LAB MANUALS

WORKSHOP PRACTICE LAB
(BWS-151/BWS-251)

Student Name: ………………………
Class & Section: …………………….
University Roll No.: ....

DEPARTMENT OF MECHANICAL ENGINEERING
KIET GROUP OF INSTITUTIONS, GHAZIABAD
SESSION…………

INDEX						
Name of Student- University Roll No.- Section-						
Sr. No	Experimental Description	Experiment Date	Submission Date	LR (10)	VV (10)	Faculty sign. with date
1	Introduction to Mechanical workshop material, tools, andmachines					
	Outcome: -. (a) To study layout, safety measures and different engineering materials (mild steel, medium carbon steel, high carbon steel, high speed steel and cast iron etc.) used in workshop. (b) To study and use of different types of tools, equipment's, devices & machines used in fitting,sheet metal and welding section. (c) To determine the least count of vernier caliper, vernier height gauge, micrometer (Screw gauge) and take different reading over given metallic pieces using these instruments.					
2	(a) Study of the working, construction and accessories of Lathe Machine. (MachineShop). (b) To prepare a job by performing Facing, Plane Turning, Step Turning, Taper Turning & Threading, operation.(Machine Shop).					
	Outcome: -. Study and practice on machine tools and their operation.					
3	(a) To make a T- shape joint as per given drawing. (Fitting Shop). (b) To preparation of U- shape job which contain Sawing, Cutting, Grinding, Drilling, & Tapping operation. (Fitting Shop).					
	Outcome: - Practice on manufacturing of components using workshop trades includingfitting, carpentry foundry, and welding.					
4	(a) To make a half lap T- joint in the given dimension. (Carpentry Shop). (b) To prepare a Mortise and Tenon joint of the given dimension. (Carpentry shop)					
	Outcome: - Practice on manufacturing of components using workshop trades including fitting,carpentry foundry, and welding.					
5	(a) To prepare a Butt Joint using MIG Welding of given dimension. (Welding Shop).					

	(b) To prepare a Lap Joint using TIG welding ofgiven dimension. (Welding Shop).					
	Outcome: -. Study and practice of Welding operation.					
6	To study and observe various stage of casting through demonstration of sand. (Foundry Shop).					
	Outcome: - Practice on manufacturing of components using workshop trades includingfitting, carpentry foundry, and welding.					
7	Study of main features and working parts of CNC machine and accessories that can be used.					
	Outcome: - Practice on main features and working parts of CNC machine and accessoriesthat can be used.					
8	3 D Printing - To prepare a product using 3D printing					
	Outcome: - Practice on main features and working parts of 3 D printing machine andaccessories that can be used.					
Grading: - A^+ = Excellent, A = Very Good, A^- = Good, B = Satisfactory, C= Poor (Experiment to be repeated)						

EXPERIMENT No-1

Introduction to Mechanical workshop material, tools and machines

Objective:

1. To study layout, safety measures and different engineering materials (mild steel, medium carbon steel, high carbon steel, high speed steel and cast iron etc.) used in workshop.
2. To study and use of different types of tools, equipment's, devices & machines used in fitting, sheetmetal and welding section.
3. To determine the least count of vernier caliper, vernier height gauge, micrometer (Screw gauge) and take different reading over given metallic pieces using these instruments.

SAFETY RULES & UNSAFE PRACTICES

Remember that "accidents do not occur, they are caused". Strictly follow the generalsafety rules given below and safe practices indicated in brief under each section.

1. Safety first, work next.
2. Know your job and follow instructions.
3. Avoid wearing clothing that might catch, moving or rotating parts. Long sleeves of shirts, long hair, necktie, and jewelry are definite hazards in the shop.
4. Wear safety shoes. Do not wear canvas shoes; they give no resistance to hard objects dropped on the feet.
5. Keep the area around machine or work clean.
6. Keep away from revolving work.
7. Be sure that all guards are in place.
8. One person only should operate the machine controls.
9. Use tools correctly and do not use them if they are not in proper working condition.
10. Wear safety goggles when working in areas, where sparks or chips of metal are flying.
11. Get to know who in-charge of first aid is and where boxes are placed and where the first aid can be found in case of emergency

FITTING

INTRODUCTION TO FITTING

In engineering, particularly in heavy and medium engineering, even today with the use of automatic machines, bench work and fitting have important roles to play to complete and finish a job to desired accuracy.

"**<u>Bench work</u>**" generally denotes the production of an article by hand on the bench.

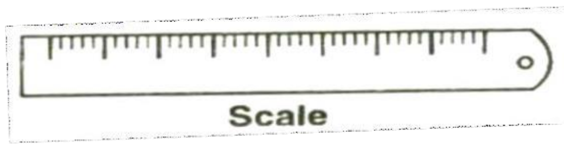
"Fitting" is the assembling together of parts and removing metals to secure the necessary fit and may or may not be carried out at the bench. There is no clear meaning between these two terms hence it is used rather loosely. Both these two types of work require the use of large number of tools and equipment's and involve number of operations to finish the work piece to desired dimensions, shape.

The operations that are carried out are:

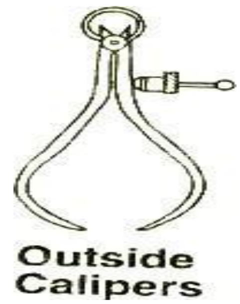
Marking out
Sawing

Chipping
Filing
Scraping
Grinding
Drilling
Reaming
Tapping
Dieing etc.

Measuring Instruments:
Steel rule:



Calipers:



Outside spring caliper:

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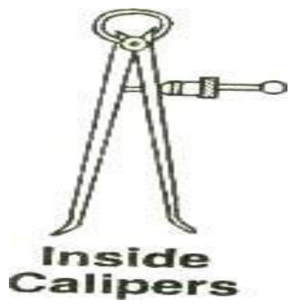

Inside spring caliper:

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Divider:

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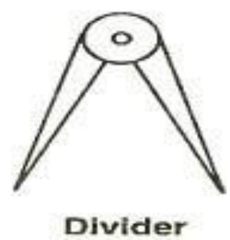
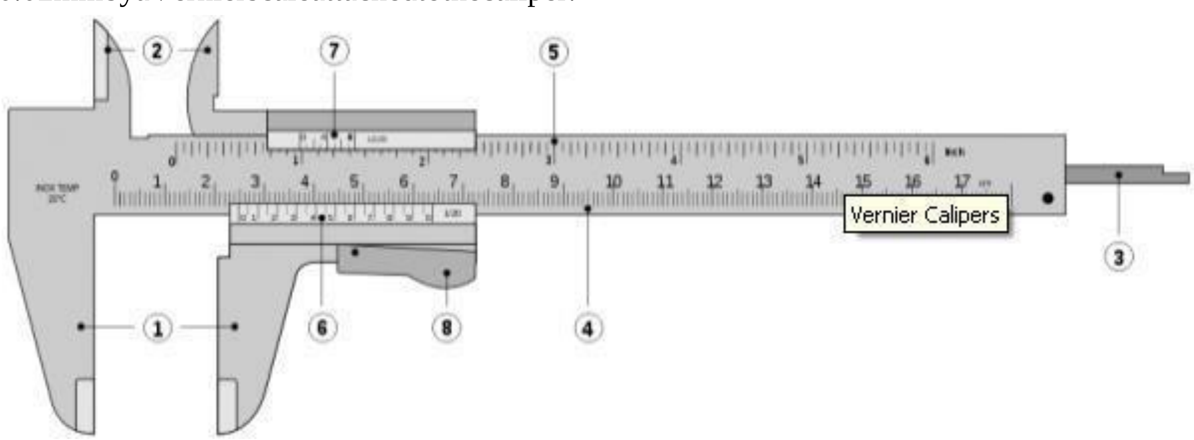


Vernier calipers:

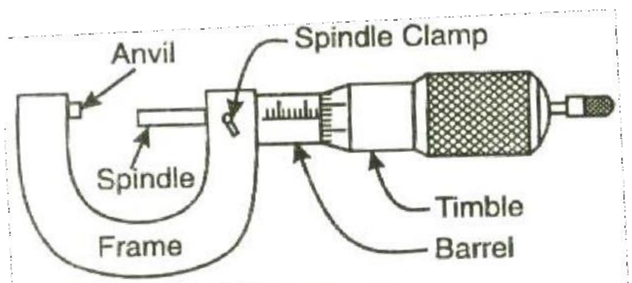
It is intended for measuring inside and outside diameters and thickness of parts etc. to an accuracyof 0.02mmbyaVernierscaleattachedtothecaliper.



1	Lower Jaws for Measuring Outer Dimensions	**5**	Main Scale in ‘inches’
2	Upper Jaws for Measuring Inner Dimensions	**6**	Vernier Scale (for ‘cm’ main scale)
3	Thin Strip for Measuring Depths	**7**	Vernier Scale (for inches main scale)
4	Main Scale in ‘cm’	**8**	Button for Fixing Vernier at Desired Position

Micrometers:

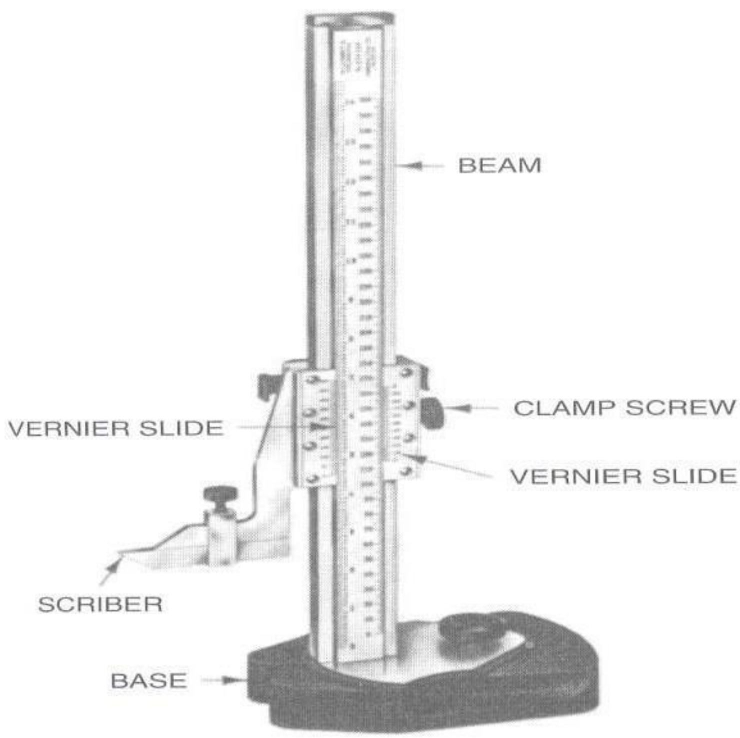
Micrometer can be further classified as external, internal, depth and screw thread micrometers. An external micrometer is used for measuring external diameter sand thickness of parts up to an accuracyof 0.01 mm.



Micrometer

The Vernier height gauge

The Vernier height, clamped with a scriber, is shown in figure. It is used for layout work. An offset scriber is used when it is required to take measurements from the surface; on which gauge is standing. the accuracy and working principle same as those Vernier caliper the capacity of height gauge is specified by the maximum height it can measure.it varies from150mmto1000mm.Itismadeof Nickel-ChromiumSteel.

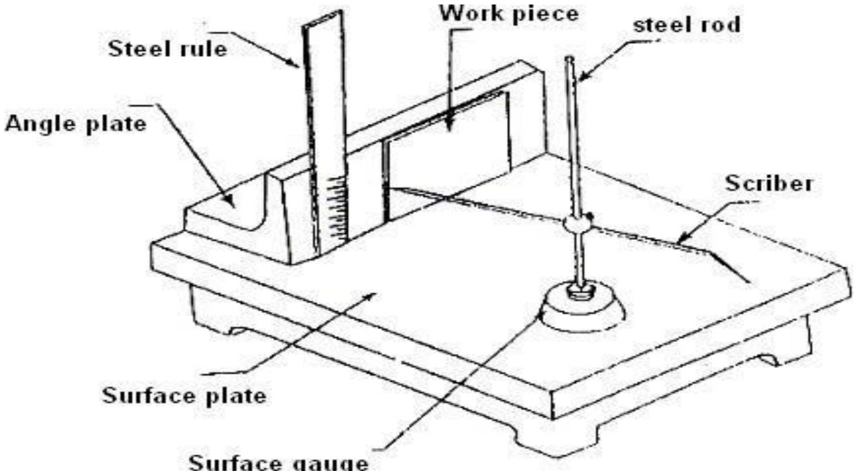


The main parts of a vernier height gage.

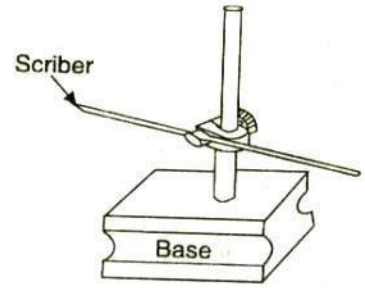
Marking tools:

Marking tools are used for lay outing the work or marking for further processing or the job. Some of the marking tools are:

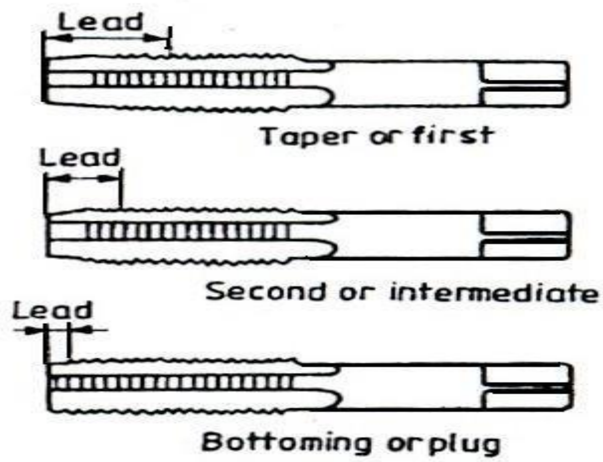
1. Surface plate
2. Scriber
3. Punch
4. ‘V’ block
5. Angle plate
6. Try – square

