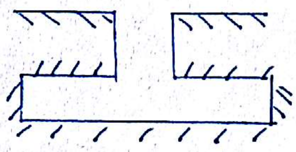
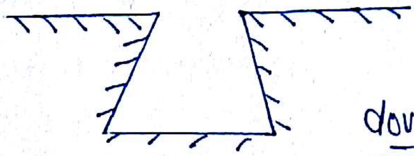
Milling

* In any machining operation direction of cutting is Generatrix and Direction of feed Directrix.

* In shaper and ~~pinner~~ planner both Generatrix & Directrix are ~~same~~ straight line. but in turning operation Generatrix circle and Directrix is straight line.

① Vertic milling Machine :



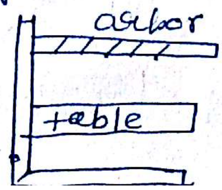


dove tail

These were the intial machine develope it is also called fixed bed type machine. ~~Motho~~ Motions are possible only along one plane.

② Column & knee type Machine :- It is a $2\frac{1}{2}$ axis machine

In this type of milling machine table is mounted on to knee of the milling machine. it is a $2\frac{1}{2}$ axis machine i.e. Counter can be cut in both in Horizontal and verticle plane and simuntenously feed can be given in verticle direction



linear interp = $\frac{1}{2}$ axis

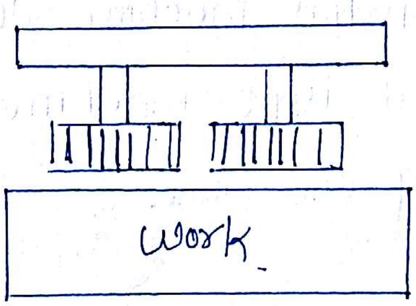
Countouring = 1 axis

③ Verticatally adjust (universal milling <45°)

It is similar to column & knee type but there is a additional facility to rotate the table less than 45° either side.

④ Rotary Type :- In this type of milling machine table can be given one complete rotation and in place of arbor there will multiple spindle in which multiple cutter mounted so machining can take places different places at simunteneously.

⑤ Planomiller :-



multiple cutter are mounted with help of individual spindle by head and reciprocation action is given by table. It is made for large size work. In a planning machind cutting action is provided by bed movement and in planomiller cutting action is provided by rotation of cutter and feed is given by table moment.

Acceptance Test

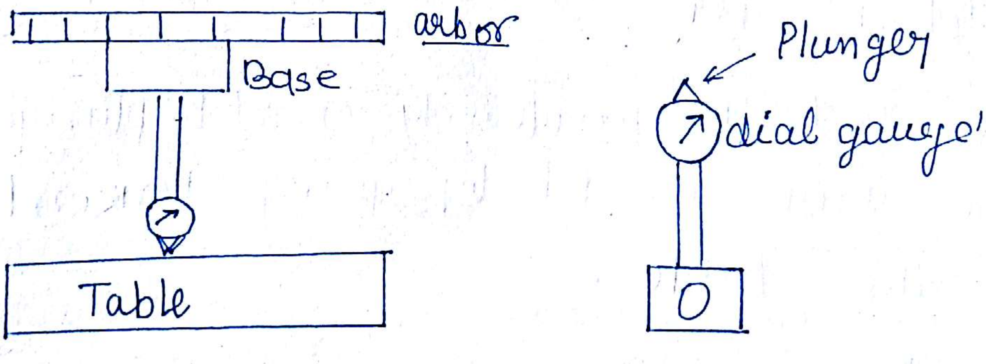
Dynamic test / Static test (Allignment test)

Acceptance test are performed on the new machine before adopting into it to mass production.

In Dynamic test standard work pieces of free Cutting steel are machine at certain speed feed and depth of cut Combination and when surface & other dimension tolerance are within a certain limit machine is adopted to mass production.

