Appendix G

ACSYS 2007: Description of the Software

This Appendix introduces and describes the various components of the **A**utomatic **C**ontrol **Sys**tems (**ACSYS**) toolbox.

G-1 Installation of ACSYS

The first time user must follow steps (1) and (2) prior using ACSYS.

1. Create a folder C:\ACSYS2007 (or any folder of your choice).
2. Copy all MATLAB and Image files from ACSYS2007 folder in the CD accompanying this textbook into your C:\ACSYS2007 folder.

Please note that if you use another folder name, the above and the following directions should be modified accordingly.

To run ACSYS2007 simply start MATLAB R14 (version 7.0 or higher)

(Note: Screen resolution of 1024 by 768 pixels or higher is recommended for best graphics quality), and at the MATLAB prompt, type

```
cd C:\ACSYS2007
```

You may also use the MATLAB Directory Browser to move to the ACSYS2007 folder. See MATLAB documentation for instructions. Next, in the MATLAB Command Window, at the prompt (>>) type

```
Acsys
```

Figure G-1 should appear. Upon clicking any button, the corresponding toolbox appears.

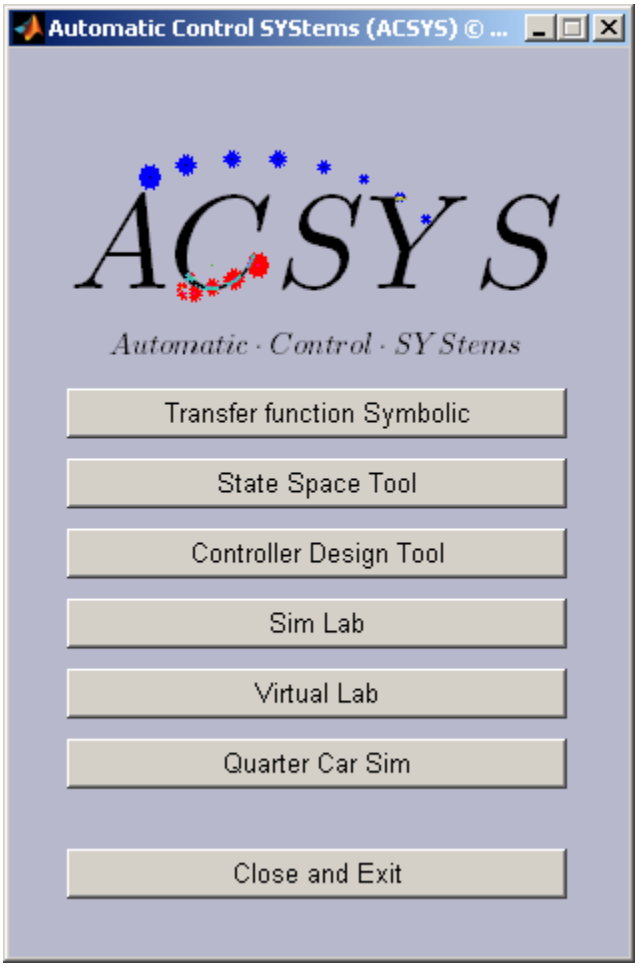

Figure G-1 The Automatic Control Systems (ACSYS) toolbox main window.

G-2 Description of the Software

The Automatic Control Systems Tool (**ACSYS**) consists of a number of m-files and GUIs (Graphic User Interface) for the analysis of simple control engineering transfer functions. In all, ACSYS is composed of six different toolboxes and a tool for converting engineering quantities between SI and other units. These components cover various topics encountered in the study of control systems. These include:

- The Transfer function Symbolic or **tfsym**
- The State Space Tool or **Statetool**
- The Controller Design Tool or **Controls**
- The SIMLab or **simlab**
- The Virtual Lab or **virtuallab**
- The Quarter Car Simulation or **quartercarsim**

G-2-1 tfsym

If you have access to the MATLAB Symbolics Tool, you may use the ACSYS "Transfer Function Symbolic" Tool by pressing the appropriate pushbutton in the ACSYS window. The Symbolic Tool window is shown in Figure G-5. Click in

the “Help for the 1st Time User” button to see the instructions on how to use the toolbox. The instructions appear on help dialog Window as shown in Figure G-6. As instructed, you must run this program within the MATLAB Command Window after clicking the desired buttons.

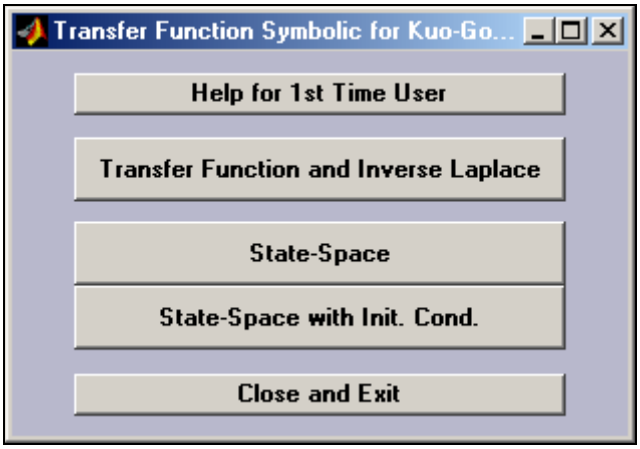

Figure G-5 The Transfer Function Symbolic Window.

