DISCUSSION

1. What are advantages of Helical gear over straight spur gear?

ans. i. Angled teeth engage gradually causing smooth and quiet running

ii. Higher load capacity for helical gears

iii. More durable as less wear and tear due to load distribution.

2. What are sources of error in above method of cutting helical gear?

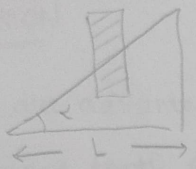
ans. Major sources of error in above method are:-

i. Approximating the shaft diameter to 164 mm than taking 164.25 mm leading to error in number of teeths and spacing of teeths

ii. Approximating the transmission ratio to one of available ones ($\frac{1}{4}$) leads to error as well.

3. What is herringbone gear?

ans. Specific type of double helical gear that is a side to side combination of two helical gears of opposite hands. Each helical groove forms a V shape on the top view.



$$\tan\alpha = \frac{\pi d_p}{L}$$

$$L = \frac{\pi d_p}{\tan\alpha} = \frac{\pi \times 160}{\tan 15^\circ}$$

$$\boxed{L = 1875.93 \text{ mm}}$$

Rotation of the shaft after gear quadrant = $\frac{L}{5} U_n$

Since the transmission ratio of the gear is 1:1, the rotation transferred to the worm gear = $\frac{L}{5} U_n$

Rotation of the worm = $\frac{L}{5} \times U_n \times \frac{1}{40} = 1$ rotation of w/p

$$U_n = \frac{40 \times 5}{L} = 0.1061$$

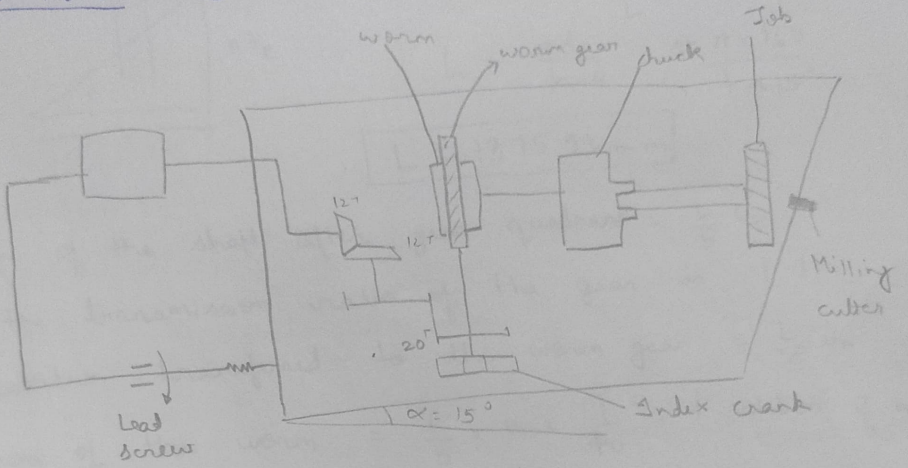
The exact transmission ratio is impossible to obtain given the limitations on the available standard gears with the standardised set no. of teeth. The closest rational no. that would be available is $\frac{1}{9} = 0.11$

So, we need to set the gear quadrant in such a way that we get a ratio of 1:9.

This done by the following manner:

$$\frac{24}{96} \times \frac{32}{72} = \frac{1}{9}$$

Coupled Motion : (Feed + job rotation)



The feed motion is given to the workpiece by moving the entire table with the help of the lead screw. Since the helical gear has a particular pitch, the feed has to be coupled with the cutting motion, that is the rotation of the workpiece.

For one complete rotation of the job, the feed that has to be provided = 1 (Pitch of the gear)

Pitch of the lead screw = 5 mm

Gear ratio of the gear chain quadrant = U_n

worm gear no. of teeth = 40

No. of starts in worm = 1

For 1 rotation of spindle → 40 rotations of crank pin

$= \frac{40}{U}$ rotations of lead screw.