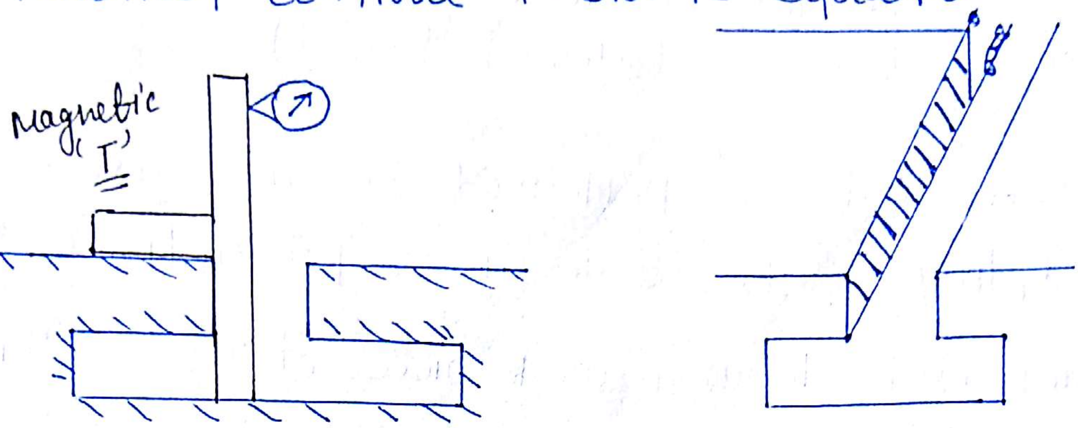
Allignment or static test are performen on machine when it is stationary for a milling machine two test are very important

① Whether table movement parallel to arbor axis



Base of dial gauge is fixed over the arbor with plunger of dial gauge touching the table. By given Giving bi-axial movement to table if there is no variation in dial gauge it mean table movement are parallel.

(2) Whether Central T-Slot is square

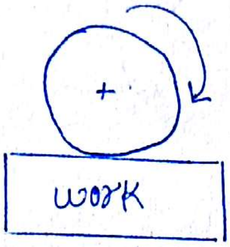


Accuracy of centrar T-Slot is important because workpiece and other machining feocture are mounted of central T-slot.

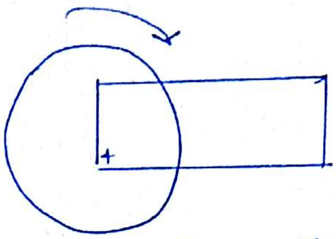
To Check the $\perp^{erity}$ of Slop a magnetic 'T' is inserted in slot with plunger touching one of it's side. Base of dial gauge is fixed over arbor. By giving motion to the table if there is no variation in the dial gauge it means Slot is $\perp^{er}$.

To check the parallality of slot plunger move over the surface of slot by giving Horizontal motion to the table.

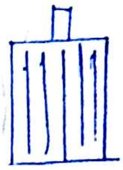
Types of milling



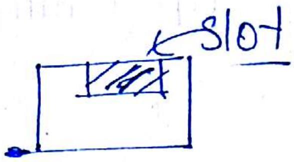
Slab/peripheral milling



Face milling



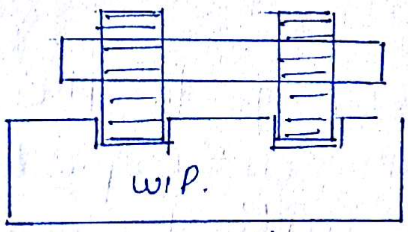
End milling



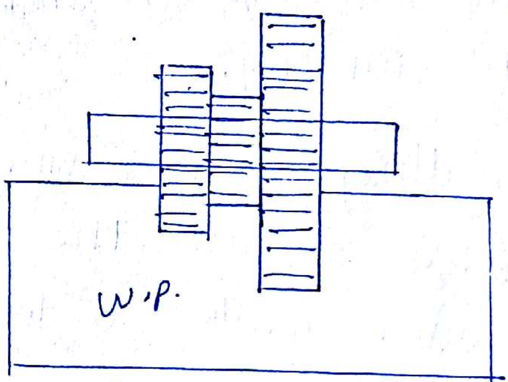
* In slab milling operation axis of rotation of cutter is parallel to the work surface
* In case of face milling operation axis of rotation of cutter will be perpendicular to work surface.

End milling is a combination of slab milling operation and it used to cut slot.

