SSY281 - Model Predictive Control
Micro-Assignment MA09 - Stability

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Question 1 *Give the definition of local stability for a generic dynamical systems. What does it mean?*

The origin is locally stable for the system if, for any $\epsilon > 0$, there exists a $\delta > 0$ such that $|x(0)| <$ implies $|x(k)| < \epsilon$ for all k 0.

This statement means that for any starting point close to the origin, all the consecutive time steps will remain close to the origin.

Question 2 *What is the difference between local and global stability? Is the system $x+ = 0.3x + 5u$ locally or globally asymptotically stable?*

Global stability, in contrast to the definition of the last question, means that the system will converge to the origin when time step goes to infinity for any initial state, given a system without inputs.

The system is globally asymptotically stable because the system is linear and all the eigenvalues are strictly inside the unit circle (0.3).

Question 3 *Find a Lyapunov function for the system in the previous question.*

$$V(x^+) = \tag{1}$$

Question 4 *List the tuning parameter in a RH controller that closed-loop stability depends on.*

Another option is to make use of constraint management, such that the constraints are softened. In this way, there will be always a feasible solution, however the constraints might be slightly violated.

Question 5 The closed-loop stability of a RH controller is achieved by choosing the terminal set as a control invariant set and the terminal cost as the optimal cost-to-go of the corresponding unconstrained LQ controller. Can you provide an intuitive explanation of this?