

CHEM-E7190/2021: Exercise III - Stability, Controllability, Observability

1. The dynamic equations of the stirred tank system in state-space form (with some steady-state values, you can use your own values) are the following:

$$\dot{x}(t) = \begin{bmatrix} -0.5 & 0 \\ 0 & -1 \end{bmatrix} x(t) + \begin{bmatrix} 1 & 0 & 0 \\ -0.1 & 1 & 1 \end{bmatrix} u(t)$$
$$y(t) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} x(t) + \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} u(t)$$

Please answer for the following questions and explain your results.

- (a) Calculate the stability of the system
 - (b) Calculate the controllability gramian of the system.
 - (c) Calculate the controllability matrix and the controllability of the system.
 - (d) Calculate the observability gramian of the system.
 - (e) Calculate the observability matrix and the observability of the system.
2. Given $x(0) = 0$ and any \bar{x} , compute $u(t)$ such that $x(\bar{t}) = \bar{x}$ for some $\bar{t} > 0$