4) $V = PE + KE,$

$KE = \frac{1}{2} m V_1^2 + \frac{1}{2} m V_2^2$, $V_1 = \dot{\theta}(l-p)$, $V_2 = \dot{\theta}(L+p)$

$KE = \frac{1}{2} m \dot{\theta}^2 (l^2 + p^2)$

$PE = 2mgh = 2mg\,p(1-\cos\theta)$

$V = \frac{1}{2} m \dot{\theta}^2 (l^2+p^2) + 2mg\,p(1-\cos\theta)$

$V(\underline{0}) = 0$, first part of lyapunov

$$\nabla V = \begin{pmatrix} 2mpg\sin\theta \\ 2m\dot{\theta}(l^2+p^2) \end{pmatrix}, \quad \dot{V} = (\nabla V)^T \dot{x}$$

$$\dot{V} = \begin{array}{l} 2mpg\dot{\theta}\sin(\theta) \\ +2m\dot{\theta}\left[\frac{-Pg\sin\theta}{l^2+p^2} - \frac{B\dot{\theta}}{2m(l^2+p^2)}\right](l^2+p^2) \end{array} = \begin{array}{l} 2mpg\dot{\theta}\sin\theta \\ +2m\dot{\theta}\left[-\cancel{P}g\sin\theta - \frac{B\dot{\theta}}{2m}\right] \end{array}$$

$\dot{V} = 0$ for any $\dot{\theta} = 0$, so there are $\underline{x} \neq \underline{0}$ which $\dot{V}$ is not less than zero, so we cannot conclude global asymptotic stability.

5)
$$\underline{A} = \begin{bmatrix} \frac{\partial \dot{x}_1}{\partial x_1} & \frac{\partial \dot{x}_1}{\partial x_2} \\ \frac{\partial \dot{x}_2}{\partial x_1} & \frac{\partial \dot{x}_2}{\partial x_2} \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ \frac{-Pg\cos\theta}{l^2+p} & \frac{-B}{2m(l^2+p^2)} \end{bmatrix}$$

$$\underline{A} = \begin{bmatrix} 0 & 1 \\ \frac{-Pg}{l^2+p^2} & \frac{-B}{2m(l^2+p^2)} \end{bmatrix}$$