⇒



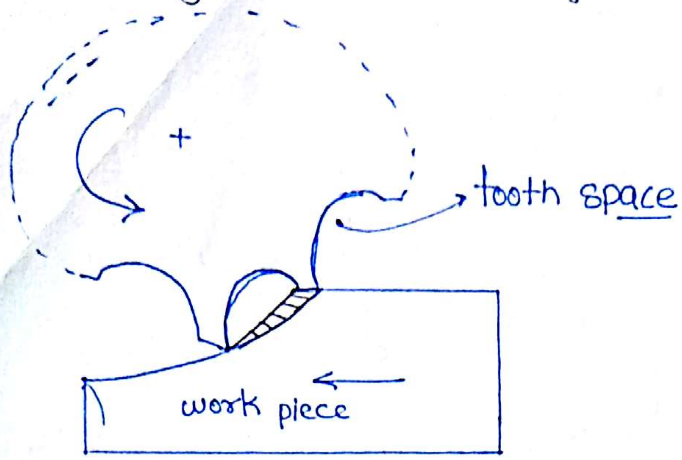
straddle milling



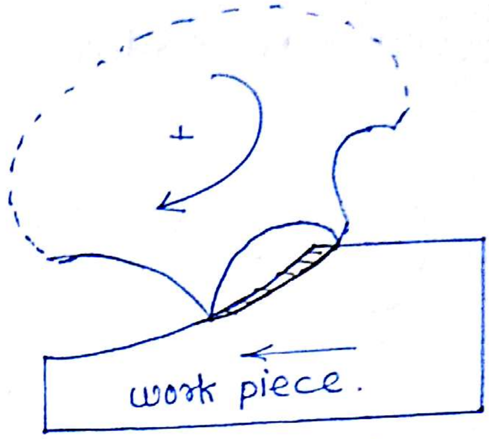
Gang milling

* when the machining taking place on work at to different places simuntaneously it is called straddle milling.
* When the no. of cutter are more than two it is called a gang milling

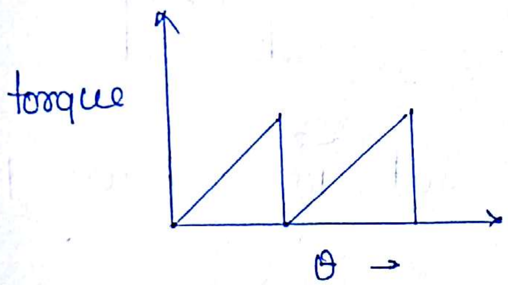
Up milling & Down milling

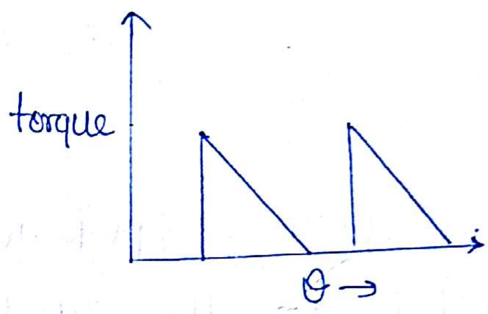


up milling



Down milling





- In up milling process direction of motion of cutter and workpiece is opposite. and In case of down milling it is in same direction.
- In up milling process min. chip thickness is at begaining at max. at end and opposite will be case in down milling.
- In up milling process since hot chip go to the the tooth space so due the diffusion cutting edge will become weak. so tool life will be more in down milling.
- In up milling process cutting edge is rubbing over the finish part before starting the cutting action so this will spoil the surface finish. Surface finish is better in down milling.

- In up milling since the workpiece is pulled against the table so faster will be under Tension. In tension backless error will not have any effect so accuracy will be better in up milling.

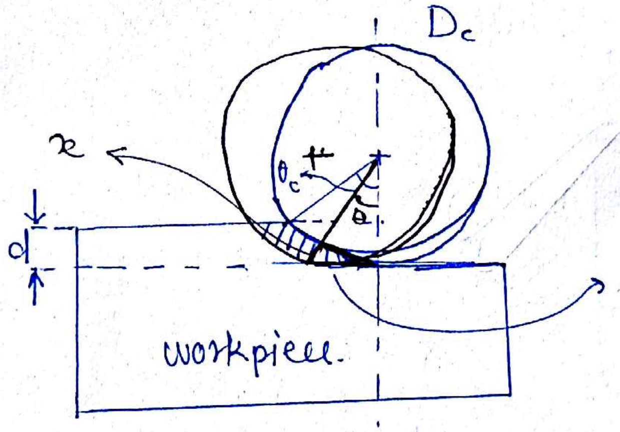
✱

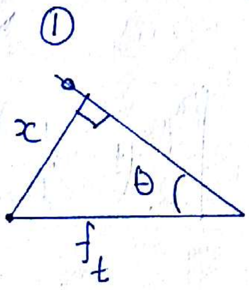
Uncut chip thickness

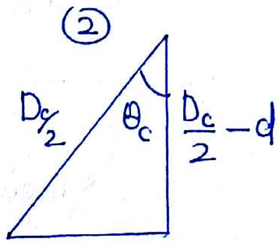
milling feed = mm/rev.

