Tutorial #6 : Gears

Module $m = \dfrac{\text{Pitch diameter}}{\text{Number of teeth}}$

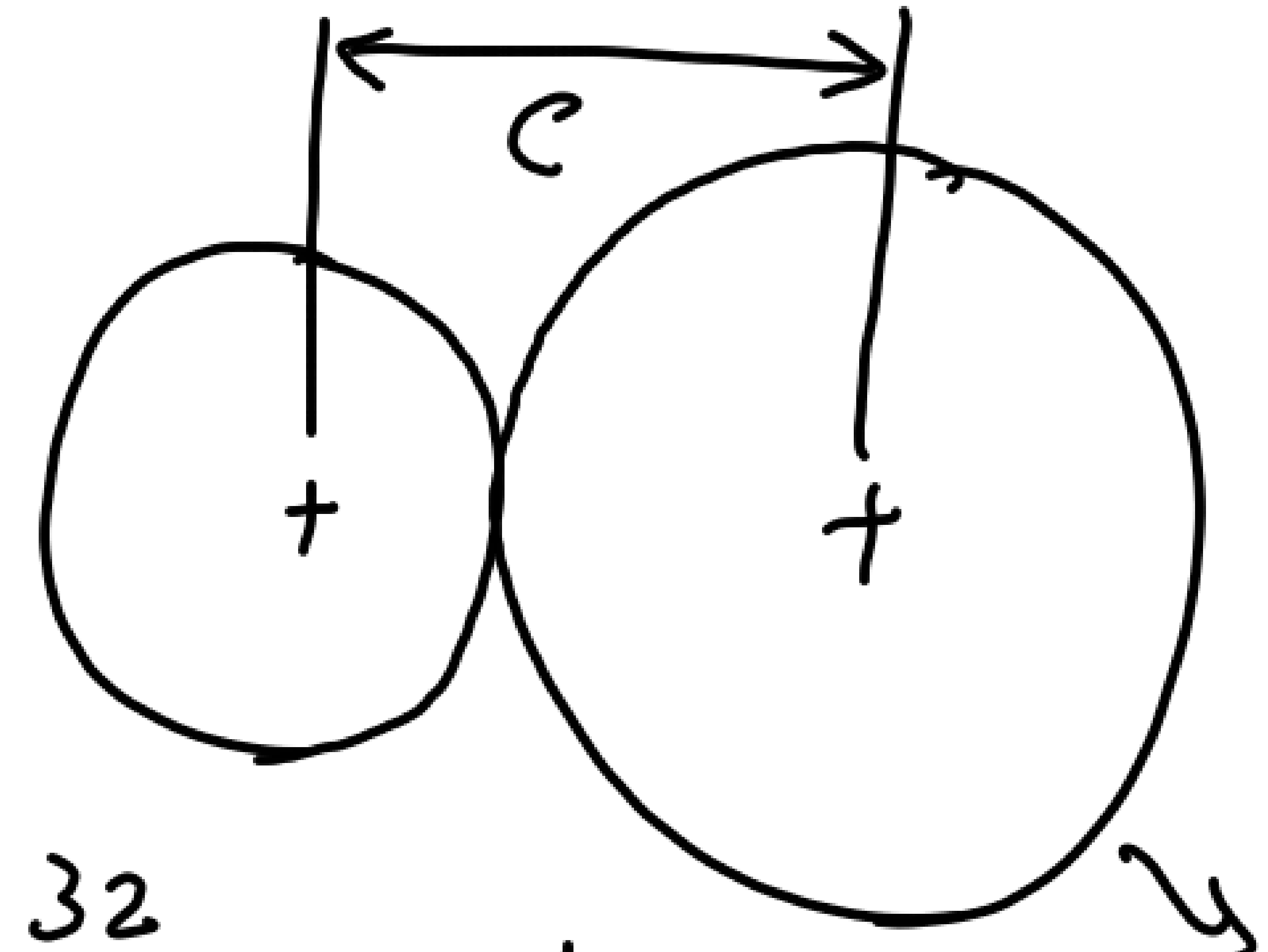
$$\therefore m = \frac{d_G}{N_G} = \frac{d_P}{N_P} = \frac{2r_G}{N_G} = \frac{2r_P}{N_P}$$

G : Gear ; P : Pinion

Centre to centre distance

$$C = \underbrace{(r_P + r_G)}_{\text{pitch circle radius}}$$

(1)



