5. Module of gear - 2 marks

6.

(a) Two parallel shafts, about 600 mm apart, are to be connected by spur gear wheels. One shaft is to run at 120 RPM and other at 360 RPM. Design the wheels, if the diametral pitch of the teeth is to be 0.25 mm. 8

7. Circular pitch of gear - 2 marks

8. Velocity ratio of simple gear train and compound gear train - 7,7 marks

October 2018

(b) With a sketch explain the Reverted gear train and describe it's velocity ratio. 8

OR

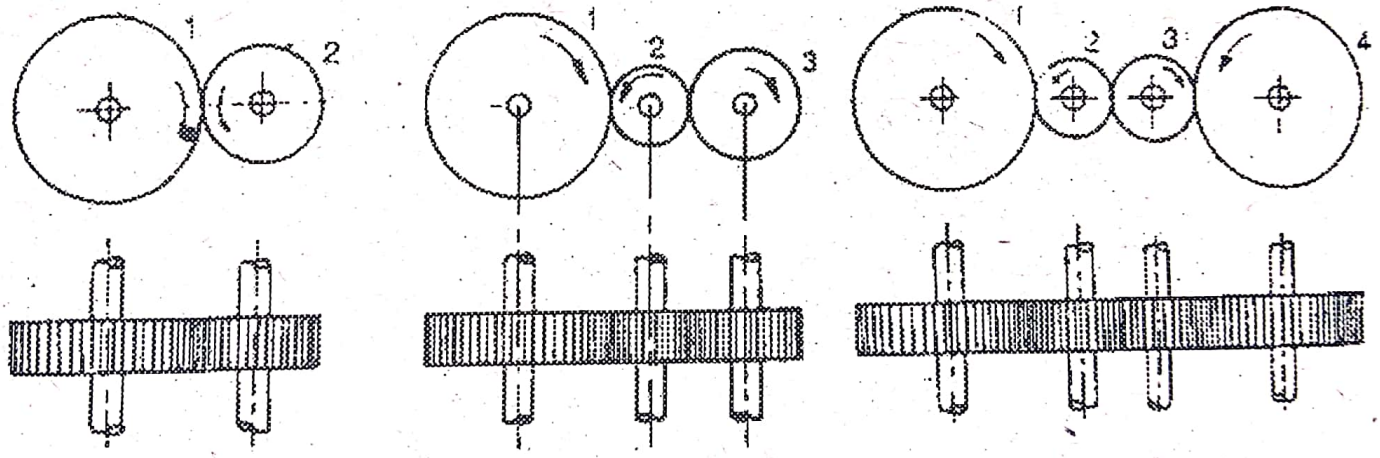
X (a) With a sketch explain the compound belt drive and describe it's velocity ratio. 7

(b) A set of spur gear wheels are arranged as follows :

Gear "A" drives Gear "B". Gears "B" and "C" is a compound wheel. Gear "C" drives Gear "D". If number of teeth on Gear A = 25, on B = 50, on C = 35 and on D = 70. If Gear A rotates at 300 RPM, find the RPM of wheel D. 8

10.8 SIMPLE GEAR TRAIN

In a simple gear train, each shaft carries only one gear as shown in *Fig*10.10



(a) (b) (c)

Fig. 10.10 Simple gear train.

In *Fig* 10.10 (a), gear 1 drives gear 2, both the gears are rotate in opposite directions. When one intermediate gear is added as shown in *Fig* 10.10 (b) the rotation of the driver and the follower will be in the same direction. It may also be noted that when the number of intermediate gears are odd, the motion of the driver and follower is like. If it is even they are rotate in opposite direction. Generally all odd numbered simple gear train, the driver and driven gears rotates in one direction and all even numbered simple gear train, the driver and driven gears rotates in the opposite direction. Consider the *Fig* 10.10 (b).

Let N_1, N_2, N_3 be the speeds of gear 1,2 and 3 respectively, and

Let T_1, T_2, T_3 be the number of teeth on gear 1,2 and 3 respectively.

In this gear train, gear 1 drives gear 2 , while gear 2, drives gear 3,

We know that speed ratio or velocity ratio is the ratio of speed of the driving gear to that of the driven gear. The reciprocal of speed ratio is known as *train value* .i.e., it is the ratio of the speed of the follower to the speed of the driver. In gear trains the term train value is always used.

