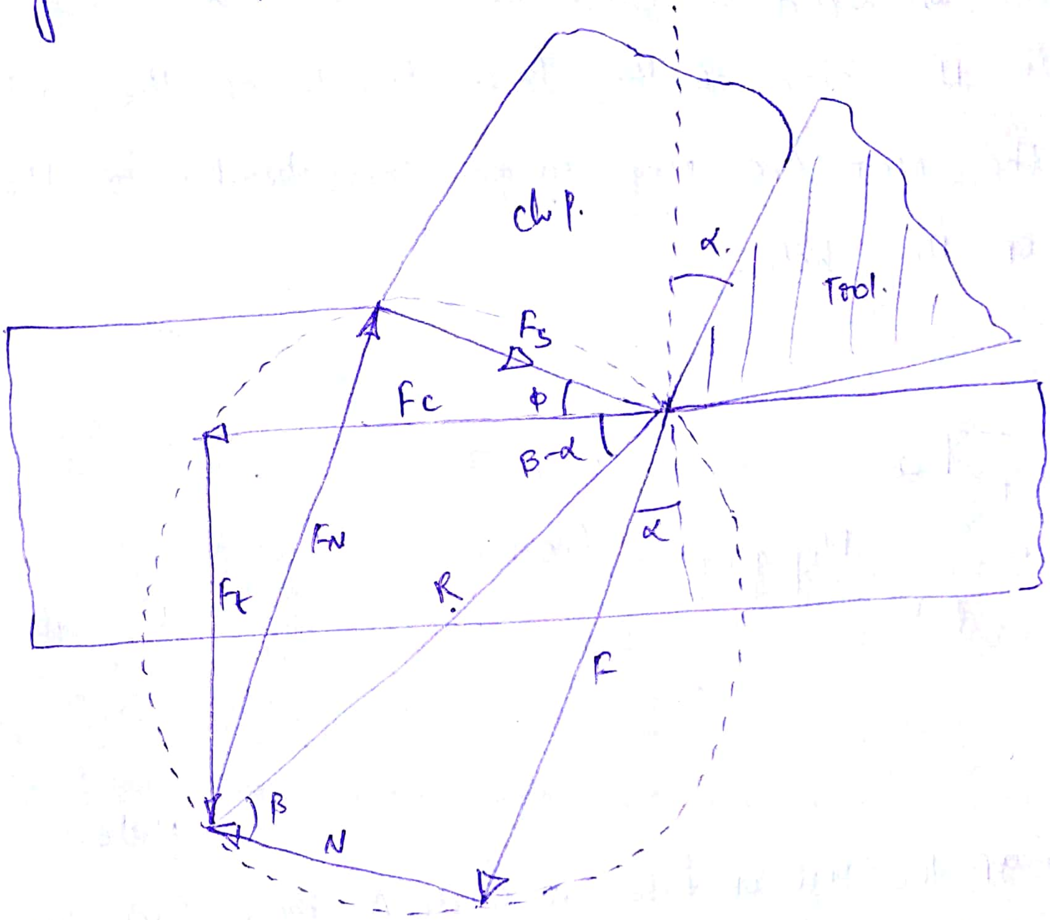
1 (a)

In orthogonal cutting process different type of forces acting on chip.



Fc ⇒ cutting force

Ft ⇒ Thrust force

F ⇒ ~~shear~~ Friction Force

N ⇒ Normal force to Friction

Fs ⇒ shear force in shear Plane

FN ⇒ Normal force on shear Plane.

Power for metal cutting $\boxed{(P_{kw}) = F_c \times V}$

Fc ⇒ cutting force involved in power consumption

1 (b)

Given:

Taylor's equation $VT^{0.13} f^{0.6} d^{0.3} = C$

$T_1 = 60 min$
$V_1 = 40 m/min$
$f_1 = 0.25 mm/rev.$
$d_1 = 2 mm$

$T_2 = ?$
$V_2 = 40 \times 1.25 = 50 m/min$
$f_2 = 0.25 \times 1.25 = 0.3125 mm/rev$
$d_2 = 2 \times 1.25 = 2.5 mm$

$$V_1 T_1^{0.13} f_1^{0.6} d_1^{0.3} = V_2 T_2^{0.13} f_2^{0.6} d_2^{0.3}$$

$$40 \times 60^{0.13} \times 0.25^{0.6} \times 2^{0.3} = 50 \times T_2^{0.13} \times 0.3125^{0.6} \times 2.5^{0.3}$$

$$T_2^{0.13} = \frac{40 \times 60^{0.13} \times 0.25^{0.6} \times 2^{0.3}}{50 \times 0.3125^{0.6} \times 2.5^{0.3}}$$

$$T_2^{0.13} = \frac{36.499}{32.7530} = 1.1143$$

$$T_2 = (1.1143)^{\frac{1}{0.13}}$$

$$\boxed{T_2 = 2.3 min}$$

2 (a)

Types of chip:

(1) Continuous chip
(2) Discontinuous chip
(3) Continuous chip with BUE.

1) Continuous chip:
- Continuous chips are formed when machining ducti materials (low carbon steel, mild steel, copper, Aluminum, etc) with a cutting tool of large rake angle and sharp cutting edge.
- chip flows off the tool face in the form of a ribbon.
- High cutting speed, small feed & depth of cut, & low friction are favorable condition for formation of continuous chip.
- Long chip can cause problems of chip disposal.

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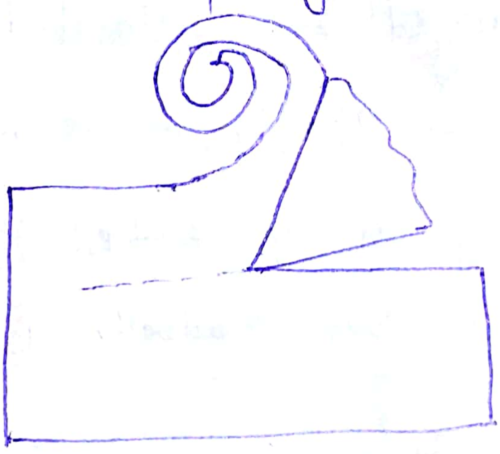
(2) Discontinuous chip:

