Engineering 446

Control Systems Laboratory

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Lab Assignment #1
Simulink software tutorial

Introduction:

This is the first laboratory assignment in this Control Systems course. This lab is an introduction to the Simulink software tools available within Matlab. It covers how to add and remove components as well as wires. The fundamentals, so to speak, of the matlab program, which stands for matrix laboratory. Then further instruction is given as to how one can modify the components as desired. There is a step-by-step guide which allows the student to follow along to gain practice with Matlab functionality. Scopes are added to the system at desired points in order to record the output in graph form at that point in the wire. This portion of the laboratory assignment was straight forward in regard to the steps provided to follow along with. The modifications mode to the components can be confirmed as being correct once the student matches their graph provided by the source with the graph provided in the instruction.

Problem Definition:

The problems introduced to the student in this lab assignment are those where they are required to find the correct component from the provided list on Matlab. The intention of this portion is to gain familiarity with the components and where they are located within the Matlab menus. After practicing pulling up the required components a couple times, general familiarity of the location of components begins becoming established. Another point to this portion of the exercise is to gain familiarity with potential locations of components. For example, now that the student knows that the scope utility is located in the sink folder, they could likely guess where to find other similar tools, which would be within the same subfolder. The same situation is present with sources, it would be easy to guess where the sin or step functions are located after having practiced inserted such functions into the example diagrams.

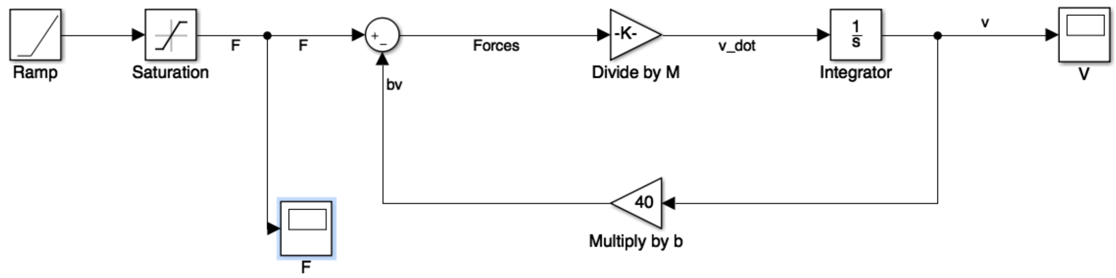
The problem, as presented, in this lab assignment requires the student to make appropriate modifications to an exemplified system and then record the outputs at the scope for verification of correct operation.

<u>What is a step input? Ramp input?:</u>

Among the standard inputs that are considered to be universal, the step input and ramp input are among them. The step input provides what might be expected by the user, a constant voltage of a period of time that will change periodically. As in Matlab; sample time, steptime, stepsize and final time can be customized within the input argument. Much the same is possible for a ramp input which provides a viable input, the unit ramp responses can be solved for using laplase equations.

<u>Explanation of the experiments:</u>

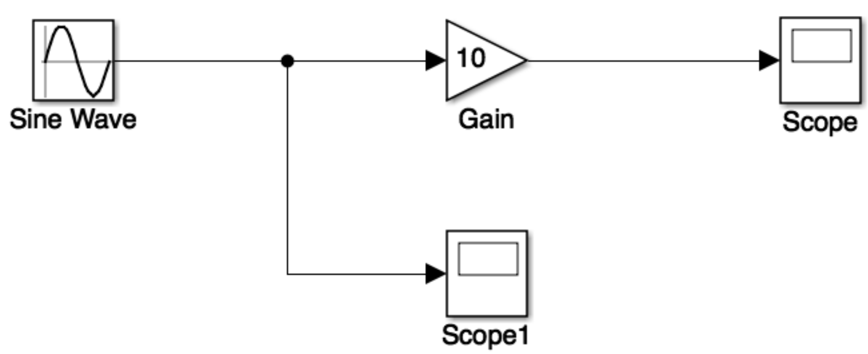
The first step in this assignment is to open Simulink using the appropriate command within the matlab program. The command is simply, Simulink, unless you choose to open it through the menu. The first setup has a sin wave function provided as a source while a gain component is also added and finally a scope to visualize the output of the system. After the blocks have been added they are then modified to change their amplitude, frequency, phase, ect. Some complexity is added to the system by adding additional lines feeding into or out of a component. For example; the gain utility has the output wire split to feed back into the system as well as into a scope for observing the output, V.



