and fringe thickness will keeps on ↑ in outward dirn. In case of concave, at the centre we will get alternatively white and black fringe.

28/9/2016

MACHINE TOOLS

* **ACCEPTANCE TEST** → Acceptance Tests are performed on the new machine before interacting into mass production. In dynamic Test, free cutting steels are machined at some standard speed, feed and depth of cut combination and if the dimension is within the toolerance & surface finish is also within some toolerable limit, machine is inducted to mass production.

- Dynamic Test — Free cutting steel
- Static Test (Alignment)

LATHE :- ① **Speed Lathe (1200-3600 rpm)** :- It is the initial m/c developed in the Lathe category. There is no carriage in the m/c and spindle, tailstock & toolpost are mounted on adjustable slide. only 2 to 3 cutting speeds are available for use.

② **Engine/Centre Lathe - $1\frac{1}{2}$ axis** :- There is carriage in this machine. over the carriage, there is cross-slide & over the cross-slide, there is Toolpost. It is $1\frac{1}{2}$ axis machine.

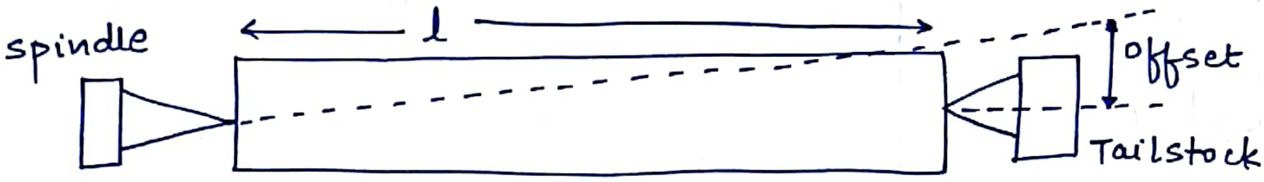
③ **Tool Room Lathe** :- This machine is similar to the engine lathe but varieties of cutting speeds are available for use. These lathes are used to optimize the cutting parameters.

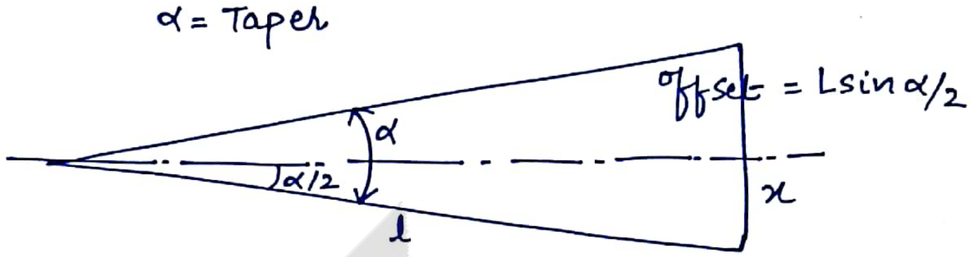
④ **Bench Lathe** :- These are small capacity Engine lathes meant for small size workpieces.

Collet → holds the W/P.

⑤ **Capstan and Turret lathe** :- In these machines there is no tailstock, and it is replaced by a hexagonal turret. At each and every phase of this turret, there is a Tool. So on such machines, 7 Tools can be mounted simultaneously. These are hard automated machines meant for small size workpieces.

Taper
① cross slide
② Tailstock offset



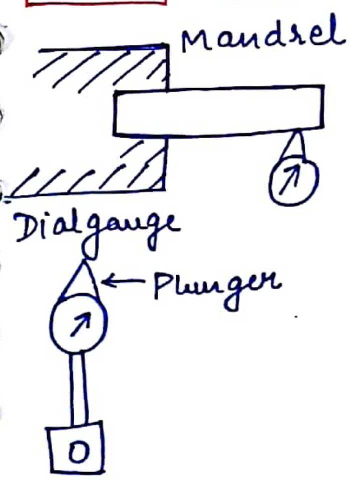


* Size of the Lathe is defined by :-
① distance b/w the live and the dead centre.
② Maximum swing diameter.
③ Height of spindle axis from Bed.

* Acceptance for a Lathe machine / Alignment Test :-

Test 1 :- whenever the bed is flat :- Bed area is divided into segments with segment size equal to size of spirit level. By keeping the spirit level from segment to segment, if the Bubble movement of spirit level is within some toolerable limit, bed is considered as Flat.

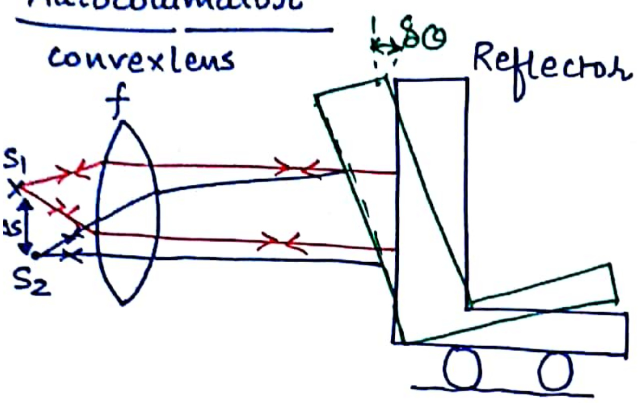
Test 2 :- Whether spindle axis is ∥ to the carriage movement :-



A mandrel is fitted in the spindle with plunger touching one of its corner. Base of the dial gauge is fixed over the carriage. By moving the carriage towards the spindle. If there is no variation in the dial gauge. It means spindle axis is ∥ to the carriage movement. It is not possible to have this error zero. so this error is permissible in the vertical dirn. and also towards the Tool. This permissible errors are < 0.03mm.

Test 3 :- Whether axis of work is parallel to the spindle axis:-

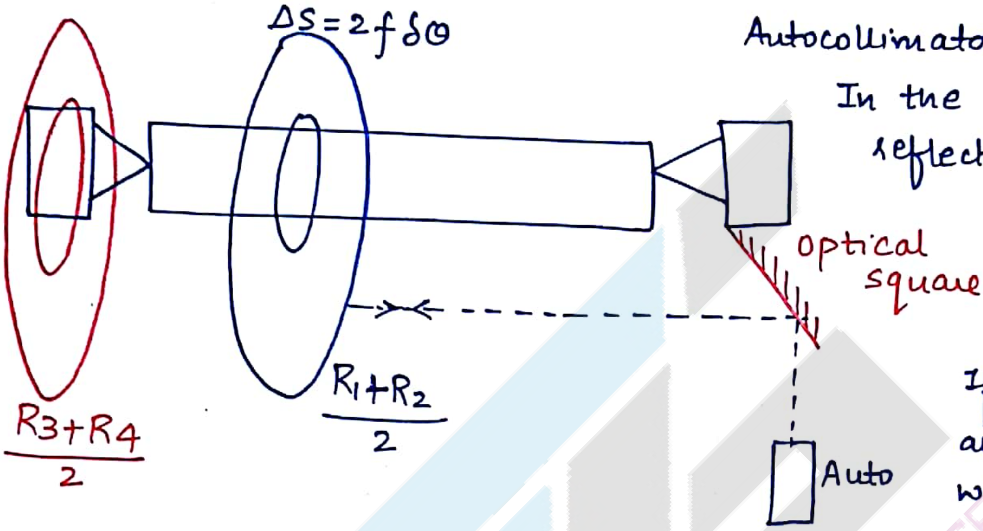
Autocollimator



large w/Ps has to be held b/w the headstock and Tailstock. In this ~~saturation~~ situation, work axis may not coincide with the spindle axis. Reflector of Autocollimator is initially placed on the work and with 180° phase difference, Autocollimator readings are taken.

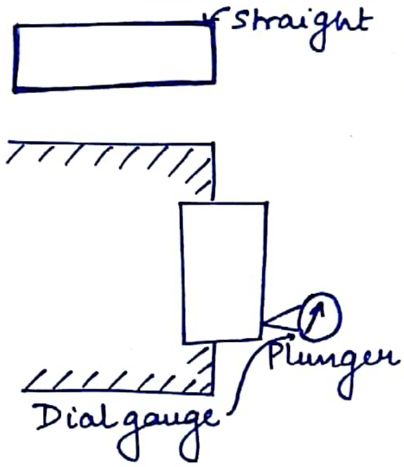
In the second setting, reflector is placed on the spindle and same experimentation is being repeated.

If both axis are parallel autocollimator readings will match.



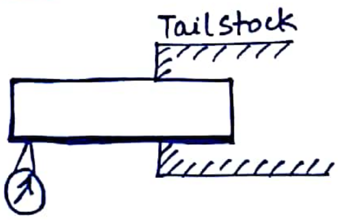
Test 4 :- Whether cross slide movements are perpendicular to the workaxis.

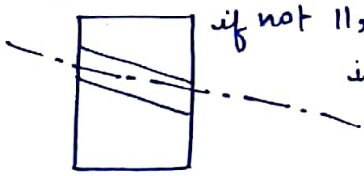
One straight edge is fixed in the spindle with plunger of dial gauge touching one of its side. Base of the dial gauge is fixed over the cross slide. ~~wh~~ By moving cross-slide, if there is no variation in the dial gauge, it means crossslide movements are normal.



Test 5 :- Whether Tailstock ~~with~~ quill

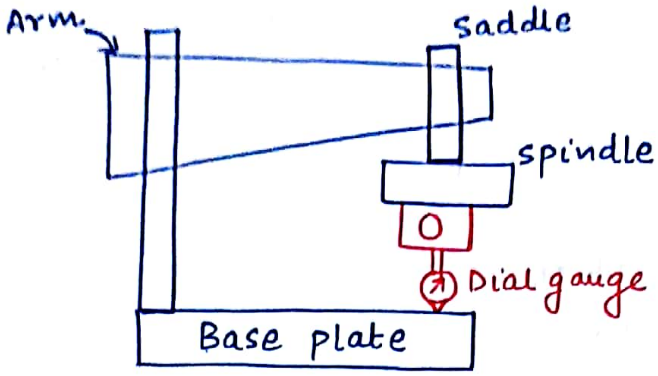
as in previous test no. 2, if tailstock is || to the axis of the quill.





if not ||, then hole is in inclined dirn.

* Radial Drilling M/C

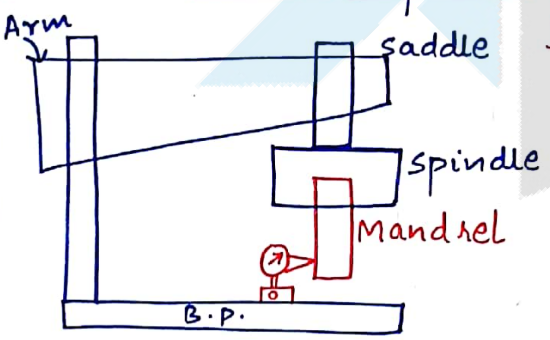


Test 1 :- Whether arm and saddle movements are parallel to the Base plate.

Base of the dial gauge is fixed over the spindle with plunger touching the Base plate. Initially, saddle is fixed and arm is rotated. If there is no variation in the dial gauge, it means arm movements are parallel.

In the second setting, arm is fixed and the saddle is moved over the arm. If there is no variation in the dial gauge, it means saddle movements are parallel.

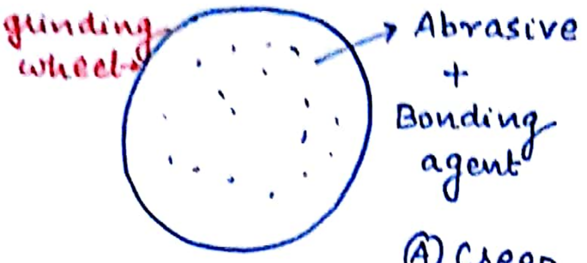
Test 2 :- Whether spindle axis is parallel to the drill axis and normal to the Base plate.



A Mandrel is fitted in the spindle with plunger of the dial gauge touching at the bottom. Base of the dial gauge will be on the base plate. By giving downward motion to the spindle, if there is no variation in the dial gauge. it means spindle axis is parallel to the drill axis.

GRINDING :-

R.S. parwar vol-1
⇩
Welding → CH-1
Read must



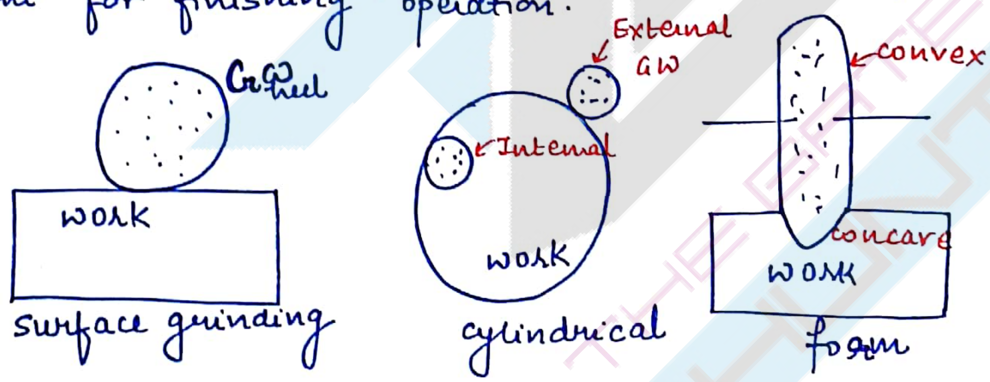
Infeed
Throughfeed

Ⓐ Creep feed grinding
infeed ↑ N ↓

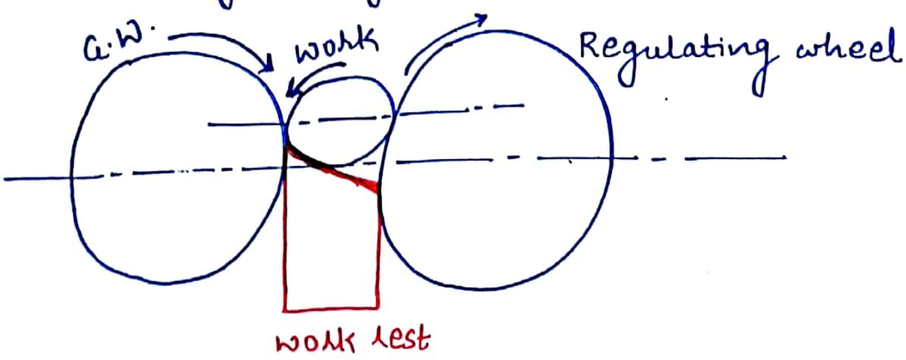
Ⓑ High speed grinding
infeed ↓ N ↑

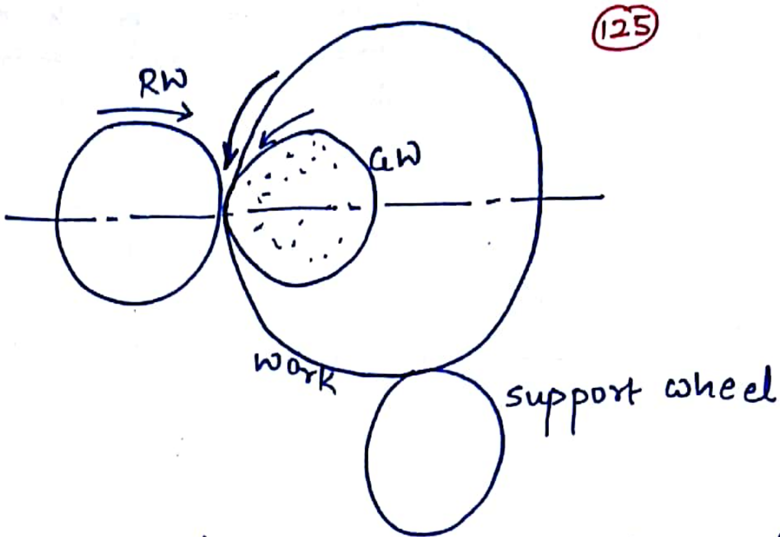
In feeds are feeds experienced by the grinding wheel normal to the surface of grinding wheel.

Through feed is feed experienced by the grinding wheel ∥ to the axis of wheel. In creep feed grinding, infeeds are high and speeds are low. and it is meant for Bulk material Removal that is Roughning operation. In high speed grinding, Infeeds are low and speeds are high and it is meant for finishing operation.



Centreless Grinding

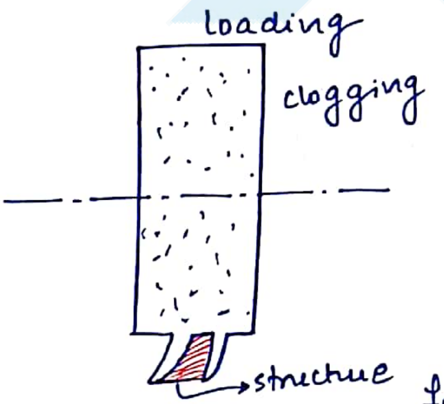




The process is used to m/c small size balls, fragile workpieces, rods and other symmetric parts. during the machining, w/p centre is not fixed. Work axis will always be slightly higher than the common axis of Regulating wheel and grinding wheel. Regulating wheel is slightly at an angle from the axis of grinding wheel. because force will always be normal to the surface of grinding wheel. One component of this force will be normal to the surface of grinding wheel and hence it provide infeeds. The other component of this force will be parallel to the axis of grinding wheel and it provides throughfeed. so, workpiece will be grinded & automatic will be comeout from the other side.

$$F_c V = F_s V_s + \underline{F V_c}$$

$$\frac{F_c V}{V_w t_1} = V_c w t_2$$

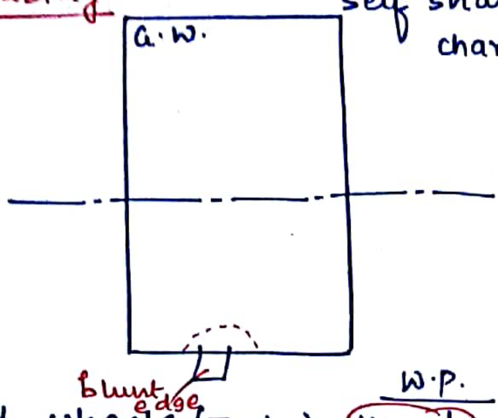


open - ductile

close (dense) - Brittle

Space b/w the 2 consecutive abrasive is called structure. If the space is more, it is called open structure and when the space is less, it is called closed structure. For m/cing ductile materials, we use open structure and for m/cing Brittle material, we use closed structure. During machining, continuous chips goes into this space and ~~hence~~, when this portion of the material is not in contact with the work, then due to centrifugal action, chips will go away. If Ductile materials are machined using closed structure, hot chips will be forced to enter into the space which is not sufficient to accomodate them. so, there will be welding b/w the abrasives. If such cutting conditions continues, all the abrasives will be welding and after certain period, grinding wheel is rubbing over the work without any cutting. This phenomenon is called loading.

Glazing



self sharpening characteristics: As soon as fresh cutting edge comes in contact with the work, sharp edges will become blunt. This will increase the drag between the abrasive and the workpiece. If the Bonding agent is weak, the abrasive will automatic comeout from the wheel and the fresh abrasive from the background start cutting action. It is called self sharpening characteristic. The wheels in which self sharpening phenomenan is predominant are called soft wheels. and the grinding wheels in which blunt cutting edge does not come out automatically are called Hard wheels.

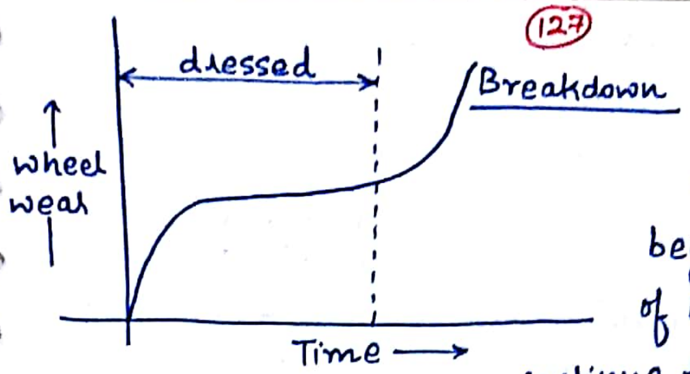
Soft wheels (Tools) - Hard (W.P.)
Hard - Soft

for machining soft materials, hard wheels are used and vice-versa. It is because Brittle materials require sharp cutting edges because it needs higher cutting forces. when hard materials are being machined using hard Tools, slowly all the abrasives will become blunt and after sometime, wheel is rubbing over the ~~curve~~ work without any cutting. This phenomenan is called glazing.

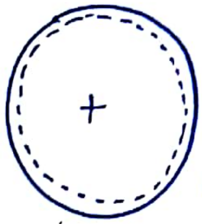
* ISO DESIGNATION

C 25 M 5 V

- C → Type of Abrasive
  - A → Al_2O_3
  - C → carbide
  - D → diamond
- 25 → Size of Abrasive
  - 10-24 Roughery
  - 30-60 Medium
  - 70-180 finish
  - 220-600 superfinish
- M → Hardness
  - A-H – soft wheel
  - I-P – Medium
  - Q-Z – Hard
- 5 → structure
  - 0 - dense
  - 16 - open
- V → Type of Bond
  - V → vitrified (clay)
  - S → silicate
  - B → Resonoid
  - R → Rubber
  - M → Metal



As soon as fresh grinding wheel comes in contact with the workpiece, sharpe edges are trying to roundoff, so wheel wear will be high in the begining. after a certain period, conditions of loading (or) glazing will exist and if we continue to use the same wheel, there will be wheel Breakdown. Before this condition arises, wheel needs to be withdraw from the workshop and dressed. Time between the two dressings is called wheel life. During Dressing, wheel looses its cylindricity. The process of making it again cylinder is called wheel Truing.



29/9/2016

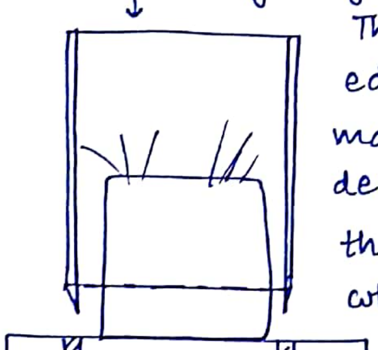
DRILLING

DRILLING :- Drilling is a process of creating a hole and the hole produced will be slightly smaller in size because some margin is kept for reaming operation. Reaming is a process of finishing (or) exacting the hole.

Drills are made slightly tapered because due to unbalanced masses, its body may rub the finished part and spoil the surface finish.

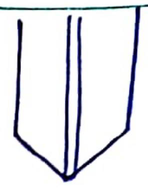
BORING :- It's a process of enlarging the Hole and generally it is done by using a single point cutting tools but multiple point cutting tools are also available.

TREPANNING :- very large diameter holes are produced by trepanning.

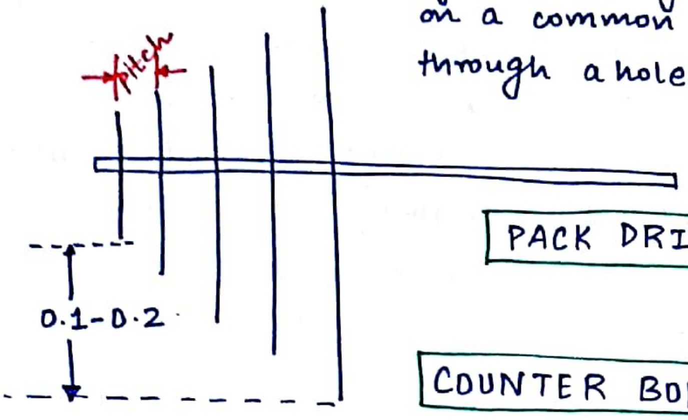


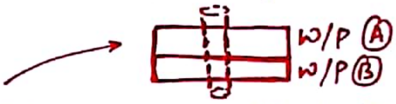
The Tool is in the form of a Tube with cutting edges on the periphery. only small amount of material will be removed in machining. very deep holes are produced by gun drill. Through the centre of a Drill, there is a hole through which we are injecting cutting fluid in the machining area. This cutting fluid not only takes away the heat from the machining area but also helps in disposing the chips.

Gun drills



BROACHING :- Gradually increasing diameter cutting edges are mounted on a common shaft and when the Broach is pulled through a hole, we get mirror like surface finish.



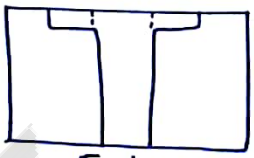


PACK DRILLING :- Put the one W/P to/over another W/P and drill it simultaneously.

COUNTER BORING :- Counter Boring is a process of enlarging the hole in the begining by end milling process and it is a seating place for bolts heads and nuts.

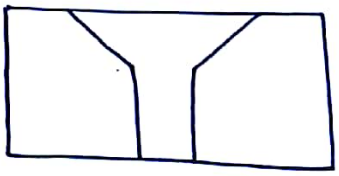
BLIND DRILLING

Blind Hole

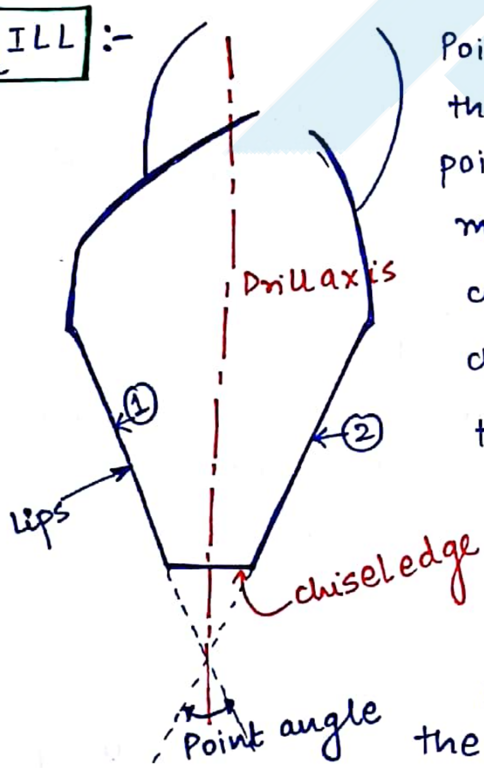


End Milling

COUNTER SINKING :- Countersinking is a process of making the hole slightly taper in the begining by sinking Tools or drills of slightly larger diameter.

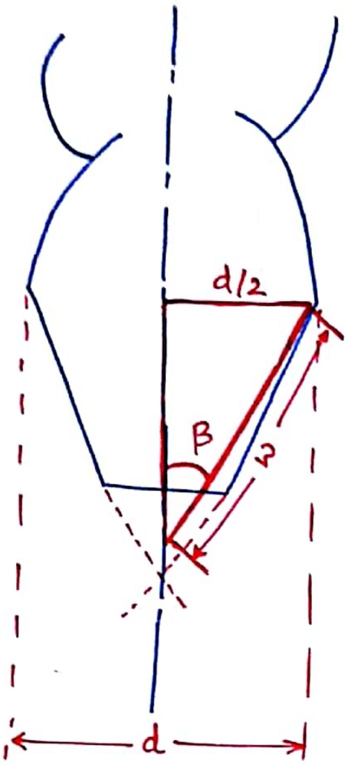


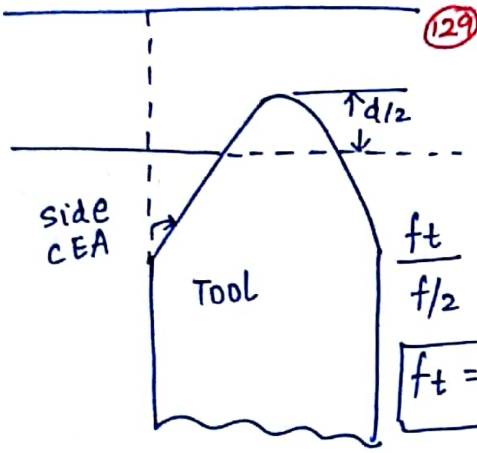
DRILL :-

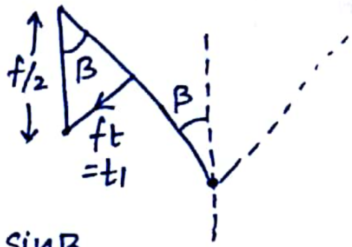


Point angle in drill is having exactly same fn. as that of side cutting edge angle in the single point cutting Tool. width of chip in any machining process is the length of principal cutting edge covered by the chip and uncut chip thickness is the true feed experienced by the cutting edge in the normal direction.

As it can be seen in the analysis that by decreasing the point angle, chips becomes thinner and wider. while machining ductile material since we get continuous chips, if the chips are thicker, due to work hardening, chips will be accumulated in the helix and will not come out. That's the reason for machining ductile materials, we use smaller point ∠ so that chips are thinner.

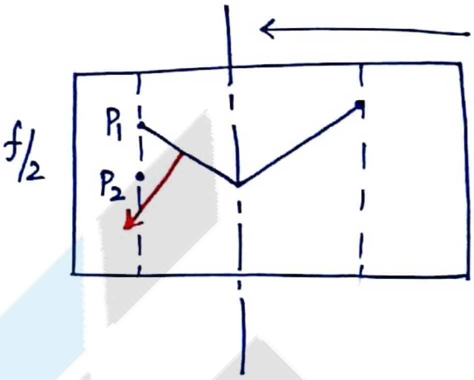






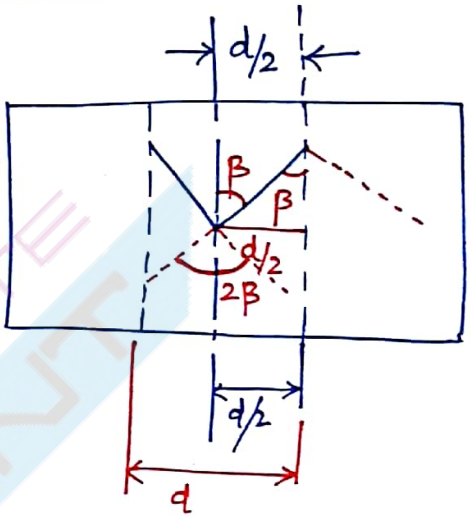
$$\frac{f_t}{f/2} = \sin\beta$$

$$\boxed{f_t = t_1 = f/2 \sin\beta}$$

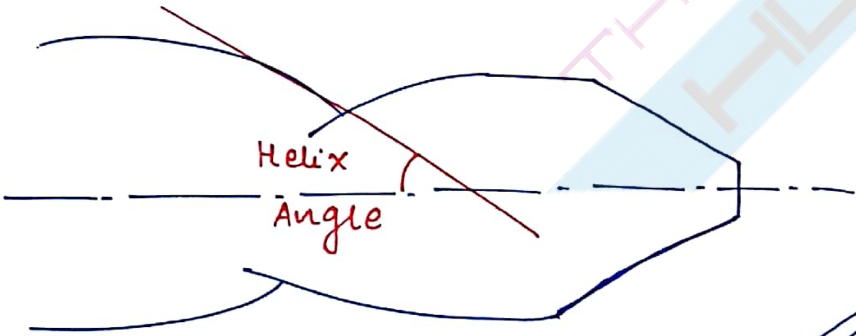


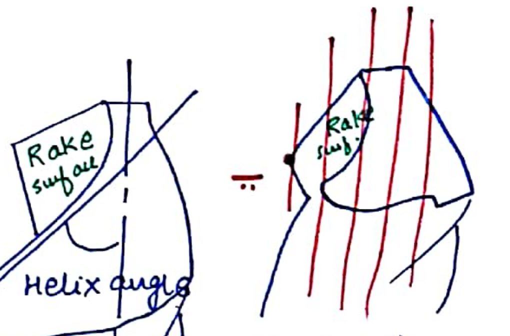
$$\frac{d/2}{w} = \sin\beta$$

$$\boxed{W = \frac{d/2}{\sin\beta}}$$



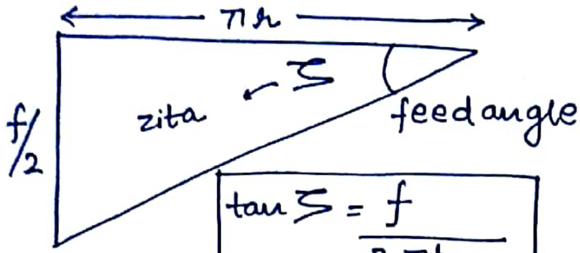
* **Rake ∠ in Drill :-**





at the centre of the drill, since cutting edge merges into the chisel edge so Rake angle will be zero. In the outward direction, Rake angle keeps on increasing and on the periphery, since cutting edge merges into the helix, rake ∠ becomes equal to the helix angle.

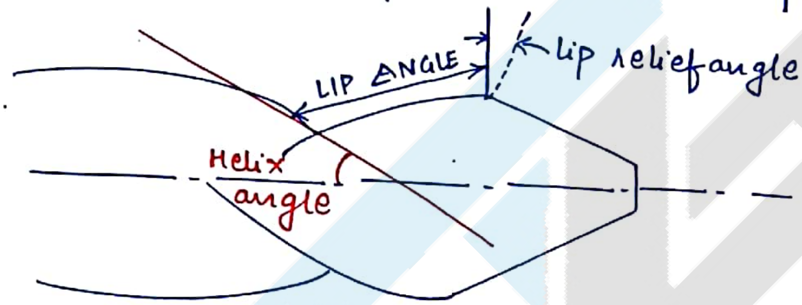
feed angle



$$\tan \zeta = \frac{f}{2\pi r}$$

The workpiece material that is going from the backside of the cutting edge forms an angle from the plane ⊥r to the drill axis called "Feed angle." Due to this feed angle, workpiece material will try to hit the cutting edge from the Back side. To avoid this collision, clearance ∠ is provided on the drills. For machining ductile materials, since there will be more elastic recovery, so clearance angles has to be more.

	Ductile Material	Brittle material
clearance	8-12°	6-9°
Point	118°	135°



CH#6

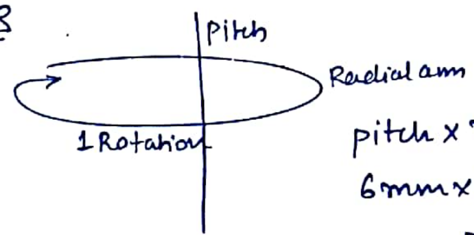
Q1> a

(2) d/2 b✓

(3) $v = 3.9\,m/min$ $p = 6mm$

$d = 30mm$

SIR

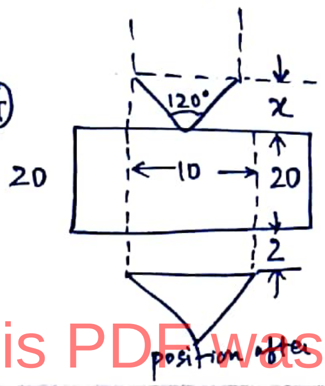


pitch × rpm = speed

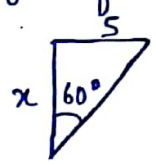
6mm × N = 3.9 × 1000 mm

N = 650 ✓ (a) ✓

(4)



length of cut = $l = x + 20 + 2$



$5/x = \tan 60°$

$x = 2.88$

⇒ time = $\frac{\text{No. of Rev}}{\text{rpm}}$

$= \frac{l}{0.2}$

No. of Revolutions req. = $\frac{L}{feed}$ and time = $\frac{\text{No. of Rev}}{rpm}$

(131)

$= \frac{24.88}{0.2}$

$= 124.43 \text{ rev}$

$= \frac{124.43}{300}$ min

$= 24.88$ sec

(5) c

(6) d

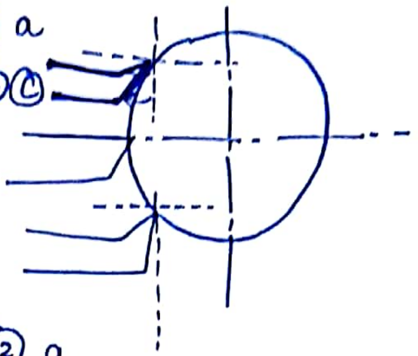
(7) a (End milling cutter)

(8) d

(9) a

(10) a

(11) c



(12) a

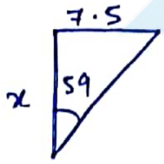
(13) t = 50mm

d = 15mm

N = 500 rpm

f = 0.2mm/rev

118° 2mm



$\tan 59 = \frac{7.5}{x}$

$x = 4.50$

$l = 282.5$

$\frac{58.50}{0.2}$

$\frac{292.5}{500}$

(35.10)

(a) ✓

(17) c ✓

(18) d ✓

(14) c ✓

(15) b

(16) b

(19) D = 10 mm

d = 50 mm

N = 600 rpm

f = 0.2 mm/rev

120° = β

T = 0.44 ✓

(20) 10mm (d/2) ✓

(21) Drill life = ____ min

$Tm_1 \to$ machining Time for making one hole

Drill life = $\frac{\text{\_\_\_\_ min}}{Tm_1}$ = ____

Mean = Tm_1 + idle Time (no Tool changing Time included).

me

20 m/min = V

f.R. = 0.2mm/rev

D.L. = 100 min

l = 45mm

20 sec

(22S)

$\frac{\pi DN}{60} = V$

$\Rightarrow \frac{\pi(15/1000)N}{60} = \frac{20 \times 1m}{60 \text{ sec}}$

N = 424

SIR

l = 45

no. of Rev = $\frac{45}{0.2}$ rev

V = πDN

20 = π × 0.015 N

$n = \frac{100}{0.53}$

$0.53 + \frac{20}{60} =$

$Tm = \frac{n_0}{N}$

= 0.53 min

(i) 188

(ii) 0.88 min.

(22) D = 20mm
t = 30 mm
lip ∠ = 120°
overtravel = 2mm
N = 500 rpm
f/tooth = 0.01

x = 3mm

$\frac{l}{0.2}$ = 3500
420sec

245sec ✓

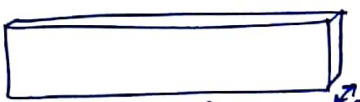
CH #9 (Grinding)

(1) b
(2) b
(3) cbn → are only use to make single point cutting Tools

(d)

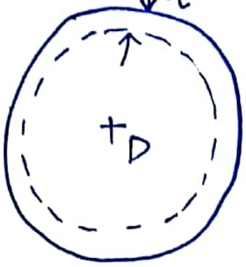
(4) b
(5) c
(6) a
(7) c
(8) c flexible wheels (clay/vitrified)

(9) b
(10) c
(11) b
(12) c
(13) c
(14)



(14) SIR Weal ratio = $\frac{\text{work}}{\text{Total mass}}$

$= \frac{2.5 \times 200 \times 5}{\pi \times 300 \times 20 \times 10^{-3} \times 25} = 5.305$



$\pi D t w_1$

(15) Sol

D = 220 mm
N = 3600 rpm

w = 22m
d = 0.04

SIR specific energy × MRR = energy

$40 \times 22 \times 0.04 \times \frac{1180}{60} = f \cdot V$

↓ cutting power

V = πDN

fc = 16.6 N.

AA60K5V8

300mm (d)
25mm wide

CH ④

① (ma) $D_1 = 6.25mm$, $D_2 = 25mm$ > $V = 18\frac{m}{min}$

$V = \frac{\pi D N}{60}$

$\frac{18m}{60} = \frac{\pi D N}{60}$

① SIR $v = 18\ m/min$

$d_1 = 6.25 = 6.25mm$

$d_2 = 25$

$18 = \pi d_1 N_1 = 916$

$18 = \pi d_2 N_2 \rightarrow 229$

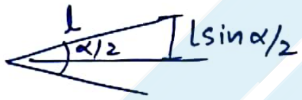
$\frac{N_2}{N_1} = (8)^{1/5}$

② b ✓

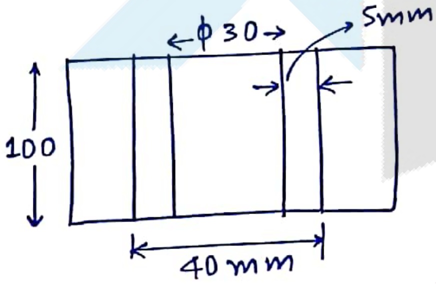
| | | | | | |

Ⓑ ✓

③ Ⓑ ✓



④



$v = 30m/min$

$f = 0.1mm/rev$

① $d = 2$

$30 \rightarrow 34$

$d_{mean} = 32$

$v = \pi d_m N_1 \rightarrow 298$

$no. = \frac{100/0.1}{N_1} = T_1$

↓ 3.35

② $d = 2$

$34 \rightarrow 38$

$d_m = 36\ mm$

$T_2 = \frac{100/0.1}{N_2 \rightarrow 265}$ 3.77

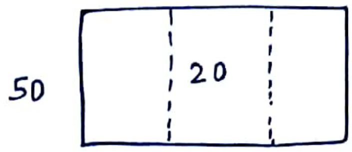
③ $d = 1$

$38 \rightarrow 40$

$d_m = 39$

$T_3 = \frac{100/0.1}{N_3 \rightarrow 146 \rightarrow 6.84}$

⑤ (133)



no. of Revolutions req. $= \frac{50}{0.2} = 250$

① $d_1 = 10mm$

$V = \pi d_1 N_1 \rightarrow 319$

$T_1 = \frac{250}{N_1}$ +

② $d_2 = 20$

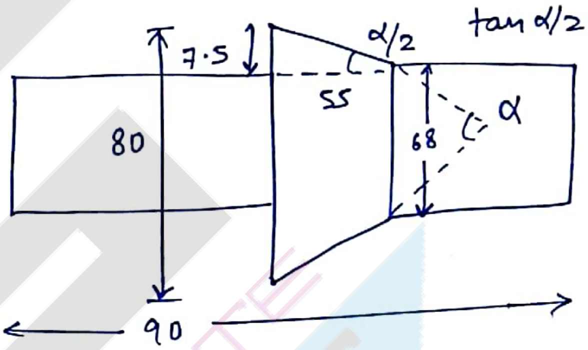
$v = \pi d_2 N_2 \rightarrow 160$

$T_2 = \frac{250}{N_2}$

(2.35) ✓ ⓓ ✓

⑥ $\frac{500}{60\ sec} \times \frac{360°}{30°}$ Hz ⓒ ✓

⑦



$\tan \alpha/2 = \frac{7.5}{55}$

offset $= 90 \sin \alpha/2$

ⓐ ✓

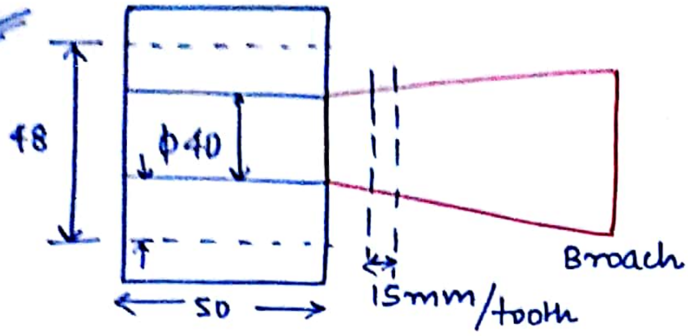
$T_1 + T_2 + T_3 =$

⑧ 4mm/rev

⑨ x_x_x_ = 60,000 ✓

Ans (11.08 min)

(10)



$d = 4\,mm$

no. of Teeths $= \frac{4}{0.01} = 400$

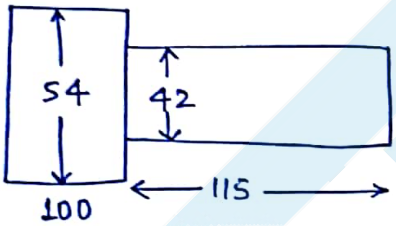
$l = 50 + 399 \times 15$

Time $= \frac{l}{0.35} = 17.24$

(11) ϕ60

$f = 1.2\ mm/rev$

$v = 20\ m/min$



$V = \pi d_m N_1$

(1) 60 → 54 $d = 3$ $d_m = 57$

$l = 215\,mm$

no. of rev. $= \frac{215}{1.2}$ rev

$T_{m_1} = \frac{no}{N_1}$

(2) 54 → 42   12mm

$d = 3$

54 → 48

$d_m = 51$

$t = 115$

$T_2 =$

(3) $d = 3\,mm$

48 → 42

$d_m = 45$

(T_3)

3.04 sec Ans

$T_1 + T_2 + T_3$

(12) $l = 15 + 1 = 16\,cm$

no. of threads $= 48$

$t_1 = \frac{48}{rpm} \times 7$

3.82 min Ans

$V = \pi D N$ ✓

(13) 4 cm → 3.5 $D_m = 3.75\,cm$

$L = 15\,cm$ $\frac{}{N}$ ✓

~~12.5~~

16.25

1.47 ~~sec~~ min ✓

(14) $D_m = 46\,mm$

$L = 50\,mm$

$N = 450\,rpm$

$L = 3\,mm$

$f = 0.2\,mm/rev$

all $= 3\,mm$

rev $= \frac{56}{0.2}$

0.622

1.17 min ✓

(14) SIR   ϕ50 → 42

$N = 450\,rpm$

$d = 3\,mm$

$l = 50$

$f = 0.2\,\frac{mm}{rev}$ $L = 53$

No. of rev $= \frac{53}{0.2} = 265$

(1) $d = 3$ ϕ50 to 44

$\frac{53/0.2 \times 2}{450}$

(1.17) min

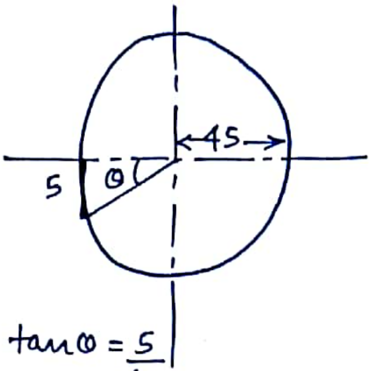
(15) 52mm → 44mm

$L = 200\,mm$

8.8 min

135

(16)



$\tan\theta = \frac{5}{45}$

$\theta = 6.3°$

$10 - 6.8 = 3.62$ ✓

$5 + 6.8 = 11.$~ ✓

(17) 4.5

$8 \times 0.0125 = 0.1$ mm

$\frac{4.4}{0.1} = 44$

$= 22 \times 43 + 8 \times 20 + 4 \times 20$

= ______ .