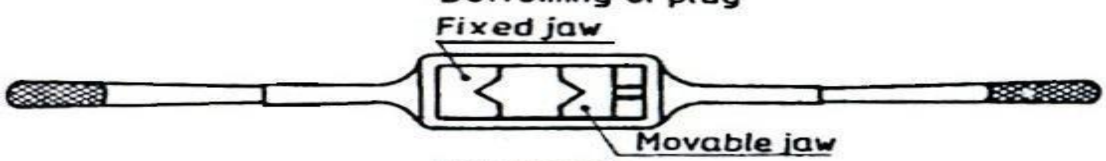


Surface plate

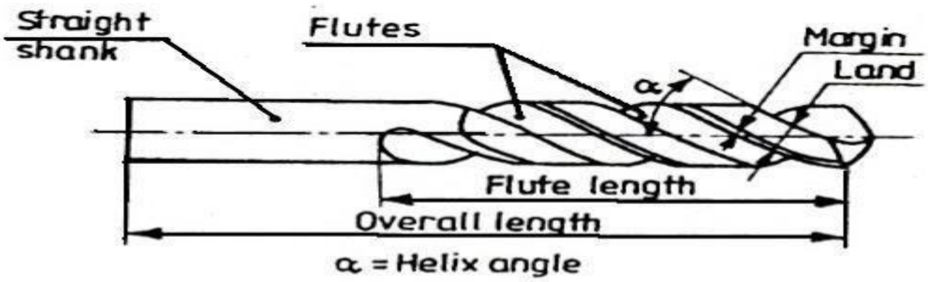


Surface Gauge

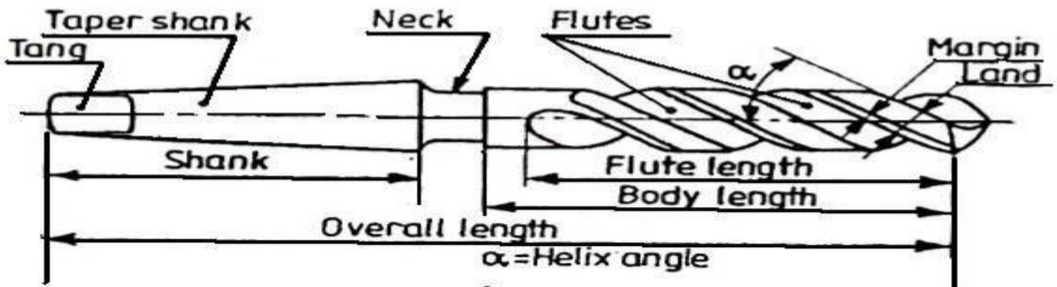




Tap wrench



a



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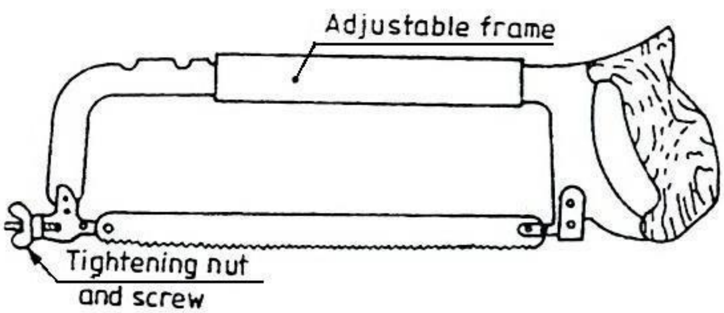
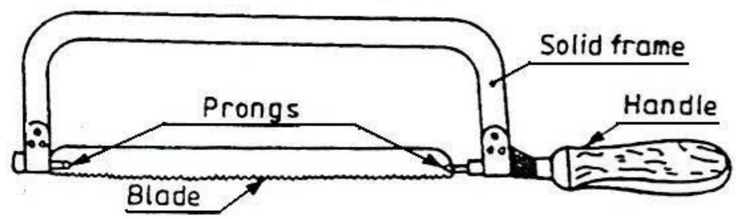
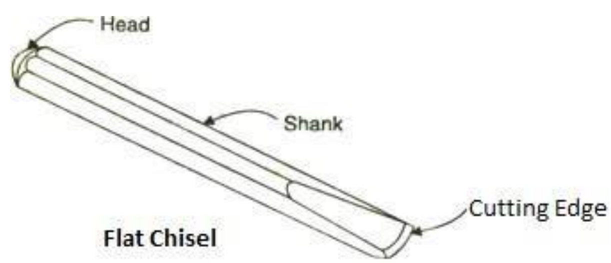
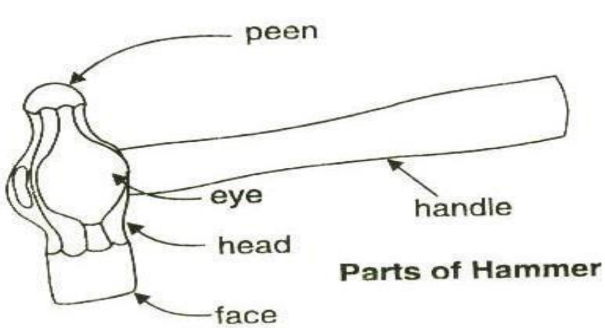




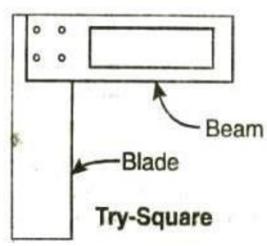


Flat Chisel

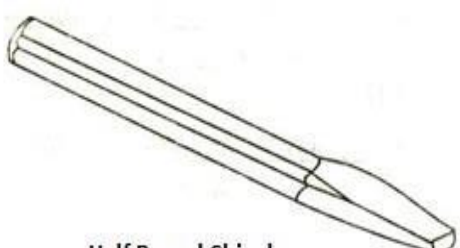
Cross Cut Chisel



Parts of Hammer

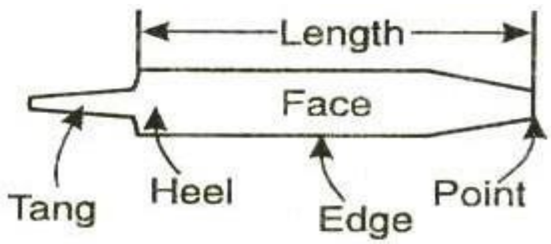


Try-Square

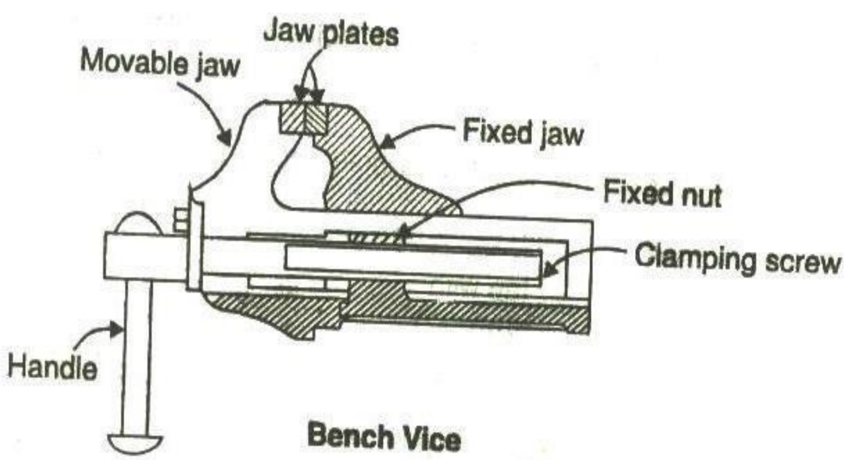


Half Round Chisel

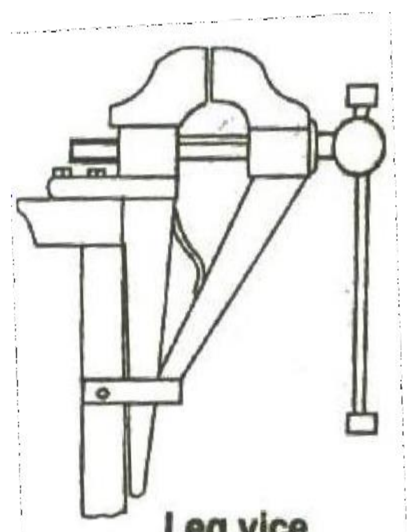
Diamond Point Chisel



Parts of File



Bench Vice



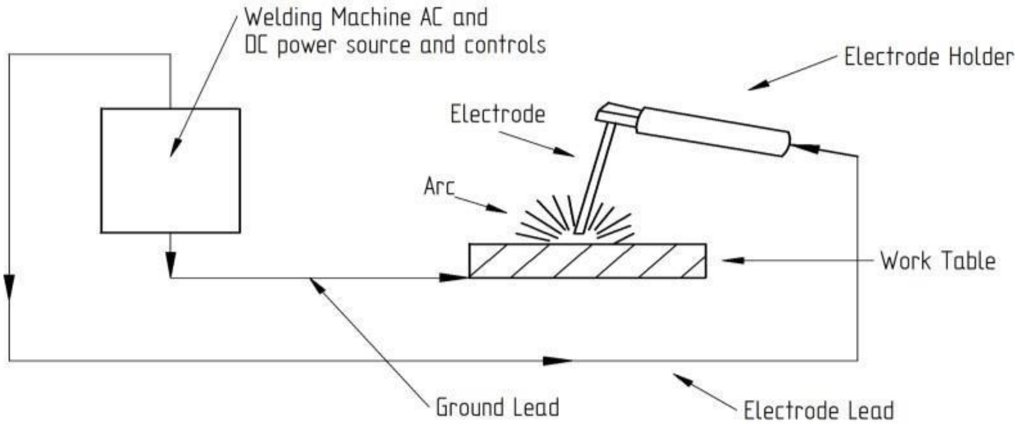
Leg vice

WELDING

Welding is the metallurgical process of joining two metals by application of heat with or without pressure and filler material.

Arc welding machines:

Both Alternatecurrent and direct current are used for electricarc welding, each having its application.



SHEET METAL

Introduction to sheet metal work:

Sheet metal work is working with metal sheets from 16 – 30 gauge, using hand tools and simple machines. By marking, development, cutting, forming into shape and joining to fabricate many domestic utility items, machine covers, hoppers, guards, tanks, stacks, duct work, pipes, bend, boxes, etc. common metals used in sheet metal work are black iron, galvanized iron, stainless steel, copper, brass, zinc, aluminum, tin plate and lead.

The material, which is used in workshop, is galvanized iron. It is zinc coated hence it is known as galvanized iron. This sheet can withstand contact with water and exposure to atmosphere.

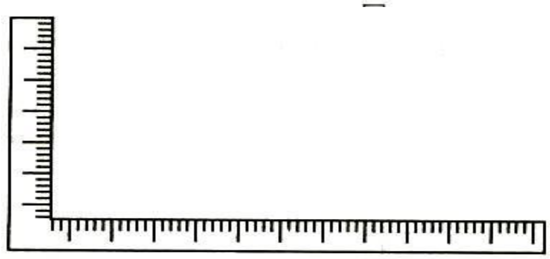
Sheet metal operations:

1) Shearing
2) Punching
3) Drawing
4) Notching
5) Flattering

Tools used in sheet metal work:

- Ball peen hammer
- Snip
- Straight edge
- Stake
- Rivets
- Steel rule
- Scriber
- Mallet
- Trammel etc.

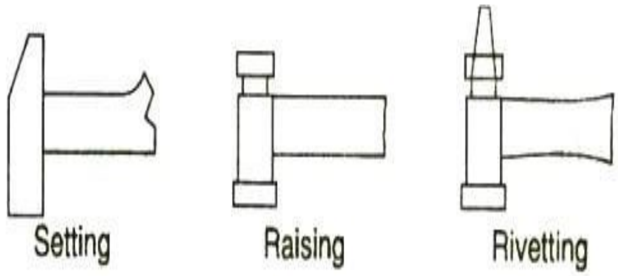
Some of these are mentioned in fitting section.



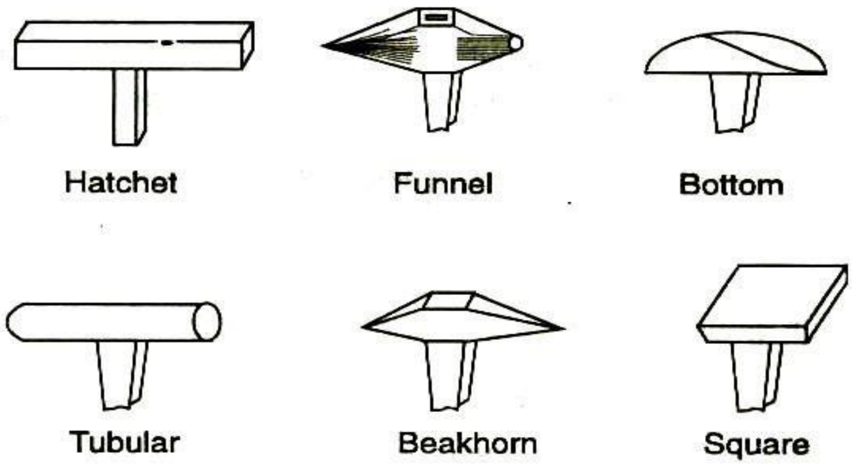
STEEL SQUARE

PRICK PUNCH

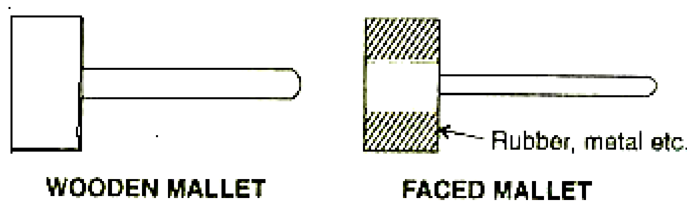
CENTER PUNCH



HAMMERS



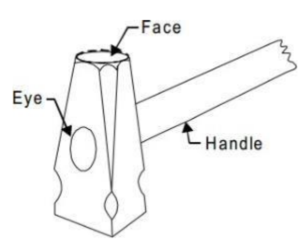
STAKES

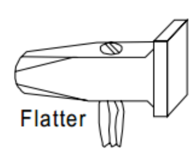


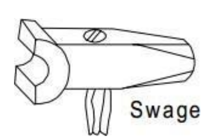
BLACKSMITHY

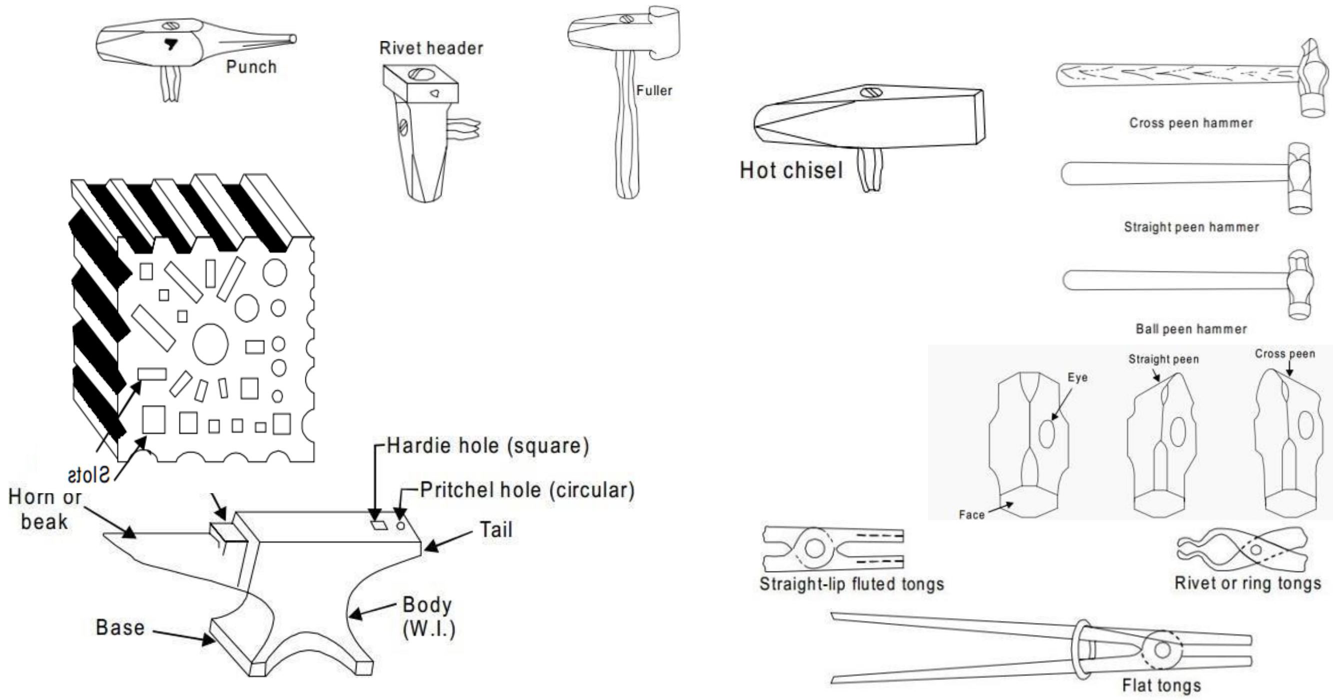
Black smithy or Forging is an oldest shaping process used for the producing small articles for which accuracy in size is not so important. The parts are shaped by heating them in an open fire or hearth by the blacksmith and shaping them through applying compressive forces using hammer.

