surface finish,
- Wooden laminated patterns are strong,
- It can be easily repaired.

**Disadvantages**

- It is susceptible to moisture,
- It tends to warp,

- It wears out quickly due to sand abrasion,
- It is weaker than metallic patterns.

### 3.3.6. Pattern types (single piece, two piece or multiple piece patterns)

**Types of Pattern**

The types of the pattern and the description of each are given as under.

1. One piece or solid pattern,
2. Two piece or split pattern,
3. Cope and drag pattern,
4. Three-piece or multi- piece pattern,
5. Loose piece pattern,
6. Match plate pattern,
7. Follow board pattern,
8. Gated pattern,
9. Sweep pattern,
10. Skeleton pattern and
11. Segmental or part pattern

**Wooden Pattern and Wooden Core Box Making Tools**

- The job of pattern maker is basically done by a carpenter. The tools required for making patterns, therefore do not much differ from those used by a carpenter, excepting the special tools as per the needs of the trade. In addition to tools used by a carpenter, there is one more tool named as the contraction rule, which is a measuring tool of the patternmaker's trade.
- All castings shrinks during cooling from the molten state, and patterns have to be made correspondingly larger than the required casting in order to compensate for the loss in size due to this shrinkage.
- Various metals and alloys have various shrinkages. The allowance for shrinkage, therefore, varies with various metals and also according to particular casting conditions, and hence the size of the pattern is proportionally increased

### 3.3.7. Tools and equipment used in the pattern making

## 1. Measuring and Layout Tools

1. Wooden or steel scale or rule
2. Dividers
3. Calipers
4. Try square
5. Caliper rule
6. Flexible rule
7. Marking gauge
8. T-bevel
9. Combination square

## 2. Sawing Tools

1. Compass saw
2. Rip saw
5. Back saw
6. Panel saw
7. Miter saw

## 3. Planning Tools

1. Jack plane
2. Circular plane
3. Router plane
4. Rabbet plane
5. Block plane
6. Bench plane
7. Core box plane

## 4. Boring Tools

1. Hand operated drills
2. Machine operated drills
3. Twist drill
4. Countersunk
5. Brace
6. Auger bit
7. Bit gauge

## 5. Clamping Tools

1. Bench vice
2. C-clamp
3. Bar clamp
4. Hand screw
5. Pattern maker's vice
6. Pinch dog

## 6. Miscellaneous Tools

1. Screw Driver
2. Vaious types of hammers
3. Chisel
4. Rasp
5. File
6. Nail set
7. Screw driver
8. Bradawl
9. Brad pusher
10. Cornering tool

### 3.3.8. Finishing the pattern

- After the patterns are prepared they should be finished by sanding or other finishing methods. Because finishing of casting is depend on the finishing of pattern. The finished patterns are colored according to their purposes

| *Surface* | *Colour/Mark* |
|---|---|
| Surface to be left as cast (unmachined) : | Blue (Steel)<br>Red (Grey cast iron)<br>Grey (Malleable cast iron)<br>Orange (Heavy metal castings)<br>Brown (Light metal castings) |
| Surfaces to be machined : | Yellow |
| Core prints for unmachined openings and end prints : | |
| Periphery | Black |
| Ends | Black |
| Core prints for machined openings : | |
| Periphery | Yellow stripes or black |
| Ends | Black |
| Pattern joints (split pattern) : | |
| Cored section | Black |
| Metal section | Clear varnish |
| Touch core : | |
| Core shape | Black |
| Legend | "Touch" |
| Seats of and for loose core prints : | Green |
| Stop-offs : | Diagonal black stripes or clear varnish |
| Chilled surfaces : | |
| Outlined in legend | Black "chill" |
| Fillets : | Black broken line |

- The pattern shop area involves the making, assembly and storage of patterns for use in moulding and core-making foundry processes .pattern is a replica of the final object to be made by casting process, with some modifications

### 3.4. Hand and handheld power tools.

- **Carpentry machines**

Wood working machines are employed for large production work. These possess the following advantages over the hand tools.