1875 mm = $\frac{40}{U} \times 5$ mm of linear movement

$\therefore U = \frac{200}{1875} \approx \frac{1}{9} \leftarrow \frac{a}{b} \times \frac{c}{d} \times \frac{e}{f}$

Here, $\frac{24}{96} \times \frac{32}{86} \times \frac{86}{72} = \frac{1}{9}$

$L = \pi D_p \tan\alpha = 1875$ mm

We use a 73 hole indexing plate.

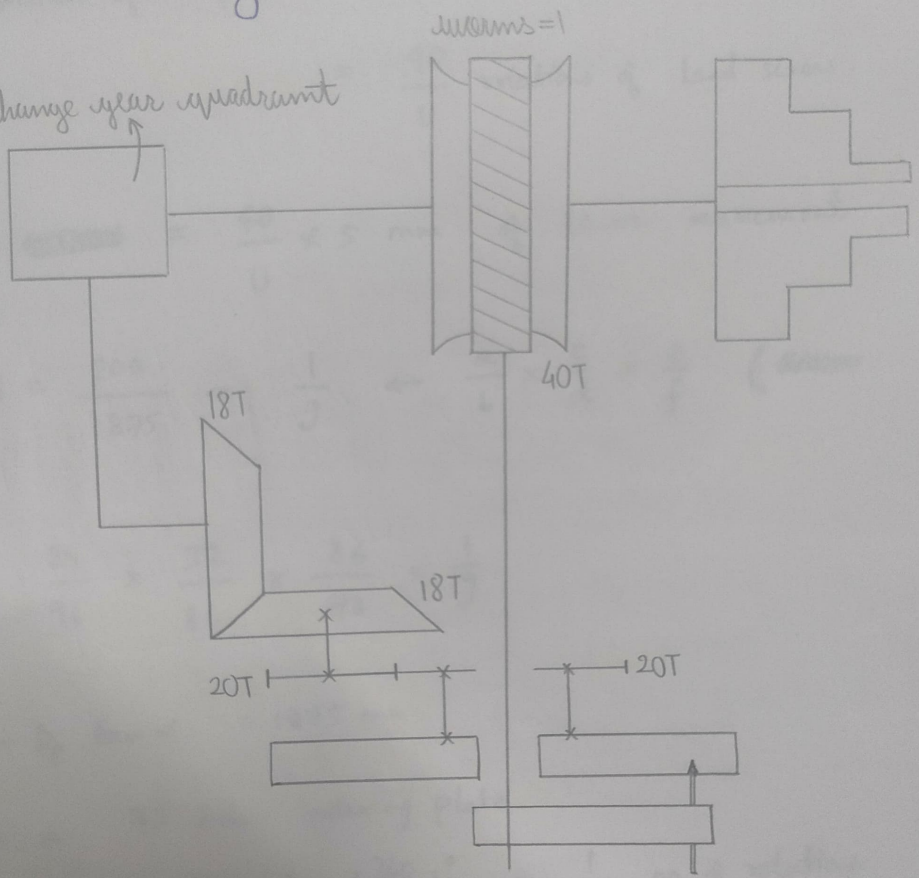
Degree of rotation = $\left(\frac{360}{73}\right)^\circ = \frac{1}{73}$ no. of rotations.

$\therefore \theta = \left(\frac{40}{72} - \frac{40}{73}\right) \times 360^\circ = 2.74^\circ$

$U_d = 40 \times \left[1 - \frac{N_{req}}{N_{available}}\right] = 40 \times \left(1 - \frac{73}{72}\right)$

$= -\frac{40}{72} = -\frac{a}{b} \times \frac{c}{d}$

Differential indexing –



CP – Circular Pitch

CP_n – Circular Pitch for helical Gear. (Normal)

From Geometry, $CP_n = CP \cos\alpha$

Similarly, there are three modules defined for the helical gear, the additional being the normal module M_n.

