STUDY OF LATHE

Aim:

To understand the working principle and operations done in lathe machine to identify the various components of lathe machine and its function

Machining processes:

Machining is one of the processes of manufacturing in which the specified shape to the work piece is imparted by removing surplus material. Conventionally this surplus material from the work piece is removed in the form of chips by interacting the work piece with an appropriate tool. This mechanical generation of chips can be carried out by single point or multi point tools or by abrasive operations these are summarized below

Single point tool operations	Multi-point tool operations	Abrasive operations
1. Boring	1. Drilling	1. Lapping
2. Shaping	2. Tapping	2. Honing
3. Planning	3. Reaming	3. super finishing
4. Turning	4. Hobbing	4.Grinding
	5. Broaching	
	6. Sawing	
	7. Milling	

Multi-point tool operations:

The process of chip formation in metal cutting is affected by relative motion between the tool and the work piece achieved with the aid of a device called machine tool. This relative motion can be obtained by a combination of rotary and translator movements of either the tool or the work piece or both. The kind of surface that is produced by the operation depends on the shape of the tool and the path it traverses through the materials.

When the workpiece is rotated about an axis and the tool is traversed in a definite path relative to the axis, a surface of revolution is generated. When the tool path is parallel to the axis, the surface generated is a cylinder as in straight turning or boring operations. Similarly, planes may be generated by a series of straight cuts without rotating the workpiece as in shaping and planning operations (Fig.3).

In shaping the tool is reciprocating and the work piece is moved crosswise at the end of each stroke. Planning is done by reciprocating the work piece and crosswise movement is provided to the tool.

Surface may be machined by the tools having a number of cutting edges that can cut successively through the work piece materials. In plane milling, the cutter revolves and moves over the work piece as shown Fig.

4. The axis of the cutter is parallel to the surface generated.

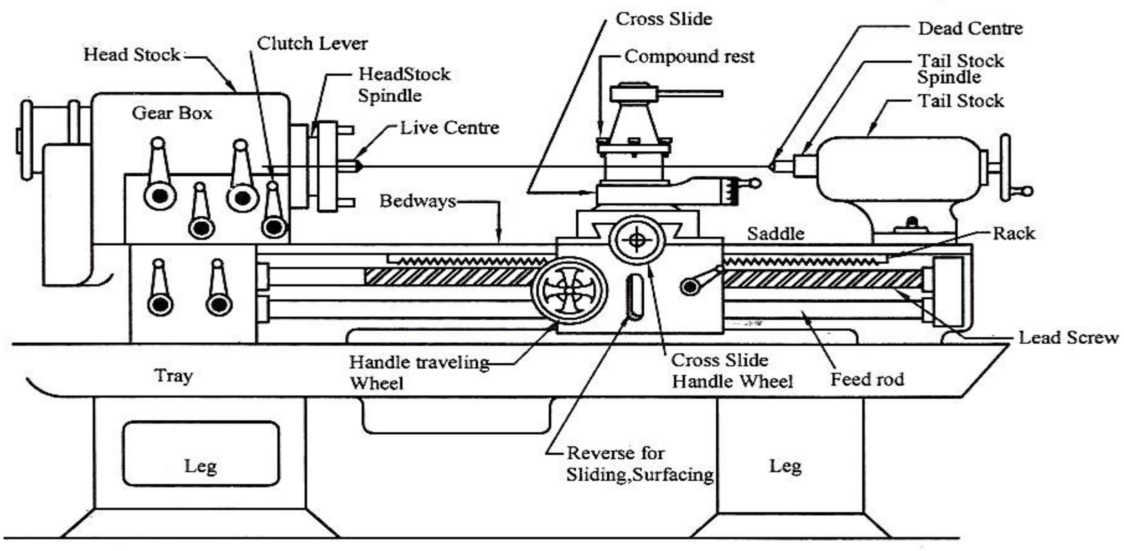
Similarly in drilling, the drill may turn and be fed into the work piece or the work piece may revolve while the drill is fed into it (Fig.5).

The machine tools, in general, provide two kinds of relative motions. The primary motion is responsible for the cutting action and absorbs most of the power required to perform the machining action.

The secondary motion of the feed motion may proceed in steps or continuously and absorbs o1nly a fraction of the total power required for machining. When the secondary motion is added to the primary motion, machine surfaces of desired geometric characteristics are produced.

Lathe:

Lathe is the machine tool which is used to perform several operations on the work piece. Lathe is useful in making several parts which is further assembled to make new machine. Hence lathe is known as “mother of machines”.



Centre Lathe

Basic working principle of lathe:

In lathe, the work piece is held in the chuck, a work holding device. The cutting tool is mounted in the tool post. The chuck is rotated by means of power. When the chuck rotates, the work piece also rotates. The tool is moved against the rotating work piece by giving small amount of depth of cut. The material is removed in the form of chips. Continuous feed and depth of cut is given until the required dimensions are obtained in the work piece.

Types of lathe machines:

There are different types of lathe machines, they are

1. Centre lathe
2. Tool room lathe
3. Bench lathe
4. Capstan lathe
5. Turret lathe
6. Automatic lathe

Description of lathe:

Lathe is a machine which has several parts in it. They are

Bed:

It is the base of the machine. On its left side, the head stock is mounted and on its right it has movable casting known as tailstock. Its legs have holes to bolt down on the ground.

Head stock:

It consists of spindles, gears and speed changing levers. It is used to transmit the motion to the job. It has two types; one is the headstock driven by belt and the other one is the gear driven.

Carriage:

Carriage is used to carry a tool to bring in contact with the rotating work piece or to with draw from such a contact. It operates on bed ways between the headstock and tail stock.

Saddle:

It is an ‘H’ shaped part fitted on the lathe bed. There is a hand wheel to move it on the bed way. Cross slide, compound rest, tool post is fitted on this saddle.

Cross slide:

It is on the upper slide of saddle in the form of dove tail. A hand wheel is provided to drive the cross slide. It permits the cross wise movement of the tool (i.e.) movement of tool towards or away from the operator.

Compound rest:

It is fitted over the cross slide on a turn table. It permits both parallel and angular movements to cutting tool.

Tool post:

It is fitted on the top most part of the compound rest. Tool is mounted on this tool post. Cutting tool is fixed in it with the help of screws.

Apron:

It is the hanging part in front of the carriage. It accommodates the mechanism of hand and power feed to the cutting tool for carrying out different operations.

Lead screw:

It is a long screw with ACME threads. It is used for transmitting power for automatic feed or feed for thread cutting operation.

Tail stock:

It is located at the right end of the lathe bed and it can be positioned anywhere in the bed. It is used for supporting lengthy jobs and also carries tool to carry out operations such as tapping, drilling and reaming.

GAS WELDING PRACTICE

Aim:

To join the given two work piece as per the required type of joint by gas welding

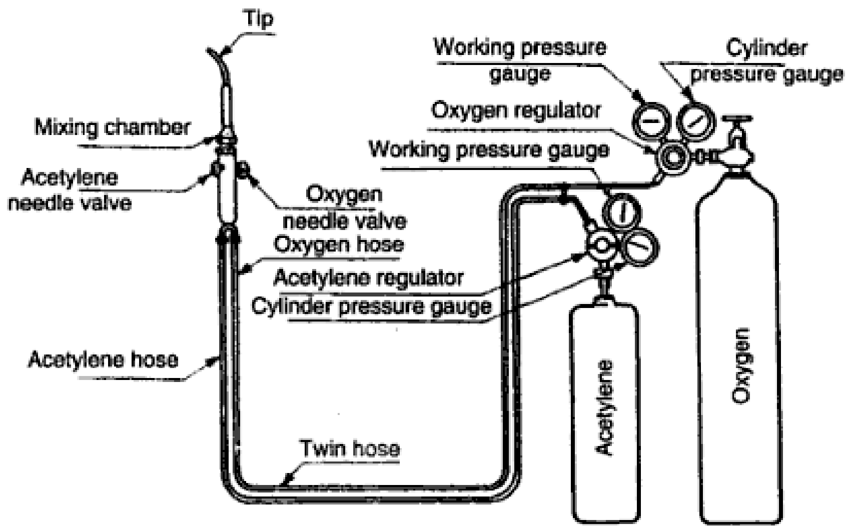
Materials required:

Two mild steel plates.

Tools required:

1. Oxygen and acetylene gas cylinders with pressure regulators
2. Gas welding torch
3. Filler rod
4. Gloves and apron
5. Safety goggles, gloves
6. Chipping hammer
7. Wire brush

Procedure:



oxy-acetylene gas welding.

1. Clean the given work piece thoroughly and remove rust, scale and other foreign materials.
2. Position the joining work pieces properly.
3. Open acetylene and oxygen cylinder valves and open the acetylene torch valve.
4. Light the tip of torch using the lighter.
5. Adjust oxygen and acetylene torch to get the required flame.
6. Hold the welding torch and filler rod along the line of weld and weld by maintaining 3 mm gap between plate and inner core of flame.

Result:

Thus the required welding is obtained by gas welding process.

STUDY OF FOUNDRY

Aim:

To understand the basic concepts of foundry by carrying out simple exercises relevant to its principles

Introduction:

Foundry is a process of forming different shapes and sizes of metals in their molten state. It is also called as metal casting. The shape of the metal cast obtained depends on the shape and size of the cavity produced in sand mould by using a wooden model. This wooden model is called a pattern.

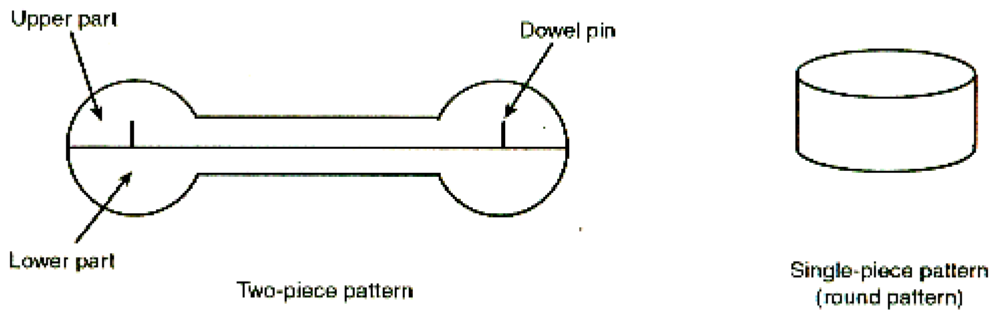
The foundry process involves three steps:

- Making the required pattern
- Moulding process to produce the cavity in sand using the pattern
- Pouring the molten metal into the cavity to get the casing

Pattern:

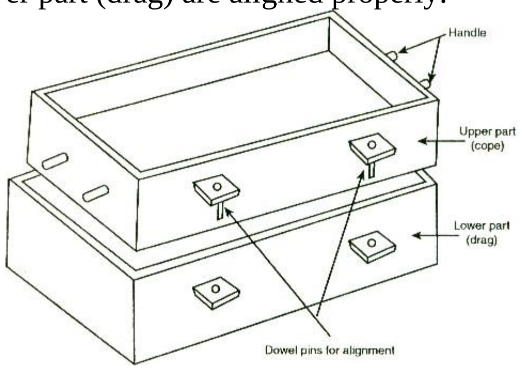
A pattern is normally a wooden model which is the facsimile of the cast/product to be made. There are many types of patterns and are either one piece or two - pieces.

Moulding Box:



Pattern

A moulding box is normally a rectangular wooden/metal box with bottom and top surfaces open. The upper part (cope) and the lower part (drag) are aligned properly.

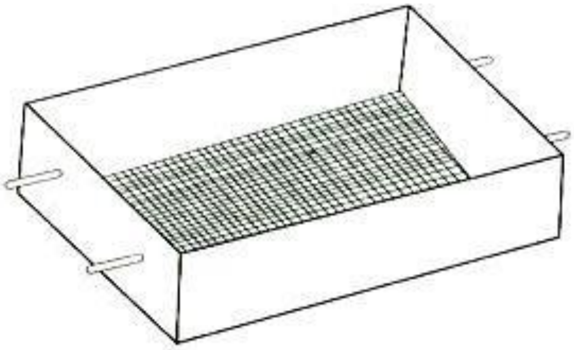


Sieve:

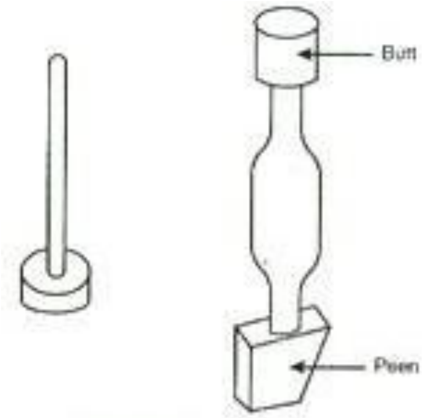
A sieve is used to remove foreign materials from the moulding sand. A sieve is a rectangular or circular frame with a wire mesh.

Rammer:

A rammer is used to press or ram the moulding sand uniformly into the moulding box.



Sieve



Rammers

Strike-off Bar:

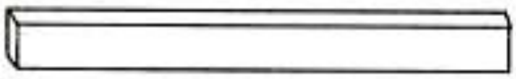
A strike off bar is a flat-edged rectangular bar made of wood. It is used to remove excess sand on top of the mould box after ramming.

Vent wire:

A vent wire is a steel wire used to produce holes in sand fill after ramming. This enables the gases to escape out to the atmosphere when the molten metal is poured into the cavity of the mould.