$N_P = 32$

$N_G = 84$ Pitch circle

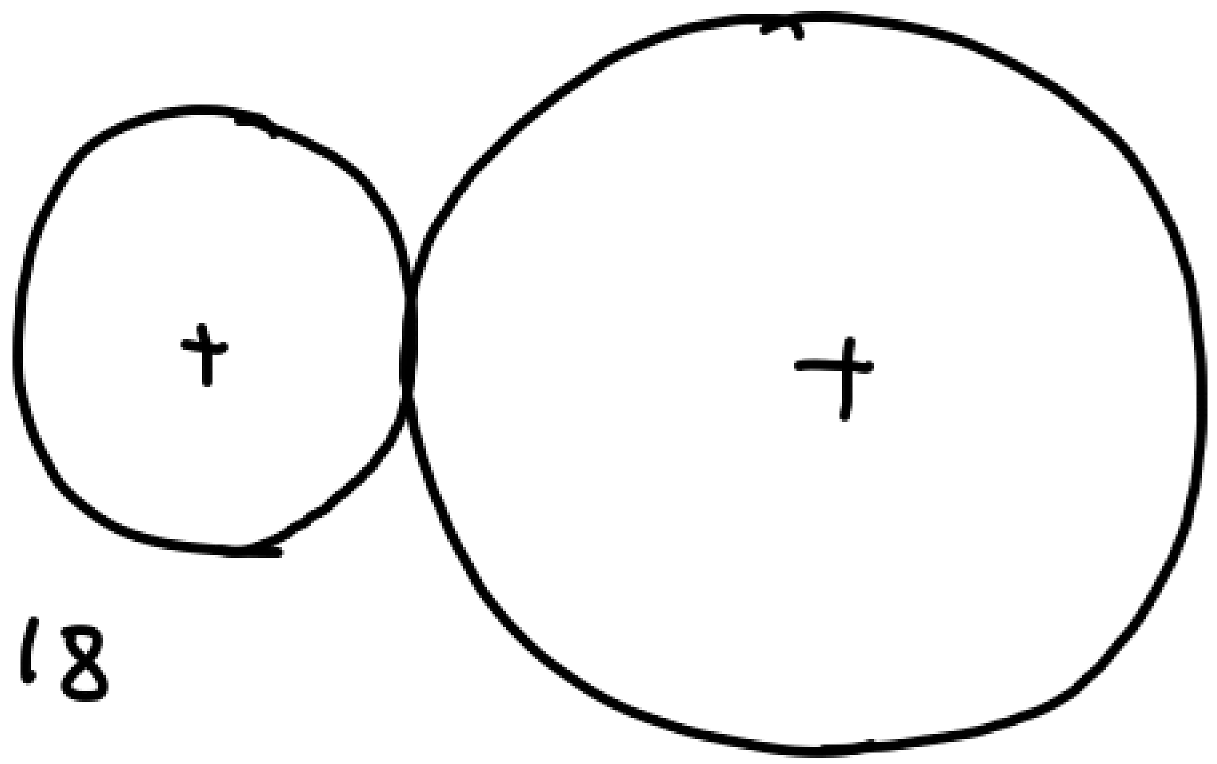
$C = 87\ mm$

$$C = r_P + r_G = \frac{mN_P}{2} + \frac{mN_G}{2}$$

$$\therefore m = \frac{2C}{(N_P + N_G)} \rightarrow \underline{\text{ANSWER}}$$

Once "m" is known, all the associated dimensions of Gear can be computed.

(Q)