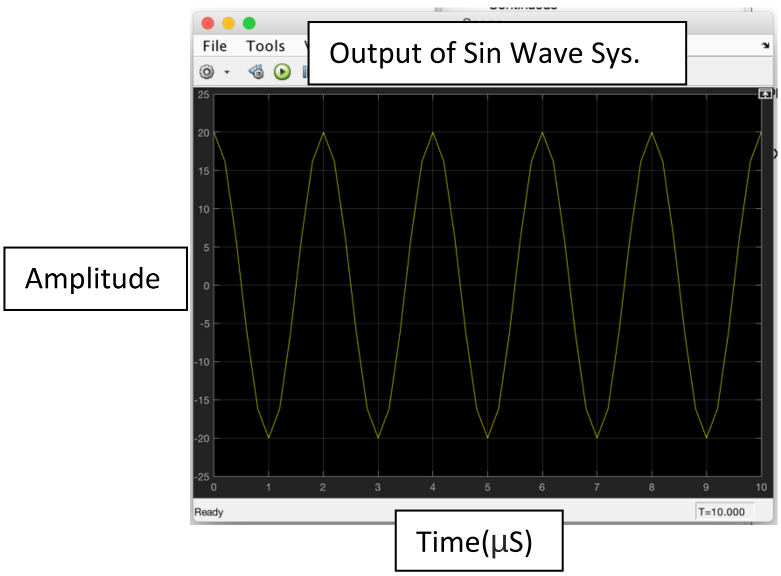
The above system represents the most complex system setup in this lab assignment. This is representing a first order system that is similar to a real life system with horizontal forces applied. Within this example the sources, gain and sum functions have been modified to the desired values.

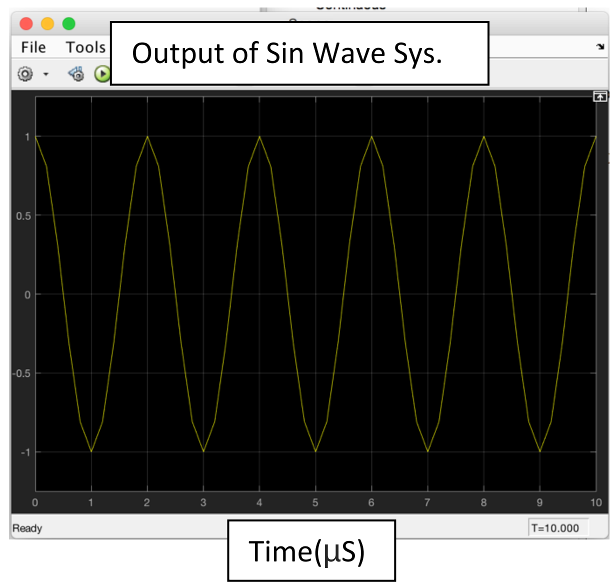
The big take away idea from this section is to build a system and record it's output at the scope. Then modifications are made and the same scope is used to record the changes in the system as a result of the changes made.

