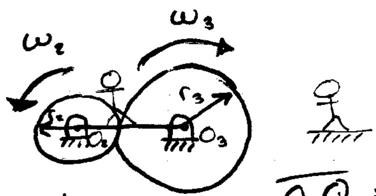
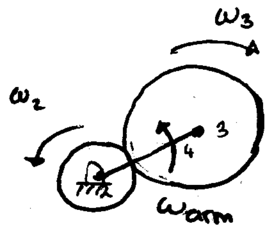


absolute

$\overline{O_2 O_3} = r_2 + r_3$

$\omega_{arm} = 0$

$\omega_3 / \omega_2 = -N_2 / N_3$



$$\frac{\omega_3 - \omega_{arm}}{\omega_2 - \omega_{arm}} = -N_2/N_3$$

relative velocity

Ring advantages:

1. High gear ratio
2. Compact
3. Simultaneous, concentric bidirectional outputs from a single unidirect input

Ex. 9-5

$N_2 = 40$

$N_3 = 20$

$N_4 = 80$

$n_{arm} = 200$ RPM (CW)

$n_2 = 100$ RPM (CW)

$n_4 = ?$

Solution:

$$\frac{n_3 - n_{arm}}{n_2 - n_{arm}} = \frac{-N_2}{N_3}$$

$$n_3 - n_{arm} = (-N_2/N_3)(n_2 - n_{arm})$$

$$n_3 = (1 + N_2/N_3)\, n_{arm} - (N_2/N_3)\, n_2$$
$$= (1 + 40/20)(-200) - (40/20)(-100)$$
$$= -400 \text{ RPM}$$

$$\frac{n_4 - n_{arm}}{n_3 - n_{arm}} = +\frac{N_3}{N_4} \quad \text{(Internal)}$$

$$n_4 - n_{arm} = (N_3/N_4)(n_3 - n_{arm})$$

$$n_4 = (1 - N_3/N_4)\, n_{arm} + (N_3/N_4)\, n_3 = -250 \text{ RPM}$$

$$\frac{n_4 - n_{arm}}{n_2 - n_{arm}} = \frac{-N_2}{N_3}\frac{N_3}{N_4}$$

$$\frac{\omega_6 - \omega_{arm}}{\omega_8 - \omega_{arm}} = \left(-\frac{N_3}{N_6}\right)\left(-\frac{N_8}{N_5}\right) = \frac{N_3 N_8}{N_6 N_5}$$

B_1 is engaged, $\omega_8 = 0$

$$\omega_6 - \omega_{arm} = N_3 N_8 / N_6 N_5 \, (-\omega_{arm})$$

$$\frac{\omega_6}{\omega_{arm}} = 1 - \frac{N_3 N_8}{N_6 N_5} = 1 - \left(27(30) / 27(24)\right) = 0.25 = 1/4$$

$$\frac{\omega_6 - \omega_{arm}}{\omega_7 - \omega_{arm}} = \left(\frac{-N_3}{N_6}\right)\left(\frac{-N_7}{N_4}\right) = \frac{N_3 N_7}{N_6 N_4}$$

B_2 is engaged, $\omega_7 = 0$

$$\omega_6 - \omega_{arm} = N_8 N_7 / N_6 N_4 \, (-\omega_{arm})$$

$$\frac{\omega_6}{\omega_{arm}} = 1 - \frac{N_3 N_7}{N_6 N_4} = 1 - \frac{27(21)}{27(33)} = 0.3686 = (1/2.75)$$

→ Can take photocopies of textbook

2.0 → 2.5, 2.7, 2.9, 2.11, 2.12 → 2.14, 2.18, 2.17

3.0 → 3.6, 3.8, 3.9

4.0 → 4.6, 4.8, 4.9 → 4.11

5.0 → 5.5, 5.7, 5.9, 5.6

7.0 → 7.3, 7.5, 7.6, 7.7

10.6 → 10.10

11.0 → 11.4, 11.8

13.0 → 13.8 × not included

9.0 → 9.9, 9.11 → 9.12 → defn of terms, velocity ratio, torque ratio, gear ratio

- Planetary with rel. vel.

Assignments:

- → A1 covers 2
- → A2 covers 3
- → A3 covers 5
- → A4 covers 6
- → A5 covers 7
- → A6 covers 10
- → A7 covers 11

- look at mock exam gear train problems (esp. 4.1 / 4.2)
- First reference is assignments

For Mock Exam:

(4.1)

$n_{arm} = -60$ RPM

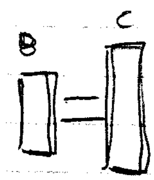
$n_A = 0$ (Fixed)

$n_D = ?$

Use relative velocity method:

(1) $$\frac{n_D - n_{arm}}{n_C - n_{arm}} = -\frac{N_C}{N_D} = -\frac{100}{35}$$

(2) $$\frac{n_C - n_{arm}}{n_A - n_{arm}} = -\frac{N_A}{N_B} = \frac{-108}{27}$$



$$\left(\frac{n_D - n_{arm}}{\cancel{n_C - n_{arm}}}\right)\left(\frac{\cancel{n_C - n_{arm}}}{n_A - n_{arm}}\right) = \left(\frac{-100}{35}\right)\left(\frac{-108}{27}\right) = 11.428$$

(*) $n_D = (11.428)(-n_{arm}) + n_{arm}$

$= (1 - 11.428)(n_{arm}) = (-10.428)(-60) = 625.7$ RPM

WORST EXAMPLE HE'S EVER DONE IN CLASS

(4.2)

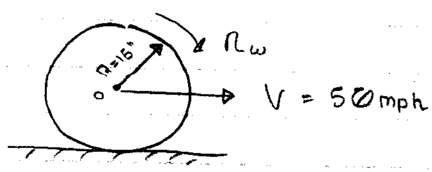
$n_A = 10$, $n_B = -20$

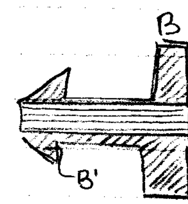
(a) $$n_D = n_{arm} = \frac{n_A + n_B}{2} = \frac{10 - 20}{2} = -5 \text{ RPM}$$

(b) $n_A = 10$, $n_B = 0$

$$n_D = \frac{10 + 0}{2} = 5 \text{ RPM}$$

(9-27)





$n_{engine} = 2000$ RPM

$m_G = 1:1$

a) n_{wheel}

$$\left(\text{mph} = \frac{5280 \text{ ft}}{60 \times 60}\right) = 1.4667 \text{ ft/s}$$

$$n_{wheel} = \frac{V}{R} = \frac{(50)(1.4667)(12)}{(15)}\left(\frac{60}{2\pi}\right)$$

$= 560.24$ RPM

$$m_G = \frac{n_{engin}}{n_{wheel}} = \frac{2000}{560.24} = 3.57$$

b) $$n_{arm} = \frac{n_{right} + n_{left}}{2} \longrightarrow n_{left} = n_{arm} - n_{right}$$

$= 2(560.24) - 800$

$= 320.48$ RPM

P1 $I_{13} \longrightarrow \omega_3, \omega_4, V_P$

$I_{15} \longrightarrow \omega_5, V_C$

$M_A = \frac{F_{out}}{F_{in}} = \frac{V_D}{V_C}$

} refer to assignment Q where we found M_A

P2 Fivebar velocity analysis (IC method)

P3 $\hat{A}_P = \hat{A}_C + \hat{A}_{AP}$

$= A_C^{n} + A_C^{t}$

P4 Dynamic analysis $\longrightarrow$ 3 bar