

Q.1)  $l = 15\text{cm}$  - Wheel to wheel distance  
 $r_c = 3\text{cm}$  - Wheel radius

(a)  $V_{xb} = 5\text{cm/s}$

$\omega_z = 0.1\text{rad/s}$

$$V_{xb} = \frac{r_c}{2} (V_R + V_L)$$

$V_R$  - Velocity of Right wheel

$V_L$  - Velocity of Left wheel

$$\Rightarrow 5 = \frac{3}{2} (V_R + V_L) \quad (\text{in cm/sec})$$

$$\Rightarrow V_R + V_L = \frac{10}{3} \quad \text{---(1)}$$

$$\omega_z = \frac{r_c}{l} (V_R - V_L)$$

CCW is +ve

$$\Rightarrow 0.1 = \frac{3}{15} (V_R - V_L)$$

$$\Rightarrow V_R - V_L = 0.5 \quad \text{---(2)}$$

(1)+(2)

$$V_R = 1.415 \text{ rad/s}$$

(1)-(2)

$$V_L = 1.415 \text{ rad/s}$$

$$(b) V_{x_b} = -1.5 \text{ cm/s} \quad \omega_2 = 0.2 \text{ rad/s}$$

$$-1.5 = \frac{3}{2} (V_R + V_L)$$

$$0.2 = \frac{3}{15} (V_R - V_L)$$

$$\Rightarrow V_R + V_L = -1 \quad \text{---(1)}$$

$$\Rightarrow V_R - V_L = 1 \quad \text{---(2)}$$

(1)+(2)

$$V_R = 2.45 \text{ rad/s}$$

$$V_R = 0 \text{ rad/s}$$

(1)-(2)

$$V_L = -0.55 \text{ rad/s}$$

$$V_L = -1 \text{ rad/s}$$

Q.2

R = 50 cm - Radius of circle to be followed  
in CCW

t = 70 s Time to complete = 70 s

$$\therefore \omega = \frac{2\pi}{70} \approx 0.09 \text{ rad/s}$$

$$V_R \times r_c = \omega (R + l/2)$$

$$V_L \times r_c = \omega (R - l/2)$$

$$V_R = \frac{0.09}{3} (50 + 7.5)$$

$$V_L = \frac{0.09}{3} (50 - 7.5)$$

$$V_R = 1.725 \text{ rad/s}$$

$$V_L = 1.275 \text{ rad/s}$$

$$\boxed{\text{For CCW } V_R = 1.725 \text{ rad/s}}$$

$$V_L = 1.275 \text{ rad/s}$$

$$\boxed{\text{For CW } V_R = 1.275 \text{ rad/s}}$$

$$V_L = 1.725 \text{ rad/s}$$

8.3

 $N = 10 \text{ ticks/revolution}$  $r_c = 0.1 \text{ m} - \text{wheel radius}$  $\theta l = 0.2 \text{ m} - \text{wheel base length}$  $(x, y, \phi) = (0, 0, 0)$  Initial pose $t = 0.5s$  $\Delta \text{tick}_R = 5 - \text{Right wheel}$  $\Delta \text{tick}_L = 3 - \text{Left wheel}$ 

$$D_R = 2\pi r \frac{\Delta \text{tick}}{N}$$

$$D_R = 2\pi \times 0.1 \times \frac{5}{10} = 0.314 \text{ m} - \text{Distance travelled by Right wheel}$$

$$D_L = 2\pi \times 0.1 \times \frac{3}{10} = 0.188 \text{ m} - \text{Distance travelled by Left wheel}$$

$$D_c = \frac{D_L + D_R}{2} = \frac{0.314 + 0.188}{2} = 0.251 \text{ m} - \text{Distance travelled by centre}$$

 $\phi' (x', y', \phi') = \text{New pose}$ 

$$\phi' = \phi + \frac{D_R - D_L}{l}$$

$$x' = x + D_c \cos \phi$$

$$[x' = 0.251 \text{ m}]$$

$$\boxed{\phi' = 0.63 \text{ rad}}$$

$$y' = y + D_c \sin \phi$$

$$\begin{aligned} x' &= x + D_c \cos \phi \\ x' &\neq 0.2028 \text{ m} \\ u' &= y + D_c \sin \phi \end{aligned}$$

$$(x', y', \phi') = (0.251, 0, 0.63)$$