Lab 5 (Modeling Stiffness – Flexible Joint):

Pre-Lab: Read section 2 of the Flexible Joint Workbook and answer the questions in section 2.2 before coming to the lab.

Lab Experiment:

1. Connect the Flexible Joint to the SRV02 as shown in the Rotflex User Manual located in C:\User\Student\Matlab\ROTFLEX\References
2. Connect the SRV02, VoltPaq, and Q2_USB data acquisition board with the following changes. You can use the wiring section of the Flexible Joint User Manual as a guide.
    a. Do not connect the Tach terminal to the S1&S2 terminal on the SRV02 or the other S1&S2 terminal to the S1&S2 terminal on the amplifier.
    b. The 5-pin-DIN to 4xRCA does not need to be connected.
    c. Connect the encoder terminal on the Flexible joint to the encoder channel #1 on the data acquisition board.
3. Open q_rotflex_id.mdl and run the experimental setup detailed in section 4.2 of the Flexible Joint Workbook.
    a. In addition, double-click on the HIL Read Timebase block and change the clock to 0 instead of 1.
    b. Run setup_rotflex.m with CONTROL_TYPE set to STUDENT. If prompted to enter in the stiffness Ks, enter 0 or hit Ctrl+C to stop running the script. The necessary parameters will have been loaded.
4. Read and implement the Finding Stiffness experiment in section 2.3.1 of the workbook.
    a. The values for the Flexible Joint parameters can be found in the table below.
    b. The value for d_{12} will be 21cm, corresponding to the Arm Anchor Point 1 position.
5. Open q_rotflex_val.mdl and run the experimental setup in section 4.3.
    a. The HIL Initialize Block will need to be set to q2_usb and the Timebase block will need to be changed to 0.
6. Read and implement the Model Validation experiment in section 2.3.2 of the workbook.
7. Have the Control system matrices and poles saved or written down. The open-loop poles will be needed for the next pre-lab.
8. Questions posed in the lab are to be answered in the lab report. These answers will be required for questions in the next pre-lab.

Post-Lab: Write a lab report detailing the procedure and results of the experiments run. Guidelines for writing the lab report can be found in section 5 of the Flexible Joint Workbook.

3 SYSTEM SPECIFICATIONS

Table 3.1, below, lists and characterizes the main parameters associated with the ROTFLEX module. Some of the parameters listed in Table 3.1 are used in the mathematical model.

Symbol	Description	Value	Unit
	Module Dimensions	10 x 8 x 5	cm^3
L_1	Main arm length	29.8	cm
L_2	Load arm length	15.6	cm
	Distance between joint to middle of load arm		
d_{12}	Arm Anchor Point 1	21.0	cm
d_{12}	Arm Anchor Point 2	23.5	cm
d_{12}	Arm Anchor Point 3	26.0	cm
	Module body mass	0.3	kg
m_1	Main arm mass	0.064	kg
m_2	Load arm mass	0.03	kg
K_{enc}	Encoder resolution (in quadrature mode)	4096	Counts/Rev
K_1	Spring #1 stiffness	187	N/m
K_2	Spring #2 stiffness	313	N/m
K_3	Spring #3 stiffness	565	N/m

Table 3.1: Rotary Flexible Joint specifications.

Figure 3.1 below is a model depicting the Rotary Flexible Joint system. The ROTFLEX module has been designed to allow many configurations. As you can see in Figure 3.1, there are 3 anchor positions on the arm as well as 3 anchor positions on the body. By attaching the springs in different anchor points, it is possible to realize a wide range of spring constants of the joint. There is also an additional load arm provided with the system that allows for variable load inertias. Coupled with the 3 sets of springs (each with a different spring constant), there are 112 distinct system dynamics attainable with this module.