COMMON HAND FORGING TOOLS









FORGING OPERATIONS:

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

1. Drawing-down
2. Upsetting
3. Flattering
4. Swaging:
5. Bending:
6. Twisting:

Iron-Carbon Alloy:

If the carbon is less than 2% in the iron-carbon alloy, it is known as steel. Again, based on the carbon content, it is called mild steel, medium carbon steel and high carbon steel. The heat treatment to be given to these steels and their applications are shown in table below.

	Carbon %	**Hardening temp. 0C**	**Tempering temp. 0C**	**Applications.**
Mild Steel	0.1	800-840	250-300	Chains, rivets, soft wire, sheet
	0.25	800-840	250-300	Tube, rod, strip
	0.5	800-840	250-300	Girders
	0.6	800-840	250-300	Saws, hammers, smith's and general purpose tools
Medium Carbon steel	0.75	760-800	250-300	Cold chisels, smith's tools shear blades, table cutlery
	0.9	760-800	250-300	Taps, dies, punches, hot shearing blades Drills, reamers, cutters, blanking and slotting tools, large turning tool
	1.0	760-800	250-300	
High Carbon	1.2	720-760	250-300	Small cutters, lathe and engraving tools, files drills
	1.35	720-760	250-300	Extra hard, planning, turning and slotting tools, dies and mandrels
	1.5	720-760	250-300	Razor blades

MACHINE SHOP

EXPERIMENT No-2(a)

Object: Study of the working, construction and accessories of Lathe Machine.

Lathe Theory: The lathe is a machine tool which holds the work piece between two rigid and strong supports called centers or in a chuck or face plate which revolves. The cutting tool is rigidly held and supported in a tool post which is fed against the revolving work. The normal cutting operations are performed with the cutting tool fed either parallel or at right angles to the axis of the work.
The cutting tool may also be fed at an angle relative to the axis of work for machining tapers and angles.

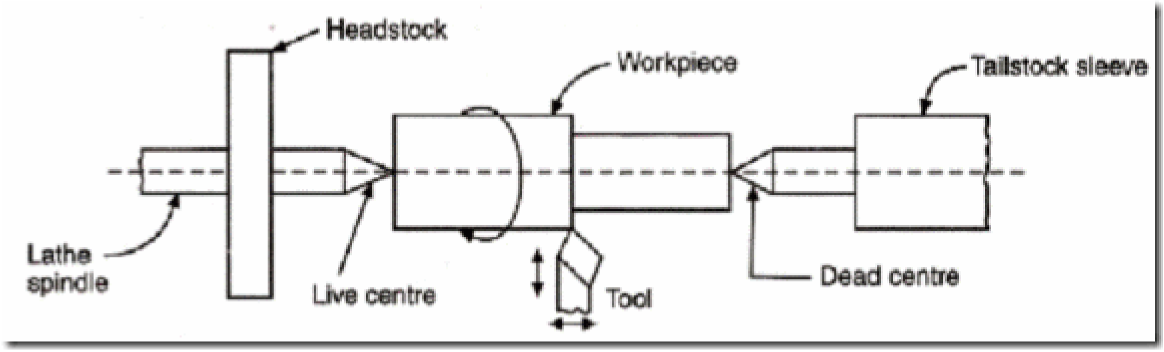


Fig. (a): Working principle of latheMain parts of Lathe Machine:

The main parts of the lathe are as follows:

1. Bed2.Legs 3. Headstock 4. Gear Box 5. Carriage 6. Saddle 7. Cross slide

8. Tool post 9. Compound rest 10. Apron. 11. Tailstock 12. Centers

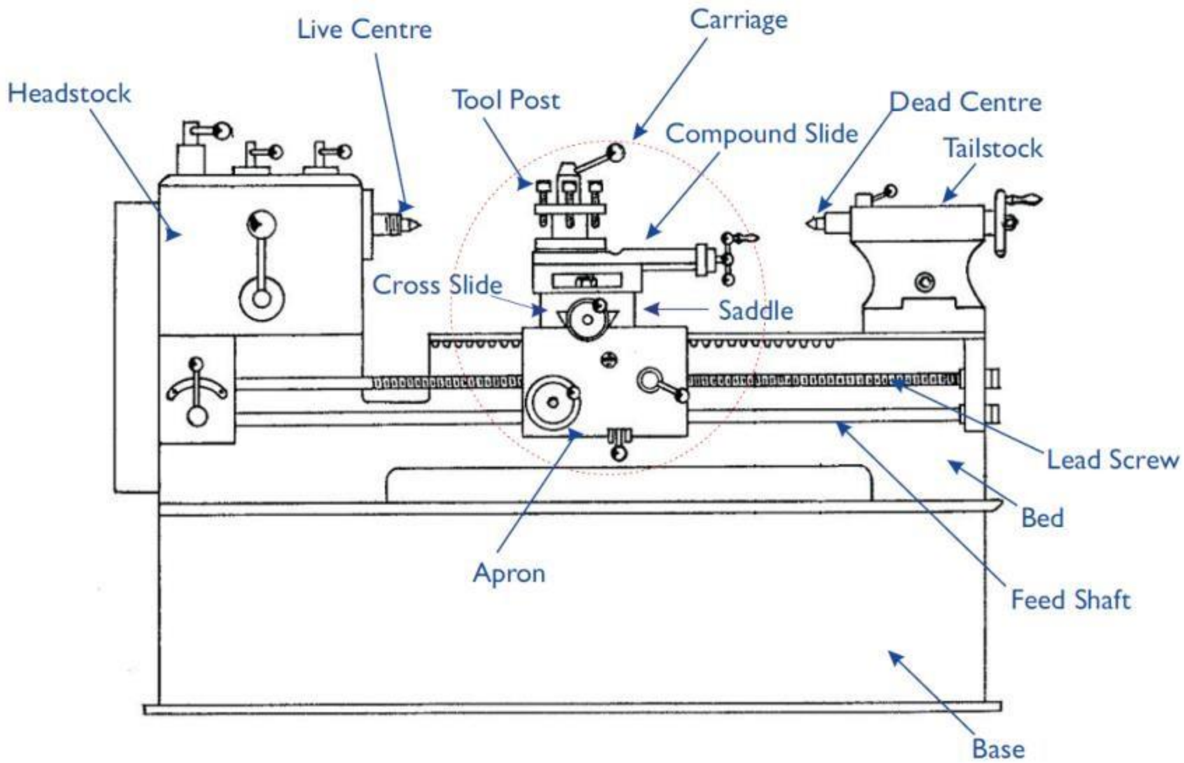


Fig (b): Parts of Lathe Machine

Different operations performed on Lathe Machine:

1. **Turing:** Different type of turning is as follows:

   (i) **Longitudinal Turning (Straight Turning):**

   (ii) **Transverse Turning (Facing):** Facing is used to make a flat surface at the end of the work piece. The work part should be rotating, and the implied feed should be radial

   (iii) **Angular Turning (Taper turning):** Like contour turning the tool is not fed parallel to the axis of rotation of the work part. The tool is fed at an angle. This turning operation gives a conical and taper cylindrical shape.

2. **Contour turning:** In this operation of lathe machine the tool is not fed in a straight path. Instead, the tool follows a contour. A contoured form is created in the turned part.

3. **Form turning:** In this method a special shaped tool is used. The tool is inserted radially.

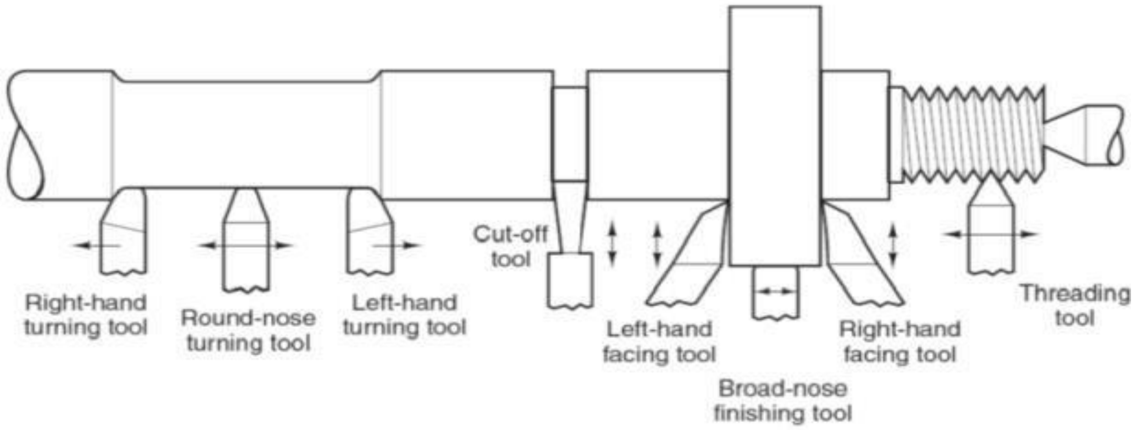


Fig. (c): Lathe Operations

4. **Chamfering:** Only the cutting edge at used at the corner of cylindrical shapes which is used for stress relieving of the work piece.

5. **Cutoff or Parting:** In parting operation the tool is fed radially, and the end part of the work piece is cut off.

6. **Boring:** A single point tool head is fed linearly to the end of the work piece (on the inside diameter).

7. **Threading:** A pointed tool is used at the outside surface of the work piece with linear feed.

8. **Drilling:** Drilling and reaming is done by feeding the lathe tool along the axis of the rotating job part.

9. **Knurling:** It is a metal forming method which creates a regular cross hatched pattern. It is not a machining process. It does not involve any cutting of the metal.

10. **Grooving**: Grooving is the act of making grooves of reduced diameter in the work piece.

11. **Forming**: The forming is an operation that produces a convex, concave or any irregular profile on the work piece.

MACHINE SHOP

EXPERIMENT No-2(b)

Object: To prepare a job by performing facing, Plane Turning, Parting, Step Turning, Taper Turning and Threading operations.

Requirements (Material): A mild Steel rod of diameter 30mm and length of 120 mm.

Requirements (Machine & Tools): Center lathe, Steel scale, surface gauge, outside caliper, turning tool, tool for threading cutting, thread gauge, combination drill and countersunk tool.

Theory: Turning is the most common operation of the lathe. The work piece is held between the centers in the chuck, and it revolves on its axis. The tool is held in the tool post and moves parallel to the axis of the piece penetrating its surface. The tool removes the metal in the form of chips from the surface of the work piece and a cylindrical surface is produced. This operation is called turning. If the tool moves inclined to the axis of the work pieces, a conical surface is produced, and this operation is called taper turning. Threading is an operation of making threads on the cylindrical surface of the piece. The movement of the tool in of the work is obtained by means of the lead screw, which driven by train of gears from the spindle. The gears are arranged in the gearbox according to the number per inch to be cut.

Procedure:

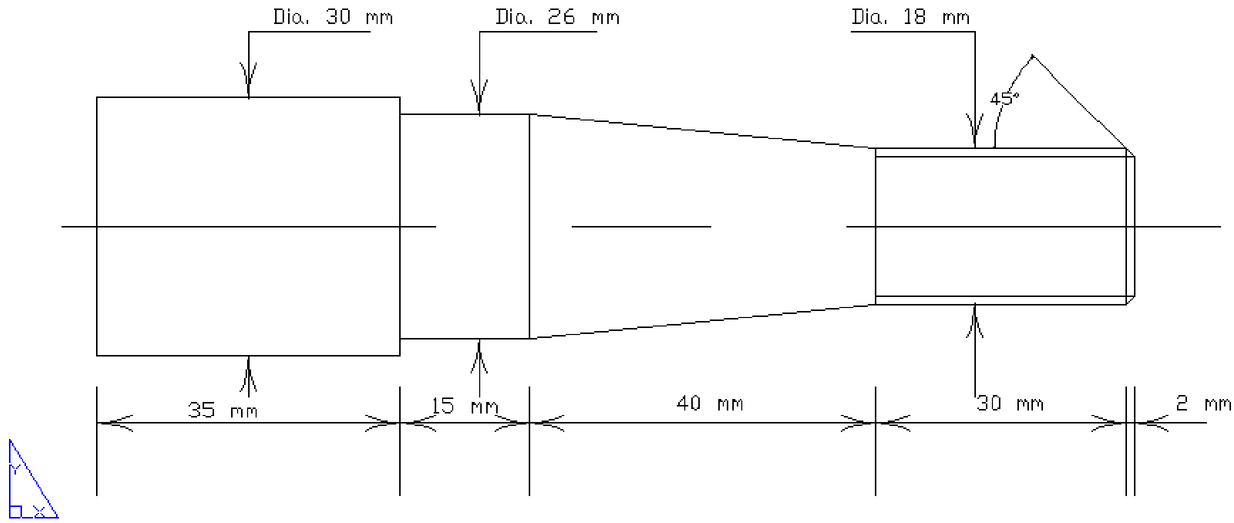
1. Hold the job in the chuck and check the centering.
2. Face at one end of the job.
3. Mark the center and do center hole by the combination and countersunk tool.
4. Now, support the tool on dead center.
5. Do turning throughout the length of the required diameter.
6. Do taper on 40mm length, making the diameter 26mm on one side and 18mm on the other side, by setting the taper angle.
7. Calculate the Taper angle to see the compound rest as follows.
8. Do threading on 30 mm length and 18mm diameter by setting the gears in the gear box for metric thread M18*2 (2mm is the pitch for 18mm diameter threads) shown in Fig. 2(b).
9. At the end of the thread, chamfer at 45^0.
10. Finish the job removing burrs.

Precautions:

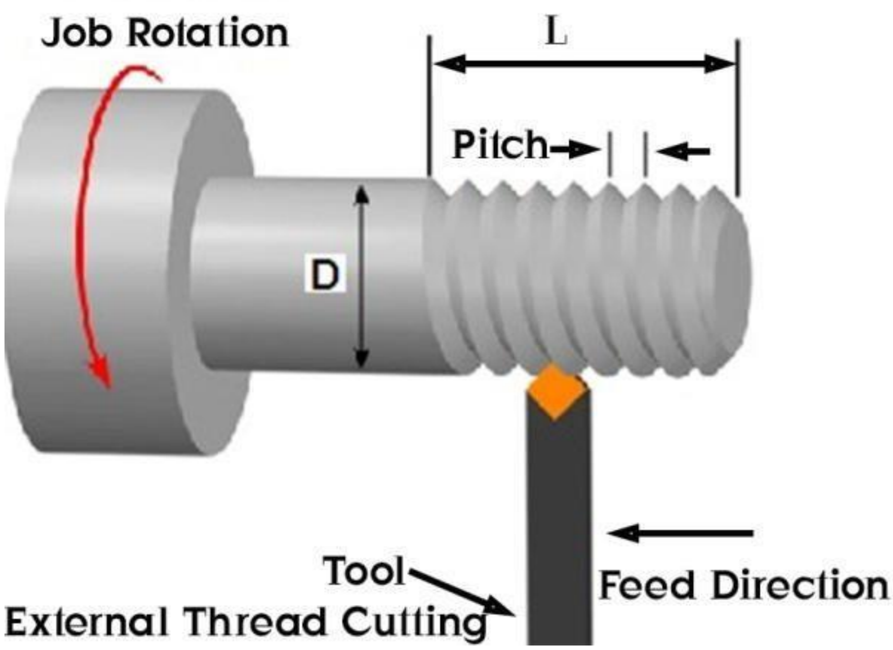
1. Hold the job firmly and accurately in the chuck.
2. Job and tool should be in the center.
3. Tools used should be sharp.
4. Setting of taper angles should be done carefully.
5. Cutting of taper threads should be done carefully.
6. Do not check the dimensions of the job during its rotation.
7. Wear apron, shoes and keep the sleeves up.

