

5: WEEKLY ASSIGNMENTS

WEEK 1 INTRODUCTION

Objectives

To get an overview of the course. To receive assignments of a project and project group. To understand how to operate the data acquisition station. To understand what the input function and the output function are for the system. To observe steady-state performance of the system. To begin to make measurements on the system and analyze your data.

Background

Each system has some "input function" and some "output function." The input function is called $M(t)$, it is usually a function of time. The output function is called $C(t)$, it also is usually a function of time. The names of the functions come from the fact that later they are called the Manipulated variable and the Controlled variable. A diagram that shows the input-output relation is in Figure 2.

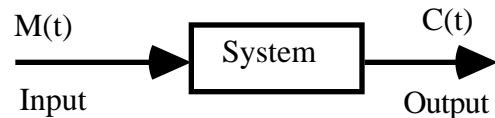


Figure 2. Single-Input, Single-Output system diagram

This week and next week, you are to make measurements on your system, learn about the variability of the measurements and find the steady-state operating curve (SSOC) for your system.

Variations in Measured Quantities (ENGR 322)

Every time an experimental measurement is taken, there is some error associated with the measurement. Today you are to determine the error in measurements in your system. Do this by taking steady-state measurements of the output function, $C(t)$, for a number of data points. Find the mean and standard deviation of the measurements you make. Report your results as $mean \pm 2x(standard\ deviation)$. This range will include the true value of the function at a confidence level of 95%. Be aware that the standard deviation may be different at different operating points. Software packages like Excel or Kaleidagraph can help a lot with the statistics.

The following graph shows how this statistical analysis could look. This graph is the measured output for a steady input.

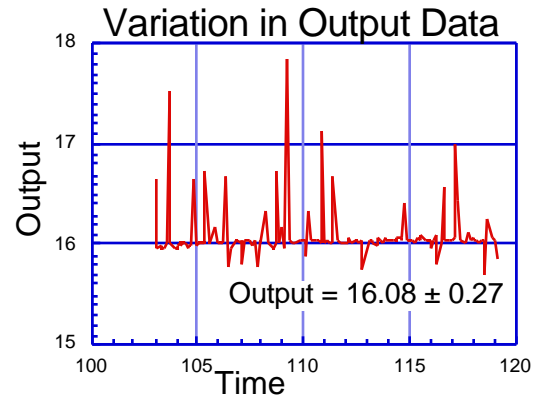


Figure 3. Output data varying with time

System Operating Curve

For each value of a constant value of the input function, there will be a value of the output function; this is called the steady-state value of the output for that value of the input. A graph of the output function (on the ordinate) versus the input function (on the abscissa) is called a steady-state operating curve.

An example of what steady-state operating curves look like is in Figure 4.

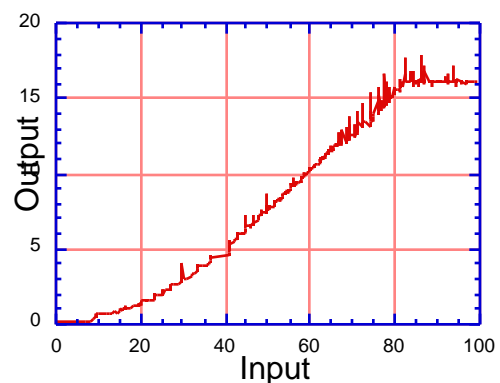


Figure 4. Two examples of Steady-State Operating Curves

An example of what the steady-state operating curve (SSOC) looks for the Crane system is in Figure 5. (Friction is the apparent cause of the hysteresis observed in the SSOC of the Crane system.)

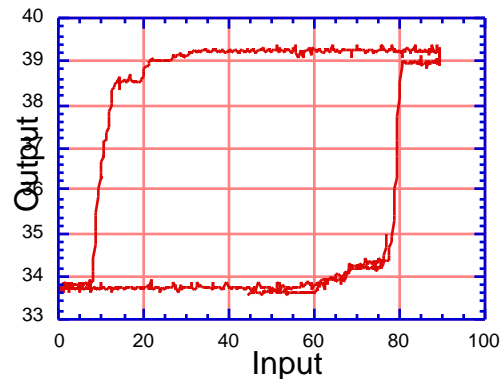


Figure 5. An example of Steady-State Operating Curve for the Crane system

Lab Assignments

248 Position Control

Take data on the position of the cart. Make estimates of the error in measuring position at several points. Begin to measure or make estimates of the parameters for the system: mass of cart, mass of payload, and friction of cart on rails.

249 Speed Control

Take data on the motor RPM. Make estimates of the error in measuring RPM at several speeds.

303 Temperature Control

Take data on the temperature of the water in the reservoir. Make estimates of the error in measuring temperature at several temperatures. Measure the hot water flow rates at several motor speeds.