Draw spike:

A draw spike is a steel spike with sharp pointed end. This is used to pick the pattern from the mould after ramming.



Strike-off bar

Vent wire

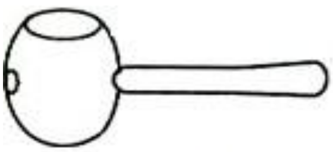
Draw spike

Mallet:

A mallet is used to give light blow to the draw spike to drive it into the pattern in order to lift the pattern with the help of draw spike. It is round or rectangular and is made of hard wood.

Lifter:

A lifter is used to remove the loose sand in the cavity produced in moulding. It is also used to finish the walls of the cavity after removing the pattern.



Mallet

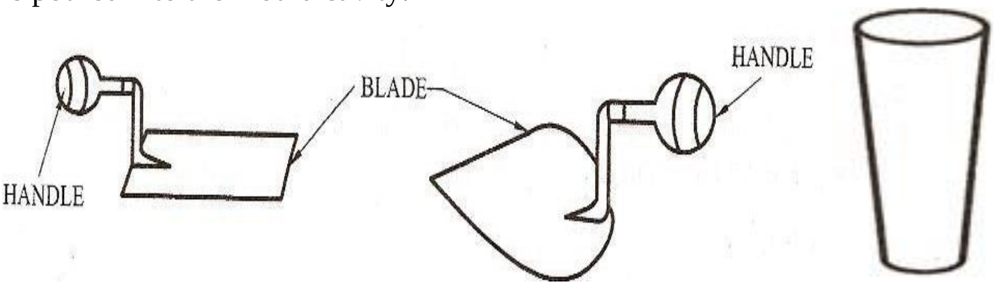
Lifter

Trowel:

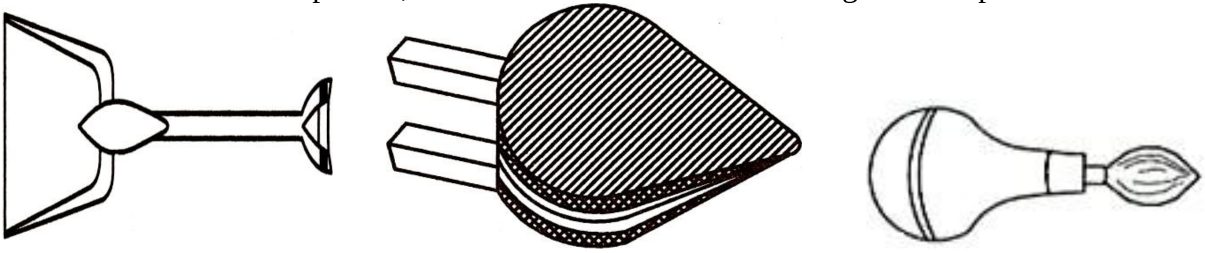
A trowel is used to finish the cavity obtained in the mould. Trowels of various shapes and sizes are used in moulding process.

Sprue Pin:

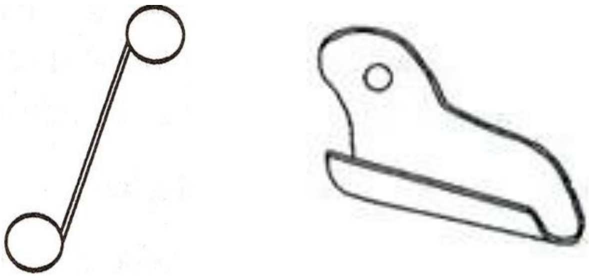
A sprue pin is a cylindrical and tapered wooden piece used to make a hole through which the molten metal is poured into the mould cavity.



Core:
The core is used to make a hole or hollow casting. The core is normally made of core sand. The core sand can be removed easily after the casting. The core sand is having
90% silica sand and the remaining is binding materials (saw dust, asbestos, linseed oil, molasses etc.)
Shovel:
It is used to mix and move the mould sand from one place to another in the foundry shop. It consists of a broad iron pan fitted with a long wooden handle.
Bellow:
It is used to blow out sand particles and dust on the surface of the mould.
Swab:
It is used to apply water on the edges of the pattern before removing it from the mould. It is easy to remove the moisturized pattern, otherwise mould sand sticks along with the pattern.

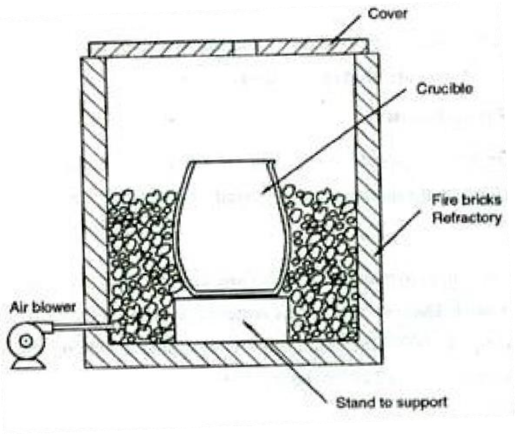


Slick:
It is used to repair and smoothen the mould surface after removing the pattern. It consists of spoon shaped double ended trowel.
Gate cutter:
It is used to cut gates in the mould. The gate is connecting the runner hole and the mould cavity.



Melting furnaces:
The melting furnaces are used to melt the metal to be cast. Furnaces used to melt ferrous or non- ferrous metals are

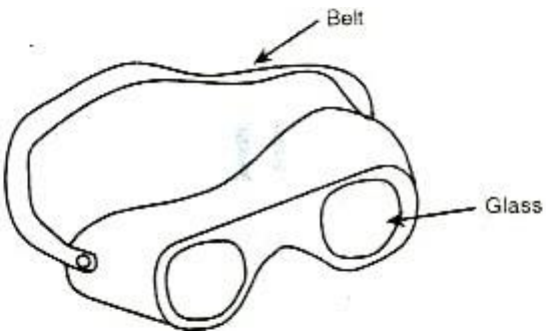
1. Coke fired crucible furnace
2. Oil fired crucible furnace
3. Gas fired crucible furnace
4. Cupola furnace
5. Electric furnace

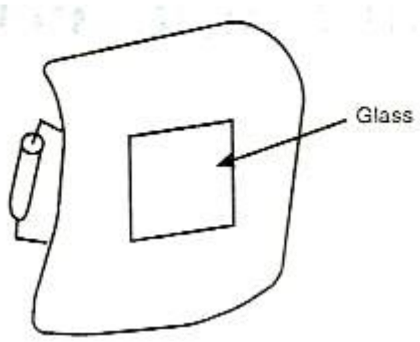


<u>STUDY OF WELDING</u>

Aim:
To understand the basic concepts of welding by carrying out simple exercises relevant to its principles
Introduction:
Welding is the progress of joining two metal plates using a joining material by heat. It is commonly used to join metal plates in making boilers, vessels, furnitures, automobile parts, etc.
Safety equipments and tools:
Welding goggles:

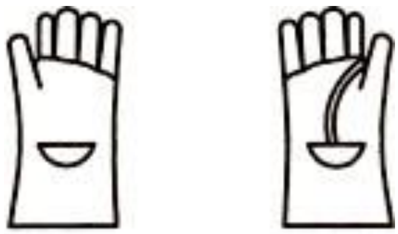
Goggles with glasses are used to protect the eyes of the eyes of the welder from the light sparks produced during welding.
Face shield:
A face shield is also used to protect the eyes of the welder from the light sparks produced during welding.
It is normally held in hand.

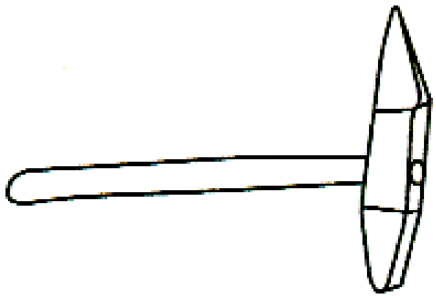




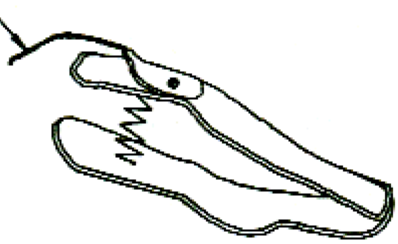
Welding goggles Face shield

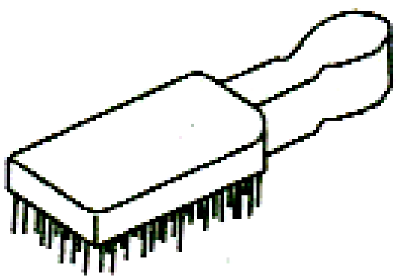
Hand gloves:
It is used to protect the hands of the welder from the effect of ultra violet rays, infra red rays, heat and sparks.
Chipping Hammer:
A chipping hammer is used to remove slags which from during welding.





Ground Clamp:
It is connected to the end of the ground cable. It is normally clamped to the welding table or the job itself to complete the electric circuit.
Wire brush:
The wire brush is used to clean the surface to be welded.





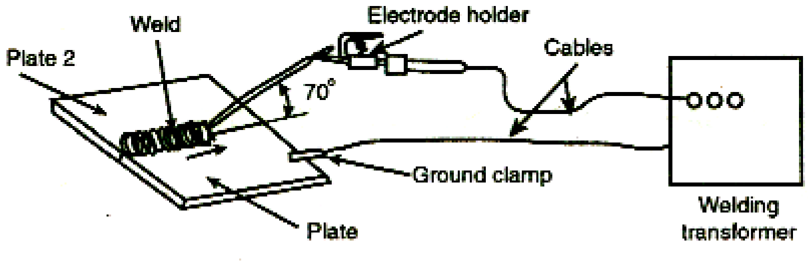
Types of Welding:

The two types of welding most prevalently in use are
1. Arc welding

2. Gas Arc welding

1. Arc welding:

Electric arc welding is widely used to join metal plates using a filler rod. The filler rod (welding rod) melts on the electric arc produced and welds the metal plates.



Arc welding

2. Gas welding

Gas welding is a process in which the required heat to melt the surfaces is supplied by a high temperature flame obtained by a mixture of two gases. Usually the mixture of oxygen and acetylene is used for welding purpose. The filler rod and parent metal plates are melted by the heat of the flame produced using oxygen and acetylene gas mixture. Gas welding is also widely used to join metal plates.

Expt. No. 1(a) SINGLE V BUTT JOINT

Aim:

To join two given metal plates by a single 'V' butt joint in arc welding

Materials required:

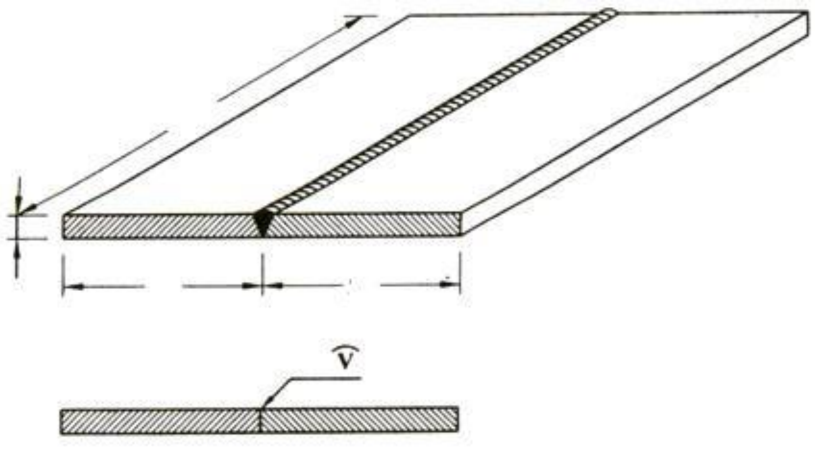
MS flat: Length	=	mm
Breadth	=	mm
Thickness	=	mm

Tools Required:

1. Welding transformer
2. welding rods
3. Safety gloves

4. Goggle
5. Chipping hammer
6. Flat file

Diagram:



Welded Joint Representation

All dimensions are in 'mm'

Procedure:

1. Check the surface to be welded and file the edge of the plates for perfect joint and more strength.
2. Hold the welding rod in the electrode holder and clamp the ground clamp to the plate to be welded.
3. Position the plates to be welded touching each other (butting) and tag weld on the ends to avoid the movement of the plates during welding.
4. Now start welding one end of the plates.
5. The electric arc produced melts the welding rod and joints the two metal plates. Maintain a gap of 3 mm between the plate and the welding rod.
6. Complete the welding process by removing slag using chipping hammer.

Result:

Thus the two metal plates are welded in single 'V' butt joint.

Expt. No. 1(b) DOUBLE V BUTT JOINT

Aim:

To join two given metal plates by a double 'V' butt joint in arc welding

Materials required:

MS flat: Length = mm

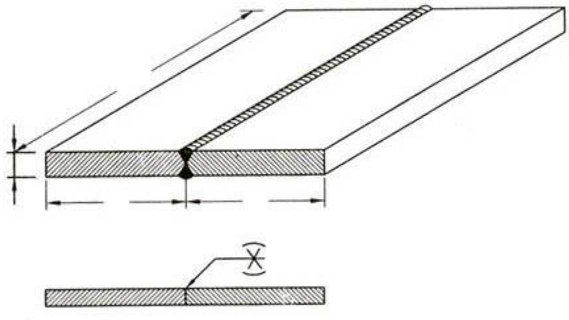
Breadth = mm

Thickness = mm

Tools Required:

1. Welding transformer
2. welding rods
3. Safety gloves
4. Goggle
5. Chipping hammer
6. Flat file

Diagram:



Welded Joint Representation

Procedure:

1. Clean the surface to be welded and file the edge of the plates for perfect joint and more strength.
2. Hold the welding rod in the electrode holder and clamp the ground clamp is clamped to the plate to be welded.
3. Position the plates to be welded touching each other (butting) and tag weld on the ends to avoid the movement of the plates during welding.
4. Now start welding one end of the plates.
5. The electric arc produced melts the welding rod and joints the two metal plates. Maintain a gap of 3 mm between the plate and the welding rod.
6. Complete the welding process by removing slag using chipping hammer.

