MENG366 SYSTEM DYNAMICS AND CONTROL LABORATORY

LABORATORY 2: BLOCK DIAGRAM REDUCTION

1. OBJECTIVE

In this laboratory exercise, you will learn to use MATLAB and Simulink to simplify a block diagram and make a reduction. This experiment demonstrates how to use Simulink to reduce block diagrams. Block diagram reduction can be used to simplify complex systems and make them easier to analyze and understand.

2. COMPONENTS & EQUIPMENT

PC with MATLAB and Simulink toolbox installed.

3. BACKGROUND

MATLAB is a proprietary multi-paradigm programming language and numeric computing environment developed by MathWorks. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages.

Although MATLAB is intended primarily for numeric computing, an optional toolbox uses the MuPAD symbolic engine allowing access to symbolic computing abilities. An additional package, Simulink, is a MATLAB-based graphical programming environment for modeling, simulating and analyzing multidomain dynamical systems. Its primary interface is a graphical block diagramming tool and a customizable set of block libraries. It offers tight integration with the rest of the MATLAB environment and can either drive MATLAB or be scripted from it.

As of 2020, MATLAB and Simulink have more than 4 million users worldwide in various backgrounds of engineering and science, especially in automatic control and digital signal processing for multidomain simulation and model-based design.

4. LAB DELIVERIES

Include the following elements in the report document:

<table>
<tr><th>Section</th><th>Element</th></tr>
<tr><td>1</td><td>Theory of operation
Include a brief description of every element and phenomenon that appear during the experiments.</td></tr>
<tr><td>2</td><td>Experiment steps:
1) Open Simulink and create a new model.
2) Add the following blocks to the model:
a. A summing block
b. Two gain blocks
c. A product block
d. A feedback loop
3) Connect the blocks to construct a system.
4) Set the gain of the first gain block to 2 and the gain of the second gain block to 3.
5) Simulate the model.
6) Observe the output of the model.
7) Reduce the block diagram by merging the two gain blocks into a single gain block with a gain of 2 * 3 = 6.
8) Simulate the reduced block diagram.
9) Observe that the output of the reduced block diagram is the same as the output of the original block diagram.
10) Use the "Control Systems Toolbox" to add additional blocks to your model, such as integrators, differentiators, and filters.
11) Use the "Simulink Coder" to generate C code from your Simulink model. This code can then be used to implement the reduced block diagram on a real-world system.
12) Experiment with different block diagrams and reduction techniques to see how they affect the output of the system.</td></tr>
<tr><td>3</td><td>Results of the experiments
<table>
<tr><th>Part</th><th>Experiment Results</th></tr>
<tr><td>1</td><td>MATLAB code and simulation results.</td></tr>
<tr><td>2</td><td>Simulink block diagram and simulation results.</td></tr>
</table></td></tr>
<tr><td>4</td><td>Answer the questions
<table>
<tr><th>Questions</th><th>Questions</th></tr>
<tr><td>1</td><td>Why use MATLAB and Simulink for system simulations?</td></tr>
<tr><td>2</td><td>What are the major differences between MATLAB and Simulink simulations?</td></tr>
</table></td></tr>
<tr><td>5</td><td>Conclusions
Write down your conclusions, things learned, problems encountered during the lab and how they were solved, etc.</td></tr>
<tr><td>6</td><td>Images
Paste images (e.g. scratches, drafts, screenshots, photos, etc.) in the lab report document (only .docx, .doc or .pdf format is accepted). If the sizes of images are too large, convert them to jpg/jpeg format first, and then paste them in the document.

Attachments (If needed)
Zip your projects. Send it as attachments, or provide link to the zip file on Google Drive / Dropbox, etc.</td></tr>
</table>

5. REFERENCES & ACKNOWLEDGEMENT

1. Norman S. Nise, “Control Systems Engineering”, 7th Ed.
2. https://en.wikipedia.org/wiki/MATLAB
3. https://en.wikipedia.org/wiki/Simulink