Equation 4.33 ⇒

$$\dot{p} = \frac{M_{bx} - (I_{zz} - I_{yy})qr}{I_{xx}}$$

$$\dot{q} = \frac{M_{by} - (I_{xx} - I_{zz})rp}{I_{yy}}$$

$$\dot{r} = \frac{M_{bz} - (I_{yy} - I_{xx})pq}{I_{zz}}$$

$p = r_1$

$q = r_2$

$r = r_3$

$$\dot{p} = \dot{r}_1 = \frac{M_{bx} - (I_{zz} - I_{yy})r_2 r_3}{I_{xx}} \quad (*)$$

$$\dot{q} = \dot{r}_2 = \frac{M_{by} - (I_{xx} - I_{zz})r_1 r_3}{I_{yy}} \quad (*)$$

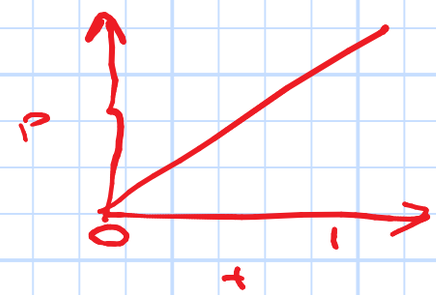
$$\dot{r} = \dot{r}_3 = \frac{M_{bz} - (I_{yy} - I_{xx})r_1 r_2}{I_{zz}} \quad (*)$$

```
# Defining Rotation Function
function dr = Rotation(t, r, Mbx, Mby, Mbz, Ixx, Iyy, Izz)
    dr = [ *
           *
           * ]
end

#rotation_eq_41 = @(t,r) Rotation(Mbx ... )
  rotation_IC = [ 0  0  0 ]

#[t,r] = ode45(rotation_eq_41, [0:0.001:10], rotation_initial_cond)
```

∴ As a result ⇒ when $M_x = 0$ other forces = 0



Equation 4.28 ⇒

$$\dot{u} = \frac{1}{m}F_{bx} - (qw - rv)$$

$$\dot{v} = \frac{1}{m}F_{by} - (ru - pw)$$

$$\dot{w} = \frac{1}{m}F_{bz} - (pv - qu)$$

$u = l_1$

$v = l_2$

$w = l_3$

$$\dot{u}_1 = \dot{l}_1 = \frac{1}{m}F_{bx} - (ql_3 - rl_2) \quad (*)$$

$$\dot{v}_1 = \dot{l}_2 = \frac{1}{m}F_{bz} - (rl_1 - pl_3) \quad (*)$$

$$\dot{w} = \dot{l}_3 = \frac{1}{m}F_{bz} - (pl_2 - ql_1) \quad (*)$$

```
# Defining Translation Function
function dl = Translation(t, l, Fbx, Fby, Fbz, p, q, r)
    dl = [ *
           *
           * ]
end

#translation_eq_29 = @(t,l) Translation(t, l, m, Fbx, Fby, Fbz, p, q, r)
```

Equation 4.41 ⇒

$\dot{\phi} = p + q(\sin\phi + r\cos\phi)\tan\theta$

$\dot{\theta} = q\cos\phi - r\sin\phi$

$\dot{\psi} = \dfrac{q\sin\phi + r\cos\phi}{\cos\theta}$

ask

$\phi = a_1$

$\theta = a_2$

$\psi = a_3$

?

What is the output unit?

$$\dot{a}_1 = p + (q(\sin(a_1) + r\cos(a_1))\tan(a_2)$$

$$\dot{a} = q\cos(a_1) - r\sin(a_1)$$

$$\dot{a}_3 = \frac{q\sin(a_1) + r\cos(a_1)}{\cos(a_2)}$$

Equation 4.38 ⇒

$$\# \dot{P}_{Ix} = r_{11} u + r_{12} v + r_{13} w$$

$$\# \dot{P}_{Iy} = r_{21} u + r_{22} v + r_{23} w$$

$$\# \dot{P}_{Iz} = r_{31} u + r_{32} v + r_{33} w$$

where

$$R = R_{B \to I} = \begin{bmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \end{bmatrix}$$