Result:
Thus the two metal plates are welded in double ‘V’ butt joint.

Expt. No. 1(c) LAP JOINT

Aim:
To join two given metal plates by a lap joint in arc welding
Materials required:

MS flat: Length = mm

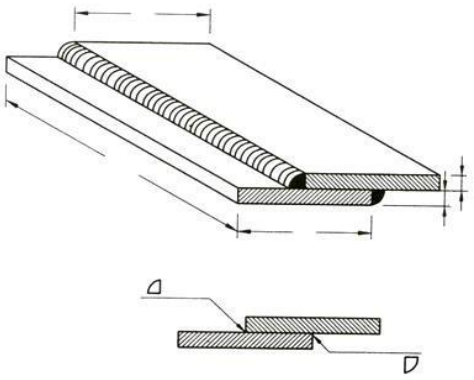
Breadth = mm

Thickness = mm

Tools Required:

1. Welding transformer
2. welding rods
3. Safety gloves
4. Goggle
5. Chipping hammer
6. Flat file

Diagram:



Welded Joint Representation

All the dimensions are in 'mm'

Procedure:

1. Clean the surface to be welded and file the edge of the plates for perfect joint and more strength.
2. Hold the welding rod in the electrode holder and clamp the ground clamp to the plate to be welded. Position the plates to be welded overlapping and tag weld on the ends to avoid the movement of the plates during welding.
3. Now start welding one end of the plates.
4. The electric arc produced melts the welding rod and joints the two metal plates. Maintain a gap of 3 mm between the plate and the welding rod.
5. Complete the welding process by removing slag using chipping hammer.

Result:

Thus the two metal plates are welded in lap joint.

Expt. No. 2 GEAR PATTERN

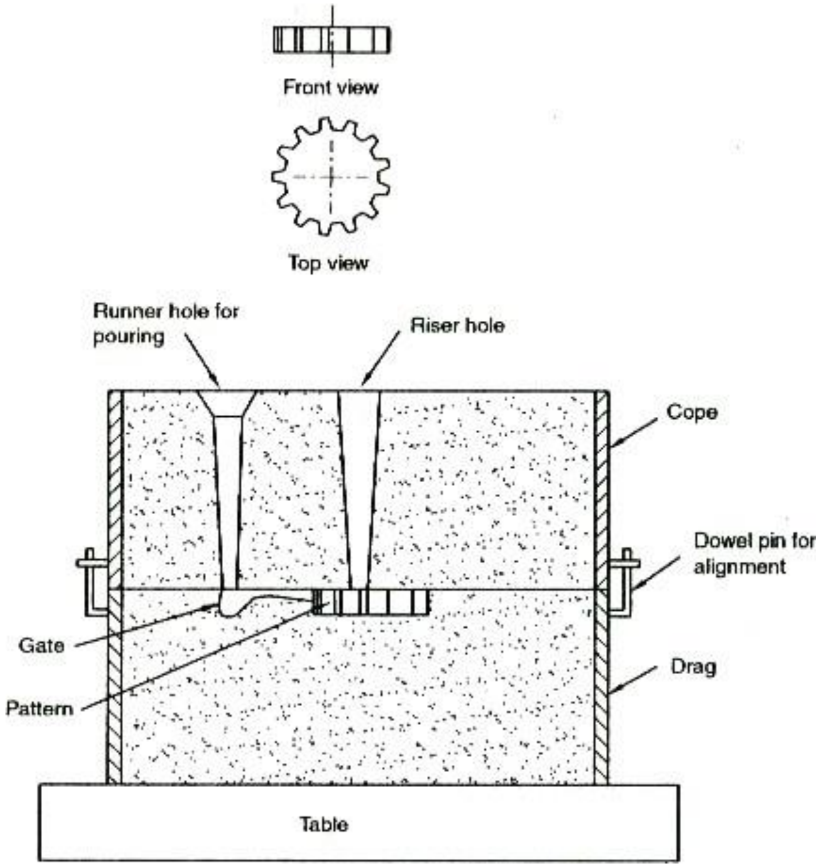
Aim:

To prepare a sand mould using a gear pattern

Tools required:

1. Shovel
2. Sieve
3. Mould box
4. Rammer
5. Trowel
6. Strike off bar
7. Lifter
8. Gate cutter
9. Runner
10. Riser
11. Vent rod
12. Draw spike
13. Swap etc.

Gear pattern:



Procedure:

1. Clean the mould box, pattern, tools and table/floor.
2. Fill the drag with green sand after positioning the gear pattern on the table.
3. Ram the green sand carefully and the excess sand is struck off.
4. Tilt the drag upside down and sprinkle river sand on top of it.
5. Position the cope on top of the drag.
6. Position the sprue pin and riser pin, then fill the cope with sand and ramming is done and the excess sand is struck off.
7. Remove the sprue pin and the riser pin carefully.
8. Apply water on the edges of the pattern and remove it carefully using the draw spike, and then finish the cavity.
9. Vent holes are made using vent wire.
10. A funnel-shaped opening and gate is made to pour the molten metal.

Result:

Thus the mould of the given gear pattern is obtained.

Expt. No.3 (a) TAPER TURNING USING COMPOUND REST

METHOD

Aim:

To produce the component by performing taper turning using lathe

Materials required:

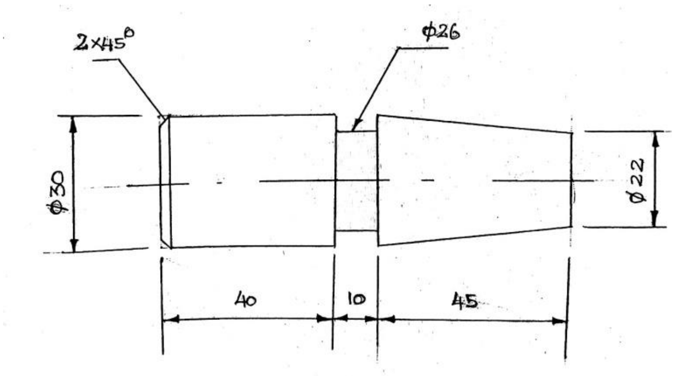
Mild steel Φ 32 mm X 100 mm long

Tools required:

1. Chuck key
2. Tool post spanner
3. Verneir caliper

4. Steel rule
5. Single point cutting tool

Specimen drawing:



All dimensions are mm

Procedure:

Check the size of raw material given and ensure the size.

1. Hold the workpiece in the chuck and tight it properly.
2. Clamp the tool on post properly and check the centre of work piece with cutting tool tip.
3. Do the facing operation by giving cross feed to the cross slide and reduce length.
4. Do the turning operation by giving longitudinal feed to the carriage and reduce the diameter of the work piece.
5. Two or three pass can be given for turning operation.
6. Remove the work piece and hold in chuck on other side and do the turning operation for the remaining portion of the work piece.
7. Calculate the taper angle and swivel the compound rest and clamp it properly.
8. Do the taper turning operation by giving angular feed to the compound rest as per the dimension.
9. Do the facing operation and get the required length.
10. Remove the component carefully and check the dimension.

Result:

Thus the component is produced as per the given drawing using lathe.

Expt. No.3(b) ECCENTRIC TURNING

Aim:

To turn a given work piece eccentrically in a lathe machine as per the given dimensions

Material required:

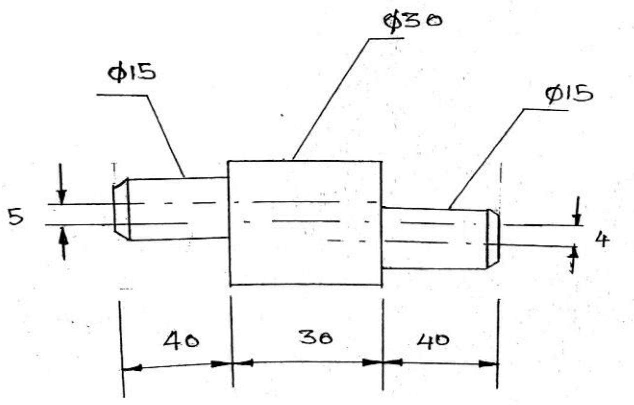
Mild steel Φ 32 mm X 75 mm long

Tools required:

1. Steel rule
2. Dot punch
3. Ball pen hammer
4. Single point cutting tool
5. Surface gauge
6. Drill bit

7. Drill chuck
8. Boring tool

Specimen drawing:



Procedure:

1. Check the size of raw material given and ensure the size.
2. The work piece is fixed in the four jaw chuck using surface gauge.
3. The cutting tool is fixed in the tool post to the lathe axis.
4. Facing operation has been done on both sides of given work pieces.
5. Marking and punching is to be done on the given work pieces as per the dimension.
6. Then the work piece is fixed in the chuck such that the offset point coincides with spindle axis.
7. Using the turning tool, turning operation has been performed.
8. The same procedure is also carried out to the other side of the work piece for the given offset distance.
9. Thus the eccentric turning would be finished.

Result:

Thus the work piece is turned eccentrically as per the given dimensions.

Expt. No.4(a) KNURLING

Aim:

To produce the component by performing knurling operation using lathe

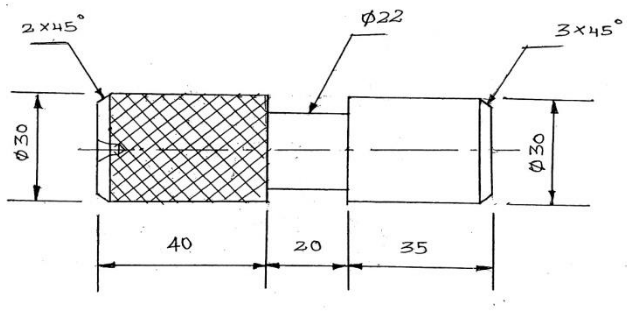
Material required:

Mild steel rod size of dia. 32 mm and length 100 mm

Tools required:

1. Single point cutting tool
2. Knurling tool
3. Pitch gauge
4. Drill chuck with centre drill bit

Specimen drawing:



All dimensions are in mm

Procedure:

1. Check the size of raw material given and ensure the size.
2. Held the work pieces in the chuck and tight it properly.
3. Clamp the tool on tool post properly and check the centre of work piece with cutting tool tip.
4. Do the facing operation by giving cross feed to the cross slide and reduce the length.
5. Do the turning operation by giving longitudinal feed to the carriage and reduce the length.
6. Two or three passes can be given for the turning operation.
7. The grooving tool is fixed in the tool holder on lathe.
8. The work piece is fixed in the machine vice. Then switch on the machine.
9. Make the grooving operation as per the dimension using grooving tool.
10. Then place a knurling tool in the tool holder of lathe.
11. Make the knurling operation as per the dimension using knurling tool.
12. Make the chamfer at the end of the component.
13. Remove the component and inspect its size.

Result:

Thus the component is produced by performing knurling and grooving operation using lathe.

Expt. No.4(b) EXTERNAL THREAD CUTTING

Aim:

To produce the component by performing threads cutting operation using lathe

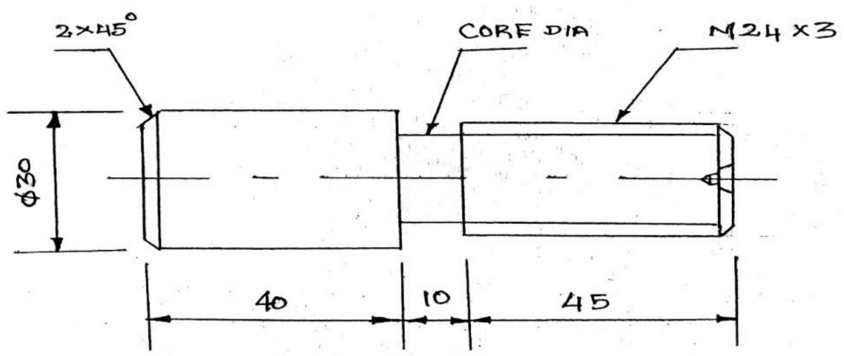
Material required:

Mild steel Φ 32 mm X 100 mm long

Tools required:

1. Chuck key
2. Tool post spanner
3. Verneir caliper
4. Steel rule
5. Single point cutting tool
6. V thread cutting tool
7. Pitch gauge
8. Grooving tool
9. Drill chuck with centre drill bit

Specimen drawing:



Procedure:

1. Check the size of raw material given and ensure the size.
2. Hold the work pieces in the chuck and tight it properly.
3. Clamp the tool on tool post properly and check the centre of work piece with cutting tool tip.
4. Do the facing operation by giving cross feed to the cross slide and reduce the length.

