ENG 4550 – Introduction to Control Systems
Lab 5




Lab 5: SRV02 Position Control –Ramp Response with No Steady-State Error

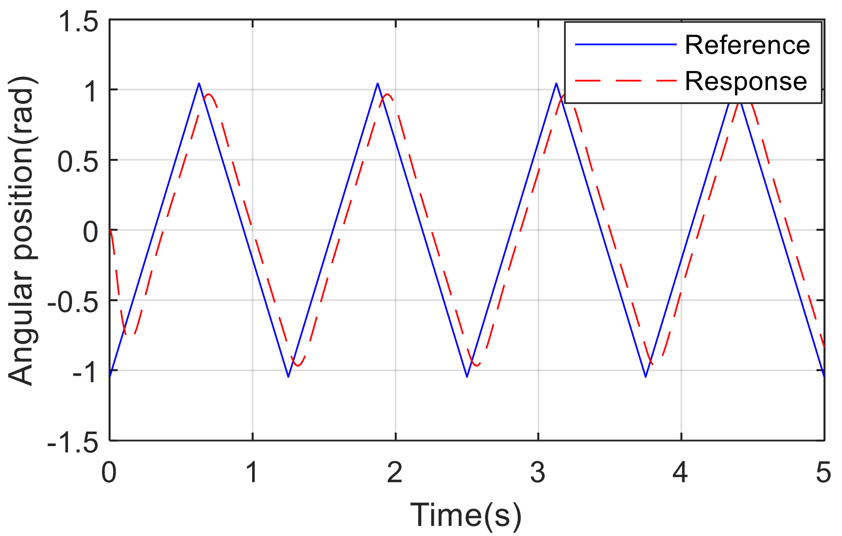
What we have done in Lab 4

Ramp Response Using PV Controller

1. Simulation
2. Experimental test

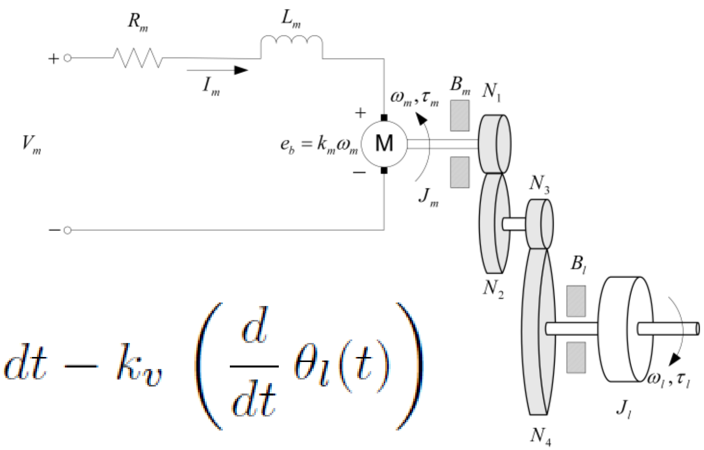
$$V_m(t) = k_p\ (\theta_d(t) - \theta_l(t)) - k_v\ \left(\frac{d}{dt}\,\theta_l(t)\right)$$

Steady-state error



1. **x label, y label (Variable name & unit)**
2. **Legend**
3. **Different colors and line style (solid, dashed, or dotted)**

Lab 5



$$P(s) = \frac{K}{s\left(\tau s + 1\right)}$$

$$V_m(t) = k_p\left(\theta_d(d) - \theta_l(t)\right) + k_i \int \left(\theta_d(t) - \theta_l(t)\right) dt - k_v \left(\frac{d}{dt}\theta_l(t)\right)$$

Try to eliminate the steady-state error when tracking a ramp input. (PIV)

1. Simulation
2. Experimental test

Submission of next lab

1. Lab report (Lab 5)

- Finish your lab report according to the template in Section 2.5.3 and tips in Section 2.5.4.

II. RESULTS

Do not interpret or analyze the data in this section. Just provide the results.

1. Response plot from step 5 in Section 2.3.3, *Simulated controller with ramp input*
2. Response plot from step 5 in Section 2.3.3, *Implemented controller with ramp input*
3. Provide applicable data collected in this laboratory (from Table 2.1).