Consider a pair of gears 1 and 2 , the train value is

$$\frac{N_2}{N_1} = \frac{T_1}{T_2} \qquad \text{.....}(i)$$

Similarly pair of gears 2 and 3 , the train value is

$$\frac{N_3}{N_2} = \frac{T_2}{T_3} \qquad \text{.....}(ii)$$

Multiplying equation (*i*) and (*ii*), the train value of simple gear train is

$$\frac{N_3}{N_2} \times \frac{N_2}{N_1} = \frac{T_2}{T_3} \times \frac{T_1}{T_2}$$

Or

$$\frac{N_3}{N_1} = \frac{T_1}{T_3} \qquad \text{...(10.8)}$$

i.e. $$\text{Train value} = \frac{\text{Speed of follower}}{\text{Speed of driver}} = \frac{\text{No. of teeth on driver}}{\text{No. of teeth on driven}}$$

$$\therefore \quad \text{Speed ratio} = \frac{1}{\text{Train value}}$$

Or, $$\frac{N_1}{N_3} = \frac{T_3}{T_1} \qquad \ldots(10.9)$$

Hence, in a simple gear train, we can seen that the velocity ratio or speed ratio is independent of the intermediate gears. These intermediate gears are also called *idle gears*, as they do not effect velocity ratio or speed ratio of the system.

10.9 .COMPOUND GEAR TRAIN

A compound gear train is one in which each intermediate gear shaft carries two gears which are fastened together rigidly. *Fig* 10.11 illustrates the compound gear trains comprising gears 1,2,3 and 4 .

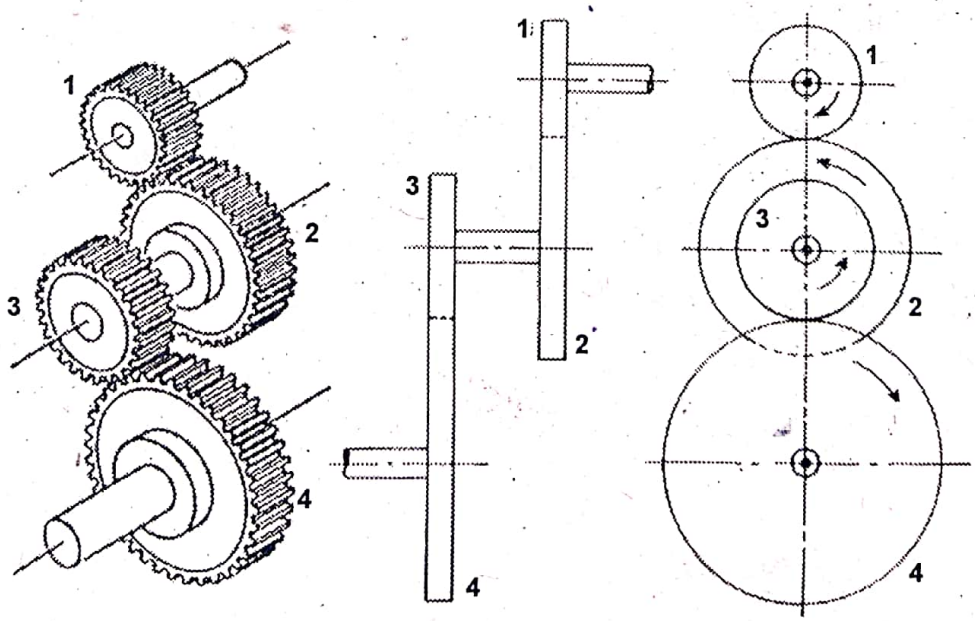


Fig10.11 Compound gear train

In *Fig* 10.11 gear 1 is the driving gear and gear 4 is the driven gear or follower. These two gears are connected by means of a compound gear 2 and 3 which are mounted on the same intermediate shaft. Therefore the speed of the gear 2 is equal to the speed of the gear 3 . In *Fig* 10.11 only one compound gear or one intermediate shaft so the direction of rotation of follower is same as that of driver. If the number of intermediate compound gear shafts is even then the driver and driven is rotated in opposite direction. In the figure gear 1 drives gear 2 , while gear 3 drives gear 4 . In this type of gear train the velocity ratio is depends upon each of the intermediate gears. Compared to simple gear train, the main advantage of compound gear train is that it can provide a larger velocity ratio in a limited space and the drive is compact.

