

$$V_x = \frac{1}{2}(V_L + V_R) = \frac{1}{2}(\dot{\phi}_L r + \dot{\phi}_R r) = (\dot{\phi}_L + \dot{\phi}_R) \frac{r}{2} \quad (1)$$

$$\frac{V_L}{x - \frac{b}{2}} = \frac{V_R}{x + \frac{b}{2}} = \omega \quad (2)$$

$$V_L \left(x + \frac{b}{2}\right) = V_R \left(x - \frac{b}{2}\right) \quad (3)$$

$$(V_L - V_R)x = -V_R \frac{b}{2} - V_L \frac{b}{2} \quad (4)$$

$$x = \frac{(V_R + V_L) \frac{b}{2}}{V_R - V_L} \quad (5)$$

$$\omega = \frac{V_R}{\frac{(V_R + V_L) \frac{b}{2}}{V_R - V_L} + \frac{b}{2}} = \frac{V_R}{\frac{(V_R + V_L)b + b(V_R - V_L)}{2(V_R - V_L)}} = \frac{2V_R(V_R - V_L)}{2bV_R} \quad (6)$$

$$\omega = \frac{V_R - V_L}{b} \quad (7)$$

$$\omega = \frac{r\dot{\phi}_R - r\dot{\phi}_L}{b} = \frac{r(\dot{\phi}_R - \dot{\phi}_L)}{b} \quad (8)$$

$$\frac{2V_x}{r} = \dot{\phi}_R + \dot{\phi}_L \quad (9)$$

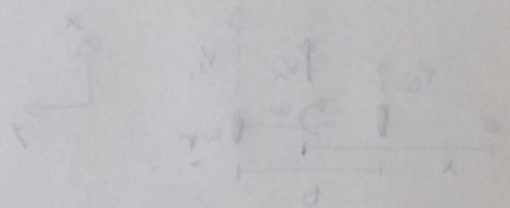
$$\frac{\omega b}{r} = \dot{\phi}_R - \dot{\phi}_L \quad (10)$$

$$\frac{2V_x + \omega b}{r} = 2\dot{\phi}_R \quad (11)$$

$$\dot{\phi}_R = \frac{2V_x + \omega b}{2r} \quad (12)$$

$$2\dot{\phi}_L = \frac{2Vx}{r} - \frac{\omega b}{r} \quad (13)$$

$$\dot{\phi}_L = \frac{2Vx - \omega b}{2r} \quad (14)$$



$$(2) \quad \frac{d}{dt} (mV + m\dot{\phi}) = (r\dot{\phi} + r\dot{\phi}) \frac{1}{r} = (r\dot{\phi} + r\dot{\phi}) \frac{1}{r} = \dot{\phi}$$

$$(3) \quad \omega = \frac{rV}{\frac{1}{2}bx} = \frac{V}{\frac{1}{2}x}$$

$$(4) \quad \left(\frac{b}{2} - x\right) rV = \left(\frac{b}{2} + x\right) rV$$

$$(5) \quad \frac{b}{2} rV - \frac{b}{2} rV = r(V - V)$$

$$(6) \quad \frac{d(V + rV)}{dt} = x$$

$$(7) \quad \frac{(V + rV) rV}{rV + rV} = \frac{\frac{V}{\frac{1}{2}x} + r\left(\frac{V}{\frac{1}{2}x}\right)}{V - V} = \omega$$

$$(8) \quad \frac{V - rV}{r} = \omega$$

$$(9) \quad \frac{(V - rV) r}{r} = \frac{rV - rV}{r} = \omega$$

$$(10) \quad \dot{\phi} + \dot{\phi} = \frac{rV}{r}$$

$$(11) \quad \dot{\phi} - \dot{\phi} = \frac{rV}{r}$$

$$(12) \quad \dot{\phi} = \frac{rV + rV}{r}$$

$$(13) \quad \frac{rV + rV}{r} = \dot{\phi}$$