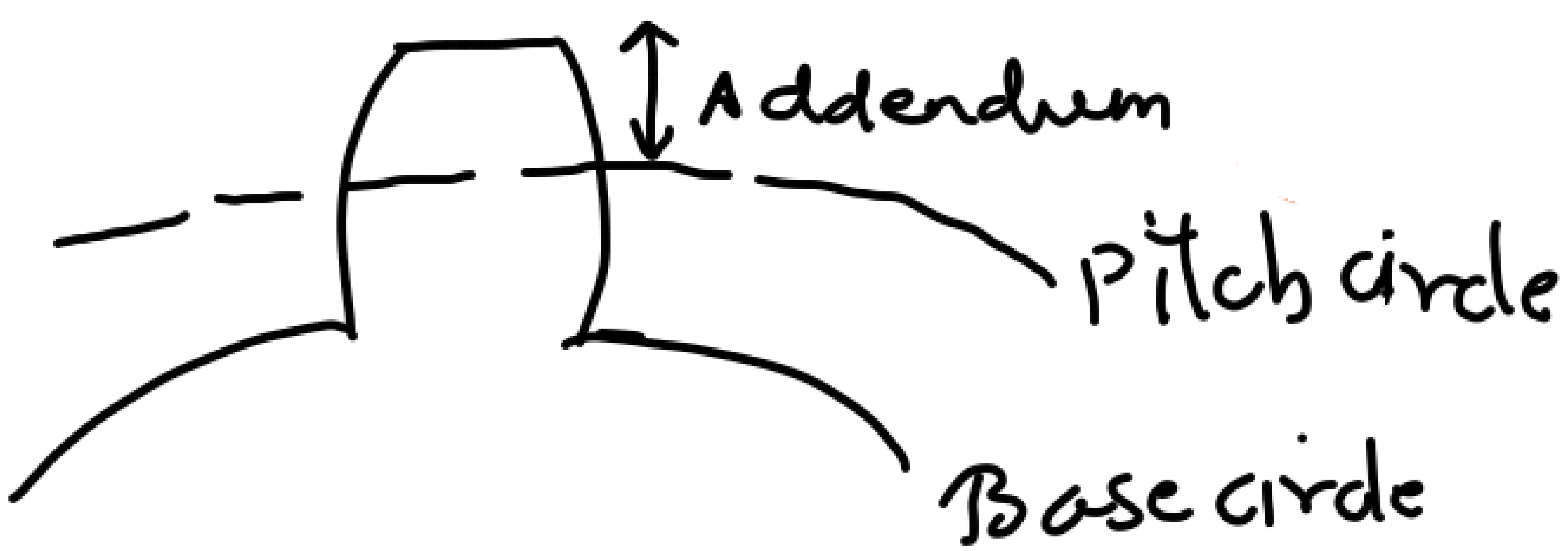
$N_P = 18$

$N_G = 26$

Module $m = 3\,mm$;

Pressure angle $\phi = 20^\circ$;

Addendum $a_G = a_P$ (Given)



Constraint on a_G to avoid interference

$$a_G + r_G \leq \sqrt{r_G^2 + (r_P^2 + 2 r_P r_G)\sin^2\phi}$$

$$\frac{a_G}{r_G} \leq \sqrt{1 + \left\{\left(\frac{r_P}{r_G}\right)^2 + 2\left(\frac{r_P}{r_G}\right)\right\}\sin^2\phi} - 1$$

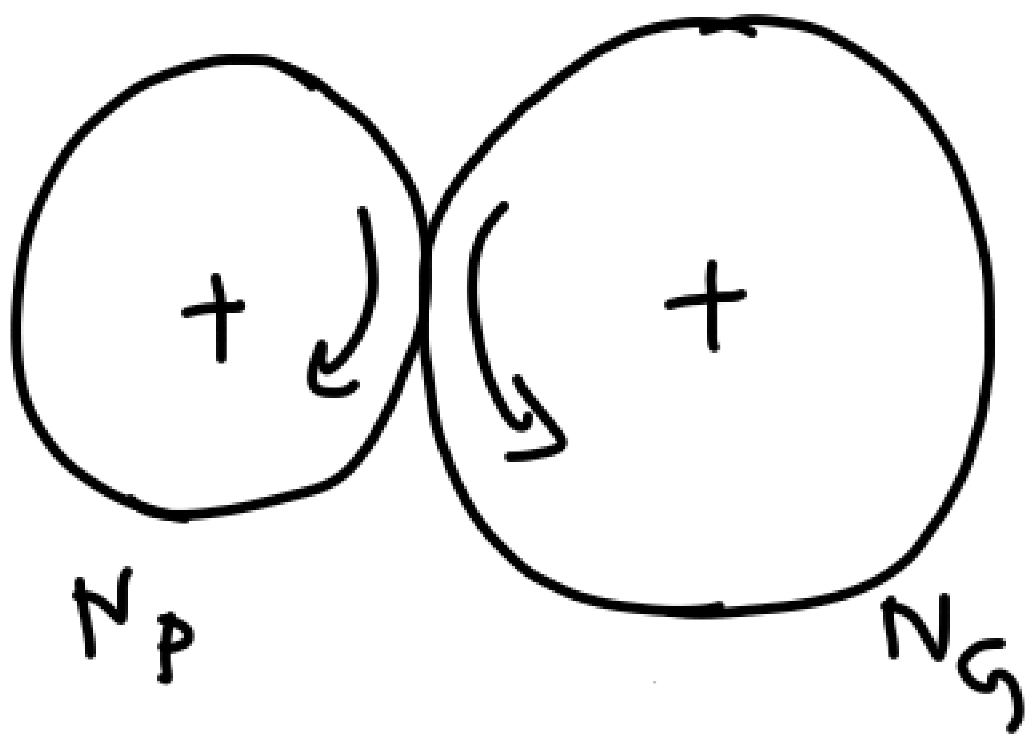
$$\frac{r_P}{r_G} = \frac{N_P}{N_G} = \frac{18}{26}; \quad r_G = \frac{m N_G}{2}$$

$a_G \leq$ ______ (Round off the answer to nearest integer)

