# 1 Description Lab 1

## 1.1 Task 1

### 1.1.1 Subtask 1a

Insert $x_w = v_w = \frac{dv_w}{dt} = i_A = 0$ into equation 3 of the mathematical model.

$$\frac{dv_w}{dt} = 0 = \frac{1}{m_w + m_s(1-\cos(\phi)^2)}(m_s l\omega^2 \sin(\phi) - m_s g \sin(\phi)\cos(\phi)) \tag{1}$$

$$m_s l\omega^2 \sin(\phi) = m_s g \sin(\phi)\cos(\phi) \tag{2}$$

$$l\omega^2 = g\cos(\phi) \tag{3}$$

Than change the fourth equation of the mathematical model to get the form $\dot{\omega}(t) = p_1 f1(\phi(t), \omega(t), \dot{\omega}(t))$.

$$\frac{d\omega}{dt} = \frac{1}{l\left(1 - \frac{m_s}{m_w+m_s}\cos(\phi)^2\right)}\left(g\sin(\phi) - \frac{m_s}{m_w+m_s}\underbrace{l\omega^2}_{g\cos(\phi)}\sin(\phi)\cos(\phi)\right) \tag{4}$$

$$\frac{d\omega}{dt} = \frac{1}{l\left(1 - \frac{m_s}{m_w+m_s}\cos(\phi)^2\right)}\left(g\sin(\phi)\left(1 - \frac{m_s}{m_w+m_s}\cos(\phi)^2\right)\right) \tag{5}$$

$$\frac{d\omega}{dt} = \frac{g}{l}\sin(\phi) \tag{6}$$

### 1.1.2 Subtask 1b

### 1.1.3 Subtask 1c

### 1.1.4 Subtask 1d

## 1.2 Task 2

### 1.2.1 Subtask 1a

$$\begin{aligned}
\dot{\omega} - g\sin(\phi) &= \frac{1}{\left(1 - \frac{m_s}{m_w+m_s}\cos(\phi)^2\right)}\left(g\sin(\phi) - \frac{\cos(\phi)F}{m_w+m_s} - \frac{m_s}{m_w+m_s}l\omega^2\sin(\phi)\cos(\phi)\right) - g\sin(\phi) \\
&= \frac{1}{\left(1 - \frac{m_s}{m_w+m_s}\cos(\phi)^2\right)}\left(-\frac{\cos(\phi)F}{m_w+m_s} - \frac{m_s}{m_w+m_s}l\omega^2\sin(\phi)\cos(\phi) + \frac{m_s}{m_w+m_s}g\cos(\phi)^2\sin\right. \\
&= \frac{m_w+m_s}{m_s+m_w\sin(\phi)^2}\left(-\frac{\cos(\phi)F}{m_w+m_s} - \frac{m_s}{m_w+m_s}l\omega^2\sin(\phi)\cos(\phi) + \frac{m_s}{m_w+m_s}g\cos(\phi)^2\sin(\phi)\right) \\
&= \frac{1}{m_s+m_w\sin(\phi)^2}\left(-\cos(\phi)F - m_s l\omega^2\sin(\phi)\cos(\phi) + m_s g\cos(\phi)^2\sin(\phi)\right)
\end{aligned} \tag{7}$$

#### 1.2.2 Subtask 1b

#### 1.2.3 Subtask 1c

#### 1.2.4 Subtask 1d

#### 1.2.5 Subtask 1e

#### 1.2.6 Subtask 1f

### 1.3 Task 3