Homework 6, Problem 2

Practice Exercise 8.1 (h)

David Lim

A16398479

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```
clear
syms theta1 theta2 m1 m2 L1 I1 I2 'real'
```

Mass matrix:

```
M = [m1*L1^2+m2*theta2^2+I1+I2 0; 0 m2]
```

```
M =
```

$$\begin{pmatrix} m_1 L_1^2 + m_2 \theta_2^2 + I_1 + I_2 & 0 \\ 0 & m_2 \end{pmatrix}$$

Jacobian:

```
J = [-theta2*sin(theta1) cos(theta1); theta2*cos(theta1)
sin(theta1)]
```

```
J =
```

$$\begin{pmatrix} -\theta_2 \sin(\theta_1) & \cos(\theta_1) \\ \theta_2 \cos(\theta_1) & \sin(\theta_1) \end{pmatrix}$$

End-effector mass matrix:

```
Lambda = simplify(J'\M/J)
```

```
Lambda =
```

$$\begin{pmatrix} \frac{m_2\,{\theta_2}^2 + I_1\,\sin(\theta_1)^2 + I_2\,\sin(\theta_1)^2 + \sigma_2}{{\theta_2}^2} & \sigma_1 \\ \sigma_1 & \frac{I_1 + I_2 + {L_1}^2\,m_1 + m_2\,{\theta_2}^2 - I_1\,\sin(\theta_1)^2 - I_2\,\sin(\theta_1)^2 - \sigma_2}{{\theta_2}^2} \end{pmatrix}$$

where

$$\sigma_1 = -\frac{\sin(2\,\theta_1)\,\left(m_1\,{L_1}^2 + I_1 + I_2\right)}{2\,{\theta_2}^2}$$

$$\sigma_2 = {L_1}^2\,m_1\,\sin(\theta_1)^2$$

For $\theta_1 = 0$:

```
subs(Lambda,theta1,0)
```

```
ans =
```

$$\begin{pmatrix} m_2 & 0 \\ 0 & \frac{m_1\,{L_1}^2 + m_2\,{\theta_2}^2 + I_1 + I_2}{{\theta_2}^2} \end{pmatrix}$$