$t_1 \propto$ feed/tooth

$t_1 = \frac{f}{n_t}$ ← no of teeth.







$\theta \rightarrow 0$ to θ_c

$D_c >>> d$

$x_{min} = 0$, $\theta = 0$

θ_c = contact angle

x_{max} at $\theta = \theta_c$

from Δ①

$x = f_t \sin\theta$

from Δ②

$$\cos\theta_c = \frac{D_c/2 - d}{D_c/2}$$

$$\cos\theta_c = 1 - \frac{2d}{D_c}$$

$$\sin\theta = \sqrt{1-\cos^2\theta}$$

$$\sin\theta_c = \sqrt{1-\left(1-\frac{2d}{D_c}\right)^2}$$

$$\sin\theta_c = 2\sqrt{\frac{d}{D_c}\left(1-\frac{d}{D_c}\right)}$$

So $x = f_t \sin\theta$

$$x_{max} = 2f_t\sqrt{\frac{d}{D_c}\left(1-\frac{d}{D_c}\right)}$$

at $\theta = \theta_c$

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

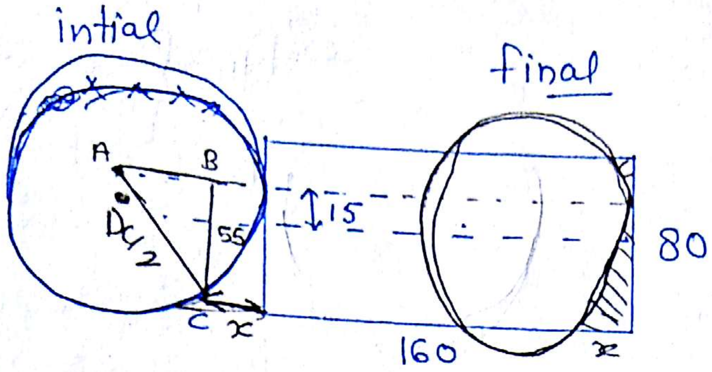
$$x_{mean} = f_t\sqrt{\frac{d}{D}\left(1-\frac{d}{D}\right)}$$

Question A 80 x 160 mm surface is rough machine by @ using a face milling cutter of 150 mm diameter having 10 teeth. The cutter center is offset by 15 mm from the line of symetry of work piece

(i) estimate the time to rough ~~ma~~ the surface if feed = 0.25 mm cutting speed 20 m/min

(ii) with 5 mm approch 5mm over ~~un~~ run what is the single pass feed time

(iii) If cutter is symetric what is rough and finish time.



$n_t = 10$ teeth

$f_t = 0.25$ mm/teeth

$D_c = 150$ mm

$V = 20$ m/min

length of cut $= 160 + x$ $\qquad D_c = 150$ mm

from $\triangle ABC$

$$AB = \sqrt{\left(\frac{D_c}{2}\right)^2 - (55)^2}$$

$$AB = 50.99$$

$$AB \simeq 51 \text{ mm}$$

$$x = 75 - 51 = 24 \text{ mm}$$

So length of cut $= 160 + 24$

$$L_c = 184 \text{ mm}$$

$$f_t = 0.25 \text{ mm}$$

$$\text{feed} = 0.25 \times 10 = 2.5 \text{ mm/rev.}$$

total no. of rev in cutting $= \dfrac{184}{2.5}$ rev.