CH #5

Q(1) c ✓

(2) c ✓

(3) t_1 = cutting time

t_2 = return time

$t_1 + t_2 = 2 \rightarrow 1.6 t_2 = 2 \rightarrow t_2 = 1.25$

$\left(\frac{t_1}{t_2}\right) = 0.6 \rightarrow t_2 = 0.6 t_1$

$t_1 = 0.75$

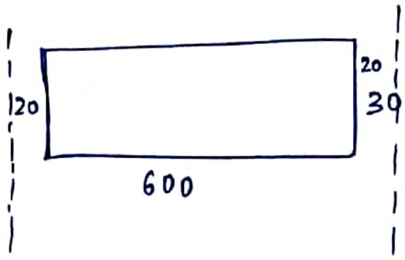
$t_2 = 1.25$

$l = 250$

$v = l/t_1$

(12) ✓

Q4



$V = 8$ m/min

$f = 0.3$ mm/s

$\frac{t_2}{t_1} = 1/2$

no. of st $= \frac{30}{0.3} = 100$

$t_1 = \frac{0.640}{8}$ min

$t_1 = 0.08$ min

$t_2 = 0.04$ min

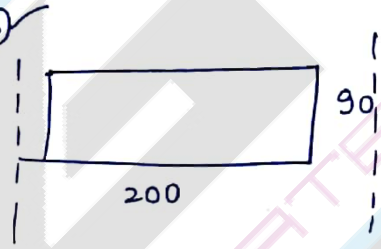
$t = t_1 + t_2 = 0.12$ (Time consume in 1 stroke)

So in 100 strokes, $t = 0.12 \times 100$

(b) ✓ $t = 12$ min

(5) (6) ✓

(6)



$V = 13.5$ m/min

$f = 0.57$ mm/

$l = 240$ mm

$w = 98$ mm

no. of st. $= \frac{98}{0.57}$

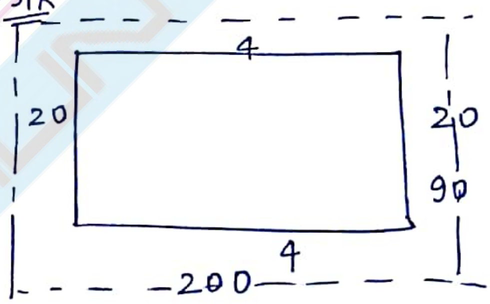
$t_1 = \frac{240}{13.5}$

$t = t_1 + t_2$

$\frac{t_2}{t_1} = 0.83$

(a) ✓

(6) SIR



(7) SIR

Specific energy × MRR = Energy

$1.49 \times 4 \times 0.25 \times 200 =$

MRR = $w t_1 V$

$w = \frac{d}{\cos\psi}$

$t_1 = f\cos\psi$

$t_1 = 1$ sec

$V = \frac{200}{1} = 200$ mm/s

(8) $V = 18\,m/min$

$$rpm = \frac{1}{t_1 + t_2}$$

$$\frac{t_1}{t_2} = 3/2$$

$$t_1 = \frac{0.2}{18}\ min$$

$rpm = 54.54$ (Ans)

$l = 200$

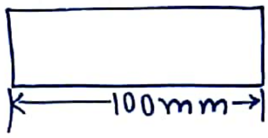
$V = 18\,m/min$

(10) $l = 200$

$$\frac{t_2}{t_1} = \frac{2}{3}$$

0.167 m/s ✓

(9) $f = 0.001\,mm$



$V = ?$ $\qquad \frac{V_R}{V_C} = \frac{2}{1}$

$L = 150\,mm.$

SIR

$$\frac{100}{0.001} = 10^5 \text{ strokes}$$

$$\frac{t_2}{t_1} = \frac{1}{2}$$

$l = 150\,mm$

$$t_1 = \frac{0.15}{V}$$

$$t_2 = \frac{t_1}{2}$$

$t = (t_1 + t_2) \times 10^5 = 10 \times 60.$

$t_1 + t_2 = 0.006$ ✓

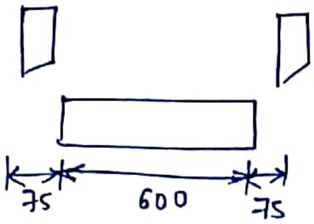
$2t_2 + t_2 =$ —

$t_2 = 0.002$ ✓

$t_1 = 0.004$

$V = 37.5$ ✓

(11)



$V = 9\,m/min$

$$\frac{t_2}{t_1} = \frac{1}{4}$$

3.12 min ✓

$f = 3\,mm$

$c = 75$ ✓

(12) $W = 310\,mm$

$l = 2000\,mm$

$f = 1\,mm/stroke$

$t_1 = 2\,sec$

$t_2 = 1\,sec$

$t = 3\,sec$

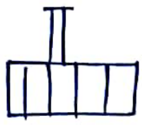
Total time $= 3 \times 310 = \frac{930}{2}$ sec

$\Rightarrow 465$ sec

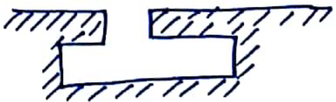
(13.) 4.25 ~~sec~~ min.

MILLING

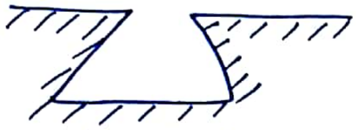
① **VERTICAL**



It was the initial m/c developed in the milling category and it is also called fixed Bed Type. Milling cutters are mounted with individual spindles. T-slot and Dovetail slots can easily be machined on this machine.



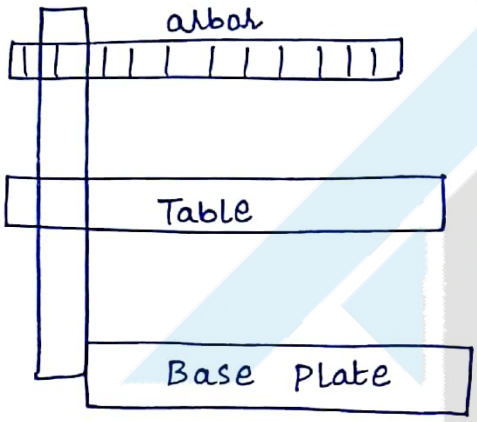
T-slot



Dovetail

Generatrix is the path of cutting and Directrix is the path of feed.

② **COLUMN & knee Type** :→ In column and knee type milling m/c, table is at the knee of the machine. multiple milling cutters can be mounted on the arbour. Biaxial feed can be controlled in two planes simultaneously. It is $2\frac{1}{2}$ axis machine. In universal



③ **Universal Milling M/c** :- In universal milling m/c. all the features of column and knee type are present.
(vertically adjusted)

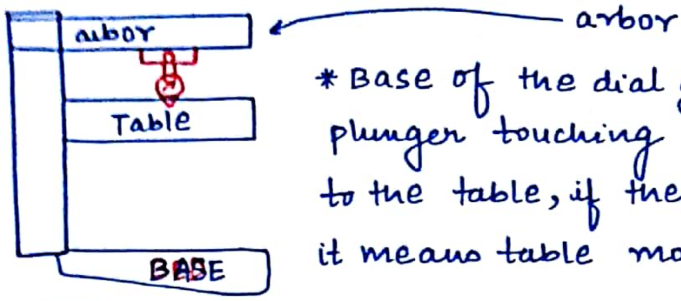
additionally, Table can be given rotation 45° on both the sides. In ④ **Rotary milling machine**, complete rotation of Table can be given. cutters are mounted on individual spindle and machining can take place simultaneously at 2 different places.

⑤ **Plano Miller** :- Constructionwise it is also similar to a planning machine. But in place of single point cutting tool, there is milling cutter. It is meant for heavy workpieces. In a planning machine, cutting action is provided by the movement of table but in a milling m/c, cutting action is provided by the rotation of cutter.

Size of a Milling machine :- is defined by max^m. moment that can be given to the table in x, y and z direction.

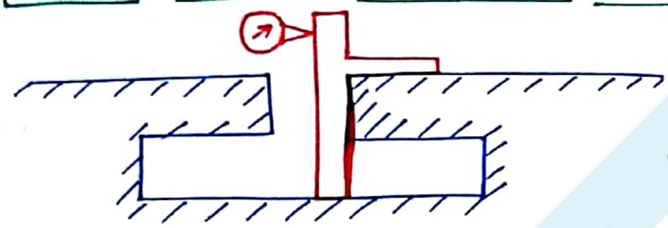
* ACCEPTANCE TEST of a Milling machine :-

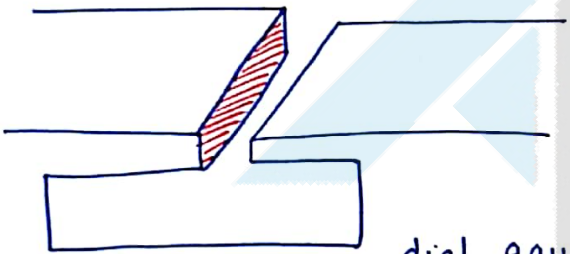
Test 1 :- whether arbor axis is parallel to the table movement.



* Base of the dial gauge is fixed over the arbor with plunger touching the table. By giving Biaxial movement to the table, if there is no variation in the dial gauge, it means table movements are ∥ to the arbour axis.

Test 2 :- whether central T-slot is square

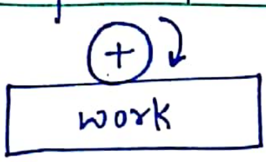




Accuracy of central T-slot is important because workpieces and other machining fixtures are mounted on the central T-slot. To check the perpendicularity, a magnetic T is inserted in the slot with plunger of dial gauge touching the Top surface as shown in fig. Base of the dial gauge is fixed over the arbor. By giving vertical move^{ve}ment to the table, dial gauge moves over the T. if there is no variation in the dial gauge, it means slot is perpendicular. To check the parallel nature of the slot, plunger of the dial gauge is moved over the surface of the Tslot by giving horizontal movement to the table.

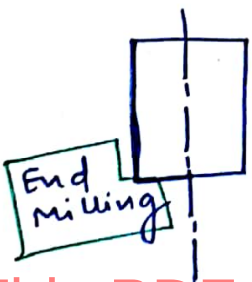
3/10/2016

Milling :- ① **Peripheral / slab**



when the axis of rotation of the cutter is ∥ to the machine surface, it is called peripheral / slab milling operation. If the axis of Rotation of cutter is ⊥r to the machined surface, it is called face milling operation.

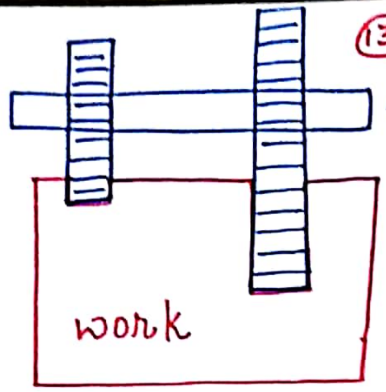
② **Face Milling**



when the milling cutter is such that partly the material is removed by face milling and partly by slab. It is called end milling operation.

③

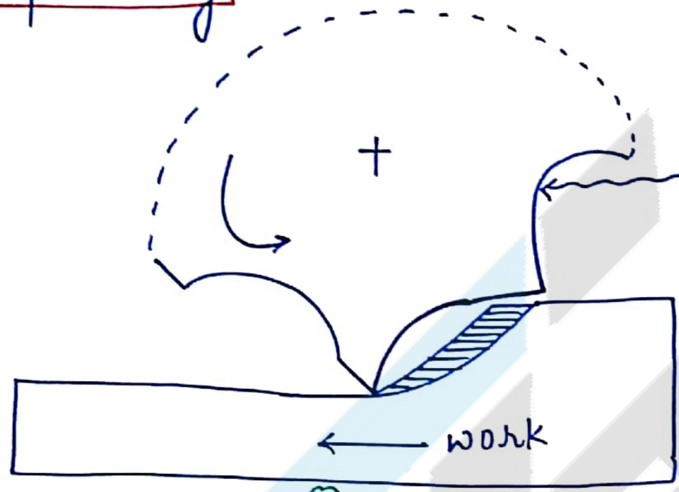
(139)



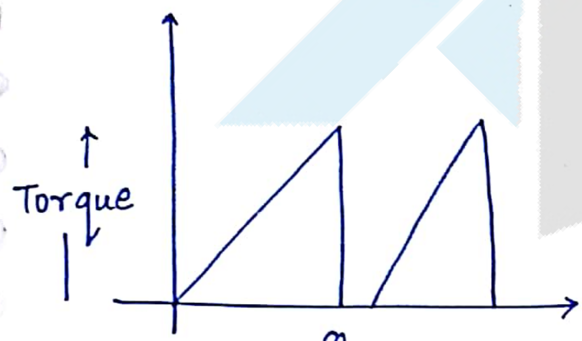
straddle

④ Straddle Milling :- when two cutters are mounted on arbor to perform machining operations at two different locations. It is called straddle milling. But when there are more than 2 cutters; it is called a Gang Milling.

* Up - Milling

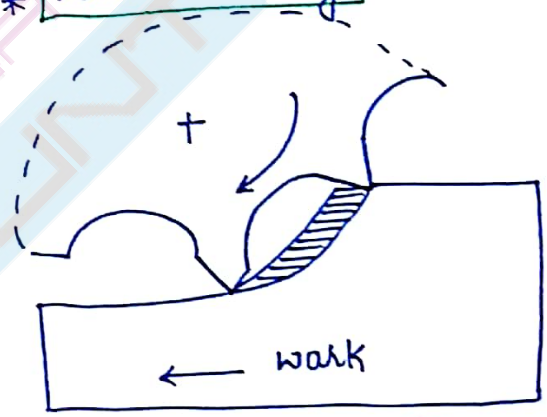


ⓐ

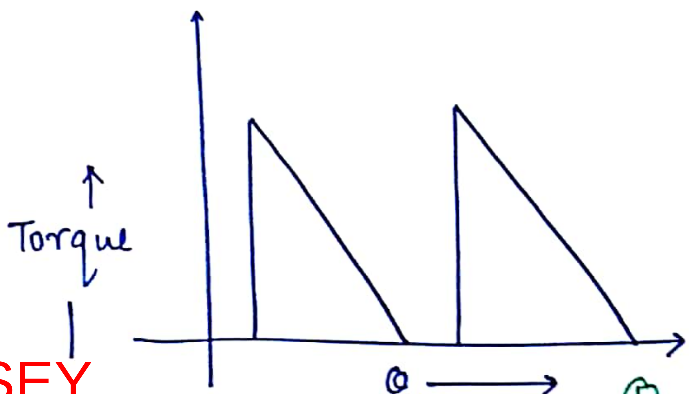


ⓑ

* Down - Milling



ⓐ



ⓑ

MOHIT CHOUKSEY

Points :- ⓐ In upmilling process, cutter and workpiece motions are in opposite directions.

ⓑ In upmilling chip thickness varies minm. in the beginning and maxm at the end. In downmilling, since maxm. chip thickness is in the beginning, so cutting edge will experience a shock.

ⓒ In upmilling, Before starting the cutting, cutting edge rubs over the finished part and hence spoils the surface finish so the surface finish will be better in the down milling.

ⓓ In the upmilling process, since hot chips goes to the tooth space and stays there for longer period of time so due to diffusion, cutting edge will become weaker and weaker, so Tool life will be more on down milling.

ⓔ In the upmilling process, since the fasteners are under tension, so Backlash error will not have any effect so will be more accurate products can be machined in up-milling.

* FEED PER TOOTH

$$f_t = \frac{f\,(mm/rev)}{n_t}$$

f → Total ~~tooth~~ feed

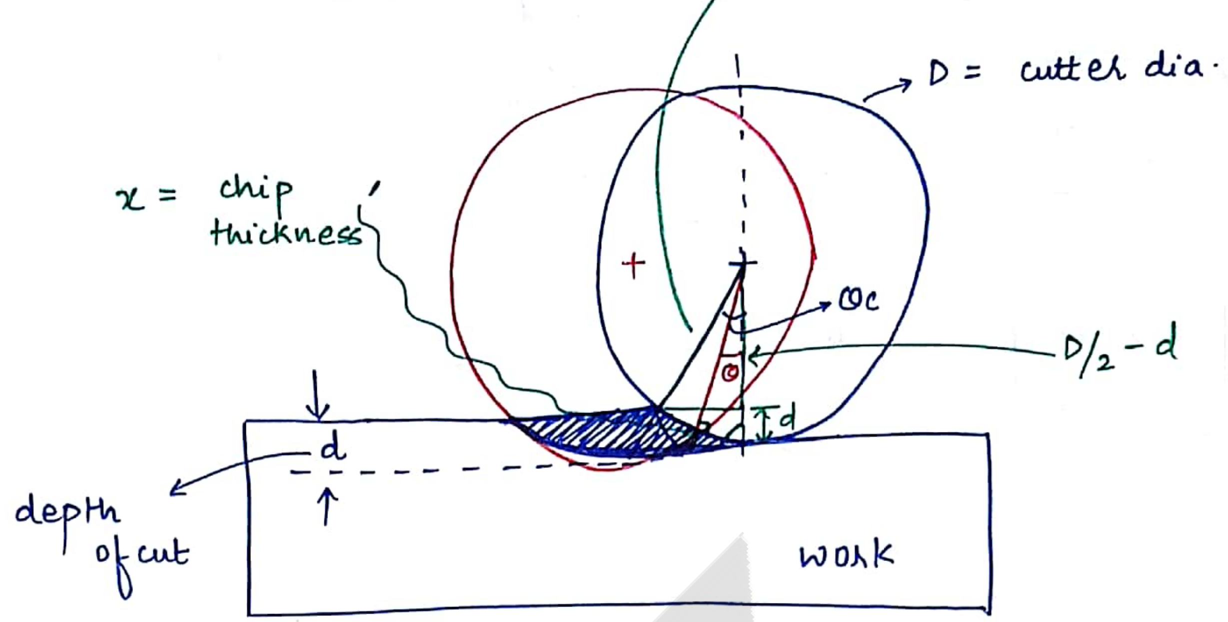
n_t → No. of teeths on cutter

✓ $\theta = 0^\circ$, $x = 0$

✓ $\theta = \theta_c \Rightarrow x = x_{max}$

MOHIT CHOUKSEY

assumptions :- (1) $\theta = 90°$.
(2) $d <<< D$.



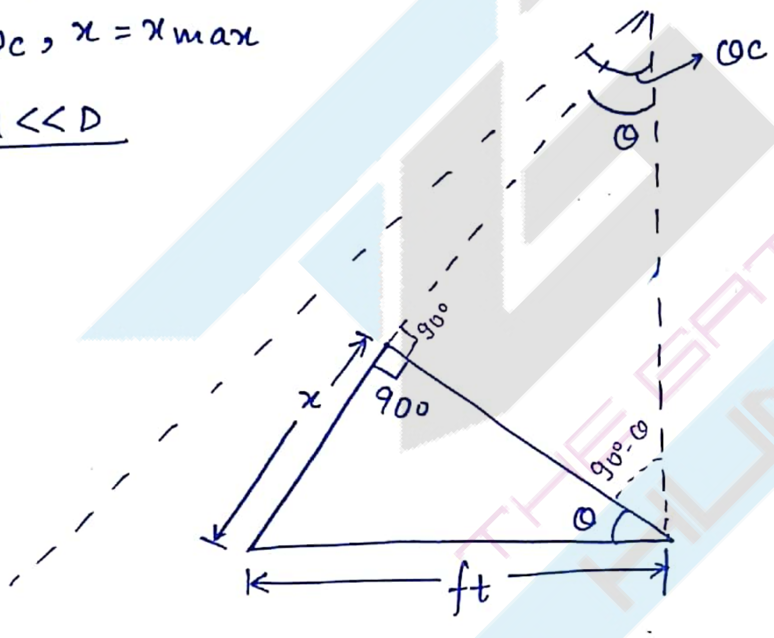
$\theta = 0, \; x = 0$

$\theta = \theta_c, \; x = x_{max}$

$d << D$

$$\cos\theta_c = \frac{(D/2 - d)}{(D/2)}$$

$$\boxed{\cos\theta_c = 1 - \left(\frac{2d}{D}\right)}$$



$$x = f_t \sin\theta$$

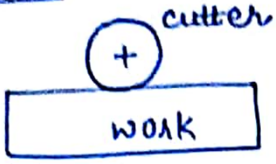
$$x_{max} = f_t \sin\theta_c = f_t\sqrt{1 - \left(1 - (2d/D)\right)^2}$$

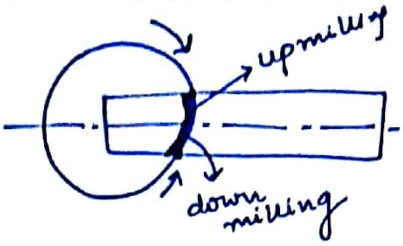
$$\boxed{x_{max} = 2f_t\sqrt{d/D\,(1 - d/D)}}$$

$$x_{mean} = \frac{0 + x_{max}}{2}$$

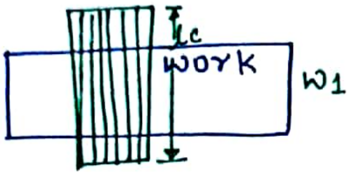
$$\boxed{x_{mean} = f_t\sqrt{d/D\,(1 - d/D)}}$$

$\frac{V_c \omega t_1}{V_c \omega t_2}$

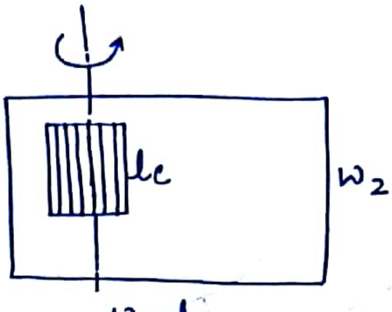




Face milling is combination of (up + down) milling



$\omega = \omega_1$



$w = l_c$

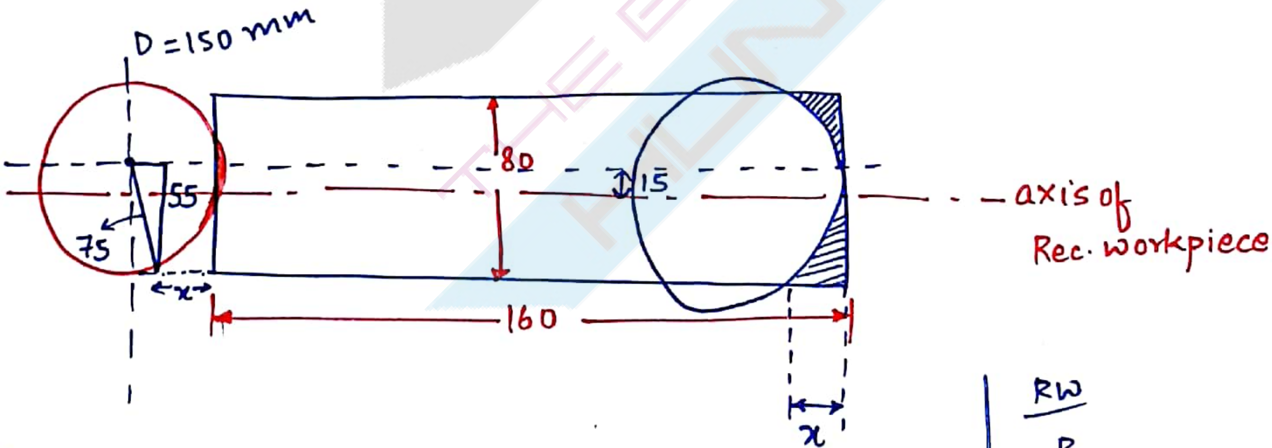
Q A surface 80 X 160 mm² is rough machine using a face milling cutter of diameter 150 mm having 10 Teeths. The cutter centre is offset by 15 mm from the line of symmetry of workpiece. If the feed per tooth is 0.25 mm, cutting speed is V = 20 m/min.

Calculate :- ① Time to run machine.

② with 5 mm approach and 5 mm overrun, what is single pass feed time.

③ If the cutter is symmetric what is rough and finish machine time.

Sol

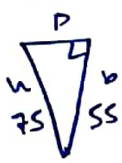


$n_t = 10$

$f_t = 0.25$ mm

V = 20 m/min

RW



$p^2 + b^2 = h^2$

$p^2 + 55^2 = 75^2$

length of cut = 160 + x

= 160 + 24

= 184

f = 10 X 0.25 = 2.5 mm/rev

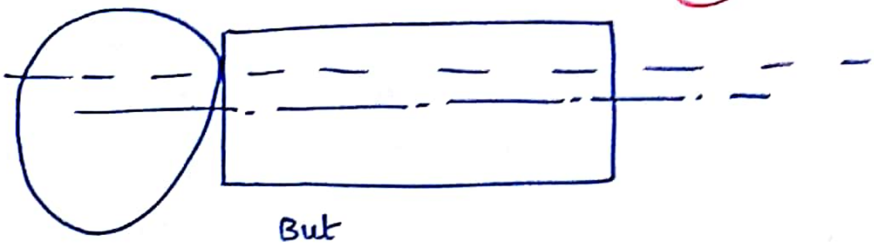
no. of Rev = $\frac{184}{2.5}$ = T_1

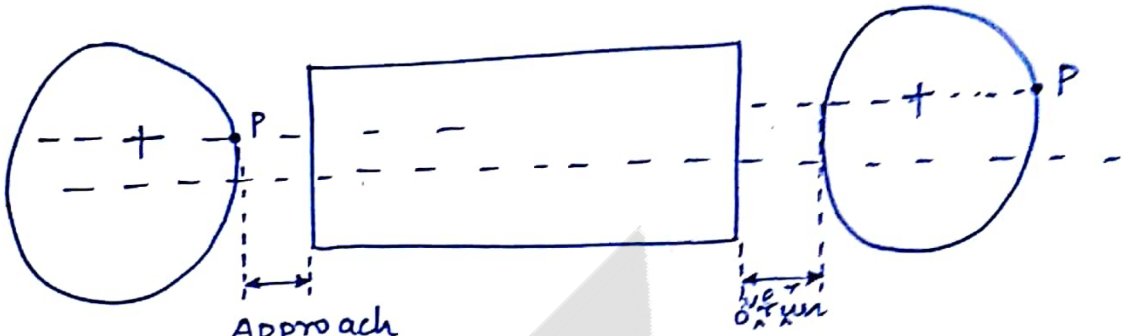
V = 20

$\pi \times 0.15 \times N = 20$

N =

T_1 = time = 1.73 min





$l = 5 + 160 + 5 + 150$

$l = 320\,mm$

$f = 2.5\,mm/rev$

No. of Rev. $= \frac{184}{2.5} = \frac{320}{2.5} = 128$

$20 = \pi \times 0.15 \times N$

$N = 43$

$T_{M_2} = \frac{\frac{320}{2.5}}{43}$

$T_{M_2} = 3.01\,min$

(iii) symmetric means w/p & cutter axis same.

$T_1 = 1.61\,min.$ (Rough machining)

T_2 ← finish m/c $= 3.01\,min$

MOHIT CHOUKSEY

Q The thickness of a rectangular Brass plate of length Lw and width Bw has to be reduced by t mm in one pass by slab milling cutter of length lc greater than Bw. Diameter of cutter is Dc, no. of teeths Zc, cutting velocity Vc, feed per tooth is So. calculate the machining time.

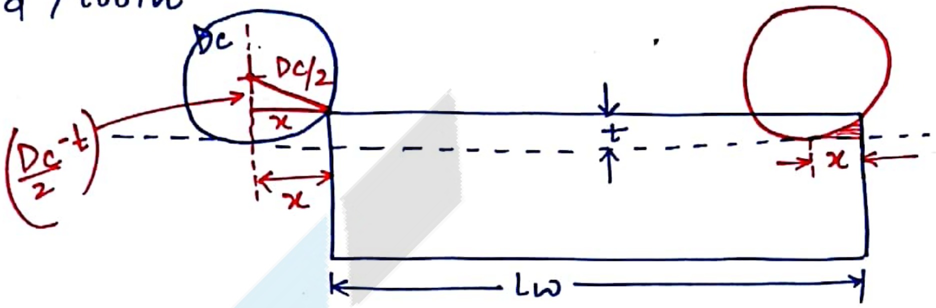
Sol.

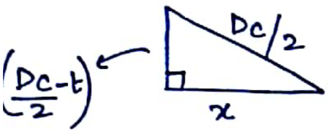
Zc = no. of teeths

Vc = cutting velocity

So = feed / tooth

$l_c > B_w$ → length of cut





Length of cut = $L_w + \sqrt{t(D_c - t)}$

$$x = \sqrt{\left(\frac{D_c}{2}\right)^2 - \left(\frac{D_c}{2}-t\right)^2}$$

$$x = \sqrt{t(D_c - t)}$$

$$\text{Time} = \frac{\left\{L_w + \sqrt{t(D_c-t)}\right\}\pi D_c}{S_o Z_c V_c} \quad \text{Ans}$$

feed/rev = $S_o Z_c$

$V_c = \pi D_c N$

$$N = \frac{V_c}{\pi D_c}$$

Q Estimate the power required during upmilling of mild steel Block of 20 mm width with a slab milling cutter having 10 teeths, (75 mm diameter), & 10° Radial Rake. The feed velocity of the table is 100mm/min, coefficient of friction is 0.5 and shear strength of material is 400 MPa, the depth of cut is 5mm and the cutter rotates at 60 rpm.

MOHIT CHOUKSEY

Sol: width = 20 mm

$n_t = 10$ → $\frac{360°}{10} = 36°$

D = 75 mm

$\alpha = 10°$

f = 100 mm/min

$\mu = 0.5$

$\tau_s = 400$ MPa

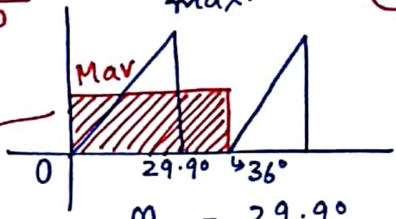
d = 5 mm

N = 60 rpm

$f_1 = \frac{100}{60}$ mm/rev

$f_t = \frac{f_1}{10}$

max.

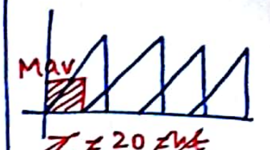


$\theta_c = 29.9°$

$x_{max} = 2 f_t \sqrt{d/D(1 - d/D)}$

$= 0.083$ mm

Power = Mav × ω



Z × 20 ...

$\frac{360}{18} = 20°$

$\frac{1}{2} M_{max} \times 29.9 = Mav \times 18$

$Mav \times 36 = \frac{1}{2} M_{max} \times 29.9$

Lee & shaffer,
$\phi + \beta - \alpha = 45°$

$F_s = \tau_s \frac{w t_1}{\sin\phi}$

$\frac{F_c}{F_s} = \frac{\cos(\beta - \alpha)}{\cos(\phi + \beta - \alpha)}$ → ✓

β → $\tan^{-1}\mu$

$\tan^{-1}\mu = \beta$

$\beta = 26.56$

$\phi + 26.56 - 10 = 45$

$\phi = 28.44°$

$F_s = \frac{400 \times 10^6 \frac{N}{m^2} \times 20 \times 0.083}{\sin 28.44}$

$F_s = 1394.26$

$F_c = \frac{0.95 \times 1394}{0.707}$

$M_{max} = F_c \times D/2$

Fc = 1893 N ✓

$M_{max} = 70231.61$

P = 185 W ✓

MOHIT CHOUKSEY

WB (1) → b

(2) → c

(3) → one face

$l = 100$

$\text{Time} = \left(\frac{110}{30}\text{ min} + 2\right) \times 6$

(4) → (d) ✓

(5) → (d) ✓

(6) → (d) ✓

(7) → (a) ✓

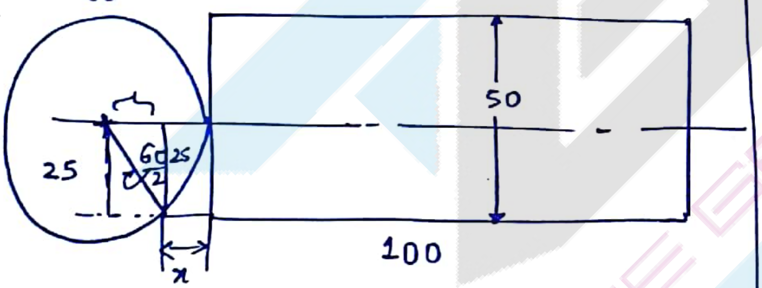
(8) → (a) ✓

(9) → (a)

(10) $D = 60$ mm

$z = 20$

$t = 15$



$l = 100 + x$

(a)

~~$60^2 = 25^2 + ?^2$~~

$30^2 = 25^2 + ?^2$

$x = 13.41$

(11) (c) ✓

(12) c ✓

(13) b ✓

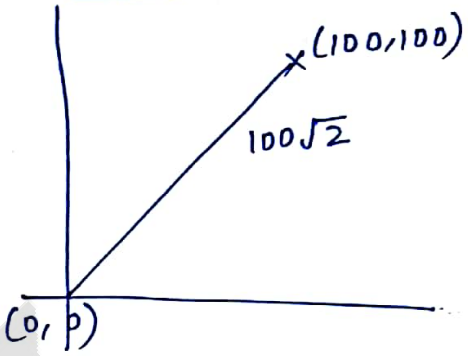
(14) b ✓

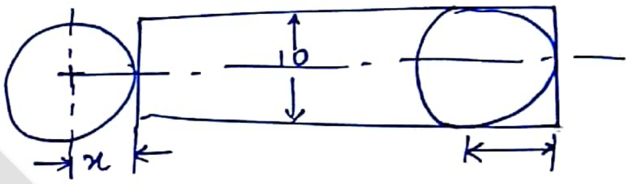
(15) c ✓

(16) later

(17) GATE

$l = \frac{100}{\sqrt{2}} + x$





$l = 100\sqrt{2} + 5$

$l = 146.42$

$\frac{146.42}{50}$

2.92

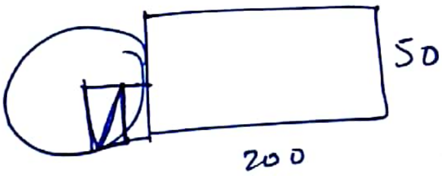
175 ✓

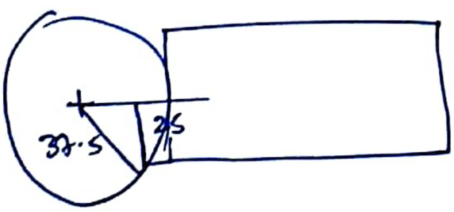
(18) $x_m = ft\sqrt{d/D\,(1 - d/D)} \to 1$

$d \ll D$

0.707 ✓

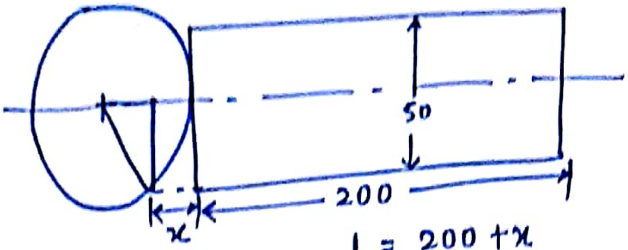
(19)





MOHIT CHOUKSEY

(19)

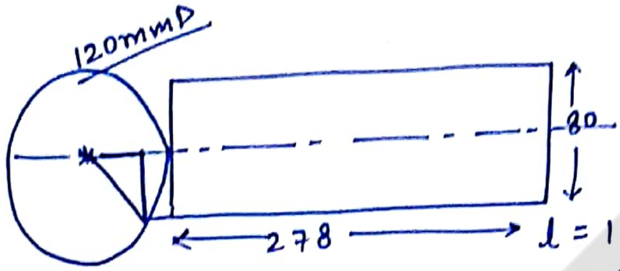


$l = 200 + x$

$l = 209.54$ ✓

(20)

10 teeth = Z



$l = 1 + 278 + 1 + 120$ ✓

(6) ✓

$\boxed{l = 400\ mm}$

(22) → wrong qn.

* **JIGS AND FIXTURES** :- These are auxiliary devices used in the mass production, if we want to maintain accuracy in machining, it is important that the m/cing is taken place in a single plane of reference only. fixture ensures that every ~~wh~~ time workpiece is loaded in a single plane fixture also decreases the loading and unloading time. Jig is having one additional fn. to perform that is guiding the Tool. Jigs are used in drilling, Boring, reaming, Broaching etc.

1/10/2016

other Topic :- Machinability :-

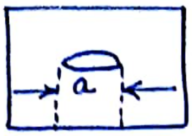
1. Tool life.
2. Surface finish.
3. Cutting forces.

→ $\dot{\epsilon}_z = 0$ Plane strain ⇒ $k' = \frac{\sigma_0}{\sqrt{3}}$

$\sigma_1 - \sigma_2 = 2k'$ Stress $= \frac{\sigma_0}{2} = k'$

$\boxed{2k' = \sigma_0}$

IES 5.52 — Material science.



fracture toughness

$K_c = Y \sigma \sqrt{\pi a}$

σ → strength; Y → variable

(a) ⟶ for internal cracks.

(a/2) ⟶ for external cracks.

IES 5.53

$$\frac{1}{\rho} = \Sigma \frac{x_i}{\rho_i}$$

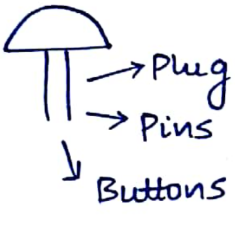
(5.53)

Q.) Laterm.

Jigs contd. . . .

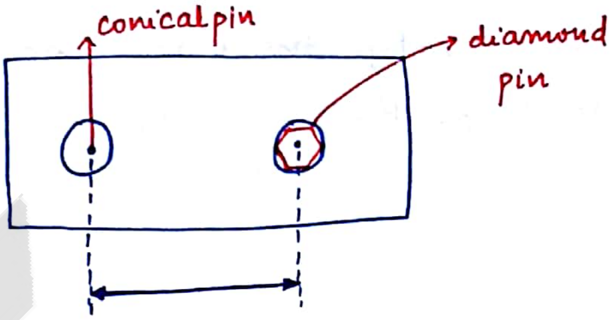
* **Components of Jig** :- ① Locating elements.
  ② clamping elements. — Pneumatic. / Toggles and wedges.
  ③ Tool guiding elements.
  ④ Jig Body.

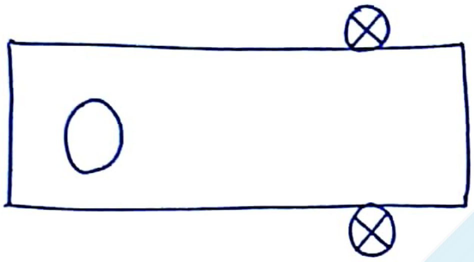
① **3-2-1 Principle** :- There are 12 degrees of freedom of any workpiece in machining that is movement along +ve and -ve direction along the axis and also clockwise and anticlockwise rotation along x, y, z-axis. Three hemispherical pins are provided in the base. so when the flat surface rest on these pins, it will be a 3-point contact. Three points can define a plane. This ensures that everytime machining is taking place in a single plane only. These 3 pins arrest 5 degrees of freedom that is movement along -z dirn. and clockwise and anticlockwise rotation along x and y axis. Two pins are provided on a plane ⊥r to the Base along the length direction. These pins

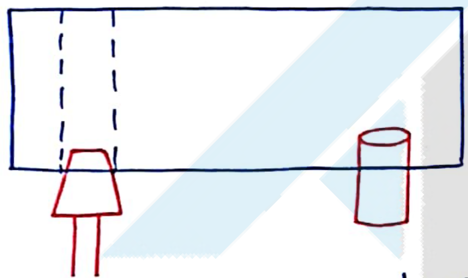


arrest 3 more degrees of freedom that is movement along -x dirn, and clockwise & anticlockwise rotation along z-axis. A 6th pin is provided on a plane ⊥r to the previous 2 planes and this pin arrest's one more degrees of freedom that is movement along -y direction. so by providing these 6 pins, 9 degrees of freedom will be arrested. Remaining 2 degrees of freedom will be arrested by clamping elements. Before starting the machining, 11 degrees of freedom must be arrested.

② **RADIAL LOCATION** :-

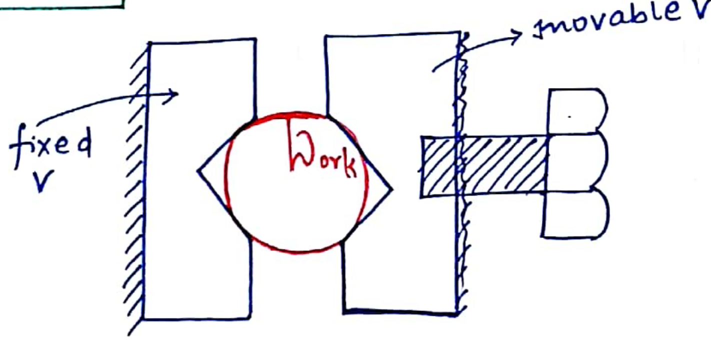






A Radial locations are used when in the workpiece, there is already one drilled hole. By Inserting the conical pin into the hole, 9 DOF can be arrested. conical pins are used to accomodate any variation in the size of hole. Two more degrees of freedom (DOF) are arrested by providing cylindrical pins on the side of the work. If there are 2 holes in the work, one conical pin is inserted in the smaller hole and one diamond pin is inserted in the larger hole. Two surfaces of the diamond pin are relieved to facilitate the variation in the centre to centre distance in the hole.

③ **V-locators** :-



✓ w/p. (when fixed b/w), loose all the DOF.

✓ used for cylindrical and spherical w/p's.

* Steps in designing a Jig :-

Step 1 :- The W/P for which the jig has to be design, its plan, elevation and end view are drawn with RED PENCIL.