<u>Models/Calculations/ Simulation Results:</u>

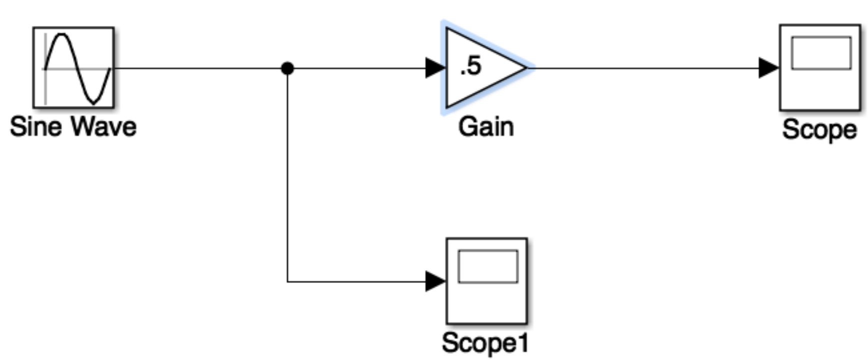


The image above and all models in this section were made while following along with the laboratory tutorial. This particular model represents a Sen Wave as a source feeding into a gain component and being measured at the locations with a scope. Below is a visual representations of the desired output, before and after making modifications to the gain.

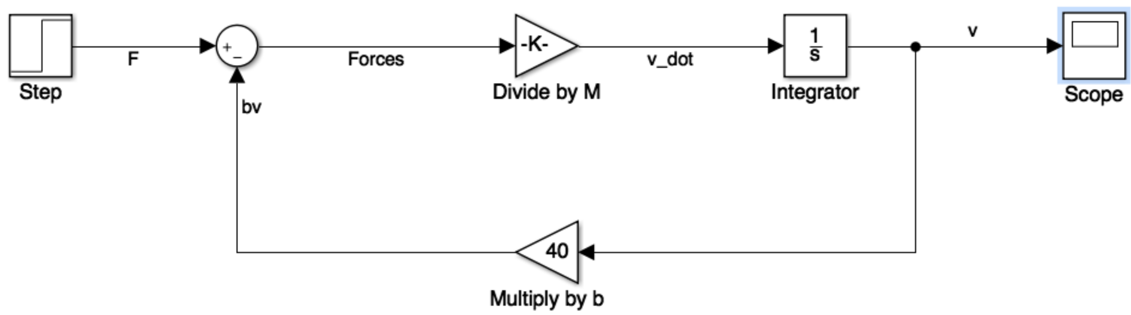




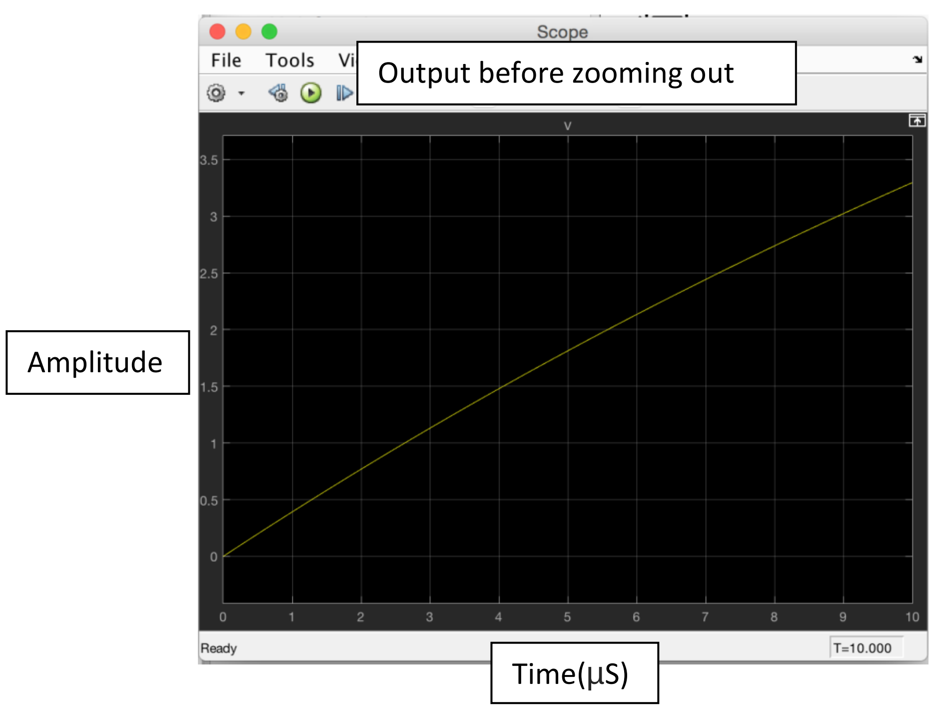
Notice the amplitude in the graph to the right (above) is 1/10th of the other graph. This is a result of changing the gain in the model from 10 to 0.5 as shown below:



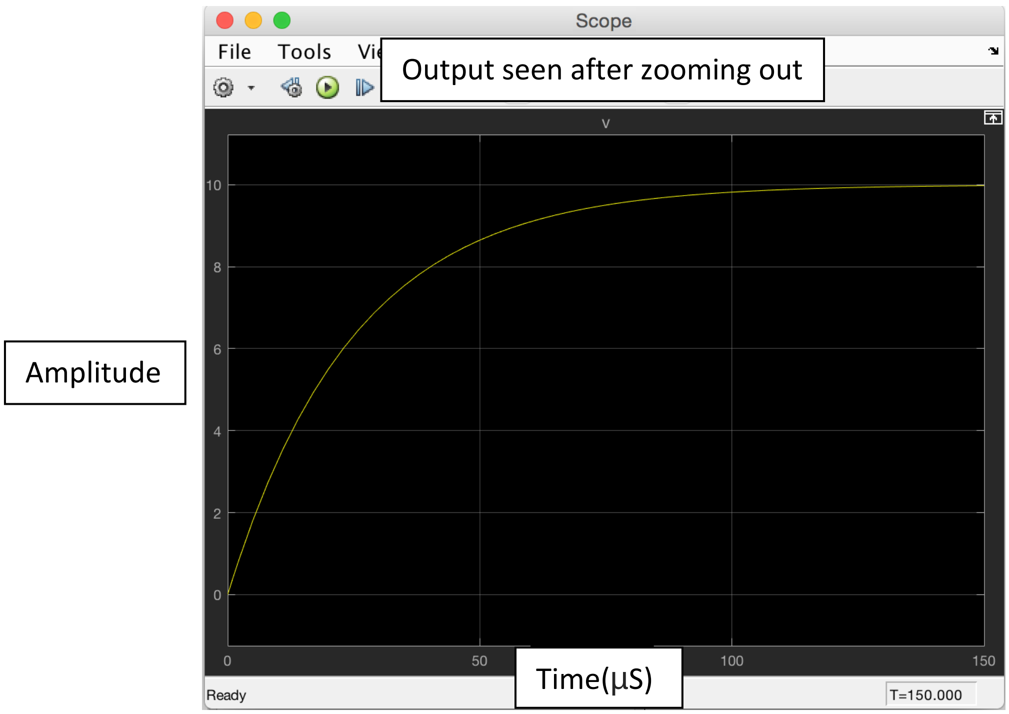
The next step in the tutorial is to add a step function as the source of the system being modeled. This model is shown below:



What we observe seems to be a ramp response from the system however after we make futher modifications to the components as indicated in the tutorial and the result is the following graph as seen at the scope in this system.