1. The carpentry machines help to reduce fatigue of carpenter.
2. The carpentry machines are used for production work.
3. The carpentry machines save time and are used for accuracy work.
4. They are used for variable job variety and more designs are possible.

Different machines are needed to save time and labor in carpentry work for various quick wood working operations especially for turning and sawing purposes. The general wood working machines are wood working lathe, circular saw and band saw.

- **Wood Working Lathe**

A general wood working lathe is shown in Fig. 2.1 which resembles roughly to an engine lathe. It consists of a cast iron bed, a headstock, tailstock, tool rest, live and dead centres and drawing mechanisms.

The long wooden cylindrical jobs are held and rotated between the two centres.

The tool is then fed against the job and the round symmetrical shape on the jobs is produced. Scrapping tool and turning gauge are generally used as a turning tool on a woodworking lathe.

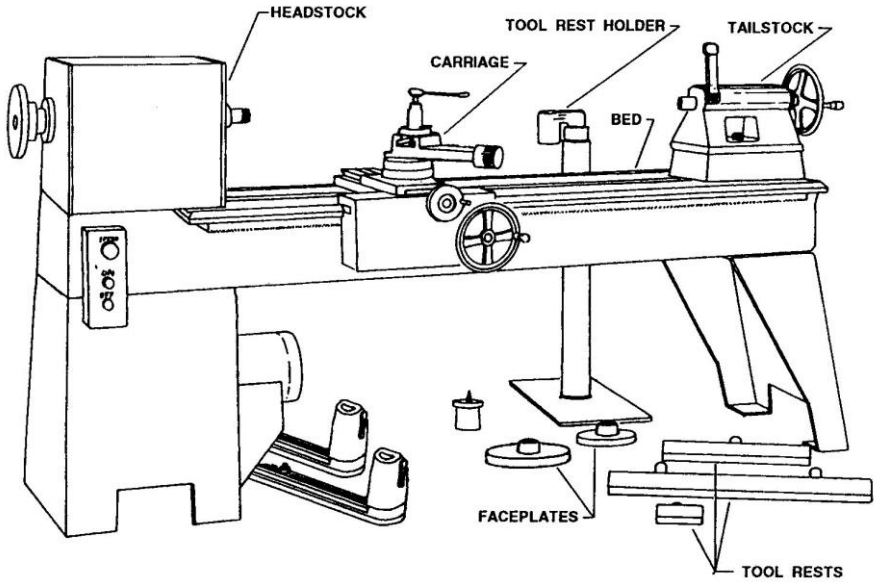



Fig. 3.19 wood lathe

- **Band Saw**

Band saw is shown in Fig. 3.19. This generally used to cut the heavy logs to required lengths, cutting fine straight line and curved work. It consists of a heavy cast bed, which acts as a support

for the whole machine, a column, two wheel pulleys, one at the top and other at the bottom, an endless saw blade band, a smooth steel table and guide assembly.