5. Do the turning operation by giving longitudinal feed to the carriage and reduce the length.
6. Two or three pass can be given for the turning operation.
7. Remove the work piece and hold in chuck on the other side and do the turning operation for the remaining work piece.
8. Engage the back gear mechanism to reduce the speed of the work piece.
9. Check the pitch required, calculate the tumbler gear, and engage it with head stock.
10. Move the carriage towards tail stock and make a mark on the dial.
11. Give small depth of cut and engage the half nut so that the carriage will move automatically towards head stock and cut the v-thread on the work piece.
12. After reaching the required length of thread, release the tool by rotating cross slide in opposite to the depth of cut by counting the number of rotation.
13. Move the carriage towards tail stock, give depth of cut and engage the half nut.
14. Repeat the procedure to produce complete form of v-thread. After finishing remove the work piece from the chuck.

Result:

Thus the component is produced as per the given drawing using lathe.

Expt. No.4(c) INTERNAL THREAD CUTTING

Aim:

To produce the component by performing drilling, boring and thread cutting using lathe

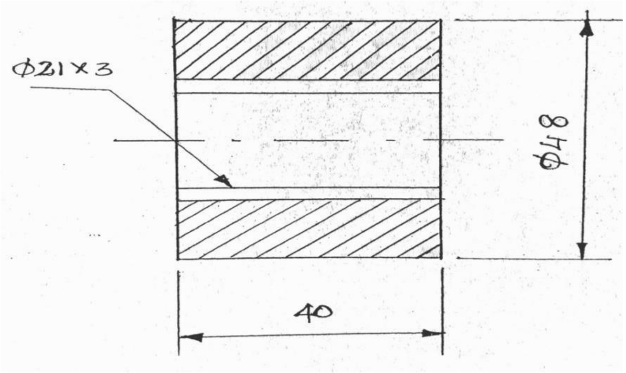
Material required:

Mild steel Φ 50 mm X 45 mm long

Tools required:

1. Chuck key
2. Tool post spanner
3. Vernier caliper & Steel rule
4. Single point cutting tool & Boring tool
5. Drill chuck with drill bits
6. Internal thread cutting tool

Specimen drawing:



All dimensions are in mm

Procedure:

1. Check the size of raw material given and ensure the size.
2. Hold the workpiece in the chuck and tight it properly.
3. Clamp the tool on tool post properly and check the centre of work piece with cutting tool tip.
4. Do the facing operation by giving cross feed to the cross slide and reduce the length.
5. Hold the drill bit on the tail stock and unclamp the tail stock, then move it towards the head stock and ensure the centre coincidence with work piece centre.
6. Start the motor and give depth of cut to the drill bit by rotating the tail stock wheel and make complete hole.
7. Clamp the boring tool on the tool post to perform the boring operation.
8. Clamp the internal thread tool on the tool post to perform internal threading operation,
9. Engage the back gear mechanism to reduce the speed of the work piece.
10. Check the pitch required, calculate the tumbler gear and engage it with head stock.
11. Move the carriage towards tailstock and make marking on the dial.
12. Give small depth of cut and engage the half nut so that the carriage will move automatically towards headstock and cut the v thread on the work piece.
13. Release the tool by rotating cross slide in opposite to the depth of cut by counting number of rotation after reaching the required length of thread.
14. Move the carriage toward the tail stock and give depth of cut and engage the half nut.
15. Repeat the procedure to produce complete form of v thread. After finishing remove the work piece from the chuck.

Result:

Thus the component is produced as per the given drawing using lathe.

Expt. No.5(a) SQUARE HEAD SHAPING

Aim:

To make round work piece to square by using shaper

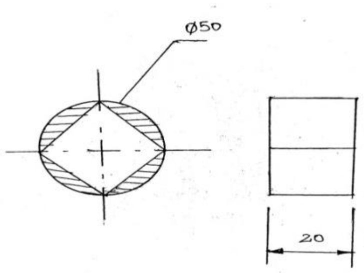
Material required:

Mild steel Φ 50 mm x 25 mm long

Tools required:

Steel rule, dot punch, hammer, verneir height gauge, T-square, scriber, surface plate, single point cutting tool, tool holder.

Specimen drawing:



All dimensions are in mm

Procedure:

1. Check the size of raw material given and ensure the size.
2. The work piece is fixed in the three jaw chuck.
3. The cutting tool is fixed in the tool post to the lathe axis.
4. Facing operation has been done on both sides of given work pieces.
5. Chalk is applied uniformly on the face of the work piece.
6. Marking and punching is to be done on the given work pieces as per the dimension.
7. The cutting tool is fixed in the tool holder in shaper machine.
8. The work piece is fixed in the machine vice, then switch on the machine.
9. At the end of each stroke give the feed to the work piece.
10. Shaping operation has been done on four sides in the work piece till the round work piece is turned into square shaped as per the given dimension.

Result:

Thus the round work piece is machined to square work piece by shaper machine.

Expt. No.5(b) HEXAGONAL HEAD SHAPING

Aim:

To make a round work piece to hexagonal shape by using shaper

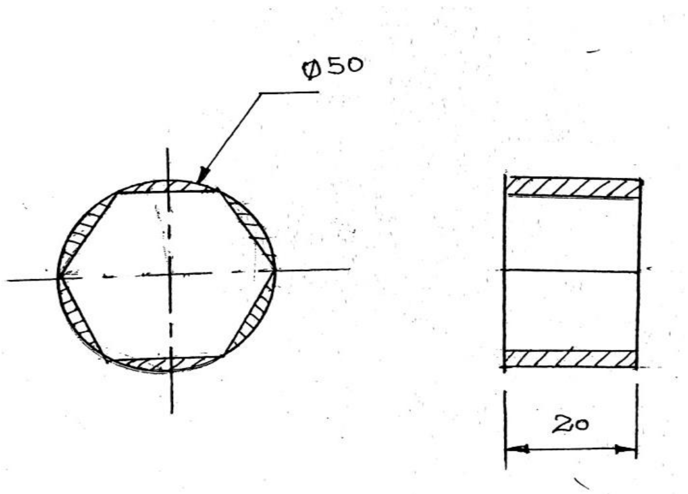
Material required:

Mild steel rod size of dia. 32 mm and length 50 mm

Tools required:

Steel rule, dot punch, hammer, verneir height gauge, T-square, scriber, surface plate, single point cutting tool, tool holder.

Specimen drawing:



Procedure:

1. Check the size of raw material given and ensure the size.
2. The work piece is fixed in the three jaw chuck.
3. The cutting tool is fixed in the tool post to the lathe axis.
4. Facing operation has been done on both sides of given work pieces.
5. Chalk is applied uniformly on the face of the work piece.
6. Marking and punching is to be done on the given work pieces as per the dimension.
7. The cutting tool is fixed in the tool holder in shaper machine.
8. The work piece is fixed in the machine vice, then switch on the machine.
9. At the end of each stroke give the feed to the work piece.
10. Follow the same procedure to the other side of the work piece.
11. Shaping operation has been done on six sides in the work piece till the round work piece is turned into hexa shaped as per the given dimension.

Result:

Thus the round work piece is machined to hexagonal shape by shaper machine.

STUDY OF MILLING MACHINE

- Definition:

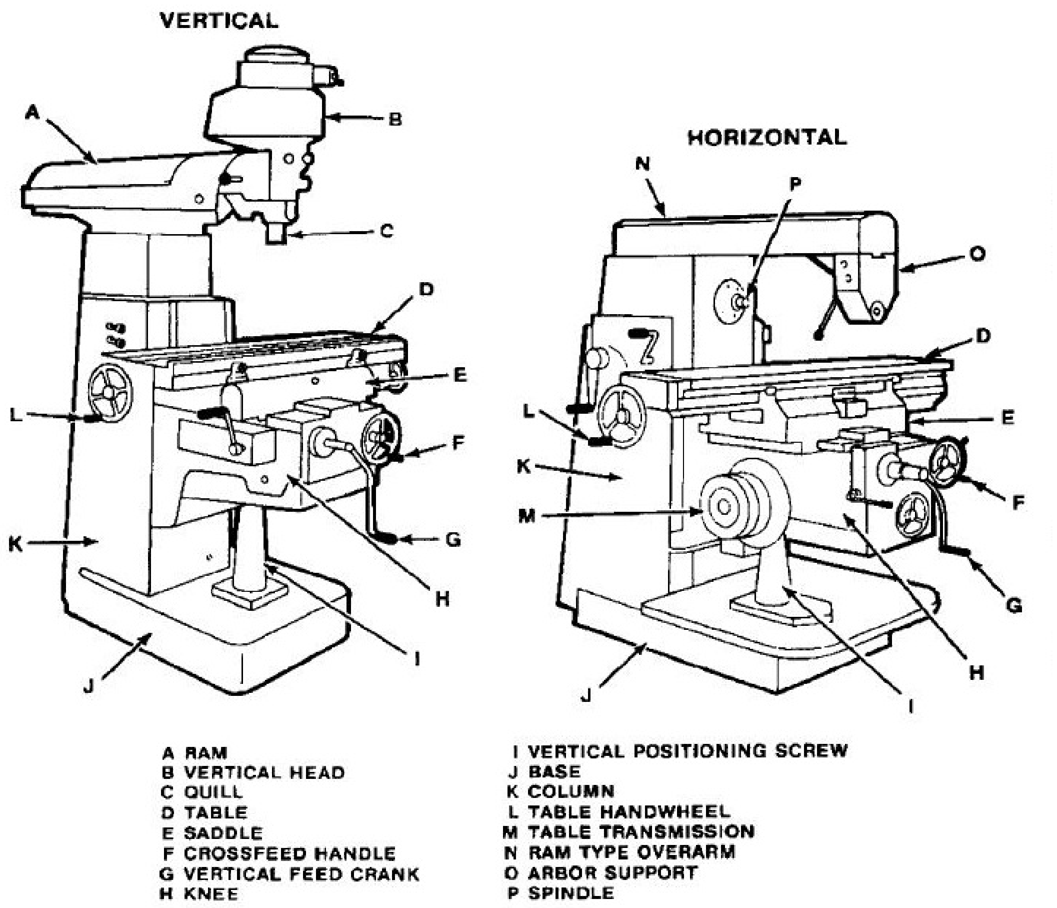
  Milling is the process of machining flat, curved or irregular surface by feeding the work piece against a rotating cutter containing a number of cutting edges

- Operation:

  The milling machine consists basically of a motor driven spindle, which mounts and revolves the milling cutter and a reciprocating adjustable worktable, which mounts and feed the work piece

- Types of Milling Machines:

1. Knee-type milling machine; **2.** Universal Horizontal milling machine; **3.** Ram type milling machine; **4.** Universal Ram type milling machine; **5.** Swivel cutter head ram type milling machine

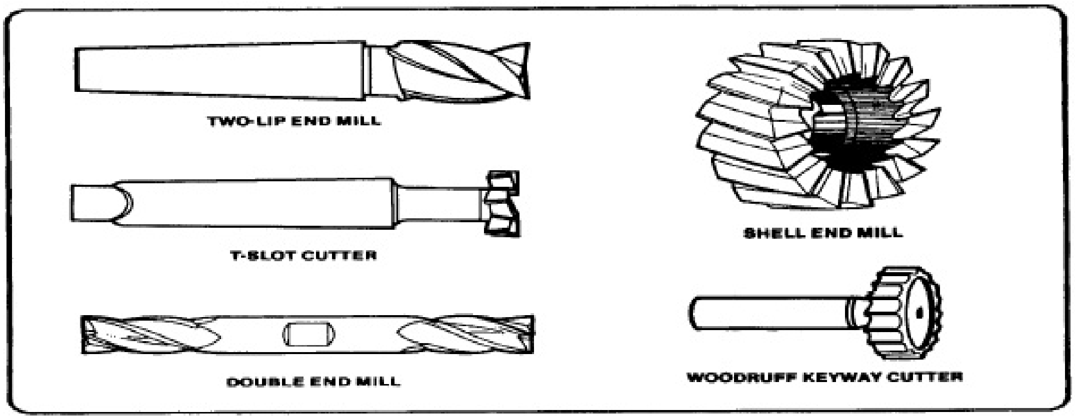


Vertical and Horizontal milling machines

- **Milling Cutters:**

  Milling cutters are usually made of high-speed steel and are with its parts and angles identified. The types of milling cutter are been classified as follows

  1. Helical milling cutter; 2.Saw milling cutter; 3.Side milling cutter; 4.End milling cutter; 5.T slot milling cutter ; 6.Angle milling cutter