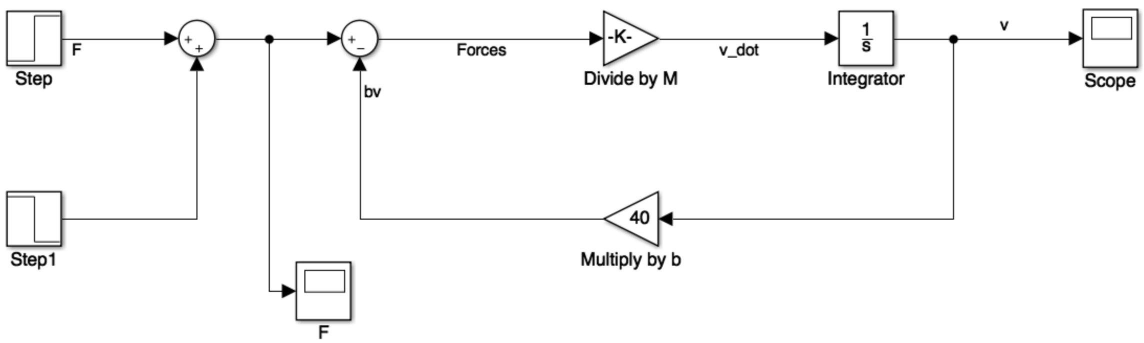


This type of graph may not give the user enough information or rather, enough points on the x or y axis, to allow for proper analysis. The issue with this particular graph is that it is only being viewed up to ten points on the x-axis. The parameters are changed to allow 150 points to be viewed and the result is as follows:

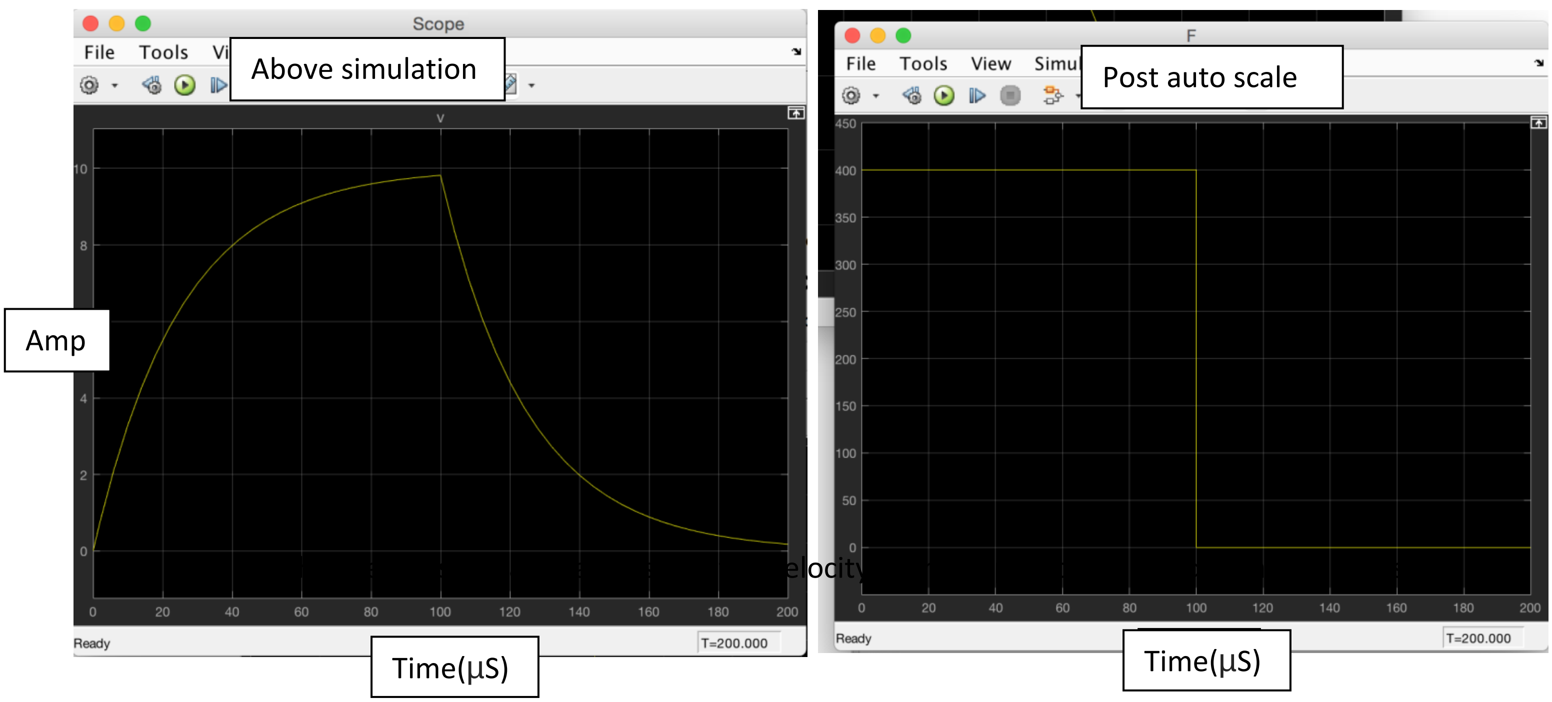


The graph above provides much more detailed information that can be useful about the trend the model is following at it's output.

Further complexity is added to the model as seen below. The tutorial has the user add a second step function as a source while splitting the wire from a new addition component to feed into a new scope marked as “F” through the text editing feature.



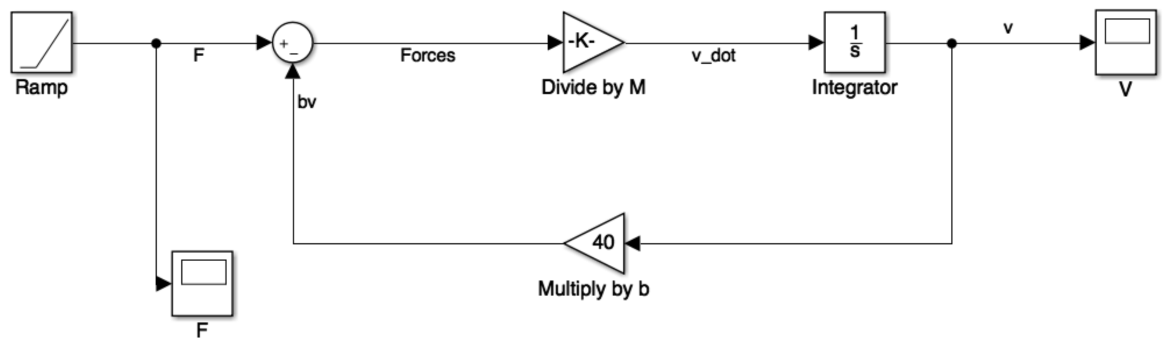
The outputs at the scopes can be viewed below: Please note that auto correcting the window has a different effect in the newest version of Simulink.



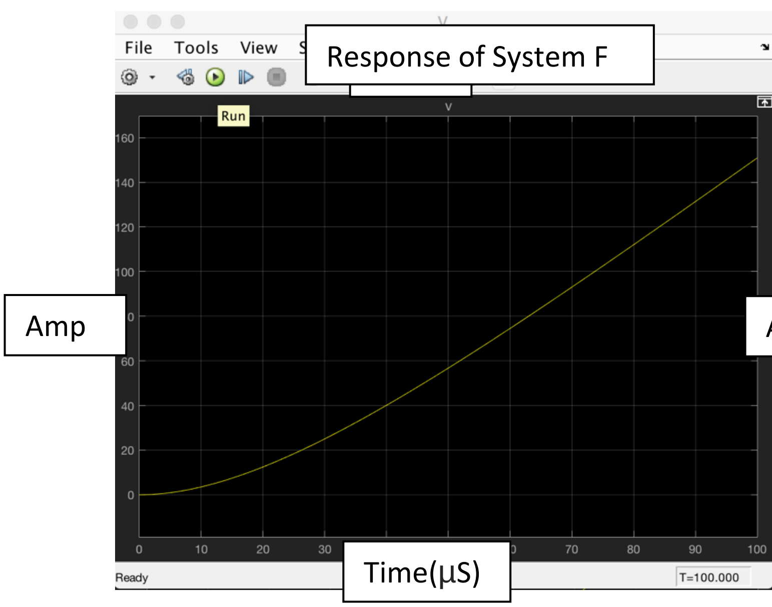
is expected from the first-order response. Important features of the model are visible from comparing the input and output plots shown on the previous page.