307 Level Control

Take data on the height of the water in the tanks. Make estimates of the error in measuring height at several heights. Measure the water flow rate and compare with the rotameter. Make estimates of the error in measuring flow rates at several flow rates. Measure the pump flow rates at several values of pump speed (%). Measure the output flowrate at several values of water level.

308 Pressure Control

Take data on the pressure of the air in the tube. Make estimates of the error in measuring air pressure at several pressures.

309 Flow Control

Measure the flow of the water going through the flow meter. Compare the computer reading, the meter indicator and the measurement. Make estimates of the error in measuring water flow rate at several flow rates.

DATA ACQUISITION PROGRAM - LABVIEW

LabVIEW stands for "Laboratory Virtual Instrument Engineering Workstation." It is used in this lab for control of the experiments and data acquisition, analysis and presentation. If you want to know more, the LabVIEW manuals are in room 213, Grote Hall. LabVIEW works by utilizing data acquisition boards that are installed inside the computers.

LabVIEW Tutorial

Turn on the computer. (See Section 3 for specific instructions for your system.)

Open the "329 Lab" folder by double-clicking on the icon with that name.

Open the program for your system by double-clicking on the icon with the name you wish to use. Today, you'll want the one that has the word "Manual" in the name.

You'll get a screen similar to the one in Figure 6, on the next page.

At the top of the window is the name of the controller program.

Across the top of the Mac controller window there are little boxes.

One of them is the "RUN" button. **THIS IS THE ONE YOU WANT TO USE.** Click on it when you want to take data.



The other buttons do other things, things you don't want. **DO NOT CLICK ON THEM!**

Across the top of the Windows controller window there 1 little box.

It is the "RUN" button. Click on it when you want to take data.

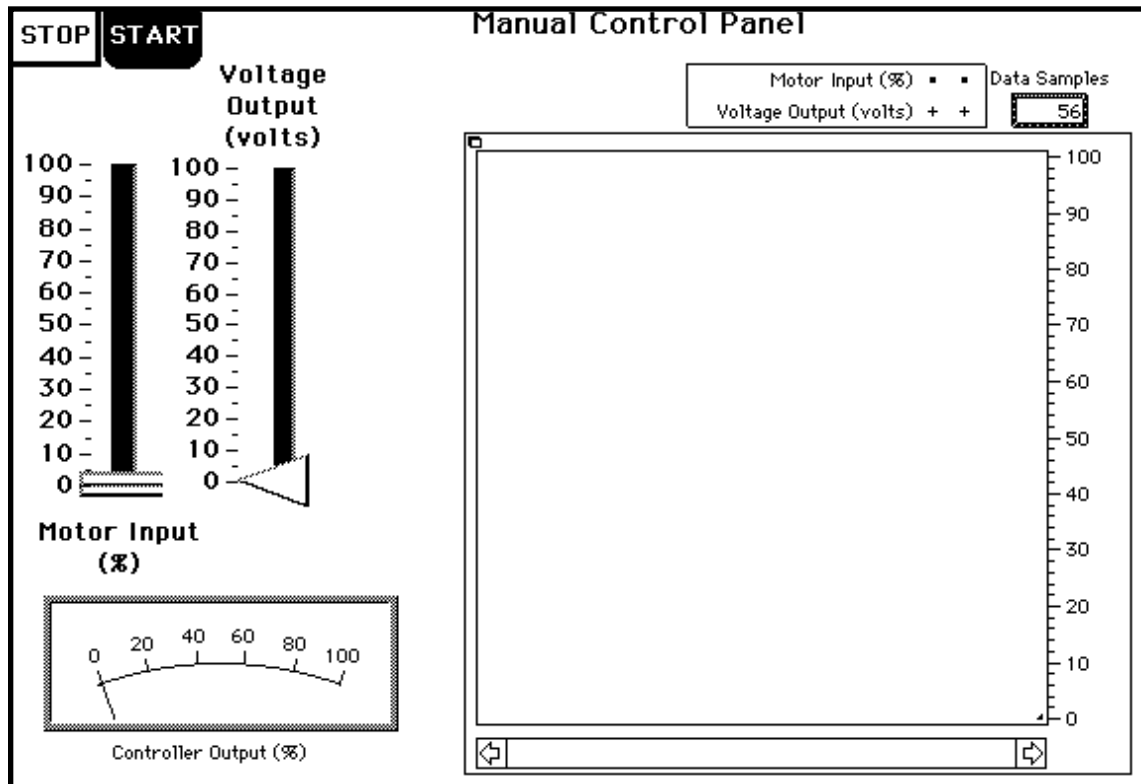


Figure 6. Manual LabVIEW Operating Panel

On the left is the "controller."

The manual slide control: this directly controls the "input" of your system

Next to it is a slide indicator: it indicates the value of the "output" of your system

Below it is a meter labelled "Controller Output (%)." It is the "output" of the controller. In terms of the diagrams in section 4 of this manual, it is the symbol "M" (for manipulated variable) for your system. (It is not the "output" of your system.)