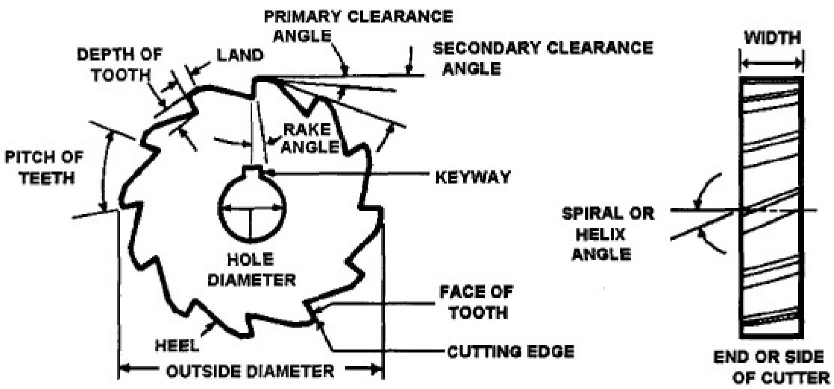


Milling cutter type

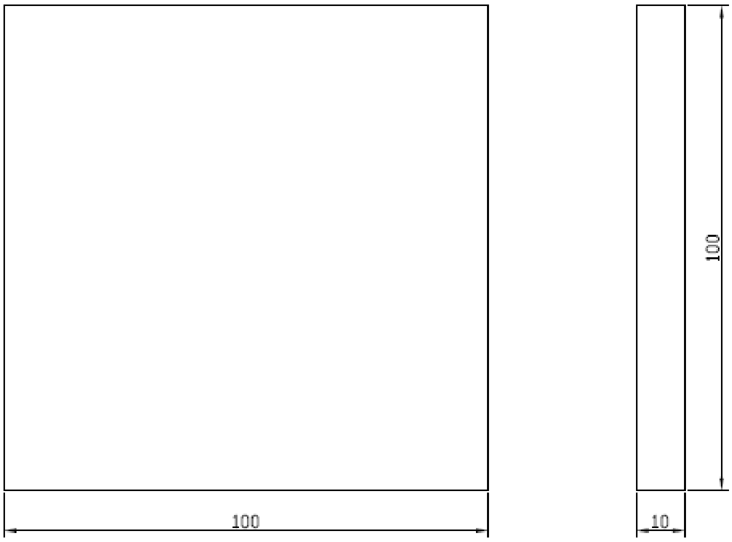
- Selection of milling cutter:
  The selection of milling cutter can be done through the possible ways

  1. High speed steel, stellite and cemented carbides have a distinct advantage of being capable of rapid production when used on a machine that can reach the proper speed.
  2. The harder the material, the greater will be the heat generated in cutting. Cutter should be selected for the heat resisting properties.
  3. The two side milling cutters can be used for the majority of operations

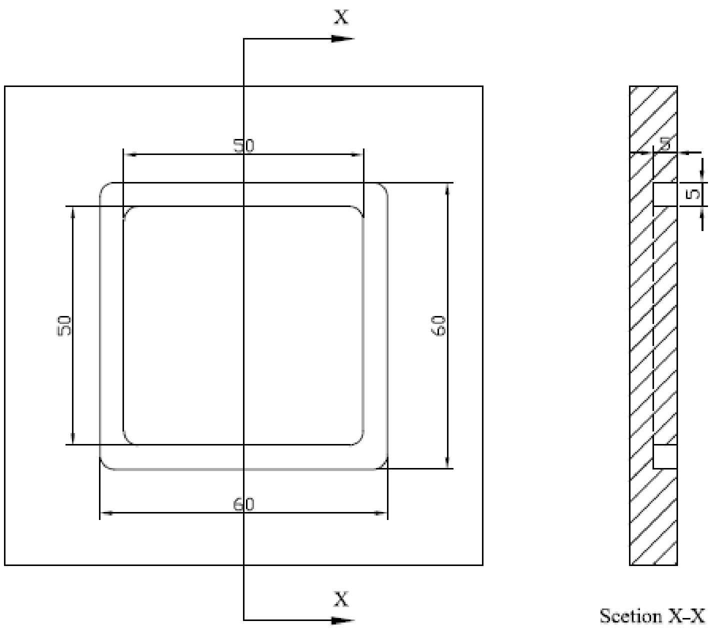
- **Cutting Tool Nomenclature:** Shown below is a self-explanatory figure of cutting tool nomenclature



Cutting tool Nomenclature



Before Machining



After Machining

Calculation:

- Feed in mm/rev = Feed per tooth (ft) X number of cutter teeth(n)

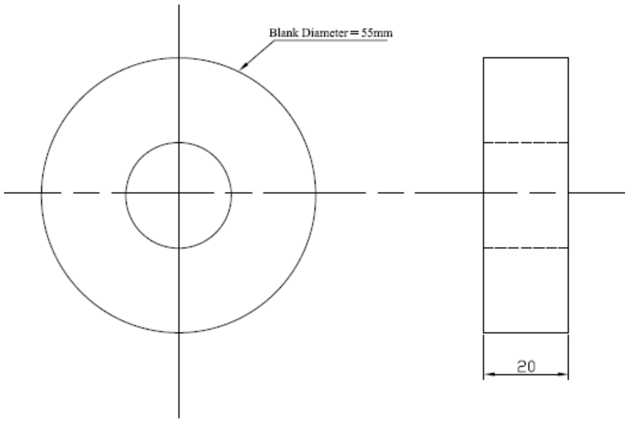
Feed per min (table feed) = F = feed per rev x cutter speed in RPM(V) = ft X n X V

Ex.No:7 CONTOURS MILLING USING VERTICAL MILLING MACHINE

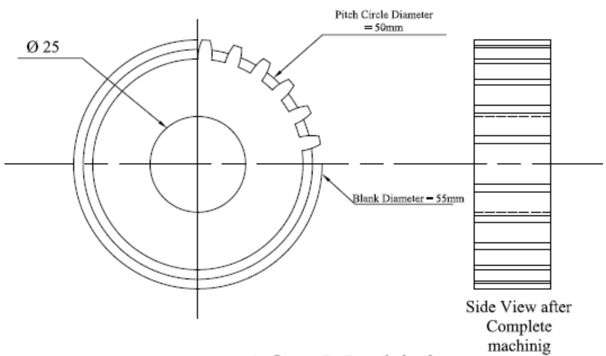
- **Aim:** To perform the contour milling on given work piece using vertical milling machine
- **Apparatus Required:**
  - Vertical Milling machine
  - HSS – M8 end mill cutter
- **Materials Required:**
  - Aluminium work piece – 100mm X 100mm X 10mm
- **Procedure:**
  - Hold the work piece in the Arbor which holds it perfectly for machining
  - Switch the spindle on and required RPM of rotation is set for the milling cutter
  - The average cutting speed can be taken from the table listed as follows

Material of W/p	Brass	Cast Iron	Bronze	Mild Steel	High Carbon steel	Hard Alloy Steel	Aluminium
Cutting speed m/min	45-60	21-30	24-45	21-30	15-18	9-18	150-300

  - Depth of cut can be 3mm to 8mm for roughing operation and 0.5mm to 1.5mm for finishing operation
  - After setting the depth of cut, machining is carried out on the work piece with the specified cutting parameters
  - The required contour profile is produced on the work piece



Before Machining



After Machining

Calculation:

- **Module of the cutter (m) =** 2.5 mm

- **Blank Diameter = ** 55 mm
- **Pitch Circle Diameter:**
  - For any gear, Outer Diameter(OD) = Pitch circle diameter + (2 X module)
  - For the given conditions, **Pitch circle diameter (PCD)** = OD – (2 X m)

    = 55 – (2 X 2.5)

    = 50 mm
- **Number Of teeth:**
  - Number of Teeth (Z) = PCD / m

    = 50 / 2.5= 20

Therefore number of teeth = 20

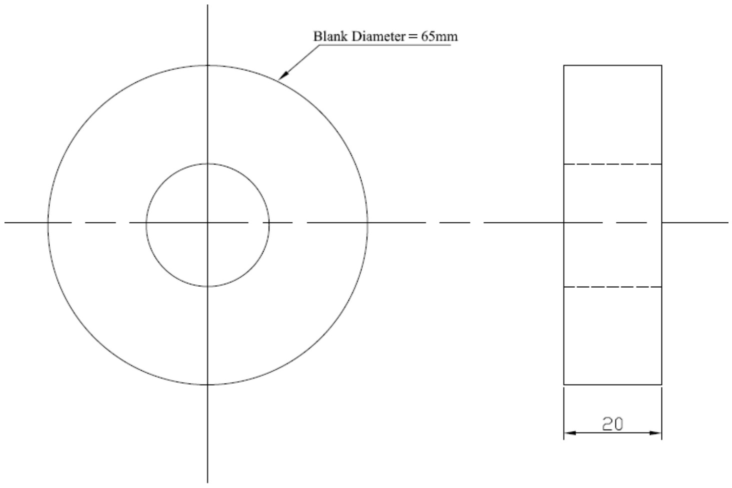
- **Indexing Calculation:**
  - Indexing = 40 / Z = 40 / 20 = 2

Result:

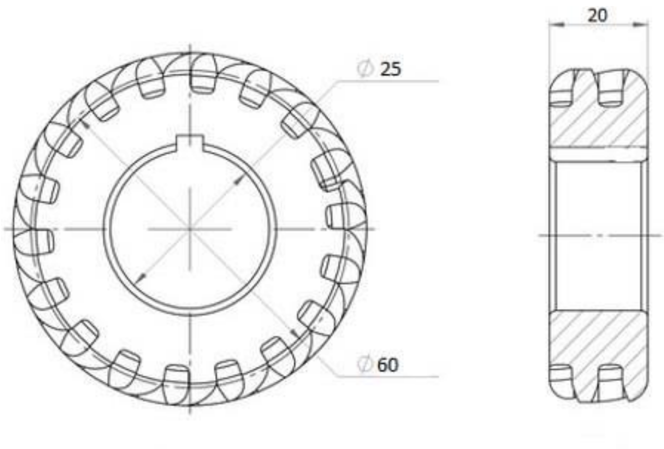
Hence the required contour profile is produced on the work piece using vertical milling machine

Ex.No:8 (a) SPUR GEAR CUTTING IN MILLING MACHINE

- **Aim:** To produce a spur gear out of the given work piece using milling machine
- **Apparatus Required:**
  - Horizontal Milling machine
  - M10 – End Mill Cutter (HSS)
  - Gear tooth Vernier
- **Materials Required:**
  - Cast Iron Work piece – 55mm diameter, 20mm thickness
- **Procedure:**
  - The gear blank is held between the dividing head and tailstock using a mandrel.
  - The cutter is mounted on the arbor and the cutter is centred accurately with the gear blank
  - Set the speed and feed for machining. For giving depth of cut, the table is raised till the periphery of the gear blank just touches the cutter
  - The Micrometre dial of vertical feed screw is set to zero at this position. Then the table is raised further to give the required depth of cut
  - The machine is started and feed is given to the table to cut the first groove of the blank.
  - After the cut, the table is brought back to the starting position. Then the gear blank is indexed for the next tooth space
  - This is continued till all the teeth are cut
  - Dimensions of the gear teeth profile are checked using the gear tooth Vernier



Before Machining



After Machining

- **Calculation:**
  - **Pitch circle Diameter D_P** = Diameter of the Blank(**D**) – (2 X Module(**m**)) = 65-(2X2.5)=60
  - **Number of teeth Z** = Pitch circle Diameter / module = 60 / 2.5 = 24
  - **Circular Pitch $P_C = \pi D_P / Z$**
  - The relationship between **normal pitch** and **transverse pitch** is given by PN = PC X cosα
  - **Helical Gear considerations:**
    - Helix Angle α is related to Pitch circle diameter (DP) and the lead of the helix (L) by the following relation

    $\tan \alpha = \pi D_P / L =$

    - With any of the two known values, the third value can be found
  - **Indexing Calculation:** Indexing = 40 / Z =

Result: Thus a spur gear is made from the give work piece using milling machine

Ex.No:8 (b) **HELICAL GEAR CUTTING IN MILLING MACHINE**

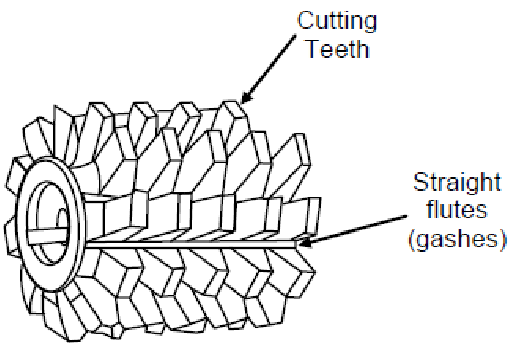
- **Aim:** To cut a helical gear out of the given blank in milling machine
- **Apparatus Required:**
  - Horizontal Milling machine
  - M10 – End Milling cutter
- **Materials Required:** Cast Iron Blank – 65mm diameter and 20mm thickness
- **Procedure:**
  - The M10 milling cutter is set on the mandrel
  - The table is swivelled to an inclination of α (Helix Angle) with the axis of work piece
  - The required gear ratio is set between the work table and the mandrel holding the work piece so that movement of the work table rotates the work piece through the proper helix angle progressively
  - The spindle is switched on and the required depth of cut is set before the tool cuts the work piece.
  - Single teeth cavity is cut through the work piece.
  - After Indexing the next tooth is cut in similar fashion and so on
  - The gear tooth dimensions are checked using a gear tooth Vernier

- **Result:** Thus a helical gear is cut out of the given blank using horizontal milling machine

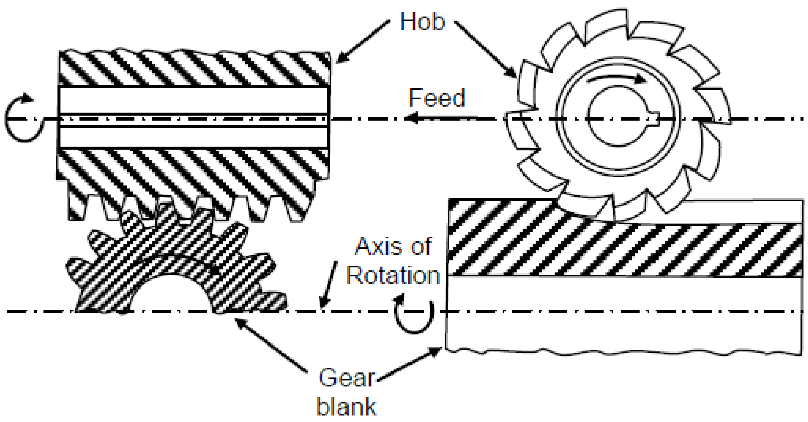
<u>**STUDY OF GEAR HOBBING MACHINE**</u>

