Norwegian University of Science and Technology
Department of Engineering Cybernetics

Exercise 5
Hints

Problem 1 (60 %) Open-Loop Optimal Control

a The dynamic system is described in discrete time. This determines the condition on the eigenvalues of A for stability.

b The dimensions of x_t and u_t are important when formulating the matrices.

c

d We went through how to set up these matrices in class. Each row of the matrix equation $A_{\text{eq}} z = b_{\text{eq}}$ represents the state equation for one time instant t.

As noted in the assignment text, the functions `eye`, `kron`, `diag`, `ones`, and `blkdiag` are very useful when constructing large matrices in MATLAB. Read the Wikipedia on the Kronecker product if you are not familiar with the concept. A quick example is

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \otimes M = \begin{bmatrix} M & 0 & 0 \\ 0 & M & 0 \\ 0 & 0 & M \end{bmatrix} \tag{1}$$

where $\otimes$ denotes Kronecker product. You can also take a look at the MATLAB example posted online.

The KKT system should be solved in MATLAB using the backslash operator (\). It is possible to use the function `inv`, but this is not recommended.

e You can reuse most of the code from 4) when setting up the QP in MATLAB.

f Remember that there are no constraints on x_t here. Since you need to specify the bounds on z, this must be solved somehow.

Problem 2 (40 %) Model Predictive Control (MPC)

a

b If you have the structure right, the main challenge might be to index all your vectors correctly. Pay close attention to what happens in your code and debug carefully.

c