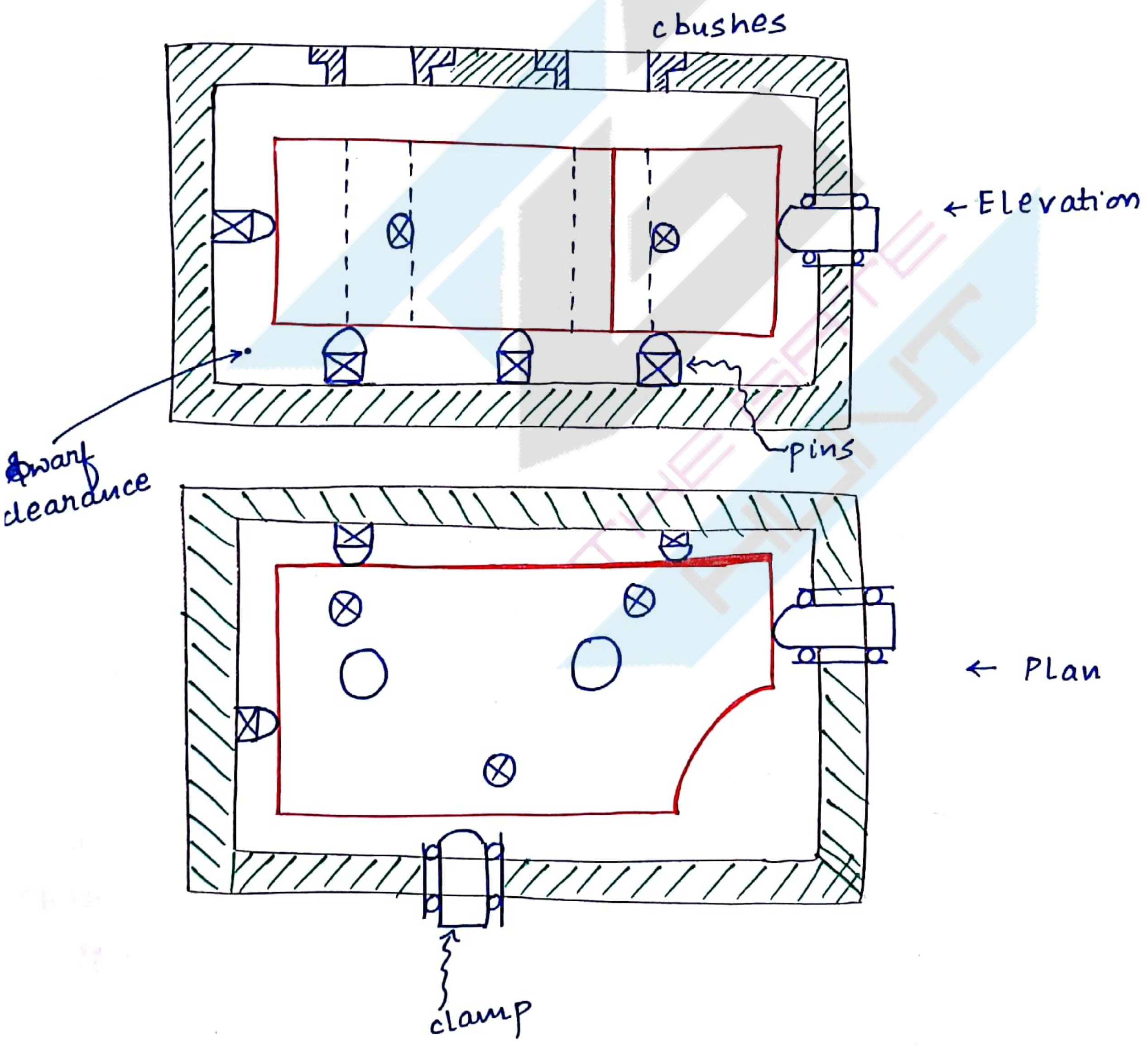
Step 2 :- Identify the places where machining has to be perform.

Step 3 :- Identify the type of locating element.

Step 4 :- Identify the places where locating elements has to be provided.

Step 5 :- Identify the places where clamping has to be performed.

Step 6 :- Draw the Jig Body.

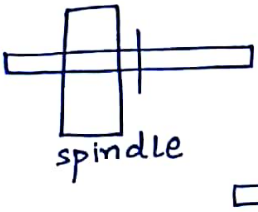


MOHIT CHOUKSEY

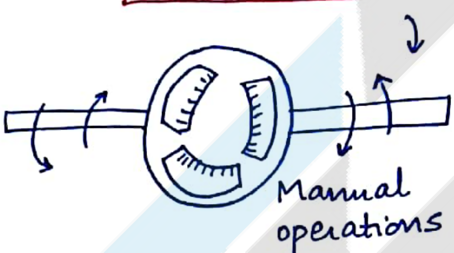
WB ch-12
① → d
② → b.
③ → c.
④ → c.

Screw & Gear Manufacturing

Screw :- Producing screws over a lathe is called thread chasing. A hard automated lathe targetted to produce screw thread in mass is called swiss automate.



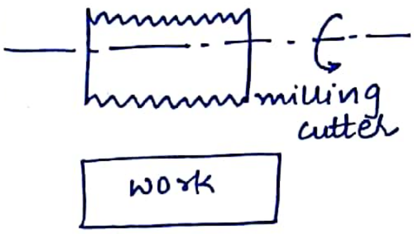
DIE THREADING :-



Tapping is a process to produce internal threads manually and
Die threading is a process of producing external threads manually.

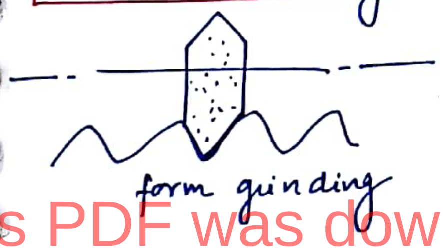
But threads can be produced only in a certain diameter range.

Thread Milling :- In case of milling once the req. tooth depth is achieved, milling cutter is withdrawn and work blank is indexed. although any type of thread can be produced on a milling m/c but since indexing mechanism is not accurate so threads produced will not be accurate.



Thread Rolling :- workblank is pressed b/w the two flat dies and the impressions of die appears on the work. Since the threads are produced purely by plastic deformation, so threads will be stronger but the process can be used only in the mass production. Internal threads can also not be produced by this process.

Thread Grinding :- Most accurate threads are produced by grinding but since the wheel wear will be quite high so threads will be expensive.

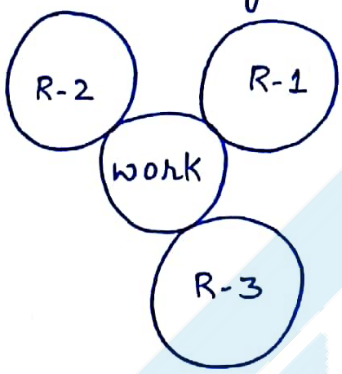


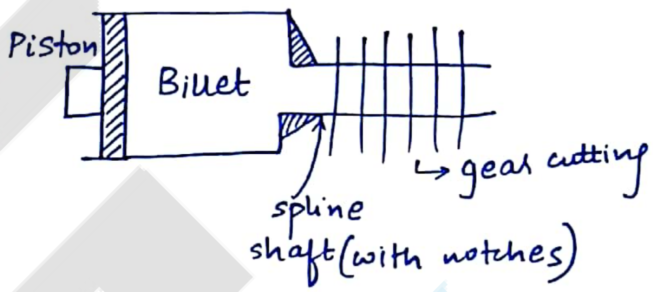
MOHIT CHOUKSEY

Gear Material → (a) Cast Iron
(b) steel
(c) Bronze
(d) Aluminium
(e) plastic and Nylon
↓ Toys
↳ Xerox machine

Manufacturing of Gears :- ✓ FORMING

FORMING → Rolling
FORMING → Extrusion

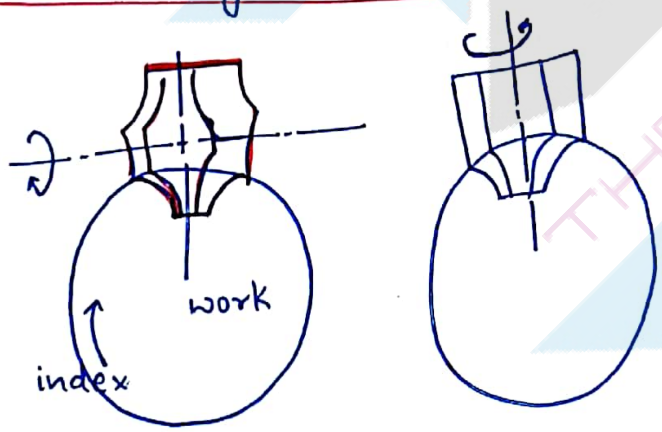


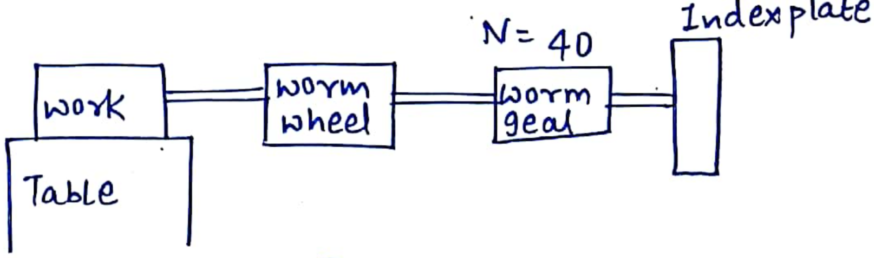


✓ **Gear Milling (Method)** :-

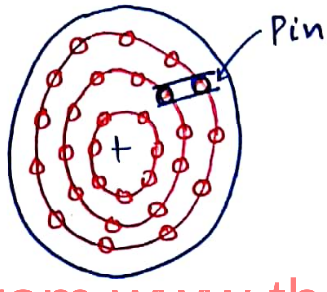
$$\frac{40}{N} = \frac{40}{30} = \frac{4}{3} = 1 + \frac{1}{3} = 1 + \frac{7}{21}$$

↓ $N = 30$





19, 20, 21

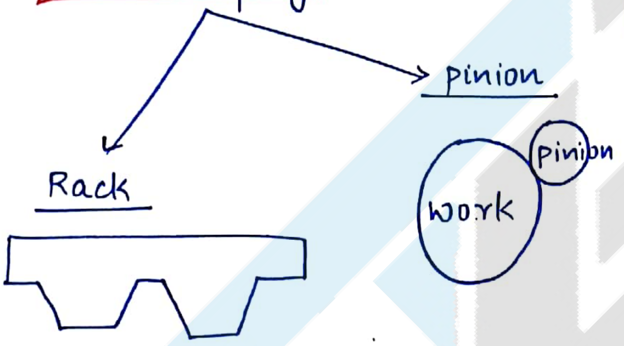


$$\frac{40}{50} = \frac{4}{5} = \frac{16}{20}$$

Both slab and end milling cutters can be used to machined gears. After producing one teeth, cutter is withdrawn and the work is advanced by one pitch. Since this indexing mechanism is controlled by a gear train and there will be backlash error in the measurement of pitch. so gears produced will not be accurate. but any type of gear can be cut on the machine.

* **Gear Broaching** :- Splined Broaches are used in the gear manufacturing. Initially a finite hole has to be drilled and when we pull the Broach through the hole; all the teeth will be generated. The processes can be used to make external gears also and the process is called ~~part~~ of Broaching. since broaches are expensive, process can be used only in the mass production.

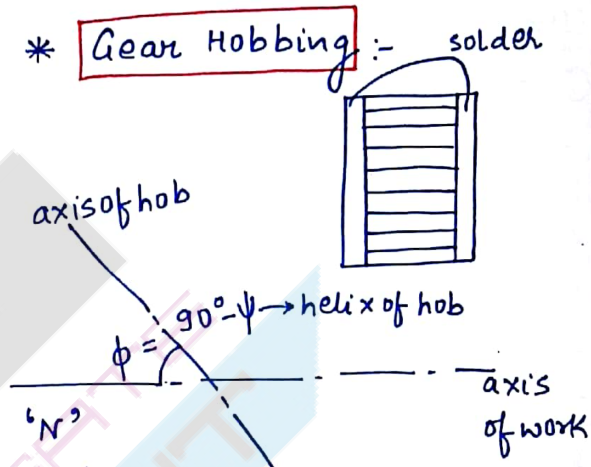
* **Gear Shaping** :-



Gear shaping with rack type cutter, once the required tooth depth is achieved, cutter is withdrawn and the workblank is indexed. so only external gears can be produced and Because of indexing mechanisms, gears produced will not be accurate.

In pinion type cutter, there is a continuous indexing once the req. tooth depth is achieved, 3 motions are started simultaneously :- (a) Rotory motion of work (b) Rotory motion of pinion (c) Reciprocating motion of pinion. Both internal & external gears can be produced by pinion cutter. both helical and spur gears can be cut on a shaper but when helical gears has to be produced, work has to be mounted on a helical drive.

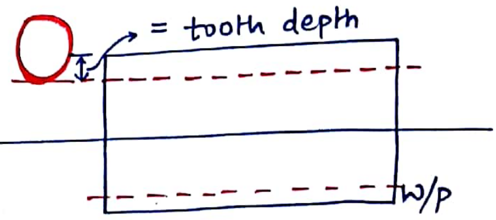
* **Gear Hobbing** :-



$$\frac{\text{rpm of hob}}{\text{rpm of work}} = N \text{ (for single start)}$$

Double start = $N/2$

= $N/3$



Gear Hobbing → It is the fastest method of producing gears. Hob is just like a splined screw and by using the single hob, any type of helix can be cut on the work just by changing the angle between the hob axis and the work. For producing spur gears, angle b/w these two axis should be equal to 90° − helix angle on the hob. Initially, hob is lowered to a point to achieve the required Tooth depth, then 3 motions are started simultaneously :- ① Rotation of work. ② Rotation of hob. ③ Axial movement of work. when hob moves from one side of work to other side, all the teeths will be produced.

{ Most accurate gears → By Broaching }

CH#8

① → ⑥

2> → c

3 → d

4 → b

5 → a

6 → d

7 → d

8 → a

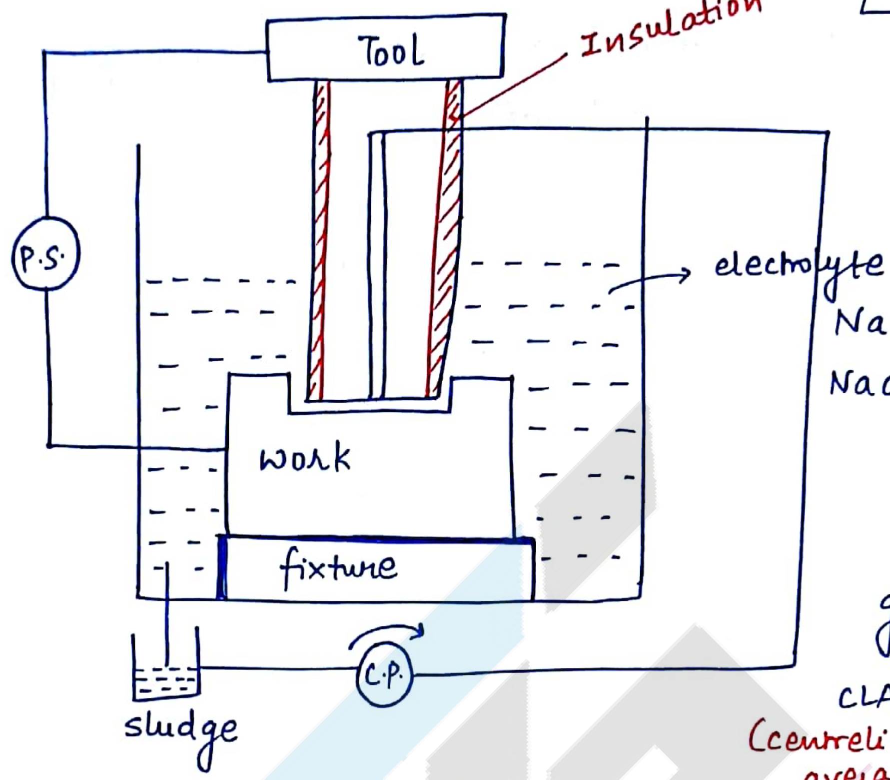
9 → a

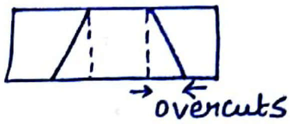
10 → 20

UNCONVENTIONAL MACHINING

* Electrochemical machining

I ↑ V ↓





$NaCl \rightarrow$ rough

$NaClO_3 \rightarrow$ finish

gap → 0.03 – 0.5 mm

CLA Ra → 0.2 – 0.8 μ (microns)

(centreline average)

$Fe \rightarrow Fe^{+2} + 2e^-$

$NaCl \rightarrow Na^+ + Cl^-$

$2H_2O + 2e^- \rightarrow H_2\uparrow + 2OH^-$

$Fe^{+2} + 2OH^- \rightarrow Fe(OH)_2\downarrow$ sludge

electrochemical grinding (ECG)

95% electro

5% grinding

* In ECM process, the mechanics of material removal is electrolysis. which is reverse of electroplating. material is removed atom by atom that is anodic dissolution. It is high current, low voltage process and higher is the current, more will be the material Removal Rate. Tool is made up of some conducting material like Copper alloys and its surface is insulated, so that Reaction doesn't takes place sideways. Before pumping the electrolyte back to the machining area, it needs to be cooled otherwise it leads to overcut. * In electrochemical grinding, in grinding wheel, the Bonding agent is some conducting material and 95% of m/c takes place by electrolysis and 5% by pure grinding.

Since hydrogen gas is produced in the electrolysis Rxn., so there will be a safe passage for its removal.

- Small size steam turbine blades are manufactured by ECM process.
- medium size gas turbine blades are ———,, ———,,– investment casting.
- large size water turbine blades are produced in a copying lathe using sialon as a tool material.

*5/10/2016

ECM

Mass ∝ charge

∝ It

$m = Z I t$ (gm)

Z ↓ Electrochemical equivalent

$Z = \frac{e}{F}$

e → chemical equivalent

F → Faraday's constant

$e = \frac{\text{Atomic wt.}}{\text{valency}}$

MRR → cm^3/s

$MRR = \frac{eI}{F\rho}$

$\delta = \frac{e}{F\rho}$ (specific MRR)

Electrode feed Rate

$= \delta \times S_1$ ← current density

$S_1 = I/A$

$I = \frac{\Delta V}{R}$

$R = \rho_s \frac{l}{A}$ ← gap

WB Pg (31)

Q6>

$\rho = 6000\ kg/m^3$

At. wt. = 56

v = 2

S/R

(put units in CGS)

	At. wt	val	
P	24	4	x
Fe	56	2	(1-x)

$$\frac{1}{e} = \frac{x \cdot 4}{24} + \frac{(1-x)2}{56}$$

$$MRR = \frac{eI}{F\rho}$$

$$50\ (mm^3/s) = \frac{e\,(2000A)}{96500 \times 6000 \times 1000 g}\ m^3$$

$$50 \times \left(\frac{1}{10}\right)^3 = \frac{e\,(2000)\,(100)^3}{96500 \times 6000 \times 1000}$$

$$= 3.45 \times 10^{-3}$$

$$e = 14.49$$

$$\frac{1}{14.49} = \frac{x}{6} + \frac{2-2x}{56}$$

$$\frac{1}{14.49} = \frac{56x + 12 - 12x}{336}$$

$\boxed{x = 0.25}$ 25 % Ans

Q10

$wt = 56$

$v = 2$

$\rho = 7.8\ gm/cm^3$

$I = ?$

$MRR = 2\ cm^3/min$

$$MRR = \frac{eI}{F\rho}$$

(a) ✓

(27) Fe (56 = wt, v = 2)

$$e = \frac{56}{2}$$

$$MRR = \frac{eI}{F\rho}$$

$I = 1000A$ $MRR = 0.26\ gm/s$

$\eta_I = 90\%$

Ti $wt = 48$ $I = 2000A$

$v = 3$ $90\% = \eta_I$ $MRR = ?$

0.29 Ans

$I_1 \rightarrow 0.9 \times I$ ✓

$I_2 \rightarrow 0.9 \times I$ ✓

(28)

~~R = ρ_s l/A = 6 × 0.6~~

$e = \frac{56}{2} = 28$

$MRR = \frac{eI}{F\rho}$

$= \frac{28 \times 480}{96500 \times 7.6}$

$MRR = 0.018 \frac{cm^3}{s}$

(29) $MRR = 0.036$

$feed = 5.88 \times 10^{-3} cm/s$

$A = 25 \times 25 \, mm^2$

CGS

$A = 625 \left(\frac{1}{10}\right)^2$

$l = 0.25$

$\rho_s = 3 \, \Omega \, cm$

$$R = \frac{3 \times 0.25 (1/10)}{625 (1/10)^2} = 0.012$$

$$I = \frac{\Delta V}{R} = \frac{12}{0.012} = 1000A$$

$$MRR = \frac{\frac{55.85}{2} \times 1000}{96500 \times 7860 \times 1000 \times /(100)^3}$$

MRR = 0.036

$$\delta = \frac{e}{F\rho} = \frac{\frac{55.85}{2} \times 100^3}{96500 \times 1000 \times 7860 \times 10^3}$$

$$\delta = 3.68 \times 10^{-8}$$

$$Feed = \delta \times \delta_1$$

$$= \delta \times \frac{I}{A} = \frac{3.68 \times 10^{-8} \times 1000}{(25 \times 25)(1/10)^2}$$

$$F = 5.88 \times 10^{-3} \, cm/s.$$

(30) $l = 2\,mm$

over voltage $= 2.5\,V$

$\rho_s = 50\,\Omega\text{-}mm$

feed rate $= 0.25\,mm/min$

$\rho = 7.86\,gm/cm^3$

$A = 56$

$Z = 2$

$\Delta V = ?$

Supply $= \Delta V -$ over.

$R = \rho_s \frac{l}{A} = 7.86 \times \frac{(2)(1/10)}{-}$

$$\frac{0.25\,(1/10)}{(60)} = \frac{e}{F\rho} \times \frac{I}{A}$$

$$\frac{0.25}{60 \times 10} = \frac{\left(\frac{56}{2}\right)}{96500 \times 7.86} \times \frac{I}{A}$$

$$4.16 \times 10^{-4} = 3.69 \times 10^{-5} \times \frac{I}{A}$$

$$11.29 = \frac{I}{A}$$

$$11.29 = \frac{\frac{\Delta V}{R}}{A} = \frac{\Delta V}{R} A = \Delta V \rho_s \frac{L}{A} A$$

$$= \Delta V\ 50 \times 1/10 \times 2/10$$

$\Delta V = 11.29$

Supply voltage $= 11.29 - 2.5$

$= 8.79\,V$ ✓ Ans

T1	Wt	V
Co	58.93	2
Ni	58.71	2
Cr	51.99	6

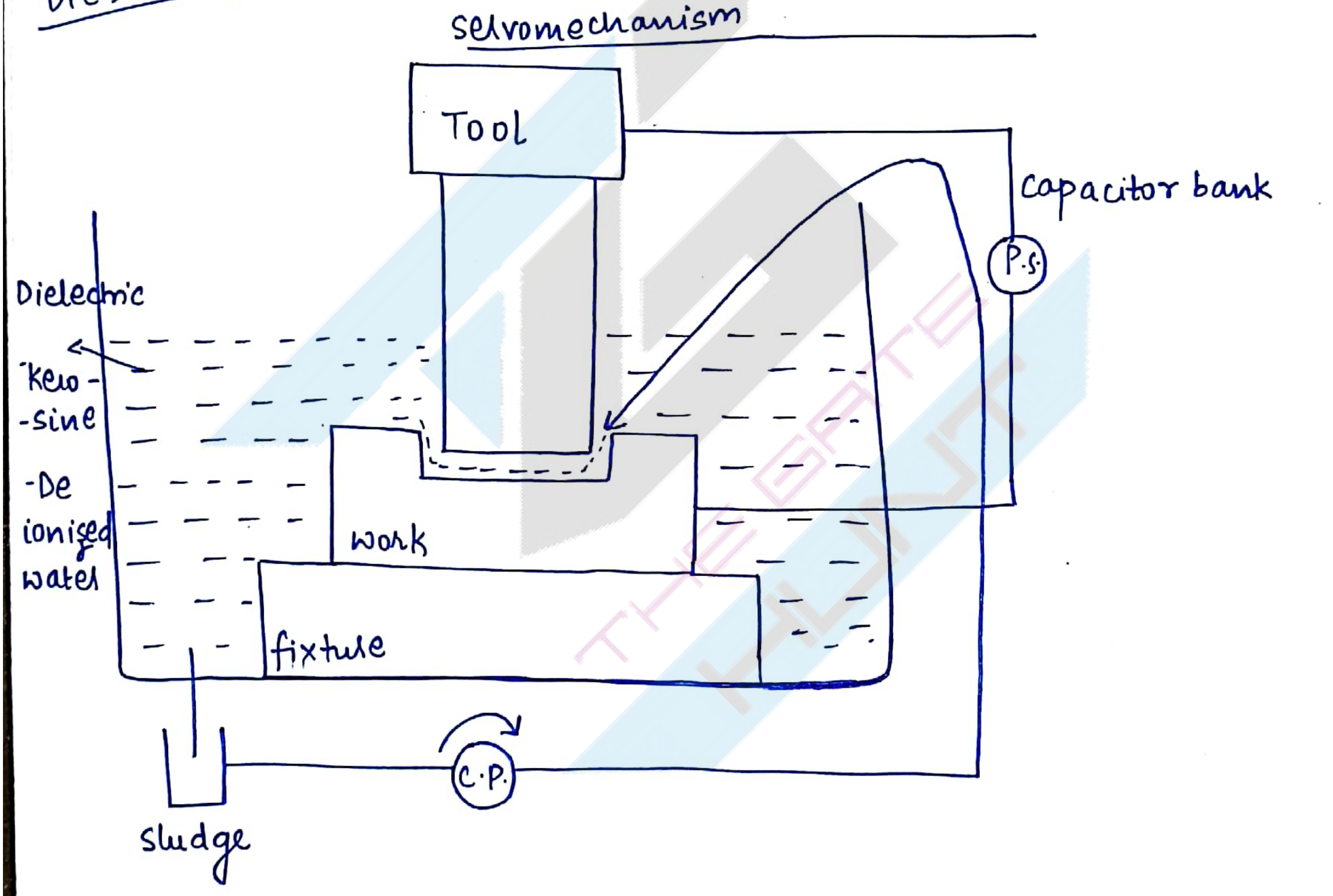
(HW)

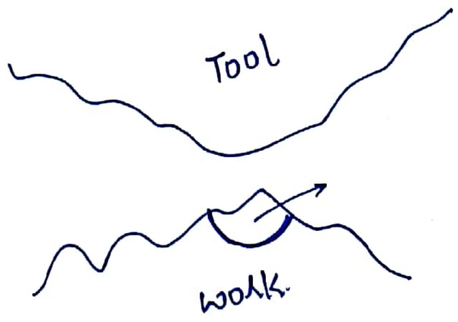
* ELECTRODISCHARGE MACHINING (EDM)

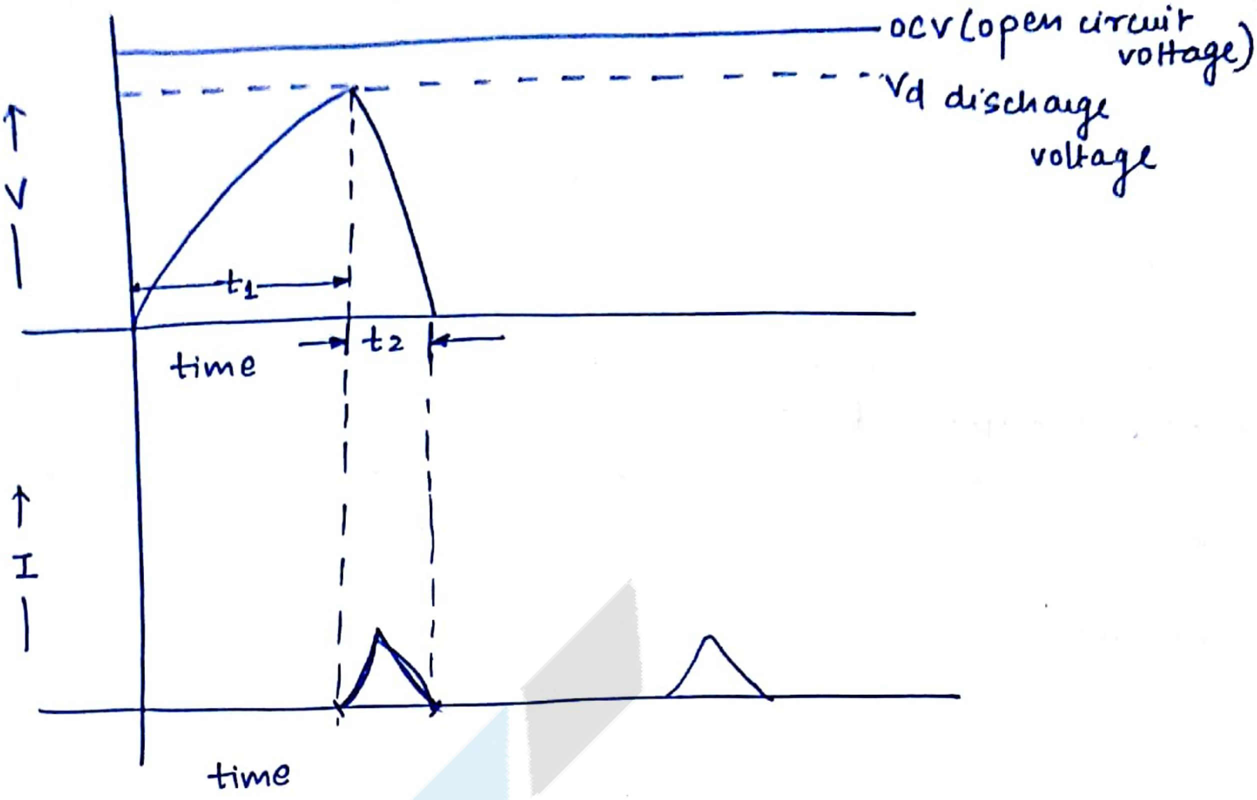
V↑ I↓

Pulsed DC

Diesinking







wire cut EDM

→ EDM is high voltage, low current process. Transformer is a power bank of capacitors and during the major portion of the cycle, capacitor bank charges. The movement voltage across capacitor reaches the discharge voltage, entire capacitor bank discharges. This produces spark at the Tool. This spark will developed at the poin where there is a minm. gap b/w the Tool and the work. Di-electr which was initially non-conducting turns to conduct into very small region. so arc will be transported through this dielectric & bombard the W/P. This produces crater over the work. As the spark is being transported, a portion of kerosene will also burn leaving carbon residue. These carbon residues acts like a solid lubricant which helps in chipping the material so the surface within the crater will be very smooth. Mechanics of material removal is melting, vapourization and errosion (obj → ~~corrosion~~ dont include).

The removed material if it gets accumulated in the machining area, it will decrease the material removal rate. It is because the spark will first interact with these removed material and the portion of that energy will be lost. A servomechanism is connected to a tool which senses the voltage between tool and the work. If this voltage decreases below the certain value, servomechanism withdraws the tool and flushing mechanism removes the material from the machining area. servomechanism also/again places the tool back to its original position. The process is generally used in Die sinking. Principle of wire cut EDM is exactly same and the process is used in cutting any profile in the workpiece. we keep on moving the wire so that wear on the wire is uniform. graphite is the material used as tool in EDM because not only its Melting point is high but also it can be machined to a great degree of accuracy.

$$Gap = 0.025 - 0.05 \text{ mm}$$

$$R_a \sim 0.25 \mu s \text{ (microns)}.$$

$$V_d = V_0 \left(1 - e^{-t/RC}\right)$$

t → time
R → Resistance
C → capacitance

$$\frac{V_d}{V_0} = 1 - e^{-t/RC}$$

$$e^{-t/RC} = 1 - \frac{V_d}{V_0} = \left(\frac{V_0 - V_d}{V_0}\right)$$

$$-t/RC = \ln\left(\frac{V_0 - V_d}{V_0}\right)$$

$$-t = RC \ln\left(\frac{V_0 - V_d}{V_0}\right)$$

$$\boxed{t = RC \ln\left(\frac{V_0}{V_0 - V_d}\right)}$$

$$\text{frequency} = 1/t = f$$

Energy transfer/spark

$$E = \frac{1}{2} C V_d^2$$

Avg. Power

$$P = \frac{E}{t_1 + t_2}$$

$t_2 << t_1$

$$P = \frac{E}{t} = \frac{C V_d^2}{2t}$$

$$P = \frac{C R}{2t\,R} V_0^2 (1 - e^{-t/RC})^2$$

Let $\boxed{\frac{t}{RC} = N}$

$$P = \frac{V_0^2}{2NR} (1 - e^{-N})^2$$

$$\frac{dP}{dN} = 0$$

$N = 1.26$

$V_d = 72\% \cdot V_0$

$$\frac{V_0^2}{2NR} (1 - e^{-N})^2$$

$$\frac{V_0^2}{2R} \frac{(1 - e^{-N})^2}{N}$$

$$\frac{1 + e^{-2N} - 2e^{-N}}{N}$$

$$\frac{1}{N} + \frac{e^{-2N}}{N} - \frac{2e^{-N}}{N}$$

$x^n \quad n x^{n-1}$

$x^{-1} = -1 x^{-1-1}$

$= \frac{-1}{x^2}$

$\frac{-1}{N^2}$

WB Q17
Pg 33

$V_d = 100V$

$t = 25 \mu s$

$P = 1 kW$

$C = ?$

$$P = \frac{C V_d^2}{2t}$$

$$P = \frac{C (100)^2}{2 \times 25}$$

(b) ✓

Q31

$V_c = V_s \times 0.716$

$R = 10 \Omega$

$C = 200 \mu F \rightarrow 10^{-6}$

Ans: 2.54 ms

$$\frac{V_c}{V_s} = 0.716 = 1 - e^{-t/RC}$$

$$0.716 = 1 - e^{-t/2 \times 10^{-3}}$$

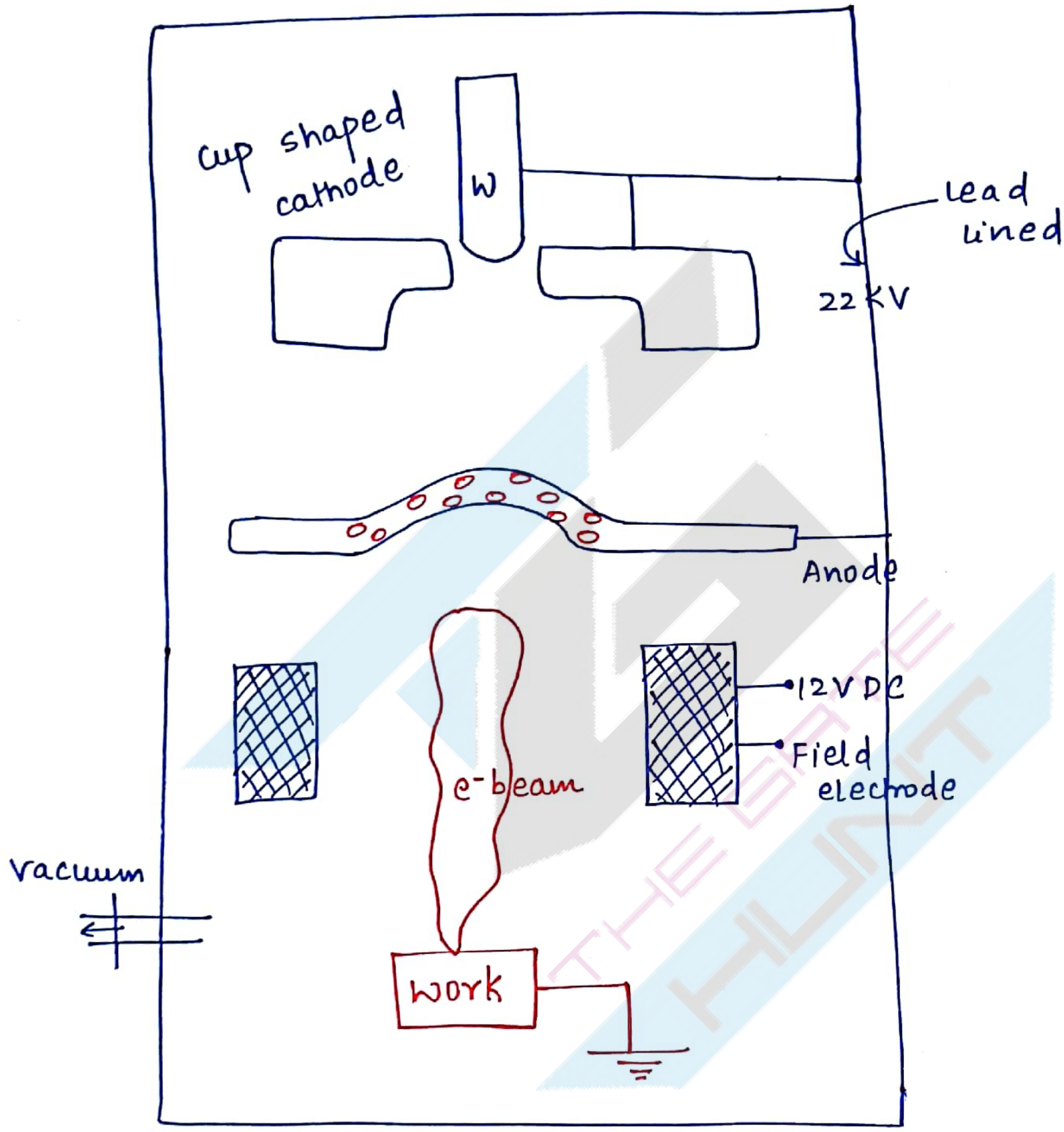
$$0.998 = e^{-t/2 \times 10^{-3}}$$

$$-2.002 \times 10^{-3} = -t/2 \times 10^{-3}$$

T2 $R = 40\,\Omega$

$C = 20\,\mu F =$

* EBW ($e^{\ominus}$ Beam welding):-

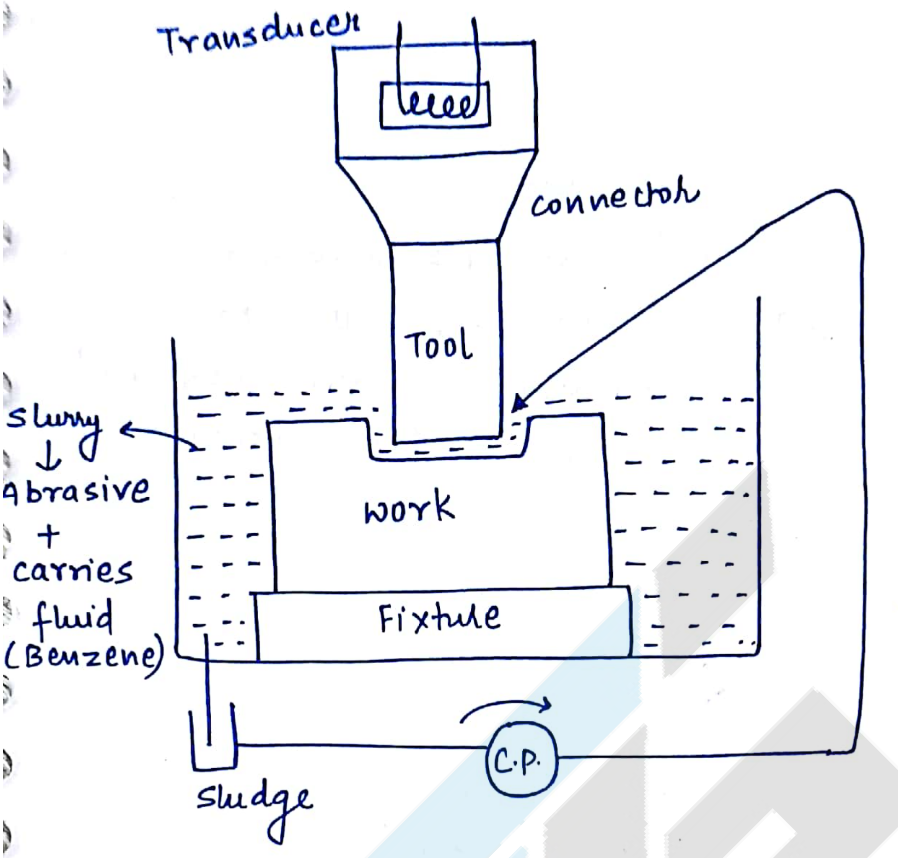


* Ultrasonic (USM) Machining :-

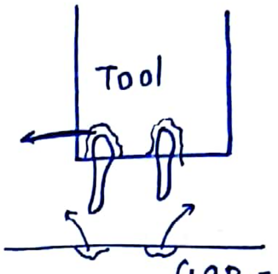
(165)

Magnetostrictive

Piezoelectric



Tool wear ↑ USM, EDM, ECM ↓ MRR



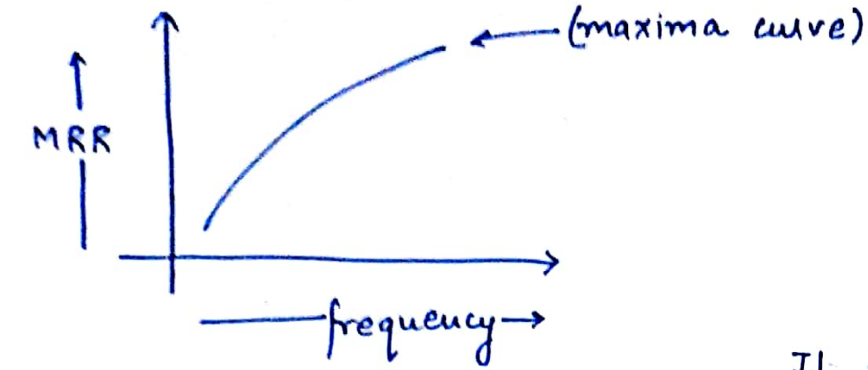
Gap = 0.25 mm

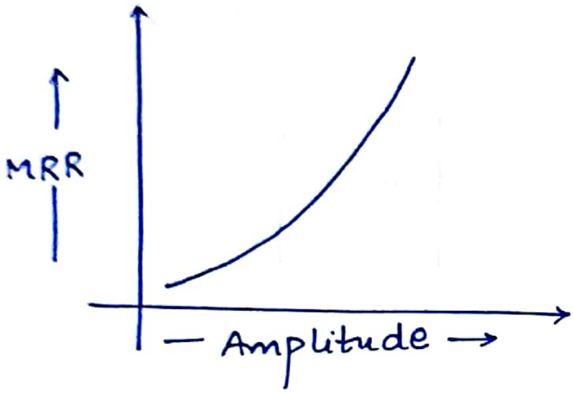
Ra = 0.25 - 0.75 μs

(CLA value)

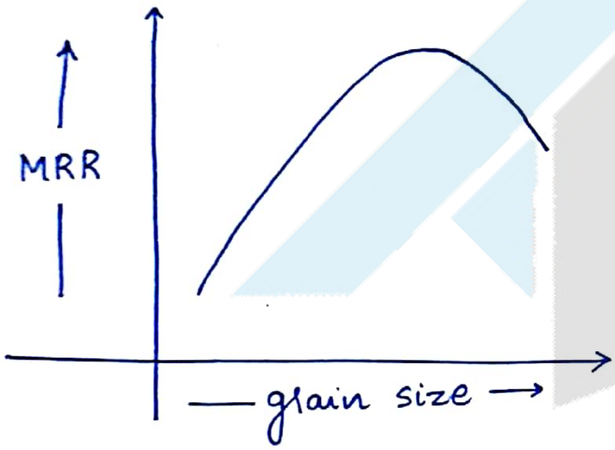
work material needs to be conducting when ECM & EDM processes has to be used. For machining glasses & other ceramic materials, USM is used. High frequency vibrations are produced by a transducer and with the help of a connector, it is transported to the tool. Tool is made up of some ductile material; so abrasives are /will be embedded into the tool. During the downward journey of a tool, abrasives will hammer the work material and small portion of the material will be chipped out. The process will be uneconomical for machining ductile materials because after machining, abrasives will remain into the w/P, so a separate process is required to clean the workpiece. The Tool is slightly tapered to maintain linearity in the machining process.

By increasing the frequency, impact on the work will be there more no. of times per unit time so MRR will go up.

