ME46085 Mechatronic System Design - 2022/2023 Q2
Assignment – Industrial Motion System (Part 2)

In the second part of the assignment, you will identify an industrial motion system using experimental data. The model considered in this part is the more complicated version of the Wirebonder X-Stage, introduced in Part 1 of the assignment. The position of the x-stage is measured using encoders. The x-stage should follow a reference trajectory.

To identify dynamics, the response of the system was measured in a closed loop. Figure 1 presents a block diagram of the control system. A disturbance signal f are used and signals u, x, e were measured. The obtained measurements are included in the file **ClosedLoopSignals.mat**. The data file contains signals in the order of [*f, u, x, e*]. A zero reference was used to measure the provided data. The sampling frequency used is given as 8000 Hz.

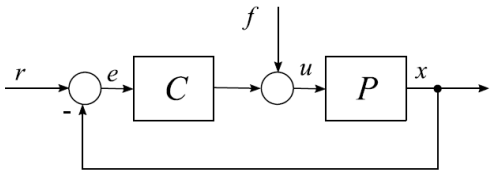

Figure 1: Block Diagram of the system

Provided below are the questions to be answered using the provided data. It is highly recommended to proceed in a sequential manner, as the information obtained will help you to answer the following questions (Q).

1. Explain why the closed-loop identification procedure was used in this case.
2. Plot the provided signals in the time domain. What can be interpreted from the characteristics of input disturbance signal f and position output x?
3. Calculate and present the closed-loop frequency responses from input disturbance f to u, and x, respectively. Explain what these frequency response functions represent in the closed-loop system.
4. Calculate and present the frequency response of the plant. Explain analytically the procedure used to obtain the plant model using the results from Q3. Further comment and give reasons for the possible differences from the mathematical plant obtained in Assignment Part 1.

   (Hint: Which sensitivity functions ("*gang of six*") were measured in question 3? How are they related to C and P? Manipulate them to get P.)
5. Compute the transfer function from u to x, to directly estimate the plant model and compare your results with results obtained in Q4. Comment if there are observed differences.
6. Calculate and present the frequency responses of the controller (C) used in the experiments.
7. Recreate the controller in MATLAB based on the controller estimated in Q6. Present the used transfer functions and controller parameters. Compare the frequency response of the recreated controllers with the experimental results of Q6.
8. Recreate all the closed-loop transfer functions considered in this assignment using the recreated controller and estimated model of the plant. Compare the recreated and measured closed-loop transfer functions. Comment on the differences.

   (Note: Measured functions are using estimated plant (Q4) and estimated controller (Q6) using provided measurements. Recreated functions are using estimated plant (Q4) and recreated controller (Q7).)
9. Present the closed-loop response to a step reference input (r). For this case, don't include the disturbance signal (f) in the closed loop. Use the recreated feedback controller (Q7) and estimated plant (Q4).