Let N_1, N_2, N_3 and N_4 be the speeds of gear 1,2,3 and 4 respectively, and T_1, T_2, T_3 and T_4 be the number of teeth of gear 1,2,3 and 4 respectively

Consider a pair of gears 1 and 2 , the train value is

$$\frac{N_2}{N_1} = \frac{T_1}{T_2} \qquad \text{.....}(i)$$

Similarly, pair of gears 3 and 4 , the train value is

$$\frac{N_4}{N_3} = \frac{T_3}{T_4} \qquad \text{.....}(ii)$$

Multiplying (*i*) and (*ii*), the train value of compound gear train is

$$\frac{N_4}{N_3} \times \frac{N_2}{N_1} = \frac{T_3}{T_4} \times \frac{T_1}{T_2}$$

(But $N_3 = N_2$ since keyed on same shaft)

$$\therefore \quad \frac{N_4}{N_1} = \frac{T_1 T_3}{T_2 T_4} \qquad \text{... (10.10)}$$

i.e. $\textit{Train value} = \dfrac{\textit{Speed of follower}}{\textit{Speed of driver}}$

Example 10.11*:** Two parallel shafts, about 600 mm apart, are to be connected by spur wheels. One shaft is to run at 120 rpm and the other at 360 rpm . Design the wheels, if the diametral pitch of the teeth is to be 0.25 mm (March 2007, November 2005, April 2001***)

***Solution* :**

Given :

Distance between parallel shafts, $C = 600$ mm

Speed of first gear, $N_1 = 120$ rpm

Speed of second gear, $N_2 = 360$ rpm

Diametral pitch of gear, $p_d = 0.25$ mm

***Analysis* :**

Using the relation for velocity ratio of gear drive

$$\frac{d_2}{d_1} = \frac{N_1}{N_2} = \frac{120}{360} = \frac{1}{3}$$

or $$d_1 = 3d_2 \quad \text{.....}(i)$$

Using the expression for the centre distance between gears.

$$C = \frac{d_1 + d_2}{2}$$

Or, $d_1 + d_2 = 2C = 2 \times 600 = 1200$ .....(*ii*)

From equation (*i*) and (*ii*)

Pitch circle diameter of first gear, $d_1 = 900$ mm

Pitch circle diameter of second gear, $d_2 = 300$ mm

Using the relation for diametral pitch of mating gears.

$$p_d = \frac{T_1}{d_1} = \frac{T_2}{d_2} = 0.25$$

$\therefore$ Number of teeth on first gear, $T_1 = 0.25 d_1 = 0.25 \times 900$

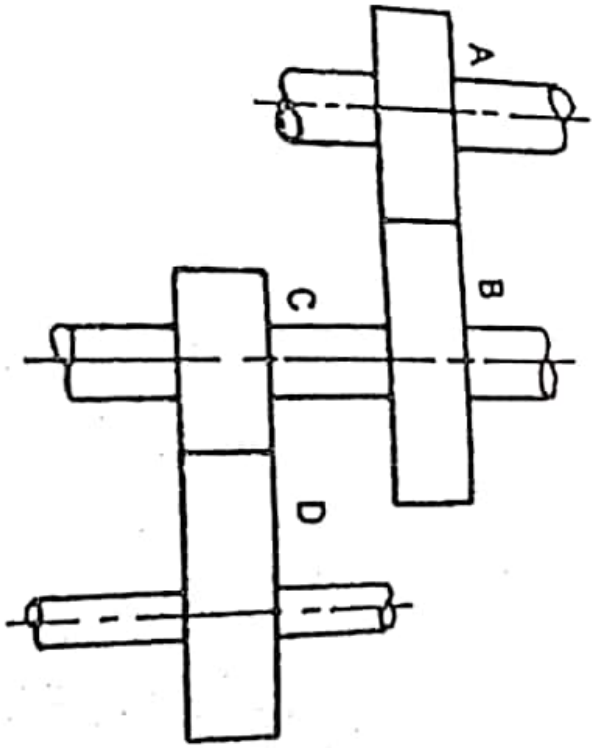
$= 225$

Number of teeth on second gear, $T_2 = 0.25 d_2 = 0.25 \times 300$

$= 75$

Result :

Number of teeth on spur wheels are **225** and **75**



No.of teeth on A TA = 25 , TB = 50

TC = 35 TD = 70

Let N4 be the speed of Wheel D

Then Velocity Ratio = N4 / N1 = (TA / TB) x (TC / TD)

N4 = [(25 x 35) / (50 x 70)] x 300 = 75 RPM ---------- **(Ans.)**