1.

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & -k_2 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & -k_1 k_{pp} & -k_1 k_{pp} k_d \end{bmatrix} \cdot \begin{bmatrix} \lambda \\ r \\ p \\ \dot{p} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ k_1 k_{pp} \end{bmatrix} p_c$$

A_c B_c

MATLAB dlqr: $Q = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ $R = 1 \Rightarrow K = \begin{bmatrix} -0,6488 & -2,4757 & 1,3122 & 0,4625 \end{bmatrix}$

eigenvalues: $\lambda < 1$

$\Delta x = x - x^*$
$\Delta u = u - u^*$ $\Rightarrow$ x^* and u^* found in Lab 2

$u = -kx$

2.

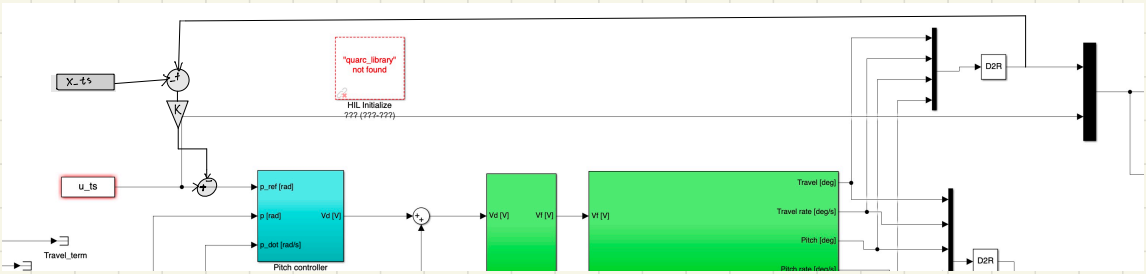
$\Delta x_{i+1} = A \Delta x_i + B \Delta u_i$

$B \Delta u_i = B \cdot (u - u^*)$

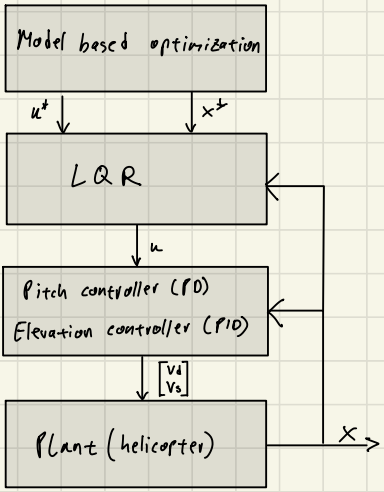
$u_k = u^* - K(x - x^*)$

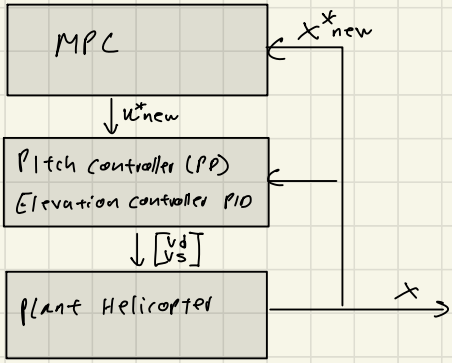
u^* ↓ LAB2 — x^* ↓ LAB2

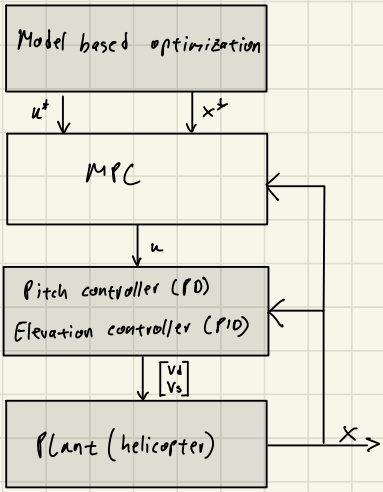
K → Processverdi



3.


Model based optimization
u^*
x^*
LQR
u
Pitch controller (PD)
Elevation controller (PID)
V_d
V_s
Plant (helicopter)
x


MPC
x^*_{new}
u^*_{new}
Pitch controller (PD)
Elevation controller PID
V_d
V_s
Plant Helicopter
x


Model based optimization
u^*
x^*
MPC
u
Pitch controller (PD)
Elevation controller (PID)
V_d
V_s
Plant (helicopter)
x