Gives maximum value of a_G

Gear Trains

Simple Gear train

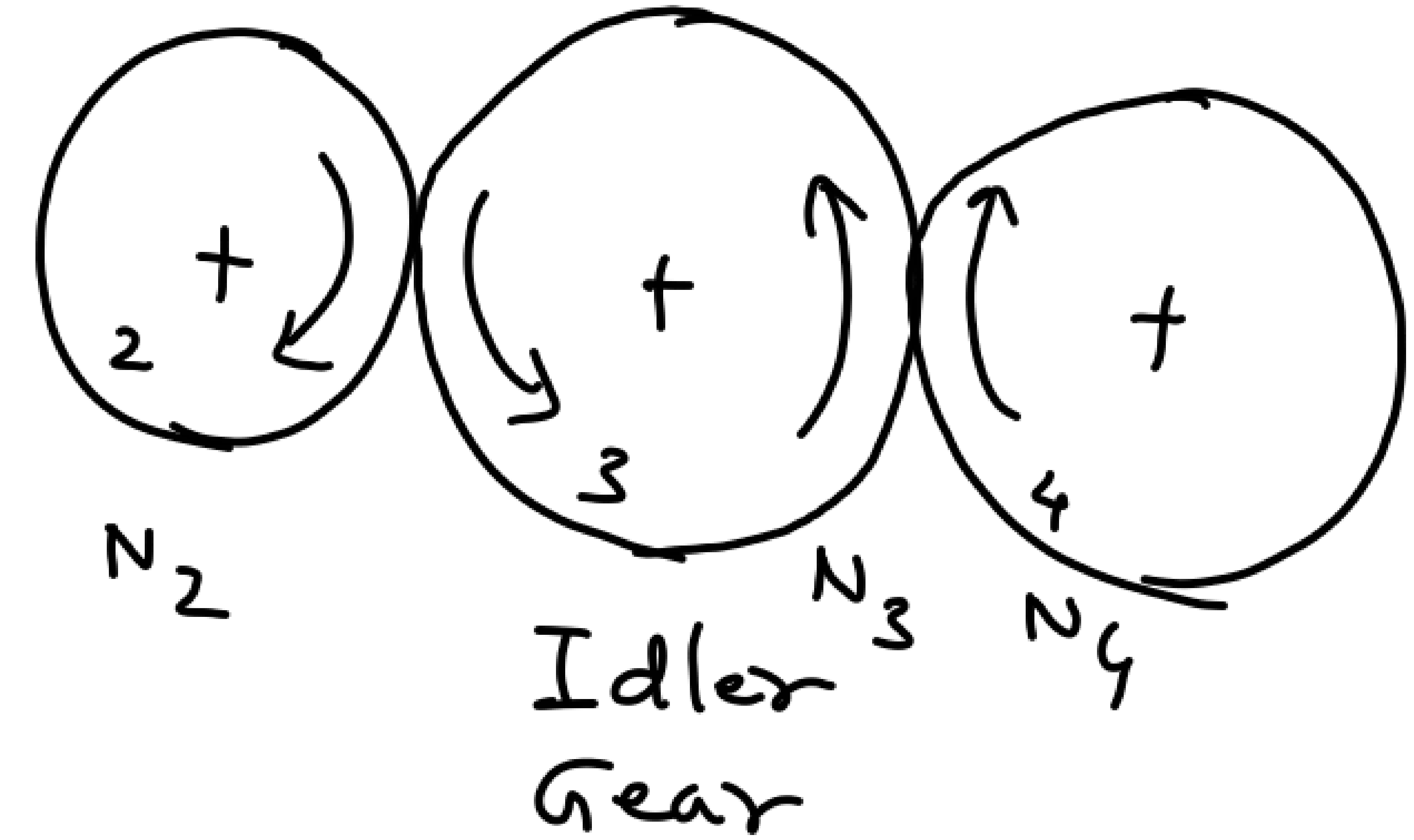


Speedratio/Velocity ratio

$$\frac{\text{Output Speed}}{\text{Input Speed}} \quad \boxed{\frac{\omega_G}{\omega_p} = \frac{-N_p}{N_G}}$$