VIVA QUESTION:

1. Lathe bed is usually made of
2. Which of the following options best describes the Centre lathes?
3. Assume a machining process of taper turning. In this process, a large diameter of taper is 'D' and it is uniformly decreased to the small diameter of the taper 'd' at the horizontal length of tapered part of work piece is 'L'. What is the correct formula for half of tapper angle (2α / 2)?
4. Part name of Centre lathe machine.
5. The included angle of live center nose



Dia. 30 mm
Dia. 26 mm
Dia. 18 mm
45°
35 mm
15 mm
40 mm
30 mm
2 mm



Job Rotation
L
Pitch
D
Tool
Feed Direction
External Thread Cutting

FITTING SHOP

EXPERIMENT No-(3a)

Object: To make a T- shape joint as per given drawing.

Requirements (Material): Mild Steel Plate of size (40 mm x 40 mm x 5mm).

Requirements (Tool): Hand hacksaw, double cut file, Single cut file, Try square, Steel rule, Scriber, Center punch, Hammer& Chisel.

Theory: Some operations are easy & economical to perform by hand than by with the help of machine. Fitting is one of them. Fitting means to fit two or more parts for making an assembly
T-shape part is an important part which is prepared in the fitting shop.

Drawing: Shows in Fig. shows T- shape part

Procedure:

1. Using file prepare all sides of the work piece and make them at right angles to each other.
2. **Color** one surface of the work piece with wet chalk and allow it to dry for 5-10 minutes.
3. Mark the work piece according to the drawing. With help of scriber & steel rule.
4. Punch the work piece on marked lines by a center punch and hammer.
5. Cut the work piece into two equal parts on the marked line by hand hacksaw.
6. Remove material according to the worked line using hand hacksaw from male as well as from female part respectively.
7. File-finish, the mating surfaces of the two pieces by a file and check the accuracy of the surfaces.
8. Prepare piece to make T-shape.

Precautions:

1. Work piece should be clamped tightly in the bench vice.
2. Marking and punching should be done carefully.
3. Filling and sawing should be done carefully and accurately.
4. Surfaces should be surface finished correctly.

VIVA QUESTION:

1. Which material is used to make the file?
2. What is the No. of teeth in a ' BASTARD FILE' per Cm?
3. How to calculate the least count of a Vernier
4. What is the purpose of soft hammer in fitting shop? example bearing
5. How to specify a file?

3 T-SHAPE

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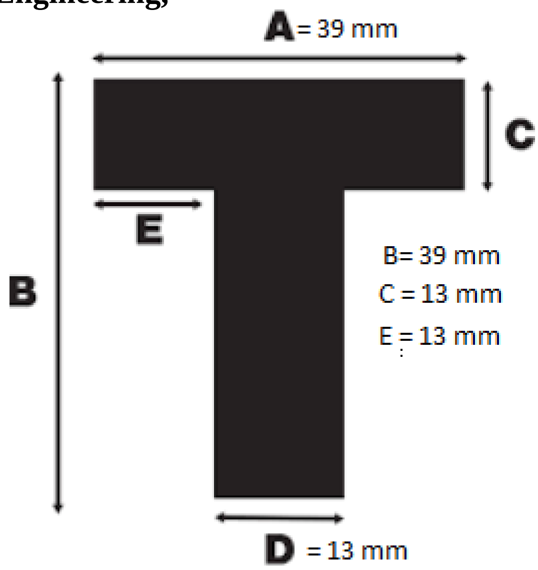

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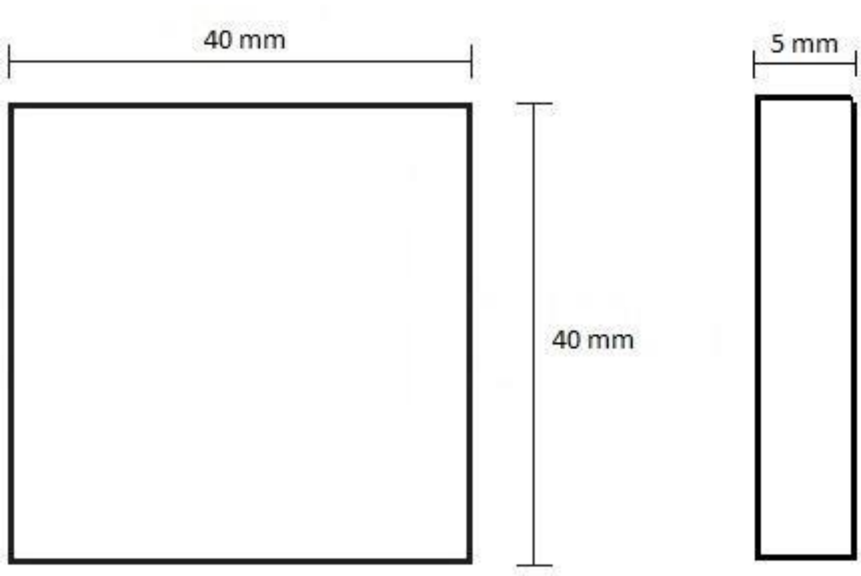

Dimension of Specimen (Raw Material of Mild Steel (5 mm thick plate): 1 PIECE OF (4**0 mm x 40 mm**)

FITTING SHOP

EXPERIMENT No-(3b)

Object: To preparation of U- shape job which contain Sawing, Cutting, Grinding, Filing, Drilling, & Tapping operation.

Requirements (Material): Mild Steel Plate of size (40mm x 40 mm x 5 mm).

Requirements (Tools & Machine): Bench vice, Steel scale, try square, Scriber, Punch, Hand hacksaw, File, Hammer, Divider, Die-stock, and twist drill& Drilling Machine.

Theory: Filing is a process by which the metal is removed in the form of small particles from the work piece with the help of a file. For filing, the work piece is tightly clamped in the bench vice. The surface to be filed is kept horizontal. The file is held in position on the work piece by both the hands. The handle of the file is in the right hand and the left hand is on the second end, pressing it downwards. The file is moved forwards horizontally through its full length, pressing it on the work piece. By doing so, the teeth of the file cut the metal in the form of fine particles from the work piece. The file is drawn back without pressing it on the work piece. The process is repeated until the work completes. The filed surface is checked by a try square.
Fig.
shows a work piece on which Cutting, Filing, Drilling, &Tapping are to be performed.
.

Procedure:

1. Clamp the work piece in the bench vice, keeping the flat surface just 2 mm to 3 mm above the jaws of the vice.
2. File carefully the flat surface of the work piece without touching the surface of bench vice.
3. Check the flatness of filed surface with the help of try square.
4. **Color** one surface of the work piece with wet chalk and allow it to dry for 5-10 minutes.
5. Mark the work piece with the help of steel rules & scriber, according to the drawing for cutting and for drilling.
6. Punch the work piece on the marked lines by a center punch and hammer.
7. Clamp the work piece in the bench vice keeping the marking vertical for hack sawing
8. Do hack sawing up to the required length.
9. Do filing on both the surfaces, which are cut.
10. Check the accuracy of the surface by a try square.
11. Clamp the work piece on the vice of the drilling machine table.
12. Keep the drill bit point on the center point of the hole, which is already punched.
13. Start the drilling machine and drill the required hole.
14. Finish all the surfaces of the work piece by a file.

Precautions:

1. Hold the job firmly in bench vice.
2. Mark the job accurately.
3. Do not drill without center punch mark.
4. Hack sawing should be done carefully
5. Drilling should be done carefully.
6. Filing should be done carefully.

4 U-SHAPE

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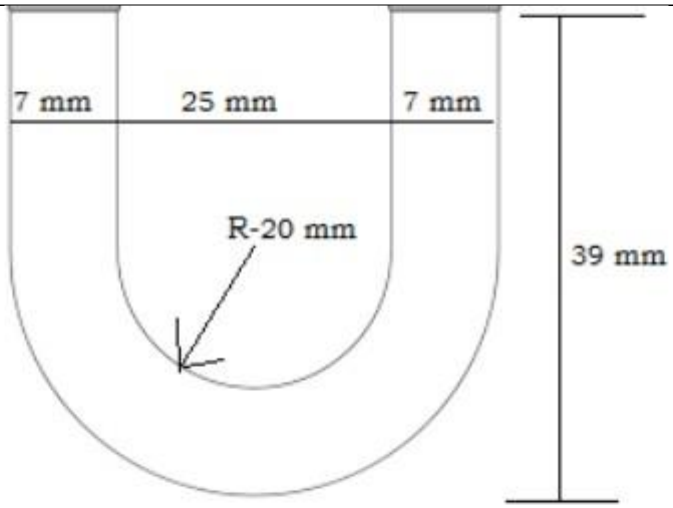

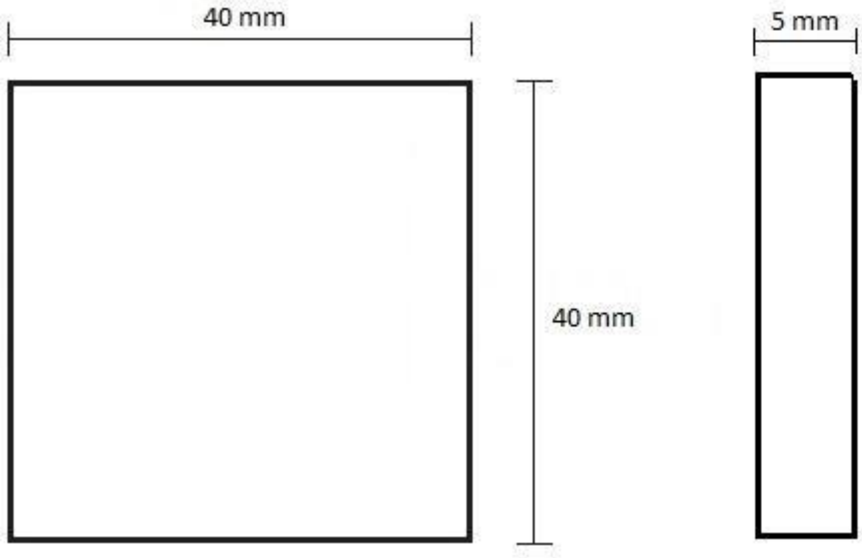

Dimension of Specimen (Raw Material of Mild Steel (5 mm thick plate): 1 PIECE OF (4**0 mm x 40 mm**)

CARPENTRY SHOP

EXPERIMENT No-(4a)

Object: To make a Half Lap T-joint in the given dimension.

Requirements (Material): Wooden Pieces of 150 mm x 75mm x 25 mm (2 Nos.)

Requirements (Tool): Wooden-vice, Steel Rule, try square, Iron jack plane, Marking Gauge, Tenon Saw, Firmer Chisel, Mallet Hammer, Pencil, Rip Saw, Hammer, Rasp file, Sandpaper.

Operations:

1. Get a Wooden Piece of required size from the Wood plan by cutting with help of rip Saw.
2. Prepare a smooth surface of wood with the help of Iron jackplane.
3. After marking to the required size, cheek the accuracy by try square.
4. Mark the piece as per drawing with the help of steel rule, try square, marking gauge and pencil.
5. Hold the piece in the Carpentry 's vice and cut it by the Rip saw, and tenon saw on the markedlines i.e., along and across the grains of wood.
6. Remove the undesired part with the help of tenon saw, firmer chisel and mallet, as shown Fig.5(a)
7. After removing the material part, the left remaining part of the work piece is smoothened with the help sandpaper or smooth file.
8. Check the fitness of the required half lap T-joint by fitting both parts, as shown Fig.5(b)

Precautions:

1. Wooden piece should be held properly in the vice before planning.
2. Marking should be done accurately and properly.
3. Plane the job accurately and cutting should be done carefully.
4. Always take clearance in the cutting operation & do not work on marking line.
5. Tools, which are not to be used, should be kept in their respective positions.

VIVA QUESTION:

1. What is the name of saw used to cut along the grain?
2. What type of chisels is used in carpentry work normally?
3. What is the purpose of a Mortise chisel?
4. What is the name of saw used to cut across the grain?
5. Can you tell the name of self-locking type of joint used in carpentry?

5(a) HALF-LAP JOINT
(1st/2nd Semester, Carpentry Shop-Department of Mechanical Engineering,
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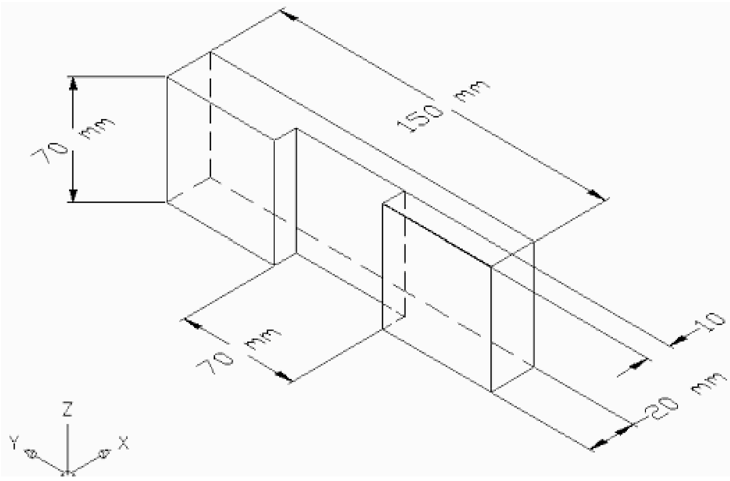
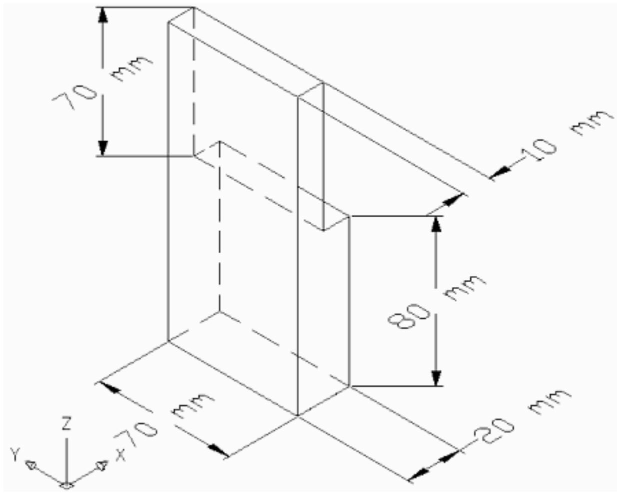
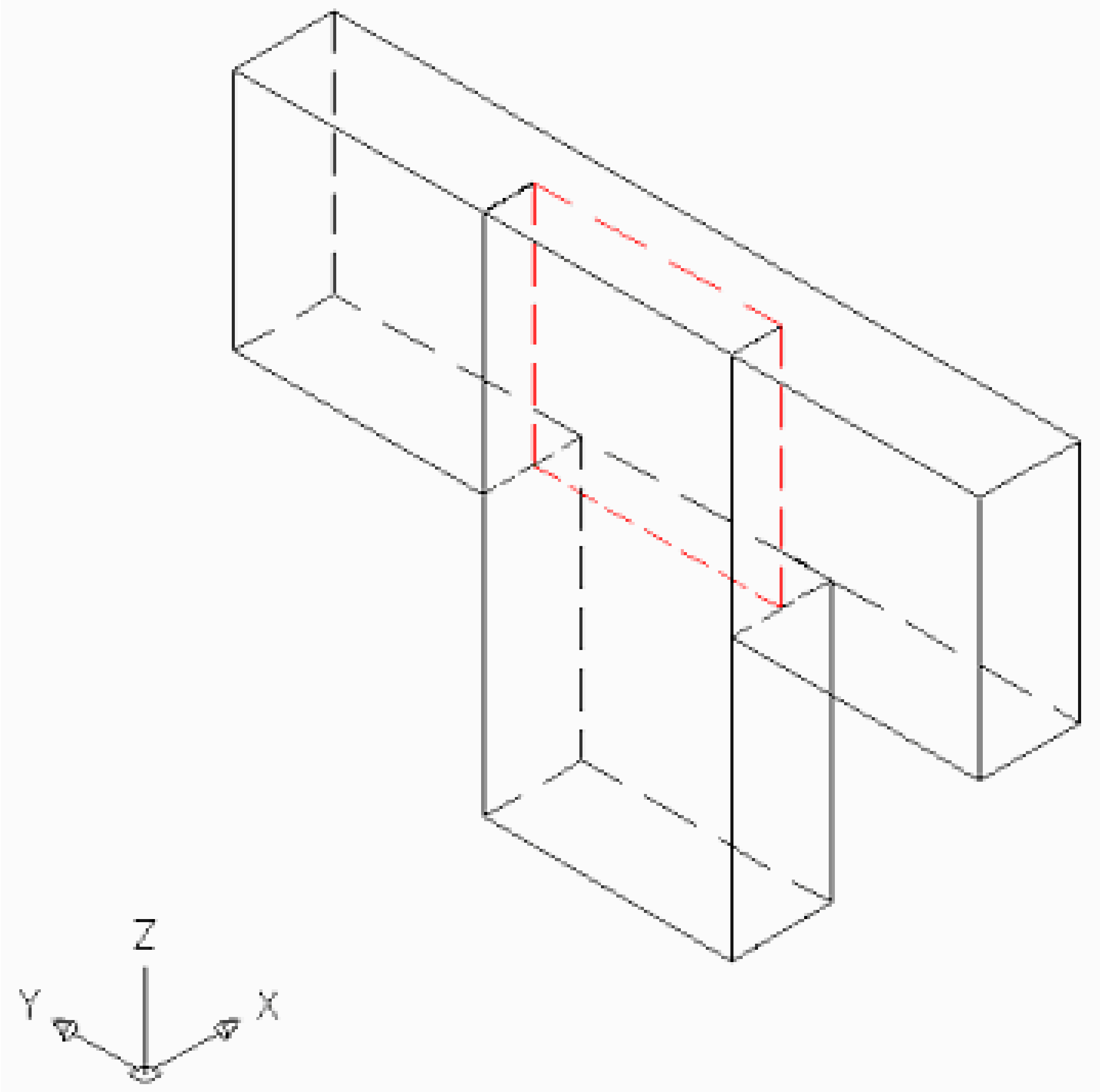
PART 'A'	PART 'B'
	