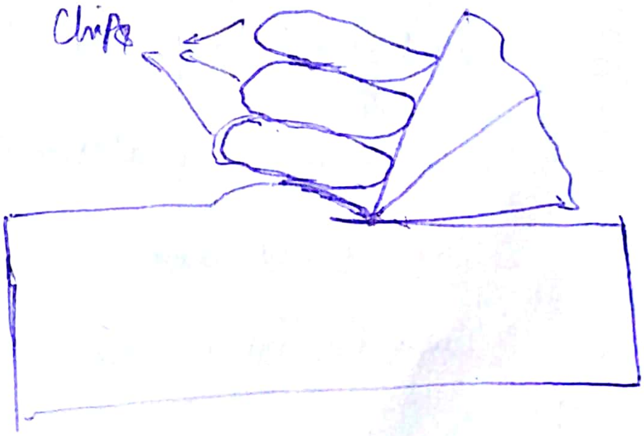
- This type of chip is produced when machining brittle material, such as cast iron and bronze, with a cutting tool having low rake angle.
- The following factors favors the formation of discontinuous chip

  1. Low or Medium cutting speed
  2. Large feed and depth of cut
  3. Absence of cutting fluid.

- Chips are broken into small segments instead of plastic flow of chip along tool face.
- The discontinuous chips may also result if the material is ductile and the coefficient of friction between chip and tool is very high.



Continuous chip



Discontinuous chip.

(3) Continuous chips with Built up edge (BUE)

- Continuous chip with BUE are formed when machining ductile metals with a cutting tool of smaller rake at Medium ~~Cutting~~ cutting velocity.

Condition for BUE :

- Ductile work material.
- cutting velocity is Medium
- Medium feed.
- cutting fluid absent or inadequate

- In machining ductile materials like steels with long chip tool contact length (small rake angle), lots of stress and temperature develops in the secondary deformation zone at the chip tool interface

- under such high stress and temperature in between two clean Metal surfaces, strong bonding may locally takes place due to adhesion similar to welding.

- Such bonding will be encouraged and accelarated if the chip-tool materials have mutual affinity or solubility. The weldment starts forming as an embryo at the most favorable location and thus gradually grows.

- with the growth of BUE, the force F also gradually increase due to wedging action of the tool tip along with the BUE formed on it.

(2) (b) Given:

$d = 0.25mm$ $\quad$ $V = 40 m/min$

$b = 4mm$ $\quad$ $F_c = 1150N$

$r = 0.45$ $\quad$ $F_t = 140N$

$\alpha = 10^\circ$

$\phi = ?$, $\beta = ?$, $F_s = ?$, $P_{power} = ?$

$$\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha}$$

$$\tan\phi = \frac{0.45 \times \cos 10^\circ}{1 - 0.45 \sin 10^\circ} = \frac{0.44316}{0.92185}$$

$$\boxed{\phi = 25.67^\circ}$$

$$\tan\beta = \frac{F}{N}$$

$$\beta = \tan^{-1}\left(\frac{F}{N}\right)$$

$$F = F_c \sin\alpha + F_t \cos\alpha = 1150 \times \sin 10^\circ + 140 \times \cos 10^\circ$$

$$F = 199.69 + 137.87$$

$$F = 337.56N$$

$$N = F_c \cos\alpha - F_t \cdot \sin\alpha = 1150 \times \cos 10^\circ - 140 \sin 10^\circ$$

$$= 1132.52 - 24.31$$

$$= 1108.21N$$

$$\beta = \tan^{-1}\left(\frac{337.56}{1108.21}\right)$$

$$\boxed{\beta = 16.94^\circ}$$

$$F_s = F_c \cos\phi - F_t \sin\phi$$

$$= 1150 \times \cos 25.67 - 140 \times \sin 25.67$$

$$= 1036.499 - 60.64$$

$$\boxed{F_s = 975.85N}$$

$$P = F_c \times V = 1150 \times \frac{40}{60} \left(\frac{N\text{-}m}{s}\right) = 766.67\,W$$

$$\boxed{P = 0.76667 kW}$$

3 (a)

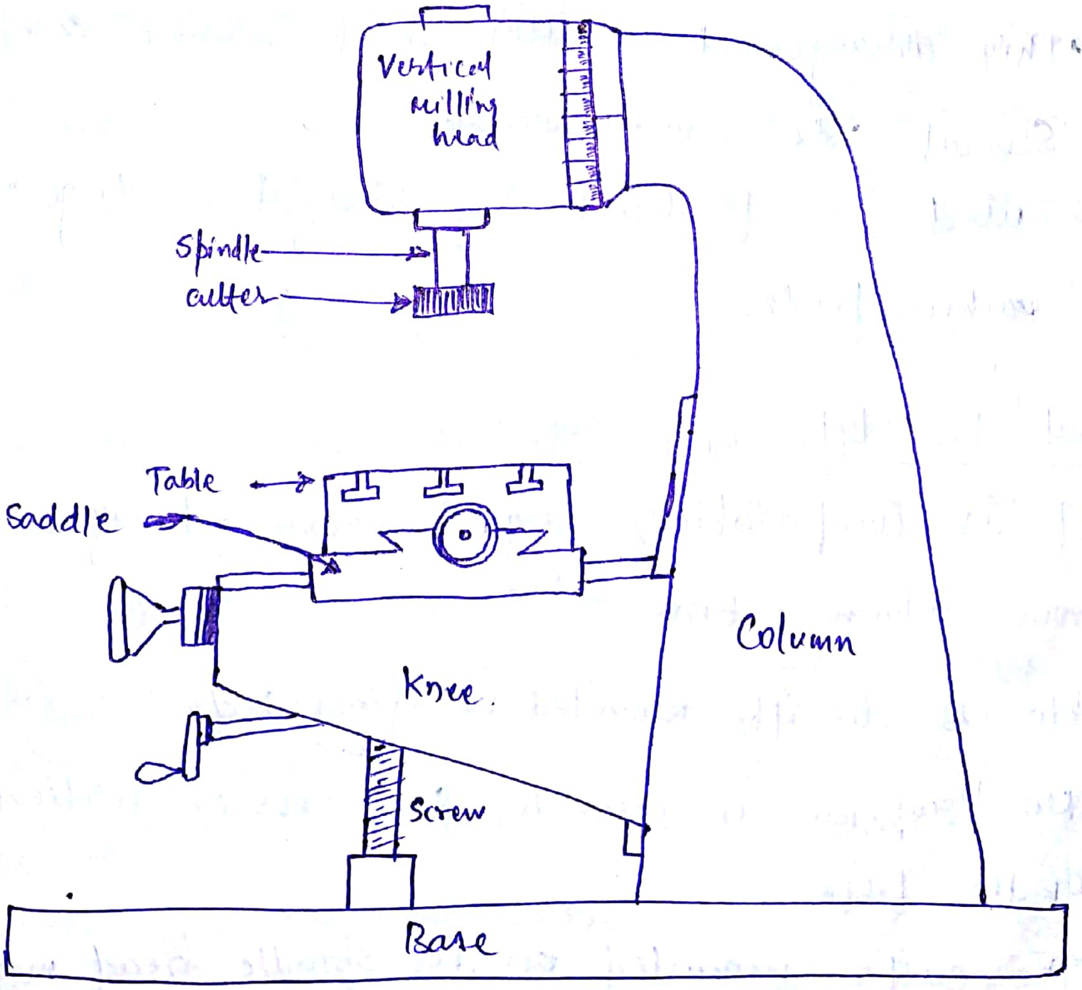
: Milling Machine:

"It is a metal cutting operation in which the excess material from the workpiece is removed by rotating multipoint cutting tool called milling cutter."

- A milling machine is a machine tool that removes metal as the work is fed against a rotating multipoint cutter. The milling cutter rotates at high speed and it remove metal at a very fast rate with the help of multiple cutting edges.
- One or more number of cutter can be mounted simultaneously on the milling machine. This is the reason that a milling machine finds wide application in Production work.
- used for Machining flat surfaces, contoured surfaces, external and internal threads.
- As the workpiece moves against the cutting edge of milling cutter, metal is removed in form of chips.
- Machined surface is formed in one or more passes of the work.
- The work to be machined is held in a vice, a rotary table, a three jaw chuck, an index head, in a special fixture or bolted to machine table.

(2) Vertical Milling M/C :

- Spindle is vertical or perpendicular to the work table
- It has all movements of the table for proper setting and feeding the work
- Spindle head may be swivelled at an angle, permitting the milling cutter mounted on the spindle to work on angular surfaces.
- In some machines spindle can also be adjusted up or down relative to the work.
- Adopted for machining grooves, slots, and flat surfaces.



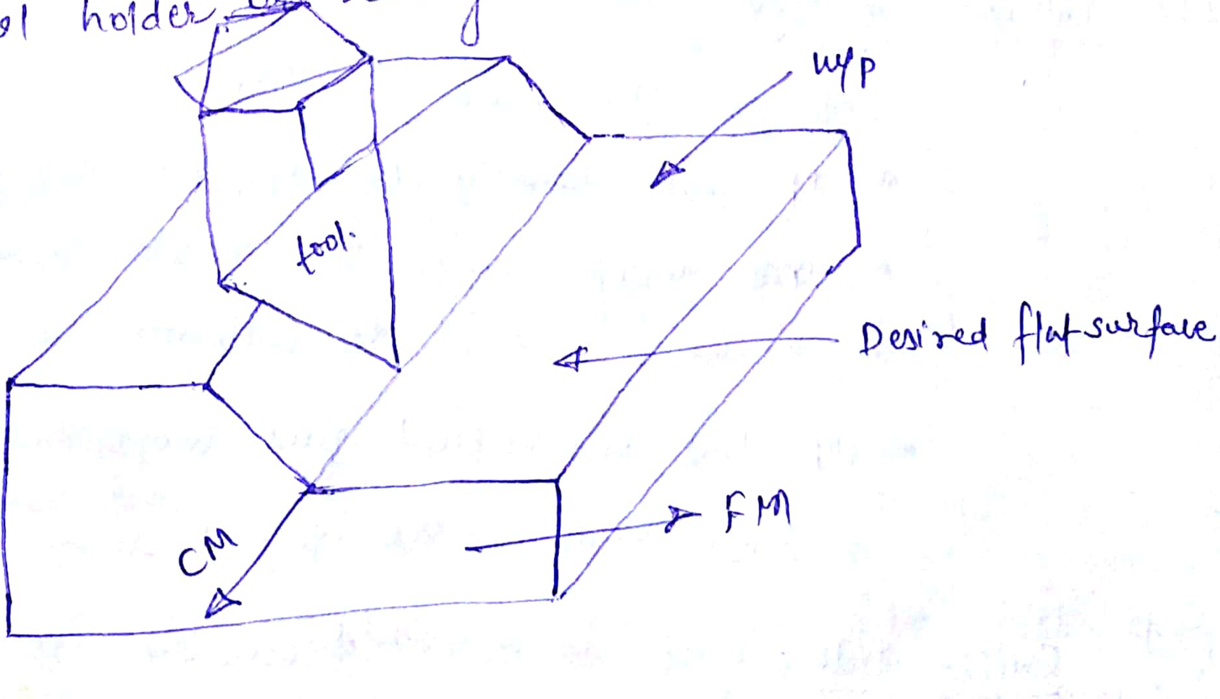
3 (b)

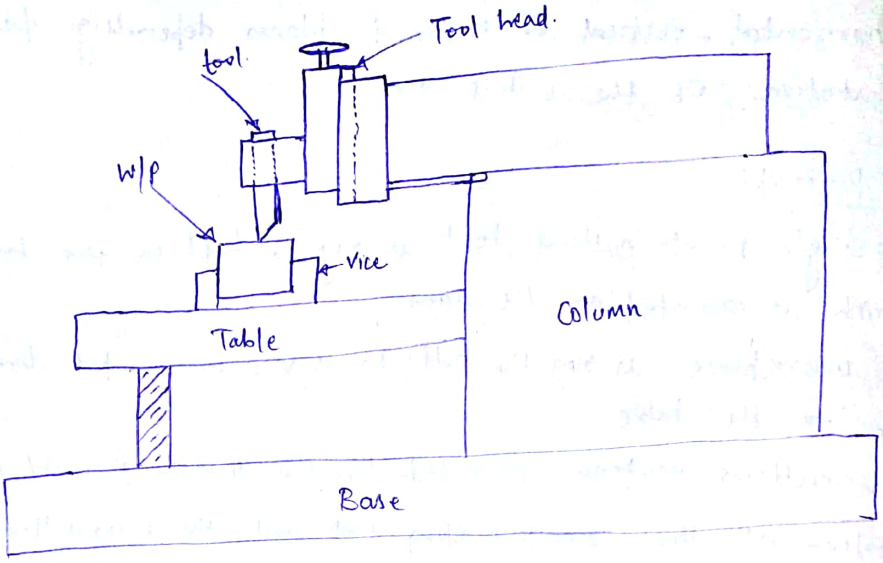
' Shaper machine:

- Shaper is a machine tool which produces flat surfaces in horizontal, vertical or inclined planes depending upon the orientation of the cutting tool.