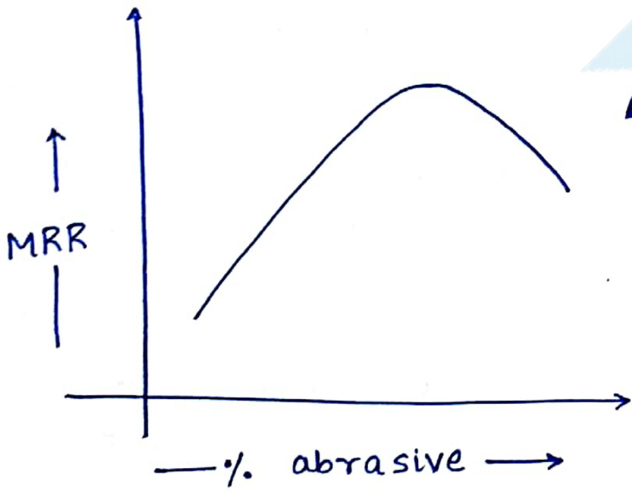




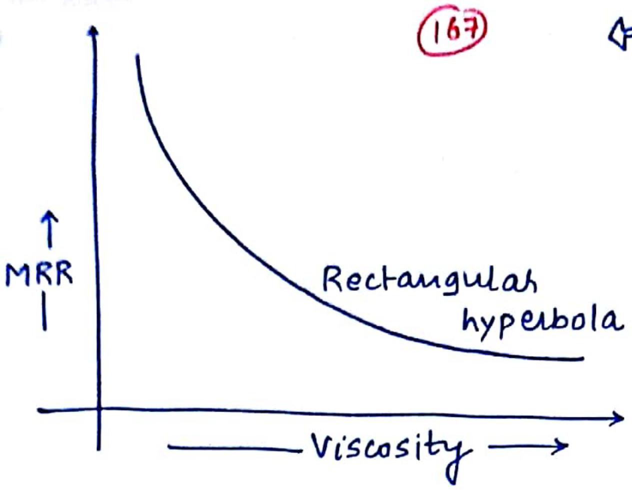
If amplitude is high, abrasives will get more time to accelerate this will ↑ the momentum of abrasives and hence MRR will increase.



By increasing the size of abrasives, impact will be there on the larger area, so the MRR will go up But when the size of abrasive goes beyond a certain value, it approaches towards the amplitude, so abrasives will not have sufficient time to accelerate. This will decrease MRR.

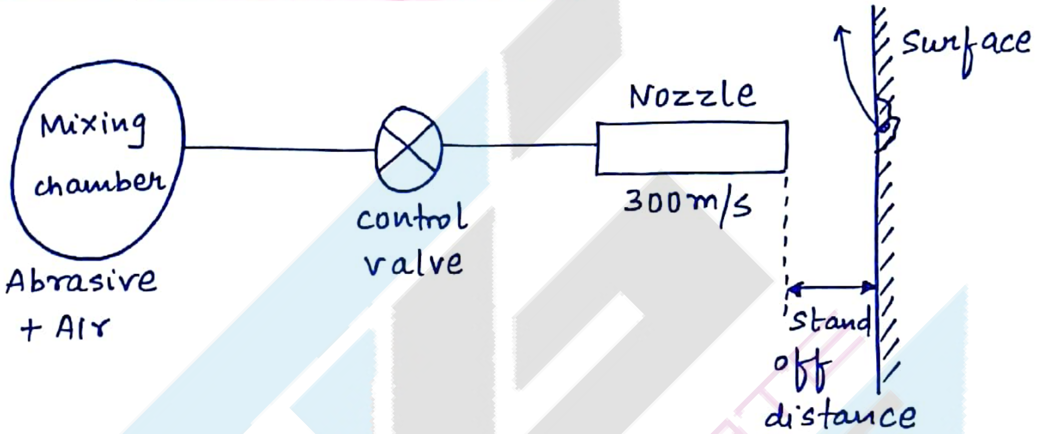


Initially by increasing the concentration of abrasives, impact will be there at more no. of places, so MRR will go up. But when concentration exceeds beyond a certain value, there will be collision b/w the abrasives and a portion of momentum will be loss, so this will decrease MRR.



⇦ If the viscosity of the carrier fluid is high, disposing the chips from the machining area will be difficult, so a portion of Removed material will always remain in the tool workpiece gap. So abrasives will first collide with the removed material and hence a portion of their energy will be lost. so, MRR will keep on decreasing.

* ## ABRASIVE JET MACHINING :-



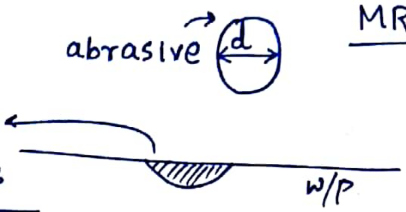
Mixture of abrasive and carrier fluid comes out through the nozzle and when abrasives bombard the work, there will be localized crack. Due to high speed wind, the crack will be propogated and the chips will blow away. The process is used in :- ⓐ making very fine holes. (in the Tool).

ⓑ M/cing inaccessible areas.

ⓒ Cleaning metallic moulds.

ⓓ Cutting flash from forged component.

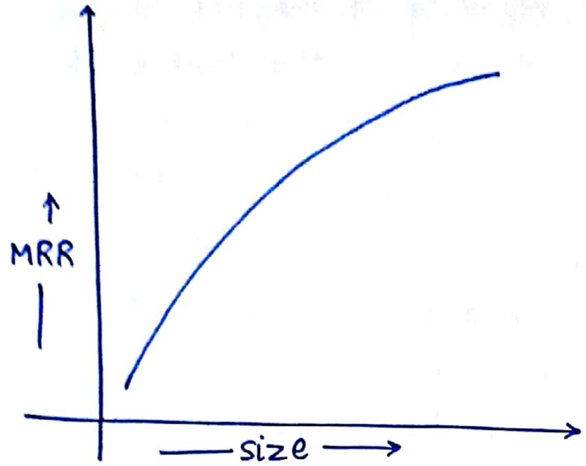
ⓔ Removing parting lines, etc.



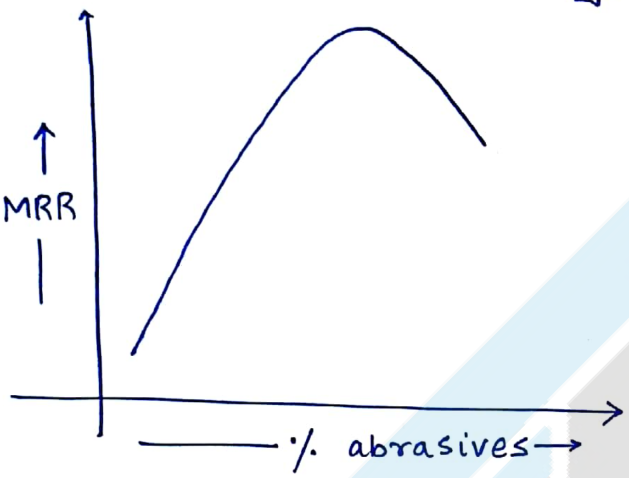
MRR = volume of crater × No. of Abrasi/time

$\propto d^3$

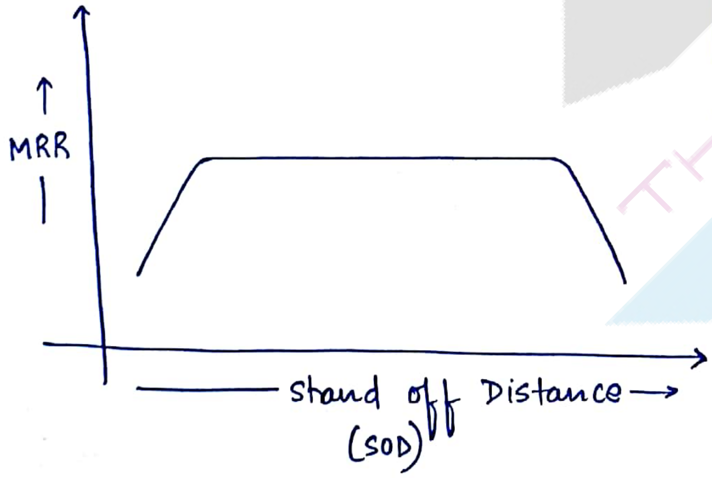
$MRR \propto d^3$



⇐ as the size ↑, abrasive will impact the larger area, hence MRR ↑.



⇐ (same as previous one)

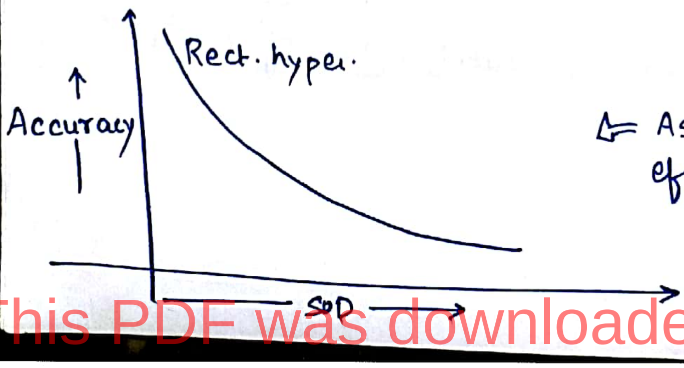


⇐ {initially when SOD ↑, more time for accl^r.}
↳ momentum ↑ MRR ↑.

In middle, Balance b/w accl^r. & drag (momentum kha gaya), when stand off dis. ↓, MRR ↓ }

SIR → as the SOD increases, there will be more time for accleration, so MRR will also increase.

In B/w there will be a Balance, b/w acceleration and air drag, so constant MRR will observed. after a certain distance, drag overpowers and hence, MRR will go down.



⇐ As SOD increases, due to mushrooming effect, accuracy will be lost.

CH # 10

(1) → b
(2) → b
(3) → d
(4) → b
(5) → d
(6) → a → b(25)
(7)
(8) b
(9) d (11) b
(12) d
(13) d
(14) b
(15) d
(16) c
(17) ✓
(18) d ← learn the sequence
(19) a ←
(20) a
(21) c (not deposition)
(22) d
(23) c
(24) c
(25) Repeat
(26) a
(27) ✓

(32) specific energy × MRR = Energy

(169)

$12 \times W \times t_1 \times V = 12$

$W \to 150\mu s$, $t_1 \to 1mm$, $V \to ?$

$$V = \frac{1}{150 \times 10^{-6} \times 1}$$

2. SYLLABUS

ME6402 MANUFACTURING TECHNOLOGY – II L T P C 3 0 0 3

OBJECTIVES:

- To understand the concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and broaching.
- To understand the basic concepts of Computer Numerical Control (CNC) of machine tools and CNC Programming

UNIT I THEORY OF METAL CUTTING 9

Mechanics of chip formation, single point cutting tool, forces in machining, Types of chip, cutting tools– nomenclature, orthogonal metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT II TURNING MACHINES 9

Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes- tool layout – automatic lathes: semi automatic – single spindle: Swiss type, automatic screw type – multispindle.

UNITIII SHAPER, MILLING AND GEAR CUTTING MACHINES 9

Shaper - Types of operations. Drilling, reaming, boring, Tapping. Milling operations-types of milling cutter. Gear cutting – forming and generation principle and construction of gear milling, hobbing and gear shaping processes –finishing of gears.

UNIT IV ABRASIVE PROCESS AND BROACHING 9

Abrasive processes: grinding wheel – specifications and selection, types of grinding process–cylindrical grinding, surface grinding, centreless grinding and internal grinding- Typical applications –concepts of surface integrity, broaching machines: broach construction – push, pull, surface and continuous broaching machines

UNIT V CNC MACHINING 9

Numerical Control (NC) machine tools – CNC types, constructional details, special features, machining centre, part programming fundamentals CNC – manual part programming – micromachining – wafer machining

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to understand and compare the functions and applications of different metal cutting tools and also demonstrate the programming in CNC machining.

TEXT BOOKS:

- Hajra Choudhury, "Elements of Workshop Technology", Vol.II., Media Promoters
- Rao. P.N “Manufacturing Technology - Metal Cutting and Machine Tools", Tata McGraw-Hill, New Delhi, 2003.

REFERENCES:

- Richerd R Kibbe, John E. Neely, Roland O. Merges and Warren J.White “Machine Tool Practices”, Prentice Hall of India, 1998
- HMT, "Production Technology", Tata McGraw Hill, 1998.
- Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", Mc Graw Hill, 1984
- Roy. A.Lindberg, “Process and Materials of Manufacture,” Fourth Edition, PHI/Pearson Education 2006.

3. TABLE OF CONTENTS

ME6402 MANUFACTURING TECHNOLOGY – II L P T C

1. **Aim and objective of the subject**

To understand the concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, and grinding and allied machines and broaching.

To understand the basic concepts of Computer Numerical Control (CNC) of machine tools and CNC Programming.

2. **Need and importance for study of the subject**

The students can able to understand and compare the functions and applications of different metal cutting tools and also demonstrate the programming in CNC machining.

LESSON PLAN

Name of subject & code: ME6402 & Manufacturing Technology–II

Text book

1. Hajra Choudhury, "Elements of Workshop Technology", Vol.II., Media Promoters
2. Rao. P.N "Manufacturing Technology - Metal Cutting and Machine Tools", Tata McGraw-Hill, New Delhi,2003.

References

1. Richerd R Kibbe, John E. Neely, Roland O. Merges and Warren J.White "Machine Tool Practices", Prentice Hall of India,1998
2. HMT, "Production Technology", Tata McGraw Hill,1998.
3. GeofreyBoothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1984
4. Roy. A.Lindberg, "Process and Materials of Manufacture," Fourth Edition, PHI/Pearson Education2006.

Sl. No.	WEEK	Topics	No of Hours	Book No.
UNIT-I : THEORY OF METAL CUTTING				
1	WEEK I	Mechanics of chip formation	1	T1,T2
2		Types of chip	1	T1
3		single point cutting tool	1	T1,R2
4		cutting tools – nomenclature	1	T1,R5
5		orthogonal metal cutting, forces in machining	1	T1
6	WEEK II	thermal aspects, cutting tool materials	1	T1,R5,T2
7		tool wear,	1	T1,R1
8		tool life, cutting fluids	1	T2, R5
9		surface finish, Machinability	1	T2,R5
UNIT – II : TURNING MACHINES				
10	WEEK III	Centre lathe, constructional features, specification, operations	1	T1,R5
11		taper turning methods	2	T1,R5
12		thread cutting methods, special attachments	1	T2
13		machining time and power estimation	1	T1,T2
14		Capstan and turret lathes	1	T1
15	WEEK IV	tool layout	1	T1,T2
16		automatic lathes: semi automatic ,single spindle	1	T2,R5
17		Swiss type, automatic screw type ,multi spindle	1	T2,R5
UNIT – III : SHAPER, MILLING AND GEAR CUTTING MACHINES				
18	WEEK V	Shaper - Types of operations	2	T1,T2
19		Drilling ,reaming, boring, Tapping	1	T1,R5
20		Milling operations, types of milling cutter.	2	T1,R5

Sl. No.	WEEK	Topics	No of Hours	Book No.
21	WEEK VI	Gear cutting – forming and generation principle	1	T1
22		construction of gear milling ,hobbing and gear shaping processes	2	T1,R5
23		finishing of gears.	1	R5
UNIT – IV : ABRASIVE PROCESS AND BROACHING				
24	WEEK VII	Abrasive processes: grinding wheel – specifications and selection	3	T1,T2
25		types of grinding process– cylindrical grinding, surface grinding, centreless grinding and internal grinding	2	T2,R5
25	WEEK VIII	Typical applications – concepts of surface integrity	1	T1
26		broach construction	1	T1,R5
27		push, pull, surface and continuous broaching machines	2	T1,R5
UNIT – V : CNC MACHINING				
28	WEEK IX	Numerical Control (NC) machine tools	1	T1,T2
29		CNC types	1	T2,R5
30		constructional details, special features	2	T1
31	WEEK X	machining centre	1	T1,R5
32		part programming fundamentals CNC	1	T1,R5
33		manual part programming	2	T2,R5
34		Micromachining, wafer machining	1	T1, T2,R5

UNIT-I

THEORY OF METAL CUTTING

PART-A

1. **List the various metal removal processes? (AU Apr2011,Dec12)**
   - Non cutting process or chip less process.
   - Cutting process or Chip process.
2. **How chip formation occurs in metal cutting? (AU Apr 2011,Dec11)**

The material of the work piece is stressed beyond its yield point under compressive force. This cause the material to deform plastically and shear off.

3. **What is tool wear? (AU Apr2011)**

During machining the toll is subjected to three important factors such as forces, temperature and sliding action due to relative motion between tool and work piece. Due to these factors tool will undergo wear.

4. **Mention the cutting fluids? (AU Apr2012)**

Two basic types are
   - Water based cutting fluids
   - Straight or heat oil based cutting fluids.

5. **Define tool life. (AU Dec 2010) (AU Apr2013)**

Tool life is defined as the time elapsed between two consecutive tool re-sharpening. During this period the toll serves effectively and efficiently.

6. **What are the objectives and functions of cutting fluids?(AU Dec 2010,Apr13)**
   - It is used to cool the cutting tool and work piece
   - It improves surface finish
   - It protects finished surface from corrosion
   - It washes away chips from tool
7. **Briefly explain the effect of rake angle during cutting? (AU Dec 2010,Apr09)**

Effect of back rack angle:
For softer material greater angle should be given For harder material smaller angle is enough
Effect of Side rack angle: Curling of chip depends on this angle.

8. **What are the factors responsible for built up edge in cutting tools?(AU Dec 2009)**
   (i) Low cutting speed
   (ii) Small rake angle
   (iii) Coarse feed
   (iv) Strong adhesion between chip and tool face.

9. List out the essential characteristics of a cutting fluid. (AU Dec 2009,Apr12)
   (v) It should have good lubricating properties
   (vi) High heat absorbing capacity
   (iii) High flashpoint
   (iv) It should be odorless

10. Name the various cutting tool materials. (AU Dec 2008,Apr09).

- Carbon tool steel
- High speed steel
- Cemented carbides
- Ceramics
- Diamonds

11. Give two examples of orthogonal cutting. (AU Dec2007)

(vii) Turning (ii) Facing (iii) Thread cutting (iv) Parting off

12. What are the four important characteristics of materials used for cutting tools?

(viii) Hot hardness (ii) Wear resistance (iii High thermal conductivity (iv) Easy to grind and sharpen (v) Resistance to thermal shock

13. What is the function of chip breakers? (AU Dec2006)

The chip breakers are used to break the chips into small pieces for removal, safety and to prevent both the machine and work damage

14. Name the factors that contribute to poor surface finish in cutting.(AU Dec2006)

- Cutting speed
- Feed
- Depth of cut

15. Compare orthogonal and oblique cutting? (AU Dec 2012, Apr2010)

Sl. No.	*Orthogonal cutting*	*Oblique cutting*
1.	The cutting edge of the tool is perpendicular to the cutting velocity vector.	The cutting edge is inclined at an acute angle with the normal to the cutting velocity vector.
2.	The chip flows over the tool face and the direction of chip-flow velocity is normal to the cutting edge.	The chip flows on the tool face making an angle with the normal on the cutting edge.

PART–B

1. What is chip? Explain different types of chips produced during formation? (AU Dec 2010) (AU Apr 2010) (AU Dec2006)

TYPES OFCHIPS

Different types of chips of various shape, size,colour etc.are produced by machining depending

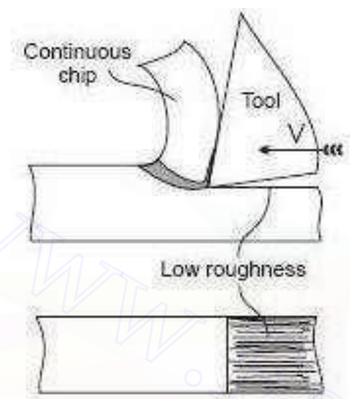
- Type of cut, i.e., continuous (turning, boring etc.) or intermittent cut (milling).
- Work material (brittle or ductile etc.).
- Cutting tool geometry (rake, cutting angles etc.).
- Levels of the cutting velocity and feed (low, medium or high).

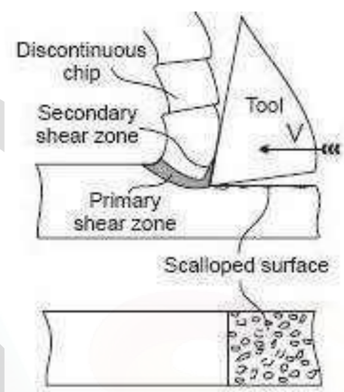
Cutting fluid (type of fluid and method of application).

The basic major types of chips and the conditions generally under which such types of chips form are given below:

CONTINUOUS CHIPS WITHOUT BUR

When the cutting tool moves towards the work piece, there occurs a plastic deformation of the work piece and the metal is separated without any discontinuity and it moves like a ribbon. The chip moves along the face of the tool. This mostly occurs while cutting a ductile material. It is desirable to have smaller chip thickness and higher cutting speed in order to get continuous





chips. Lesser power is consumed while continuous chips are produced. Total life is also mortised in this process. Formation of continuous chips Formation of discontinuous chips

The following condition favors the formation of continuous chips without BUE chips:

- Work material -ductile.
- Cutting velocity -high.
- Feed -low.
- Rake angle - positive and large.
- Cutting fluid - both cooling and lubricating.

DISCONTINUOUSCHIPS

This is also called as segmental chips. This mostly occurs while cutting brittle material such as cast iron or low ductile materials. Instead of shearing the metal as it happens in the previous process,themetal is being fractured like segments of fragments and they pass over the tool faces. Tool life can also be more in this process. Power consumption as in the previous case is alsolow..

The following condition favors the formation of discontinuous chips:

- Of irregular size and shape: - work material - brittle like grey cast iron.
- Of regular size and shape: - work material ductile but hard and work hardenable.
- Feed rate -large.
- Tool rake -negative.
- Cutting fluid - absent or inadequate.

CONTINUOUS CHIPS WITH BUE

When cutting a ductile metal, the compression of the metal is followed by the high heat at face. This in turns enables part of the removed metal to be welded into the tool. This is known as built up edge, a very hardened layer of work material attached to the tool face, which tends to act as a cutting edge itself replacing the real cutting tooledge.

The built-up edge tends to grow until it reaches a critical size (~0.3 mm) and then passes off With the chip, leaving small fragments on the machining surface. Chip will break free and cutting forces are smaller, but the effect is a rough machined surface. The built-up edge disappears at high cutting speeds. The weld metal is work hardened or strain hardened. While the cutting process is continued, some of built up edge may be combined with the chip and pass along the tool face. Some of the built up edge may be permanently fixed on the tool face. This produces a rough surface finish and the tool life may be reduced.

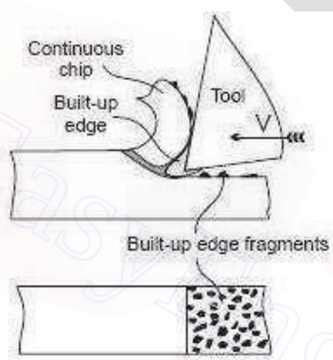


Fig. 1.26 Formation of continuous chips with BUE

The following condition favors the formation of continuous chips with BUE chips:

- Work material -ductile.
- Cutting velocity - low (~0.5m/s,).
- Small or negative rake angles.
- Feed - medium or large.
- Cutting fluid - inadequate or absent.

Often in machining ductile metals at high speed, the chips are deliberately broken into small segments of regular size and shape by using chip breakers mainly for convenience and reductionof chip-tool contactlength.

2. Explain cutting fluid purposes, method of application and their types? (AU Dec 2009 , Apr10)

Purposes and application of cutting fluid

□Cooling of the job and the tool to reduce the detrimental effects of cutting temperature on the job and the tool.

- Lubrication at the chip - tool interface and the tool flanks to reduce cutting forces and friction and thus the amount of heat generation.
- Cleaning the machining zone by washing away the chip - particles and debris which, if present, spoils the finished surface and accelerates damage of the cutting edges.
    - Protection of the nascent finished surface - a thin layer of the cutting fluid sticks to the machined surface and thus prevents its harmful contamination by the gases like SO_2, O_2, H_2S, and N_XO_Y present in the atmosphere.

However, the main aim of application of cutting fluid is to improve machinability through reduction of cutting forces and temperature, improvement by surface integrity and enhancement of tool life.

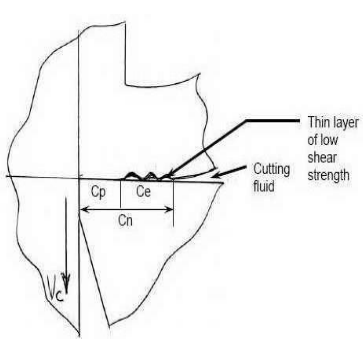
Essential properties of cutting fluids

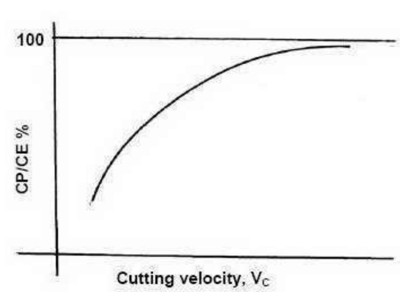
To enable the cutting fluid fulfill its functional requirements without harming the Machine - Fixture - Tool - Work (M-F-T-W) system and the operators, the cutting fluid should possess the following properties:

- *For cooling:*
    - High specific heat, thermal conductivity and film coefficient for heat transfer.
    - Spreading and wetting ability.
- *For lubrication:*
    - High lubricity without gumming and foaming.
    - Wetting and spreading.
    - High film boiling point.
    - Friction reduction at extreme pressure (EP) and temperature.
- Chemical stability, non-corrosive to the materials of the M-F-T-W system.
- Less volatile and high flashpoint.
- High resistance to bacterial growth.
- Odorless and also preferably colourless.
    - Non toxic in both liquid and gaseous stage.
    - Easily available and low cost.

Principles of cutting fluid action

The chip-tool contact zone is usually comprised of two parts; plastic or bulk contact zone and elastic contact zone as indicated in Figure





Cutting fluid action in machining Apportionment of plastic and elastic contact zonewithincrease in cutting velocity The cutting fluid cannot penetrate or reach the plastic contact zone but enters in the elastic contact zone by capillary effect. With the increase in cutting velocity, the fraction of plastic contact zone graduallyincreases and covers almost the entire chip-tool contact zone. Therefore, at high speed machining, thecutting fluid becomes unable to lubricate and cools the tool and the job only by bulk external cooling.

The chemicals likechloride, phosphate or sulphide present in the cutting fluid chemically reacts with the work material at the chip under surface under high pressure and temperature and forms a thin layer of the reaction product. The low shear strength of that reaction layer helps in reducing friction.

To form such solid lubricating layer under high pressure and temperature some extreme pressure additive (EPA) is deliberately added in reasonable amount in the mineral oil or soluble oil. For extreme pressure, chloride, phosphate or sulphide type EPA is used depending upon the workingtemperature, moderate (2000 C ~ 3500 C), high (3500 C ~ 5000 C) and very high (5000 C ~ 8000 C) respectively.

Types of cutting fluids and their application

Generally,cuttingfluidsareemployedinliquidformbutoccasionallyalsoemployedingaseous form. Only for lubricating purpose, often solid lubricants are also employed in machining and grinding.

The cutting fluids, which are commonly used, are:

Air blast or compressed air only

Machining of some materials like grey cast iron become inconvenient or difficult if any cutting fluid is employed in liquid form. In such case only air blast is recommended for cooling and cleaning.

Solid or semi-solid lubricant

Paste, waxes, soaps, graphite, Moly-disulphide (MoS_2) may also often be used, either applied directly to the workpiece or as an impregnant in the tool to reduce friction and thus cutting forces, temperature and toolwear.

Water

For its good wetting and spreading properties and very high specific heat, water is considered as the best coolant and hence employed where cooling is most urgent.

Soluble oil

Water acts as the best coolant but does not lubricate. Besides, use of only water may impair the machine-fixture-tool-work system by rusting. So oil containing some emulsifying agent and additive like EPA, together called cutting compound, is mixed with water in a suitable ratio (1 ~ 2 in 20 ~ 50). This milk like white emulsion, called soluble oil, is very common and widely used in machining andgrinding.

Cutting oils

Cutting oils are generally compounds of mineral oil to which are added desired type and amount of vegetable, animal or marine oils for improving spreading, wetting and lubricating properties. As and when required some EP additive is also mixed to reduce friction, adhesion and BUE formation in heavy cuts.

Chemical fluids

These are occasionally used fluids which are water based where some organic and or inorganic materials are dissolved in water to enable desired cutting fluid action.

- ***Chemically inactive type*** - high cooling, anti-rusting and wetting but less lubricating.
- *Active (surface) type* - moderate cooling and lubricating.

Cryogenic cutting fluid

Extremely cold (cryogenic) fluids (often in the form of gases) like liquid CO2 or N2 are used in some special cases for effective cooling without creating much environmental pollution and healthhazards.

Methods of application of cutting fluid

The effectiveness and expense of cutting fluid application significantly depend also on how it is applied in respect of flow rate and direction of application. In machining, depending upon the requirement and facilities available, cutting fluids are generally employed in the following ways (flow):

- Drop-by-drop under gravity.
- Flood under gravity.
- In the form of liquid jet(s).
- Mist (atomized oil) with compressed air.
- Z-Z method - centrifugal through the grinding wheels (pores)

The direction of application also significantly governs the effectiveness of the cutting fluid in respect of reaching at or near the chip-tool and work-tool interfaces. Depending upon the requirement and accessibility the cutting fluid is applied from top or side(s). In operations like deep hole drilling the pressurized fluid is often sent through the axial or inner spiral hole(s) of the drill.

For effective cooling and lubrication in high speed machining of ductile metals having wide and plastic chip-tool contact, cutting fluid may be pushed at high pressure to the chip-tool interface through hole(s) in the cuttingtool

Selection of cutting fluid

The benefits of application of cutting fluid largely depend upon proper selection of the typeof

the cutting fluid depending upon the work material, tool material and the machining condition. As for example, for high speed machining of not-difficult-to-machine materials greater cooling type fluids are preferred and for low speed machining of both conventional and difficult-to-machine materials greater lubricating type fluid ispreferred.

Selection of cutting fluids for machining some common engineering materials and operations are presented asfollows:

Grey castiron:

- Generally dry for its self lubricating property.
- Air blast for cooling and flushing chips.
- Soluble oil for cooling and flushing chips in high speed machining and grinding.

Steels:

- If machined by HSS tools, sol. Oil (1: 20 ~30) for low carbon and alloy steels and neat oil with EPA for heavy cuts
- If machined by carbide tools thinner sol. Oil for low strength steel, thicker sol. Oil (1:10 ~ 20) for stronger steels and straight sulphurise oil for heavy and low speed cuts and EP cutting oil for high alloy steel.
- Often steels are machined dry by carbide tools for preventing thermal shocks.

Aluminium and its alloys:

- Preferably machined dry.
- Light but oily soluble oil.
- Straight neat oil or kerosene oil for stringent cuts.

Copper and its alloys:

- Water based fluids are generally used.
- Oil with or without inactive EPA for tougher grades of Cu-alloy.

Stainless steels and Heat resistant alloys:

- High performance soluble oil or neat oil with high concentration with chlorinated EP additive.

The brittle ceramics and cermets should be used either under dry condition or light neat oil in case of finefinishing.

Grinding at high speed needs cooling (1: 50 ~ 100) soluble oil. For finish grinding of metals and alloys low viscosity neat oil is alsoused.

3. Explain various cutting tool materials? (AU Apr 2011,Dec12)

Essential properties of cutting tool materials

The cutting tools need to be capable to meet the growing demands for higher productivity and economy as well as to machine the exotic materials which are coming up with the rapid progress in science and technology. The cutting tool material of the day and future essentially require the following properties to resist or retard the phenomena leading to random or early tool failure:

- High mechanical strength; compressive, tensile, and TRA.

- Fracture toughness - high or at least adequate.
- High hardness for abrasion resistance.
- High hot hardness to resist plastic deformation and reduce wear rate at elevated temperature.
- Chemical stability or inertness against work material, atmospheric gases and cutting fluids.
- Resistance to adhesion and diffusion.
- Thermal conductivity - low at the surface to resist incoming of heat and high at the core to quickly dissipate the heat entered.
- High heat resistance and stiffness.
- Manufacturability, availability and low cost.

Needs and chronological development of cutting tool materials

With the progress of the industrial world it has been needed to continuously develop and improve the cutting tool materials andgeometry:

- To meet the growing demands for high productivity, quality and economy of machining.
- To enable effective and efficient machining of the exotic materials those are coming up with the rapid and vast progress of science and technology.
- For precision and ultra-precision machining.
- For micro and even nano-machining demanded by the day and future.

It is already stated that the capability and overall performance of the cutting tools depend upon:

- The cutting tool materials.
- The cutting tool geometry.
- Proper selection and use of those tools.
- The machining conditions and the environments.

Characteristics and applications of cutting tool materials

a) High Speed Steel (HSS)

Advent of HSS in around 1905 made a break through at that time in the history of cutting tool materials though got later superseded by many other novel tool materials like cemented carbides and ceramics which could machine much faster than the HSS tools.

The basic composition ofHSS is 18% W, 4% Cr, 1% V, 0.7% C and rest Fe. Such HSS tool could machine (turn) mild steel jobs at speed only up to 20 ~ 30 m/min (which was quite substantial thosedays)

However, HSS is still used as cutting tool material where:

- The tool geometry and mechanics of chip formation are complex, such as helical twist drills, reamers, gear shaping cutters, hobs, form tools, broaches etc.

- Brittle tools like carbides, ceramics etc. are not suitable under shock loading.
- The small scale industries cannot afford costlier tools.
- The old or low powered small machine tools cannot accept high speed and feed.
- The tool is to be used number of times by sharpening.

With time the effectiveness and efficiency of HSS (tools) and their application range were gradually enhanced by improving its properties and surface conditionthrough:

- Refinement of microstructure.
- Addition of large amount of cobalt and Vanadium to increase hot hardness and wear resistance respectively.
- Manufacture by powder metallurgical process.
- Surface coating with heat and wear resistive materials like TiC, TiN, etc. by Chemical Vapour
- Deposition (CVD) or Physical Vapour Deposition (PVD)

b) Stellite

- This is a cast alloy of Co (40 to 50%), Cr (27 to 32%), W (14 to 19%) and C (2%).Stellite is quite tough and more heat and wear resistive than the basic HSS (18 - 4 - 1) But such satellite as cutting tool material became obsolete for its poor grindability and especially after the arrival of cemented carbid

d) Sintered Tungsten carbides

- The materials advent of sintered carbides made another breakthrough in the history of cutting tool

i) Straight or single carbide

- First the straight or single carbide tools or inserts were powder metallurgical produced by mixing, compacting and sintering 90 to 95% WC powder with cobalt. The hot, hard and wear resistant

WCgrainsareheldbythebinderCowhichprovidesthenecessarystrengthandtoughness.

Such tools are suitable for machining grey cast iron, brass, bronze etc. which produce short discontinuous chips and at cutting velocities two to three times of that possible for HSS tools.

Compositecarbides

- Single carbide is not suitable for machining steels because of rapid growth of wear, particularly crater wear, by diffusion of Co and carbon from the tool to the chip under the high stress

and temperature bulk (plastic) contact between the continuous chip and the tool surfaces.

- For machining steels successfully, another type called composite carbide have been developed by adding (8 to 20%) a gamma phase to WC and Co mix. The gamma phase is a mix of TiC, TiN, TaC, NiCetc. which are more diffusion resistant than WC due to their more stability and less wettability by steel.

ii) Mixed carbides

- Titanium carbide (TiC) is not only more stable but also much harder than WC. So for machining ferritic steels causing intensive diffusion and adhesion wear a large quantity (5 to 25%) of TiC is added with WC and Co to produce another grade called mixed carbide. But increase in TiC content reduces the toughness of the tools. Therefore, for finishing with light cut but high speed, the harder grades containing up to 25% TiC are used and for heavy roughing work at lower speeds lesser amount (5 to 10%) of TiC is suitable.

e) Plain ceramics

- Inherently high compressive strength, chemical stability and hot hardness of the ceramics led to powder metallurgical production of indexable ceramic tool inserts since1950.
- Alumina (Al_2O_3) is preferred to silicon nitride (Si_3N_4) for higher hardness and chemical stability. Si_3N_4 is tougher but again more difficult to process. The plain ceramic tools are brittle in nature and hence had limited applications.

Cutting tool properties of alumina ceramics

Advantages	**Shortcoming**
Very high hardness	Poor toughness
Very high hot hardness	Poor tensile strength
Chemical stability	Poor TRS
Anti welding	Low thermal
Less diffusivity	Less density
High abrasion resistance	
High melting point	
Very low thermal conductivity*	
Very low thermal expansion	

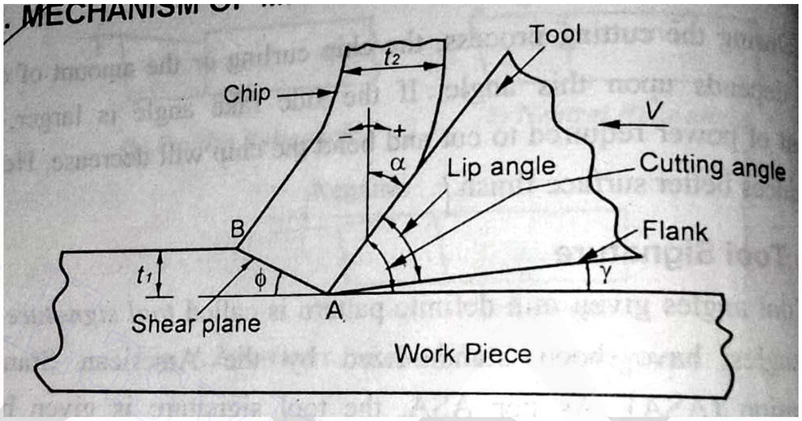
Basically three types of ceramic tool bits are available in the market:

- Plain alumina with traces of additives - these white or pink sintered inserts are cold pressed and are used mainly for machining cast iron and similar materials at speeds 200 to 250 m/min.
- Alumina; with or without additives – hot pressed, black colour, hard and strong – used for
- Machining steels and cast iron at VC = 150 to 250 m/min.
- Carbide ceramic (Al_2O_3 + 30% TiC) cold or hot pressed, black colour, quite strong and enough tough - used for machining hard cast irons and plain and alloy steels at 150 to 200m/min.
- The plain ceramic outperformed the existing tool materials in some application areas like high speed machining of softer steels mainly for higher hot hardness

However, the use of those brittle plain ceramic tools, until their strength and toughness could be substantially improved since 1970, gradually decreased for being restricted to:

- Uninterrupted machining of soft cast irons and steels only
- Relatively high cutting velocity but only in a narrow range (200 ~ 300 min)
- Requiring very rigid machine tools
- Advent of coated carbide capable of machining cast iron and steels at high velocity made the ceramics almost obsolete.

4. Explain Mechanism of metal cutting? (AU Dec 2010,Apr13)



During machining the cutting tool exerts a compressive force on the work piece. The material of the work piece is stressed beyond its yield point under this compressive force. This cause the material to deform plastically and shear off. The plastic flow takes place in a localized region called shear plane. This shear plane extends from the cutting obliquely upto the uncut surface ahead of tool. The sheared material begins to flow along the cutting tool face in the form of small pieces called chips. The compressive force applied toformthechipiscalledcuttingforce.Whenthechipsflowsover thetool,it willwear offthetool.Dueto friction, wearing heat isproduced.

The heat generated raises the temperature of the work, cutting tool and chip. The temperature rise in cuttingtool tendstosoftenit and causes the loss of keenness in the cutting edge thereby leading to its failure.Thecuttingforce, heat and abrasives wear are the basic features of the metal cutting process.

The following points are worth to benoting:

- Shear plane is actually a narrow zone of the order of about0.025mm
- The cutting edge of the tool is formed by two intersecting surfaces
- The surface along which the chip moves upwards is called rake surface
- The surface which is relieved to avoid rubbing with machined surface is called shank.

During cutting forces, the following properties of the work piece material quite important

- Hardness
- Abrasive qualities

- Toughness
- Tendency to weld
- Inherent hard spots and surface inclusions Types of metal cutting process
- Orthogonal cutting (Two dimensional cutting)
- Oblique cutting (Three dimensional cutting)

Orthogonal Cutting

In orthogonal cutting, the cutting edge of the tool perpendicular to the cutting velocity vector. Orthogonal cutting involves only two forces and makes this analysis simpler.

Oblique cutting

In oblique cutting, the cutting edge is inclined at an acute angle with the normal to the cutting velocity vector. The analysis of the oblique cutting is more complex.

5. In an orthogonal cutting operation on a work piece of width 2.5mm, the uncut chip thickness was 0.25mm and the tool rake angle was zero degree. It was observed that the chip thickness was 1.25mm.The cutting force was measured to be 900N and the thrust force was found to be 810 N.(AU Dec 2013,Apr 12)

(a) Find the shear angle.

(b) If the coefficient of friction between the chip and the tool, was 0.5, what is the machining constant Cm

Given data:

$b = 2.5mm$

$t_1 = 0.25mm$

$\alpha = 0°$

$t_2 = 1.25mm$

$F_z = 900N$

$F_x = 810N$

$\mu = 0.5$

To find:

(i) Shear Strength

(ii) Machining constant

☺ ***Solution:***

$$\text{Chip thickness ratio, } r = \frac{t_1}{t_2} = \frac{0.25}{1.25} = 0.2$$

$$\text{Shear angle, } \beta = tan^{-1}\left[\frac{r\cos\alpha}{1-r\sin\alpha}\right]$$

$$= tan^{-1}\left[\frac{0.2\cos 0}{1-0.2\sin 0}\right]$$

$\beta = 11.31°$

Shear force, $F_s = F_z \cos\beta - F_x \sin\beta$

$= 900 \cos 11.31 - 810 \sin 11.31$

$F_s = 723.66N$

Shear stress or strength,

$$\tau_s = \frac{F_s}{A_1} = \frac{723.66}{2.5 \times 0.25} \times \sin 11.31$$

$[\because A_1 = bt_1 = 0.25 \times 2.5]$

$\tau = 227N/mm^2$ **Ans.**

$\mu = \tan\gamma$

$\gamma = \tan^{-1}\mu = \tan^{-1}(0.5) = 26.56$

Machining constant, $C_m = 2\beta + \gamma - \alpha = 2 \times 11.31 + 26.56 - 0$

$C_m = 49.18°$ **Ans.**

Result:

(i) Shearing strength, $\tau = 227N/mm^2$

(ii) Machining constant, $C_m = 49.18°$

PART- C

1. State the parameters that influence the life of tool and discuss?(AU Apr 2010)

Factors Affecting Tool Life

The life of the cutting tool is affected by the following factors.

(i) Cutting speed.
(ii) Feed and depth of cut
(iii) Tool geometry
(iv) Tool material
(v) Cutting fluid
(vi) Work material
(vii) Rigidity of work, tool and machine.

1. Cutting speed

Cutting speed has greater influence on the tool life. When the cutting speed increases, the cutting temperature will increase. Due to this, hardness of the tool decreases. Hence, the tool flank wears and crater wear occurs. From the above, it is obvious that when cutting speed increases, the tool life will decrease. The tool life will be increased at low cutting speeds.

There is a definite relationship between cutting speed and tool life. This relation is given by *Taylor's formula* as follows:

$$\boxed{VT^n = C}$$

Where,

V = Cutting speed in m/min.

T = Tool life in minutes.

n = exponent or index which depends on the tool and work.

= 0.1 to 0.5 for high speed steel tools

= 0.2 to 0.4 for tungsten carbide tools

= 0.4 to 0.6 for Ceramic tools

C = Constant. It is numerically equal to the cutting speed that gives a tool life of one minute.

If the higher cutting speed is permitted by a tool for the same life, we can say that the tool is having better cutting properties and it will be more productive.

For finding tool life, tools are operated to failure at different cutting speeds and the test results are plotted. A typical cutting speed (V) versus Tool life (T) relationship is shown in fig. 1.19.

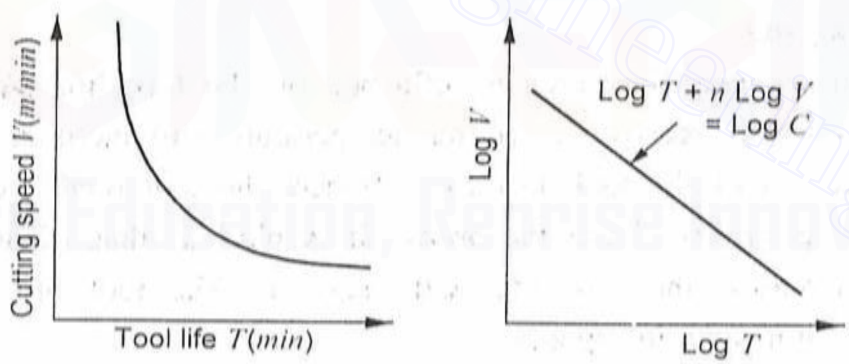


Fig. 1.19 Tool life Vs Cutting speed

In general, a parabolic decrease in tool life with increased cutting speed is obtained (Refer fig. 1.19.). Such a relationship is plotted as a straight line on log – log graph as shown in fig 1.19. These plots indicate that as cutting speed increases with decrease in tool life.

