Lateral Dynamics

$$\dot{\phi} = P$$
$$\dot{P} = \frac{L}{I_x}$$

$$L = -K_\phi \phi - K_P P \rightarrow \dot{P} = \frac{-K_\phi \phi - K_P P}{I_x}$$

$$\begin{bmatrix} \dot{\phi} \\ \dot{P} \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -\frac{K_\phi}{I_x} & -\frac{K_P}{I_x} \end{bmatrix} \begin{bmatrix} \phi \\ P \end{bmatrix}$$

Eigenvalues: $|A - \lambda I|$: $\lambda^2 + \frac{K_P}{I_x}\lambda + \frac{K_\phi}{I_x} = 0$

$$\lambda_1 = -\frac{1}{\tau} = -\frac{1}{0.5} = -2$$
$$\lambda_2 = 10\lambda_1 = -20$$

$$(\lambda - \lambda_1)(\lambda - \lambda_2) = (\lambda + 2)(\lambda + 20) \rightarrow \lambda^2 + 22\lambda + 40$$

$$\frac{K_P}{I_x} = 22 \rightarrow K_P = 22(5.8e-5) = 0.001276$$

$$\frac{K_\phi}{I_x} = 40 \rightarrow K_\phi = 40(5.8e-5) = 0.00232$$

Longitudinal: same eigenvalues

$$K_q = 22 I_y \quad K_\theta = 40 I_y$$

$$K_q = 22(7.2e-5) = 0.001584$$

$$K_\theta = 40(7.2e-5) = 0.00288$$