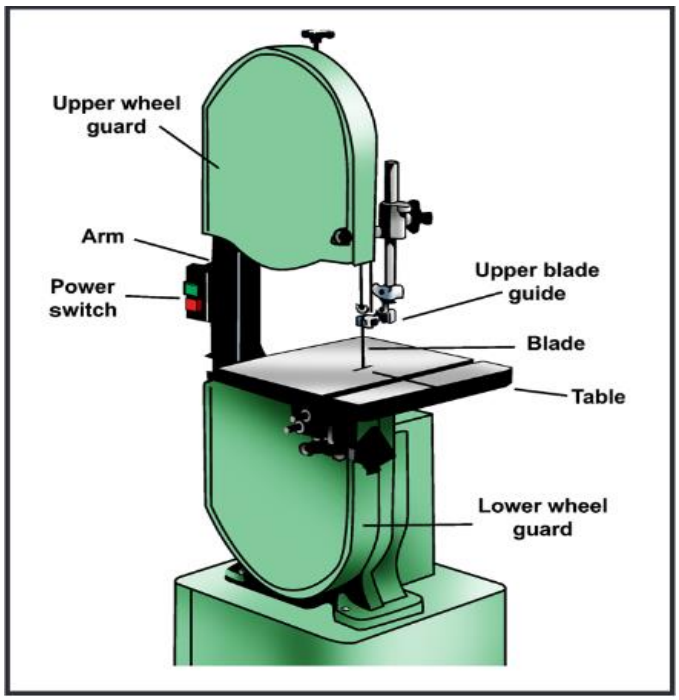



**Fig. 3.20** Band saw

- **Circular saw:**
  - ✓ A circular saw is a power-saw using a toothed or a abrasive disc or blade to cut different materials using a rotary motion spinning around an arbour. In woodworking, the term "circular saw" refers specifically to the hand-held type and the table saw and chop saw are other common forms of circular saws. "Skill saw" has become a generic trademark for conventional hand-held circular saws.
  - ✓ Circular saw blades are specially designed for each particular material they are intended to cut and in cutting.
  - ✓ A circular is used to perform various operations such as grooving, rebating, chamfering etc.
  - ✓ The principal parts include the frame, arbour, table, blade, guides for taking cuts, guards and fencing.


Fig 3.21. Hand-held circular saw

- **The Table saw:**

A table saw or saw bench is a woodworking tool consisting of a circular saw blade, mounted on an arbour, that is driven by an electric motor (either directly, by belt, or by gears).

The blade protrudes through the surface of a table, which provides support for the material, usually wood, being cut.

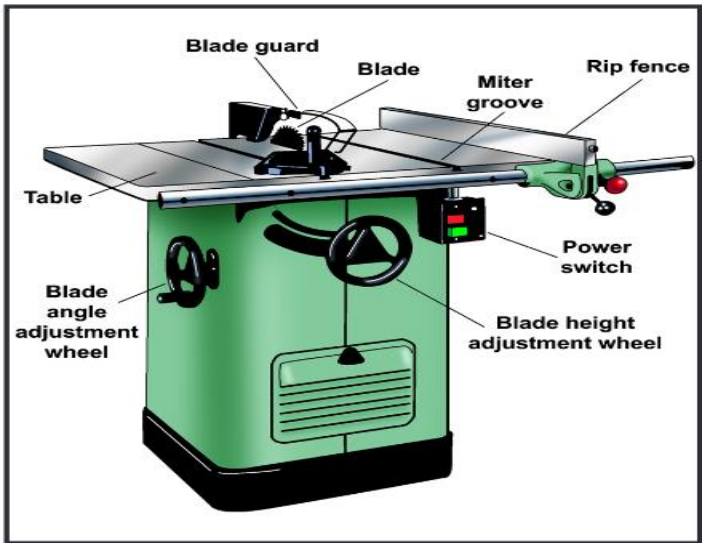



Fig.3.22. Table saw

- **Jointers**

✓ Jointers come in different sizes and perform functions similar to those of a hand plane.

- ✓ Small jointers are portable and large jointers are stationary.
- ✓ Main parts of a jointer include an on/off switch, in feed table adjustment levers, in feed table, tilting fence, cutter guard, and out feed table. See Figure 2.5. The three main adjustable parts are the in feed table, tilting fence, and out feed table. .