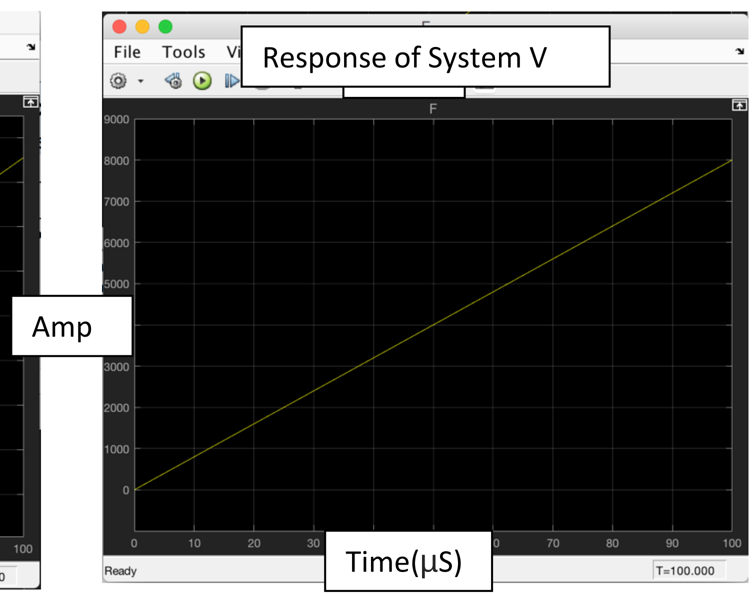
As an additional example the user will model a ramp response system:

AMp



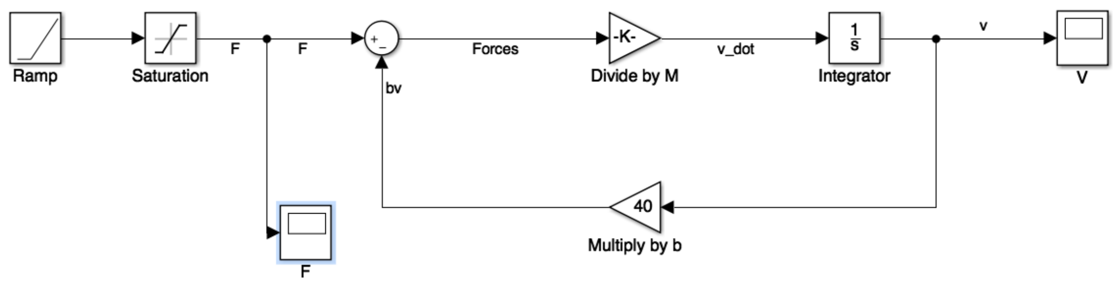
The user will double click the ramp block in order to modify the slope to equal a new value of 80 N/s. Other parameters are kept constant while the parameters of the simulation are set to allow for viewing of more points.