Obviously, if a very low cutting speed is used, the tool will loose a long life. If the surface finish of the tool is improved, both the tool life and efficiency of the tool are improved due to the reason that friction between tool and chip is minimized. Roughness of the tools cutting edge could result in a concentration of stresses which may cause surface cracks and chipping of tool.

Generally, the following factors influenced in the cutting speed permitted by a tool.

- Tool life
- Properties of material being machined
- Rate of feed and depth of cut
- Tool geometry
- Cutting fluid used
- Type of machining process
- Surface finish to be obtained

2. Feed and depth of cut

The life of the cutting tool is influenced by the amount of metal removed by the tool per minute. When we are using fine feed, the area of chip passing over the tool face is greater than that of a coarse feed for a given volume of metal removal. If we offset this advantage in favour of the thick chip, the tool forces to produce thicker chips. Anyway, it is possible to balance two opposing influences to obtain optimum feed rate.

The effect of feed and depth of cut on tool life is given by the formula

$$V = \frac{257}{T^{0.19} \times f^{0.36} \times t^{0.08}} \; m/min$$

Where, V - Cutting speed

T - Tool life

f - feed in mm/min

t - depth of cut in mm

This relation is generally applied for machining low carbon steel by a cemented carbide tool. Tool life is decreased with increase in feed and depth of cut.

3. Tool geometry

Large rake angle reduces the tool cross section. Hence, the amount of heat absorbed by the tool is also reduced. This weakens the tool. So, correct rake angle must be used for long tool life. The optimum rake angle for maximum tool life lies between –5° to +10° for turning austenitic steel by a carbide tool. If the relief angle is more, less will be the friction of the tool on the work. But, more relief angle decreases the tool life because of decreased strength. The optimum relief angle is 12° to 15°. Similarly, a higher value of side cutting edge angle gives longer life to tool.

The optimum side cutting edge angle lies between 30° and 25° Increase in nose radius improves the tool life since the stress concentration is less for greater nose radius. The relationship between cutting speed, tool life (T) and nose radius (r) is as follows

$$VT^{0.0927} = 331\, r^{0.244}$$

The proper end cutting edge angle is provided to improve surface finish, rigidity and equivalent cutting speed. The optimum end cutting edge angle varies from 4° to 10°.

4. Tool material

An ideal tool material is one which removes maximum volume of material at all cutting speeds. Physical and chemical properties of tool material will influence on tool life. For a given cutting speed H.S.S, tool is more durable than carbon steel tool. But carbide tools have more life than high-speed tool.

5. *Cutting fluid*

Heat produced during metal cutting is carried away from the tool and work by means of cutting fluid. It reduces friction at chip tool interface and increases tool life.

Cutting fluid which directly controls the amount of heat at the chip tool interface and it is given by the formula.

$$T\theta^{n} = C$$

Where, T - Tool life

θ - Temperature of chip tool interface in °C

n - An index which depends on shape and material of the cutting tool.

6. *Work piece material*

Tool life also depends on the microstructure of the work piece material. Tool life will be more when machining soft metals than hard metals like cast iron and alloy steel.

7. *Rigidity of work, tool and machine*

A strongly supported tool on a rigid machine will have more life than tool machining under vibrating machine. Loose work piece will decrease the tool life.

UNIT –II

TURNING MACHINES AND SPECIAL PURPOSE LATHES

PART-A

1. **What are the various thread cutting methods? (AU Apr 2011,Dec 12)**

(i) Reversing the machine.
(ii) Marking the lathe parts
(iii) Using a chasing dial or thread indicator
(iv) Using thread chaser

2. **What is Swiss type automat? (AU Apr2011)**

In this type, the work piece is feed against the tool. The head stock carrying the bar stock moves back and forth for providing the feed movement in the longitudinal direction.

3. **Explain the following parts of lathe? (AU Dec 2010, Apr12)**

(a) Lathe bed
(b) Carriage

Lathe bed: It is the base of the machine. It carries headstock on its left end and tailstock on its right end.

Carriage: It is the moving part that slides over the guide ways between headstock and tailstock.

4. **What is an apron? (AU Dec2010**)

It is an integral part of several gears, levers and clutches which are mounted with saddle for moving the carriage along with lead screw while thread cutting.

5. **List any four methods by which taper turning is done in a center lathe. (AU Apr 2010)(AU Dec2009)**

i) Form tool method

(ii) Tailstock set over method

(iii) Compound rest method

(iv) Taper turning attachment method

6. **Distinguish between Capstan lathe and Turret lathe. (AU Apr 2010,Apr13)**

SNo	CAPSTANLATHE	TURRETLATHE
1.	Turret head is mounted on a ram which slides over the saddle.	Turret head is directly mounted on saddle .But it slides on the bed
2.	Turret movement is Limited	Turret moves on the entire length of the bed without any restriction.

7. Mention four different types of chucks used in a machine shop. (AU Dec2009)

(i) Three jaw chuck (or) self centering chuck

(ii) Four jaw chuck or independent chuck

(iii) Magnetic chuck

8. What is the purpose of a mandrel? How many types of mandrels is there in common use? (AU Dec2012)

Mandrels are used for holding hollow work pieces

(1) Plain mandrel

(2) Collar mandrel

(3) Cone mandrel

(4) Step mandrel

(5) Gang mandrel

9. What are the advantages of using a collect chuck? (AU Dec 2008, Apr10)

(i) Job setting will be easy and quicker

(ii) Heavy cut can betaken

10. Why is it essential that the cutting point of the tool should be level with the spindle center while machining taper on a work piece. (AU Dec2008)

It is done to avoid eccentric taper.

11. What are the advantages of automatic lathes? (AU Dec 2006, Apr07)

(i) Mass production of identical parts.

(ii) High accuracy is maintained

(iii) Time of production is minimized.

(iv) The bar stock is fed automatically.

12. What are the functions of feed rod and lead screw? (AU Dec2006)

Feed Rod: It is used to guide the carriage in a straight line when it moves along the bed.

Lead screw: It is used to move the carriage while thread cutting operation is carried out. It also ensures the proper speed of work relative to the tool for thread cutting operation.

13. Why were power chucks developed? (AU Dec2006)

Power chucks are primarily developed for the application as work holding divides for automatic machines, numerical control and CNC machines.

PART -B

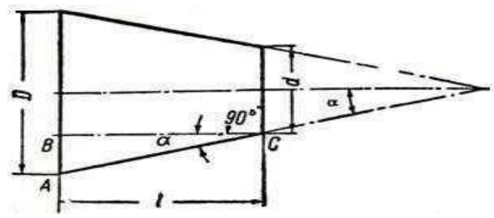
1. Explain the various taper turning methods? (AU Apr 2011) (AU Dec2010)

A taper may be defined as a uniform change in the diameter of a work piece measured along its length. *Taper may be expressed in two ways:*

- Ratio of difference in diameter to the length.
- In degrees of half the included angle.

D - Large diameter of the taper. d - Small diameter of the taper.

l - Length of tapered part. α - Half angle of taper.



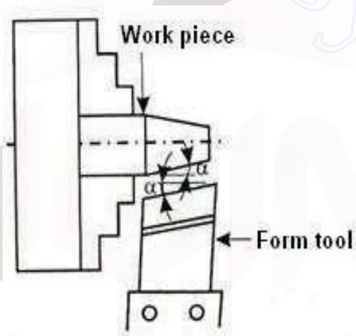
Details of a taper

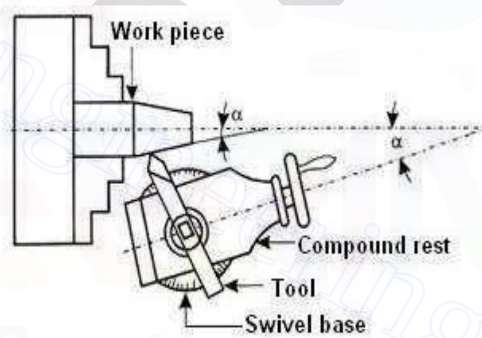
Generally, taper is specified by the term conicity. Conicity is defined as the ratio of the difference in diameters of the taper to its length. Conicity, **K**

Taper turning is the operation of producing conical surface on the cylindrical work piece on lathe.

Taper turning by a form tool

A broad nose tool having straight cutting edge is set on to the work at half taper angle, and is fed straight into the work to generate a tapered surface. In this method the tool angle should be properly checked before use. This method is limited to turn short length of taper only. This is due to the reason that the metal is removed by the entire cutting edge will require excessive cutting pressure, which may distort the work due to vibration and spoil the work surface.





Taper turning by a form tool   Taper turning by swiveling the compound rest

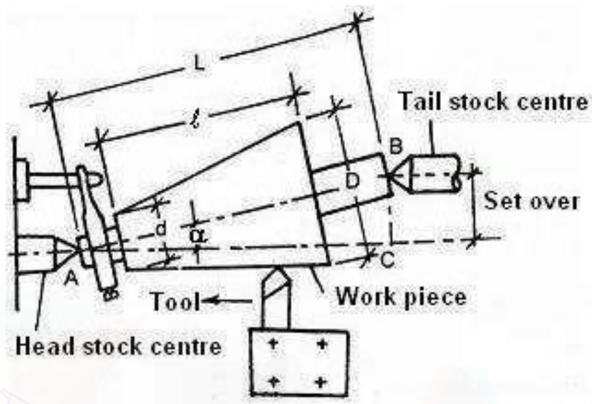
Taper turning by swiveling the compound rest

This method is used to produce short and steep taper. In this method, work is held in a chuck and is rotated about the lathe axis. The compound rest is swiveled to the required angle and clamped in position. The angle is determined by using the formula, **tanα = (D-d/2L)**

Then the tool is fed by the compound rest hand wheel. This method is used for producing both internal and external taper. This method is limited to turn a short taper owing to the limited movement of the compound rest. The compound rest may be swiveled at 45^0 on either side of the lathe axis enabling it to turn a steep taper. The movement of the tool in this method being purely controlled by hand, this gives a low production capacity and poorer surface finish.

Taper turning by offsetting the tailstock.

The principle of turning taper by this method is to shift the axis of rotation of the work piece, at an angle to the lathe axis, which is equal to half angle of the taper, and feeding the tool parallel to the lathe axis.



This is done when the body of the tailstock is made to slide on its base towards or away from the operator by a set over screw. The amount of set over being limited, this method is suitable for turning small taper on long jobs. The main disadvantage of this method is that live and dead centers are not equally stressed and the wear is not uniform. Moreover, the lathe carrier being set at an angle, the angular velocity of the work is not constant.

Taper turning by using taper turning attachment

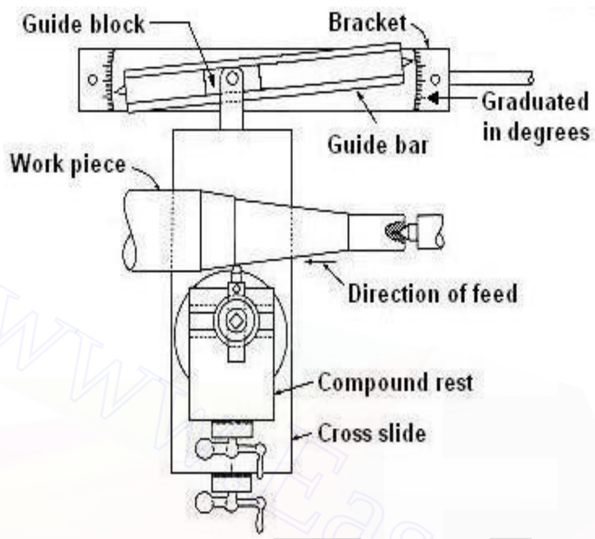
It consists of a bracket or frame which is attached to the rear end of the lathe bed and supports a guide bar pivoted at the centre. The guide bar having graduations in degrees may be swiveled on either side of the zero graduation and is set at the desired angle with the lathe axis. When this attachment is used the cross slide is delinked from the saddle by removing the binder screw. The rear end of the cross slide is then tightened with the guide block by means of a bolt. When the longitudinal feed is engaged, the tool mounted on the cross slide will follow the angular path, as the guide block will slide on the guide bar set at an angle to the lathe axis.

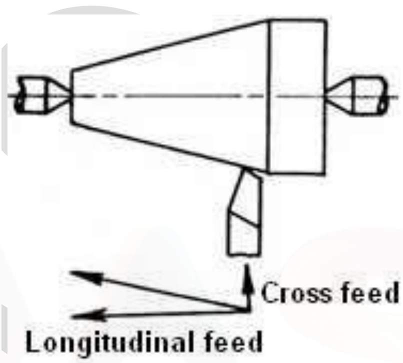
The required depth of cut is given by the compound slide which is placed at right angles to the lathe axis. The guide bar must be set at half taper angle and the taper on the work must be converted in degrees. The maximum angle through which the guide bar may be swiveled is 10^0 to 12^0 on either side of the centre line.

The advantages of using a taper turning attachment are:

- The alignment of live and dead centers being not disturbed; both straight and taper turning may be performed on a work piece in one setting without much loss of time.
- Once the taper is set, any length of work piece may be turned taper within its limit.

- Very steep method. Taper on a long work piece may be turned, which cannot be done by any other
- Accurate taper on a large number of work pieces may be turned.
- Internal tapers can be turned with ease.





Taper turning attachment Taper turning by combining feed

Taper turning by combining longitudinal feed and cross feed

This is a more specialized method of turning taper. In certain lathes both longitudinal and cross feeds may be engaged simultaneously causing the tool to follow a diagonal path which is the resultant of the magnitude of the two feeds. The direction of the resultant may be changed by varying the rate of feeds by changing gears provided inside the apron.

2. Discuss about capstan and turret lathe.

Capstan and turret lathes are production lathes used to manufacture any number of identical pieces in the minimum time. These lathes are development of center lathes. The capstan lathe was first developed in the year 1860 by Pratt and Whitney of USA.

In contrast to center lathes, capstan and turret lathes:

- Are relatively costlier.
- Are requires less skilled operator.
- Possess an axially movable indexable turret (mostly hexagonal) in place of tailstock.
- Holds large number of cutting tools; up to four in indexable tool post on the front slide, one in the rear slide and up to six in the turret (if hexagonal) as indicated in the schematic diagrams.
- Are more productive for quick engagement and overlapped functioning of the tools in addition to faster mounting and feeding of the job and rapid speed change.

- Enable repetitive production of same job requiring less involvement, effort and attention of the operator for pre-setting of work-speed and feed rate and length of travel of the cutting tools.
- Are suitable and economically viable for batch production or small lot production.
  Capable of taking multiple cuts and combined cuts at the same time.

Major parts of capstan and turret lathes

Capstan and turret lathes are very similar in construction, working, application and specification. The major parts are:

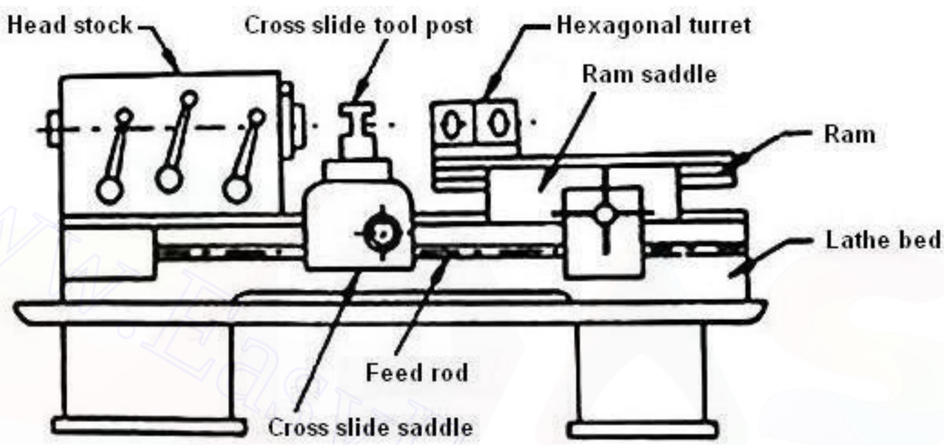


Fig. 2.60 Basic configuration of a Capstan lathe

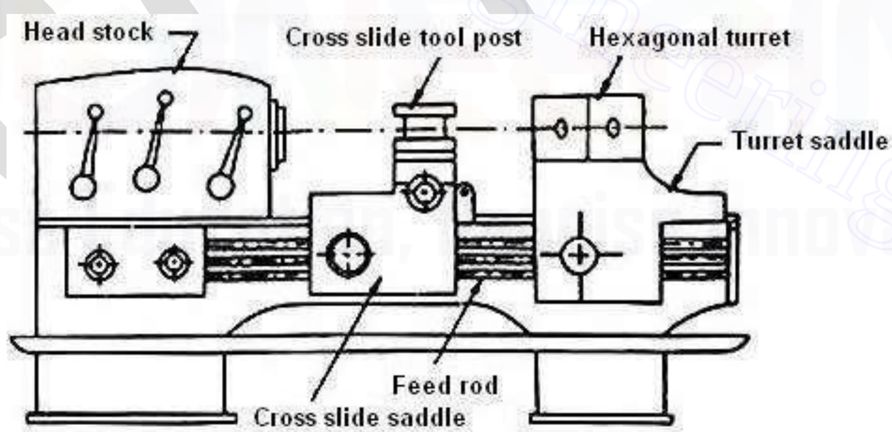


Fig. 2.61 Basic configuration of a Turret lathe

Bed

The bed is a long box like casting provided with accurate guide ways upon which the carriage and turret saddle are mounted. The bed is designed to ensure strength, rigidity and permanency of alignment under heavy duty services.

HEADSTOCK

The headstock is a large casting located at the left hand end of the bed.

- Step cone pulley driven headstock.
- Direct electric motor driven headstock.
  All geared headstock.
- Pre-optive or pre-selective headstock.

Step cone pulley driven headstock:

This is the simplest type of headstock and is fitted with small capstan lathes where the lathe is engaged in machining small and almost constant diameter of work pieces. Only three or four steps of pulley can cater to the needs of the machine. The machine requires special countershaft unlike that of an engine lathe, where starting, stopping and reversing of the machine spindle can be effected by simply pressing a foot pedal.

Electric motor driven headstock:

In this type of headstock the spindle of the machine and the armature shaft of the motor are one and the same. Any speed variation or reversal is effected by simply controlling the motor. Three of four speeds are available and the machine is suitable for smaller diameter of workpieces rotated at high speeds.

All geared headstock:

On the larger lathes, the headstocks are geared and different mechanisms are employed for speed changing by actuating levers. The speed changing may be performed without stopping the machine.

Pre-optive or pre-selective headstock:

It is an all geared headstock with provisions for rapid stopping, starting and speed changing for different operations by simply pushing a button or pulling a lever. The required speed for next operation is selected beforehand and the speed changing lever is placed at the selected position. After the first operation is complete, a button or a lever is simply actuated and the spindle starts rotating at the selected speed required for the second operation without stopping the machine. This novel mechanism is effect by the friction clutches.

Cross slide and saddle

In small capstan lathes, hand operated cross slide and saddle are used. They are clamped on the lathe bed at the required position. The larger capstan lathes and heavy duty turret lathes are equipped with usually two designs of carriage.

- Conventional type carriage.
- Side hung type carriage.

Side hung type carriage

The side-hung type carriage is generally fitted with heavy duty turret lathes where the saddle rides on the top and bottom guide ways on the front of the lathe bed. The design facilitates swinging of larger diameter of work piece without being interfered by the cross-slide. The saddle and the cross-slide may be fed longitudinally or crosswise by hand or power. The longitudinal movement of each tool may be regulated by using stop bars or shafts set against the stop fitted on the bed and carriage. The tools are mounted on the tool post and correct heights are adjusted by using rocking or packing pieces.

Ram saddle : In a capstan lathe, the ram saddle bridges the gap between two bed ways, and the top face is accurately machined to provide bearing surface for the ram or auxiliary slide. The saddle may be adjusted on lathe bed ways and clamped at the desired position. The hexagonal turret is mounted on the ram or auxiliary slide.

Turret saddle

In a turret lathe, the hexagonal turret is directly mounted on the top of the turret saddle and any movement of the turret is effected by the movement of the saddle. The movement of the turret may be effected by hand or power.

Turret

The turret is a hexagonal-shaped tool holder intended for holding six or more tools. Each face of the turret is accurately machined. Through the centre of each face accurately bored holes are provided for accommodating shanks of different tool holders. The centre line of each hole coincides with the axis of the lathe when aligned with the headstock spindle. In addition to these holes, there are four tapped holes on each face of the turret for securing different tool holdingattachments.

Working principle of capstan and turret lathes

The work pieces are held in collets or chucks. In turret lathes, large work pieces are held by means of jaw chucks. These chucks may be hydraulically or pneumatically operated. In a capstan lathe, bar stock is held in collet chucks. A bar feeding mechanism is used for automatic feeding of bar stock. At least eleven tools can be set at a time in turret and capstan lathes. Six tools are held on the turret faces, four tools in front square tool post and one parting off tool at the rear tool post. While machining, the turret head moves forward towards the job. After each operation, the turret head goes back. The turret head is indexed automatically and the next tool comes into machining position. The indexing is done by an indexing mechanism. The longitudinal movement of the turret corresponding to each of the turret position can be controlled independently.

By holding different tools in the turret faces, the operations like drilling, boring, reaming, counter boring, turning and threading can be done on the component. Four tools held on the front tool post are used for different operations like necking, chamfering, form turning and knurling. The parting off tool in the rear tool post is used for cutting off the work piece. The cross wise movements of the rear and front tool posts are controlled by pre-stops.

3. Explain Bar feeding mechanisms

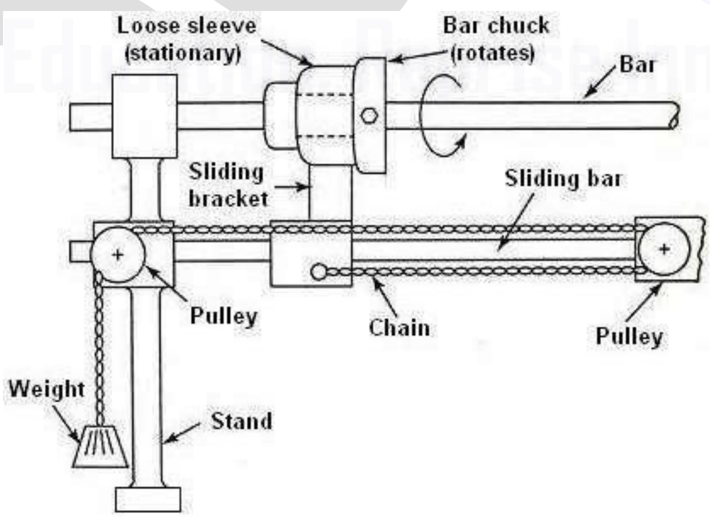
The capstan and turret lathes while working on bar work require some mechanism for bar feeding. The long bars which protrude out of the headstock spindle require to be fed through the spindle up to the bar stop after the first piece is completed and the collet chuck is opened. In simple cases, the bar may be pushed by hand. But this process unnecessarily increases the total production time by stopping, setting, and starting the machine. Therefore, various types of bar feeding mechanisms have been designed which push the bar forward immediately after the collet releases the work without stopping the machine, enabling the setting time to be reduced to the minimum.

Type1:

After the work piece is complete and part off, the collet is opened by moving the lever manually in the rightward direction. Further movement of the lever in the same direction causes forward push of the bar with the help of ratchet - pawl system. After the projection of the bar from the collet face to the desired length controlled by a preset bar stop generally held in one face of the turret, the lever is moved in the leftward direction to close the collet. Just before closing the collet, the leftward movement of the lever pushes the ratchet bar to its initia lposition.

Type2:

The bar is passed through the bar chuck, spindle of the machine and then through the collet chuck. The bar chuck rotates in the sliding bracket body which is mounted on a long sliding bar. The bar chuck grips the bar centrally by two set screws and rotates with the bar in the sliding bracket body. One end of the chain is connected to the pin fitted on the sliding bracket and the other end supports a weight. The chain running over two fixed pulleys mounted on the sliding bar. The weight constantly exerts end thrust on the bar chuck while it revolves on the sliding bracket and forces the bar through the spindle at the moment the collet chuck is released. Thus bar feeding may be accomplished without stopping the machine. In this way the bar is fed without stopping the machine. After a number of such feedings, the bar chuck will approach the rear end of the head stock. Now the bar chuck is released from the bar and brought to the left extreme position. Then it is screwed on to the bar



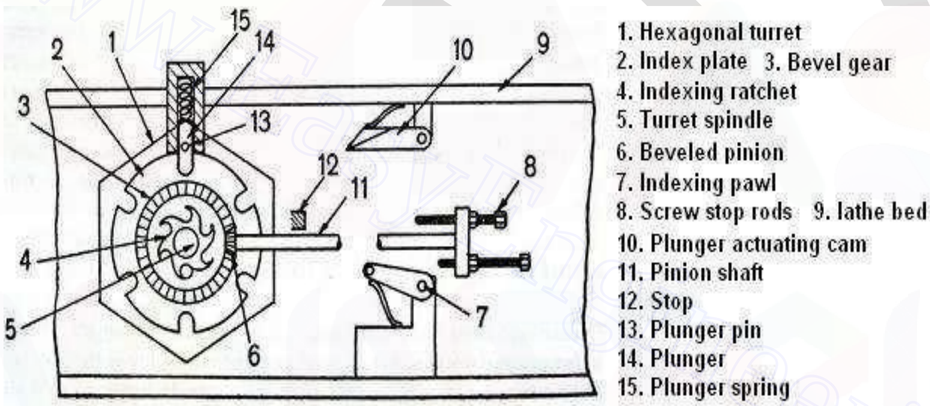
4. Explain Turret indexing mechanism

Construction:

It illustrates an inverted plan of the turret assembly. This mechanism is also called as Geneva mechanism. There is a small vertical spindle fixed on the turret saddle. At the top of the spindle, the turret head is mounted. Just below the turret head on the same spindle, a circular index plate having six slots, a bevel gear and a ratchet are mounted. There is a spring actuated plunger mounted on the saddle which locks the index plate this prevents the rotation of turret during the machining operation. A pin fitted on the plunger projects out of the housing. An actuating cam and an indexing pawl are fitted to the lathe bed at the required position. Both cam and pawl are spring loaded.

Working principle:

When the turret reaches the backward position (after machining) the projecting pin of the plunger rides over the sloping surface of the cam. So the plunger is released from the groove of the index plate. Now



the spring loaded pawl engages the ratchet groove and rotates it. The index plate and the turret spindle rotate through 1/6 of a revolution. The pin and the plunger drop out of the cam and hence the plunger locks the index plate at the next groove. The turret is thus indexed and again locked into the new position automatically. The turret holding the next tool is now fed forward and the pawl is released from the ratchet plate by the spring pressure. The pinion shaft has a bevel pinion at one end. The bevel pinion meshes with the bevel gear mounted on the turret spindle. At its other end, a circular plate is connected. Six adjustable stop rods are fitted to this circular plate. When the turret rotates, the bevel pinion will also rotate. And hence the circular stop plate is also indexed by 1/6 of a revolution. The ratio of the teeth between the pinion and the gear is chosen according to this rotation.

5. Describe the holding devices in a lathe. (AU Dec 2006) (AU Dec2008)

Work holding devices used in capstan and turret lathes

The standard practice of holding the work piece between two centers in a centre lathe finds no place in a capstan lathe or turret lathe as there is no dead centre to support the work piece at the other end. Therefore, the work piece is held at the spindle end by the help of chucks and fixtures. The usual methods of holding the work piece in a capstan and turret lathes are:

1. **Jaw chucks**

The jaw chucks are used in capstan lathes having two, three or four jaws depending upon the shape of the work piece. The jaw chucks are used to support odd sized jobs or jobs having Larger diameter which cannot be introduced through the headstock spindle and gripped by collet chucks.

2. **jaw chuck self centering chuck**

It is used for bar work. The two jaws hold the irregular work more readily since the clamping is at two points which are diametrically opposite. It is available in size from about 125 mm to 250 mm outside diameter to hold bar stock of diameter from about 20 mm to 45 mm.

3. **jaw chuck self-centering chuck**

It is used for holding round or hexagonal bar stock or other symmetrical work. It is suitable for gripping larger diameter bars, circular castings, forgings etc. It is available in size from about 100 mm to 750mm outside diameter and they can hold work upto about 650mm diameter.

4. **jaw independent chuck**

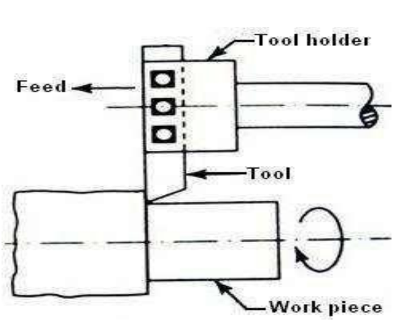
It is used occasionally for gripping irregular shaped work pieces, where the number of articles required does not justify the manufacture of special fixtures. It is used for holding rough castings and square or octagonal work. Each jaw can be operated independently and is reversible. It is available in sizes up to about 1000 mm diameter.

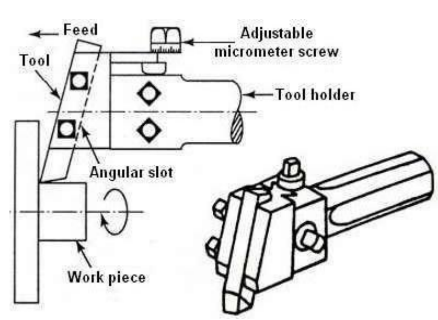
5. **Tool holding devices used in capstan and turret lathes**

The wide variety of work performed in a capstan or turret lathe in mass production necessitated designing of many different types of tool holders for holding tools for typical operations. The Tool holders may be mounted on turret faces or on cross-slide tool post and may be used for holding tools for bar and chuck work. Certain tool holders are used for holding tools for both bar and chuck work while box tools are particularly adapted in bar work.

6. **Straight cutter holder**

This is a simple tool holder constructed to take standard section tool bits. The shank of the holder can be mounted directly into the hole of the turret face or into a hole of a multiple turning head. In this type of holder, the tool is held perpendicular to the shank axis. The tool is gripped in the holder by three set screws. Different operations like turning, facing, boring, counter boring, chamfering, etc. can beperformed by holding suitable tools in the holder.



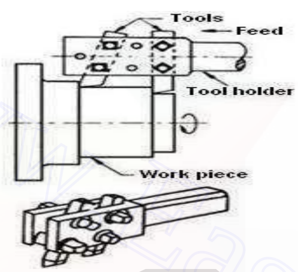


7. Plain or adjustable angle cutter holder

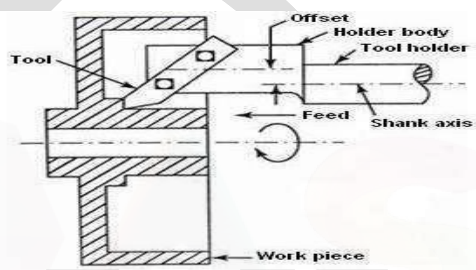
It is similar as that of a straight cutter holder but having an angular slot. The tool is fitted in this slot by means of setscrews. The inclination of the tool helps in turning or boring operations close to the chuck jaws or up to the shoulder of the work piece without any interference. In plain type of holder, the setting of the cutting edge relative to the work is effect by opening the set screws and then adjusting the tool by hand. In adjustable type of holder, the accurate setting of the tool can be effect by rotating a micrometer screw.

8. Multiple cutter holder

This holder can accommodate two or more tools in its body. This feature enables turning of two different diameters simultaneously. This will reduce the time of machining.



Multiple cutter holder



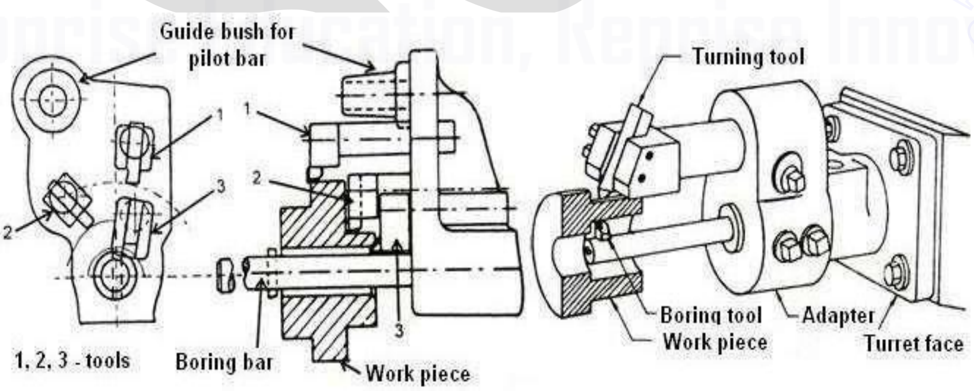
Offset cutter holder

Turning and boring tools can also be set in the holder to perform two operations at a time.

9. Offset cutter holder

In this type, the holder body is made offset with the shank axis. Larger diameter work can be turned or bored by this type of holder. .

10. Combination tool holder or multiple turning head

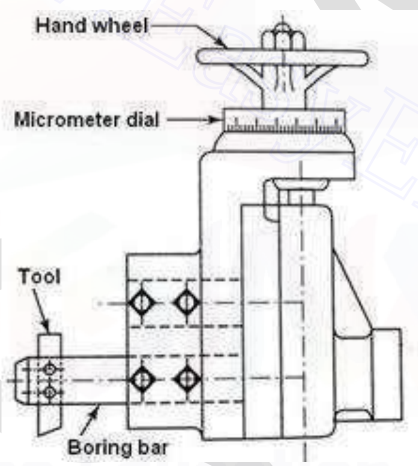


It is used for holding straight, angular, multiple or offset cutter holders, boring bars, etc. for various turning and boring operations, so that it may be possible to undertake a number of operations simultaneously. The tools are set at different positions on the work surface by inserting the shank of tool holders in different holes of the multiple head body, and they are secured to it by tightening separate set screws. A boring bar is held at the central hole of the head which is aligned with the axis of the supporting flange. The head is supported on the turret face by tightening four bolts passing through the holes of the flange. The tool holder has a guide bush. The pilot bar projecting from the head stock of the machine slides inside the guide bush. This gives additional support to the tool while cutting and prevents any vibration or deflection.

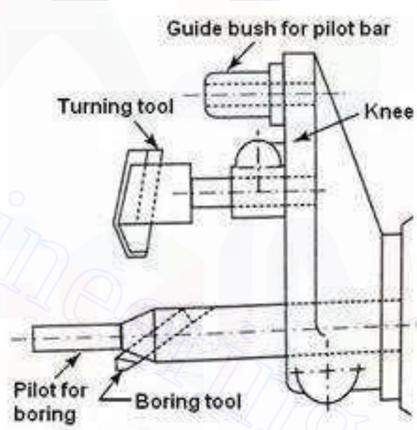
11. Sliding tool holder

It is useful for rough and finish boring, recessing, grooving, facing, etc. The holder consists of a vertical base on which a slide is fitted. The slide may be adjusted up or down accurately by rotating a hand wheel provided with a micrometer dial. Two holes are provided on the sliding unit for holding tools. The lower hole which is aligned with the lathe axis is used for holding boring bars, drills, reamers, etc.

The upper hole accommodates a turning tool holder. After necessary adjustments the slide is clamped to the base by a clamping lever for turning or boring operations. For facing or recessing operations, the crosswise movement of the tool is obtained in the vertical plane.



Sliding tool holder



Knee tool holder

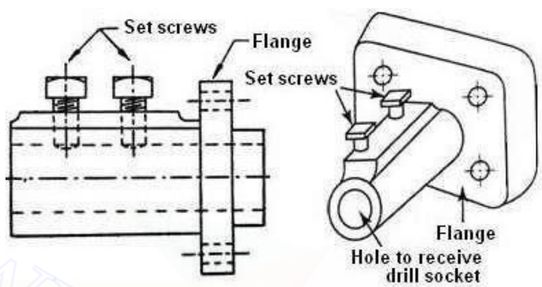
The slide is equipped with two adjustable stops for facing or similar operations in order to be able to duplicate the workpiece. The holder base is clamped directly on the turret face by studs.

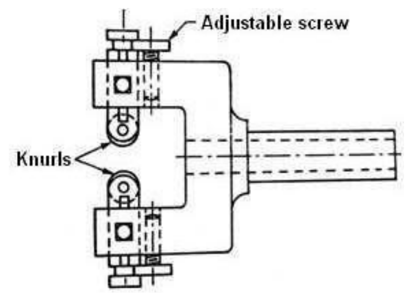
12. Knee tool holder

It is useful for simultaneous turning and boring or turning and drilling operations. The knee holder is bolted directly on the turret face. The axis of the lower hole coincides with the lathe axis and is used for holding boring bars, drills, etc. The turning tool holder is fitted in to the centre hole. A guide bush is provided at the top of the holder for running of pilot bar.

13. Flange tool holder

This holder is also called as extension holder, drill holder or boring bar holder. These holders are intended for holding drills, reamers, boring bars, etc. The twist drills having Morse taper shank are usually held in a socket which is parallel outside and tapered inside. The socket is introduced in the hole of the flange tool holder and clamped to it by set screws. The flanged end of the holder is bolted directly to the face of the turret and is accurately centered.





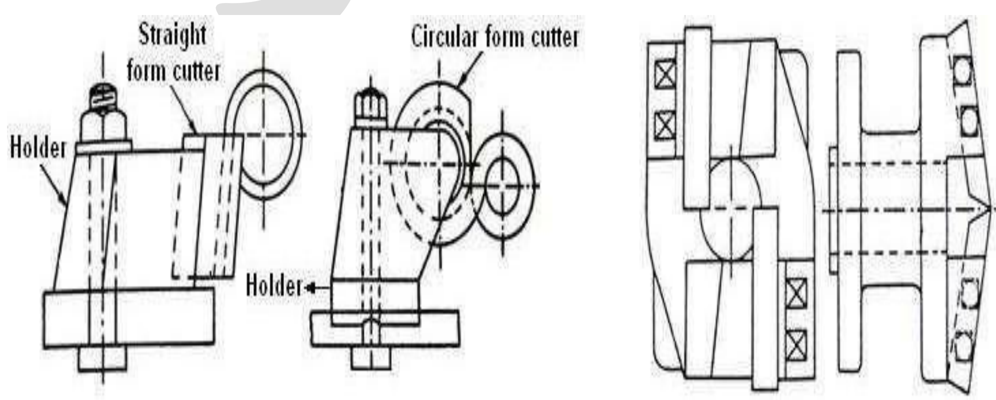
Knurling tool holder

14. Knurling tool holder

It may be mounted on the turret face or on the tool posts of the cross-slide. The holders with knurls mounted on the cross-slide can perform knurling operation on any diameter work.The position of knurls can be adjusted in a vertical plane to accommodate different diameters of work, while the relative angle between them can also be varied to produce different patterns of knurled surface.

15. Form tool holder

Two sets of form tool holders have been designed for holding straight and circular form cutters. The usual procedure of holding a form tool holder is on the cross-slide. In the straight form tool holder, the tool is mounted on a dovetail slide and the height of the cutting edge may be adjusted by moving the tool within the slide. The height of the circular form tool may be adjusted by rotating the circular cutter.



6. Explain the single spindle automats.

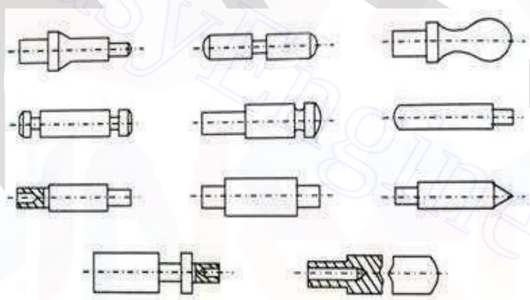
These machines have only one spindle. So, one component can be machined at a time. These are modified form of turret lathe. These machines have maximum of 4 cross slides in addition to a 6 stations or 8 station turret. These cross slides are operated by disc cams which draws the power from the main spindle through cycle time change gears. The single spindle automats are of the following types:

SINGLE SPINDLE AUTOMATIC CUTTING OFF MACHINE

This machine produces large quantities of work pieces of smaller diameter and shorter lengths. Components with simple form are produced in this machine by means of cross sliding tools.

Construction

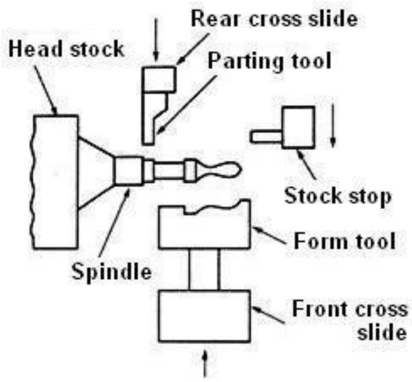
This machine is simple in design. The head stock with the spindle is mounted on the bed. Two cross slides are located on the bed at the front end of the spindle. The front cross slides are used for turning and forming operations. The rear tool slide is used for facing, chamfering, recessing, under cutting and cutting off operations. Cams on a camshaft actuate the movements of the cross slides through a system of levers.



Arrangement of tool slide Simple parts produced on cutting off machine

Working principle

The required length of work piece (stock) is fed out with a cam mechanism, up to the stock stop which is automatically advanced in line with the spindle axis, at the end of each cycle. The stock is held in the collect chuck of the rotating spindle. The machining is done by tools held in cross slides operating only in the crosswise direction. The form tool held in the front tool slide produces the required shape of the component. The parting off tool in the rear tool slide is used to cut off the component after machining. Special attachments can be employed if holes or threads are required on the simple parts. This machine has a single cam shaft which controls the working and idle motions of the tools. The cam shaft runs at constant speed. Therefore working motions and idle motions takes place at the same speed. Hence the cycle time is more.



PART-C

1. Explain swiss type automatic screw machine

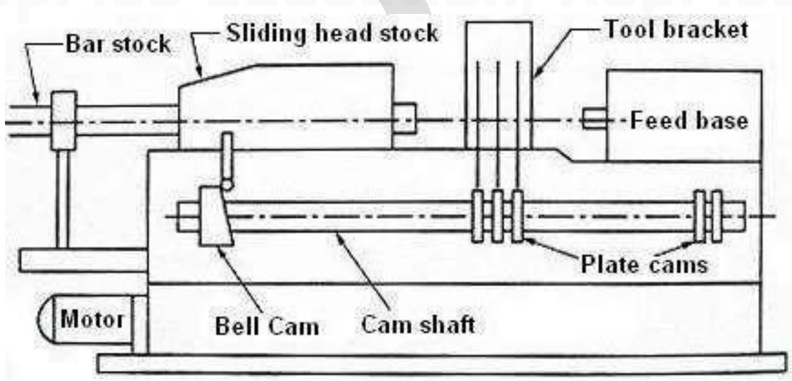
This machine was designed and developed in Switzerland. So it is often called as Swiss auto lathe. This machine is also known as 'Sliding head screw machine', or 'Movable headstock machine', because the head stock is movable and the tools are fixed. This machine is used for machining long accurate parts of small diameter (2 mm to 25 mm).

Construction Sliding Head Stock:

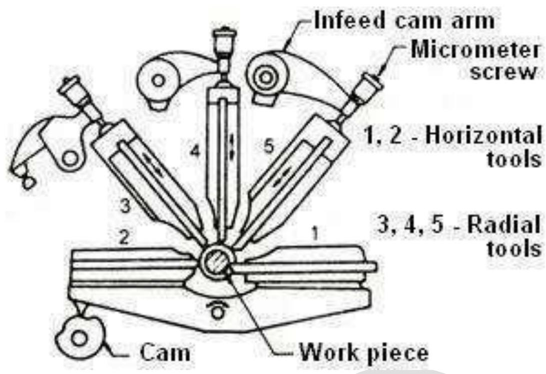
This head stock has a collet. The bar stock is held in this collet. The headstock slides along the guide ways of the bed. A bell cam connected to the cam shaft controls this sliding motion.

Tool Bracket:

The tool bracket is mounted on the bed way near the head stock. The tool bracket supports 4 or 5 toll slides. It also has a bush for supporting and guiding the bar stock. Two slides are positioned horizontally (front and rear) on which the turning tools are normally clamped. The other slides are arranged above these slides. These slides can move radially. All the slides can move back and forth. These slides are actuated independently by sets or rocker arms and plate cams. Plate cams are fitted to the camshaft.



