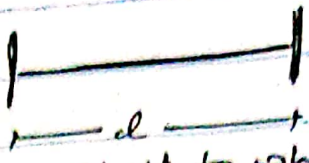
Question 1

$l = 15$ cm

$R = 3$ cm



(a) $V_{xb} = 5$ cm/s $\quad \Omega_z = .1$ rad/s

$$\dot{x} = \frac{R}{2}(V_r + V_l)\cos\phi$$
$$\dot{y} = \frac{R}{2}(V_r + V_l)\sin\phi$$
$$\dot{\phi} = \frac{R}{L}(V_r - V_l)$$

By Both

$$v = \frac{R}{2}(V_r + V_l)$$
$$\omega = \frac{R}{L}(V_r - V_l)$$

By Unicycle Model.

$$\begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\phi} \end{bmatrix} = \begin{bmatrix} \cos\theta & 0 \\ \sin\theta & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} v \\ \omega \end{bmatrix}$$

from eqns.

$$V_r + V_l = 10/3$$
$$V_r - V_l = .5$$

$\therefore V_r = 1.915$ rad/s

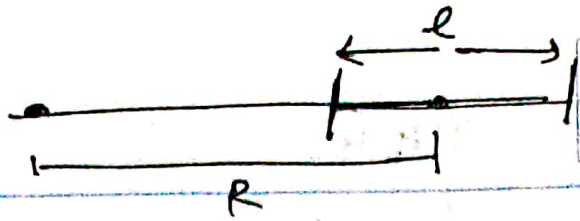
$V_L = 1.415$ rad/s

(b) Similar to part a. Substituting Values we get

$$V_r + V_L = -1.5$$
$$V_r - V_L = 1$$

$V_r = 0$ rad/s

$V_L = -1$ rad/s



Question 2

from the given data

$R = 50cm.$ ⟶ length of ICC

$$f = \frac{1}{70} \qquad \omega = 2\pi f = \frac{2\pi}{70} \text{ rad/sec}$$

Assuming that CCW Rotation.

① V_R

$$\begin{cases} V_R \times r = \omega \left(R + l/2\right) \\ V_L \times r = \omega \left(R - l/2\right) \end{cases}$$

$V_R = r\omega$ ②

$V_R = \omega_r$ or V_R = wheel's ω

⇒

$$V_R = \frac{.09}{3}(50 + 7.5)$$

$$V_L = \frac{.09}{3}(50 - 7.5)$$

So for counter clockwise Rotation

⇒ $V_R = 1.725$ rad/s

→ $V_L = 1.27$ rad/s.

V_R & V_L are wheel Rotation Speeds.

Question 3

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$N = 10$ No. of Tics per Revolution

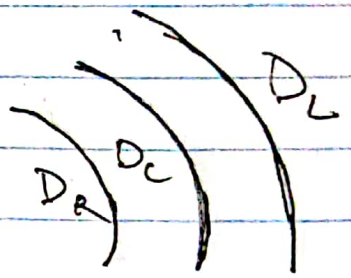
$r = .1\ m$ Wheel Radius

$l = .2\ m$ Axel length

$\Delta tick = tick' - tick$

$\Delta tick$ for Right Wheel $= 5$

$\Delta tick_L = 3$



$$D_{R/L} = 2\pi r \frac{\Delta tick}{N}$$

$$\Rightarrow D_R = 2\pi \times .1 \times \frac{5}{10} = .1\pi$$

$$\Rightarrow D_L = 2\pi \times .1 \times \frac{3}{10} = .06\pi$$

$$D_c = \frac{D_L + D_R}{2} = \frac{.16\pi}{2} = .08\pi$$

$$x' = x + D_c \sin\phi$$
$$y' = y + D_c \sin\phi$$
$$\phi' = \phi + \frac{D_R - D_L}{l}$$

$$\Rightarrow \begin{aligned} x' &= .251 \\ y' &= 0 \\ \phi' &= .63 \end{aligned}$$