Length of Specimen: **150 mm**; Cross Section of Specimen: **70 mm x 20 mm**

(b) HALF-LAP JOINT
(1^{st}/2^{nd} Semester, Carpentry Shop-Department of Mechanical Engineering, KIET Group of Institutions, Ghaziabad)



Dimension of WOODEN Specimen (RAW MATERIAL): **150 mm x 70 mm x 20 mm**
Dimension of fitting Section: **70 mm x 70 mm x 10 mm**

CARPENTRY SHOP

EXPERIMENT No-(4b)

Object: To prepare a Mortise and Tenon Joint of the given dimension.

Requirements (Material): Wooden Pieces of 150 mm x 50m x 50mm (2 Nos.)

Requirements (Tools): Carpentry Vice, Steel Rule, try square, Iron jack plane, Marking Gauge, Tenon Saw, Firmer Chisel, Mallet Hammer, Pencil, Rip Saw, Hammer, Rasp file & Sand Paper.

Operations:

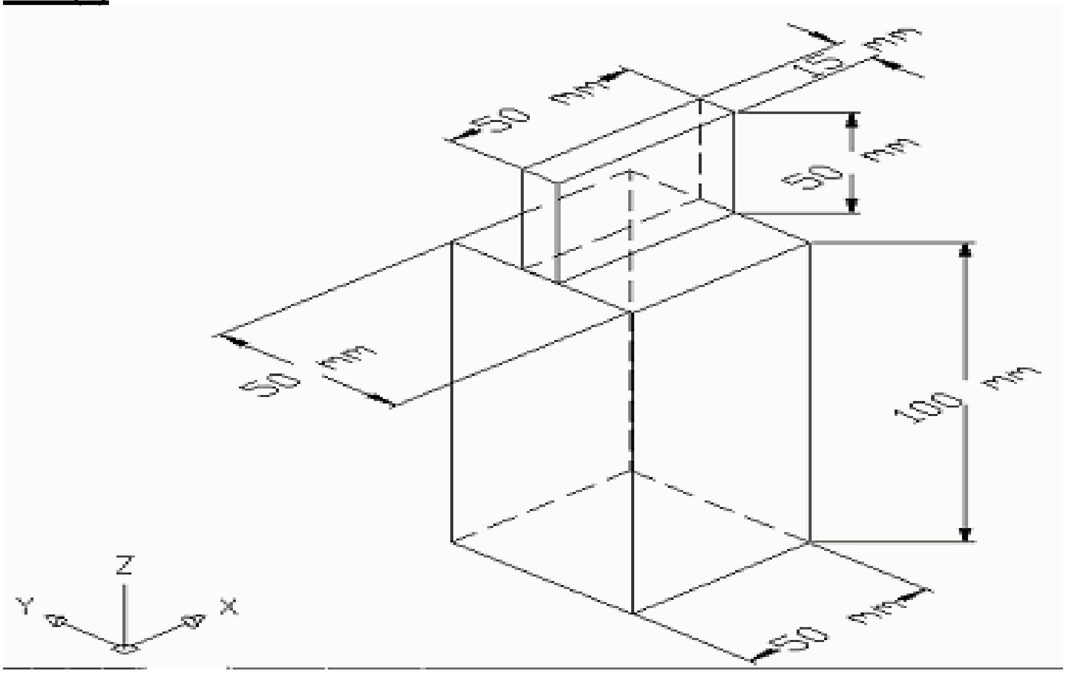
1. Get a Wooden Piece of required size from the Wood plan by cutting with help of rip Saw.
2. Prepare a smooth surface of wood with the help of Iron jackplane.
3. After marking to the required size, check the accuracy by try square.
4. Mark the piece as per drawing with the help of steel rule, try square, marking gauge and pencil.
5. Hold the piece in the Carpentry 's vice and cut it by the Rip saw, and tenon saw on the marked linesi.e., along and across the grains of wood.
6. Remove the undesired part with the help of tenon saw, firmer chisel and mallet, as shown Fig. (a)
7. After removing the material part, the left remaining part of the work piece is smoothened with the help sandpaper or smooth file.
8. Check the fitness of the required joints by fitting both parts, as shown Fig. (b)

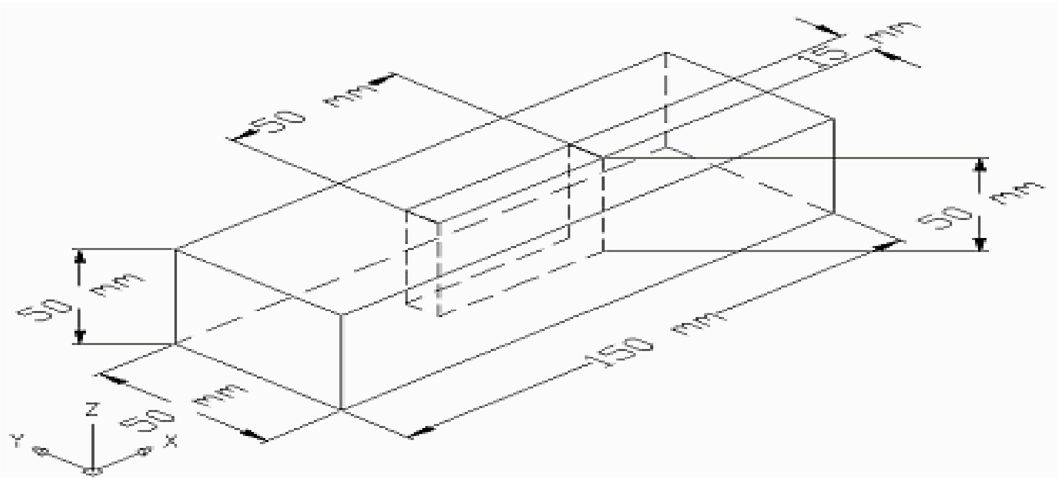
Precautions:

1. Wooden piece should be held properly in the vice before planning.
2. Marking should be done accurately and properly.
3. Plane the job accurately and cutting should be done carefully.
4. Always take clearance in the cutting operation & do not work on marking line.
5. Tools, which are not to be used, should be kept in their respective positions.

(a) MORTISE AND TENNON JOINT

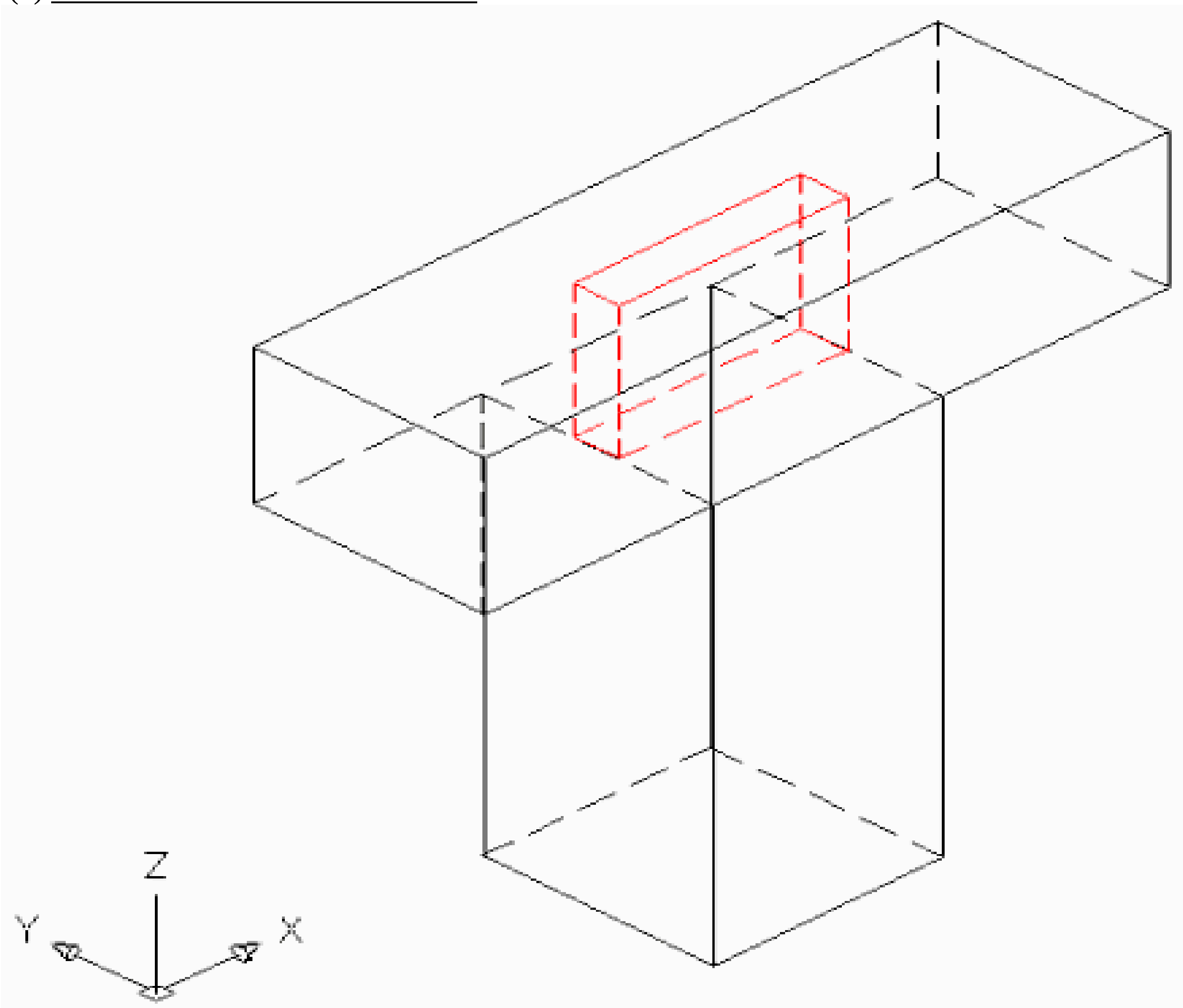
Part (a)





Part (b)

(b) MORTISE AND TENNON JOINT



Dimension of WOODEN Specimen (RAW MATERIAL): **150 mm x 50 mm x 50 mm**
Dimension of fitting Section: **50 mm x 50 mm x 15 mm**

WELDING SHOP

EXPERIMENT No-5

Object: To Prepare a Lap & Butt joint of given dimension.
Lap Joint:
Material Used: M.S plate of dimension (40mm x 40 mm x 5 mm) two pieces.

Requirements (Tools& Equipment's): Steel Rule, Scriber, Try Square, Files, Face Shield Goggles, Electrodes, Chipping Hammer, Wire Brush, Apron, Welding Table, Bench-vise, Hand Hacksaw, Electric Are Welding Machine along with all its accessories.

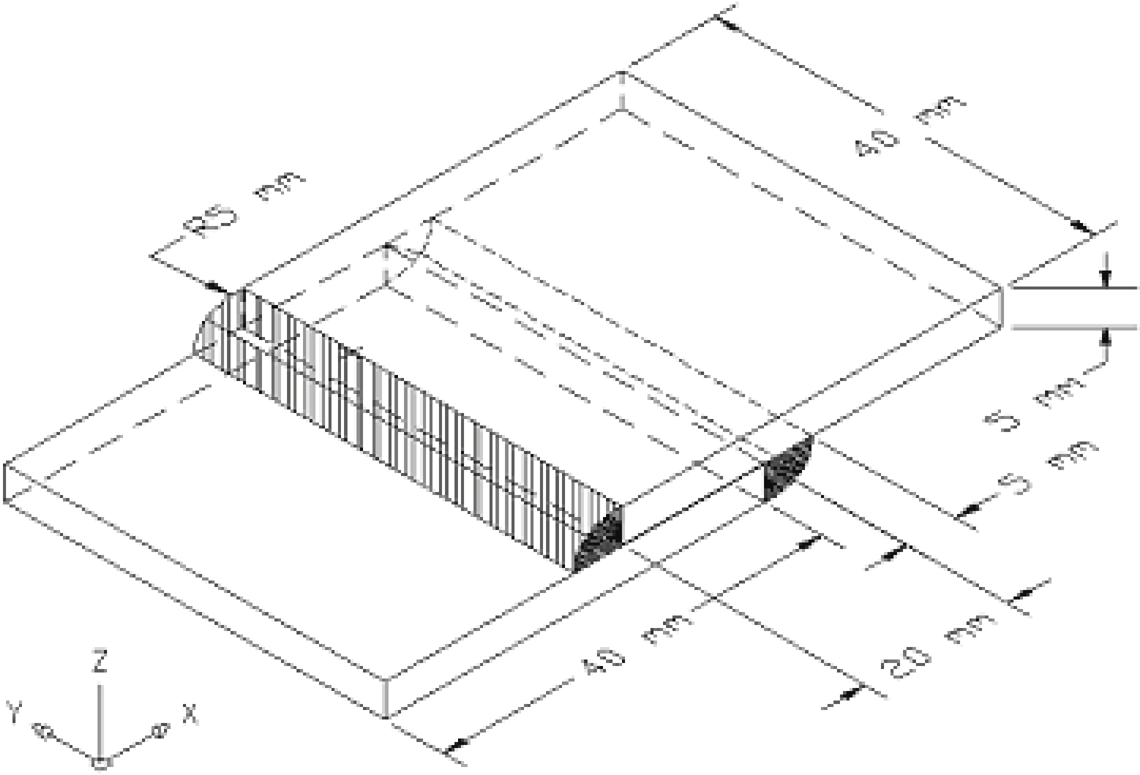
Procedure:

1. Cut the required size of Piece from mild steel flat with help of hand hacksaw.
2. First, we hold the work piece in the bench vice and start filling to remove surface irregularities.
3. Prepare the edges of both piece through 45^0 and make a V shape for the Welding operation.
4. After edge preparations, place the two pieces in proper position on the welding table for the Lap joint preparation
5. Hold the electrode in the welding electrode holder and switch on the welding transformer.
6. Make a minimum distance between the job and the electrode to produce a suitable arc.
7. Prepare a Proper arc at one end to the other end at a Proper Speed to complete the weld.
8. After Welding on both sides remove the extra filler Metal burs from the weld by chipping hammer and wire brush, shown in Fig. 8

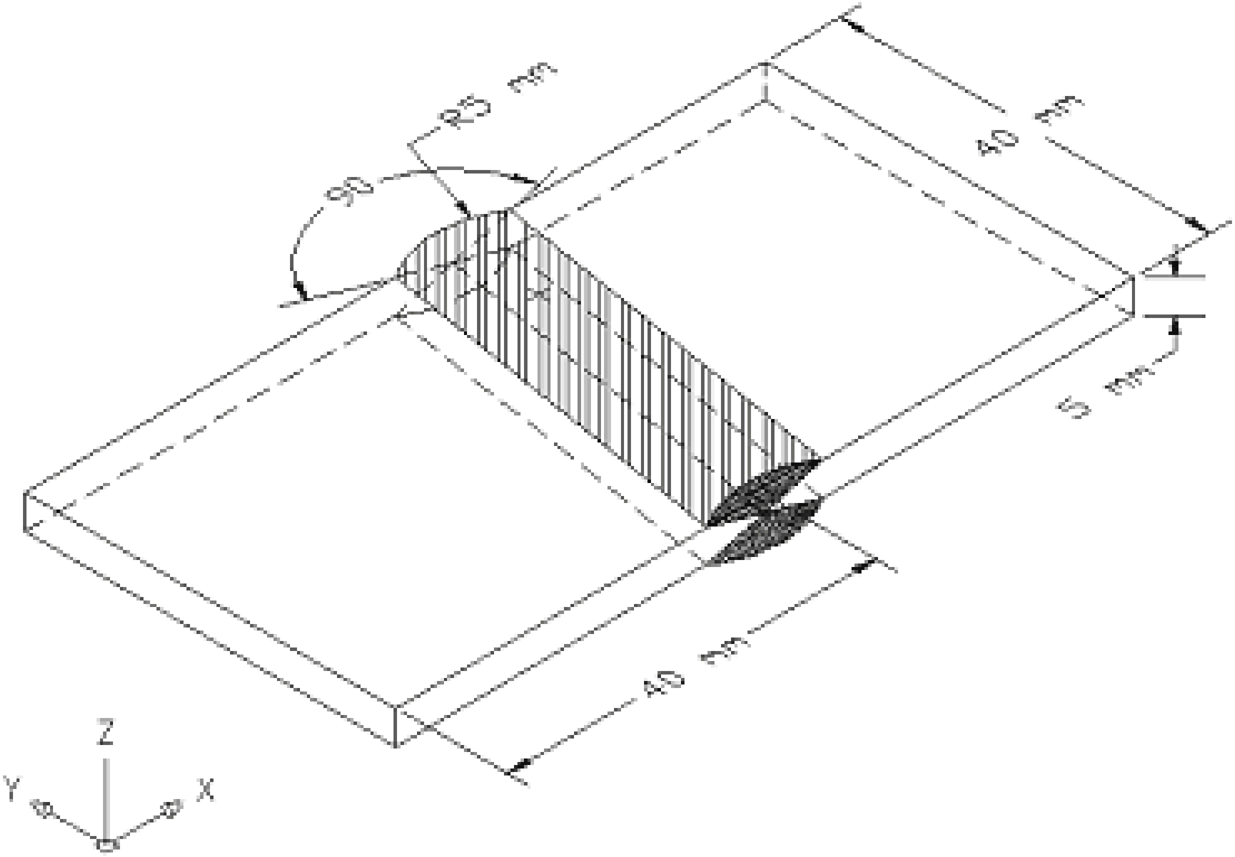
Precautions:

2. The joints of the cable should not be loose.
3. Make Proper arc for Welding.
4. Be careful & don't weld without face shield or goggle and apron.
5. Remove all flammable material from the welding area and keep the electric cable in good conditions. Repair the insulation if damaged.
6. Keep your skin covered as far as possible (radiation from the bright arc light may cause skin injuries).
7. Don't see the produced arc by naked eyes, always use apron and hand gloves at the time of welding.

LAP JOINT



Dimension of Specimen (Raw Material of Mild Steel): **40 mm x 40 mm**

BUTT JOINT

Dimension of Specimen (Raw Material of Mild Steel): **40 mm x 40 mm x 5 mm**;

FOUNDRY SHOP
EXPERIMENT No-6

Objective: To study and observe various stages of casting through demonstration of sand.

Theory:

Casting is one of oldest and one of the most popular processes of converting materials into final useful shapes. Casting process is primarily used for shaping metallic materials; although it can be adopted for shaping other materials such as ceramic, polymeric, and glassy materials. In casting, a solid is melted, treated to proper temperature, and then poured into a cavity called mold, which contains it in proper shape during solidification. Simple or complex shapes can be made from any metal that can be melted. The resulting product can have virtually any configuration the designer desires.

Casting product range in size from a fraction of centimeter and fraction of kilogram to over 10 meters and many tons, moreover casting has marked advantages in production of complex shapes, of parts having hollow sections or internal cavities, of parts that contain irregular curved surfaces and of parts made from metals which are difficult to machine.

Several casting processes have been developed to suit economic production of cast products with desired mechanical properties, dimensional accuracy, surface finish etc. The various processes differ primarily in mold material (whether sand, metal, or other material) and pouring method (gravity, pressure or vacuum). All the processes share the requirement that the material solidify in a manner that would avoid potential defects such as shrinkage voids, gas porosity and trapped inclusions. Any casting process involves three basic steps, i.e., mold making, melting, and pouring of metals into the mold cavity, and removal and finishing of casting after complete solidification.

Sand Casting Processes:

Sand is one of the cheaper, refractory materials and hence commonly used for making mold cavities.Sand basically, contains grains of silica (SiO_2) and some impurities. For mold making purposes sand is mixed with a binder material such as clay, molasses, oil, resin etc.

Green Sand Molding:

In green sand molding process, clay (a silicate material) along with water (to activate clay) is used as binder. The mold making essentially consists of preparing a cavity having the same shape as the part to be cast. There are many ways to obtain such a cavity or mold, and in this demonstration, you will learn to make it use a wooden ‘pattern’, metal ‘flasks’ and ‘green sand’ as mold material.

A pattern is a reusable form having approximately the same shape and size as the part to be cast. A pattern can be made from wood, metal, or plastic; wood being the most common material. Green sand refers to an intimate mixture of sand (usually river sand), bentonite clay (3-7 percent by weight of sand, to provide bonding or adhesion between sand grains), and water (3-6 percent by weight of sand, necessary to activate the bonding action of the clay).

Mixing the above ingredients in a sand4 muller best provides the intimate mixing action. In practice, a major part of this sand mixture consists of ‘return sand’, i.e. the reusable portion of the sand left after the solidified metal casting has been removed from the mold. Molding flasks are rectangular frames with open ends, which serve as containers in which the mold is prepared. Normally a pair of flasks is used; the upper flask is referred to as ‘Cope’ and the lower one as ‘drag’. A riddle is a relatively coarse sieve. Riddling the green sand helps in breaking the lump and aerates the sand.

Sometimes the casting itself must have a hole or cavity in or on it. In that case the liquid metal must be prevented from filling certain portions of the mold. A ‘core’ is used to block-off portions of the mold from being filled by the liquid metal. A core is normally made using sand with a suitable binder like molasses. Core is prepared by filling the core-box with core sand to get the desired shape and the baking this sand core in an oven at suitable temperature.

During mold making a suitable ‘gating system’ and a riser’ is also provided. The gating system is the network of channels used to deliver the molten metal from outside the mold into the mold cavity. The various components of the gating system are pouring cup, sprue, runners, and gates. Riser or feeder head is a small cavity attached to the casting cavity and the liquid metal of the riser serves to compensate the shrinkage in the casting during solidification.

Fig. shows the various parts of a typical sand mold. Several hand tools, such as rammer, trowel, sprue pin, draw spike, slick, vent wire, gate cutter, strike off bar etc. are used as aids inmaking a mold.

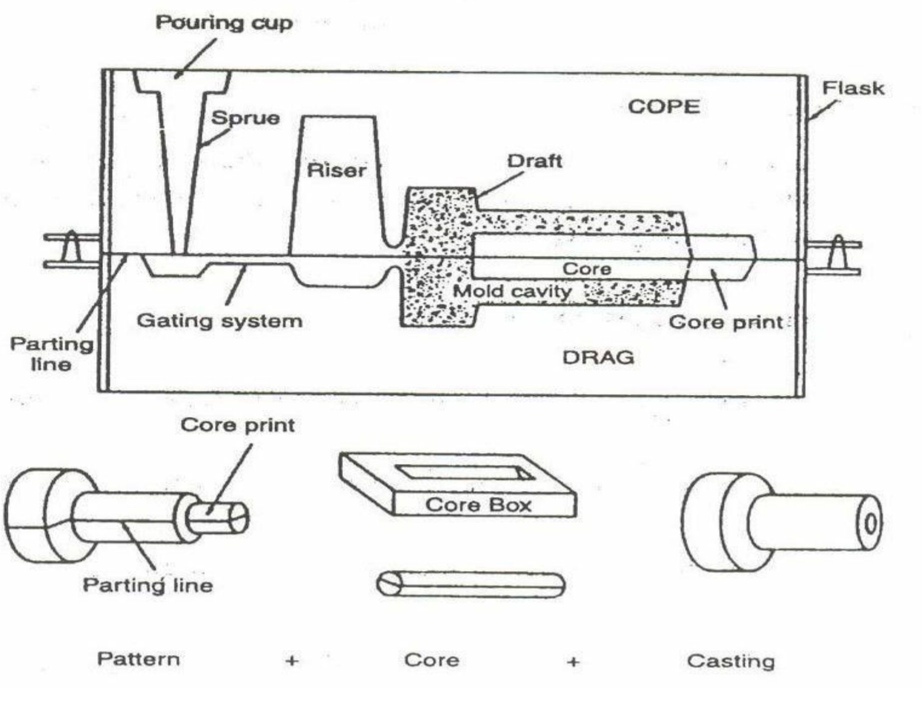


Fig): Cross section of a typical two-part sand mold, indicating various mold Components and terminology

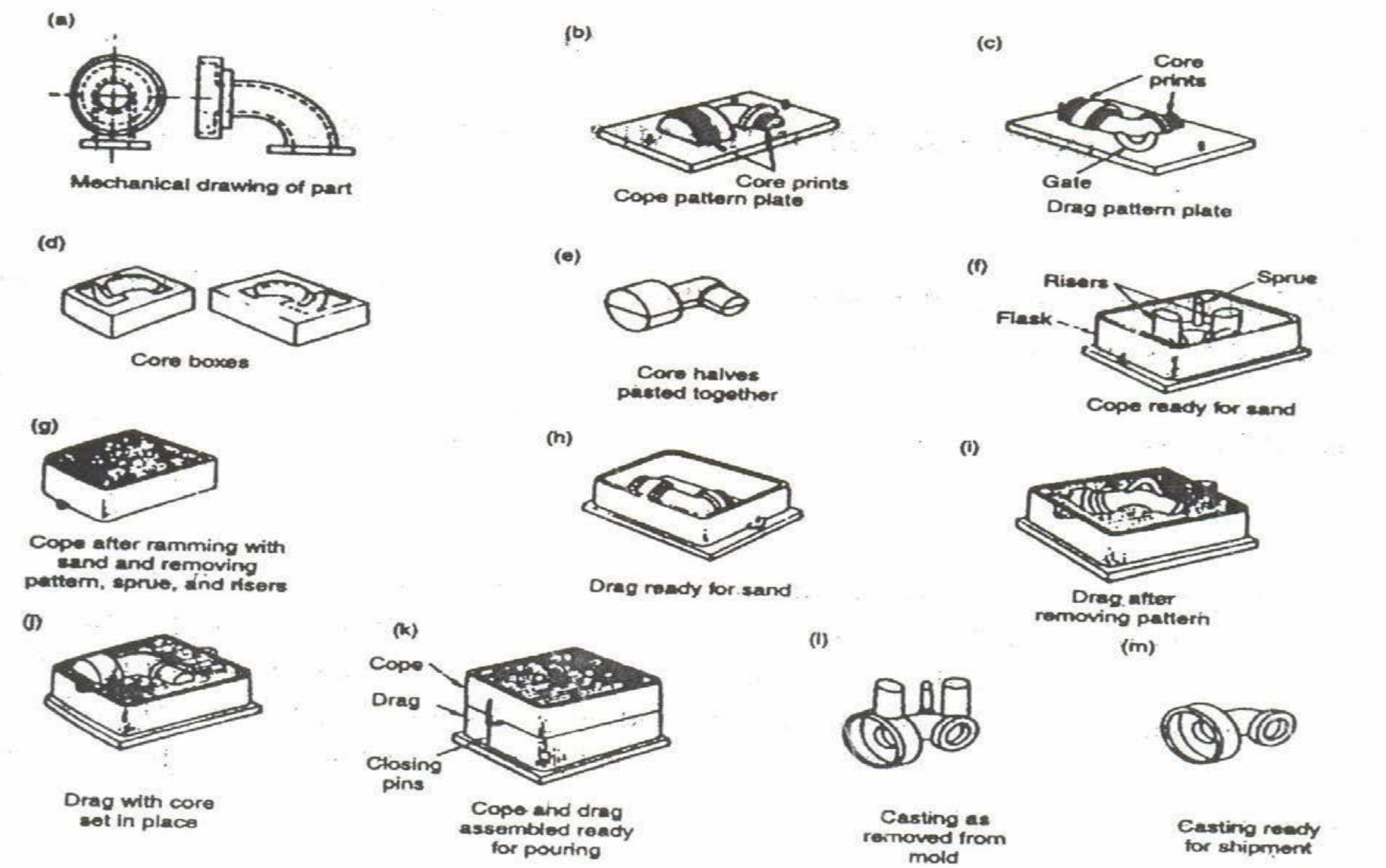


Fig (b): Schematic illustration of the sequence of operations for sand casting.

Mold Making:

1. Place the drag part of the molding flask and riddle molding green sand to a depth of 2 cm in the drag.
2. Place the pattern at the center of the drag (flask)
3. Pack the sand carefully around the pattern with figures. Heap more molding sand in the drag and ram with rammer carefully
4. Place the core half of the pattern over the drag pattern matching the guide pins and place the gating system with sprue and riser in proper positions.
5. Complete the cope half by repeating steps.
6. Remove the extra sprue and riser pins and make a pouring basin.

VIVA QUESTION:

1. Can you tell the name of bottom and top parts of the moulding box?
2. What are the materials to be charged in a cupola furnace?
3. What are the main ingredients of good moulding sand?
4. What is the optimum water content for making a mould cavity?
5. What is the purpose of draft in pattern?

Object: To prepare a mold of HEXAGONAL PATTERN.

Requirements (Tools): Sand, clay, water, cope& drag box, peen hammer, vent wire, ejector pin, powder for parting surface, wooden pattern, shovel, raiser, runner-gating systems, Trowels, draw, screw, clamp, sprit level, Gate cutter, Gaggers, mallet sprue cutter, strike off bar, rapping plates riddle, hand rammer, floor rammer.