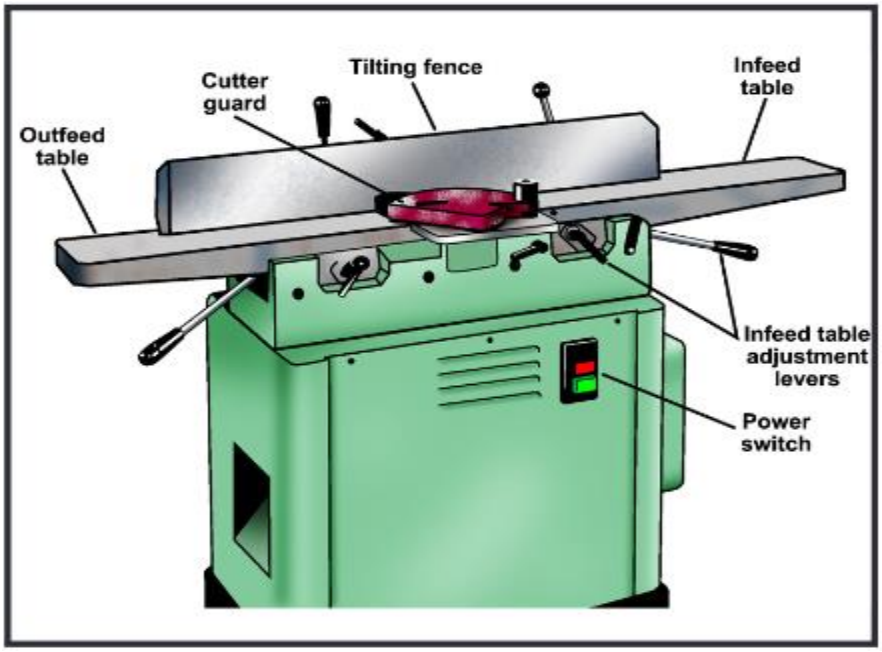



Fig.3.23: Jointer.

- **The Drill Press**
  - ✓ The drill press provides you with the ability to do precision drilling and deliver especially accurate large-diameter holes.
  - ✓ One of the best features of a drill press is the ability for you to set the depth of the hole.
  - ✓ This is especially useful when you have a number of holes you need to drill, all to the same depth.
  - ✓ The drill press also allows you to use forstner bits, hole saws and spade bits, drilling large diameter holes
  - ✓ to depths that would be very difficult to drill by hand

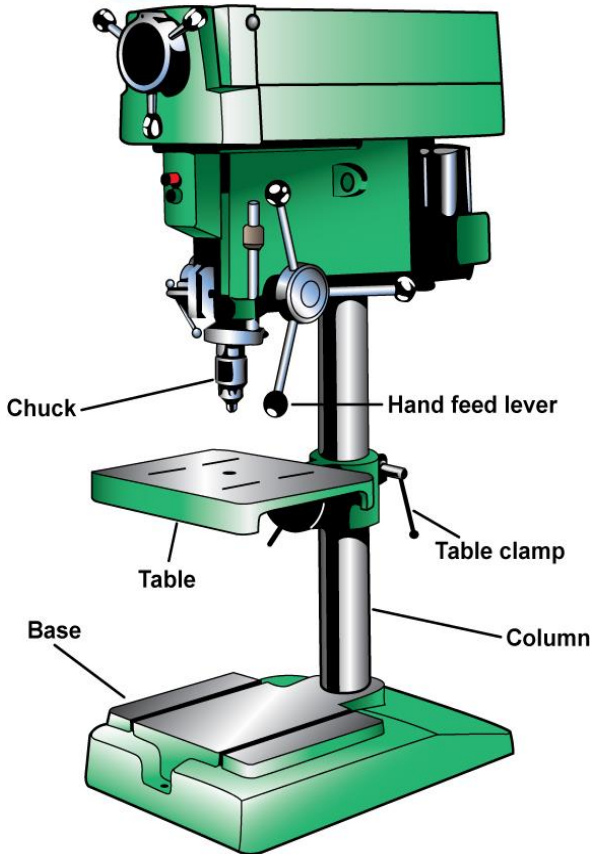



Fig .3.24: floor drill press

- **Portable Hand drill**

✓ Drills are commonly used in woodworking, metalworking, construction and do-it-yourself projects. Specially designed drills are also used in medicine, space missions and other applications.

✓ Drills are available with a wide variety of performance characteristics, such as power and capacity.