When a particular module for a helical gear is specified it is taken as the normal module M_n.

$M_n = M \cos\alpha$

Now, let us find five dimensions of the helical gear we are supposed to machine.

D.P. = 12 (in FPS units)

$m_n = \frac{25.4 \text{ mm}}{12} = 2.117$

$Z = 73$, $\alpha = 15°$ (helix angle)

$d_o = (Z+2)m$

$= 75 \times \frac{m_n}{\cos\alpha} = 164.376 \text{ mm}$

$d_p = d_o - 2m = 159.99 \approx 160 \text{ mm}$

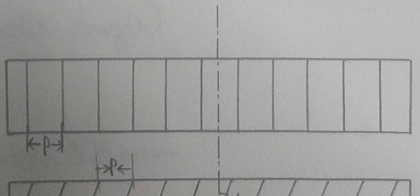
Helical Gear –

Helical gears are preferred over spur gears for the following reasons of reducing noise and increasing the smoothness of the operation.

Whole spur gear comes into contact with the meshed spur gear teeth. As a result, greater force is applied which may increase the wear and tear of a spur gear. But in helical gear, tooth comes into contact gradually and hence wear and tear is reduced.

Teeth of such gears form a part of a helix and the normal force between the teeth is inclined to the axis of rotation.

The diagram of spur and helical gears can be drawn as follows –



Diameter of pitch circle = d_p

Number of teeth = z

Circular pitch = C.P.

$\Rightarrow$ C.P. $\times z = \pi d_p$

$$C.P. = \frac{\pi d_p}{z}$$

Parameter $\left(\frac{d_p}{z}\right)$ is known as (m) module which is the popular specification of the gear.

However, the term diametrical pitch (DP) is also used in certain cases.

So, $$C.P. = \pi m$$

Addendum = m (followed as a standard)

$\therefore$ outer circle diameter d_a :-

$$d_a = d_p + 2m$$

$\therefore$ $d_a = zm + 2m = (z+2)m$

For the two gears do mesh, they must have the same module or diametrical pitch.

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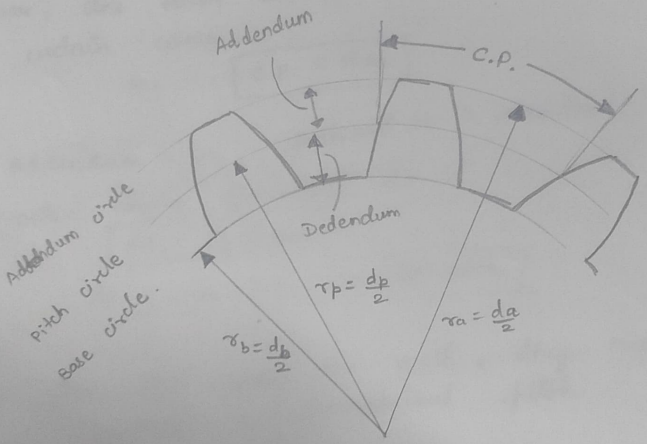
SHEET NO.

Gear metrology :-

Spur Gear :-

Spur gears are used for connecting parallel shafts and the teeth in it might be straight ie. parallel to axis of rotation or helical.

Different parameters of a gear :-



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Objective -

To machine a 12 DP, 73 teeth, right hand helical gear with 15° helix angle on a horizontal column and a knee type universal milling machine with a rotary disc type from gear-cutter.

Apparatus -

a) Horizontal column and knee type universal milling
b) 12 DP no. 2 cutter
c) Gear tools
d) Vernier calliper
e) Dial indicator
f) Cast iron gear blank & mandrel
g) change gears
h) Indexing head.

Theory and procedure -

Spur gear cutting is generally made by 2 methods :-
① Gear Hobbing ② Gear Shaping
The helical gear machining operation is similar to the gear shaping operation where form cutters are used to give the gear blank the form of the cutters.
The helical gear milling is thus a form cutting operation.