Procedure:

1. Prepare mix of sand lay & water in correct,
2. Keep drag upside down on a clean surface,
3. Place pattern within the box & on the surface at suitable position,
4. Put parting surface using powder,
5. Put first layer of sand and ram if and repeat till the box fills completed,
6. Turn up the drag box,
7. Put parting surface again using same powder,
8. Place raiser, runner getting systems over mould part within drag to say the pattern position,
9. Put sand mix within the cope box and ram if lager by lager,
10. After the cope fills up completed remove raiser & runner,
11. Remove cope from drag and remove pattern & getting system from drag part with the help of ejectorpin & hammer.

Precautions:

1. Parting line should be put carefully,
2. Ram sand mix to get optimum strength,
3. Be careful to while setting the position of the raiser, runner & gating systems.
4. Take out the pattern carefully.

(a). HEXAGONAL PATTERN

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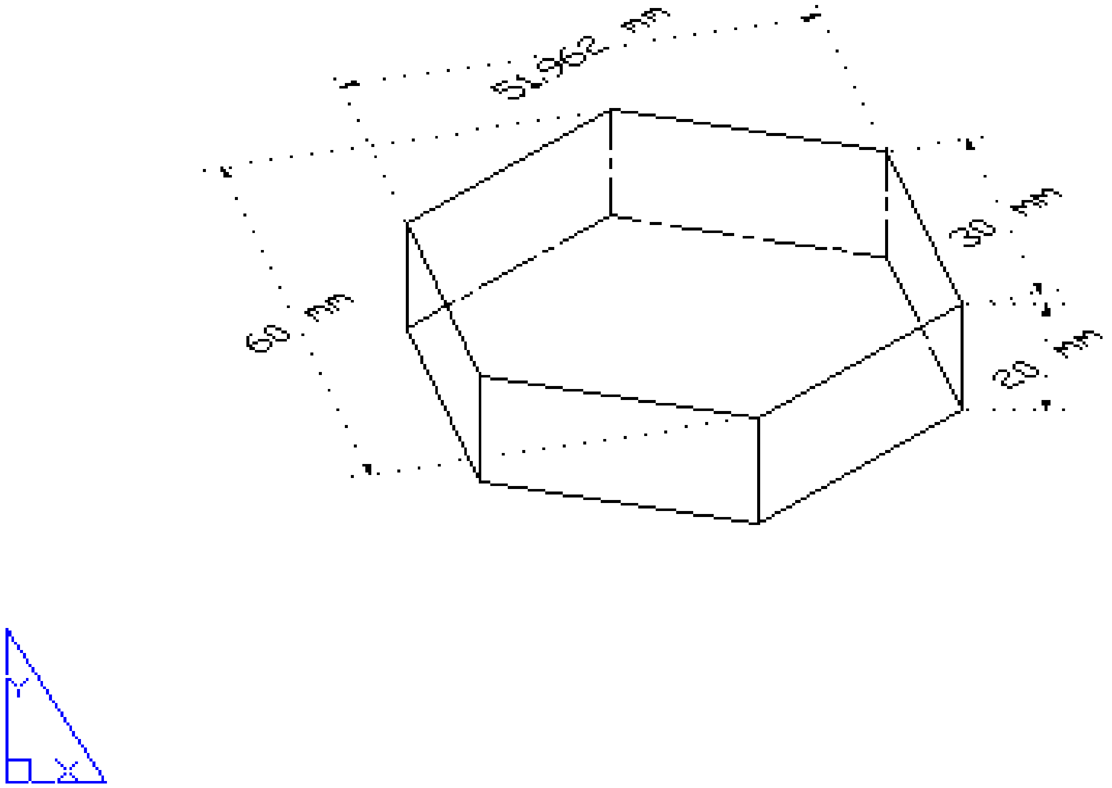

ACROSS FLAT - 51.962 mm. **[FOUNDRY SHOP]**

CNC SHOP
EXPERIMENT No-7

Objective: Study of main features and working parts of CNC machine and accessories that can be used.

CNC Machine Theory: Computer numeric controlled (CNC) is any machine tool (i.e., lathe, mill, etc.) which employs computerized control to the motion of one or more than one axes on the machine. In the case of manually operated machines, the quality and production time of the produced products mainly depends on the skill set of the human operator. CNC machines can produce parts/components rapidly with good accuracyin comparison to manually operated machines. In CNC, each machine tool has a programmable logic controller, which allows the programs to be input (by using keyboard) and stored at each machine. These programs can be created online/off-line and downloaded to the micro-processors present at individual machine tools. CNC machine tools use these programs to provide the necessary instructions to control the speeds of spindle, motion of axis, etc. CNC machine tools have a capability of 2-D and 3-D contouring that means the simultaneous motion of multiple axes is possible.

Features of CNC machine

The main features of the CNC machine are given below **[1]**.

(a) The part program can be entered into the computer using the keyboard and can be stored in the computer memory. Thus, it can be used again and again as per the requirement.
(b) The entered part program can be edited in the case of error or can be changed as per the part design.
(c) The cutter path and shape of the finished work can be visualized before running the program (simulation).
(d) Tool wear compensation is possible.
(e) Utilization information of machine (such as number of parts to be manufactured, time required/taken to manufacture per components, time for setting the job, etc.) can be get.
(f) Facility of the sub-program is possible in the case of repetitive sequences of machining process.

Elements of the CNC Machine

The schematic diagram showing the various elements of the CNC machine is presented in figure 7.1. Input devices, Machine control unit (MCU), Machine tool, driving system, feedback system, and display unit are the main parts of the CNC machine **[1]**.

Input devices: Input devices are used to enter/input the part program into a CNC machine. The commonly used input devices are floppy disk drive, USB flash drive, serial communication, Ethernet communication, and conversational programming.

Machine control unit (MCU): It is also known as the heart of the CNC machine. All the control functions of the CNC machine are performed via MCU. The different tasks performed by MCU are given below **[1]**.

(i) MCU reads all the coded instructions given in it and decodes all the coded instruction.
(ii) For initiating the motion commands, axis implements the interpolation (circular, linear, etc.).
(iii) MCU gives the axis motion command to the amplifier circuit for the movement of the axis mechanism.
(iv) MCU takes a feedback signal from axis speed and position for each drive axis.
(v) MCU give commands to the auxiliary control functions (such as spindle on/off, coolant supply, and tool change).

Machine tool: Machine tool consists of a spindle and sliding table to control the speed and position. The spindle controlled in Z-axis direction whereas, table of the machine is controlled in the X and Y-axis direction

Driving system: It consists of a drive motor, amplifier circuit, drive motors, and ball lead screws. The MCU sends the signals (i.e. of speed and position) of each axis to amplifier circuits. The control signals are then enhanced (increased) to activate/energize the drive motors. The energized drive motors rotate the ball lead screw to put in a position the machine table **[1]**.

Feedback system: It consists of speed and position transducers. These transducers monitor the speed and position of the cutting tool continuously. MCU receives the signals from these transducers. MCU cross-check

the variation in reference signals and feedback signals received from the transducer to produce control signals to correct the speed and position errors **[1]**.
Display unit: Used to display the commands, programs, and other useful data.

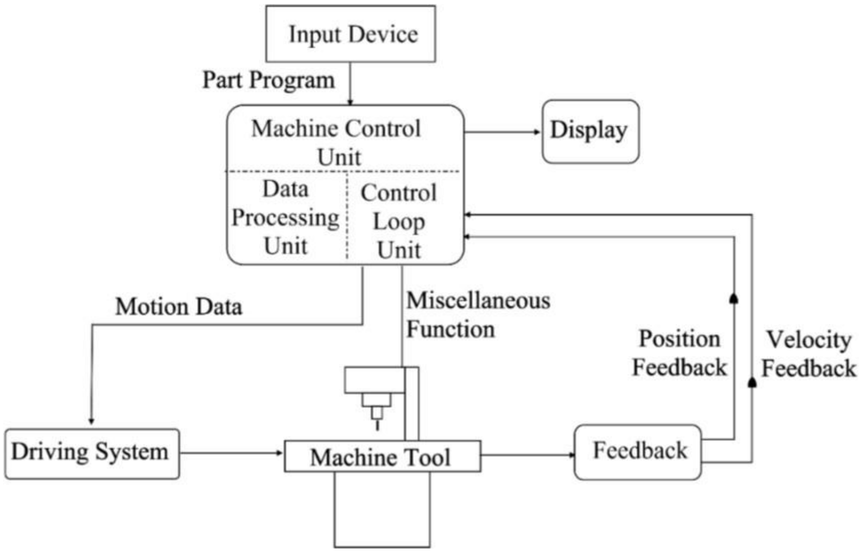

Figure: 7.1 Elements of CNC Machine **[1]**

Steps for CNC Machining

(i) Firstly, the part program is entered into the MCU.
(ii) As per the entered program, MCU prepare the motion command and sent to the drive system.
(iii) Drive system acts according to the motion commands received from the MCU. Additionally, drive system manages speed, direction and all the motions of the machine tool.
(iv) The feedback system captured and record the speed, direction, and position of the machine tool and sent the signal to MCU.
(v) The feedback signals are compared with reference signal in the MCU. If the error founds, MCU corrected the error and sent the signal to machine tool to be corrected. If there is no error, MCU gives thesignal to machine tool to further proceed the task.
(vi) Display unit is used to see all the commands and programs.

Applications of CNC Machines

The machine tools that come with the CNC machine are lathe, mills shaper welding etc. Almost all type of manufacturing industries such as automotive industry, fabricating metals industry, metal removal industry, electrical discharge machining industry, wood industry etc. uses CNC machines.

Types of CNC Machines

Some common type of CNC machines and instruments used in industry are as follows:
Drilling machine, Lathe/Turning Centre, Milling/Machine Centre, Turret Press and Punching Machine, Wire cut Electro Discharge Machine, Grinding Machine, Laser Cutting Machine, Water Jet Cutting Machine, Electro Discharge Machine, Coordinate Measuring Machine, Industrial Robot

[1] CNC Machine and It’s Working. https://www.theengineerspost.com/cnc-machine-working/ (last accessed on 07-11-2020).

Objective: To study different type of CNC machining operations.

CNC Machining Operations: CNC machining is a manufacturing process which, is used in various industries such as automotive, aerospace, construction, and agriculture. CNC machining processes has a potential to produce various products, such as components used airplane engines, internal combustion engines, automobile frames, hand and garden tools, surgical equipment's, etc. CNC machining process consists of various computer-controlled machining operations (including mechanical, chemical, electrical, and thermal processes), which remove the unwanted material from the workpiece to manufacture a predesigned part or components. The most common mechanical CNC machining operations are as follows-

- Drilling
- Milling
- Turning

CNC Drilling

This machining process uses a multi-point drill bit tool to make a cylindrical hole in the workpiece. In this process, CNC machine feeds the high-speed rotating drill bit tool perpendicularly to the surface of workpiece and make a hole of diameters equal to the diameter of the drill bit. The speed of the rotating drill depends on the workpiece material. Additionally, angular drilling operation can also be conducted by using a workpiece holding device and specialized machine configuration. Drilling operation is capable for countersinking, counterboring, tapping, and reaming.

Equipment: Drilling operation uses a rotating drill bit tool to make the cylindrical holes in the workpiece. The design of the drill bit tool is such that it allows the unwanted/waste material to remove and fall away from the workpiece in the form of chips. The drill bits are available in different sizes and shapes in the market, which are used for a specific application. Some common types of drill bits are - spotting drills (it is used for making a shallow or pilot holes), peck drills (it is used for reducing the fraction of chips on the workpiece), screw machine drills (it is used for making a holes without a pilot hole), and chucking reamers (it is used for increasing the previously produced holes).

Typically, the CNC drilling is performed by using a CNC-enabled drill presses. This drill press is especially design for making hole in the workpiece. However, the operation can also be performed by turning, tapping, or milling machines.

CNC Milling

This machining process uses a rotating multi-point cutting tools to remove the unwanted material from the workpiece. In milling operation, the workpiece is feed towards the cutting tool in the same direction in which cutting tool is rotating, whereas in manual milling the machine feeds the workpiece in the opposite direction to the cutting tool's rotation. Milling operation is capable for face milling-cutting shallow such as flat-bottomed cavities and flat surfaces into the workpiece and peripheral milling-cutting deep cavities, such as threads, and slots into the workpiece.

Equipment: Milling process uses a rotating multi-point cutting tools to make a required shape after removing the unwanted material from the workpiece. Milling tools are either oriented towards horizontal or vertical directions. Typical milling tools are – helical mills, end mills, and chamfer mills.

Typically, CNC milling machines are capable of three-axis movements. Advanced mill machines also have facility to further accommodate additional axes. There are various types of milling machines such as hand milling, universal milling, plain milling.

CNC Turning

In this process, a single point cutting tools is used to remove the unwanted material from the rotating workpiece. In this process, CNC lathe/turning machine feeds the tool in a linear direction along the surface of rotating workpiece. The unwanted material removed from the workpiece circumferentially until the required diameter is obtained, to produce cylindrical parts with internal and external characteristics (i.e., tapers, slots, threads, etc.). Turning operation is capable for facing, thread cutting, boring and grooving.

Equipment: Turning operation uses a single point cutting tools to remove the undesired material from the rotating workpiece. Turning tools are available in several designs and its use depends on the application. The different tools designs are available for finishing, roughing, forming, parting, grooving, undercutting, threading, and facing. The turning machining can be performed on CNC-enabled lathes/turning machines. The available types of lathes are turret lathes, engine lathes, and special-purpose lathes.

Table 1: Features of Common CNC Machining Operations

Machining operations	Characteristics
Drilling	• Uses a rotating multi-point drill bit tool • Drill bit fed perpendicular or angularly to workpiece • Make cylindrical holes in workpiece
Turning	• Uses a single point cutting tools • Rotates workpiece • Cutting tool fed along the surface of the workpiece • Removes unwanted material from the workpiece • Make round or cylindrical parts
Milling	• Uses a rotating multi-point cutting tools • Workpiece fed in same direction as cutting tool rotation • Removes unwanted material from workpiece • Make broader range of shapes

EXPERIMENT No 8

Objective- To prepare a product using 3-D printing.
Requirements- 3-D printing machine, Raw material (wire roll), Computer System
Theory- 3D printing is sometimes referred to as Additive Manufacturing (AM)/Rapid prototyping/Regenerative manufacturing. In 3D printing, one creates a design of an object using software and the 3D printer creates the object by adding layer upon layer of material until the shape of the object is formed. The object can be made using a number of printing materials, including plastics, powders, filaments and paper.

Types 3D printing technologies:

1. Stereolithography (SLA)

Stereolithography makes use of a liquid plastic as the source material and this liquid plastic is transformed into a 3D object layer by layer[1]. Liquid resin is placed in a vat that has a transparent bottom. A UV (Ultraviolet) laser traces a pattern on the liquid resin from the bottom of the vat to cure and solidify a layer of the resin. The solidified structure is progressively dragged up by a lifting platform while the laser forms a different pattern for each layer to create the desired shape of the 3D object[3].