Working Principle:

- A single point cutting tool is rigidly held in the tool holder, which is mounted on the ram.
- The workpiece is rigidly held in a vice or clamped directly on the the table
- The cutting motion provided by the linear forward motion ~~motion~~ of the reciprocating tool and the intermittent feed motion provided by the slow transverse motion of the job along with the bed results in ~~the~~ producing a flat surface by gradual removal of excess material layer by layer in the form of chips.
- The vertical depth of cut is given either by descending the tool holder ~~or~~ raising the bed or both.





Main Parts of a shaping M/c

(1) **Base:** It is made of cast iron, Provides support for other parts of machine

(2) **Column:**
- Box type casting mounted vertically on the top of the base.
- It has ~~two~~ guide ways on top over which ram reciprocates. The reciprocating Mechanism is housed inside the column.
- It has one vertical guide ways in front over which a cross-slide moves up and down

(3) **Cross-slide:**
- It is mounted on the front vertical guide ways.
- The table can be lowered or raised by adjusting the cross-rail.

(4) **Table:** Mounted on a saddle which is located above the Cross. rail. Top and sides are accurately machined and have T Slots.

(5) **Ram:** supports tool head on its front. It reciprocates on accurately Machined guideways on the top of column

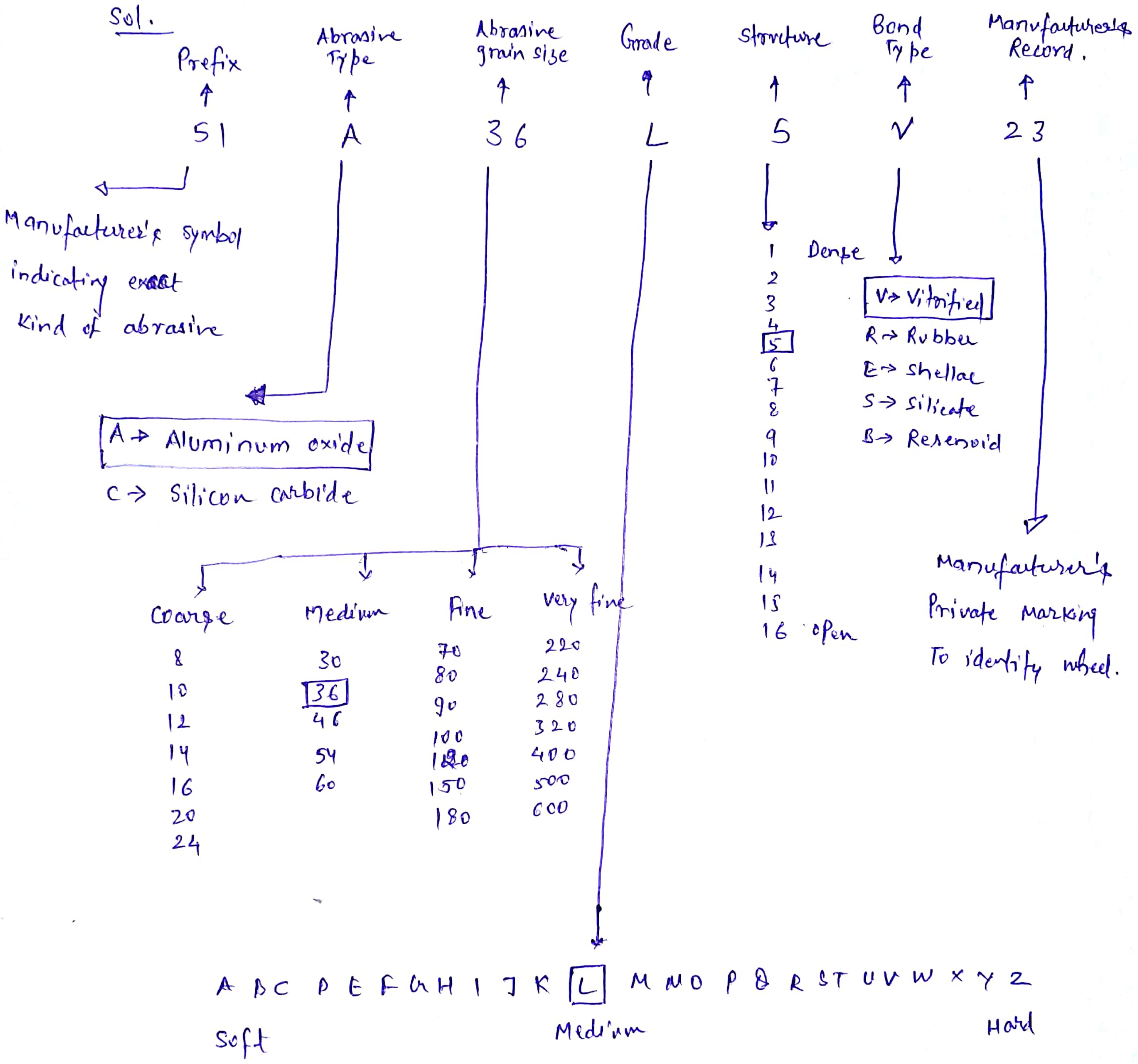
(6) **Tool head:** Fitted on the face of ram. Holds the tool rigidly
- Provide vertical and angular feeds for the tool.
- Tool head can be positioned at any angle.

Q-4 (a)

Grinding wheel designation

51 A 36 L 5 V 23

Sol.



Prefix ↑ 51

Manufacturer's symbol indicating exact kind of abrasive

Abrasive Type ↑ A

A → Aluminum oxide

C → Silicon carbide

Abrasive grain size ↑ 36

Coarse	Medium	Fine	Very fine
8	30	70	220
10	36	80	240
12	46	90	280
14	54	100	320
16	60	120	400
20		150	500
24		180	600

Grade ↑ L

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Soft Medium Hard

Structure ↑ 5

1 Dense
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16 open

Bond Type ↑ V

V → Vitorified
R → Rubber
E → Shellac
S → Silicate
B → Resenoid

Manufacturer's Record. ↑ 23

Manufacturer's Private Marking To identify wheel.

