

## Part 1 – McRuer

In the first part of PA1, you are now going to perform a set of tracking tasks.

### Overview of tracking tasks

Task	Display	System (controlled object)
A	Compensatory	First order integrator
B	Compensatory	Pure gain
C	Compensatory	Second order integrator
D	Compensatory	First order integrator high bandwidth forcing function
E	Compensatory	First order integrator low bandwidth forcing function
F	Compensatory with first order quickening	Second order integrator
G	Pursuit	Second order integrator
H	Compensatory	First order integrator with input time delay of 0.2s
I	Compensatory	First order integrator with gain (5/s)
J	Compensatory	Third order integrator

### Task instruction for experiment subjects:

The goal of each tracking task is to minimize the error between the vertical green line and the white square as best as you can.

### Questions

1. Fill in metrics for the group average *RMS Error* and corresponding *Std input* for each task in the table below. Also, for tasks A, B and C, please report the top score within your group: the best trial in terms of RMS error (and the corresponding *Std Input*).

In your presentation comment on:

- how *RMS Error* and *Std Input* are defined?
- what *Std Input* tells you about *how* you performed the task?
- the variability within each subject, and between subjects.

Task	<i>RMS Error</i>	<i>Std Input</i>
A		
B		
C		
D		
E		
F		
G		
H		
I		

2. After completing a task, the MMSlab2Plotter window shows you plots of your performance. Provide the bode plots containing transfer functions of *pilot*, *system*, and *Open Loop* of tasks A, B, and C. Note that you will have four bode plots available per subject; you can choose to show just one, or several, as long as you motivate your choice. Qualitatively describe the differences between the three bode plots using the McRuer Crossover model.

3. What are the approximate Crossover frequencies and phase margins for tasks A, B, and C?

4. Describe how the Crossover frequency relates to *RMS Error*.
5. What are the approximate effective time delays for tasks A, B, and C, assuming that the McRuer Crossover model holds? Explain why differences between the time delays occurred?
6. How does task D differ from task A? How does this affect the crossover frequency and effective time delay? Explain.
7. How does task E differ from task A? How does this affect the crossover frequency and effective time delay? Explain.
8. Is your *RMS Error* lower for task F as compared to task C? Is this what you would expect? Explain how the quickening display works and how it affects your performance.
9. Is your *RMS Error* lower for task G as compared to task C? Is this what you would expect? Why (not)?
10. Explain how the time delay of task H affects your performance as compared to task A (e.g., using the bode plots).
11. Compare the system transfer function (see *System* tab) and the results (e.g., *RMS Error*, *bode plots*) of tasks I and A. What does this tell you about the adaptive nature of the human controller?
12. Load task J. Is it possible to obtain a stable tracking performance? Why (not)?
13. Engage the quickening display for Task J. Is it now possible to obtain a stable tracking performance? Why (not)?