EE 301P: Control Systems Laboratory
Lab Exercise 10

Lab session: November 17, 2023   *Report due*: November 24, 2023

1 Objective

To design a compensator that ensures given performance characteristics of the ARM II electromechanical shoulder joint.

2 Pre-lab exercise

This lab will build on the previous lab exercise. Make sure to complete Lab Exercise 7.

1. Compute the steady-state error of the closed-loop system (with PD control) designed in Lab Exercise 7.

3 Lab Exercise

The ARM II system with the proportional derivative controller simulated in the previous class, does not have a high peak overshoot but has a steady-state error. Which implies that it has satisfactory transient performance characteristics, but requires an improvement in the steady-state characteristics. This may not be desired in practical systems. The following steps could improve the steady-state performance while maintaining a satisfactory transient performance.

a) Design a suitable compensator that can reduce the steady-state error to half the current value. For designing the compensator, you must choose one of the following combination of available components.

	Inductance L(H)	Resistance R (Ω)	Polar inertia J (lb-in-s^2)	Damping coeff. C (lb-in/deg/s)
Option 1	5	10	5	20
Option 2	10	0.5	10	1
Option 3	0.05	2	0.05	1
Option 4	2	0.2	2	0.1

Verify your design using MATLAB/Simulink.

b) What would change in the above design if the steady-state error is to be reduced further? Change the design accordingly and verify using MATLAB/Simulink.

c) Examine the possibility of implementing the revamped design derived in (b) with the components listed in the above table. List any additional components you may need.

4   Deliverables

1. Lab report, necessarily containing

   (a) All calculations required for compensator design.

   (b) Plots required to verify the predicted behaviour.

   (c) Your inferences.

2. MATLAB Code/ Simulink model.

References

[1] J.J Craig, Introduction to robotics: mechanics and control, Prentice Hall, 2005.