ELEN90055 Control Systems

Worksheet 4

Semester 2

Instructions

This worksheet covers *step response transients*. Solutions to starred problems will be provided after the practice class.

1*. A certain servo system has dynamics dominated by a pair of complex poles and no finite zeros. The time domain specifications are

Rise time:	$t_r \leq 0.6$ sec.
Overshoot:	$M_p \leq 17\%$
Settling time:	$t_s \leq 9.2$ sec.

(a) Sketch the region in the complex s-plane for which the poles could be placed such that all specifications are met.

(b) Indicate the specific locations that will have the smallest rise time, an overshoot of $M_p \leq 17\%$ and also meet the settling time specification exactly ($t_s = 9.2sec$).

2*. (Question 9, Control system final exam 2017):
Suppose you want to achieve an overshoot of no more than 10% and a rise time of at most 2 sec. Assume that there are no finite zeros in the transfer function. Sketch the region of the complex plane where all the dominant poles of the closed-loop transfer function should be located.

3*. (Question 9, Control system final exam 2016):
Suppose that you designed two controllers for a given plant and they both yield a stable closed-loop system. The first controller gives you rise time $t_r = 0.5sec$ and settling time $t_s = 10sec$. The second controller gives you the rise time $t_r = 1sec$ and settling time $t_s = 4sec$. Which controller gives you a faster response for the closed-loop system?

4. (Question 5, Control system final exam 2016):
Suppose that you have found that the characteristic polynomial of a closed-loop system takes the following form:

$$s^3 + (k_p + 3)s^2 + 4k_p s + 15$$

where $k_p > 0$ is a controller parameter that you can tune. Explain how you can use the Routh-Hurwitz criterion to check if the settling time (5% of the final value) is smaller than 2 sec (you do not need to complete all calculations - just explain the steps you would use).