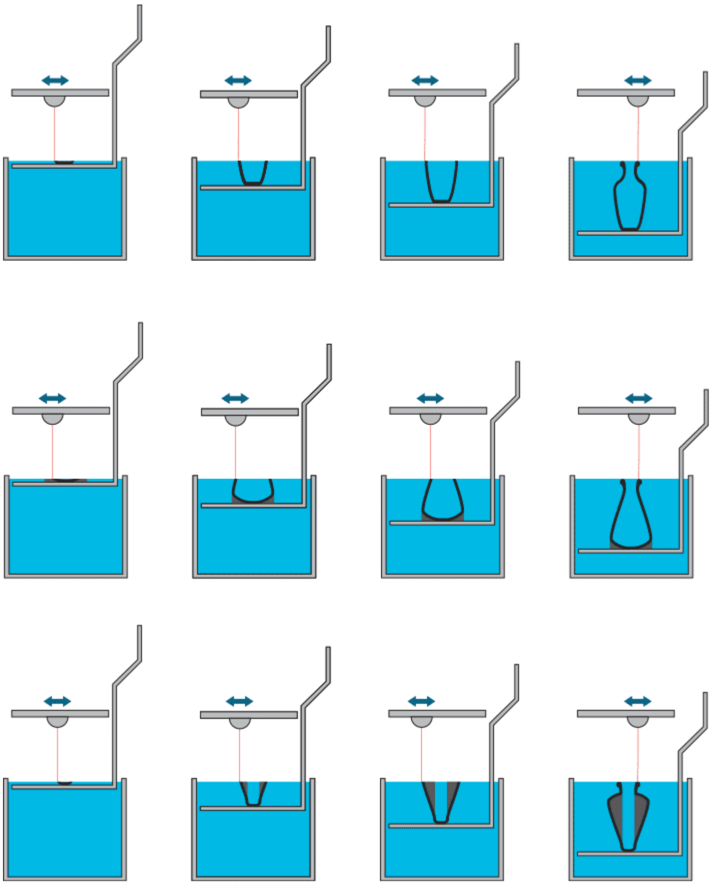

Fig. Schematic representation of Stereolithography

2. Digital Light Processing (DLP)

3D printing DLP technology is very similar to Stereolithography but differs in that it uses a different light source and makes use of a liquid crystal display panel[1]. This technology makes use of more conventional light sources and the light is controlled using micro mirrors to control the light incident on the surface of the object being printed. The liquid crystal display panel works as a photomask. This mechanism allows for a large amount of light to be projected onto the surface to be cured, thereby allowing the resin to harden quickly[1].

3. Fused Deposition Modelling (FDM)

With this technology, objects can be built with production-grade thermoplastics[1]. Objects are built by heating a thermoplastic filament to its melting point and extruding the thermoplastic layer by layer. Special techniques can be used to create complex structures. For example, the printer can extrude a second material that will serve as support material for the object being formed during the printing process[1]. This support material can later be removed or dissolved.

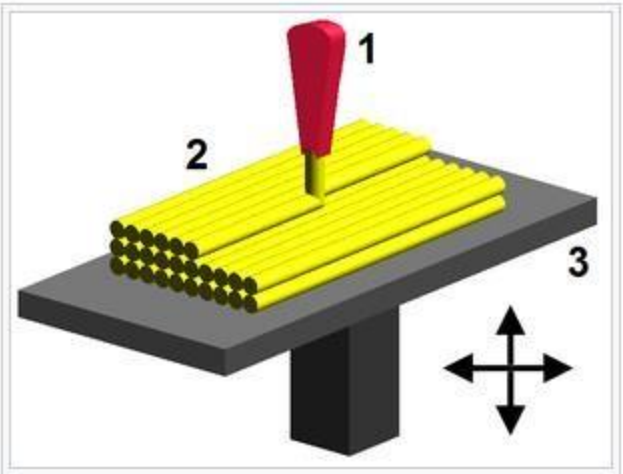

Fig. Fused deposition modelling: 1-Nozzle ejecting molten material, 2-Deposited material (modelled part), 3-Controlled movable table

4. Selective Laser Sintering (SLS)

SLS has some similarities with Stereolithography. However, SLS makes use of powdered material that is placed in a vat. For each layer, a layer of powdered material is placed on top of the previous layer using a roller and then the powdered material is laser sintered according to a certain pattern for building up the object to be created. Interestingly, the portion of the powdered material that is not sintered can be used to provide the support structure and this material can be removed after the object is formed for re-use[1].

5. Selective Laser Melting (SLM)

The SLM process is very similar to the SLS process. However, unlike the SLS process where the powdered material is sintered the SLM process involves fully melting the powdered material[1].

6. Electronic Beam Melting (EBM)

This technology is also much like SLM. However, it makes use of an electron beam instead of a high-powered laser[1]. The electron beam fully melts a metal powder to form the desired object. The process is slower and more expensive than for SLM with a greater limitation on the available materials.

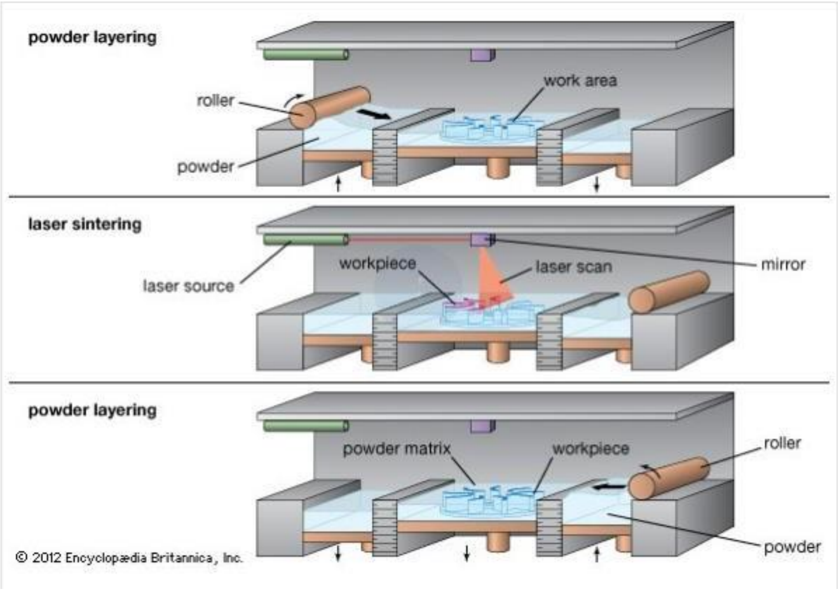

Fig. Selective Laser Sintering Process

7. Laminated Object Manufacturing (LOM)

This is a rapid prototyping system. In this process, layers of material coated with adhesive are fused together with heat and pressure and then cut into shape using a laser cutter or knife[1,2]. More specifically, a foil coated with adhesive is overlaid on the previous layer and a heated roller heats the adhesive for adhesion between the two layers. Layers can be made of paper, plastic or metal laminates[1]. The process can include post-processing steps that include machining and drilling. This is a fast and inexpensive method of 3D printing[1]. With the use of an adhesion process, no chemical process is necessary and relatively large parts can be made[2]. For example: Plywood

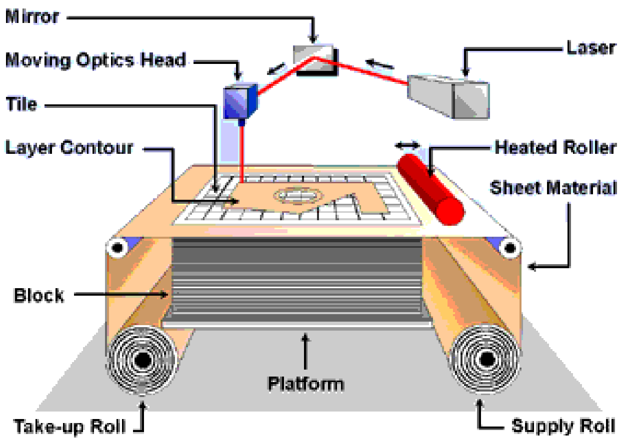

Fig. Laminated Object Manufacturing

Parts of a 3-D printer

Controller Board- The controller board, also referred to as the motherboard or mainboard, is the brain of the 3D printer. It's the one responsible for the core operation, directing the motion components based on commands sent from a computer and interpreting input from the sensors. The controller board's quality has a major effect on the overall performance of the 3D printer.
Filament- The filament is the material used to print objects on a 3D printer. It's the equivalent of the ink used on a regular office 2D printer.
Frame- The frame is the chassis of the 3D printer. It holds the other components together and is directly responsible for the stability and durability of the machine.

Motion Components- The motion components are the parts responsible for the movement of the 3D printer in the three axes.
Stepper Motors- The stepper motors, which are run by stepper drivers, are the keys to the mechanical movement of a 3D printer. Stepper motors are connected to all three axes and drive the print bed, the print head, and the threaded rods or leadscrews.
Belts- In a Cartesian 3D printer, the belts, which are connected to motors, move the X-axis and the Y-axis from side to side and are integral to the overall print speed and precision.
Threaded rods- In the Z-axis, the movement relies on threaded rods, which are also connected to stepper motors. As the threaded rod rotates, the print head moves up or down.
End Stops- Simply put, end stops are like markers that allow the 3D printer to identify its location along the three axes, preventing it from moving past its range, which can result in hardware damages.
Power Supply Unit (PSU)- The power supply unit supplies power to the entire 3D printer.
Print Bed- The print bed is where the extruder deposits the filament to form a solid object.
Print Bed Surface- As the name suggests, the print bed surface or build surface is what goes on top of the print bed. It helps the object being printed stick to the platform and allows for easier removal of completed objects.
Print Head- The print head or the extruder is the component that turns the filament into a 3D model. It's separated into two sections: a cold end and a hot end. To put it simply, the cold end clamps the filament and pushes it down to the liquid.
Feeder System- Cartesian and delta 3D printers use either a Bowden feeder system or a direct feeder system.
Dual Extrusion- 3D printers have either a single extruder setup or a dual extruder setup. The former is pretty much self-explanatory, so we'll just focus on the latter. A dual extruder 3D printer is a 3D printer that can use two different filaments at the same time. With a dual extruder 3D printer, you can print with two colors without changing the filament in the middle of the print and create more complex 3D models.
User Interface and Connectivity- A 3D printer with an LCD user interface can work as a standalone machine. In other words, you can control it without a computer connection.
File Transfer Options- Most 3D printers can connect to a computer via a USB cable, with a few models also capable of connecting via Ethernet

Steps for 3-D printing processes:

1. CAD – Produce a 3-D model using computer-aided design (CAD) software. The software may provide some hint as to the structural integrity you can expect in the finished product, too, using scientific data about certain materials to create virtual simulations of how the object will behave under certain conditions.

2. Conversion to STL – Convert the CAD drawing to the STL format. STL, which is an acronym for **standard tessellation language**, is a file format developed for 3D Systems in 1987 for use by its stereolithography apparatus (SLA) machines [source: RapidToday.com]. Most 3-D printers can use STL files in addition to some proprietary file types such as ZPR by Z Corporation and Obj DF by Object Geometries.

3. Transfer to AM Machine and STL File Manipulation – A user copies the STL file to the computer that controls the 3-D printer. There, the user can designate the size and orientation for printing. This is like theway you would set up a 2-D printout to print two-sided or in landscape versus portrait orientation.

4. Machine Setup – Each machine has its own requirements for how to prepare for a new print job. This includes refilling the polymers, binders, and other consumables the printer will use. It also covers adding a tray to serve as a foundation or adding the material to build temporary water-soluble supports.

5. Build – Let the machine do its thing; the build process is mostly automatic. Each layer is usually about 0.1 mm thick, though it can be much thinner or thicker [source: Wohler's]. Depending on the object's size, the machine and the materials used, this process could take hours or even days to complete. Be sure to check on the machine periodically to make sure there are no errors.

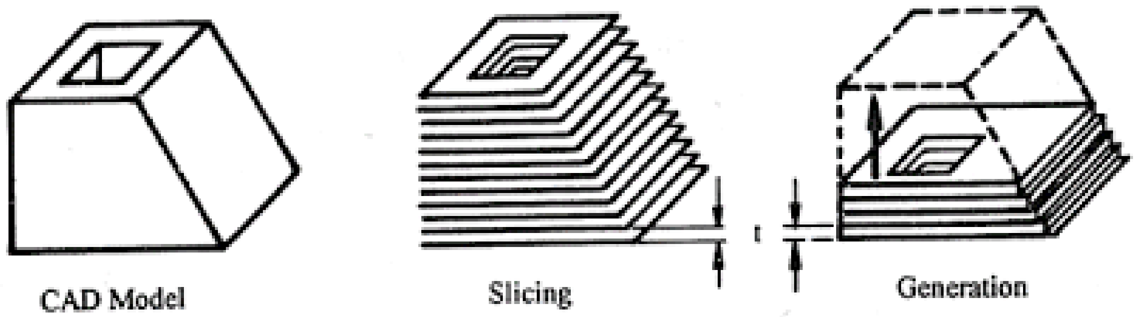

Fig. Basic principle of the generative manufacturing processes (GMP)/ 3-D printing

6. Removal – Remove the printed object (or multiple objects in some cases) from the machine. Be sure to take any safety precautions to avoid injury, such as wearing gloves to protect yourself from hot surfaces or toxic chemicals.

7. Postprocessing – Many 3-D printers will require some amount of post-processing for the printed object. This could include brushing off any remaining powder or bathing the printed object to remove water-soluble supports. The new print may be weak during this step since some materials require time to cure, so caution might be necessary to ensure that it doesn't break or fall apart.

8. Application – Make use of the newly printed object or objects.

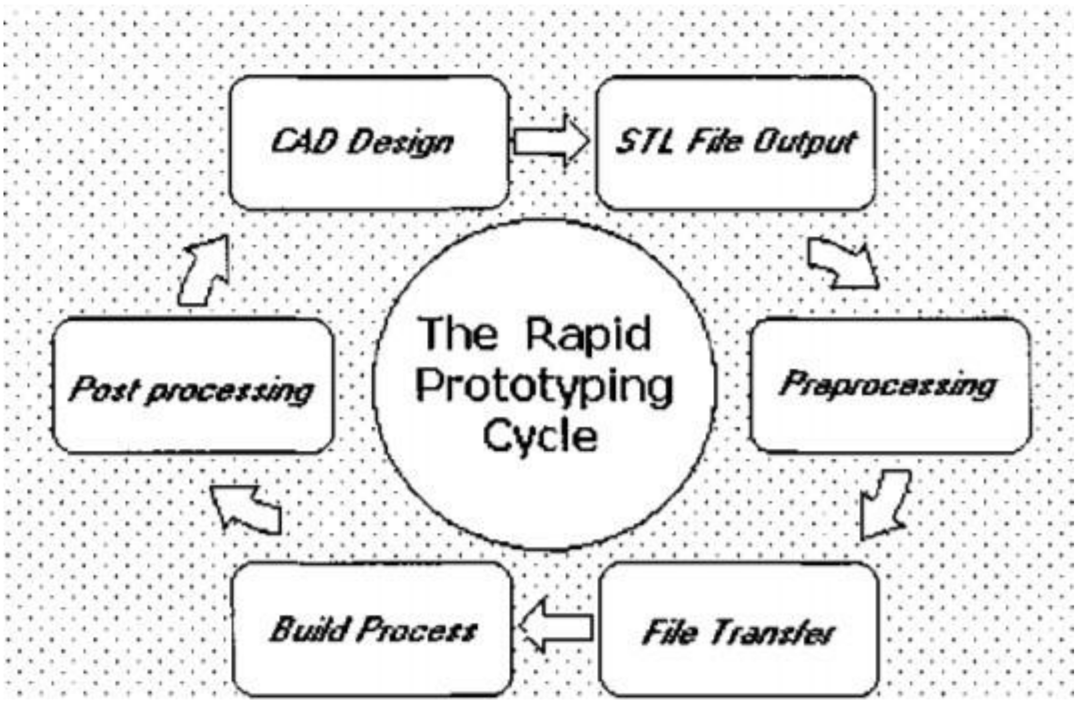

Fig. RP cycle begins with the CAD design, and may be repeated inexpensively several times until a model of the desired characteristics is produced

Advantages of 3-d printing technologies:

1. Process is independent of part features.

2. No blanks are required.

3. Tool less process.

4. Easily automation possible.

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