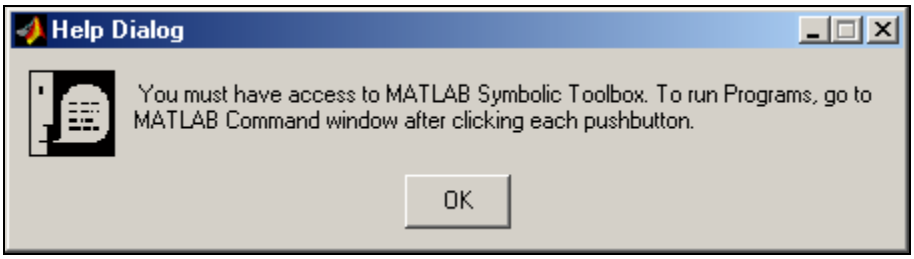

Figure G-6 The Symbolic Help Dialog.

For description of the “Transfer Function and Inverse Laplace” button, refer to Chapter 2 and for the state space applications see Chapter 5.

G-2-2 Statetool

The State Space Analysis Tool (Statetool) consists of a number of m-files and GUIs for the analysis of state space systems. The Statetool can be invoked from the Automatic Control Systems launch applet (ACSYS) by clicking on the appropriate pushbutton. This program may be used for problems in Chapters 9 and 10, and allows the user to conduct the following tasks:

- Enter the state matrices.
- Find the system characteristic polynomial, eigenvalues, and eigenvectors.
- Find the similarity transformation matrices.
- Examine the system controllability and observability properties.
- Obtain the Step, Impulse, and natural (response to initial conditions) responses; as well as the time response to any function of time.

A detailed description of the program appears in Chapter 10.

G-2-3 Controls

The Controller Design Tool (Controls) consists of a number of m-files and GUIs for the time and frequency analysis and design of simple control systems using transfer functions. The controls tool can be invoked from the Automatic Control Systems launch applet (ACSYS) by clicking on the appropriate pushbutton. This comprehensive tool is a powerful tool to solve most controller design problems (except for state space examples) discussed in this book. This software allows the user to be able to conduct the following tasks:

- Enter the Transfer Function values in polynomial form (User must use the tftool to convert the transfer function from pole, zero, gain form into the polynomial form).
- Obtain the Step, Impulse, Parabolic, Ramp or other type input time responses.
- Obtain the closed loop frequency plots.
- Obtain the phase and gain margin Bode plots and the polar plot of the loop transfer functions (in a single feedback loop configuration).
- Understand the effect of adding zeros and poles to the closed-loop or open-loop transfer functions.
- Generate Root Contour and Root Locus plots to investigate the effect that varying certain controller parameters has on the poles of a system.

- Design and compare various controllers including PID, Lead, and Lag compensators.
- Convert quantities between different units using the Unit Conversion tool.

The reader can get a detail discussion of this program in Chapter 9.

G-2-4 simlab and virtuallab

SIM Lab (simlab) and Virtual Lab (virtuallab) are series of MATLAB and Simulink files that make up an educational tool for students learning about DC motors and control systems. The SIMLab or the Virtual Lab main menu windows can be called from the Automatic Control Systems launch applet (**ACSYS**) by clicking on the appropriate pushbutton.

SIM Lab was created to allow students to understand the basic simulation model of a DC motor. The parameters of the motor can be adjusted to see how they affect the system. The Virtual Lab was designed to exhibit some of the key behaviors of real DC motor systems. Real motors have issues such as gear backlash and saturation that may cause the motor response to deviate from expected behavior. Users should be able to cope with these problems. The motor parameters cannot be modified in the Virtual Lab, as in a realistic scenario a motor may not be modified, unless it is replaced by a new one!

In both the SIMLab and the Virtual Lab, there are five experiments. In the first two experiments, feedback speed control and position control are explored.

Open loop step response of the motor appears in the third experiment. In the fourth experiment, the frequency response of the open loop system can be examined by applying a sinusoidal input. A controller design project is the last experiment.

For a detailed discussion of these topics the user is instructed to see Chapter 11.

G-3 Final Comments

This version of ACSYS (2007) has been compiled using MATLAB R14 (version 7.0), and may possibly have problems with earlier MATLAB versions. The MATLAB Toolboxes used in this software include: Control Systems, Simulink, Real-time Workshop and Windows Target. Students, who want to use the Student Version of MATLAB, should note that it contains MATLAB, Simulink and the Symbolic Math Toolbox. Students can purchase and download additional products to use with their student version. The Control System Toolbox is one of these products (see the Mathworks web page[1] for more information).

For bug reports and enhancements, please send email to mfgolnar@sfu.ca.

Thank you for trying ACSYS.

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[1] http://www.mathworks.com/products

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References

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