Abrasive Type :- (A) Aluminum oxide

Abrasive grain size :- (36) Medium grain size

Grade :- (L) → Medium Hardness of bond/strength

Structure :- (5) → Little Dense ~~Medi~~ (i.e. Porosity of wheel is little dense

Bond Type :- (V) → Vitorified type bond is used.

4 (b)

Capstan Lathe	Turret lathe
• It is light duty Machine	• It is a heavy duty machine
• The turret head is mounted on the ram and the ram is mounted on the saddle	• The turret head is directly mounted on the saddle and the saddle slides over the bed ways.
• The saddle will not moving during Machining	• The saddle is moved along with the turret head during machining
• The length wise movement of turret is less.	• The Length wise movement of turret is more
• Short workpieces only can be machined	• long w/ps can be machined
• It is easy to move the turret head as it slides over the ram.	• It is difficult to move the turret head along with saddle
• As the construction of the lathe is not rigid, heavy cut cannot be given	• As the construction of lathe is rigid, heavy cut is given
• It is used for machining w/p upto 60mm diameter	• It is used for machining w/p upto 200mm diameter
• Collet is used to hold the workpiece	• Jaw chuck is used to hold the work pieces.

(5) (a) Given:

60 H8/C8

Basic size:- 60mm

$D_1 = 50$mm

$D_2 = 80$ mm

upper deviation of shaft: $C = -(95 + 0.8D)$ um .

$IT8 = 25i$

$i = 0.45\sqrt[3]{D} + 0.001D$

Size of hole:

$D = \sqrt{D_1 D_2} = \sqrt{50 \times 80}$

$= 63.24$ mm

$i = 0.45 \times \sqrt[3]{63.24} + 0.001 \times 63.24$

$= 1.7928 + 0.06324$

$i = 1.856$ um

Tolerance ~~upper deviation~~ of hole = 25×1.856

$= 46.4$ um $= 0.0464$ mm

lower deviation of hole = 0 um

Size of shaft:

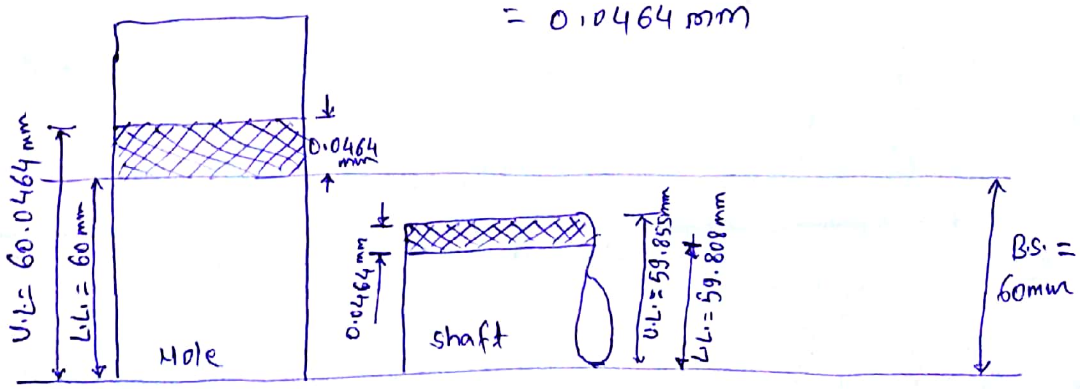
upper deviation of shaft = $-(95 + 0.8 \times 63.24)$ um

$= -0.145$ mm

Tolerance for shaft = $25i$

$= 25 \times 1.856$

$= 0.0464$ mm



5 (b)

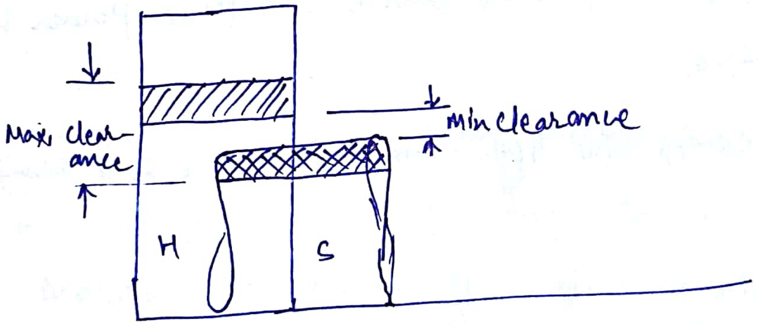
A fit may be defined as the degree of tightness and looseness between two meting parts.

Type:

(1) clearance fit
(2) Transition fit
(3) Interference fit

Clearance fit: An air space or clearance exists between the shaft and hole.

- Such fit give loose joint
- A clearance fit has positive allowance, i.e. there is minm positive clearance b/w high limit of shaft and low limit of hole



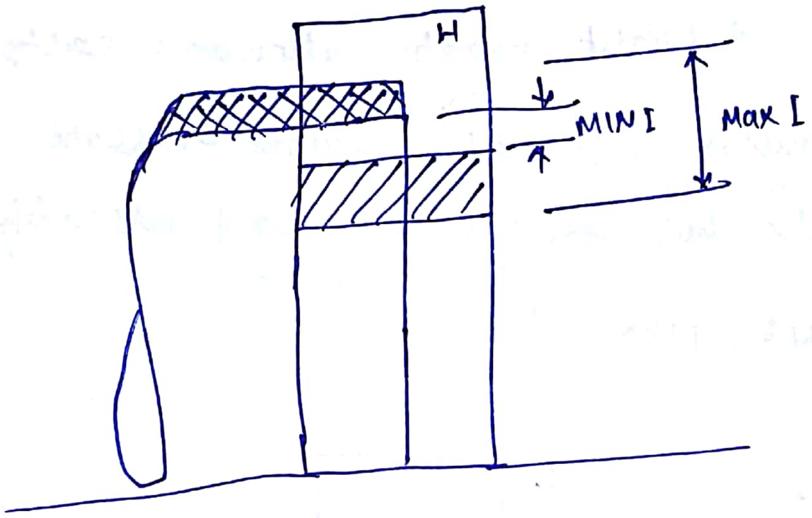
Max C. = UL of hole - Low limit of shaft

Min C = LL of hole - U.L. of Shaft.