- Gear Hobbing is a process that generates the gear profile by engagement of the tool and the work piece
- In this process, the gear blank is rolled with a rotating cutter called hob
- The Hob is a multi-point cutting tool having a number of straight flutes all around its periphery parallel to its axis
- These flutes are so shaped by giving proper angles to them so that these work as cutting edges
- In gear Hobbing operation, the hob is rotated at a suitable rpm and simultaneously fed to the gear blank
- Also the gear blank is kept revolving. Rpm of both gear blank and gear hob are so synchronized that for each revolution of gear hob, the gear blank rotates by a distance equal to one pitch distance of the gear to be cut
- Motion of both gear blank and hob are maintained continuously and steady
- A gear hob (tool) and the process of gear Hobbing are illustrated in Figure below

Schematic of gear Hobbing process



Gear Hob



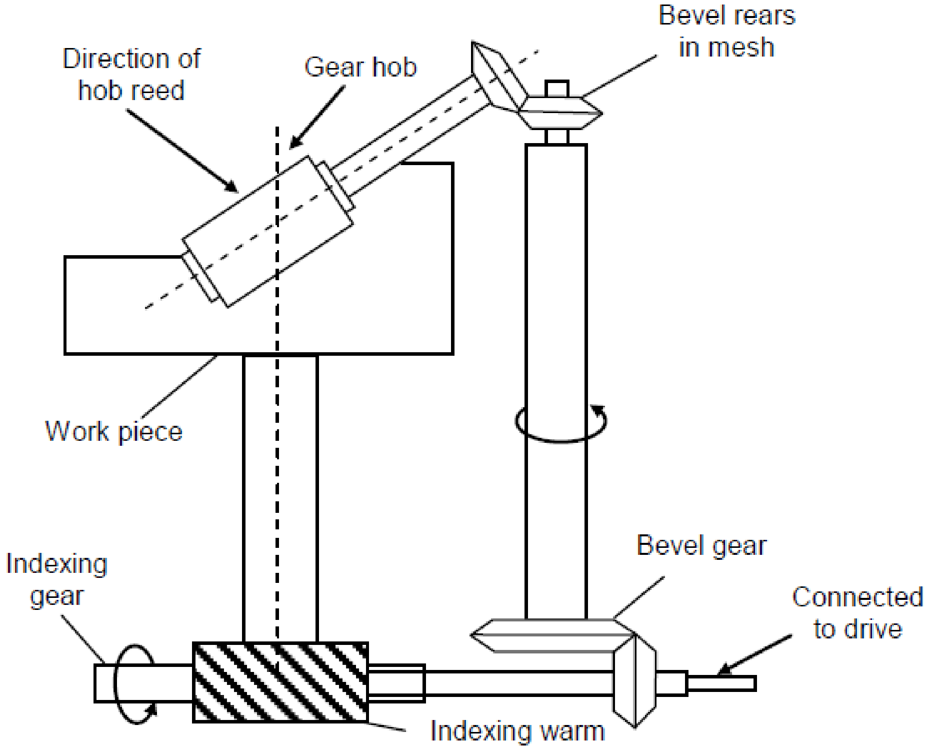
Three important parameters are to be controlled in the process of gear Hobbing

- indexing movement
- feed rate
- angle between the axis of gear blank and gear Hobbing tool

- A schematic diagram of the setup of a gear Hobbing machine is illustrated in Figure below

The axis of hob is set at an inclination equal to the helix angle of the hob, with the vertical axis of the blank

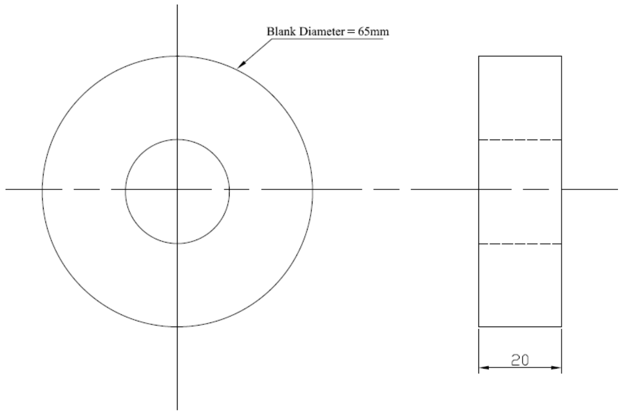
- If a helical gear is to be cut, the hob axis is set at an inclination equal to the sum of the helix angle



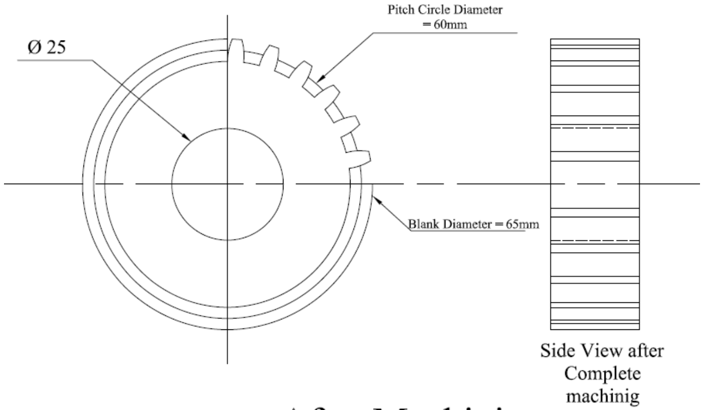
Setup for Gear Hobbing Machine

of the hob and the helix angle of the helical gear

- Proper gear arrangement is used to maintain rpm ratio of gear blank and hob
- The operation of gear Hobbing involves feeding the revolving hob till it reaches to the required depth of the gear tooth.
- Simultaneously it is fed in a direction parallel to the axis of rotation.
- The process of gear Hobbing is classified into different types according to the directions of feeding the hob for gear cutting.



Before Machining



After Machining

Calculation:

- **Module of the Hob (m) =** 2.5 mm
- **Blank Diameter =** 65 mm
- **Pitch Circle Diameter:**
  - For any gear, Outer Diameter(OD) = Pitch circle diameter + (2 X module)
  - For the given conditions, **Pitch circle diameter (PCD)** = OD – (2 X m)

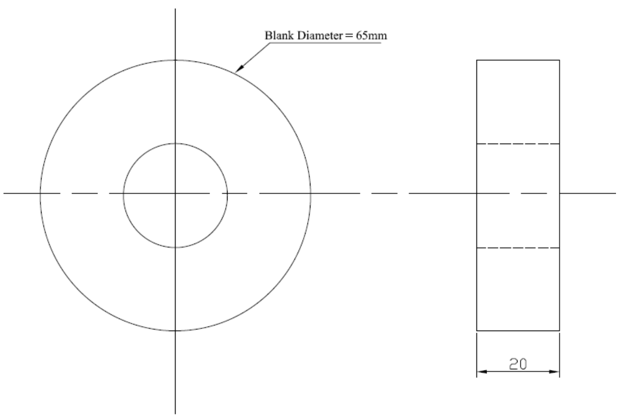
    = 65 – (2 X 2.5)= 60mm
- **Number Of teeth:**
  - Number of Teeth (Z) = PCD / m = 60 / 2.5 = 24

Therefore number of teeth = 24

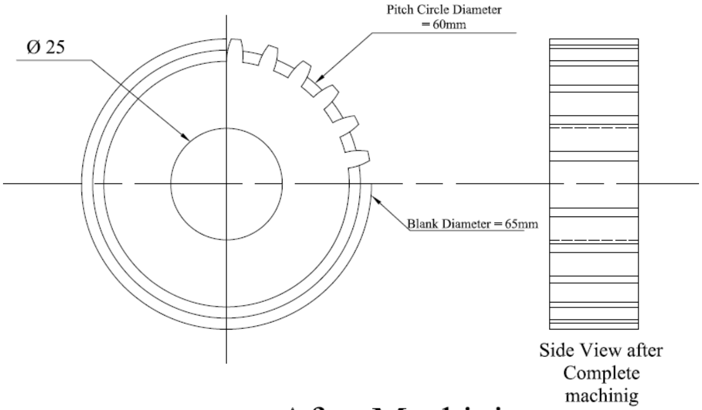
- **Indexing Calculation:**
  - Indexing = 40 / Z = 40 / 24 = 1 2/3

Ex.No: Gear Generation in Gear Hobbing machine

- **Aim:** To machine a Spur Gear using a gear Hobbing machine
- **Materials Required:** Cast Iron Blank
- **Tools Required:**
  - Gear Hobbing machine
  - Hob
  - Gear Tooth Vernier
  - Spanners
- **Procedure:**
  - The given work piece is held firmly on the spindle of the gear Hobbing machine
  - The Hob is set at an angle equal to its helix angle, with the axis of the blank for cutting spur gear
  - Gear ratio is set at a desired value to achieve the required speed of the hob and the work piece
  - The machine is switched on. The work piece and the hob are allowed to rotate, at the desired speed
  - The hob or the work piece is given full depth of cut equal to the tooth depth
  - The cutter is given feed for full width of the work piece
  - After machining all the teeth the machine is switched off
  - The dimensions of the teeth are checked using a gear tooth Vernier



Before Machining



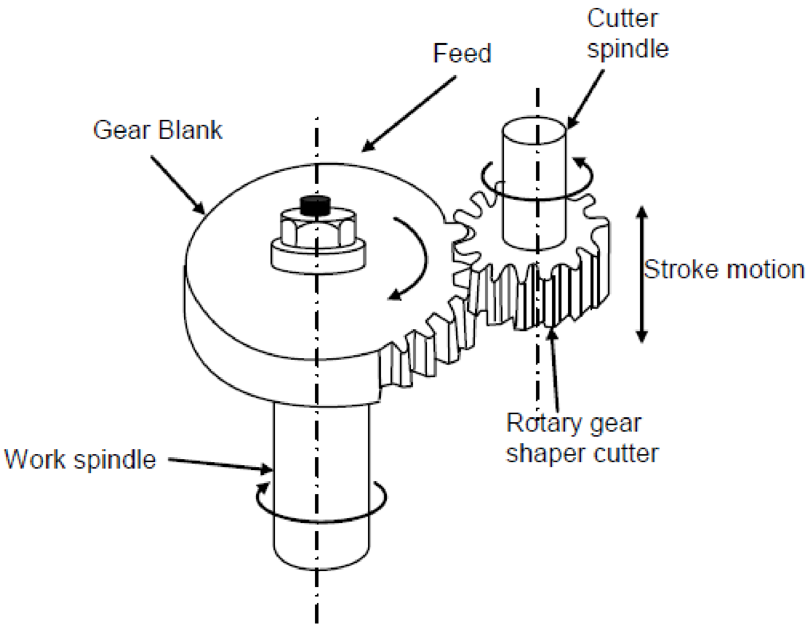
After Machining

Result

Thus the given blank (work piece) is converted into a gear of required dimensions by gear generation operation in a gear Hobbing machine

STUDY OF GEAR SHAPER MACHINE

- This process uses a pinion shaped cutter carrying clearance on the tooth face and sides and a hole at its centre for mounting it on a stub arbor or spindle of the machine
- The cutter is mounted by keeping its axis in vertical position
- It is made to reciprocate up and down along the vertical axis up to a pre decided amplitude
- Both the cutter and the gear blank are set to rotate at a very low RPM about their axis
- The relative rpm of both (cutter and blank) can be fixed to any of the available value with the help of a gear train.
- This way all the cutting teeth of cutter come is action one-by-one giving sufficient time for their cooling and incorporating a longer tool life
- The principle of gear cutting by this process as explained above is depicted in the Figure below



Process of Gear Cutting by Shaper Cutter

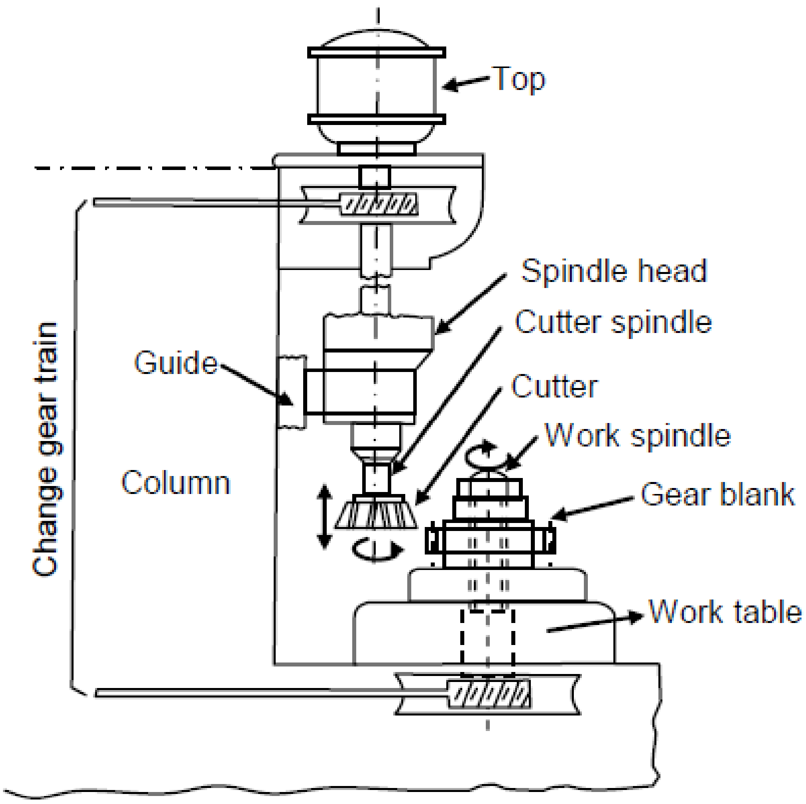
- The main parameters to be controlled in the process are described below
  - **Cutting Speed:**
  - Shaper cutter can move vertically upward and downward during the operation.
  - The downward movement of the cutter is the cutting stroke and its speed (linear) with which it comes down is the cutting speed.
  - Length of cutting stroke can be adjusted to any value out of available values on the machine

