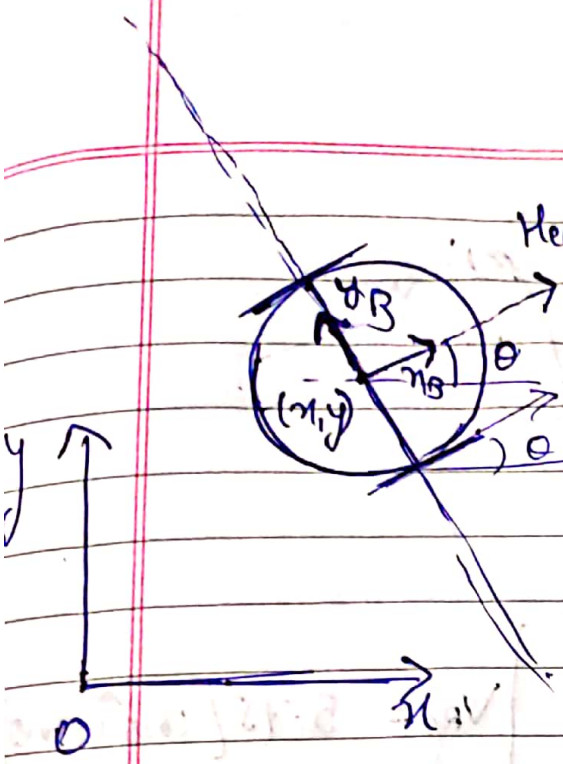


O → Fixed Frame (world)
B → Body fixed frame of robot

$$\bar{X} = \begin{bmatrix} x \\ y \\ \theta \end{bmatrix}$$

$L = 15\,cm$
$r = 3\,cm$

a) $V_{xb} = 5\,cm/s$
$\omega = 0.1\,rad/s$

V_L would be less than V_R

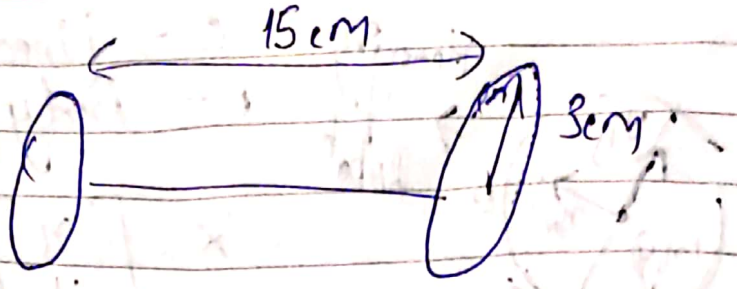
$$\omega = \frac{V_R - V_L}{L} = 0.1\,rad/s.$$

