# Optimal Control - Explicit MPC with MATLAB (Exercise)

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## Introduction

We will use the Multi-Parametric Toolbox (MPT3) in MATLAB in the upcoming exercises.

To use MPT3, first you should run this script to install MPT3 on your computer.

## Exercise 1.1 (MPT)

Formulate the MPC problem given in 8.10a [1] and solve it explicitly using the MPT. The documentation of the toolbox and some code examples can be found here.

## Exercise 1.2

Simulate the closed-loop system with your MPC controller using the `loop=ClosedLoop` and `loop.simulate` functions. Does the controller behave as you expect? Try different initial states when simulating the system. Moreover, try changing the weights in the cost function and observe how the closed-loop performance is affected.

## Exercise 1.3

Try to increase the control horizon. Do you see any difference in the explicit solution? How is the closed-loop performance affected? Also, try to tighten or soften the constraints, how does this affect the explicit solution?

## Exercise 1.4

So far, we have tried to control the states to the origin. However, the third argument in `loop.simulate` can be used to modify the reference. Try to change this reference, how does the controller perform? Can the problem be modified to handle a non-zero reference better?

Here is an example of tracking problem in MPC by using multi-parametric toolbox.

## References

[1] Hansson A. and Andersen M. Optimization for learning and control. John Wiley & Sons, 2023.