Swiss type automatic screw machine



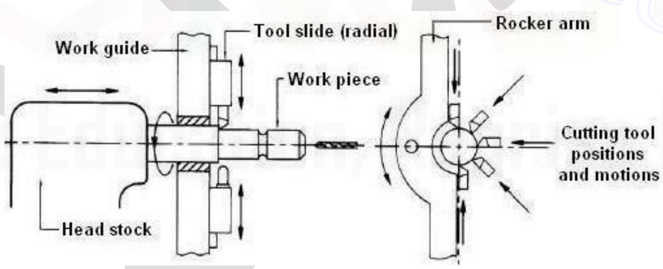
Schematic view of a tool bracket

Feed Base:

The feed base is a special attachment mounted at the right hand side of the bed. This can move along the bed. Using this attachment, operations like drilling, boring, thread cutting with taps or dies etc., are done. The movement of the feed base is controlled by the plate cam fitted to the cam shaft.

Cam Shaft:

The cam shaft is mounted at the front of the machine. It has a bell cam at the left end. This controls the sliding movement of the head stock. Plate cams fitted at the centre of the shaft controls the movement of the tool slides. Plate cam at the right end of the cam shaft controls the movement of the feed base.



Swiss type automatic screw machine

Working principle

The stock is held by a rotating collet in the head stock and all longitudinal feeds are obtained by a cam which moves the head stock as a unit. Most diameters turning are done by two horizontal tool slides while the other three slides are used principally for such operations as knurling, chamfering, recessing and cutting off. The tools are controlled and positioned by cams that bring the tools in as needed to turn, face, form, and cut off the work piece from the bar as it emerges from the bushing.

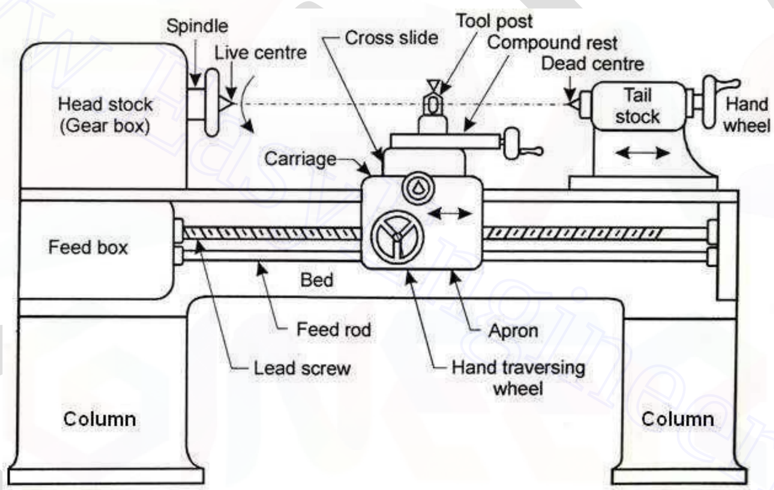
The cutting action is confined close to the support bushing reducing the overhang to a minimum. As a result, the work can be machined to very close limits. All tools can work at a time. After the work piece is machined, the head stock slides back to the original position. One revolution of the cam shaft produces one component.

A wide variety of formed surfaces may be obtained on the work piece by synchronized alternating or simultaneous travel of the headstock (longitudinal feed) and the cross slide (approach to the depth of cut). The bar stock used in these machines has to be highly accurate and is first ground on Centre less grinding machines to ensure high accuracy.

Advantages

- It is used to precision turning of small parts.
- Wide range of speeds is available.
- It is rigid in construction.
- Micrometer tool setting is possible.
- Interchangeability of cams is possible

2. Explain the construction and working principle of a lathe with a sketch. (AU Dec2007)



The major parts are:

Headstock It holds the spindle and through that power and rotation are transmitted to the job at different speeds. Various work holding attachments such as three jaw chucks, collets, and centres can be held in the spindle. The spindle is driven by an electric motor through a system of belt drives and gear trains. Spindle rotational speed is controlled by varying the geometry of the drive train.

Tailstock The tailstock can be used to support the end of the work piece with a center, to support longer blanks or to hold tools for drilling, reaming, threading, or cutting tapers. It can be adjusted in position along the ways to accommodate different length work pieces. The tailstock barrel can be fed along the axis of rotation with the tailstock hand wheel.

Bed Headstock is fixed and tailstock is clamped on it. Tailstock has a provision to slide and facilitate operations at different locations. The bed is fixed on column sand the carriage travels on it.

Carriage It is supported on the lathe bed-ways and can move in a direction parallel to the lathe axis. The carriage is used for giving various movements to the tool by hand and by power. It carries saddle, cross-slide, compound rest, tool post and apron.

Saddle It carries the cross slide, compound rest and tool post. It is an H-shaped casting fitted over the bed. It moves alone to guide ways.

Cross-slide It carries the compound rest and tool post. It is mounted on the top of the saddle. It can be moved by hand or may be given power feed through apron mechanism.

Compound rest It is mounted on the cross slide. It carries a circular base called swivel plate which is graduated in degrees. It is used during taper turning to set the tool for angular cuts. The upper part known as compound slide can be moved by means of a hand wheel.

Tool post It is fitted over the compound rest. The tool is clamped in it.

Apron Lower part of the carriage is termed as the apron. It is attached to the saddle and hangs in front of the bed. It contains gears, clutches and levers for moving the carriage by a hand wheel or power feed.

Feed mechanism The movement of the tool relative to the work piece is termed as "feed". The lathe tool can be given three types of feed, namely, longitudinal, cross and angular. When the tool moves parallel to the axis of the lathe, the movement is called longitudinal feed. This is achieved moving the carriage. When the tool moves perpendicular to the axis of the lathe, the movement is called cross feed. This is achieved by moving the cross slide. When the tool moves at an angle to the axis of the lathe, the movement is called angular feed. This is achieved by moving the compound slide, after swiveling it at an angle to the lathe axis.

Feed rod The feed rod is a long shaft, used to move the carriage or cross-slide for turning, facing, boring and all other operations except thread cutting. Power is transmitted from the lathe spindle to the apron gears through the feed rod via a large number of gears.

Lead screw The lead screw is long threaded shaft used as a master screw and brought into operation only when threads have to cut. In all other times the lead screw is disengaged from the gear box and remains stationary. The rotation of the lead screw is used to traverse the tool along the work to produce screw. The half nut makes the carriage to engage or disengage the lead screw.

working principle of lathe

For machining in machine tools the job and the cutting tool need to be moved relative to each other.

The tool-work motions are*:*

Formative motions: - cutting motion, feed motion. Auxiliary motions: - indexing motion, relieving motion.

In lathes*:* Cutting motion is attained by rotating the job and feed motion is attained by linear travel of the tool either axially for longitudinal feed or radially for cross feed. The job gets rotation (and power) from the motor through the belt- pulley, clutch and then the speed gear box which splits the input speed into a number (here 12) of speeds by operating the cluster gears.

The cutting tool derives its automatic feed motion(s) from the rotation of the spindle via the gear quadrant, feed gear box and then the apron mechanism where the rotation of the feed rod is transmitted:

Either to the pinion which being rolled along the rack provides the longitudinal feed. Or to the screw of the cross slide for cross or transverse feed.

While cutting screw threads the half nuts are engaged with the rotating lead screw to positively cause travel of the carriage and hence the tool parallel to the lathe bed i.e., job axis

The feed-rate for both turning and threading is varied as needed by operating the Norton gear and the Meander drive systems existing in the feed gear box (FGB). The range of feeds can be augmented by changing the gear ratio in the gear quadrant connecting the FGB with the spindle. As and when required, the tailstock is shifted along the lathe bed by operating the clamping bolt and the tail stock quill is moved forward or backward or is kept locked in the desired location. The versatility or working range of the centre lathes is augmented by using several special attachments.

3. Discuss about special attachments of lathe. (AU Apr2011)

Each general purpose conventional machine tool is designed and used for a set of specific Machining work on job so limited range of shape and size. But often some unusual work also need to be done in a specific machine tools, e.g. milling in a lathe, tapping in a drilling machine, gear teeth cutting in shaping machine and so on. Under such conditions, some special devices or systems are additionally used being mounted in the ordinary machine tools. Such additional special devices, which augment the processing capability of any ordinary machine tool, are known as attachments. Unlike accessories, attachments are not that inevitable and procured separately as and when required and obviously on extra payment.

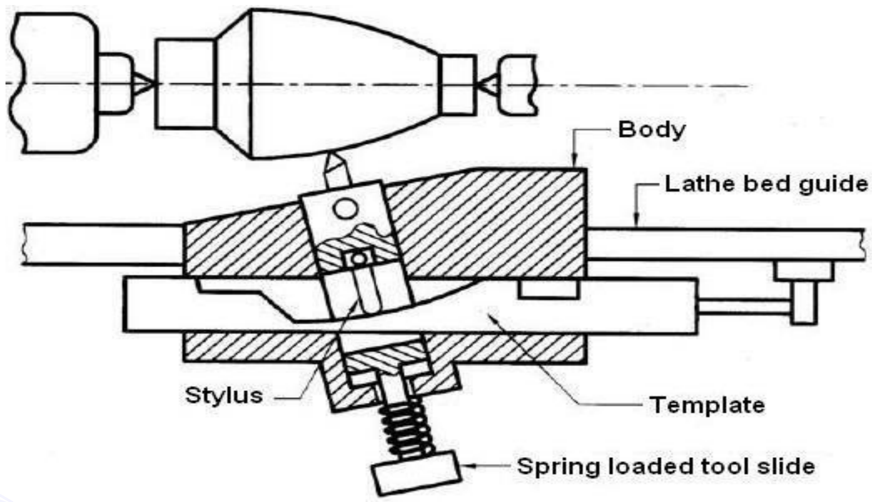
Conditions and places suitable for application of attachments in machine tools

With the rapid and vast advancement of science and technology,the manufacturing systems including machine tools are becoming more and more versatile and productive on one hand for large lot or mass production and also having flexible automation and high precision on the other hand required for production of more critical components in pieces or small batches. With the increase of versatility and precision (e.g., CNC machines) and the advent of dedicated high productive special purpose machines, the need of use of special attachments is gradually decreasing rapidly.However, some attachments are occasionally still being used on non-automatic general purpose machine tools in some small and medium scale machining industries:

When and where machining facilities are very limited.When production requirement is very small, may be few pieces. Product changes frequently as per job order.Repair work under maintenance, especially when spare parts are not available.When CNC machine tools and even reasonable number of conventional machine tools cannot be afforded.

Mechanical copy turning attachment

The entire attachment is mounted on the saddle after removing the cross slide from that. The template replicating the job-profile desired is clamped at a suitable position on the bed.

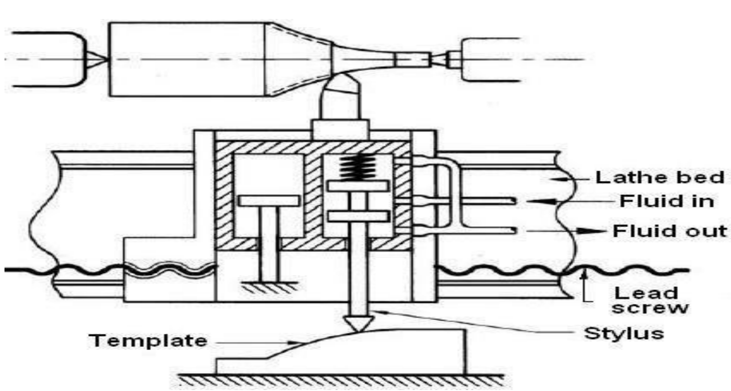


The stylus is fitted in the spring loaded tool slide and while travelling longitudinally along with saddle moves in transverse direction according to the template profile enabling the cutting tool produce the same profile on the job as indicated in the Figure.

Hydraulic copy turning attachment

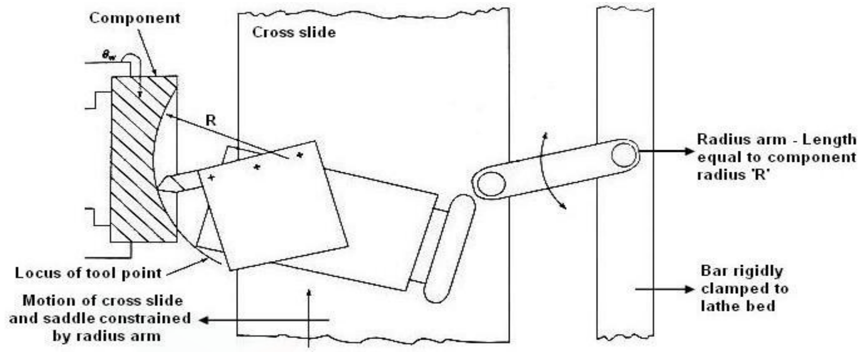
Here also, the stylus moves along the template profile to replicate it on the job. In mechanical system the heavy cutting force is transmitted at the tip of the stylus, which causes vibration, large friction and faster wear and tear. Such problems are almost absent in hydraulic copying, where the stylus works simply as a valve spool against a light spring and is not affected by the cutting force. Hydraulic copying attachment is costlier than the mechanical type but works much smoothly and accurately. The cutting tool is rigidly fixed on the cross slide which also acts as a valve cum cylinder. So long the stylus remains on a straight edge parallel to the lathe bed, the cylinder does not move transversely and the tool causes straight turning. As soon as the stylus starts moving along a slope or profile, i.e., in cross feed direction the ports open and the cylinder starts moving accordingly against the piston fixed on the saddle.

Again the movement of the cylinder i.e., the slide holding the tool, by same amount travelled by the stylus, and closes the ports. Repeating of such quick incremental movements of the tool, Δx and Δy result in the profile with little surface roughness.



Radius turning attachment

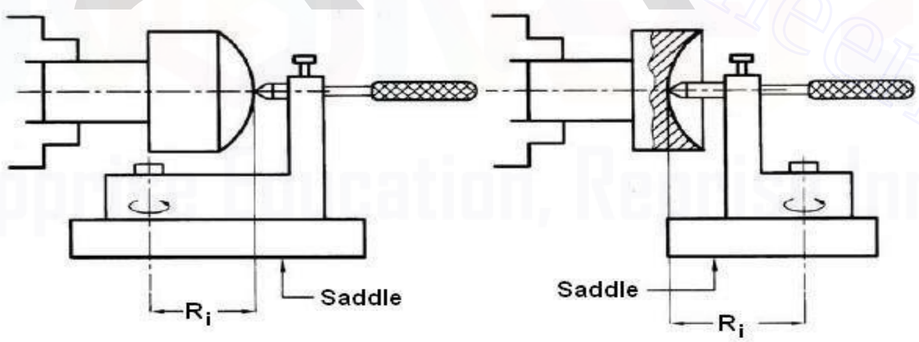
In this attachment, the cross slide is attached to the bed by means of a radius arm whose length is equal to the radius of the spherical component to be produced. The radius arm couples any movement of the cross slide or the carriage and hence the tool tip traces the radius R.



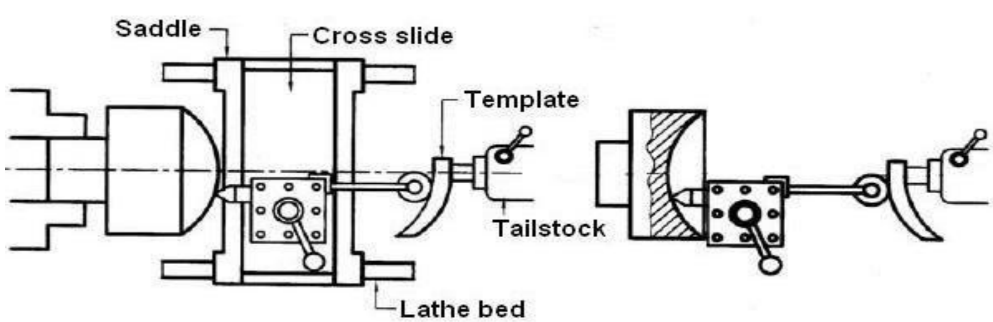
Radius turning attachment

Spherical turning attachment

These simple attachments are used in centre lathes for machining spherical; both convex and concave surfaces and similar surfaces. The distance Ri can be set according to the radius of curvaturedesired.Thedesiredpathofthetooltipiscontrolledbytheprofileofthetemplatewhich is pre-made as per the radius of curvature required. The saddle is disconnected from the feed rod and the lead-screw. So when the cross slide is moved manually in transverse direction, the tool moves axially freely being guided by the template only.



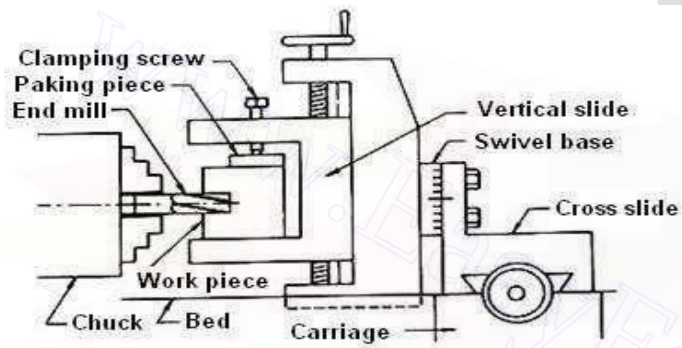
Spherical turning without template



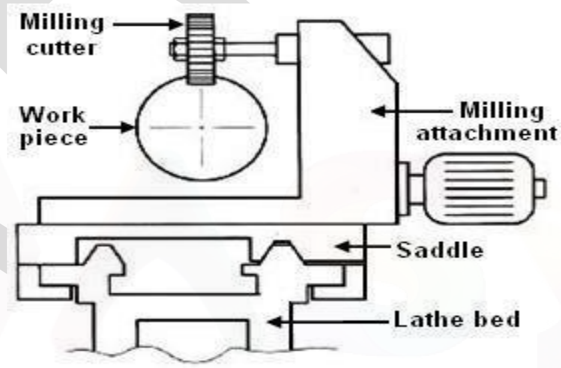
Milling attachment

For cutting grooves or keyways Here, the work piece is held on the cross slide by usinga special attachment and the end milling cutter is held in the chuck. Then the feed is given by a vertical slide provided on the special attachment.

For cutting multiple grooves and gear The attachment has a milling head, comprising a motor, a small gear box and a spindle to hold the milling cutter, mounted on the saddle after removing the cross slide etc., The work piece is held stationary between centres. The feeding is given by the carriage and vertical movement is given by the provision made on the attachment. Grooves are made on the periphery of the work piece by rotating the work piece. For cutting gears, a universal dividing head is fitted on the rear end of the headstock spindle to divide the work equally.



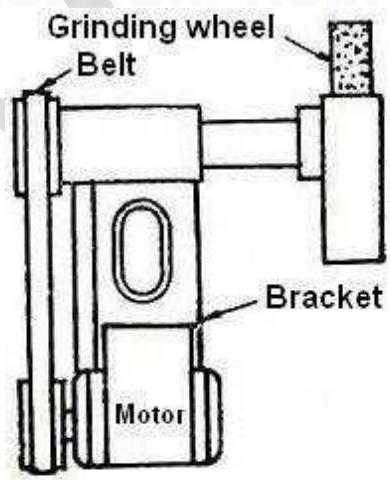
End milling attachment



Milling attachment

Cylindrical grinding attachment

Grinding attachment is very similar to milling attachment. It has a bracket. It is mounted on the cross slide. A grinding wheel attached to the bracket is driven by a separate motor. The workpiece may be held between centres or in a chuck. The grinding wheel is fed against the work piece. In this operation both work piece and grinding wheel rotate. By using this attachment both the external and internal grinding operation can be done.



Cylindrical grinding attachment

UNIT III
SHAPER, MILLING AND GEAR CUTTING MACHINES
PART-A

1. **What are the differences between drilling and reaming?(AUApr2011)**

Drilling is the operation of producing cylindrical hole in a work piece. It is done by rotating the cutting edge of a cutter known as drill. The work is rotated at high speed.

Reaming is the operation of finishing and sizing hole which is already drilled while the work is revolved at a very slow speed.

2. **Briefly describe the importance of quill mechanism. (AU Apr2011)**

If the taper shank of drill is smaller than the taper in the spindle hole, a sleeve is used. The sleeve with drill is fitted in the hole of the spindle. The sleeve has outside taper surface. This fits into the tapered hole of the spindle**.**

3. **List the types of sawing machines. (AU Dec2010)**

Types of sawing machines are (1) Reciprocating saw (2) Circular saw (3)Band saw

4. **Define the cutting speed, feed and machining time for drilling.(AUDec2010)**

Cutting Speed: It is the peripheral speed of a point on the surface of the drill in contact with the Work piece. It is usually expressed in m/min.

Feed: It is the distance of a drill moved into the work at each revolution of the spindle.
It is expressed in mm/rev.

Machining time: The time taken to complete the machining process without considering the idle time of machines is called machining time.

5. **How do you classify milling cutters?(AUDec2009)**

They are classified based on following factors

(i) According to the shape of the teeth.
(ii) According to the type of operation
(iii) According to the way of mounting on the machine

6. What do you know about straight fluted drill and fluted drill? (AU Dec2009)

The reamer with helical flutes provides smooth shear cutting action and provides better surface finish .The pitch of the flutes is made uneven to reduce vibration.

7. What is meant by up milling and down milling? (AU Dec2008)

In up milling, cutter rotates opposite to the direction of feed of the work piece whereas in down milling, the cutter rotates in the same direction of travel of the workpiece

8. What is a shell mill? (AU Dec2007)

A shell mill is a large type of face or end mil that mounts on to a arbor, rather than having an integral shank. Typically there is a hollow or recess in the centre of the shell mill for mounting hardware on to a separate arbor.

9. Mention the operations performed by a planner. (AU Dec2006)

a. Planning horizontal surface **b.** Planning of an angle **c.** Planning vertical surface

d. Planning curved surface

10. Why is sawing a commonly used process. (AU Dec2006)

a. Easy handling of machines and spindle construction

b. Fast operation and cost of machinery is less

11. What is gear hobbing? (AU Dec2010)

The process of generating a gear by means of rotating a cutter called HOB is known as Hobbing

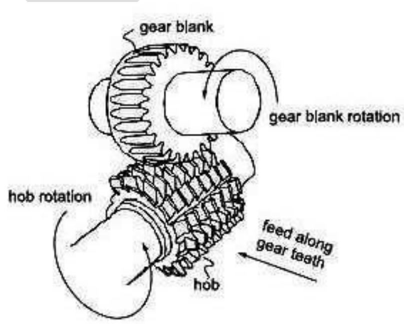
12. What are the types of surfaces that can be produced using plain cylindrical grinders? (AU Dec2006)

Plain cylindrical parts, cylinders, tapers, shoulders, fillets, cams, crank shaft etc.

PART -B

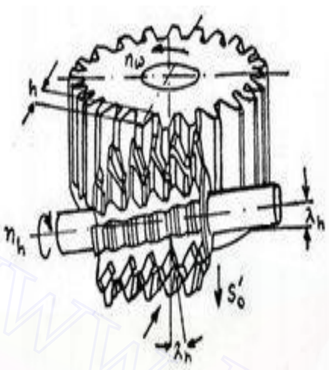
1. Explain the principle of gear hobbing with neat sketches. (AU Dec2008)

Gear hobbing is a machining process in which gear teeth are progressively generated by a series of cuts with a helical cutting tool (hob). The gear hob is a formed tooth milling cutter with helical teeth arranged like the thread on a screw. These teeth are fluted to produce the required cutting edges. All motions in hobbing are rotary, and the hob and gear blank rotate continuously as in two gears meshing until all teeth are cut. This process eliminates the unproductive return motion of the gear shaping operation. The work piece is mounted on a vertical axis and rotates about its axis. The hob is mounted on an inclined axis whose inclination is equal to the helix angle of the hob. The hob is rotated in synchronization with the rotation of the blank and is slowly moved into the gear blank till the required tooth depth is reached in a plane above the gear blank. The tool work configuration and motions in hobbing are shown in Figure, where the HSS or carbide cutter having teeth like gear milling cutter and the gear blank apparently interact like a pair of worm and worm wheel. The hob (cutter) looks and behaves like a single or multiple start worms. Having lesser number (only three) of tool–work motions, hobbing machines are much more rigid, strong and productive than gear shaping machine. But hobbing provides lesser accuracy and finish and is used only for cutting straight or helical teeth (single) of external spur gears and worm wheels.

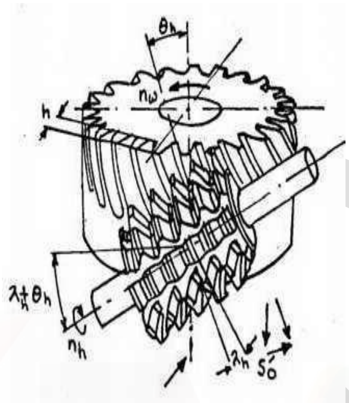


Setup of gear hobbing operation

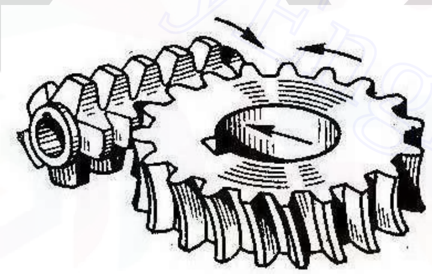
When hobbing a spur gear, the angle between the hob and gear blank axes is 90° minus the lead angle at the hob threads. For helical gears, the hob is set so that the helix angle of the hob is parallel with the tooth direction of the gear being cut. Additional movement along the tooth length is necessary in order to cut the whole tooth length. Machines for cutting precise gears are generally CNC type and often are housed in temperature controlled rooms to avoid dimensional deformations.



Spur gear



helical gear



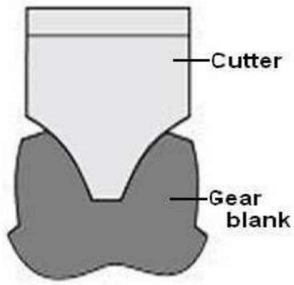
Worm wheel

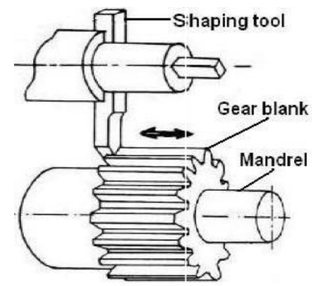
2. Write short notes on gear forming. (AU Dec2010)

Production of gears by gear forming method uses a single point cutting tool or a milling cutter having the same form of cutting edge as the space between the gear teeth being cut. This method uses simple and cheap tools in conventional machines and the setup required is also simple

Shaping, planing and slotting

Both productivity and product quality are very low in this process. So this process is used only for making one or few teeth on one or two pieces of gears as and when required for repair and maintenance purpose. The planning and slotting machines work on the same principle. Planing machine is used for making teeth of large gears whereas slotting, generally, for internal gears.





Principle of gear forming

Gear teeth cutting in ordinary shaping machine

Milling

Gear teeth can be produced by both disc type and end mill type form milling cutters in a milling machine.

Producing external teeth by form milling cutter disc type

The form milling cutter called DP (Diametral Pitch, used in inch systems which is equivalent to the inverse of a module) cutter have the shape of the teeth similar to the tooth space with the involute form of the corresponding size gear. These can be used on either horizontal axis or vertical axis milling machines, through horizontal axis is more common. The cutting tool is fed radially into the workpiece till the full depth is reached. Then the workpiece is fed past the cutter to complete the machining of one tooth space. Milling of gears is relatively common process in machine shops; it is suitable for small volume production. The work piece is actually mounted in the dividing head. In form milling, indexing of the gear blank is required to cut all the teeth. Indexing is the process of evenly dividing the circumference of a gear blank into equally spaced divisions. The index head of the indexing fixture is used for this purpose. The index fixture consists of an index head (also dividing head, gear cutting attachment) and footstock, which is similar to the tailstock of a lathe. The index head and footstock attach to the worktable of the milling machine. An index plate containing graduations is used to control the rotation of the index head spindle. Gear blanks are held between centers by the index head spindle and footstock. Workpieces may also be held in a chuck mounted to the index head spindle or may be fitted directly into the taper spindle recess of some indexing fixtures.

Production of gear teeth by form milling are characterized by:

Use of HSS form milling cutters.

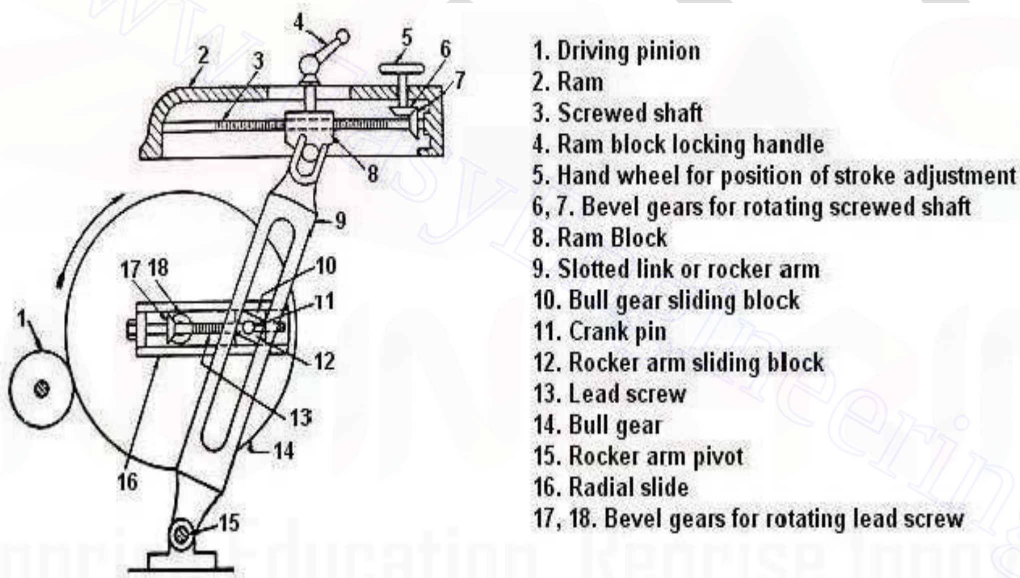
Use of ordinary milling cutters.

Low production rate:

Need of indexing after machining each tooth gap. Slow speed and feed.
Low accuracy and surface finish.
Inventory problem – due to need of a set of eight cutters for each module – pressure angle combination.
End mill type cutters are used for teeth of large gears and / or module.

3. Explain the Crank and slotted link quick return mechanism

This mechanism has a bull gear mounted within the column. The motion or power is transmitted to the bull gear through a pinion which receives its motion from an individual motor. A radial slide is bolted to the centre of the bull gear. This radial slide carries a bull gear sliding block into which the crankpin is fitted. Rotation of the bull gear will cause the crank pin to revolve at a constant speed about the centre of the bull gear.



Crank and slotted link quick return mechanism

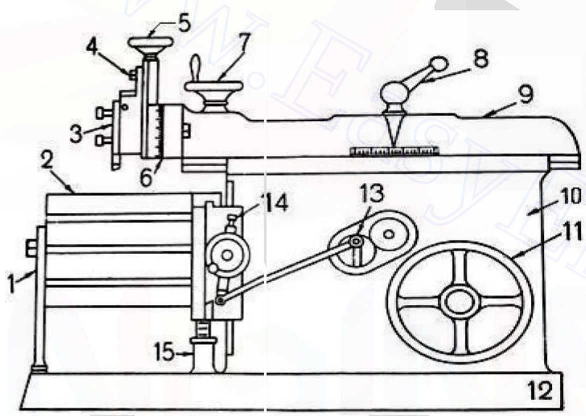
Rocker arm sliding block is mounted upon the crank pin and is free to rotate about the pin. The rocker arm sliding block is fitted within the slotted link and can slide along the slot in the slotted link (rocker arm). The bottom end of the rocker arm is pivoted to the frame of the column. The upper end is forked and connected to the ram block by a pin which can slide in the forked end. As the bull gear rotates causing the crank pin to rotate, the rocker arm sliding block fastened to the crank pin will rotate on the crank pin circle, and at the same time will move up and down in the slot provided in the slotted link. This up and down movement will give rocking motion (oscillatory motion) to the slotted link (rocker arm), which communicated to the ram. Thus the rotary motion of the bull gear is converted into reciprocating movement of the ram.

4. Discuss the principle of operation of a shaper with a neat sketch. (AU Apr2011)

- Major parts of a standard shaper
- Schematic view of a standard shaper

Base It provides the necessary support to the machine tool. It is rigidly bolted to the shop floor. All parts are mounted on the base. It is made up of cast iron to resist vibration and take up high compressive load. It takes the entire load of the machine and the forces set up by the cutting tool during machining.

Column It is a box like casting mounted upon the base. It encloses the drive mechanisms for the ram and the table. Two accurately machined guide ways are provided on the top of the column on which the ram reciprocates. The front vertical face of the column which serves as the guide ways for the cross rail is also accurately machined.



Cross rail It is mounted on the front vertical guide ways of the column. It has two parallel guide ways on its top in the vertical plane that is perpendicular to the ram axis. The table may be raised or lowered to accommodate different sizes of jobs by rotating an elevating screw which causes the cross rail to slide up and down on the vertical face of the column. A horizontal cross feed screw which is fitted within the cross rail and parallel to the top guide ways of the cross rail actuates the table to move in a crosswise direction.

Saddle It is mounted on the cross rail which holds the table firmly on its top. Crosswise movement of the saddle by rotating the cross feed screw by hand or power causes the table to move sideways. ***Table*** It is bolted to the saddle receives crosswise and vertical movements from the saddle and cross rail. It is a box like casting having T-slots both on the top and sides for clamping the work. In a universal shaper the table may be swiveled on a horizontal axis and the upper part of the table may be tilted up or down. In a heavier type shaper, the front face of the table is clamped with a table support to make it more rigid.

Ram It holds and imparts cutting motion to the tool through reciprocation. It is connected to the reciprocating mechanism contained within the column. It is semi cylindrical in form and heavily ribbed inside to make it more rigid. It houses a screwed shaft for altering the position of the ram with respect to the work and holds the tool head at the extreme forward end.

Tool head It holds the tool rigidly, provides the feed movement of the tool and allows the tool to have an automatic relief during its return stroke. The vertical slide of the tool head has a swivel base which is held on a circular seat on the ram. So the vertical slide may be set at any desired angle. By rotating the down feed screw handle, the vertical slide carrying the tool executes the feed or depth of cut. The amount of feed or depth of cut may be adjusted by a micrometer dial on the top of the down feed screw. Apron consisting of clapper box, clapper block and tool post is clamped upon the vertical slide by a screw. By releasing the clamping screw, the apron may be swiveled upon the apron swivel pin with respect to the vertical slide. This arrangement is necessary to provide relief to the tool while making vertical or angular cuts. The two vertical walls on the apron called clapper box houses the clapper block which is connected to it by means of a hinge pin. The tool post is mounted upon the clapper block. On the forward cutting stroke the clapper block fits securely to the clapper box to make a rigid tool support. On the return stroke a slight frictional drag of the tool on the work lifts the block out of the clapper box a sufficient amount preventing the tool cutting edge from dragging and consequent wear. The work surface is also prevented from any damage due to dragging.

Working principle of a standard shaper

The bull gear receives its rotation from the motor through the pinion. The rotation of the crank causes oscillation of the link and thereby reciprocation of the ram and hence the tool in straight path. The cutting motion provided by the reciprocating tool and the intermittent feed motion provided by the slow transverse motion of the work at different rate by using the ratchet - pawl system along with the saddle result in producing a flat surface by gradual removal of excess material layer by layer in the form of chips. The vertical in feed is given either by descending the tool holder or raising the cross rail or both. Straight grooves of various curved sections are also made in shaper by using specific form tools. The single point straight or form tool is clamped in the vertical slide of the tool head, which is mounted at the front face of the reciprocating ram. The work piece is clamped directly on the table or clamped in a vice which is mounted on the table. The changes in length of stroke and position of the stroke required for different machining are accomplished respectively by:

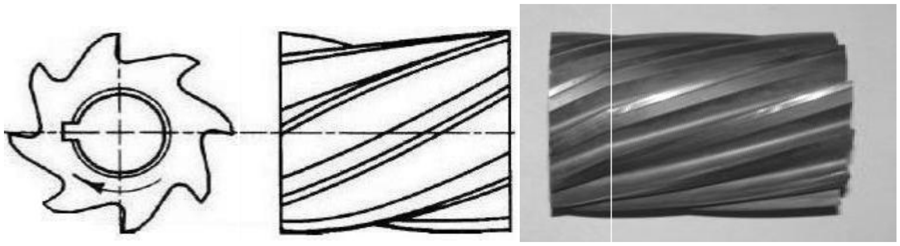
Adjusting the crank length by rotating the bevel gear mounted coaxially with the bull gear. Shifting the ram block nut by rotating the lead screw.

5. Explain various milling cutters with neat sketches? (AU Apr2011)

Many different kinds of milling cutters are used in milling machines. They are:

Slab or plain milling cutters: Straight or helical fluted

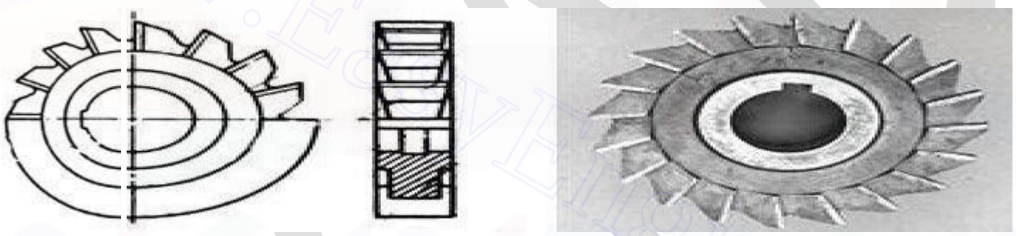
Plain milling cutters are hollow straight HSS cylinder of 40 to 80mm outer diameter having 4 to 16 straight or helical equi-spaced flutes or cutting edges on the circumference. These are used in horizontal arbor to machine flat surfaces parallel to the axis of rotation of the spindle. Very wide plain milling cutters are termed as slab milling cutters.



Slab or plain milling cutter

Side milling cutters: Single side or double sided type

These arbor mounted disc type cutters have a large number of cutting teeth at equal spacing on the periphery. Each tooth has a peripheral cutting edge and another cutting edge on one face in case of single side cutter and two more cutting edges on both the faces leading to double sided cutter. One sided cutters are used to produce one flat surface or steps comprising two flat surfaces at right angle. Both sided cutters are used for making rectangular slots bounded by three flat surfaces.

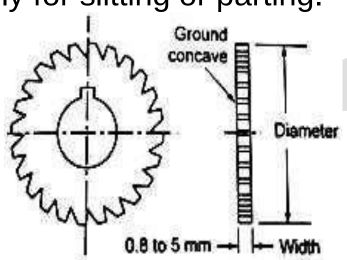


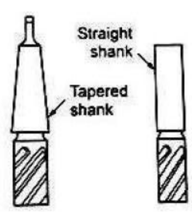
Side milling cutter

Slitting saws or parting tools

These milling cutters are very similar to the slotting cutters having only one peripheral cutting edge on each tooth. However, the slitting saws: Are larger in diameter and much thin.Possess large number of cutting teeth but of small size.

Used only for slitting or parting.





Slitting saw End milling cutters Face milling cutter

End milling cutters: With straight or taper shank

The common characteristics of end milling cutters are: Mostly made of High Speed Steel.

4 to 12 straight or helical teeth on the periphery and face. Diameter ranges from about 1 mm to 40mm. Very versatile and widely used in vertical spindle type milling machines.
End milling cutters requiring larger diameter are made as a separate cutter body which is fitted in the spindle through a taper shank arbor (Shell end mills).

Face milling cutters

The main characteristics of face milling cutters are:

Usually large in diameter (80 to 800 mm) and heavy. Used only for machining flat surfaces in different orientations. Mounted directly in the vertical and / or horizontal spindles. Coated or uncoated carbide inserts are clamped at the outer edge of the carbon steel body.

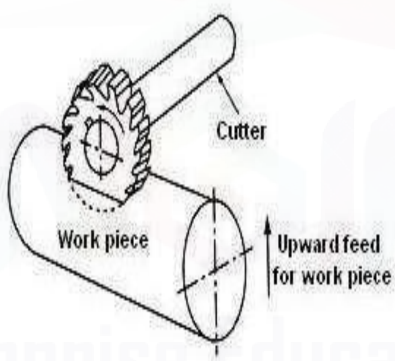
Generally used for high production machining of large jobs.

Form cutters

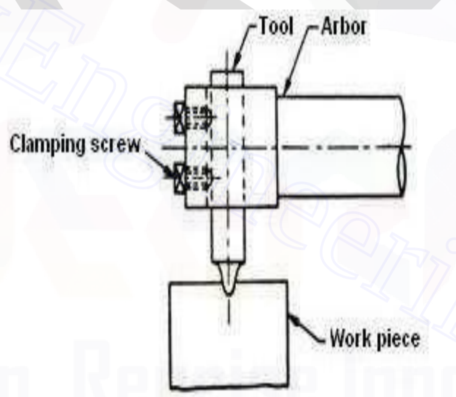
These cutters have irregular profiles on the cutting edges in order to generate an irregular outline of the work. These disc type HSS cutters are generally used for making grooves or slots of various profiles.

Woodruff key slot milling cutters

These cutters are small standard cutters similar in construction to a thin small diameter plain milling cutter, intended for the production of wood ruff key slots. The cutter is provided with a shank and may have straight or staggered teeth.



Woodruff key slot milling cutter



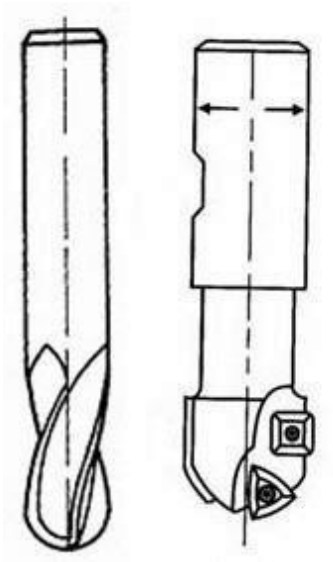
Schematic view of a fly cutter

Fly cutter

These are simplest form of cutters and are mainly used in experimental shops or in tool room works. The cutter consists of a single point cutting tool attached to the end of an arbor. This cutter may be considered as an emergency tool when the standard cutters are not available. The shape of the tool tip is the replica of the contour to be machined.

Ball nose end mill

Small end mill with ball like hemispherical end is often used in CNC milling machines for machining free form 3-D or 2-D contoured surfaces. These cutters may be made of HSS, solid carbide or steel body with coated or uncoated carbide inserts clamped at its end



Ball nose end mills

PART-C

1. With a neat sketch explain the column and knee type milling machine and name its main parts. (AU Dec2010)

Major parts of knee type milling machine

Base It is accurately machined on its top and bottom surface and serves as a foundation member for all other parts. It carries the column at its one end. In some machines, the base is hollow and serves as a reservoir for cutting fluid.

Column It is the main supporting frame mounted vertically on the base. The column is box shaped, heavily ribbed inside and houses all the driving mechanisms for the spindle and table feed. The front vertical face of the column is accurately machined and is provided with dovetail guide ways for supporting the knee. The top of the column is finished to hold an over arm that extends outward at the front of the machine.

Knee It slides up and down on the vertical guide way so the column face. The adjustment of height is effected by an elevating screw mounted on the base that also supports the knee. The knee houses the feed mechanism of the table, and different controls to operate it. The top face of the knee forms a slide way for the saddle to provide cross travel of the table.

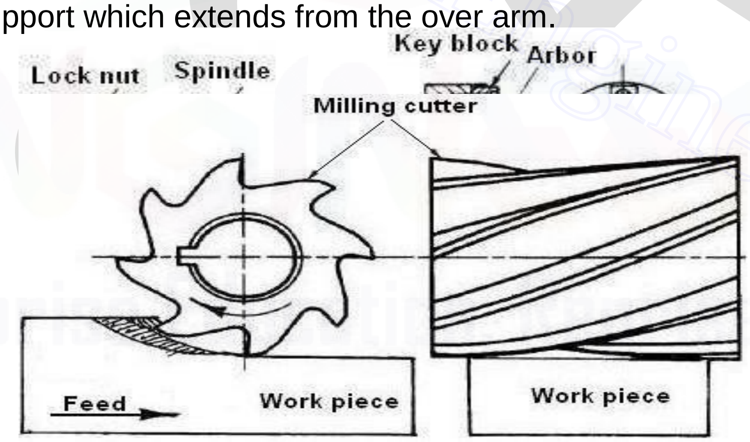
Table The table rests on ways on the saddle and travels longitudinally. The top of the table is accurately finished and T-slots are provided for clamping the work and other fixtures on it. A lead screw under the table engages a nut on the saddle to move the table horizontally by hand or power. The longitudinal travel of the table may be limited by fixing trip dogs on the side of the table. In universal machines, the table may also be swiveled horizontally.