(2) Interference fit: A negative difference between b/w diameter of hole and the shaft is called interference

- In such cases, the diameter of the shaft is always greater than the hole diameter
- It is used for components where motion, power has to be transmitted.
- Interference exists b/w high limit of hole & low limit of shaft.

Types:

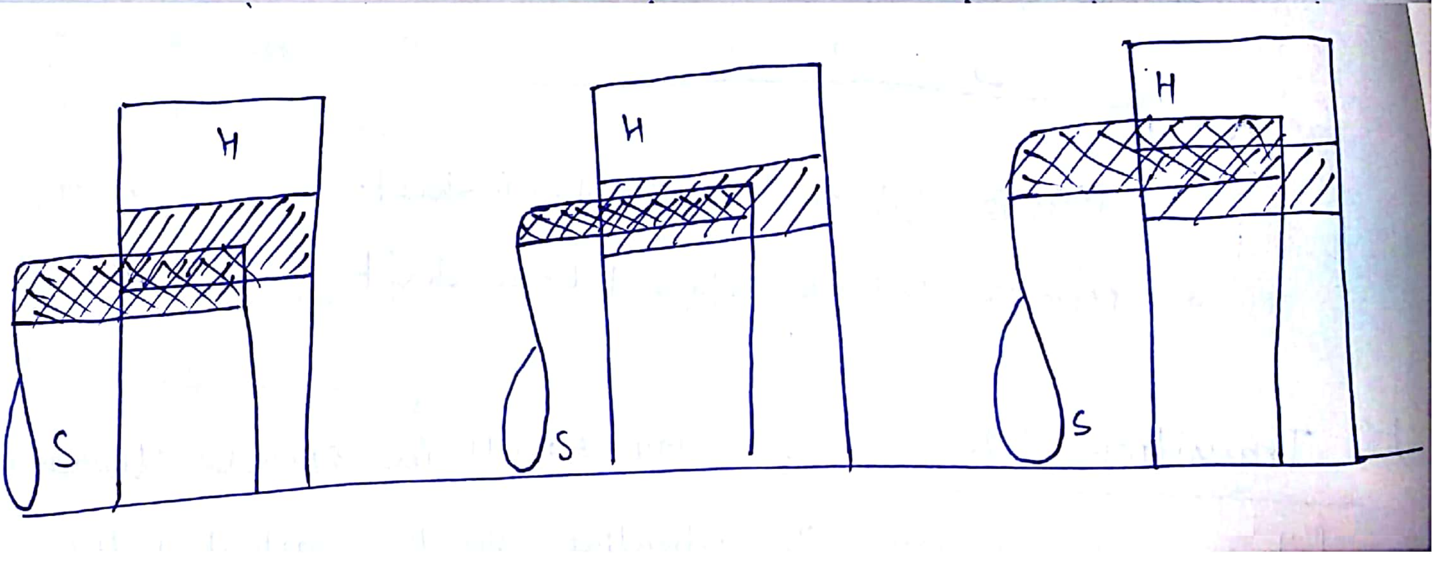


Max I = L.L of hole − U.L. of Shaft

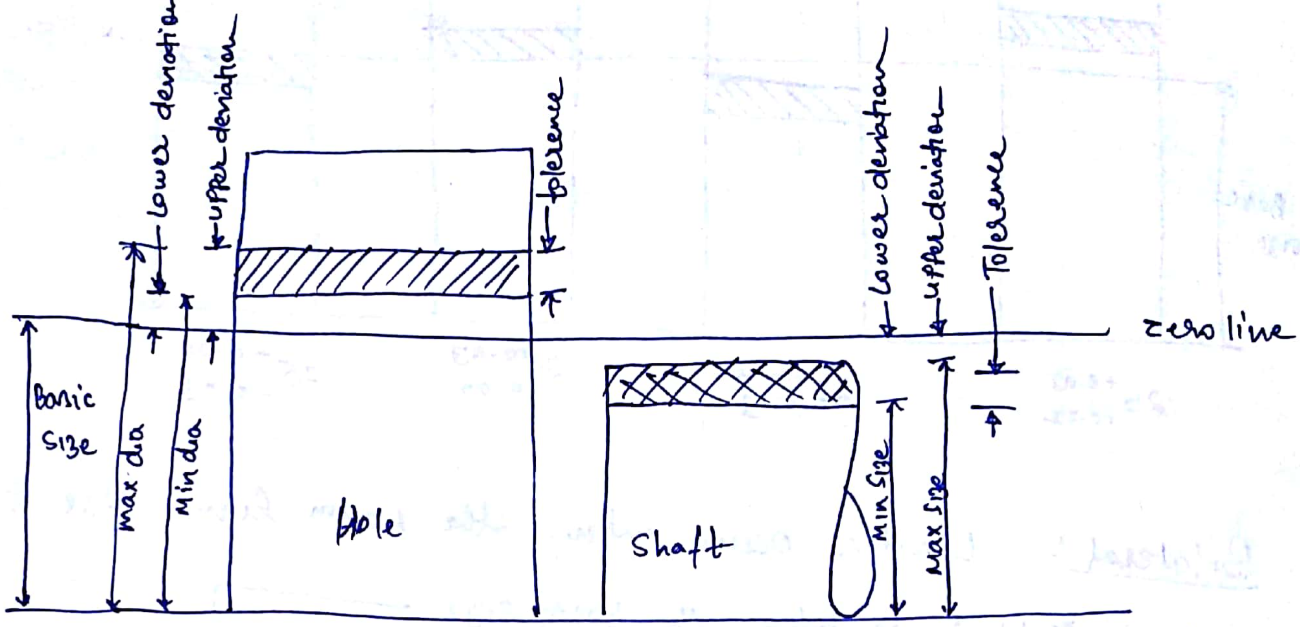
Min I = U.L of hole − L.L of shaft

3) **Transition fit:** It may result in either clearance fit or interference fit depending on the actual value of the individual tolerences of mating parts.

- It is compromise b/w clearance and interference fit
- They are used for applications where accurate location is important but either a small amount of clearance or interference is permissible



6 (a)



Nominal Size: Size of a part specified in drawing

Basic Size: Size of a part to which all limits of variations are applied.

