

$$(\frac{l \sin(\theta)}{2} - l \cos(\beta)) \hat{\mathbf{F}}_{\mathbf{x}} + (-l \sin(\beta) - \frac{l \cos(\theta)}{2}) \hat{\mathbf{F}}_{\mathbf{y}} \tag{1}$$

$$(\frac{l \sin(\phi)}{2} + l \cos(\beta)) \hat{\mathbf{F}}_{\mathbf{x}} + (l \sin(\beta) - \frac{l \cos(\phi)}{2}) \hat{\mathbf{F}}_{\mathbf{y}} \tag{2}$$

$$(l \sin(\beta) \dot{\beta} + \frac{l \cos(\theta) \dot{\theta}}{2}) \hat{\mathbf{F}}_{\mathbf{x}} + (-\frac{l \sin(\theta) \dot{\theta}}{2} - l \cos(\beta) \dot{\beta}) \hat{\mathbf{F}}_{\mathbf{y}} \tag{3}$$

$$(-l \sin(\beta) \dot{\beta} + \frac{l \cos(\phi) \dot{\phi}}{2}) \hat{\mathbf{F}}_{\mathbf{x}} + (\frac{l \sin(\phi) \dot{\phi}}{2} + l \cos(\beta) \dot{\beta}) \hat{\mathbf{F}}_{\mathbf{y}} \tag{4}$$

$$(l \sin(\beta) \ddot{\beta} - \frac{l \sin(\theta) \ddot{\theta}}{2} + l \cos(\beta) \dot{\beta}^2 + \frac{l \cos(\theta) \ddot{\theta}}{2}) \hat{\mathbf{F}}_{\mathbf{x}} + (l \sin(\beta) \dot{\beta}^2 + \frac{l \sin(\theta) \ddot{\theta}}{2} - l \cos(\beta) \ddot{\beta} + \frac{l \cos(\theta) \dot{\theta}^2}{2}) \hat{\mathbf{F}}_{\mathbf{y}} \tag{5}$$

$$(-l \sin(\beta) \ddot{\beta} - \frac{l \sin(\phi) \ddot{\phi}}{2} - l \cos(\beta) \dot{\beta}^2 + \frac{l \cos(\phi) \ddot{\phi}}{2}) \hat{\mathbf{F}}_{\mathbf{x}} + (-l \sin(\beta) \dot{\beta}^2 + \frac{l \sin(\phi) \ddot{\phi}}{2} + l \cos(\beta) \ddot{\beta} + \frac{l \cos(\phi) \dot{\phi}^2}{2}) \hat{\mathbf{F}}_{\mathbf{y}} \tag{6}$$

$$-\frac{glm_1 \sin(\theta)}{2} \hat{\mathbf{F}}_{\mathbf{x}} \tag{7}$$

$$(\frac{l^2 m_1 \left(2 \sin(\beta - \theta) \ddot{\beta} + 2 \cos(\beta - \theta) \dot{\beta}^2 + \ddot{\theta}\right)}{4} + \frac{l^2 m_1 \ddot{\theta}}{12}) \hat{\mathbf{F}}_{\mathbf{x}} \tag{8}$$

$$-\frac{glm_2 \sin(\phi)}{2} \hat{\mathbf{F}}_{\mathbf{x}} \tag{9}$$

$$(\frac{l^2 m_2 \left(-2 \sin(\beta - \phi) \ddot{\beta} - 2 \cos(\beta - \phi) \dot{\beta}^2 + \ddot{\phi}\right)}{4} + \frac{l^2 m_2 \ddot{\phi}}{12}) \hat{\mathbf{F}}_{\mathbf{x}} \tag{10}$$

$$\frac{glm_1 \sin(\theta(t))}{2} = -\frac{l^2 m_1 \left(3 \sin(\beta(t) - \theta(t)) \frac{d^2}{dt^2} \beta(t) + 3 \cos(\beta(t) - \theta(t)) \left(\frac{d}{dt} \beta(t)\right)^2 + 2 \frac{d^2}{dt^2} \theta(t)\right)}{6} \tag{11}$$

$$\frac{glm_2 \sin(\phi(t))}{2} = -\frac{l^2 m_2 \left(-3 \sin(\beta(t) - \phi(t)) \frac{d^2}{dt^2} \beta(t) - 3 \cos(\beta(t) - \phi(t)) \left(\frac{d}{dt} \beta(t)\right)^2 + 2 \frac{d^2}{dt^2} \phi(t)\right)}{6} \tag{12}$$

$$gl \left(m_1 - m_2\right) \cos(\beta) \hat{\mathbf{F}}_{\mathbf{x}} \tag{13}$$

$$\frac{l^2 \left(m_1 \sin(\beta - \theta) \ddot{\theta} - m_1 \cos(\beta - \theta) \dot{\theta}^2 + 2 m_1 \ddot{\beta} - m_2 \sin(\beta - \phi) \ddot{\phi} + m_2 \cos(\beta - \phi) \dot{\phi}^2 + 2 m_2 \ddot{\beta}\right)}{2} \hat{\mathbf{F}}_{\mathbf{x}} \tag{14}$$

$$\frac{d^2}{dt^2} \beta(t) \tag{15}$$

$$\frac{d^2}{dt^2} \phi(t) \tag{16}$$

$$\frac{d^2}{dt^2} \theta(t) \tag{17}$$