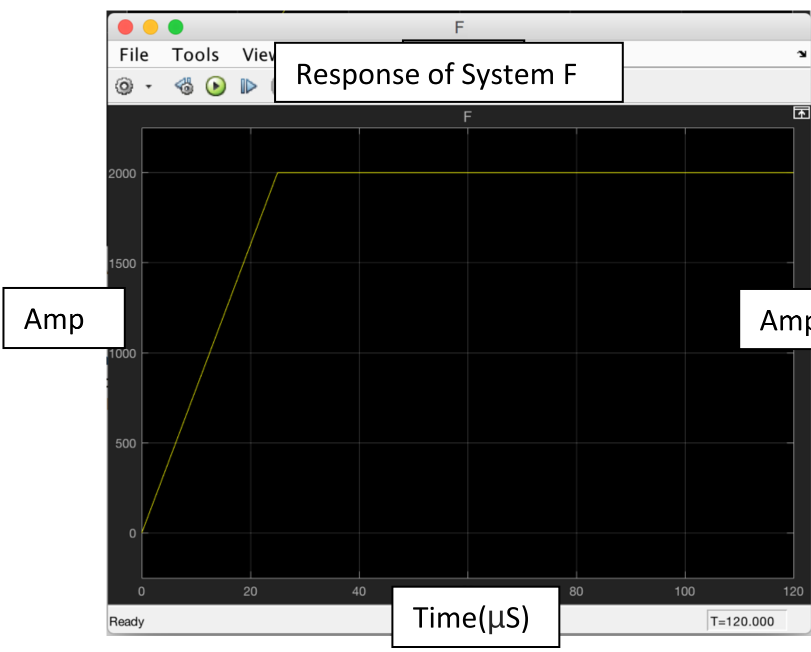


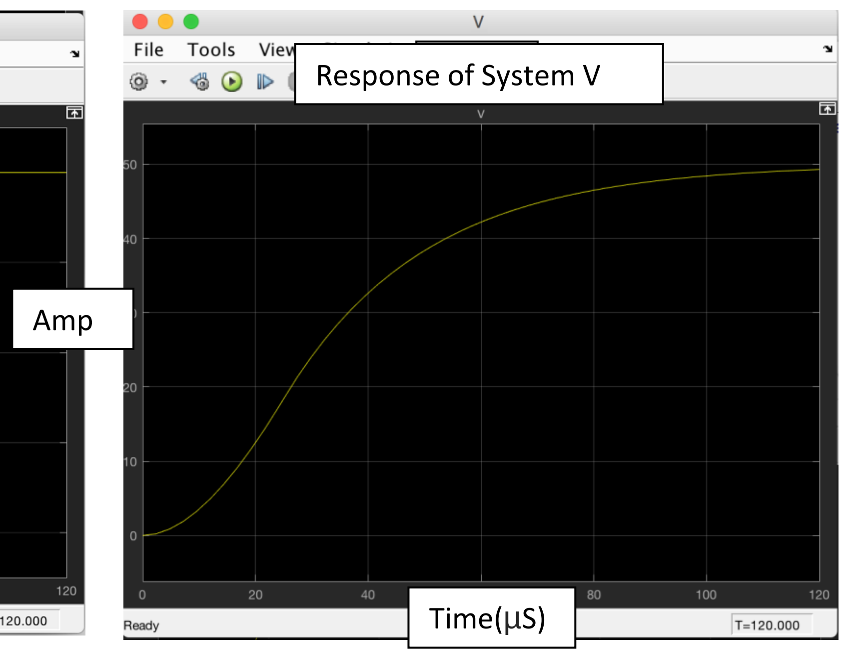
In the above graphs the trend of the system is more easily viewed by expanding the number of points on the horizontal scale of the graph by changing the parameters.

Lastly, a saturation block is added to the same model as follows:



The saturation block will allow the user to set an upper as well as lower limit for its input signal.





Here, if the input signal is greater than the maximum it outputs the set maximum value. Again, by comparison of the above graphs the input and output plots the user is able to make important recognitions above the important features of the system.

Conclusion:

This was a good introductory laboratory assignment to Matlab, or matrix lab, programming. The language has its similarities and differences to C++ programming that are becoming more and more evident. Although the software lacks power in some regards and has limited flexibility; it is fantastic at handling imaginary numbers. It is important not to confuse variables as inputs when using Matlab, for example, not to use i or j for an input then have to use those to represent imaginary numbers within the equations and suddenly things are misconstrued. It will be interesting to gain further insight into Matlab functionality and how powerful the program is as it is widely used in industry. This laboratory assignment covered the basics to introduce the user to Matlab and what it can do.

List of References

"Simulink Basics Tutorial", SFSU 446 Laboratory manual book. Provided by University.