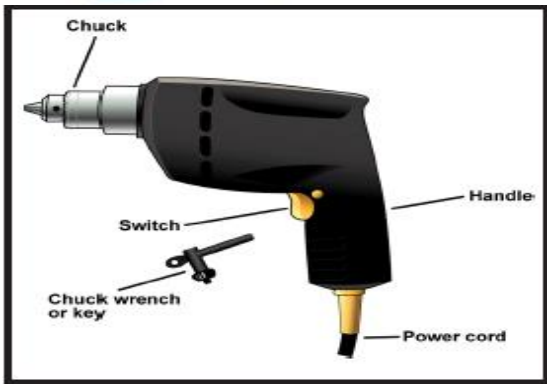



Fig.3.25: Portable hand drill

Safety considerations for a portable power drill include the following:

- ✓ Choose the right drill bit for the job. For example, do not use a square-shank bit in an electric drill.
- ✓ Make sure the bit is tight in the chuck. Use the chuck key in each hole of the chuck to tighten the bit. Be sure to remove the key before starting the drill to avoid throwing the key.
- ✓ Use a center punch to mark stock when working with metal. The indentation helps guide the bit.
- ✓ Make sure the work is held securely in place. Use a clamp or vise to hold a small piece.
- ✓ Hold the drill perpendicular to the piece to avoid binding the bit.
- ✓ Remove the bit from the drill after completing the job.

- **Orbital sander**
  - ✓ Orbital sanders (also known as finishing sanders) sand in a circular motion, and are used to achieve a fine, smooth finish on timber surfaces.
  - ✓ They are not suitable for ‘flushing off’ joints or removing wood quickly.
  - ✓ A reciprocating sander is very similar to the orbital sander but its motion is back and forth rather than circular.
  - ✓ The base of the sander has a soft rubber pad and the abrasive paper is held to it by a spring clip.

Fig.3.26: sander machine

**Bench Grinders**

- A bench grinder does work similar to a portable grinder, but it is a stationary machine mounted on a bench.
- Main parts of a bench grinder include an on/off switch, grinding wheels, safety shields, and adjustable tool rest. See Figure 3.27.
- Bench grinders are used for sharpening and reconditioning tools and for shaping and cleaning metal. Another type of stationary grinder is called the pedestal grinder. It is similar to a bench grinder but is larger and is anchored to the floor.
- Both a bench grinder and a pedestal grinder have a double-shafted motor, which allows a wheel to be mounted on each side.
- Usually one wheel is coarser in texture and is used for removing material from the surface of the piece. The other wheel is finer in texture and is used for finishing work.

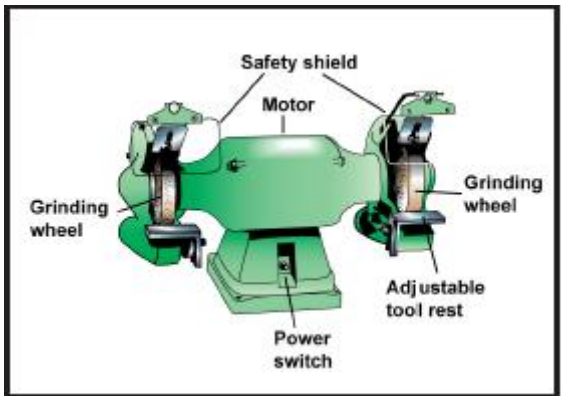



Fig.3.27. bench grinder

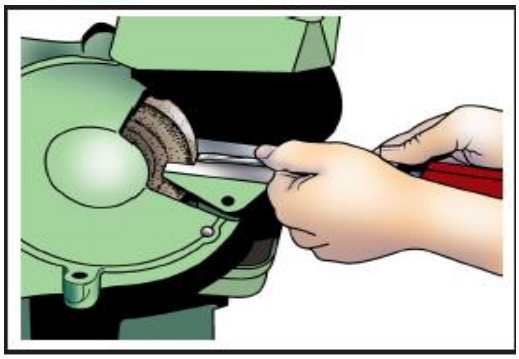


Figure 3.28 - Reconditioning a Screwdriver on a Bench Grinder, With Tool Supported by the Tool Rest

### 3.5 Pattern components

Patterns are used to mold the sand mixture into the shape of the casting and may be made of wood, plastic, or metal. The selection of a pattern material depends on the size and shape of the casting, the dimensional accuracy and the quantity of castings required, and the molding process. Because patterns are used repeatedly to make molds, the strength and durability of the material selected for a pattern must reflect the number of castings that the mold will produce
Patterns may be made of a combination of materials to reduce wear in critical regions, and they usually are coated with a parting agent to facilitate the removal of the casting from the molds.