Over hanging arm The overhanging arm that is mounted on the top of the column extends beyond the column face and serves as a bearing support for the other end of the arbor. The arm is adjustable so that the bearing support may be provided nearest to the cutter.

Front brace The front brace is and extra support that is fitted between the knee and the over arm to ensure further rigidity to the arbor and the knee. The front brace is slotted to allow for the adjustment of the height of the knee relative to the over arm.

Spindle The spindle of the machine is located in the upper part of the column and receives power from the motor through belts, gears, clutches and transmits it to the arbor. The front end of the spindle just projects from the column face and is provided with a tapered hole into which various cutting tools and arbors may be inserted. The accuracy in metal machining by the cutter depends primarily on the accuracy, strength, and rigidity of the spindle.

Arbor It may be considered as an extension of the machine spindle on which milling cutters are securely mounted and rotated. The arbors are made with taper shanks for proper alignment with the machine spindles having taper holes at their nose. The arbor may be supported at the farthest end from the overhanging arm or may be of cantilever type which is called stub arbor. The arbor shanks are properly gripped against the spindle taper by a draw bolt which extends through out the length of the hollow spindle. The threaded end of the draw bolt is fastened to the tapped hole of the arbor shank and then the lock nut is tightened against the spindle. The spindle has also two keys for imparting positive drive to the arbor in addition to the friction developed in the taper surfaces. The cutter is set at the required position on the arbor by spacing collars or spacers of various lengths but of equal diameter. The entire assembly of the milling cutter and the spacers are fastened to the arbor by a long key. The end spacer on the arbor is slightly larger in diameter and acts as a bearing bush for bearing support which extends from the over arm.



Principle of producing flat surface

Working principle of knee type milling machine

The kinematic system comprising of several mechanisms enables transmission of motion andpowerfromthemotortothecuttingtoolforitsrotationatvaryingspeedsandtotheworktable for its slow feed motions along X, Y and Z directions. The milling cutter mounted on the horizontal milling arbor, receives its rotary motion at different speeds from the main motor through the speed gear box. The feeds of the work piece can be given by manually or automatically by rotating the respective wheels by hand or by power. The work piece is clamped on the work table by a work holding device. Then the work piece is fed against the rotating multipoint cutter to remove the excess material at a very fast rate.

UNIT IV

ABRASIVE PROCESS AND BROACHING

PART A

1. What are the specifications of grinding wheel? (AU Apr 2011, Dec2010)

Type of bond

- Grit or grain size
- Grade structure Abrasive
- Manufacturer's Code

2. What is honing? (AU Apr 2011, Dec2010)

An abrading process of finishing previously machined surfaces is called honing.

3. Narrate the working principle of abrasive jet machining. (AU Apr2011)

In this type the electrolyte used is replaced by abrasive jet. But grinding process is as similar that of electrochemical grinding..

4. Define hardness of the grinding wheel. (AU Apr2010)

Grade or hardness indicates the strength with which the bonding material holds the abrasive grains in the grinding wheel.

5. Define lapping. (AU Dec2009)

Lapping is a surface finishing process used for producing geometrically accurate flat, cylindrical and spherical surfaces.

6. What is meant by "grade" and "structure" of a grinding wheel? (AU Dec 2009)

Grade or hardness indicates the strength with which the bonding material holds the abrasive grains in the grinding wheel.

Structure denotes the spacing between the abrasive grains or in other words the density of the wheel.

7. What are all the parameters that would affect the MRR in abrasive jet machining? (AU Dec2008)

The metal removal rate is affected by the following factors grinding wheel speed

Type of abrasive used

- Capacity of pump
- Capacity of filter

8. Mention four important factors that influence the selection of grinding wheel. (AU Dec2008)

(1) Constant factors

- Physical properties of material to be ground
- Amount and rate of stock to be removed

- Area of contact
- Type of grinding machine

(2) Variable factors

- Work speed
- Wheel speed
- Condition of grinding wheel

9. What is roller burnishing process? (AU Dec2007)

It is a method of cold working metal surfaces in which hardened sphere or cylindrical roller is pressed against the work to be processed

10. List the advantages of honing?

Simple process which can be done on any general purpose machines such as lathe sand drilling machines. This process can be applied for both internal cylindrical and flat surfaces. Honing enables the maximum stock removing capacity out of entire surface finishing operation.

11. What do you mean by loading of grinding wheels? (AU Dec2006)

During operation, the chips formed get entrapped in the inner granular space of abrasive particles. This is called loading

12. What is broaching. (AU Dec 2010) (AU Dec2009)

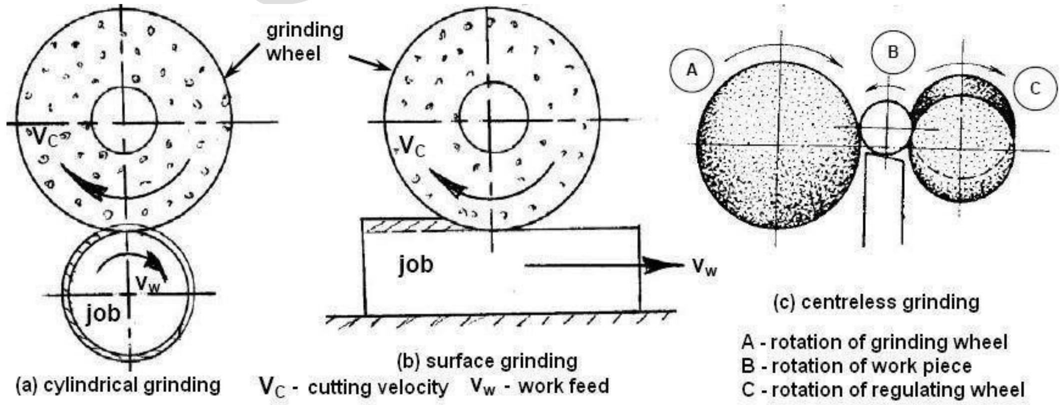
It is a process of machining a surface with a special multipoint cutting tool called "BROACH" which has successively higher cutting edges in a fixed path.

13. List four applications of broaching machines. (AU Apr2010)

(i) Straight and helical slots
(ii) External surfaces of various shape
(iii) External and internal toothed gears
(iv) Holes of cross sectional shape

PART -B

1. Explain the working mechanism of cylindrical grinding. (AU Apr2011)



Grinding processes are generally classified based on the type of surface produced. *They are:*

1. Cylindrical grinding process.
2. Surface grinding process.
3. Centreless grinding process.

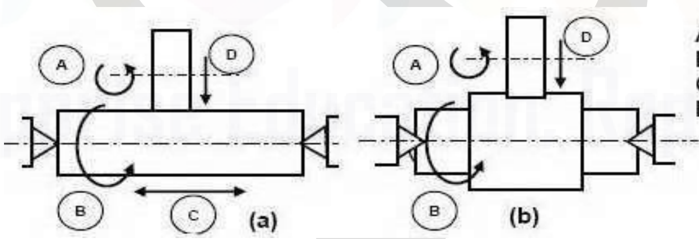
CYLINDRICAL GRINDING PROCESS

It is used generally for producing external cylindrical surfaces. The machine is very similar to a centrelathe. The grinding wheel is located similar to the tool post with an independent power and is driven at a high speed suitable for the grinding operation. There are four movements in a cylindrical grinding process. Rotation of cylindrical work piece about its axis. Rotation of grinding wheel about its axis. Longitudinal feed movement of the work past the wheel face. Movement of wheel into the work perpendicular to the axis of the work to give depth of cut.

The work which is normally held between the centres is rotating data much lower speed in a direction opposite to that of the grinding wheel. The table assembly which houses the centers can be reciprocated to provide the necessary traverse feed of the work piece past the grinding wheel. The in feed is provided by the movement of the grinding wheel head into the work piece. Typical grinding allowances left are about 0.1 to 0.3mm. Beyond this the grinding operation becomes too expensive. Types of operations in cylindrical grinding are:

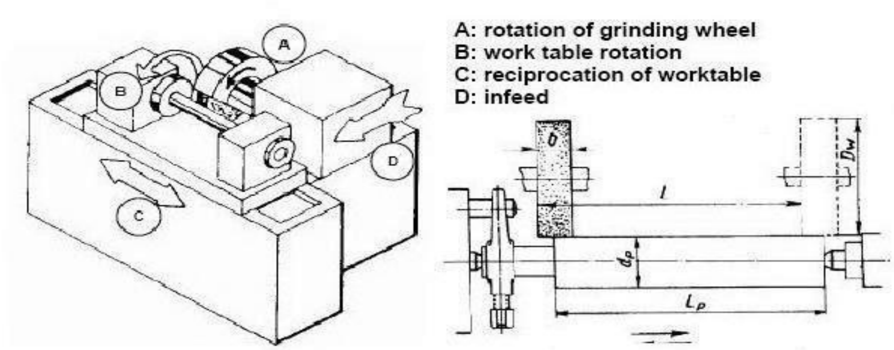
(i) Traverse grinding or in feed grinding -In this grinding wheel is moved into the work. The desired surface is then produced by traversing the work piece across the wheel

(ii) Plunge grinding - The basic movement is of the grinding wheel being feed radically into the work while the later revolves on centres. It is similar to form cutting on lathe. The method is used for short work pieces where the width of the wheel overlaps the length to be ground. Short rigid work pieces can be ground by this method.



Cylindrical grinding process (a) traverse grinding and (b) plunge grinding

(iii) Full-depth grinding



The wheel is trued to obtain an entering taper or step, and the whole allowance is ground off in one or two lengthwise passes. The method is usually applied to relatively short surfaces of rigid shaft-type work pieces Plain centre type cylindrical grinding machine

Plain centre type cylindrical grinding machine

Base:

The base or bed is the main casting that rest on the floor and supports the parts mounted on it. On the top of the base are precision horizontal ways set at right angles for the table to slide on the base. The base also houses the table drive mechanism.

Tables:

There are two tables, lower table and upper table. The lower table slides on ways on the bed and provides traverse of the work past the grinding wheel. It can be moved by hand or power within desired limits. The upper table that is pivoted at its centre is mounted on the top of the sliding table. It has T-slots for securing the head stock and tail stock or foot stock and can be positioned along the table to suit the length of the work. The upper table can be swiveled and clamped in position to provide

Adjustment for grinding straight or tapered work as desired. Setting for tapers upto $\pm 10^0$can be made in This way. Steep tapers are ground be swiveling the wheel head. Adjustable dogs are clamped in longitudinal slots and they are provided at the side of the lower or sliding table and are set up to reverse the table at the ends of the stroke.

Headstock:

The headstock supports the work piece by means of a dead centre and drives it be means of a dog, or it may hold and drive the work piece in a chuck.

Tailstock:

The tail stock can be adjusted and dampen in various positions to accommodate different lengths of work piece.

Wheel head:

The wheel head carries a grinding wheel and its driving motor is mounted on a slide at the top and rear of the base. The wheel head may be moved perpendicularly to the table ways, by hand or power, to feed the wheel to the work. The grinding wheel is fed to the work by hand or power as determined by the engagement of the cross-feed control lever.

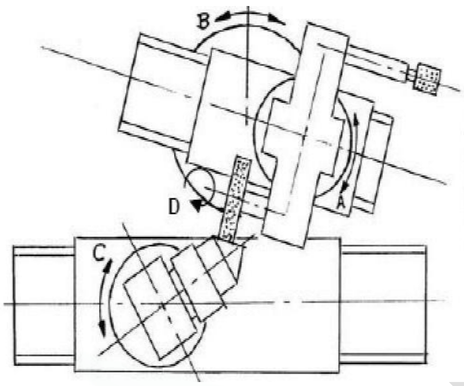
Working principle:

The machine is similar to a centre lathe in many respects. The work piece is held between head stock and tailstock centres. A disc type grinding wheel performs the grinding action with its peripheral surface. Both traverse and plunge grinding can be carried out in this machine

Universal cylindrical grinding machine

These grinders, in addition to the features offered by plain grinders, are provided with a swiveling head stock and a swiveling wheel head. This permits the grinding of taper of any angle, much greater than is possible in plain grinder. Universal machines are available to handle parts requiring swings up to 450 mm and centre distance of 1800mm. This allows grinding of any taper on the workpiece.

Universal grinder is also equipped with an additional head for internal grinding.



Important features of universal cylindrical grinding machine

Universal grinder has the following additional features:

The centre of the head stock spindle can be used alive or dead. The work can be held and revolved by a chuck. It can also be held between centres and revolved.

- The wheel head can be swiveled in a horizontal plane in any angle. The wheel head can be fed in the inclined direction also.
- The headstock can be swiveled to any angle in the horizontal plane.

Internal cylindrical grinding machine

Internal grinding is employed chiefly for finishing accurate holes in hardened parts, and also when it is impossible to apply other more productive methods of finishing accurate hold, for example, precision boring, honing etc.

There are two general methods of internal grinding:

- With a rotating work piece.
- With the work piece held stationary.

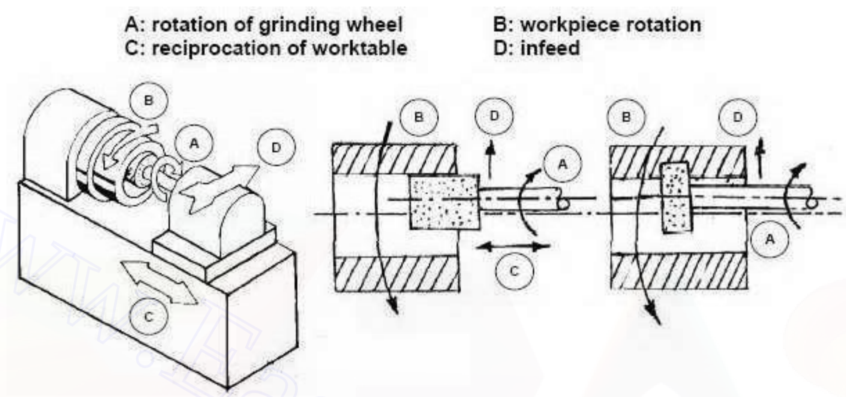
The first method is used in grinding holes in relatively small work pieces, mostly bodies of revolution, for example, the bores of gears and the inner surfaces of ball bearing rings. The work piece is held in a chuck or special fixture and rotated in the same manner as in a lathe. A straight type grinding wheel is rotated and has two feed-longitudinal feed along the wheel axis and is thus reciprocated back and forth through the length of the hole, and intermittent cross feed(radial feed) at the end of each pass, which determines the depth of cut.

The second method of internal grinding is used for grinding holes in large bulky work pieces (housing-type parts) that are inconvenient or even impossible to clamp in a chuck of the grinder. They are mounted on the table of a planetary grinding machine. In addition to rotation about its axis, the wheel spindle of this type of machine also rotates with a planetary motion about the axis of the hole being ground. Axial motion of the wheel provides the longitudinal feed.

Chucking type internal grinding machine

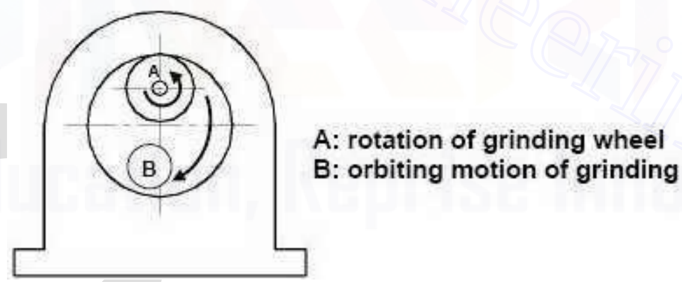
The work piece is usually mounted in a chuck. A magnetic face plate can also be used. A small grinding wheel performs the necessary grinding with its peripheral surface. Both transverse and plunge grinding can be carried out in this machine

(1)Internal grinding machine (a) transverse grinding and (b) plunge grinding



Planetary internal grinding machine

Planetary internal grinding machine is used where the work piece is of irregular shape and can not be rotated conveniently. In this machine the work piece does not rotate. Instead, the grinding wheel orbits the axis of the hole in the work piece.



2. Explain surface grinding (AU Apr2011)

Surface grinding machines are generally used for generating flat surfaces. These machines are similar to milling machines in construction as well as motion. There are basically four types of machines depending upon the spindle direction and the table motion. *They are,*

1. Horizontal spindle and rotating table grinding machine.
2. Vertical spindle and rotating table grinding machine.
3. Horizontal spindle and reciprocating table grinding machine, and
4. Vertical spindle and reciprocating table grinding machine.

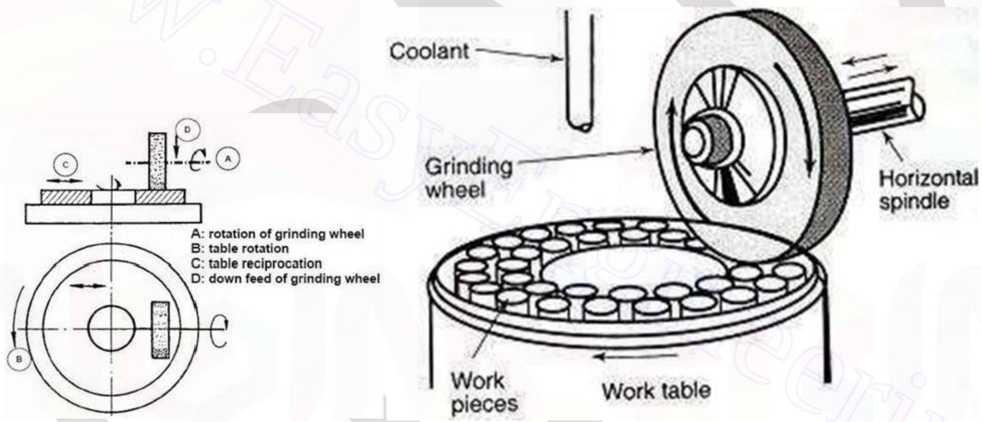
The table in the case of reciprocating machines is generally moved by the hydraulic power. The wheel head is given a cross feed motion at the end of each table motion. In this machine the wheel should over travel the work piece at both the ends to prevent the grinding wheel removing the metal at the same work spot during the table reversal.

- Vertical spindle machines are generally of a bigger capacity.
- The diameter of the wheel is wider
- than the work piece and as a result no traverse feed is required.

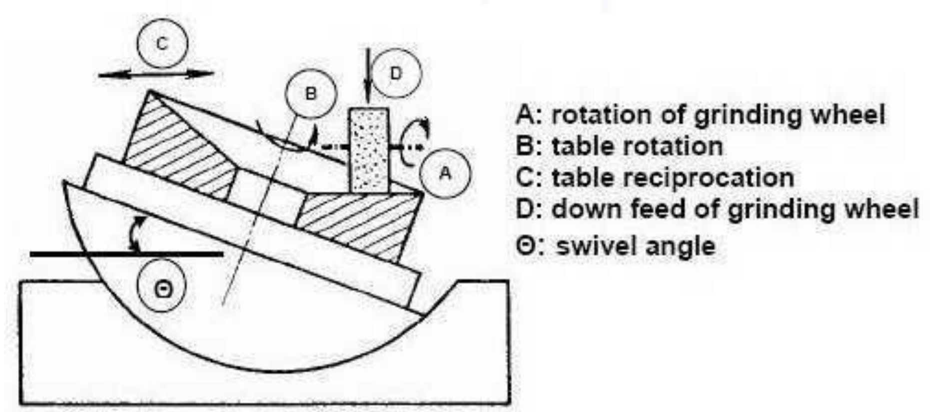
The complete machining surface is covered by the grinding wheel face. They are suitable for production grinding of very flat surfaces.

Horizontal spindle and rotating table grinding machine

In principle the operation is same as that for facing on the lathe. This machine has a limitation in accommodation of work piece and therefore does not have wide spread use. However, by swiveling the worktable, concave or convex or tapered surface can be produced on individual part



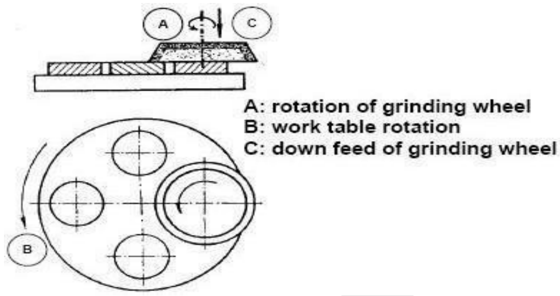
Surface grinding in horizontal



Spindle and rotating table grinding machine

Vertical spindle and rotating table grinding machine

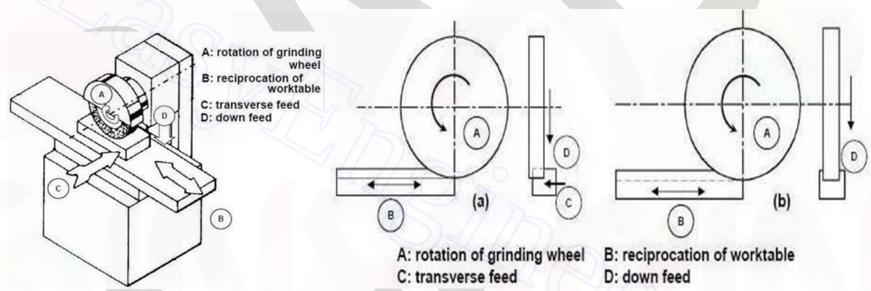
The machine is mostly suitable for small work pieces in large quantities. This primarily production type machine often uses two or more grinding heads thus enabling both roughing and finishing in one rotation of the worktable.



Surface grinding in vertical spindle and rotating table grinding machine

Horizontal spindle and reciprocating table grinding machine

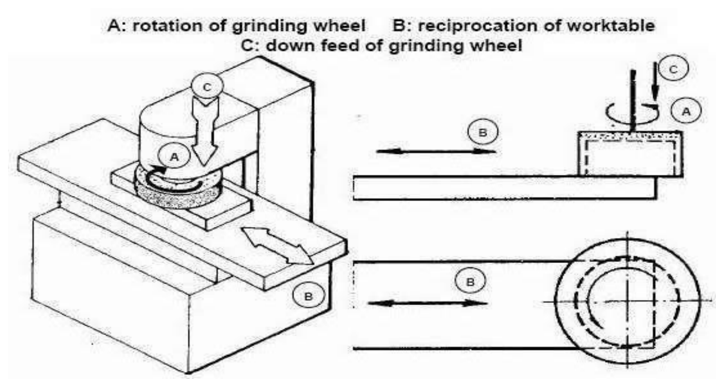
A disc type grinding wheel performs the grinding action with its peripheral surface. Both traverse and plunge grinding can be carried out in this machine.



Horizontal spindle Surface grinding (a) traverse grinding (b) plunge grinding

Vertical spindle and reciprocating table grinding machine

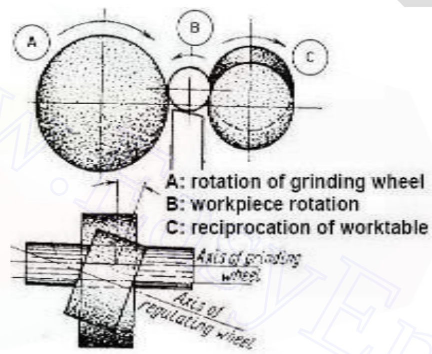
The grinding operation is similar to that of face milling on a vertical milling machine. In this machine a cup shaped wheel grinds the work piece over its full width using end face of the wheel as shown in Figure. This brings more grits in action at the same time and consequently a higher material removal rate may be attained than for grinding with a peripheral wheel.



3. Explain center less grinding and its method (AU Dec 2010) (AU Dec2008)

Centre less grinding makes it possible to grind cylindrical work pieces without actually fixing the work piece using centers of a chuck. As a result no work rotation is separately provided. The process consists of two wheels, one large grinding wheel and another smaller regulating wheel. The work is held on a work rest blade. The regulating wheel is mounted at an angle to the plane of the grinding wheel. The center of the work piece is slightly above the center of the grinding wheel. The work piece is supported by the rest blade and held against the regulating wheel by the grinding force. As a result the work rotates at the same surface speed as that of regulating wheel. The axial feed of the work piece iscontrolled by the angle of tilt of the regulating wheel. Typical work speeds are about 10 to 50m/min.

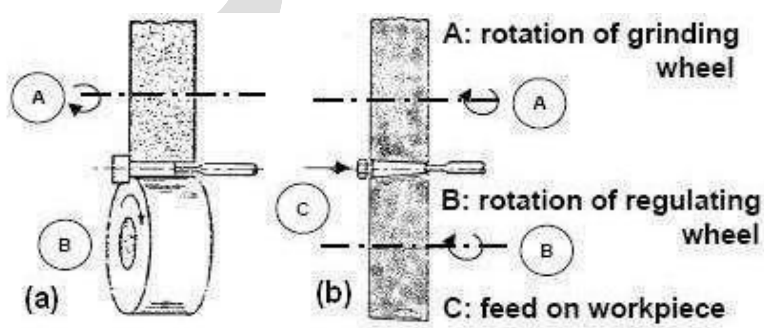
Centreless external grinding machine



Centreless external grinding machine

This grinding machine is a production machine in which outside diameter of the work piece is ground. The work piece is not held between center but by a work support blade. It is rotated by means of a regulating wheel and ground by the grinding wheel. In through-feed center less grinding, the regulating wheel revolving at a much lower surface speed than grinding wheel controls the rotation and longitudinal motion of the work piece. The regulating wheel is kept slightly inclined to the axis of the grinding wheel and the work piece is fed longitudinally

Method of center less grinding



Centreless (a) in-feed and (b) end feed grinding

1) Through feed

It is used for straight cylindrical work piece like long shafts or bars, roller pins etc. In this method, the regulating wheel is titled at a small angle. This makes the work to move axially through between the grinding wheel and regulating wheel. The guides are provided at both the ends of the wheel and guide the movement of workpiece.

2.) Infeed grinding

It is similar to plunge grinding. The work is placed on the work rest against an end stop. This prevents the axial movement of work piece. The regulating wheel and the work rest with work piece are moved towards the grinding wheel by hand feed. This method is useful to grind shoulders and formed surfaces.

3.) End feed grinding

In this method both the grinding and the regulating wheels are tapered and thus, it produces tapered work piece. The work piece is fed length wise between wheels and is ground as it advances until it reaches the end stop.

Centreless internal grinding machine

This machine is used for grinding cylindrical and tapered holes in cylindrical parts (e.g. cylindrical liners, various bushings etc). The work piece is rotated between supporting roll, pressure roll and regulating wheel and is ground by the grinding wheel

4. Explain the gear shaving, gear honing and gear lapping processes. (AU Dec2008)

HONING

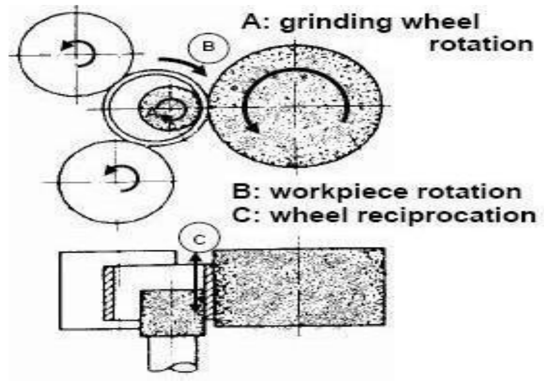
Honing is a low abrading process which uses bonded abrasive sticks for removing stock from metallic and non-metallic surfaces. This process is used primarily to remove the grinding or the tool marks left on the surface by previous operations. However, it can be used for external cylindrical surfaces as well as flat surfaces. It is most commonly used for internal surfaces.

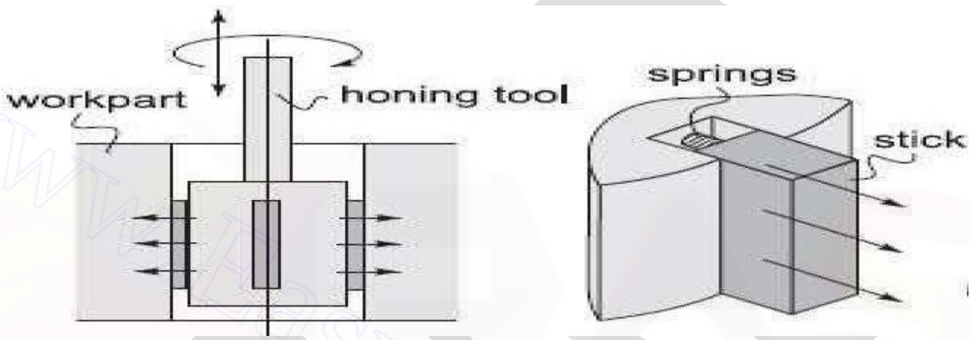
The advantages of honing are:

Correction of geometrical accuracy.

Dimensional accuracy.

Honing is a finishing process performed by a honing tool called as hone which contains a set of three to a dozen and more bonded abrasive sticks. The sticks are equally spaced about the periphery of the honing tool. The sticks are held against the work surface with controlled light pressure, usually exercised by small springs. The honing tool is given a complex rotational and oscillatory axial motion, which combine to produce a crosshatched lay pattern of very low surface roughness. In addition to the surface finish of about 0.1 μm, honing produces a characteristic crosshatched surface that tends to retain lubrication during operation of the component, thus contributing to its function and service life. A cutting fluid must be used in honing to cool and lubricate the tool and to help remove the chips. A common application of honing is to finish the holes. Typical examples include bores of internal combustion engines, bearings, hydraulic cylinders, and gun barrels.





The honing tones are given a complex motion so as to prevent every single grit from repeating its path over the work surface. The critical process parameters are:

Rotation speed. Oscillation speed.

Length and position of the stroke. Honing stick pressure.

With conventional abrasive honing stick, several strokes are necessary to obtain the desired finish on the work piece. However, with introduction of high performance diamond and CBN grits it is now possible to perform the honing operation in just one complete stroke. Advent of precisely engineered microcrystalline CBN grit has enhanced the capability further. Honing stick with microcrystalline CBN grit can maintain sharp cutting condition with consistent results over long duration. Super abrasive honing stick with mono layer configuration, where a layer of CBN grits are attached to stick by a galvanically deposited metal layer is typically found in single stroke honing application. Super abrasive honing stick with single layer configuration with the advent of precision brazing technique, efforts can be made to manufacture honing stick with single layer configuration with a brazed metal bond. Like brazed grinding wheel such single layer brazed honing stick are expected to provide controlled grit density, larger grit protrusion leading to higher material removal rate and longer life compared to what can be obtained with a galvanically bonded counterpart

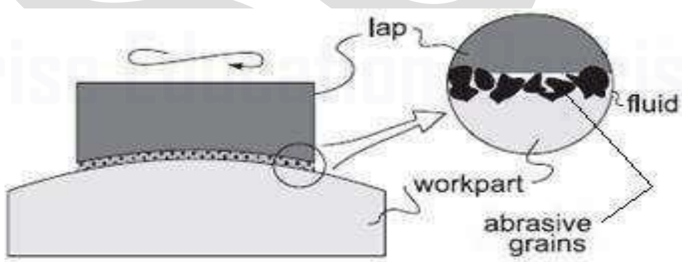
LAPPING

Lapping is a surface finishing process used on flat or cylindrical surfaces. Lapping is the abrading of a surface by means of a lap (which is made of a material softer than the material to be lapped), which has been charged with the fine abrasive particles.

The process is employed to get: Geometrically true surface. Extreme accuracy of dimension.
Correction of minor imperfections in shape. Refinement of the surface finish, and
Close fit between mating surfaces.
Lapping methods:
Hand lapping for flatwork.
Hand lapping for external cylindrical work, (Ring lapping). Machine lapping.
In lapping, instead of a bonded abrasive tool, oil-based fluid suspension of very small free abrasive grains (aluminum oxide and silicon carbide, with typical grit sizes between 300 and 600) called a lapping compound is applied between the work piece and the lapping tool. The lapping tool is called a lap, which is made of soft materials like copper, lead or wood. The lap has the reverse of the desired shape of the workpart. To accomplish the process, the lap is pressed against the work and moved back and forth over the surface in a figure eight or other motion pattern, subjecting all portions of the surface to the same action. Lapping is sometimes performed by hand, but lapping machines accomplish the process with greater consistency and efficiency. The cutting mechanism in lapping is that the abrasives become embedded in the lap surface, and the cutting action is very similar to grinding, but a concurrent cutting action of the free abrasive particles in the fluid cannot be excluded. Lapping is used to produce optical lenses, metallic bearing surfaces, gauges, and other parts requiring very good finishes and extreme accuracy. Material removal in lapping usually ranges from .003 to .03 mm but many reach 0.08 to 0.1mm in certain cases.

Characteristics of lapping process:

Use of loose abrasive between lap and the workpiece. Usually lap and workpiece are not positively driven but are guided in contact with each other.Relative motion between the lap and the work should change continuously so that path of the abrasive grains of the lap is not repeated on the workpiece.



Schematics of lapping process showing the lap and the cutting action of suspended abrasive particles.

Cast iron is the mostly used lap material. However, soft steel, copper, brass, hardwood as well as hardened steel and glass are also used.

Abrasives of lapping:

Al_2O_3 and SiC, grain size5~100μm. Cr_2O_3, grain size 1~2μm.
B_4C_3, grain size 5-60 μm. Diamond, grain size 0.5~5V.

Vehicle materials for lapping:

Machine oil. Rape oil.

Grease.

Technical parameters affecting lapping processes are:

Unit pressure.

The grain size of abrasive. Concentration of abrasive in the vehicle. Lapping speed.

Lapping is performed either manually or by machine. Hand lapping is done with abrasive powder as lapping medium, whereas machine lapping is done either with abrasive powder or with bonded abrasive wheel.

5. Briefly discuss about the different types of abrasives used in a grinding wheel. (AU Dec 2008)

Types of abrasives

Abrasives may be classified into two types:

1. ***Natural abrasives*** - Emery (50 - 60 % crystalline Al_2O_3 + Iron Oxide), Sandstone or Solid Quartz, Corundum (75 - 90 % crystalline Al_2O_3 + Iron Oxide) and Diamond.

2. ***Artificial abrasives*** - Aluminium Oxide (Al_2O_3), Silicon Carbide (SiC), Artificial diamond, Boron Carbide and Cubic Boron Nitride (CBN).

The abrasives that are generally used are

1. Aluminium Oxide.(Al_2O_3)
2. Diamond.
3. Silicon Carbide.(SiC)
4. Cubic Boron Nitride.(CBN)

1. **Aluminium oxide(Al_2O_3)**

Aluminium oxide may have variation in properties arising out of differences in chemical composition and structure associated with the manufacturing process. Pure Al_2O_3 grit with defect structure like voids leads to unusually sharp free cutting action with low strength and is advantageous in fine tool grinding operation, and heat sensitive operations on hard, ferrous materials. Regular or brown aluminium oxide (doped with TiO_2) possesses lower hardness and higher toughness than the white Al_2O_3 and is recommended heavy duty grinding to semi finishing. Al_2O_3 alloyed with chromium oxide (<3%) is pink in color. Mono crystalline Al_2O_3 grits make a balance between hardness and toughness and are efficient in medium pressure heat sensitive operation on ferrous materials.

Microcrystalline Al_2O_3 grits of enhanced toughness are practically suitable for stock removal grinding. Al_2O_3 alloyed with zirconia also makes extremely tough grit mostly suitably for high pressure, high material removal grinding on ferrous material and are not recommended for precision grinding. Microcrystalline sintered Al_2O_3 grit is the latest development particularly known for its toughness and self-sharpening characteristics. Trade names: Alundum, Aloxide, corundum, emery, etc.

2. **Silicon carbide (SiC)**

Silicon carbide is harder than alumina but less tough. Silicon carbide is also inferior to Al2O3 because of its chemical reactivity with iron and steel. Black carbide containing at least 95% SiC is less hard but tougher than green SiC and is efficient for grinding soft nonferrous materials. Green silicon carbide contains at least 97% SiC. It is harder than black variety and is used for grinding cemented carbide. Trade names: Carborundum, Crystolon, Electrolon, etc.

3. **Diamond**

Diamond grit is best suited for grinding cemented carbides, glass, sapphire, stone, granite, marble, concrete, oxide, non-oxide ceramic, fiber reinforced plastics, ferrite, graphite. Natural diamond grit is characterized

by its random shape, very sharp cutting edge and free cutting action and is exclusively used in metallic, electroplated and brazed bond. Mono crystalline diamond grits are known for their strength and designed for particularly demanding application. These are also used in metallic, galvanic and razed bond.

Polycrystalline diamond grits are more friable than mono crystalline one and found to be most suitable for grinding of cemented carbide with low pressure. These grits are used in resin bond.

4. **Cubic Boron Nitride (CBN)**

Diamond though hardest is not suitable for grinding ferrous materials because of its reactivity. In contrast, CBN the second hardest material, because of its chemical stability is the abrasive material of choice for efficient grinding of HSS, alloy steels, HSTR alloys.

Presently CBN grits are available as mono crystalline type with medium strength and blocky mono crystals with much higher strength. Medium strength crystals are more friable and used in resin bond for those applications where grinding force is not so high. High strength crystals are used with vitrified, electroplated or brazed bond where large grinding force is expected.

Microcrystalline CBN is known for its highest toughness and auto sharpening character and found to be best candidate for HEDG and abrasive milling. It can be used in all types of bond.

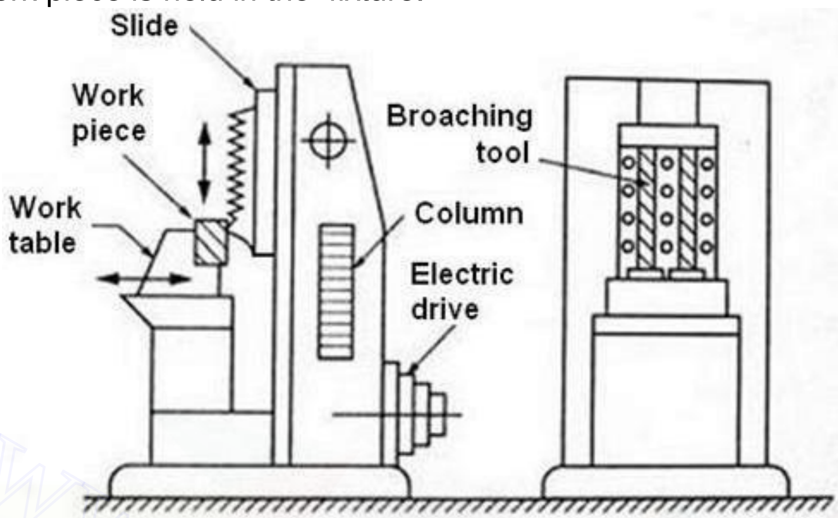
PART-C

1. Explain various broaching machine? (AU Dec2009)

PUSH BROACHINGMACHINES

In these machines the broach movement is guided by a ram. These machines are simple, since the broach only needs to be pushed through the component for cutting and then retracted. The work piece is fixed into a boring fixture on the table. Even simple arbor presses can be used for push broaching.

It consists of a box shape column, slide and drive mechanism. Broach is mounted on the slide which is hydraulically operated and accurately guided on the column ways. Slide with the broach travels at various speeds. The slide is provided with quick return mechanism. The worktable is mounted on the base in front of the column. The fixture is clamped to the table. The work piece is held in the fixture.

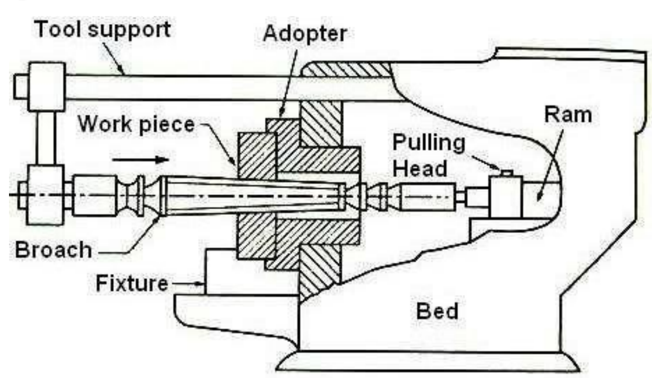


Push down type vertical surface broaching machine

After advancing the table to the broaching position, it is clamped and the slide with the broach travel downwards for machining the work piece. Then the table recedes to load a new work piece and the slide returns to its upper position. The same cycle is then repeated. Vertical broaching machines occupy less floor space and are more rigid as the ram is supported by the base. They are mostly used for external or surface broaching though internal broaching is also possible and occasionally done.

PULL BROACHINGMACHINES

These machines consist of a work holding mechanism, and a broach pulling mechanism along with a broach elevator to help in the removal and threading of the broach through the work piece. The work piece is mounted in the broaching fixture and the broach is inserted through the hole present in the work piece. Then the broach is pulled through the work piece completely and the work piece is then removed from the table. Afterwards the broach is brought back to the starting point before a new work piece is located on the table. The same cycle is then repeated.



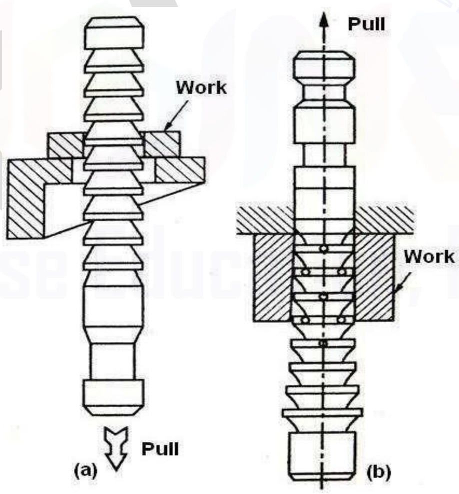
This machine has a box type bed. The length of bed is twice the length of stroke. Most of the modern horizontal broaching machines are provided with hydraulic or electric drive. It is housed in the bed. The job is located in the adopter. The adopter is fitted in the front vertical face of the machine. The small end of the broach is inserted through the hole of the job and connected to the pulling head.

The pulling head is mounted in the front end of the ram. The ram is connected to the hydraulic drive mechanism. The rear end of the broach is supported by a guide. The broach is moved along the guide ways. It is used for small and medium sized works. It is used for machining keyways, splines, serrations, internal gears, etc. Horizontal broaching machines are the most versatile in application and performance and hence are most widely employed for various types of production. These are used for internal broaching but external broaching work is also possible. The horizontal broaching machines are usually hydraulically driven and occupy large floor space.

Pull down type vertical internal broaching machine

This machine has an elevator at the top. The pulling mechanism is enclosed in the base of the machine. The work piece is mounted on the table by means of fixture. The tail end of the broach is gripped in the elevator. The broach is lowered through the work piece.

The broach is automatically engaged by the pulling mechanism and is pulled down through the job. After the operation is completed, the broach is raised and gripped by the elevator. The elevator returns to its initial position.



Pull down pull type

Pull up type vertical internal broaching machine

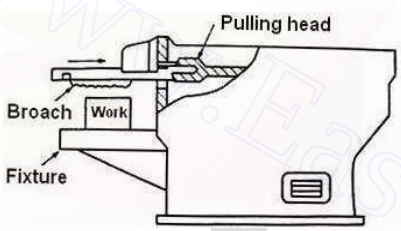
In this type, the ram slides on the vertical column of the machine. The ram carries the pulling head at its bottom. The pulling mechanism is above the worktable and the broach is in the base of the machine. The broach enters the job held against the under side of the table and is pulled upward. At the end of the operation, the work is free and falls down into a container.

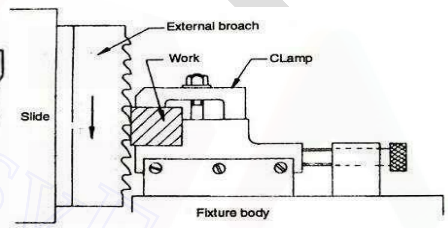
SURFACE BROACHINGMACHINES

In horizontal surface broaching machines, the broach is pulled over the top surface of the work piece held in the fixture on the worktable as shown in Fig. 4.63. The cutting speed ranges from 3 to 12 *mpm* with a return speed up to 30 *mpm*. The construction and working principle of horizontal surface broaching machine is similar to that of pull type horizontal internal broaching machine.

In vertical surface broaching machines, the work piece is held in the fixture while the surface broach is reciprocated with the ram on the vertical guide ways on the column. Surface broaching is relatively simple since the broach can be continuously held and then it will carry out only a reciprocating action.

