

$$\begin{aligned}
& (m + Z_{\bar{z}})\ddot{z} + Z_{\bar{z}}\dot{z} + Z_{\bar{\theta}}\ddot{\theta} + Z_{\bar{\theta}}\dot{\theta} + Z_z z + Z_{\theta}\theta + \frac{1}{2}Z_{zz}z^2 + \frac{1}{2}Z_{\phi\phi}\phi^2 + \frac{1}{2}Z_{\theta\theta}\theta^2 + Z_{z\theta}z\theta + \\
& \frac{1}{6}Z_{zzz}z^3 + \frac{1}{2}Z_{zz\theta}z^2\theta + \frac{1}{2}Z_{\phi\phi z}\phi^2z + \frac{1}{2}Z_{\phi\phi\theta}\phi^2\theta + \frac{1}{2}Z_{\theta\theta z}\theta^2z + \frac{1}{6}Z_{\theta\theta\theta}\theta^3 + \\
& Z_{\zeta z}(t)z + Z_{\zeta\theta}(t)\theta + Z_{\zeta\zeta z}(t)z + \\
& Z_{\zeta z}(t)z^2 + Z_{\zeta\zeta\theta}(t)\theta + Z_{\zeta z\theta}(t)z\theta + Z_{\phi\phi\zeta}(t)\phi^2 + Z_{\theta\theta\zeta}(t)\theta^2 + \\
& Z_{\tau z}\ddot{z} + Z_{\tau\theta}\ddot{\theta} + Z_{\dot{\phi}\tau}\dot{\phi}\dot{\tau} + Z_{\tau\dot{\phi}\phi}\dot{\phi}^2 + Z_{\tau\dot{\theta}\theta}\dot{\theta}^2 + Z_{\tau\phi\theta}\cos\phi\cos\theta + Z_{\ddot{\phi}\tau}\ddot{\phi}\tau + Z_{\tau\tau}\tau\ddot{\tau} + \\
& Z_{\dot{\phi}\dot{\phi}\tau\tau}\dot{\phi}^2\tau^2 + Z_{\dot{\theta}\dot{\theta}\tau\tau}\dot{\theta}^2\tau^2 = Z_w(t)
\end{aligned} \tag{2.105}$$

$$\begin{aligned}
& (J_{xx} + K_{\bar{\phi}})\ddot{\phi} + K_{\bar{\phi}}\dot{\phi} + K_{\phi|\phi}|\dot{\phi}| + K_{\phi}\phi + K_{z\phi}z\phi + K_{\phi\theta}\phi\theta + \\
& \frac{1}{2}K_{zz}\phi z^2 + \frac{1}{6}K_{\phi\phi\phi}\phi^3 + \frac{1}{2}K_{\theta\theta\phi}\theta^2\phi + K_{z\phi\theta}z\phi\theta + \\
& K_{\zeta\phi}(t)\phi + K_{\zeta\zeta\phi}(t)\phi + K_{\zeta z\phi}(t)z\phi + K_{\zeta\phi\theta}(t)\phi\theta + \\
& K_{\tau}\ddot{\tau} + K_{\tau\phi}\ddot{\phi} + K_{\bar{z}\tau}\ddot{z}\tau + K_{\bar{\theta}\tau}\ddot{\theta}\tau + K_{\tau z\phi}z\dot{\phi} + K_{\tau\phi\theta}\dot{\phi}\dot{\theta} + K_{\tau\phi\theta}\sin\phi\cos\theta + \\
& K_{\dot{\theta}\dot{\theta}\tau}\dot{\theta}^2\tau + K_{\ddot{\phi}\tau\tau}\ddot{\phi}\tau^2 + K_{\dot{\phi}\tau\tau}\dot{\phi}\tau\dot{\tau} + K_{\phi\theta\tau}\cos\phi\cos(\theta)\tau + \\
& K_{\phi\theta\tau\tau}\sin\phi\cos(\theta)\tau^2 + K_{z\dot{\phi}\tau\tau}z\dot{\phi}\tau^2 + K_{\dot{\phi}\dot{\theta}\tau\tau}\dot{\phi}\dot{\theta}\tau^2 = 0
\end{aligned} \tag{2.106}$$