On the right is a rectangle that is a strip chart recorder. The fact that this "controller" has a recorder connected to it is why the "RC" is in the nickname.

Above the recorder is a little box labelled "points" that tells you how many data readings have been made and recorded.

On TRC/303 and LRC/307 there is another little box that says how often the data readings are made and recorded. You can change that value to whatever you wish.

On FRC/309 there is a slide switch to open and close the solenoid valve on the system.

And, finally, in the top left is the "Stop" button. When you want to stop making data readings and recording them, click on this button.

Procedure for getting steady-state system performance data

Prepare system for operation (see Section 4).

Click on the RUN arrow. Move the manual control slide on the left and observe the response of the system. The chart on the right of the screen is emulating a strip chart recorder.

When you want to stop taking data, click on the STOP button. It will then ask if you want to save the data on a disk file. If you say yes, you will be asked what name you want for the data file. Choose a name that is meaningful to you.

LabVIEW will ask you if you want to draw a time-response graph of the data. This will be a graph that has time on the abscissa and the input and output functions on the ordinate. With the LabVIEW time-response graph, you can use the cursor to find the numerical values of any point on the graph. Move the graph cursor to the point you want the value of and the x-value and y-value of the point will be in the cursor panel.

It will ask you if you want to draw an input-output graph of the data. This will be a graph that has the input function on the abscissa and the output function on the ordinate. Figures 4 and 5 have examples of this input-output graph. Again, you may use the cursor to find values on the graph.

You'll probably want to play around a bit before taking any serious data. If you've just been playing around, click "NO" to all of these requests.

When you are ready to get serious and want a steady-state performance curve, set the manual "input" value to the input value you wish to use. "Run" the LabVIEW program. Observe when the system reaches steady state and collect data until at least 30 data points are acquired. Click the STOP button and save the data, perform the statistical analysis, and make the graphs.

Optional Method

When you are ready to get serious and want a steady-state performance curve, set the manual "input" value to 0. Start the instrument program (click on the RUN arrow). SLOWLY increase the value of the manual input setting. This must be slow enough so the system "output" is able to always keep up with the "input." After you max out at the top, click the STOP button and save the data, if you wish, and make the graphs.

In Figure 7 is a diagram that depicts the flow of information in the LabVIEW environment. The computer operator and the equipment transmitters provide inputs into the program. The program provides outputs to the pieces of equipment, the computer monitor and to data files on computer disks.

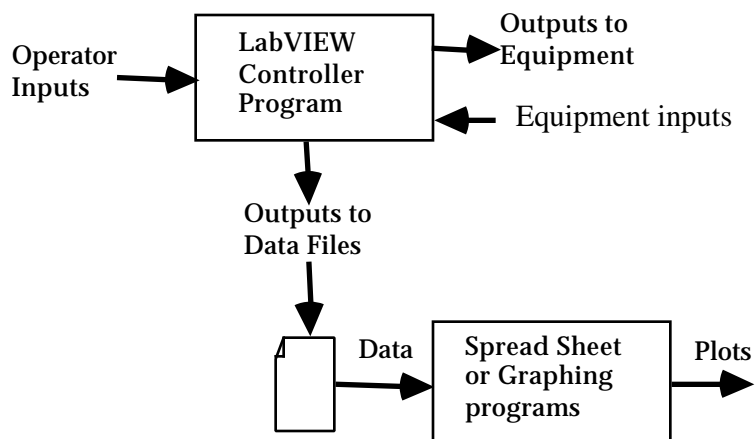


Figure 7. Information paths in laboratory experiments

After using LabVIEW, the controller program, the data can be read by other programs, such as spread sheet programs (Excel or Lotus, for examples) or graphing programs (KaleidaGraph or DeltaGraph, for examples). Excel is available on all the computers in 329 lab; KaleidaGraph is available on the Macs in the lab; DeltaGraph is available on the '486 Windows machine in the lab.

About Disks

Disk File Suggestion: For all your data files that you save this week, start their names with "W1" (meaning week #1)

For safety of your data, always save your data on your own floppy disks.

The Macs can save data on DD or HD disks. See note two pages hence about DOS disks on the Macs. The '486 can save on DD or HD formatted DOS disks. The reason you would want to save the data would be to enter it into another program for analysis or graphing (such as a spread sheet or graphing program).

The ZIP-386 machines in Grote 219 and the '486 machine in Grote 216 can read the Mac HD disks and convert the LabVIEW output to a DOS-readable file if you find that more useful. Use the Mac-Ette program for this purpose.

Note: A student from a previous year advises you to bring a new disk for each week to save your data and keep your files organized. Office Town or K-Mart has HD floppy disks for under \$10 for a box of 10.

The Macs can save files on HD or DD Mac-formatted disks or HD DOS-formatted disks. However, if you put in a DOS disk that is nearly full, the Mac has a high probability of crashing. It is better to avoid DOS-formatted disks on the Macs.

Team Work Suggestion: Make copies of the data on disks that each group member can keep.