Indexing motion:

- Indexing motion is equivalent to feed motion in the gear shaping operation. Slow rotations of the gear cutter and work piece provide the circular feed to the operation.
- These two rpms are adjusted with the help of a gear train

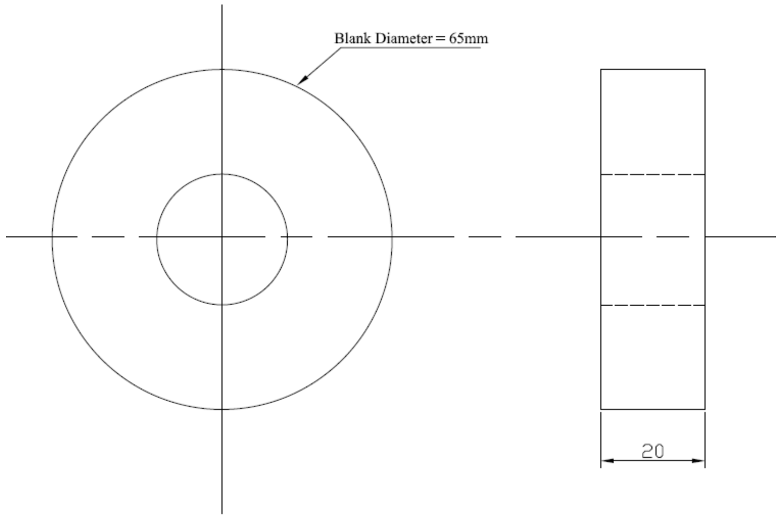
Depth Of Cut:

- The required depth is maintained gradually by cutting the teeth into two or three pass
- In each successive pass, the depth of cut is increased as compared to its previous path
- This gradual increase in depth of cut takes place by increasing the value of linear feed in return stroke

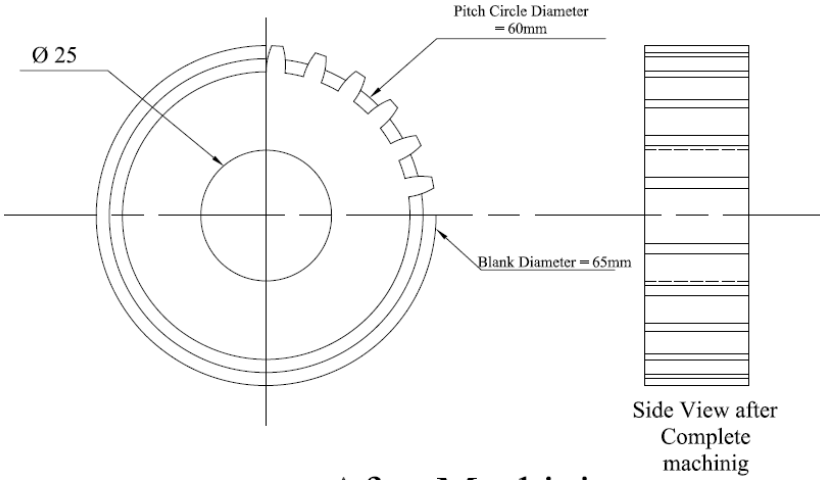


Setup for Gear Shaping Machine

- A Schematic representation of gear shaper is shown above with various parts
- The main advantage of gear shaper is that the process can be used to make a variety of gears and the cycle time for producing one work piece is very less compared to many other processes. Close tolerances can be maintained
- The main disadvantage is that there is no cutting in the return stroke. The process cannot be used to manufacture worm and worm wheel, which is a special type of gear



Before Machining



After Machining

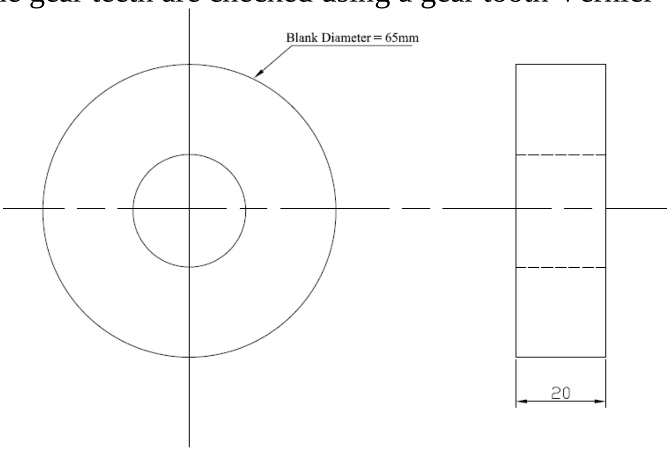
Ex. No:10 **SPUR GEAR CUTING IN GEAR SHAPER MACHINE**

Aim: To machine the given gear blank into a spur gear in gear shaper machine

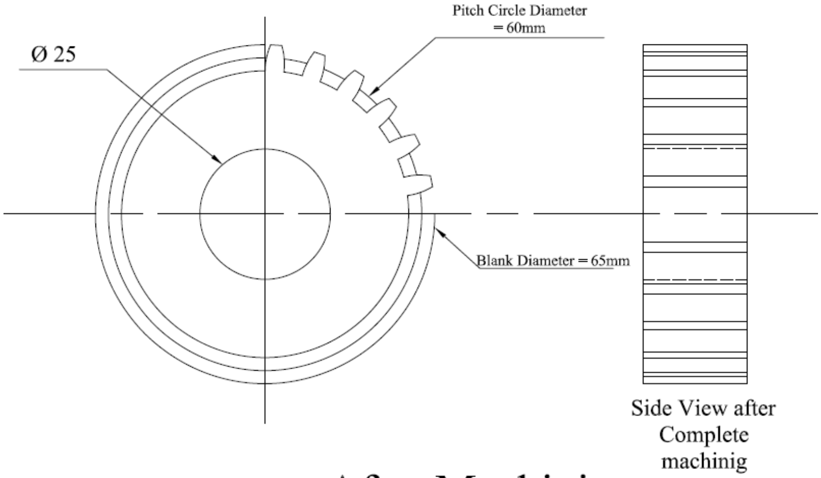
Apparatus Required:
- Gear Shaper Machine
- Shaper cutter

Material required:
- Cast iron blank

Procedure:
- The given gear blank is mounted on the work piece spindle
- The shaper cutter having the necessary cutting teeth in the shape if tooth spacing of the required work piece is mounted on the cutter spindle
- Necessary gear ratio is set between the work piece spindle and the cutter spindle for the purpose of indexing
- Machine is switched on and shaping process of the tooth spacing of the gear profile is done with the shaper cutter, in two to four passes per teeth. This feed motion is given during the return stroke
- With the indexing done through a gear train, the cutter gradually rotates and the work piece rotates in accordance with the cutter, as if they are two gears in mesh
- With one complete revolution of the work piece on its spindle the gear shaping process will be complete
- The dimensions of the gear teeth are checked using a gear tooth Vernier



Before Machining

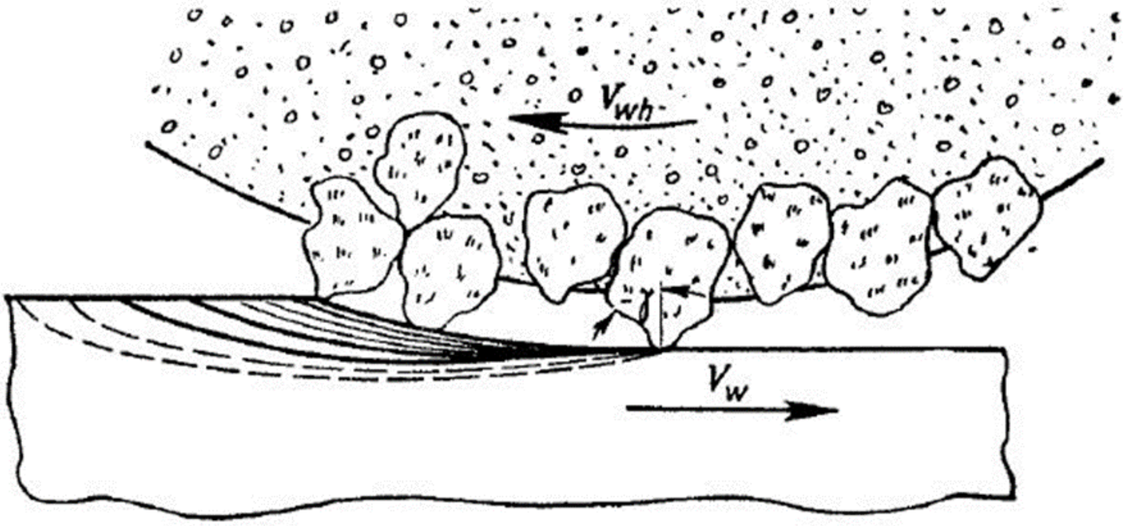


After Machining

Result: Thus the required spur gear is cut from the given blank by gear shaping process

STUDY OF GRINDING MACHINE

- Grinding is the process of removing metal by the application of abrasives which are bonded to form a rotating wheel.
- When the moving abrasive particles contact the work piece, they act as tiny cutting tools, each particle cutting a tiny chip from the work piece.
- It is a common error to believe that grinding abrasive wheels remove material by a rubbing action;
- Actually, the process is as much a cutting action as drilling, milling, and lathe turning.
- A schematic of grinding operation is shown below



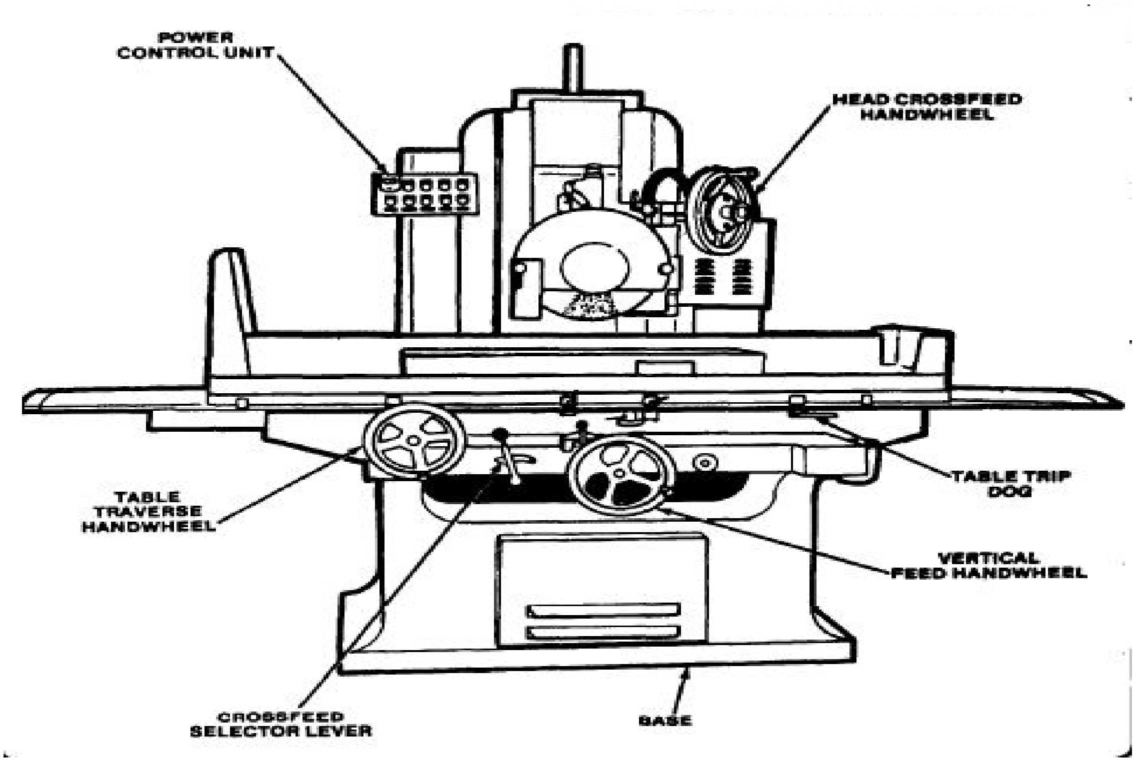
Mechanism of Grinding

Types of Grinding Machines:

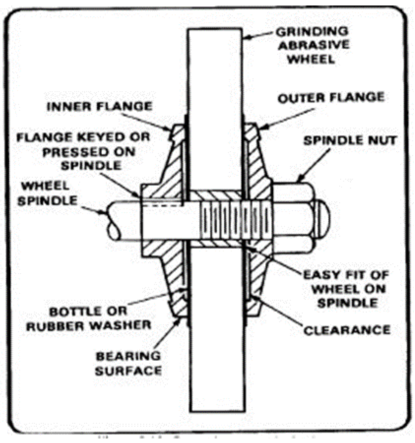
- The various types of grinding machines are described as follows
  - Utility grinding machine
  - Cylindrical grinding machine
  - Surface grinding machine.
  - Angle Grinder
  - Tool Grinding machine