Instead of using simple broach sometimes the progressive cut type broach with the teeth segments distributed into the three areas is used in surface broaching. The progressive action reduces the maximum broaching force, but results in a longer broach.



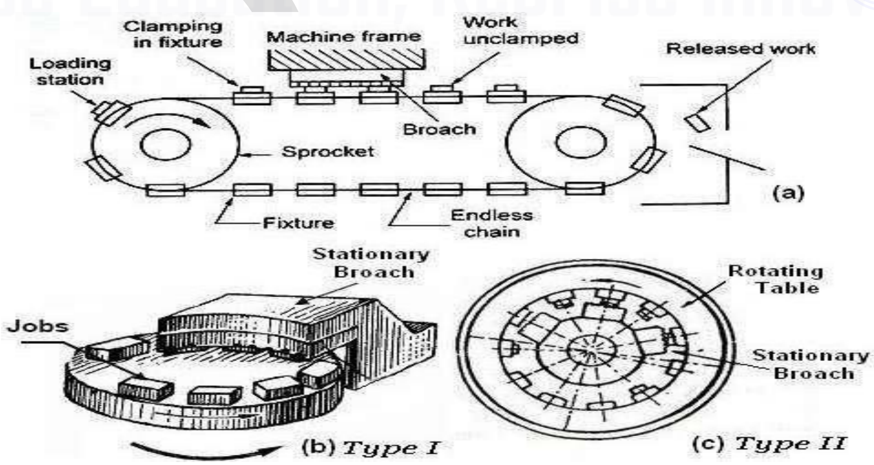


Horizontal surface broaching machine   Vertical surface broaching machine

CONTINUOUS BROACHING MACHINES

These broaching machines are also known as high production broaching machines. The reciprocation of the broach always involves an unproductive return stroke, which is eliminated in a continuous surface broaching machine. These machines are used for fast production of large number of pieces by surface broaching.

Horizontal continuous broaching machine



In this the small work pieces are mounted on the broaching fixtures which are in turn fixed to an endless chain continuously moving in between two sprockets. Broaches which are normally stationary are kept above the workpieces. The workpieces are pushed past the stationary broaches by means of the conveyor for cutting. The work pieces are loaded and unloaded onto the conveyor manually or automatically.

ROTARY CONTINUOUS BROACHINGMACHINE

TypeI:

This machine has a rotary table and a vertical column. The vertical column has a guide way. An arm is fixed in the vertical column and it moves up and down in the guide way. Work pieces are clamped in the fixtures horizontally above the work table. The broach is fixed underside of the arm. Now the work table is rotated and the broaching operation is carried out. Depth of cut is given by moving the work table in upward direction.

TypeII:

This machine has a ring shaped rotating work table. Work pieces are clamped in the fixtures in the inner periphery of the work table. The stationary broaches are fixed in the outer periphery of the vertical column located inside the work table. Now the table is rotated and the broaching operation is carried out.

Broaching operation and broaching machines are as such high productive but its speed of production is further enhanced by:

- Incorporating automation in tool – job mounting and releasing.
- Increasing number of workstations or slides for simultaneous multiple production.
- Quick changing the broach by turret indexing.

UNIT –5
CNC MACHINING

PARTA

1. **List the differences between NC and CNC.(AU Apr2011)**

S.No	NCMachines	CNCMachines
1	NC system is produced in sixties and used electronic hardware based upon digital circuit technology.	It employs a mini or micro computer to control machine tool and eliminate as far as possible, additional hardware circuits in control cabinet.
2	Less flexibility	More flexibility

2. What are linear bearings? (AU Apr2011)

A linear motion bearing or linear slide is a bearing designed to provide free motion in one dimension .Linear motion bearings are widely used to guide, support , locate and accurately move machinery components and products in a wide range of automation application.

3. Mention the type of ball screws. (AU Dec2010)

Ball screws can be classified as follows;

(1) By ball circulation method
(a) Return pipe type
(b) Deflector type (c)End cap type
(2) By preloading method
(a) Fixed point preloading method
(b) Constant pressure preloading type.
(3) By screw shaft
(a) Precision ball screws
(b) Rolled ball screws

4. What are feed drives? (AU Dec2010)

Feed drives are used to drive the axis as per the programme fed in the CNC machine.

5. What are the types of motion control system used in NC machines? (AU Dec2010)

(a) point to point or positional system
(b) Straight line or paraxial system
(c) Continuous path system

6. What is meant by APT language? (AU Apr2010)

It is the abbreviation of automatically programmed tools.APT program is used to command the cutting tool through its sequence of machining process.APT is also used to calculate the cutter positions.APT is a three dimensional system controlling up to five axes including rotational coordinates.

7. What is a preparatory function? How is it important in CNC programming? (AU Apr 2010)

Preparatory commands which prepare the machine or tool for different modes of movement like positioning contouring , thread cutting and also proceed the dimension word .They are grouped. Group cannot affect each other. Only one function from the same group can be at the same time.

8. State the limitations of CNC machine tools. (AU Dec2009)

(i) CNC machines are more expensive than manually operated machines, although costs are slowly coming down.

(ii) The CNC machine operator only needs basic training and skills, enough to supervise several machines. In years gone by, engineers needed years of training to operate centre lathes, milling machines and other manually operated machines. This means many of the old skills are been lost.

(iii) Less workers are required to operate CNC machines compared to manually operated machine

9. What is a canned cycle? (AU Dec2009)

Canned cycle is a combination of machine moves that performs anyone particular machining function such as drilling, turning, milling, boring etc.

10. Define NC. (AU Dec2009)

Controlling a machine tool by means of a prepared program is known as Numerical controller NC.

11. Name the major elements of NC machines. (AU Dec2009)

(i) Tape reader
(ii) Minicomputer
(iii) Servos and interface logic
(iv) Motion feedback

12. What are the classifications of NC machines? (AU Dec2008)

(i)Point to point NC system (ii) Straight cut NC system
(iii) Contouring NC system

13. What is the difference between incremental and absolute system. (AU Dec2008)

(a) In absolute programming the distance at my point at any instant will be measured from the origin (X=0, Y=0).

(b) Whereas in incremental programming, the instant point will be noted as (X =0, Y =0). Further measurement will be made from the particular point only.

14. What is the role of computer for NC machine tool? (AU Dec2007)

Computer numerical control is an NC system that utilizes stored program toper form basic numerical control functions .Mini or micro computer based controller unit is used.

15. What is point –to – point (PTP) system? (AU Dec2007)

It is also called positioning system. The objective of the machine tool control is to move the cutting tool to a predefined location. The speed or path is not important in this system.

PART -B

1. Write the part program for the part shown below (AU DEC 10, APR08)

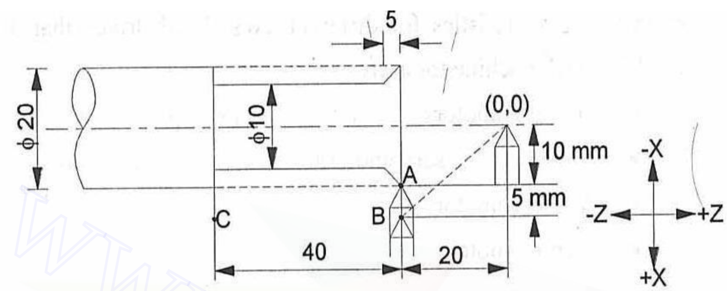
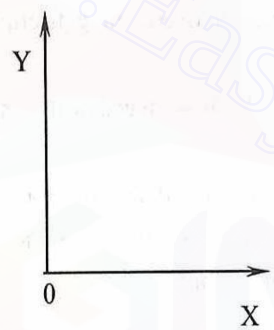


Figure 1



Programming in incremental mode

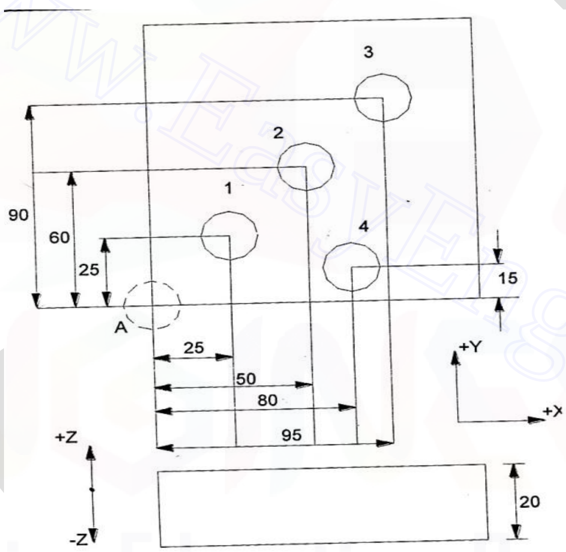
N01	G01	Z – 60	X0	F80 T1
N02	G01	Z –20	X15	
N03	G01	Z0	X –5	
N04	G01	Z –5 X –5		
N05	G02	Z –35	X0	
N06	G01	Z0	X5	
N07	M02			

Programme in absolute mode

N00	G90		
N00	G92	Z 0	X 0

N01	G01	Z – 60	X 0	F80	T1
N02	G01	Z – 20	X 15		
N03	G01	Z – 20	X 10		
N04	G02	Z – 25	X 5		
N05	G01	Z – 60	X 5		
N06	G01	Z – 60	X 10		
N07	G00	Z 0	X 0		
N12	G00	Y0			
N13	M02				

2. Write the part program for drilling holes in the parts shown in the figure. The plate thickness is 20 mm (AU DEC 09 APR08)



N100	G71	G91		
N110	M06T1			
N120	M03 S1000			
N130	G00	X00	Y00	Z10
N140	G01	Z–20	F0.5	
N150	G00	X25	Y25	Z10
N160	G01	Z–20	F0.5	
N170	G00	X50	Y60	Z10
N180	G01	Z–20	F0.5	
N190	G00	X95	Y90	Z10
N200	G01	Z–20	F0.5	
N210	G00	X80	Y15	Z10
N220	G01	Z–20	F0.5	
N230	G00	X80	Y00	Z10
N240	G00	X00	Y00	Z10
N250	M05 M02			

3. Narrate the design considerations of CNC machines. (AU Apr2011)
Productivity
•Reduction of machine Time
•Reduction of non-productive time
•Machining with more than one tool simultaneously
•Improved reliability of machine components
•Proper maintenance to prevent unscheduled stoppage
Accuracy
•Improve geometrical accuracy of machine elements
•*Lead screw*
•*Guide ways*
•Improves kinematic accuracy of machine tools
•Increases static and dynamic stiffness of machine tool structure
•Provides accurate machine tool for measuring distance
•Reduces the real deformation of tool while machining Machine response
•Magnitude of load
•Range of travel
•Safe and easy control
•Shield should be provided on the rotating and moving part
•Protects the operator from chips, abrasive ducts and coolants by using screens and shield
•Better clamping mechanism to withstand tool force
•Provides emergency stop buttons
•Provides over load production switches, buttons, *etc.,*
•Appearance
•Good appearance and attractiveness to the workers to interest on machines
•Cost
•Low cost for manufacturing and operation Operating characteristics
•Reliability
•Maintainability
•Component characteristics
•Frictional characteristics and amount of backlash
•Inertia and stiffness
•Simplicity in Design
•Uses simplified standard and sub-parts

4. Discuss about slide ways used in CNC machine tools. (AU Apr2011)
Designed to provide a free motion in one direction
•Laterally
•Longitudinally
Also called as linear motion bearing slide. Powered by either manual operation or inertial

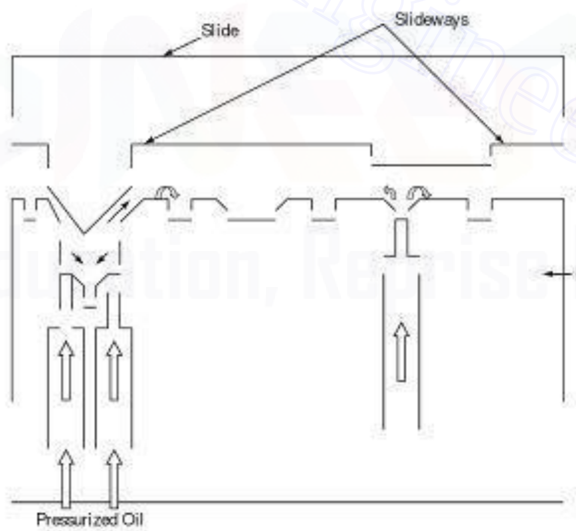
operation Types of Slide Ways
Hydrostatic slideways
•Oil lubricated slideways
•Air bearing slideways
•Antifriction slideways
•Ball type slideways
•Roller type slideways
•Wear resistant slideways
•Induction hardened slideways
•Flame hardened slideways
•Surface coated slideway

Hydrostatic Slideways

•Liquid friction condition of the interface of mating surface area achieved by supplying under pressure
•Sliding bodies must not be inclined to each other
•Used in high expensive machine Example
•Grinding machine-programmed controllable
•copying machine

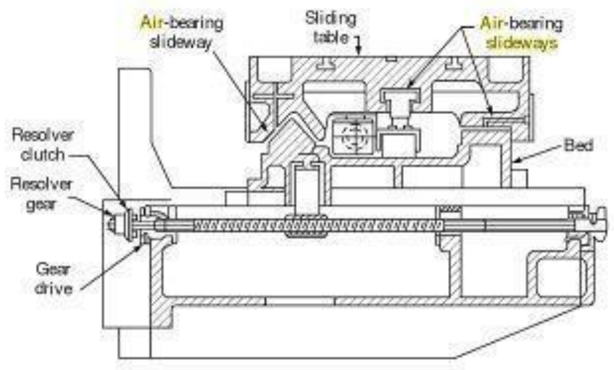
Oil Lubricated SlideWays

•Friction is minimized by forcing oil under pressure between mating surfaces
•Pressure is automatically varied according to the load on surface



Air Lubricated SlideWays

•Pressurized air issued instead of oil
•Used for positioning the slide when no machining is carried out Disadvantages
•Misalignments may happened due to lifting of slides
•Uneven distribution of load on worktable



Anti friction slideways

•Conventionalmachineshavethepropertyofstick-slipduetohighslidingfrictionatlowvelocity

•To avoid this sliding, contact is avoided by making the contact in point or line by converting sliding friction to rolling friction

Types

•Ball bearing guideways

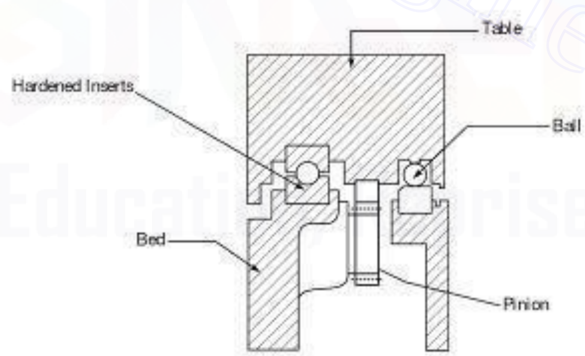
•Roller bearing guideways

Ball bearing slideways

•The bed forms the guide way for the ball to recirculation

•Hardened inserts are fitted into the table which is located on the ball track with a single flat structure in contact with the balls.

•The ball rolls between four rods, two fixed to the table and two fixed to the bed



Roller bearing Slideways

•Instead of ball, which avoids direct contact of the surface, roller is used

•Increases the load carrying capacity

•Hardened steel inserts are used as rollers to minimize the friction

•Suitable for using in boring and milling machines Wear Resistant SlideWays

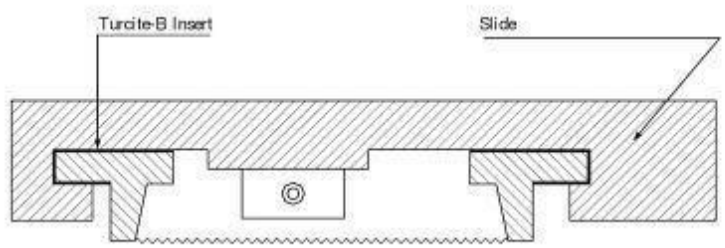
•Non metallic parts or plastic inserts are used

•Inserts stick to the underside of the moving element

•Insertsaremadeupof2materials

•First material reduces coefficient of friction

•Other increases strength, load bearing capacity and self Lubricating capacity
•Poly Tetra FluroEthene(PTFE), Ferobestos CA, turcite B are some of the materials used to make positive contact



5.Explain and list the G codes and M codes

Model G codes **-** This G code is effective until another G code in the same group is commanded.
Non-model G codes **-** This G code is effective only at the block in which it was specified.
Motion group – GO0, G01, GO2,GO3
Dwell group –GO4
Active plane selection group – G17, G18, G19 Cutter compensation group – G40, G41, G42
Units Group – G20,G21
Hole making canned cycle group – G80, G81-G89 Co – ordinate system group – G90,G91

Canned cycles or fixed cycles

The routine that automatically generates multiple tool movements from a single block is known as canned or fixed cycle. e.g. G71,G70,G81-G89,G92
G80 – canned cycle cancel.

Merits

Program becomes simple and needs less memory. Program writing is easier.

Miscellaneous or Auxiliary functions or M codes

The function related to the auxiliary or switching information like spindle start-stop, coolant on-off, etc., and not related to any dimensional movement of the machine is known as miscellaneous functions.
As per Den ford - FANUC OT (offline turning) and FANUC OM (offline milling) programming the miscellaneous functions are given below.

M - CODES – Miscellaneous Functions

Codes	Function in turningcentre	Function in machiningcentre
M00	Program stop	Program stop
M01	Optional stop	Optional stop
M02	End of program	Program reset
M03	Spindle forward	Spindle forward

M04	Spindle reverse	Spindle reverse
M05	Spindle stop	Spindle stop
M06	Automatic tool change	Automatic tool change
M07	High pressure coolant ON	Not assigned
M08	Low pressure coolant ON	Coolant ON
M09	Coolant OFF	Coolant OFF
M10	Chuck open	Vice open
M11	Chuck close	Vice close
M13	Spindle forward and coolant	Spindle forward and coolant ON
M14	Spindle reverse and coolant	Spindle reverse and coolant ON
M19	Not assigned	Spindle orientation
M20	Not assigned	ATC armin
M21	Not assigned	ATC arm out
M22	Not assigned	ATC arm down
M23	Not assigned	ATC arm up
M24	Not assigned	ATC draw bar unclamp
M25	Tail stock quill extend	ATC draw bar clamp
M26	Tail stock quill retract	Not assigned
M27	Not assigned	Reset carousel to pocketone
M30	Program stop and reset	Program reset andrewind
M32	Not assigned	Carousel CW
M33	Not assigned	Carousel CCW
M38	Door open	Door open
M39	Door close	Door close
M40	Parts catcher extend	Not assigned
M41	Parts catcher retract	Not assigned
M62 -M67	Auxiliary output functions	Not assigned
M70	Not assigned	Mirror in 'X'ON
M71	Not assigned	Mirror in 'Y'ON
M76,M77	Auxiliary output functions	Not assigned
M80	Not assigned	Mirror in 'X'OFF
M81	Not assigned	Mirror in 'Y'OFF
M98	Sub program call	Sub program call
M99	Sub program end and return	Sub program end and return

G29 -G39	Not assigned	Not assigned
G40	Tool nose radius compensation cancel	Cutter compensation
G41	Tool nose radius compensation left	Cutter compensation left
G42	Tool nose radius compensation right	Cutter compensation
G43	Not assigned	Z length offset
G44 -G49	Not assigned	Not assigned
G50	Work coordinate system shift/	Cancel scaling
	Clamping maximum spindle speed	
G51	Not assigned	Scaling
G52,G53	Not assigned	Not assigned
G54	Not assigned	Datum shift
G55 -G67	Not assigned	Not assigned
G68	Not assigned	Coordinate rotation
G69	Not assigned	Cancel rotation
G70	Finishing cycle	Not assigned
G71	Multiple turning cycle	Not assigned
G72	Multiple facing cycle	Not assigned
G73	Pattern repeating cycle	High speed peck drilling
G74	End face peck drilling	Counter tapping
G75	Grooving cycle	Not assigned
G76	Multiple threading cycle	Fine boring
G80	Not assigned	Canned cycle cancel
G81	Deep hole drilling cycle	Drilling – Spot boring
G82	Not assigned	Drilling – Counter boring
G83	Not assigned	Deep hole peck drilling
G84	Not assigned	Tapping
G85,G86	Not assigned	Boring
G87	Not assigned	Back boring
G89	Not assigned	Boring
G90	Not assigned	Absolute zero command
G91	Not assigned	Incremental command
G92	Threading cycle	Not assigned

G - CODES - Preparatory Functions

Codes	Function in turning centre	Function in machining centre
G00	Rapid movement or positioning	Rapid movement or positioning
G01	Linear movement with feed rate	Linear movement with feed rate
G02	Circular movement with feed rate (CW)	Circular movement with feed rate (CW)
G03	Circular movement with feed rate (CCW)	Circular movement with feed rate (CCW)
G04	Dwell	Dwell
G05 - G19 G20	Not assigned Inch data input	Not assigned Inch data input
G21	Metric data input	Metric data input
G22 - G27	Not assigned	Not assigned
G28	Return to home position	Return to home position

PART - C

1. Briefly explain about the classification of CNC machine tools. Classification of CNC Machine Tools

Based on the motion type 'Point-to-point & Contouring systems'

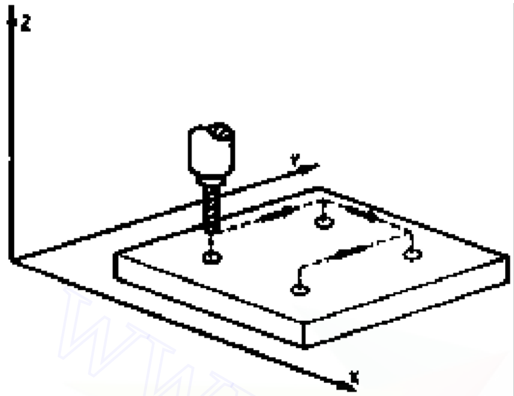
There are two main types of machine tools and the control systems required for use with themdifferbecauseofthebasicdifferencesinthefunctionsofthemachinestobecontrolled.They are known as point-to-point and contouring controls.

Point-to-point systems

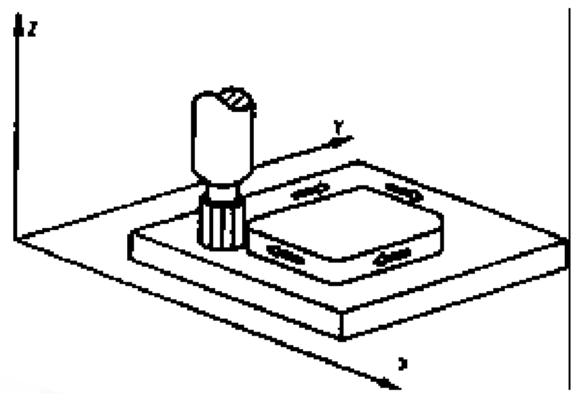
Some machine tools for example drilling, boring and tapping machines etc, require the cutter and the work piece to be placed at a certain fixed relative positions at which they must remain while the cutter does its work. These machines are known as point-to-point machines as shown in figure 3 (a) and the control equipment for use with them are known as point-to-point control equipment. Feed rates need not to be programmed. In these machine tools, each axis is driven separately. In a point-to-point control system, the dimensional information that must be given to the machine tool will be a series of required position of the two slides. Servo systems can be used to move the slides and no attempt is made to move the slide until the cutter has been retracted back.

Contouring systems (Continuous path systems)

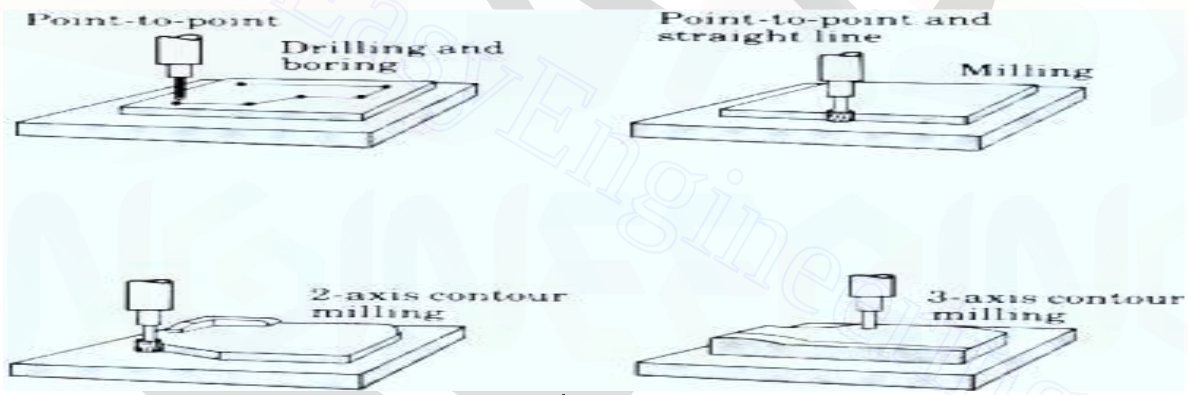
Other type of machine tools involves motion of workpiece with respect to the cutter while cutting operation is taking place. These machine tools include milling, routing machines etc. and are known as contouring machines as shown in figure 3(b),3(c) and the controls required for their control are known as contouring control. Contouring machines can also be used as point-to-point machines, but it will be uneconomical to use them unless the work piece also requires having a contouring operation to be performed on it. These machines require simultaneous control of axes. In contouring machines, relative positions of the work piece and the tool should be continuously controlled. The control system must be able to accept information regarding velocities and positions of the machines slides. Feed rates should be programmed.



Point-to-point system



Contouring system

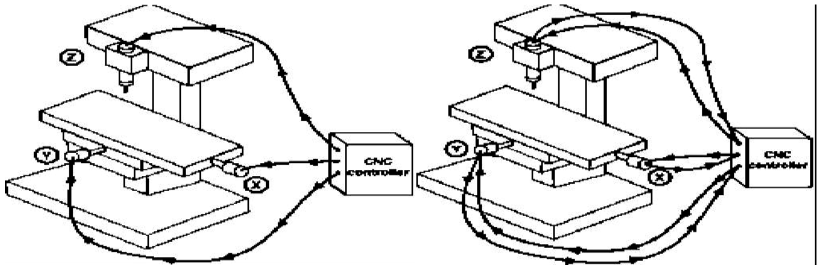


Contouring systems

(2) Based on the control loops 'Open loop & Closed loop systems'

(2.1) Open loop systems

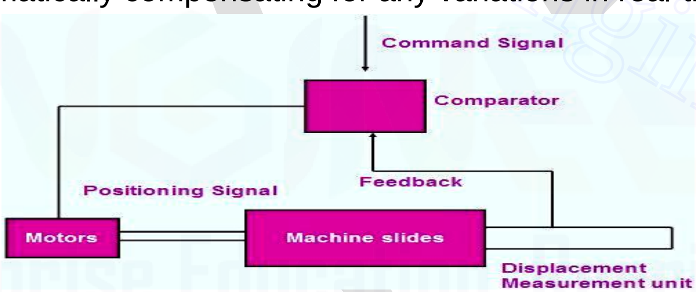
Programmed instructions are fed into the controller through an input device. These instructions are then converted to electrical pulses (signals) by the controller and sent to the servo amplifier to energize the servomotors.The primary drawback of the open loop system is that there is no feedback system to check whether the program position and velocity has been achieved. If the system performance is affected by load, temperature, humidity, or lubrication then the actual output could deviate from the desired output. For these reasons the open loop system is generally used in point-to-point systems where the accuracy requirements are not critical. Very few continuous-path systems utilize open-loop control.



Open loop control system   Closed loop control system

Closed loop systems

The closed-loop system has a feedback subsystem to monitor the actual output and correct any discrepancy from the programmed input. These systems use position and velocity feed back. The feedback system could be either analog or digital. The analog systems measure the variation of physical variables such as position and velocity in terms of voltage levels. Digital systems monitor output variations by means of electrical pulses. To control the dynamic behavior and the final position of the machine slides, a variety of position transducers are employed. Majority of CNC systems operate on servo mechanism, a closed loop principle. If a discrepancy is revealed between where the machine element should be and where it actually is, the sensing device signals the driving unit to make an adjustment, bringing the movable component to the required location. Closed-loop systems are very powerful and accurate because they are capable of monitoring operating conditions through feedback subsystems and automatically compensating for any variations in real-time.



Closed loop system

Based on the number of axes '2, 3, 4 & 5 axes CNC machines' 2& 3 axes CNC machines:

CNC lathes will be coming under 2 axes machines. There will be two axes along which motion takes place. The saddle will be moving longitudinally on the bed (Z-axis) and the cross slide moves transversely on the saddle (along X-axis). In 3-axes machines, there will be one more axis, perpendicular to the above two axes. By the simultaneous control of all the 3 axes, complex surfaces can be machined.

4 & 5 axes CNC machines

4 and 5 axes CNC machines provide multi-axis machining capabilities beyond the standard 3-axis CNC tool path movements. A 5-axis milling centre includes the three X, Y, Z axes, the A axis which is rotary tilting of the spindle and the B-axis, which can be a rotary index table.

Importance of higher axes machining:

Reduced cycle time by machining complex components using a single setup. In addition to time savings, improved accuracy can also be achieved as positioning errors between setups are eliminated.

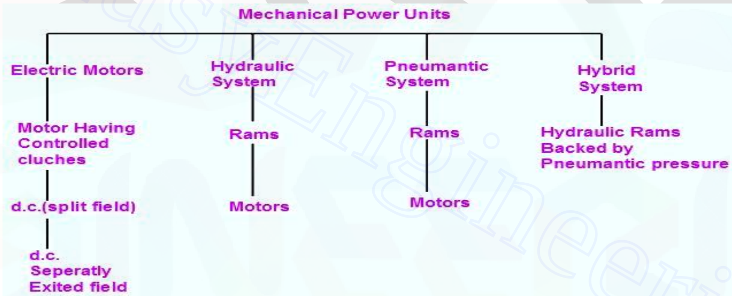
- Improved surface finish and tool life by tilting the tool to maintain optimum tool to part contact all the times.

- Improved access to under cuts and deep pockets. By tilting the tool, the tool can be made normal to the work surface and the errors may be reduced as the major component of cutting force will be along the tool axis.

- Higher axes machining has been widely used for machining sculptures surfaces in aerospace and automobile industry.

Based on the power supply 'Electric, Hydraulic & Pneumatic systems'

Mechanicalpowerunitreferstoadevicewhichtransformssomeformofenergytomechanicalpower which may be used for driving slides, saddles or gantries forming a part of machine tool. The input power may be of electrical, hydraulic or pneumatic.



Electric systems:

Electric motors may be used for controlling both positioning and contouring machines.They may be either a.c. or d.c. motor and the torque and direction of rotation need to be controlled. The speed of a d.c. motor can be controlled by varying either the field or the armature supply. The clutch-controlled motor can either be an a.c. or d.c. motor. They are generally used for small machine tools because of heat losses in the clutches. Split field motors are the simplest form of motors and can be controlled in a manner according to the machine tool. These are small and generally run at high maximum speeds and so require reduction gears of high ratio. Separately excited motors are used with control systems for driving the slides of large machine tools.

Hydraulic systems:

These hydraulic systems may be used with positioning and contouring machine tool so fall sizes. These systems may be either in the form of rams or motors. Hydraulic motors are smaller than electric motors of equivalent power. There are several types of hydraulic motors. The advantage of using hydraulic motors is that they can be very small and have considerable torque. This means that they may be incorporated in servo systems which require having a rapid response.

Reg. No. | | | | | | | | | | | | |

Question Paper Code : 51850

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Fourth Semester

Mechanical Engineering

ME 2252/ ME 43/ME 1252 A/080120016/10122 ME 403 – MANUFACTURING TECHNOLOGY – II

(Common to Industrial Engineering, Industrial Engineering and Management, Mechanical and Automation Engineering and Mechanical Engineering (Sandwich) for Sixth Semester)

(Regulations 2008/2010)

(Also Common to PTME 2250/10122 ME 403 Manufacturing Technology II for B.E. (Part-Time) Third Semester Mechanical Engineering – Regulations 2009/2010)

Time : Three Hours **Maximum : 100 Marks**

Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

1. Differentiate between Orthogonal cutting and Oblique cutting.
2. List out the important properties of cutting tool materials.
3. With simple sketches show the single point tool nomenclature.
4. What are the advantages of automats ?
5. Differentiate between up milling and down milling.
6. What is the need of broaching operation ?
7. List the various grinding processes.
8. What is lapping ?
9. List the advantages of a CNC machine.
10. Write the general format of a block in CNC part programming.

PART – B (5 × 16 = 80 marks)

11. (a) (i) Describe any four important cutting tool materials. (8)

(ii) The following equation for tool life was obtained for H.S.S tool (8)

$$V\,T^{0.13}\,f^{0.6}\,d^{0.3} = C$$

A 60 min tool life was obtained using the following condition.

V = 40 m/min, f = 0.25 mm, d = 2 mm

Calculate the effect on tool life if speed, feed, and depth of cut are together increased by 25% and also if they are increased individually by 25%.

Where f = feed, d = depth of cut and V = speed.

OR

(b) In an orthogonal cutting operation, the following data have been observed :

Uncut chip thickness	=	0.127 mm
Width of cut	=	6.35 mm
Cutting speed	=	2 m/s
Rake angle	=	20°
Cutting force	=	567 N
Thrust force	=	227 N
Chip thickness	=	0.228 mm

Determine the shear angle, friction angle, shear stress along the shear plane and the power for the cutting operation. (16)

12. (a) (i) What are the different methods of taper turning ? And explain with a neat sketch, the method of taper turning by swiveling the compound rest method. (2 + 8)

(ii) Differentiate between Capstan and Turret lathe. (6)

OR

(b) With a neat sketch, explain the salient features of Swiss type automatic lathe. (16)

13. (a) Explain with a neat sketch, the Crank and slotted link mechanism of a shaper. And also explain the arrangement used for adjusting the position of stroke. (16)

OR

(b) (i) Describe the various Sawing machines. (8)

(ii) With a neat sketch, explain the various elements of broach tool. (8)

14. (a) How a grinding wheel is specified? And describe the various factors involved in selection of a grinding wheel. (16)

OR

(b) (i) Describe with a neat sketch, the centreless grinder. (8)

(ii) With a neat sketch explain any one gear shaping process. (8)

15. (a) What are the important components of NC system ? Describe them. (16)

OR

(b) Explain with a neat sketch, the Slide ways and Ball screws used in CNC machine. (16)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 21850

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Fourth Semester

Mechanical Engineering

ME 2252/ME 43/ME 1252 A/080120016/10122 ME 403 — MANUFACTURING TECHNOLOGY – II

(Common to Industrial Engineering, Industrial Engineering and Management, Mechanical and Automation Engineering and Mechanical Engineering (Sandwich) for Sixth Semester

(Regulations 2008/2010)

(Also Common to PTME 2252/10122 ME 403 Manufacturing Technology II for B.E. (Part-Time) Third Semester Mechanical Engineering – Regulations 2009/2010)

Time : Three hours　　　　Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define chip thickness ratio.

2. State the desired characteristics of cutting tool materials.

3. Name the cutting tool nomenclature of single point tool.

4. Mention the work holding and supporting devices used in lathe.

5. What is an arbor?

6. How does a vertical shaper differ from a slotter?

7. State the differences between push and pull broaching.

8. Name the indexing methods.

9. List the feed drives used in CNC machine tools.

10. State the differences between NC and CNC machine tool.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Derive the expression of chip reduction coefficient. (8)

(ii) Discuss the purpose of cutting fluids. (8)

Or

(b) (i) Describe the factors affecting tool life. (8)

(ii) Draw the merchant force diagram and explain the forces acting it. (8)

12. (a) (i) Explain the different machining operations performed on lathe with sketches. (8)

(ii) Name the taper turning methods and explain any two with sketches. (8)

Or

(b) (i) How does a Turret lathe differ from a Capstan lathe? Explain. (8)

(ii) Discuss the features of single spindle and multi-spindle automatic lathes. (8)

13. (a) (i) What is a boring bar? Describe its utility. (8)

(ii) Describe any one type of quick return mechanism used in shaper with neat sketches. (8)

Or

(b) (i) Explain various milling processes with illustrative sketches. (8)

(ii) Differentiate between reciprocating saw and band saw. (8)

14. (a) (i) Discuss the factors influencing the selection of grinding wheel. (8)

(ii) Explain the centreless grinding operations with sketches. (8)

Or

(b) (i) Explain Buffing and Polishing. (4)

(ii) Describe the Indian standard marketing system for grinding wheels. (12)

15. (a) (i) Describe the numerical control elements present in a NC system. (8)

(ii) Describe the actuation system employed in CNC machine tools. (8)

Or

(b) Explain the following :

(i) Canned cycles (4)

(ii) Preparatory functions (4)

(iii) Motion commands in Computer Aided Part Programming. (8)

Reg. No. :

Question Paper Code : 77214

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Fourth Semester

Mechanical Engineering

ME 6402 — MANUFACTURING TECHNOLOGY – II

(Common to Industrial Engineering, Industrial Engineering and Management and Mechanical and Automation Engineering)

(Regulation 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write a short note on Heat zones in cutting.

2. Write a short note on any two modern tool materials.

3. What is meant by "swing of the lathe"?

4. What do you mean by copy turning?

5. What do you mean by differential indexing?

6. Why is milling a versatile machining process?

7. How does loading differ from glazing in grinding process?

8. What are the principal types of Broaching machines?

9. Define CNC and DNC.

10. What is adaptive control?

PART B — (5 × 16 = 80 marks)

11. (a) (i) With reference to orthogonal cutting, explain the following terms: Shear stress in shear plane, Shear strain, Cutting ratio, Shear angle. (8)

(ii) Prove that in orthogonal cutting, the kinetic coefficient of friction (μ) is given by $\mu = \dfrac{F_c \sin\alpha + F_t \cos\alpha}{F_c \cos\alpha - F_t \sin\alpha}$. (8)

Or

(b) (i) Tool life tests in turning yield the following data: (1) V = 110m/min, T = 20 min; (2) V = 85 m/min, T = 40 min. (A) Determine the n and C values in the Taylor tool life equation. Based on the equation, compute (B) the tool life for a speed of 95 m/min and (C) the speed corresponding to a tool life of 30 min. (8)

(ii) Explain different types of chips produced in cutting with neat sketches. (8)

12. (a) (i) Enumerate the purpose of various attachments used on a centre lathe. (8)

(ii) Explain with a neat sketch single spindle automatic lathe. (8)

Or

(b) (i) Describe a Universal type milling machine. (8)

(ii) Explain the salient features of an automatic screw machines. (8)

13. (a) (i) Explain with neat sketches the procedure for carrying out the following operations on a shaper: Horizontal cutting, Vertical cutting, concave surface, keyway cutting. (8)

(ii) List out the gear finishing processes. Explain any two with neat sketches. (8)

Or

(b) (i) Enumerate with a neat sketch Gear shaping. (8)

(ii) Compare Plain and Universal milling machine. (8)

14. (a) (i) Enumerate the advantages and disadvantages of centreless grinding. (8)

(ii) Explain the following in grinding (1) Dressing of (2) Truing. (8)

Or

(b) (i) The performance of a grinding wheel depends upon type of abrasive, grain size, grade, structure and bonding material. Discuss the effect of each. (8)

(ii) Discuss with neat sketch Vertical Broaching machine. (8)

15. (a) (i) Discuss the programming of NC machines. (8)

(ii) Discuss the constructional features of a NC machine tool and explain their functions. (8)

Or

(b) (i) List and explain the advantages of CNC systems over conventional NC systems. (8)

(ii) Explain the main difference between point to point and continuous path type numerically controlled machine tools. (8)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 51630

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2014.

Fourth Semester

Mechanical Engineering

ME 2252/ME 43/ME 1252 A/080120016/10122 ME 403 — MANUFACTURING TECHNOLOGY — II

(Common to Industrial Engineering, Industrial Engineering and Management and Mechanical and Automation Engineering)

(Regulation 2008/2010)

(Common to PTME 2252 Manufacturing Technology II for B.E. (Part-Time) Third Semester Mechanical Engineering — Regulation 2009)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is orthogonal rake system?

2. Why is lubrication not required while machining cast iron?

3. What is a centre gauge that is used in threading?

4. What are programmed automatic lathes?

5. Give the functions of flutes on taps.

6. List some of the materials of broaching tools.

7. What are grinding points?.Sketch the various grinding points?

8. What is a tool post grinder?

9. List the main elements of a NC machine tool.

10. What do you understand by 'canned cycle' in manual part programming?

PART B — (5 × 16 = 80 marks)

11. (a) (i) How is metal removed in metal cutting? Explain the process with simple sketch. (10)

(ii) Explain the various methods to be applied while using the cutting fluids during machining. (6)

Or

(b) (i) List the important characteristics of a cutting tool material. (6)

(ii) What is the main function of cutting fluids? and its types. (10)

12. (a) (i) Explain the method of thread cutting using compound slide in a lathe. (10)

(ii) List the type of work holding devices and tool holding devices that are generally used in a lathe. (6)

Or

(b) (i) Explain parallel action and progressive action multispindle automatics. (12)

(ii) Write the procedure of tool layout for automatic screw machine. (4)

13. (a) (i) Explain the hydraulic drive mechanism of a horizontal shaper with neat sketch. (10)

(ii) What is 'deep hole drilling'? List the measures that are taken to avoid drill run off and to drill straight holes. (6)

Or

(b) (i) Explain the indexing mechanism of a dividing head on milling machine. (12)

(ii) Write short note on reaming operation. (4)

14. (a) (i) Discuss the various types of bonding materials generally used for making grinding wheels. (10)

(ii) Write short notes on Abrasive belt grinding. (6)

Or

(b) (i) Why is gear finishing required? Discuss the various types of gear finishing operations. (12)

(ii) Write short note on super finishing. (4)

15. (a) (i) Explain the working of NC machine tool with the help of a diagram. (12)

(ii) List the advantages of CNC systems over conventional NC systems. (4)

Or

(b) (i) Explain the various steps to be followed while developing the CNC part Programs. (12)

(ii) What is 'Adaptive control'? (4)

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Reg. No. : [ ]

Question Paper Code : 21563

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Fourth Semester

Mechanical Engineering

ME 2252/ME 43/10122 ME 403/ME 1252 A/080120016 – MANUFACTURING TECHNOLOGY – II

(Common to Industrial Engineering, Industrial Engineering and Management and Mechanical and Automation Engineering)

(Regulation 2008/2010)

(Common to PTME 2252 Manufacturing Technology II for B.E. (Part-Time) Third Semester Mechanical Engineering – Regulation 2009)

Time : Three hours — Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Classify the tool wear.
2. When will be the negative rake angles be used?
3. State the various parts mounted on the carriage.
4. What are the types of single spindle automatic lathes?
5. Mention any four shaper specifications.
6. State the uses of planer.
7. How is the grinding wheel designated?
8. List the gear generating process.
9. Mention the advantages of stepping motor.
10. Define subroutine.

PART B — (5 × 16 = 80 marks)

11. (a) The Taylorian tool-life equation for machining C-40 steel with a 18:4:1 H.S.S. cutting tool at a feed of 0.2 mm/min and a depth of cut of 2 mm is given by $VT^n = C$, where n and C are constants. The following V and T observations have been noted.

V_1 m/min	25	35
T_1 min	90	20

Calculate :

(i) n and C. (8)

(ii) Hence recommend the cutting speed for a desired tool life of 60 minutes. (8)

Or

(b) (i) Enumerate the essential requirements of a tool material. (8)

(ii) Discuss the various of cutting fluids. (8)

12. (a) (i) Explain the working principle of turret lathe. (8)

(ii) Discuss any two special attachments on lathes. (8)

Or

(b) (i) Explain any four work holding devices that can be used on a lathe. (8)

(ii) Describe a single spindle automatic lathe. (8)

13. (a) (i) List out the various milling operations. (8)

(ii) Describe the working principle of column and knee type milling machine with a neat sketch. (8)

Or

(b) (i) With a neat sketch, explain the working of a vertical boring machine. (8)

(ii) Explain the various operations performed by a broaching machine. (8)

14. (a) (i) Classify the grinding machines. (4)

(ii) Explain the working principle of centreless grinding process. (12)

Or

(b) (i) Describe two types of lapping operations. (6)

(ii) Explain the principle of operation of gear hobbing process. (10)

15. (a) (i) What are the requirements of slideways? (4)

(ii) Explain the machining centre with a neat sketch. (12)

Or

(b) (i) Classify linear interpolation. (4)

(ii) Explain the part programming procedure with a suitable example. (12)

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