$$\begin{aligned}
& (J_{yy} + M_{\bar{\theta}})\ddot{\theta} + M_{\bar{\theta}}\dot{\theta} + M_{\bar{z}}\ddot{z} + M_z\dot{z} + M_z z + M_{\theta}\theta + \frac{1}{2}M_{zz}z^2 + \frac{1}{2}M_{\phi\phi}\phi^2 + \frac{1}{2}M_{\theta\theta}\theta^2 + M_{z\theta}z\theta + \\
& \frac{1}{6}M_{zzz}z^3 + \frac{1}{2}M_{zz\theta}z^2\theta + \frac{1}{2}M_{\phi\phi z}\phi^2z + \frac{1}{2}M_{\phi\phi\theta}\phi^2\theta + \frac{1}{2}M_{\theta\theta z}\theta^2z + \frac{1}{6}M_{\theta\theta\theta}\theta^3 + \\
& M_{\zeta z}(t)z + M_{\zeta\theta}(t)\theta + M_{\zeta\zeta z}(t)z +
\end{aligned}$$

$$\begin{aligned}
& M_{\zeta z z}(t) z^2 + M_{\zeta \zeta \theta}(t) \theta + M_{\zeta z \theta}(t) z \theta + M_{\phi \phi \zeta}(t) \phi^2 + M_{\theta \theta \zeta}(t) \theta^2 + \\
& M_{\tau \ddot{z}} \ddot{z} + M_{\tau \ddot{\theta}} \ddot{\theta} + M_{\tau \theta} \text{sen} \theta + \\
& M_{\dot{\phi} \tau} \dot{\phi} \tau + M_{\dot{\phi} \dot{\tau}} \dot{\phi} \dot{\tau} + M_{\tau \dot{\phi} \dot{\phi}} \dot{\phi}^2 + M_{\tau \dot{z} \dot{\theta}} \dot{z} \dot{\theta} + M_{\tau \phi \theta} \cos \phi \cos \theta + M_{\tau \ddot{\tau}} \tau \ddot{\tau} + \\
& M_{\ddot{\theta} \tau \tau} \ddot{\theta} \tau \tau + M_{\dot{\theta} \tau \dot{\tau}} \dot{\theta} \tau \dot{\tau} + M_{\theta \tau \tau} \text{sen}(\theta) \tau^2 + M_{\dot{\phi} \dot{\theta} \tau} \dot{\phi} \dot{\theta} \tau + \\
& M_{\dot{\phi} \dot{\phi} \tau \tau} \dot{\phi}^2 \tau^2 + M_{\dot{\theta} \dot{z} \tau \tau} \dot{\theta} \dot{z} \tau^2 = M_w(t)
\end{aligned}$$

$$\begin{aligned}
& T_{\tau} \ddot{\tau} + T_{\dot{\tau}} \dot{\tau} + T_{\ddot{\phi}} \ddot{\phi} + T_{\ddot{z} \tau} \ddot{z} \tau + T_{\ddot{\theta} \tau} \ddot{\theta} \tau + T_{\phi \theta} \text{sen} \phi \cos \theta + T_{\dot{z} \dot{\phi}} \dot{z} \dot{\phi} + T_{\dot{\phi} \dot{\theta}} \dot{\phi} \dot{\theta} + \\
& T_{\dot{\phi} \dot{\phi} \tau} \dot{\phi}^2 \tau + T_{\dot{\theta} \dot{\theta} \tau} \dot{\theta}^2 \tau + T_{\phi \theta \tau} \cos \phi \cos(\theta) \tau = 0
\end{aligned}$$