– ve sign to indicate change in dir$^{\text{n}}$

(Q3.) Front view

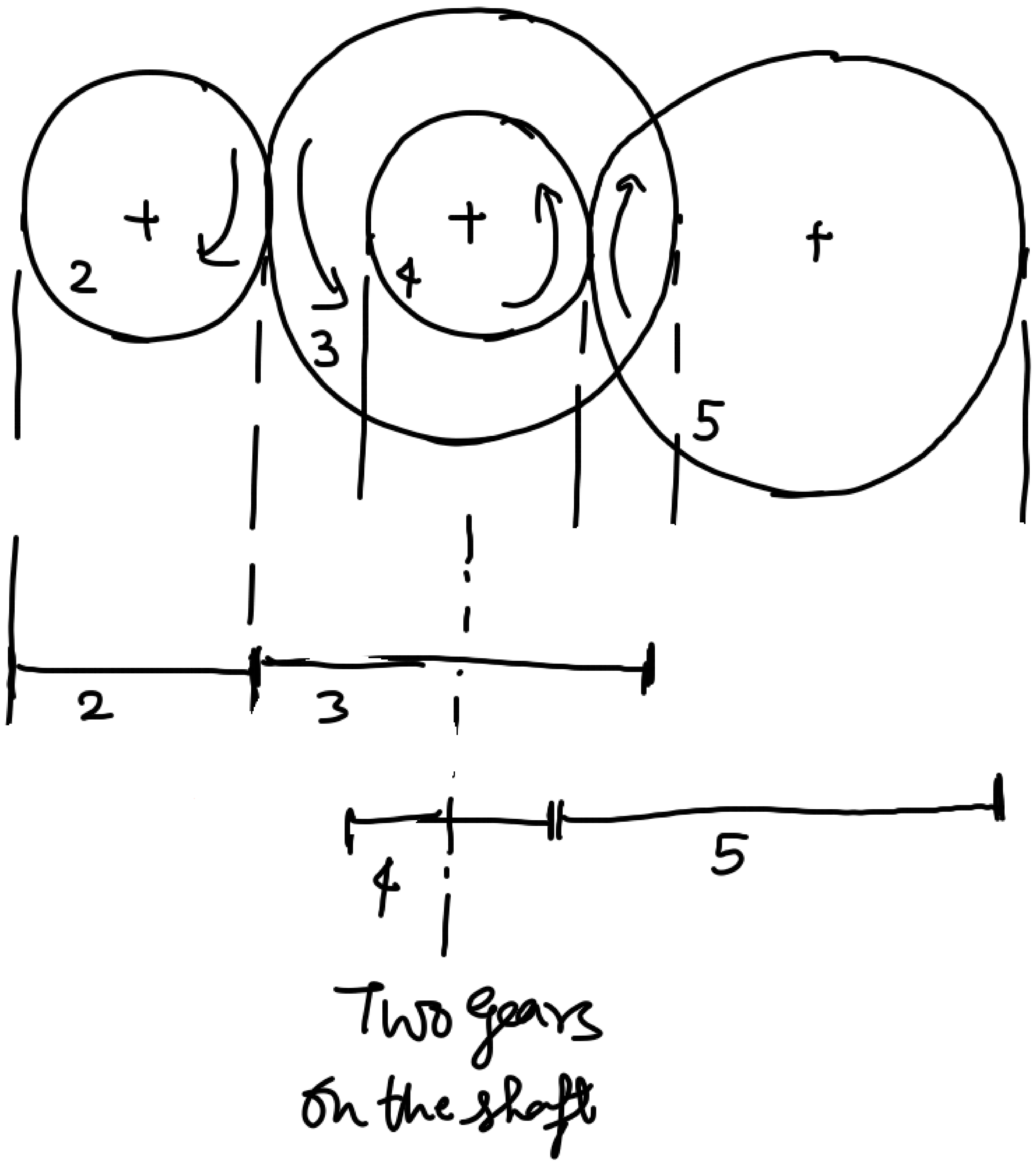


Speedratio (I^{st} order kinematic coefficient)

$$\frac{\omega_4}{\omega_2} = \left(\frac{\omega_4}{\omega_3}\right)\left(\frac{\omega_3}{\omega_2}\right) = \left(\frac{-N_3}{N_4}\right)\left(\frac{-N_2}{N_3}\right)$$