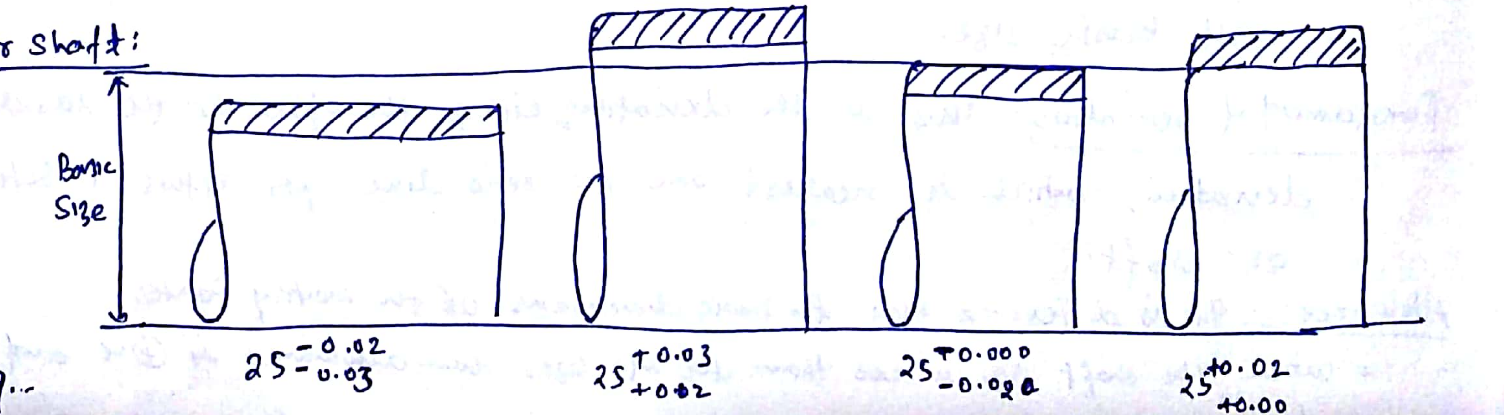
Limits: There are two extremes permissible sizes for a dimension of the part. The largest permissible size for a dimension is called upper or max^m limit., whereas smallest size is known as lower or min^m Limit

Tolerence: It is the difference b/w upper limit & lower limt.

- The Tolerence may be unilateral or bilatral.

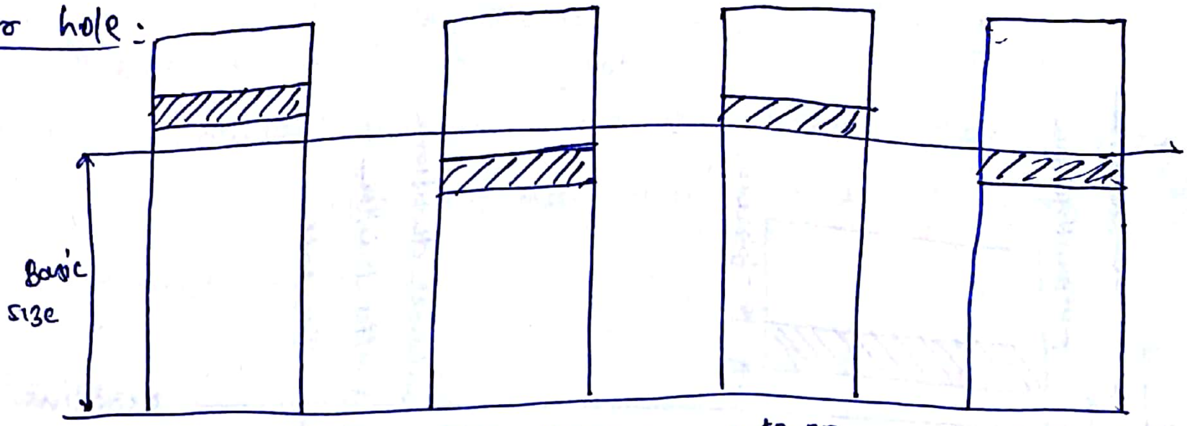
(i) **unilateral:** It occurs when both Max^m limit and Minimum limit are either above or below the basic size

for Shaft:



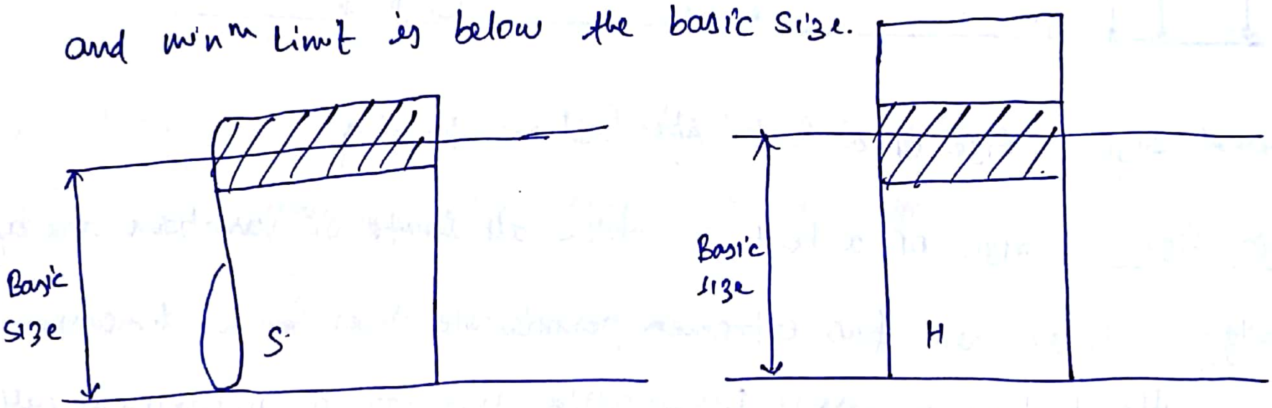
g..

For hole:



E.g. $25^{+0.03}_{+0.02}$ $25^{-0.02}_{-0.03}$ $25^{+0.03}_{+0.00}$ $25^{-0.00}_{-0.03}$

(2) **Bilateral:** Limits occur when the max^m limit size is above and min^m Limit is below the basic size.



$25^{+0.03}_{-0.02}$ $25^{+0.03}_{-0.02}$

Zero line: A straight line Corresponding to the basic size. The deviations are Measured from this line.

Upper Deviation: It is the algebric difference b/w the Max^m size and basic size

Lower deviation: It is the algebric difference between min^m size and basic size.