$= V_R - V_L = 1.5\,cm/s$

ICC will be along $(+v_B, y_B)$

$$V_R = V_{xB} + \frac{\omega l}{2}$$

$$V_L = V_{xB} - \frac{\omega l}{2}$$



$\vec{V}_{RB} = 5 + \frac{0.1 \times 7.5}{2}$

$= 5.75\ \hat{n}_B$

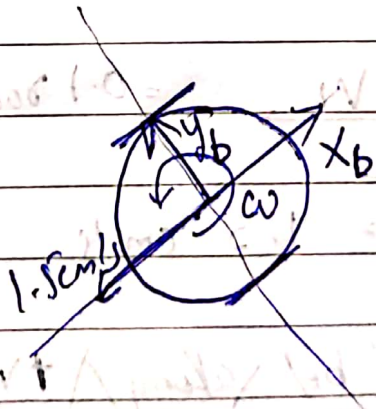
$\vec{V}_{LB} = 5 - 0.75$

$= 4.25\ \hat{n}_B$

$V_{RO} = 5.75[\cos\theta\hat{i} + \sin\theta\hat{j}$

$V_{LO} = 4.25[\cos\theta\hat{i} + \sin\theta\hat{j}$

b) $V_{xb} = -1.5$ cm/s, $\omega = 0.2$ rad/s



$|\vec{V}_L|$ must be greater than $|\vec{V}_R|$

~~$|\vec{V}_L| = |\vec{V}_{xB}| + \frac{\omega l}{2}$~~

$$V_L = V_{xB} + \frac{\omega l}{2}$$

$$= 1.5 + \frac{0.2 \times 0.75}{2}$$

$$= 1.5 + 0.15$$

$$V_{LB} = 1.65$$

$$\vec{V}_{LB} = -1.65\,\hat{n}_B$$

$$\vec{V}_{LO} = -1.65[\cos\theta\,\hat{i} + \sin\theta\,\hat{j}]$$

$$V_{RB} = V_{xB} - \frac{\omega l}{2}$$

$$= 1.5 - 0.15$$

$$= 1.35$$

$$\vec{V}_{RB} = -1.35\,\hat{n}_B$$

$$\vec{V}_{RO} = -1.35[\cos\theta\,\hat{i} + \sin\theta\,\hat{j}]$$

Q2

a) Circle of radius $(R) = 50\,cm$

70 s for $2\pi R$

1 s for $\frac{2\pi R}{70}$

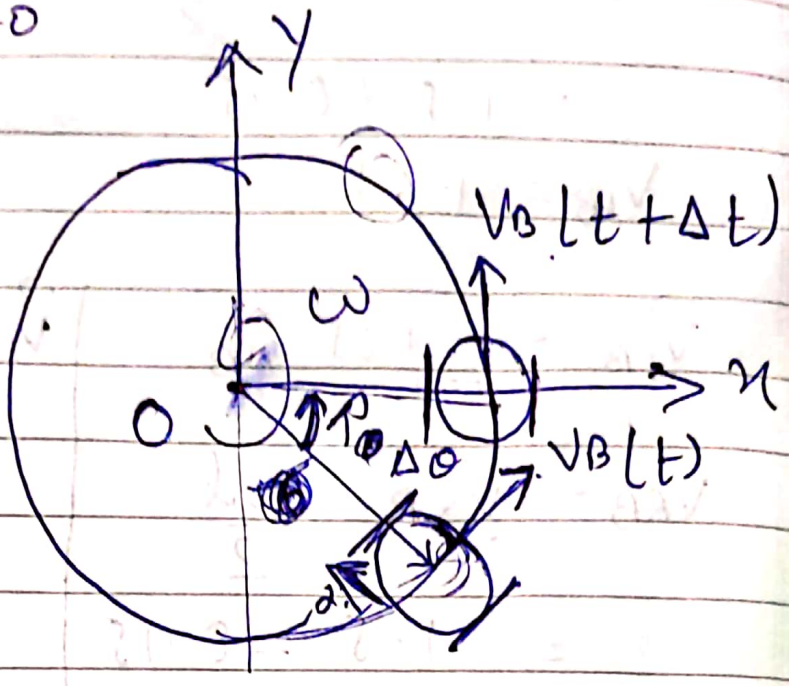
$T = 70\,s$

$f = \frac{1}{70}$

$$\omega = \frac{2\pi}{70}$$

To complete the given circle

$$\omega = \frac{2\pi}{70} \text{ rad/s}$$



$$V_B = \omega R$$

Since the velocity vector of the robot & the radius vector change at same rate i.e cover equal angles in equal times, their ang^ vel^ are same

$$V_R > V_L$$

In bot frame

$$V_R = V_B + \frac{\omega r}{2}$$

$$V_L = V_B - \frac{\omega r}{2}$$

$$\Rightarrow V_R = \omega\left(R + \frac{r}{2}\right)$$

$$= \frac{2\pi}{70}\left(50 + 1.5\right)$$

$$= \frac{(2\pi)(51.5)}{70}$$

$$= 4.62 \text{ cms}^{-1}$$

$$V_L = \omega\left(R - \frac{r}{2}\right)$$

$$= \frac{2\pi}{70}\left(48.5\right)$$

$$= 4.351 \text{ cm s}^{-1}$$

Transforming the ground frame (centered at origin)

Let Robot make an angle ϕ with +ve x axis.

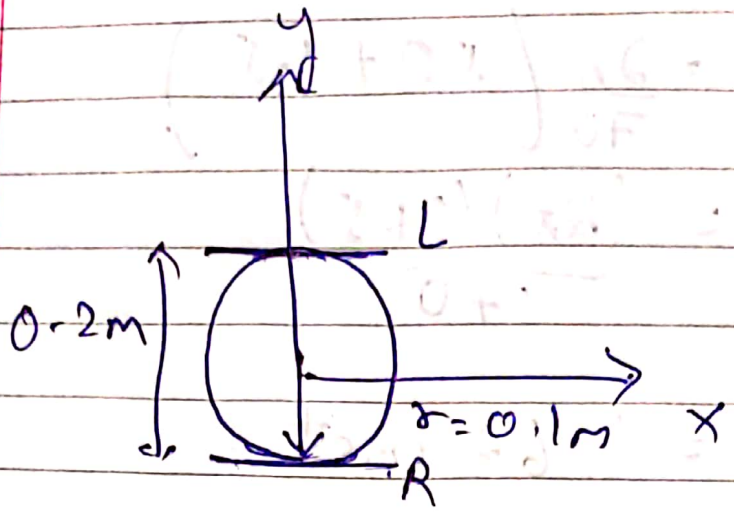
$$V_R = 4.62\left[\cos\phi\,\hat{i} + \sin\phi\,\hat{j}\right]$$

$$= 4.62\left[\cos(\omega t) + \sin(\omega t)\,\hat{j}\right]$$

$$= 4.62\left[\cos[(0.089)t]\hat{i} + \sin[(0.089)t]\hat{j}\right]$$

$V_L = 4.351 [\cos((0.089)t)\hat{i} + \sin((0.089)t)\hat{j}$

(3)



(a) No. of revolutions of Right wheel = $\frac{5}{10} = 0$

No. of revolutions of left wheel = 0.3

Distance covered by Right wheel (D_r) = $2\pi \times 0.1 \times$

$D_L = 2\pi \times 0.1 \times 0.3$

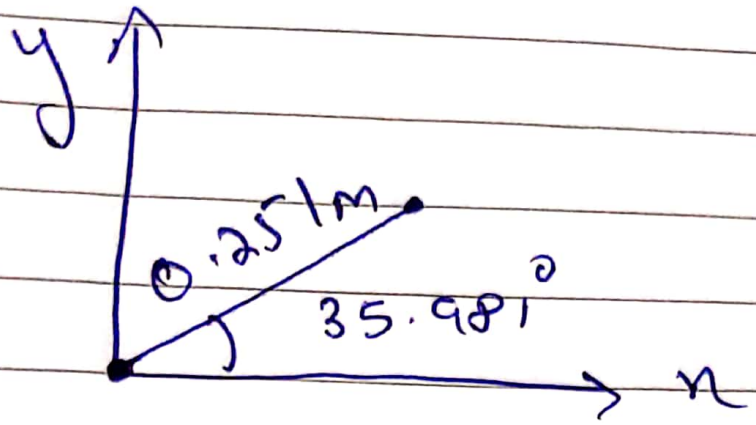
$D_r = 0.314\ m$

$D_L = 0.188\ m$

$\phi = \frac{D_r - D_L}{L} = 0.628\ rad$

$= 35.981^\circ$

$D_c = \frac{D_R + D_L}{2} = 0.251\ m$



After 0.5s robot is at
0.251m ∠ 35.981°.