$$= \left(\frac{N_2}{N_4}\right)$$

Q4. Compound Gear train



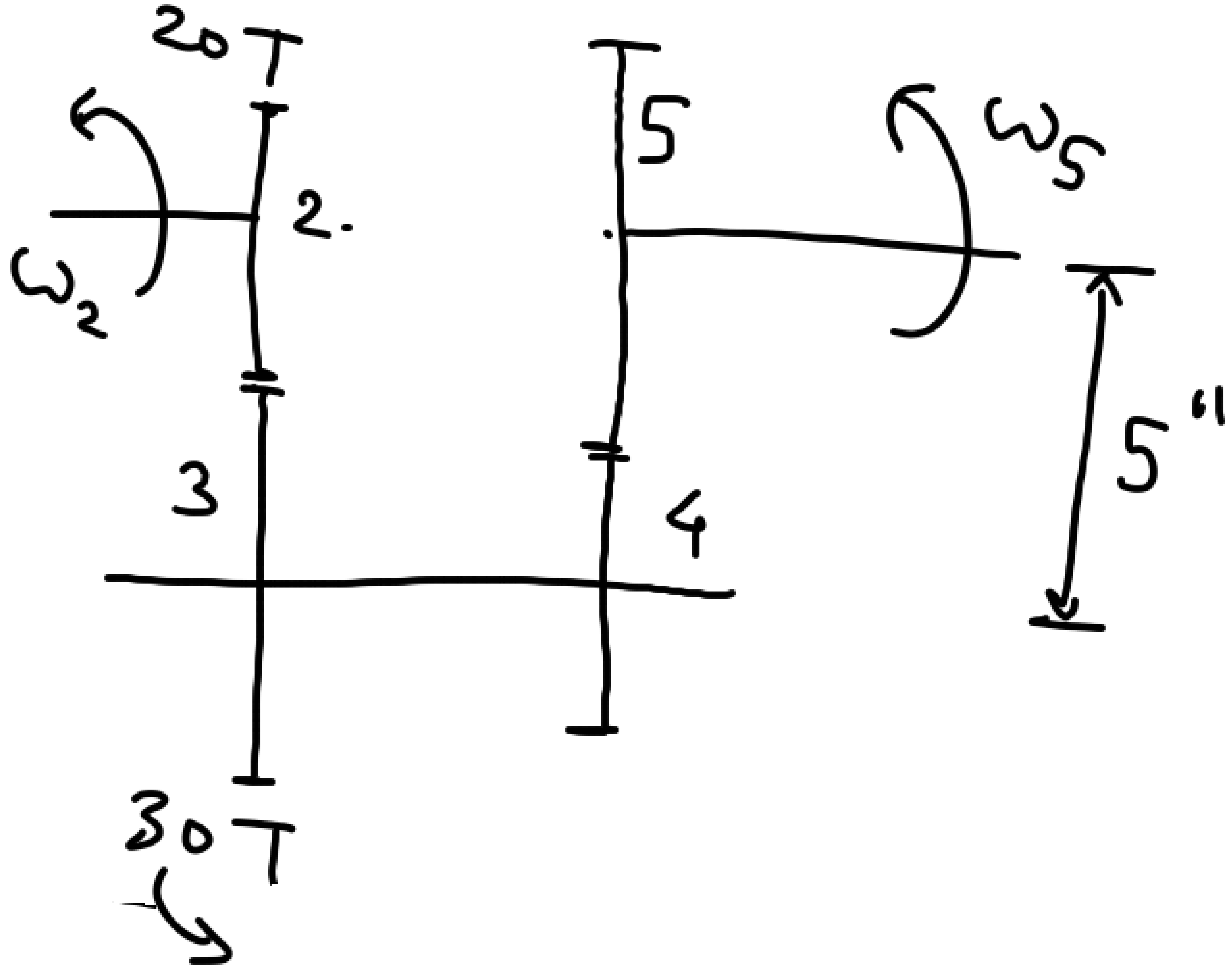
Speed ratio : $\frac{\omega_5}{\omega_2}$

$$\frac{\omega_5}{\omega_2} = \frac{\omega_5}{\omega_4}\,\frac{\omega_4}{\omega_3}\,\frac{\omega_3}{\omega_2}$$

$$= \left(\frac{-N_4}{N_5}\right)\left(1.0\right)\left(\frac{-N_2}{N_3}\right)$$

$$\boxed{\frac{\omega_5}{\omega_2} = \frac{N_2 N_4}{N_3 N_5}}$$

Q 5.



Module for gears 4 and 5

$$\omega_2 = 10\,\omega_5$$

or speed ratio $\frac{\omega_5}{\omega_2} = \frac{1}{10}$

No. of gear teeth ≥ 15

$$\frac{\omega_5}{\omega_2} = \left(\frac{\omega_5}{\omega_4}\right)\left(\frac{\omega_4}{\omega_3}\right)\left(\frac{\omega_3}{\omega_2}\right)$$

$$\frac{1}{10} = \left(\frac{\omega_5}{\omega_4}\right)(1.0)\left(-\frac{N_2}{N_3}\right)$$

$$\frac{\omega_5}{\omega_4} = -\frac{N_4}{N_5} = \underline{\qquad\qquad} \quad (1)$$

Geometric constraint:

$$r_2 + r_3 = 5 \rightarrow \frac{MN_2}{2} + \frac{MN_3}{2} = 5$$

$$r_4 + r_5 = 5 \Rightarrow \frac{mN_4}{2} + \frac{mN_5}{2} = 5$$

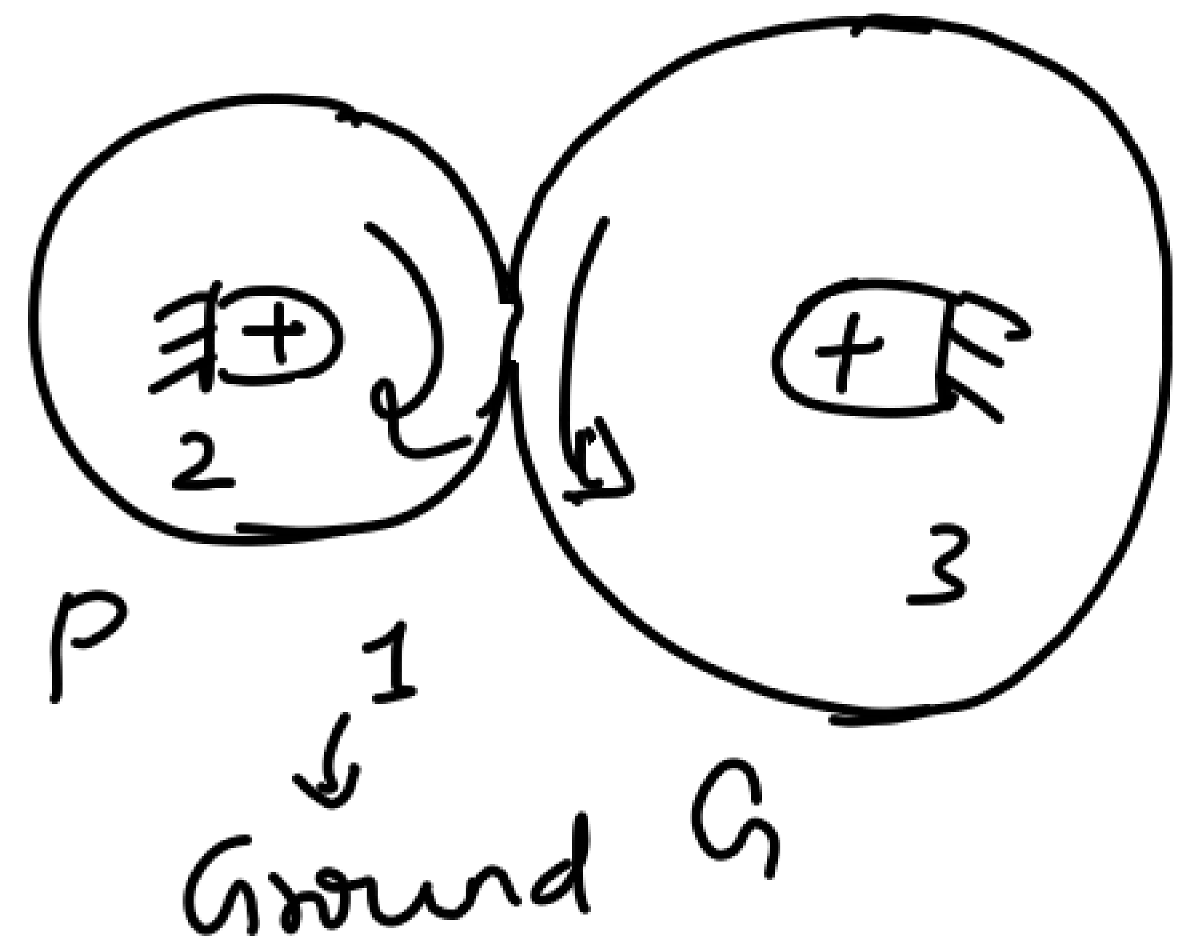
$$m(N_4 + N_5) = 10 \quad (2)$$

Based on the constraint, we take

$N_4 = 15$

we can compute N_5 and then compute module.