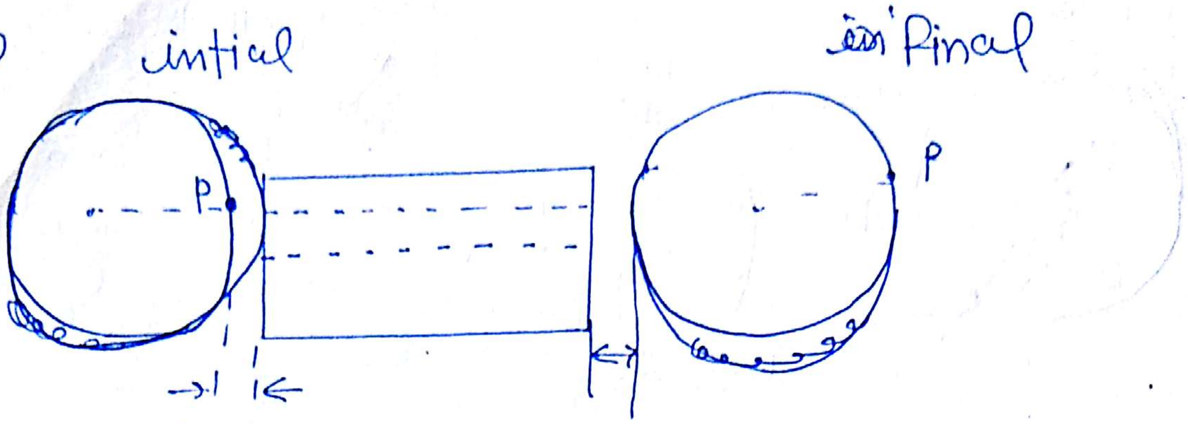
$$= 73.6 \text{ rev.}$$

$$V = \pi D N$$

$$20 \text{ m/min} = \pi \times \frac{150}{1000} \times N \Rightarrow N = 42.4413 \text{ rpm}$$

$$\text{Time} = \frac{\text{No. of rev.}}{N} = \frac{73.6}{42.4413} = 1.734 \text{ min}$$

(ii)



So total length of cut.

$$l = 5 + 160 + 5 + 150$$

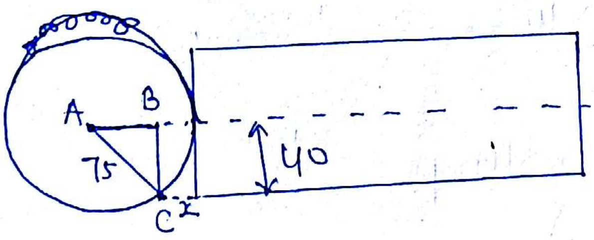
$$l = 320 \text{ mm}$$

$$\text{No. of rev.} = \frac{320}{2.5} = 128 \text{ rev.}$$

$$T_{m_2} = \frac{128}{42.44}$$

$$T_{m_2} = 3.01 \text{ min}$$

(iii)



$$AB = \sqrt{(75)^2 - (40)^2}$$

$$AB = 63.44 \text{ mm}$$

$$x = 11.55 \text{ mm}$$

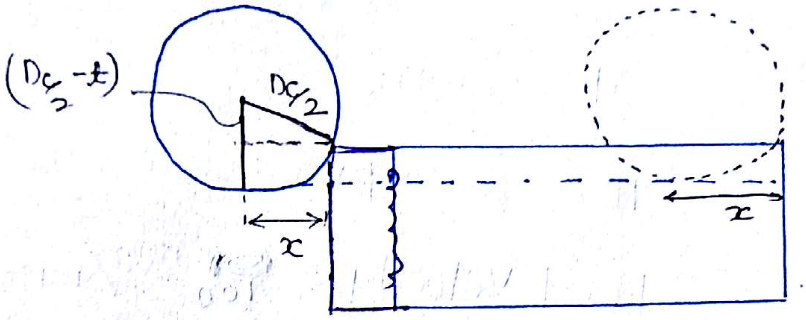
$$l_c = 160 + 11.55 \text{ mm}$$

$$l_c = 171.5571 \text{ mm}$$

$$\text{No. of rev.} = \frac{171.5571}{2.5} = 68.62 \text{ rev}$$

$$T_{m_3} = \frac{68.62}{42.4413} = 1.61 \text{ min}$$

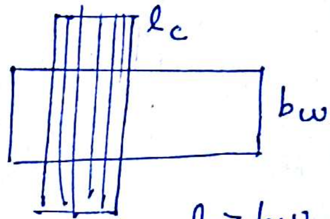
Question The thickness of a ractangular brass plate of length L_w and width b_w has to be reduce by t mm by a helical fluted slab milling cutter of length L_c ($L_c > b_w$). Cutter diameter is D_c. No of teeth are Z_c. Cutting Velocity $= V_c$ and S_o = feed/tooth. Calculate machining time.