Patterns can be designed with a variety of features to fit specific applications and economic requirements. One-piece patterns, also called loose or solid patterns, generally are used for simpler shapes and low-quantity production; they generally are made of wood and are inexpensive. Split patterns are two piece patterns, made such that each part forms a portion of the cavity for the casting; in this way, castings with complicated shapes can be produced.

The pattern is the principal tool during the casting process. It is the replica of the object to be made by the casting process, with some modifications. The main modifications are the addition of pattern allowances, and the provision of core prints. If the casting is to be hollow, additional patterns called cores are used to create these cavities in the finished product. The quality of the casting produced depends upon the material of the pattern, its design, and construction. The costs

of the pattern and the related equipment are reflected in the cost of the casting. The use of an expensive pattern is justified when the quantity of castings required is substantial.

### 3.6 Color coding Patterns.

Patterns are normally painted with different colors in such a way that mold maker would be able to understand the how to treat that particular surface. There is no universally accepted color code for a pattern. However, the common color codes used in pattern are

- Clear/ No color: denotes the parting face of the split pattern
- **Yellow**: the seats for loose core print painted yellow.
- Yellow strip on Red: indicates the seats for loose pieces.
- **Red strips on yellow background:** for supports/ stop-offs
- **Black:** the surface must be left as in the casting. This surface does not need a finishing operation.
- **Red:** the surface which painted red required to be machined

### 3.7 Performing Housekeeping

#### 3.7.1. Housekeeping safety precaution:-

- ✓ Keep always your workshop neat and clean.
- ✓ Stack the material neatly so that it will not fall when taking from the stock.
- ✓ Always keep Fire extinguisher at easily reach to hand in emergencies.
- ✓ Do not store any material in the way.

Poor floor conditions are a leading cause of Slips, Trips and Falls (STF) accidents at many workplaces.

- ✓ Ensure that floors are cleaned regularly and immediately if liquids (including water) or other materials (e.g., oil, powder) are spilled.
- ✓ Provide areas that cannot be cleaned continuously (e.g., entrance ways) with anti-slip mats and/ or anti-slip flooring.
- ✓ Use anti-slip flooring in work areas that tend to be wet or greasy (e.g., industrial kitchens and washing bays).

- ✓ In work environments where wood is handled (e.g., woodworking workshops), implement measures to prevent the accumulation of wood chips, shavings and dust as these can become slipping and fire hazards.
- ✓ Repair or replace any uneven, torn, worn out or damaged flooring or carpets as soon as possible as these are potential slipping or tripping hazards.
- ✓ Any mat or rug found loose or wrinkled should be secured accordingly.
- ✓ To prevent accidents due to poor floor conditions, always deploy barriers and warning signs around the unsafe condition until it is repaired or replaced

**3.7.2. Apply 5S**

- **Benefit of applying 5S**

The5S system sounds so simple that people often dismiss its importance. However the fact remains that 5S:

- ✓ Makes your workplace safer, cleaner and more pleasant place to work.
- ✓ Makes your job more satisfying.
- ✓ Eliminates overburdens and disappointments.
- ✓ Makes it easier to communicate with everyone you work with.
- ✓ Gives you an opportunity to give creative input how your work place should be.
- ✓ Decreases and makes defects zero that brings higher quality
- ✓ Eliminates waste that reduces cost
- ✓ Avoids delays and bring reliable delivery
- ✓ Increases safety by decreasing accidents
- ✓ Increases productivity by decreasing breakdown
- ✓ Reduces complaint and brings greater confidence and trust

- **Tools and materials used to implement Sort activity**

Tools and materials are required to implement sort, set in order and shine activities in work stations. The following are some tools and materials used to implement the first pillar of 5S-Sort.