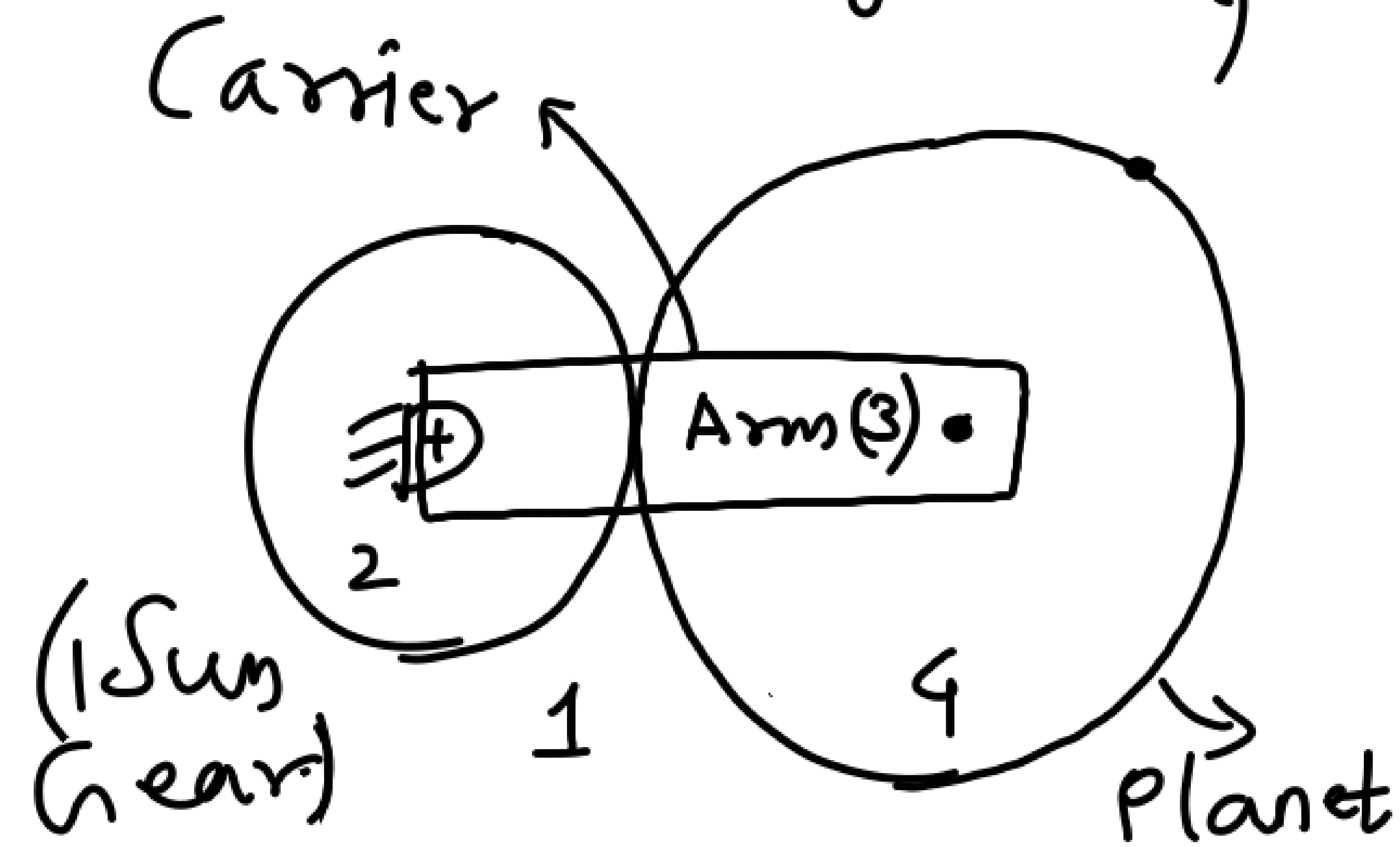
Epicyclic (Planetary) Gear train



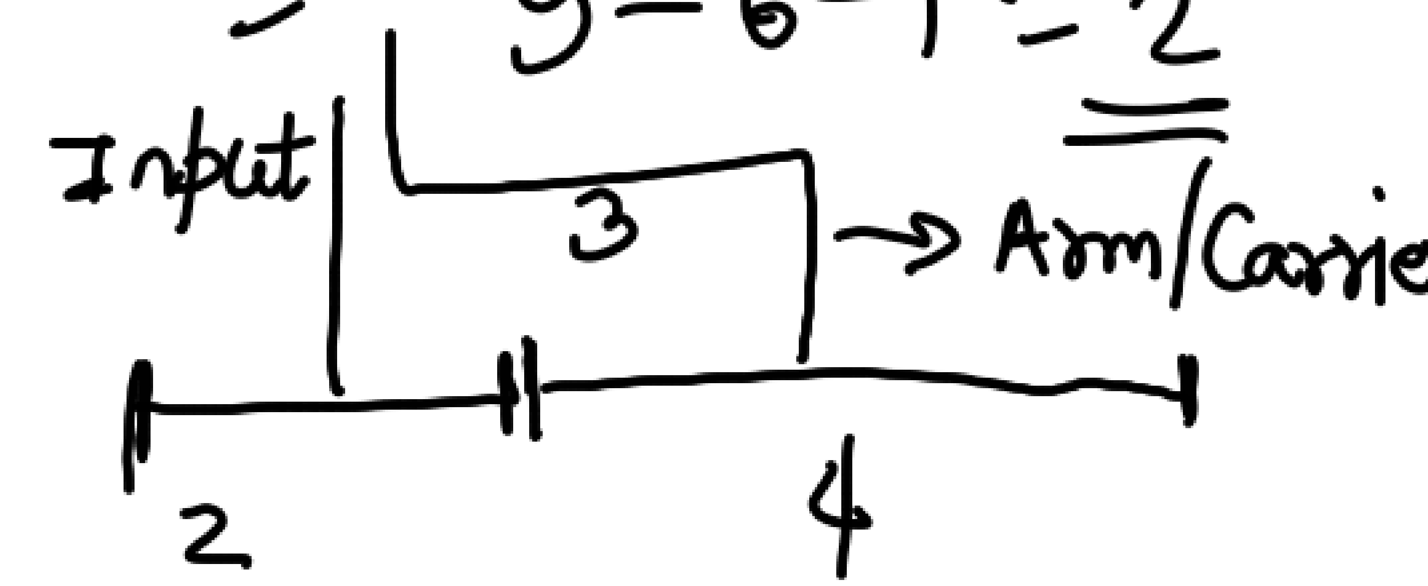
$$F = 3(n-1) - 2j - h$$
$$= 3(3-1) - 2\times 2 - 1$$
$$= 6 - 4 - 1$$
$$= 1$$

1 DOF system

Release gear 3 from ground,



$$F = 3(4-1) - 2\times 3 - 1$$
$$= 9 - 6 - 1 = \underline{\underline{2}}$$



Schematic representation