$l_c > b_w$

width $= b_w$

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



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

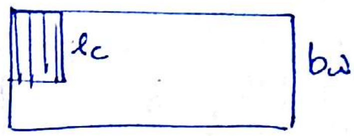
Feed $= Z_c S_o$ mm/rev.

$l_c > b_w$

एक बार मे कट देगा

$V_c = \pi D_c N$

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



$l_c < b_w$

no. of rev $= \frac{L_c + \sqrt{t(D_c - t)}}{Z_c S_o}$

No. of pass $= \frac{b_w}{l_c} = n$ ↓ High Integer

So time $T_m = \left(\frac{L_c + \sqrt{t(D_c - t)}}{Z_c S_o V_c}\right) \pi D_c$ **Ans**

Question Estimate the power require during milling of a mild steel block, 20 mm width using a slab milling cutter having 10 teeth, 75 mm diameter and 10° Radial rake. Feed velocity = 100 mm/min. Coefficient of friction & shear strength of material are 0.5 and 400 mpa, depth of cut 5 mm & cutter rotate at 60 rpm

Sol^n

$w = 20\,mm$ $\qquad$ $d = 5\,mm$

$n_t = 10$ $\qquad$ $N = 60\,rpm$

$D_c = 75\,mm$ $\qquad$ Feed velocity = 100 mm/min.

$\mu = 0.5$ $\qquad$ $\alpha = 10°$

$\tau_s = 400\,mpa$

Shear force $F_s = \dfrac{\tau_s\, w\, t_1}{\sin\phi}$

max chip thickness $x_{max} = 2 f_t \sqrt{\dfrac{d}{D}\left(1 - \dfrac{d}{D}\right)}$

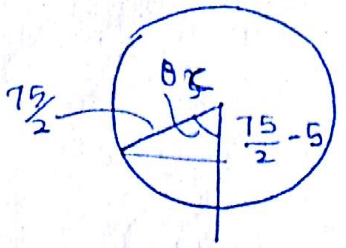
$$f_t = \frac{f}{N n_t} = \frac{100}{60 \times 10} = 0.167\ mm/tooth$$

$$x_{ma} = 2 \times \frac{1}{6}\sqrt{\frac{5}{75}\left(1 - \frac{5}{75}\right)}$$

$$x_{max} = 0.083\ mm.$$

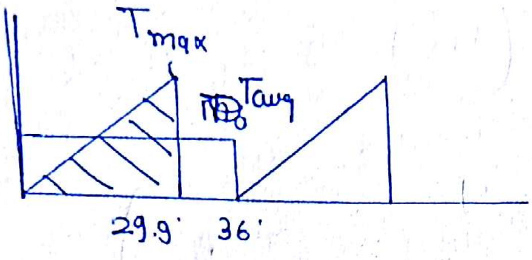
$\alpha = 10°$

Angle b/w 2 cutting edge = $\dfrac{360}{10} = 36°$



$$\cos\theta_c = \frac{(75/2 - 5)}{(75/2)}$$

$$\cos\theta_3 = 29.9^\circ$$



$$\text{Power} = T_{avg} \times \omega$$

$$\frac{1}{2} \times T_{max} \times 29.9 = T_{avg} \times 36 \Rightarrow T_{avg} = \frac{T_{max}}{2.408}$$

$$T_{max} = F_s \times \frac{D}{2}$$

$$F_s = \frac{\tau w t_1}{\sin\phi} \Rightarrow$$ less & shaffey $\phi + \beta - \alpha = 45^\circ$

