Assignment 2 – ELG4152/SYS5100

1. Consider the following state-space model:

$$\dot{\underline{x}} = \begin{pmatrix} 0 & 1 \\ 0 & -10 \end{pmatrix} \underline{x} + \begin{pmatrix} 0 \\ 1 \end{pmatrix} u$$
$$y = \begin{pmatrix} 1 & 0 \end{pmatrix} \underline{x}$$

a. Design a full-state feedback controller of the form $u = -K\underline{x} + r$ so that the closed-loop response of the output meets the specifications:

$$P.O \leq 25\%, T_s^{1\%} \leq 0.115s\,.$$

(**Hint**: A more general formula for the settling time of a second order system as a function of (ζ, ω_n) is $T_s^{\Delta} \approx -\dfrac{\ln(\Delta\sqrt{1-\zeta^2})}{\zeta\omega_n}$ where Δ refers to the specified acceptable band of the settling time which can be $1\%, 2\%, 5\%$ etc.)

Use the **step** command in MATLAB to verify that your design meets the specifications.

b. Design $\bar{N}$ such that the control law $u = -K\underline{x} + \bar{N}r$ has zero steady-state error for a unit step response.

c. Create a Simulink model of the closed-loop system.

d. Modify the simulated control signal such that it has both saturation limits $|u| \leq 100$ and rate limits $|\dfrac{du}{dt}| \leq 100{,}000$.

(**Hint**: In the Discontinuities section of the Simulink library, look for the **Rate Limiter** and **Saturation** blocks.)

What do these do to the closed-loop system?

Guidelines

Write an analytical report (max. 4 pages!!) in which you will present the results obtained with MATLAB, including graphics and the Simulink diagram. The assignment will be submitted in hardcopy by Wednesday, February 4th at the laboratory. Also, a softcopy with your MATLAB script and model (filename=yourname_elg4152A2.m/mdl) will be sent in the same day at the e-mail: vbors100@uOttawa.ca.