LAB 2: PARAMETER IDENTIFICATION

2.1. Start-Up Procedure.

2.1.1. *The Physical Setup*

For your initial setup, be sure that you have found the tools required: 4 masses (500±5 grams each), 3 springs (nominally: 175 N/m, 400 N/m, 800 N/m), and hex wrenches. Additionally, check the apparatus to be sure it is in the following configuration:

(1) The stops for cart 2 are set to allow up to 3cm of motion but not much more. The stops for carts 1 and 3 are set to render it immobile.
(2) Cart 2 should be empty.
(3) Use a single medium stiffness spring to connect cart 2 with cart 3.
(4) The damper is connected to cart 2.

2.1.2. *Safety Items.*

(1) Do not touch the device while it is moving.
(2) Before touching the apparatus, use a pencil to move the 1st mass to verify that the system is not being actively controlled.
(3) Make sure the carts can move without obstruction.
(4) Make sure that the masses are held tight by the screw.
(5) When connecting dashpot take care to not over-tighten or cross thread the screws.

2.1.3. *Exporting Data and Printing Plots.*

(1) **Data Export**: (Data → Export Raw Data). Save the file in the same directory as the Matlab codes for the lab.
(2) **Print Plot**: (Plotting → Setup Plot). Put the Encoder 1 position and Encoder 2 position on the left axis. Leave the right axis empty. (Plotting → Print Plot). You may physically print the plot OR use snip to capture the screen.

2.1.4. *Turn on the power.*

(1) Download the Matlab programs for Lab 2 from the course website.
(2) Open the ECP32 program located at start → Programs → ecp → ecp32
(3) Turn on the ECP system by pressing the black "ON" power button on the white and black box.

2.1.5. *Helpful Hints.*

(1) Be sure to fill out the "Short Form Report" as you procede through the lab. DO NOT WAIT UNTIL THE END!
(2) Reset the zero if the plot has an offset (Utility → Zero Position)

Part I. Mass, Springs, & Damping (Cart 2)

2.2. **Experiment A.** - Damping of the cart.

Goals: The goal of this experiment is to experimentally determine the damping coefficient of the cart system.

(1) Disconnect the damper from the cart and make sure it will not interfere with the movement of the cart.
(2) Make sure that the position units are in centimeter units. (Setup → User Units → Centimeters)
(3) We will now do a free vibration experiment where you set the initial conditions by hand, and then let the system evolve. You will record the response with the ECP software and export a plot and data.
   (a) (Command → Trajectory → Sinusoidal → Open Loop Move) and 0V for amplitude. Then, put the frequency at 1Hz and the reps at 10, press OK, that will give a time trace of 10 seconds which should be long enough to capture the response.
   (b) Now, displace the cart by 2-3 cm and hold it there. Go to (Command → Execute) with the normal sampling. Right after you press (Run), let go of the cart. The data will be recorded by the ECP program.
   (c) Then, **Plot** the data (see Startup 1.1.3-2). Label the plot "Figure 2.A1".
   (d) **Export** the data, call it "Lab2.A.1".
(4) Add all 5 masses to cart 2. Repeat step (3), but label the plot "Figure I.A2" and the data "Lab2.A.2".

Part II. Dashpot Damping

2.3. **Experiment B.** - Dashpot characterization.

Goals: The goal of this experiment is to characterize the damping coefficent for the dashpot. We want to create a chart that will let us 'dial' in the damping we want.

(1) Re-attach the dashpot to cart 2 and verify that the cart has all 4 masses. Cart 2 should be connected to carts 1 and 3 using the stiffest springs.
(2) Turn the thumbscrew on the dashpot until it is tight, but not too tight (clockwise turns). Then losen the dashpot until one point of the 6-sided star is up. You will use the star to determine your orientation. (see short form). Mark this position in the first box on Table II at the end of the short form.
(3) You will now determine the thumbscrew orientation for the first datapoint.
   (a) Turn on constant plotting. (Plotting → Real Time Plot). You may need to adjust the axis (Plotting → Axis Scaling).
   (b) Displace the mass by 2-3 cm and hold it there for 3 seconds. Release the mass and observe the motion.
   (c) Repeat set (b) until you observe two oscillation peaks on the same side of the waveform. The second peak must be ≥ 0.25 cm.
   (d) Rotate the thumbscrew counterclockwise until a star point is up. Write this value in the second box on Table II.

(4) You will now use the log decrement method to find the damping coefficient. Hint: Choose the first peak as peak 0 and the last peak above 0.25cm as peak n.
   (a) (Command → Trajectory → Sinusoidal → Open Loop Move) and 0V for amplitude. Then, put the frequency at 1Hz and the reps at 10, press OK, that will give a time trace of 10 seconds which should be long enough to capture the response.
   (b) Now, displace the mass by 2-3 cm and hold it there. Go to (Command → Execute) with the normal sampling. Right after you press (Run), let go of the mass. The data will be recorded by the ECP program.
   (c) Then, **Plot** the data (or save to file).
   (d) Use the log decrement method to determine the damping.
   (e) Be sure the thumbscrew position and damping ratio are entered into Table II.

(5) Turn the thumbscrew 30° **OR 60** counter clockwise (This will put the next star point up wards) and repeat step (4) until the chart is filled.

Part III. Damping (Cart 1)

2.4. **Experiment C.** - Damping of the cart.

Goals: The goal of this experiment is to experimentally determine the damping coefficient of the cart system.

(1) Ask your TA to reset the cart bumpers so cart 1 is free to move and cart 2 is fixed. Cart 1 should be connected to the base through the medium stiffness spring and 4 masses should be placed on the cart.

(2) We will now do a free vibration experiment where you set the initial conditions by hand, and then let the system evolve. You will record the response with the ECP software and export a plot and data.
   (a) (Command → Trajectory → Sinusoidal → Open Loop Move) and 0V for amplitude. Then, put the frequency at 1Hz and the reps at 10, press OK, that will give a time trace of 10 seconds which should be long enough to capture the response.
   (b) Now, displace the cart by 2-3 cm and hold it there. Go to (Command → Execute) with the normal sampling. Right after you press (Run), let go of the cart. The data will be recorded by the ECP program.
   (c) Then, **Plot** the data (see Startup 1.1.3-2). Label the plot "Figure 2.C1".
   (d) **Export** the data, call it "Lab2.C.1".

(3) Calculate the damping coefficent for cart 1.

TA INSTRUCTIONS

For experiment 3 students must ask you to reset the cart bumpers.

(1) Make sure that the switches are fully engaged for the fixed cart.
(2) Make sure cart 1 can move to ± 3 cm.
(3) Make sure cart 1 bumpers engage before the encoder cable reaches the end of it's run.

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