$\beta = \tan^{-1}(k)$, $\alpha = 10^\circ$ $\phi = 28.434^\circ$

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

$$F_s = \frac{400 \times 20 \times 0.083}{\sin(28.431)} = 1394.487 \text{ N}$$

$$T_{max} = 1394.487 \times 37.5 = 52293 \text{ N-mm}$$

$$T_{avg} = 21716.362 \text{ N-mm}$$

$$P = T_{avg} \times \omega = T_{avg} \times \frac{\pi D N}{60}$$

$$P = \frac{21.716 \times \pi \times 75 \times 60}{60}$$

Ans $P = 184\ kW$

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

$$F_c = \frac{1394.487 \cos(26.56 - 10)}{\cos(45)}$$

$$F_c = 1890.303\ N$$

T_{max} ~~T_{avg}~~ $= 70.886\ N\text{-}m$

$T_{avg} =$ ~~34.74~~ 29.43 $N\text{-}m$

$$P = T_{avg} \times \omega$$

~~$\omega = \frac{\pi D N}{60}$~~

~~$\omega = \frac{\pi \times 75 \times 60}{60}$~~

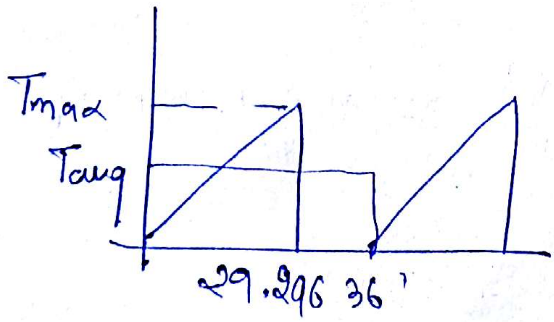
$\omega = 2\pi N$

$\omega = 2\pi \times 60/60$

$\omega = 2\pi$

$P = 29.43 \times 2\pi$

$P = 184\ kW$



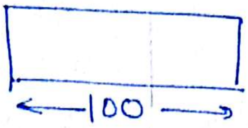
70.886

$$\frac{1}{2} \times 29.296 \times \frac{\pi}{180} \times 70.886 = T_{avg} \times 36 \times \frac{\pi}{180}$$

$T_{avg} = 29.43$

$P = T\omega$

Q.3
N.B



feed = 30 mm/min
setup time = 2 min
table travel = 10mm

$l_c = 110$ mm

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

Time = 34 min

Q.6

$V = \pi D N$ $\quad N = \frac{V}{\pi D} = \frac{22 \times 10^3}{\pi \times 70} = 100.04$ rpm

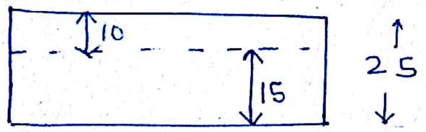
~~$N = \frac{\pi D}{V} = \frac{\pi \times 70 \times 100}{22 \times 1000} = 9.99 \times 10^{-3}$~~

$f = f_t N n$

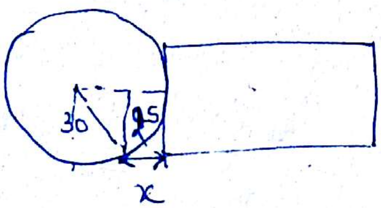
$f = 0.05 \times 12 \times 100.04$

$f = 60$ mm/min

(10)



D = 60
$n_t = 20$
$f_t = 0.03$ mm
N = 150 rpm



$l_c = 100 + x = 113.4168$

~~$l_c = 100 + 4.01 = 104.01$~~

~~x = 4.01~~

$x = 30 - \sqrt{30^2 - 25^2}$

$x = 13.4168$ mm

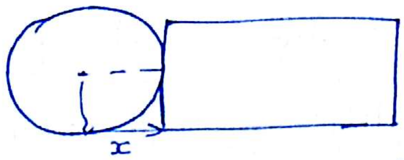
~~No. of Cutt = $\frac{104.01}{0.03 \times 20}$ = 520 173.35~~

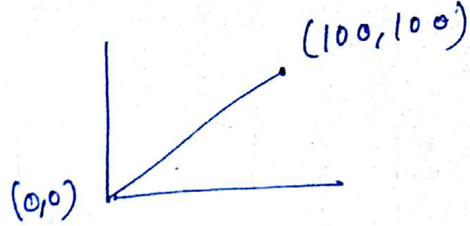
~~$T_m = \frac{173.35}{\times 150} \times 2$~~

$$T_m = \frac{113.4168}{\times 0.03 \times 150 \times 20} \times 2$$

$T_m = 2.52$ min

Q.17





$x = r$

$x = 5mm$

$l_c = 100\sqrt{2}$ mm

$l_c = (100\sqrt{2} + 5)$ mm $\approx$

feed = 50 mm/min

$$t_m = \frac{100\sqrt{2}+5}{50} = 2.92 \text{ min}$$

$= 175.70$ sec.

(18)

$$x_{max} = 2 f_c \sqrt{\frac{d}{D}}$$

$d_2 = 2d_1$

$$\frac{(x_{max})_1}{(x_{max})_2} = \frac{2 f_c \sqrt{d_1/D}}{2 f_c \sqrt{\frac{2d_1}{D}}} = 0.707$$

(19)