Construction of Grinding Machine and wheel

- The construction of grinding machine and grinding wheel are described in figure asfollows



Reciprocating surface grinding machine

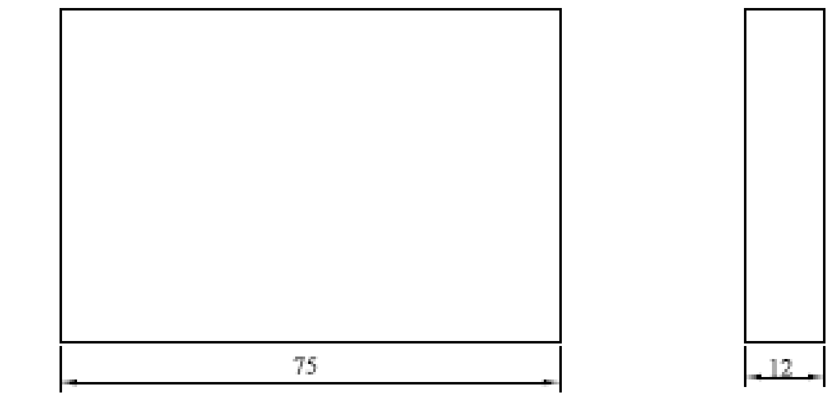


Perfect located grinding wheel

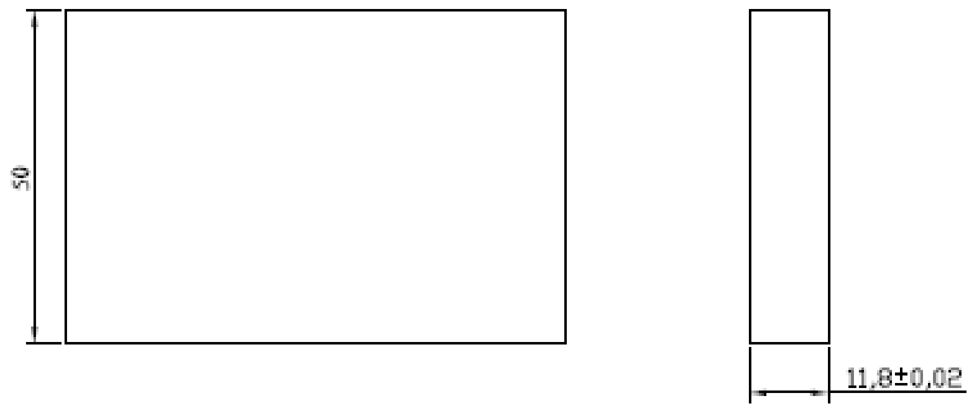
Applications

- The Grinding operations are mainly used for the applications are described as follows

I) Surface finishing ii) slitting & parting iii) De scaling, de burring IV) Stock removal finishing of flat as well as cylindrical surface



Before Grinding



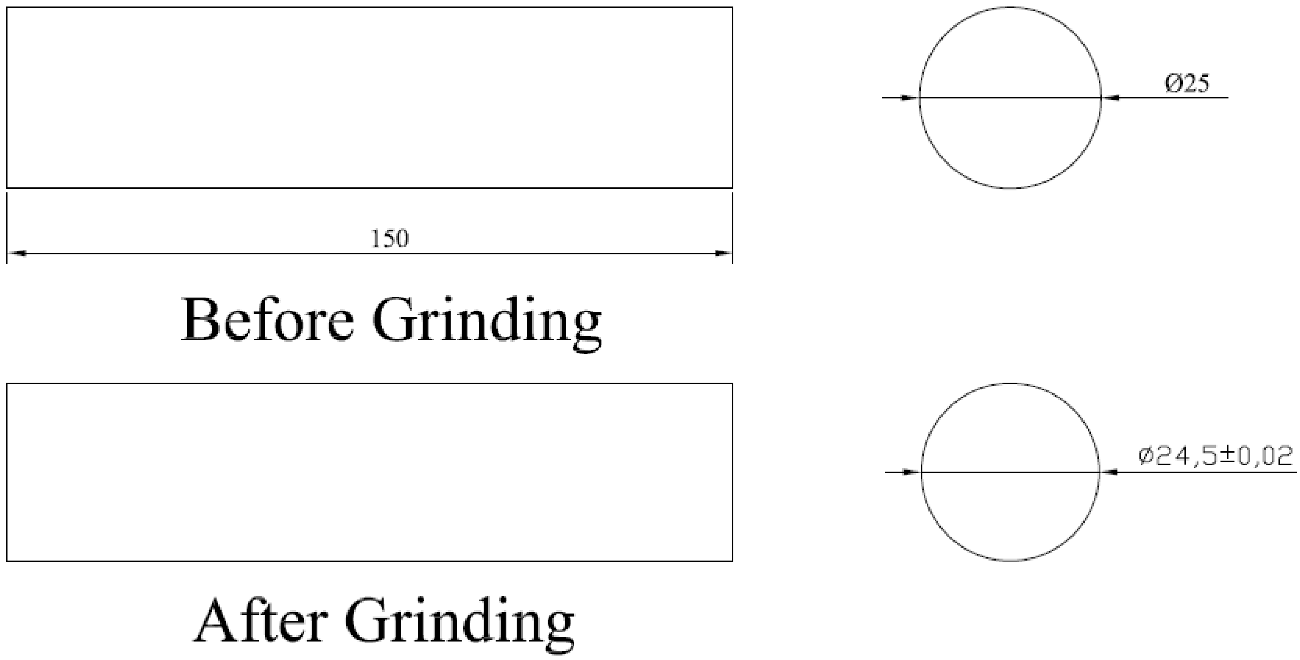
After Grinding

Ex. No:12

PLAIN SURFACE GRINDING

Date:

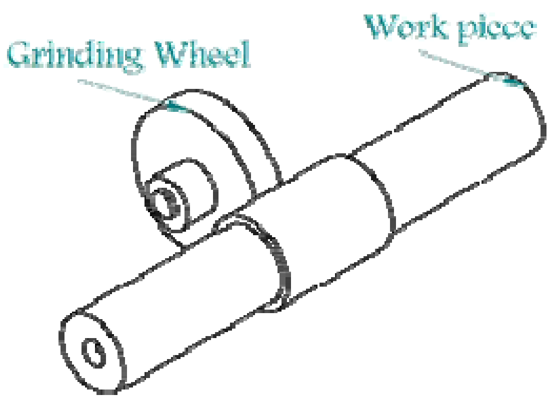
- **Aim:** To perform plain surface grinding on the given work piece to the required dimensions
- **Apparatus required:**
  - Grinding machine
  - Grinding Wheel
  - Vernier Calliper
- **Material Required:**
  - MS / CI plate 12mm X 50mm X 75mm
- **Procedure:**
  - First the work piece is placed on the magnetic chuck
  - The positioning of the work piece is aligned at right angles to the grinding wheel and exactly parallel to the sides of the magnetic chuck by using slip gauges if necessary
  - The magnetic chuck is switched on and the powerful electromagnet holds the job firmly in position
  - Now the spindle is turned on and the grinding wheel is just touched the work piece surface to mark its zero / reference position
  - Now the required feed, either totally or in steps, is given to the grinding wheel and the wheel is traversed all over the work piece
  - Same procedure is repeated until the required dimensions are achieved
  - Care should be taken for maintaining the surface finish
  - Finally the dimensions are checked using either a Vernier calliper or a screw gauge



- **Result:** Thus plain surface grinding is performed on the given work piece up to the required dimensions

Ex.No:11 **CYLINDRICAL GRINDING**

- **Aim:** To grind the cylindrical surface of the given work piece by cylindrical grinding
- **Apparatus Required:**
  - Grinding machine
  - Cylindrical grinding wheel setup
  - Steel Rule
  - Vernier Calliper
- **Materials Required:**
  - Cast iron work piece
- **Procedure:**
  - First the given work piece is preliminarily finished to the pre-required dimensions on a lathe before beginning the grinding process
  - Now the work piece is fitted in the chuck of the cylindrical grinding machine
  - The grinding wheel is just touched with the work piece and is taken as the zero reference
  - Coolant circulation is switched on and the grinding wheel is engaged with the work piece
  - Both the work piece and the grinding wheel roll on contact with each other like two gears in mesh
  - Now slowly the wheel is moved over the entire length of the work piece to get the grinded finish
  - After one feed is over, the grinding wheel is moved further towards the axis of the work piece and the process is repeated until the required dimensions are achieved
  - Finally the dimensions are checked using a Vernier calliper



Result: Thus cylindrical grinding is performed on the given work piece to the given dimensions

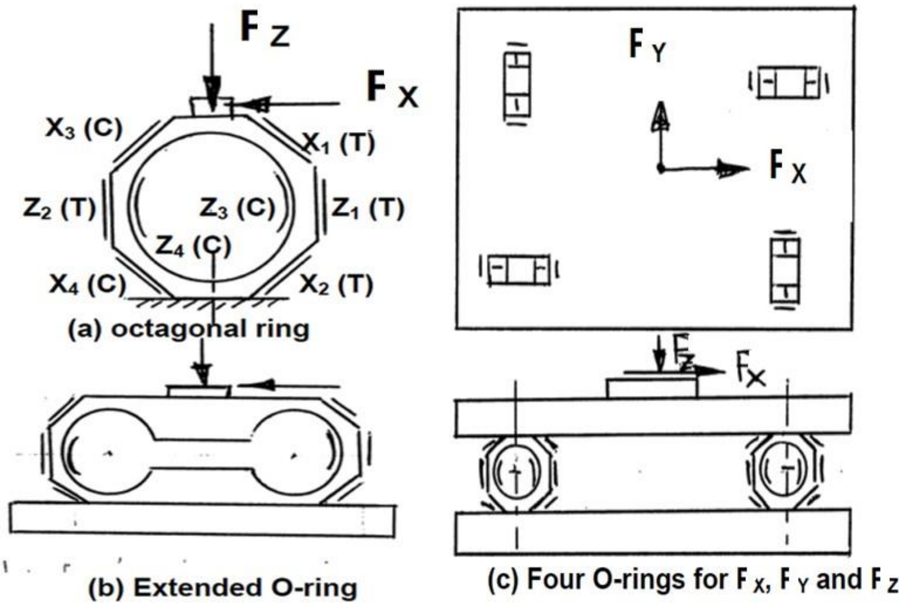
Ex.No: **LATHE CUTTING FORCE MEASUREMENT**

Date:

- **Aim:** To measure the principal forces in orthogonal machining by lathe tool dynamometer
- **Apparatus Requires:**
  - Centre lathe
  - Cutting tool with carbide tip insert
  - Lathe tool Dynamometer

    (i) Sensing Unit (ii) Force Indicator Unit (iii) Connecting wires
- **Material Required:**
  - MS / CI work piece for which the principal cutting forces of machining are to be measured
- **Procedure:**
  - The tool on which the dynamometer is to be mounted is first fixed on the tool post of the lathe
  - Next the dynamometer is inserted via the cutting edge and is pushed and made square with the tool post, resting suspended on the tool itself through the slot on the dynamometer
  - Now the dynamometer setup is tightened so that any further movement / deflection of the tool body will activate the strain gauges and will give output
  - Now the sensing unit of the dynamometer is connected to the force indicator unit with the help of the connecting wires
  - First the lathe is switched on and the carbide tip of the tool is just made to touch the work piece surface very gently and the force indicator setup is calibrated to read zero
  - Now the machining is carried out and the corresponding values of the principal forces cutting force (F_C) and Thrust force (F_T) are noted down
  - The same experiment is repeated for various depth of cuts and cutting speeds and the values of the corresponding principal forces are tabulated

- **Result:** Thus the principal forces F_C and F_T turning in lathe are measured using a dynamometer and the results are tabulated



Milling force measurement – strain gauge octagonal ring setup

Cutting force measurement Tabulation:

S.No	Depth of cut (mm)	Speed (RPM)	F_X KgF	F_Y KgF	F_Z KgF
1	0.2mm				
2	0.5mm				
3	0.8mm				

Ex. No: **MILLING – CUTTING FORCE MEASUREMENT**

Date:

- **Aim:** To measure the cutting forces in milling process using a side milling cutter
- **Apparatus Required:**

i) Horizontal milling machine ii) Side Milling cutter iii) Milling dynamometer

- **Material Required:**
- MS or CI work piece of required dimensions
- **Procedure:**
- The principal difference between the lathe tool dynamometer and the milling dynamometer is that, in a lathe the tool is stationary whereas in the milling machine the tool is rotating cutter
- Hence here the dynamometer sensing unit cannot be fixed to the tool but could be fixed to the work piece that is stationary
- Work piece is kept on a platform which is mounted over four octagonal rings as shown in figure
- The octagonal ring is mounted with a strain gauge for measuring transverse force and one for measuring radial force.
- In total the setup has four octagonal rings place in strategic positions as shown in the figure. Hence in total there are four strain gauges measuring transverse force and four for measuring radial force
- As the milling process proceeds, forces in all the three directions are measures by summing up the data from all the strain gauges and taking average
- The results are displayed in the force indicator unit of the dynamometer
- The experiment is repeated for various feeds, cutting speeds and depth of cuts
- The cutting forces in all three directions are tabulated

- **Result:** Thus the cutting forces involved in milling operation have been measured using a dynamometer