- ✓ red tags sticker
- ✓ hook nails

- ✓ shelves chip wood
- ✓ sponge broom
- ✓ pencil shadow board/ tools board

Formats (for recording necessary and unnecessary items, plans etc.

- **Tools and materials used to implement shine**

The following are some tools and materials used to implement the third pillar of 5S-Shine.

- ✓ Sponge
- ✓ Broom
- ✓ vacuum cleaner
- ✓ garbage containers
- ✓ detergent s
- ✓ bolts
- ✓ floor scrubber cleaning Pads
- ✓ Brush
- ✓ spade
- ✓ oil

**Sort:** is the 1st of the five components of 5S. Sort means sorting out necessary and unnecessary items in the workplace, dispose of the unnecessary and keeps only those items necessary for the current operations of the workplace.

**Set in order:** is the 2nd of the five components of 5S. Set-in-order means deciding the place for necessary items, arrange them to keep easy access, and display signs so that they can be found immediately and returned or replenished properly.

**Shine:** is the 3rd of the five components of 5S. It means cleaning equipment, facilities and floor space in the workplace, and ensures that they are in good operating condition


Figure 3.29: cleaning tools

**Self-Check -3**

**Part I – Choose**

**Direction - choose the best answer and write the letter of your choice separated answer sheet. (10%).**

1. ___Types of machine which is used to produce round symmetrical shape on the work pieces is ;

   A. Jointer C. vertical band saw

   B. wood lathe D. plane

2. ___Machines which used to achieve a fine, smooth finish on timber surfaces.

   A. Bench grinder B. sander C. jointer D. portable drill

3. ____Which one of the following machine is used for cutting holes on wood surface?

   A. Floor drill press B. grinder C. plane D. jointer

4. ____Cutting fine straight line and curved work, heavy logs to required lengths on wood stock is done by?

   A. Bench grinder B. Band Saw C. drill press D. All

5. _____is used to sharpening cutting tools

   A. Portable drill B. bench grinder C. floor type drill D. none

6. It is the replica of the final object to be made.

   A, Casting B, Pattern C, allowances D, All

7. Types of patterns depend upon the factors of _____.

A, The shape and size of casting C, Method of moulding employed

B, No. of castings required D, All

**Part II – True /False**

**Directions:** write true if the statement is correct and false if the statements is not correct on separated answer sheet (10%)

1. ___In the wood lathe turning operation the red zone refers to the area directly behind infront of the work pieces
2. ___Before turning on the late short check list will assure that students are ready to turn.
3. ___It is important to remove the tool rest before sanding or polishing operation.
4. ___While turning on the wood lathe if you use left hand, grasp the steel with in the first few inch down from the cutting edge and the left hand should be in contact with the tool rest.
5. ___Tailstock ram extended too far out, and live centre pressed into the end grain ensure that the stock is held properly.

**Part III - Written Test**

**Direction - Write the correct answer**

1. Write at list three the common types of patterns?

   1. _____ 2. _____3._____

2. Write at list three pattern allowances?

   1. _____ 2. _____3._____

| Operation Sheet 1 | Performing housekeeping. |
|---|---|

**Procedures**

**Step 1.** Wear proper safety cloth

**Step 2.** Select and prepare cleaning materials

**Step 3.** Sort necessary and unnecessary items in the workplace, dispose of the unnecessary and keeps only

those items necessary for the current operations

**Step 4.** Set in order the required tools on their proper place

**Step 5.** Apply cleaning equipment, facilities and floor space in the workplace, and ensures that they are in

good operating condition

| LAP Test 1 | Practical Demonstration |
|---|---|

Name: _____ Date: _____

Time started: _____ Time finished: _____

**Instructions:** Given necessary templates, tools and materials you are required to perform the following tasks within___ hour.

:

Task 1- wears PPE.

Task 2- Identifies tools and equipment's depends on their type.

Task 3- set in order by placing the tools and equipment's in proper places.

Task 4- clean each tools and equipment

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