Fundamental Deviation: This is the deviation, either the upper or the lower deviation, which is nearest one to zero line for either a hole or shaft.

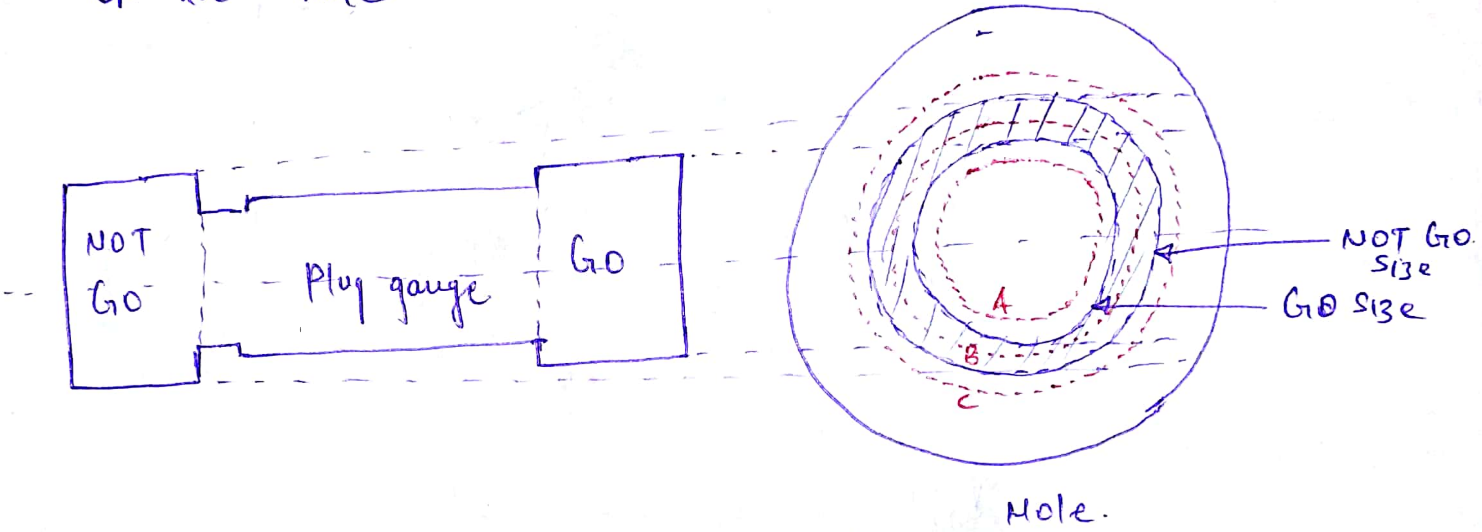
Allowance: It is difference b/w the basic dimensions of the mating Parts.

- when the shaft size is less than the hole size, then allowance is ⊕ve and when the shaft size is greater than hole size then the allowance is ⊖ve.

6 (b)

Plug gauge:

- It is used to check the holes. The GO Plug gauge is the size of the low limit of the hole while the NOT GO plug gauge corrosponds to the high limit of the hole.



E.g.- • If the size of hole is circle A then GO Plug gauge do not enter so this job (hole) is rejected.

- If the size of hole is circle B then the GO Plug gauge enter into hole and NOT-GO Plug gauge donot enter into hole. so this hole (or job) is selected.
- If the size of hole is circle C then GO Plug gauge enters into hole but NOT GO Plug gauge also enters. so this hole (or job) is rejected.

Snap gauge: It is used for gauging the shaft and male components. The GO Snap gauge is of a size corresponding to the high limit of the shaft, while the NOT-GO gauge corresponds to the low limit.

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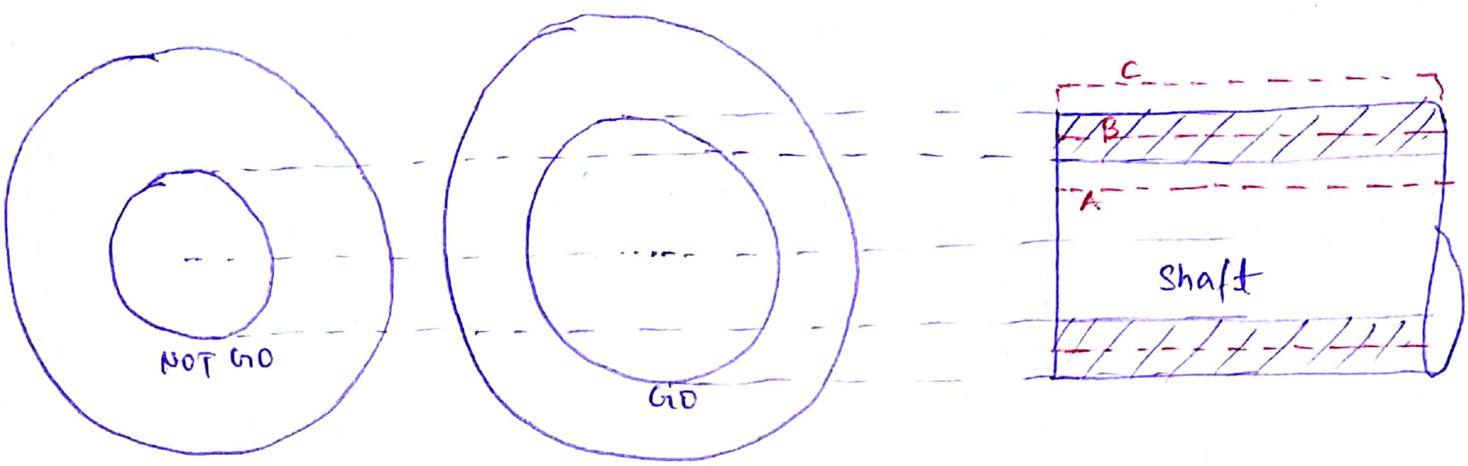

Snap gauge

E.g. :-

- when size of shaft A is inspected by snap gauge, The GO ~~Plug~~ Snap gauge enters and NOT-GO snap gauge also enters, so the shaft is rejected.
- when size of shaft B is inspected by snap gauge, the GO snap gauge enters ~~into~~ to shaft and NOT GO do not enter to the shaft. So the shaft of size B is selected.
- when the size of shaft C is inspected by snap gauge, the GO snap gauge do not enter the shaft, hence the shaft is rejected.