Submission of next lab

	Section / Question	Description	Symbol	Value	Unit
√	Question 4	**Pre-Lab: Model Parameters** Open-Loop Steady-State Gain Open-Loop Time Constant	 K τ		
√	Question 4	**Pre-Lab: PV Gain Design** Proportional gain Velocity gain	 k_p k_v		
	Question 5	**Pre-Lab: Control Gain Limits** Maximum proportional gain	 $k_{p,max}$		
	Question 6	**Pre-Lab: Ramp Steady-State Error** Steady-state error using PV	 e_{ss}		
√	Question 7	**Pre-Lab: Integral Gain Design** Integral gain	 k_i		
	2.3.1.1	**Step Response Simulation** Peak time Percent overshoot Steady-state error	 t_p PO e_{ss}		
	2.3.1.1	**Filtered Step Response Using PV** Peak time Percent overshoot Steady-state error	 t_p PO e_{ss}		
	2.3.1.2	**Step Response Implementation** Peak time Percent overshoot Steady-state error	 t_p PO e_{ss}		
	2.3.2.1	**Ramp Response Simulation with PV** Steady-state error	 e_{ss}		
	2.3.2.2	**Ramp Response Implementation with PV** Steady-state error	 e_{ss}		
√	2.3.3	**Ramp Response Simulation with with no steady-state error** Steady-state error	 e_{ss}		
√	2.3.3	**Ramp Response Implementation with with no steady-state error** Steady-state error	 e_{ss}		

Submission of next lab

1. Pre-lab Questions in Section 3.2

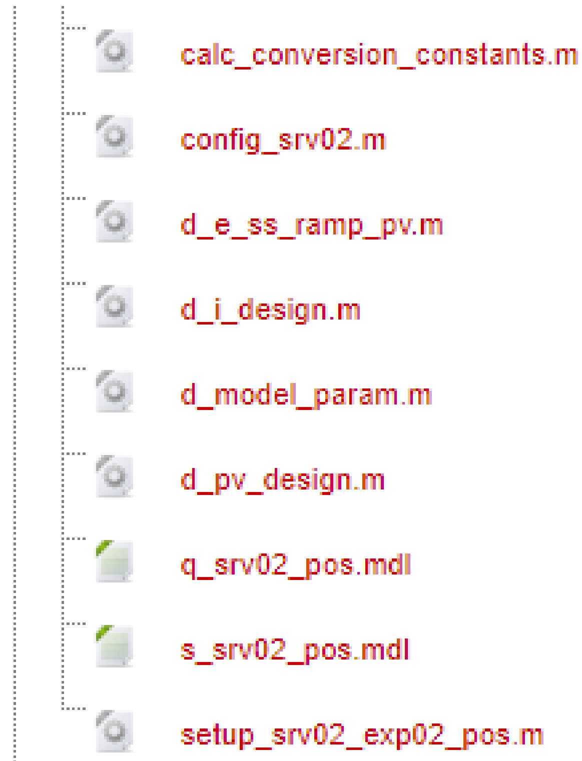
- Questions 1 – 5.

Typos:

All terms $\frac{PO}{100}$ in Section 3.1 should be *PO*.

Lab 5

- In ‘ENG4550 control systems’ on desktop, unzip ‘Lab MatlabSimulin Software-20181001.zip’ to a NEW DIRCTORY. All files you need in Lab 5 are in …/NEW DIRCTORY/Position Control (Labs 3-5)
- When complete, DELETE/REMOVE your files and the FOLDER you created.



Lab 5: steps in Section 2.3.3

1. How can the PV controller be modified to eliminate the steady-state error in the ramp response? State your hypothesis and describe the anticipated cause-and-effect leading to the expected result. **Hint:** Look through Section 2.

2. List the independent and dependent variables of your proposed controller. Explain their relationship.

3. Your proposed control, like the PV compensator, are model-based controllers. This means that the control gains generated are based on mathematical representation of the system. Given this, list the assumptions you are making in this control design. State the reasons for your assumptions.

4. Give a brief, general overview of the steps involved in your experimental procedure for two cases: (1) Simulation, and (2) Implementation.