1 Optimal Control of Pitch/Travel with Feedback (LQ)

In this task we add feedback to the optimal controller that we developed in **??**

1.1 LQ controller

Briefly explain LQ controller. Especially, but not limited to, what is the role of the matrices Q and R? Justify your choice of weights.

An LQ, or linear-quadratic, regulator is an optimal feedback controller that can be applied to a linear model $\Delta x = A\Delta x_i + B\Delta u_i$ with a quadratic cost function:

$$J = \sum_{i=0}^{\infty} \Delta x_{i+1}^\top Q \Delta x_{i+1} + \Delta u_i^\top R \Delta u_i, \quad Q \geq 0, \quad R > 0 \tag{1}$$

Here $\Delta x = x - x^*$ and $\Delta u = u - u^*$ are deviations from the optimal trajectory.

The matrix Q and the scalar R are weights in the optimalization problem. The value of Q determines how much deviation in the state value should be penalized, while the value of R determines how much input-usage should be punished. This allows the designer to optimize the regulator to the specific implementation: A system where the input is cheap (like the helicopter used in this assignment) would have a relatively small value of R compared to Q.

1.2 Model Predictive Control

Answer 10.3.1.3 here.

1.3 Experimental results

Printouts of data from relevant experiments (plots). Discussion and analysis of the results. Answer 10.3.2.5 here.

1.4 MATLAB and Simulink

Code and diagrams go here