Lab 8 - Hydraulic Fluid System

Overview

In this lab we simulate a simple hydraulic system in simscape.

For a brief MATLAB video tutorial, please refer to the Modeling a Hydraulic Actuation System.

Resources Required:
MATLAB
Simulink
Simscape
Simscape Fluids

Description of the System

The system has a hydraulic pump, 4-way valve, a piston, and a spring mass system which is moved by the fluid. Draw the system shown in Figure 1.

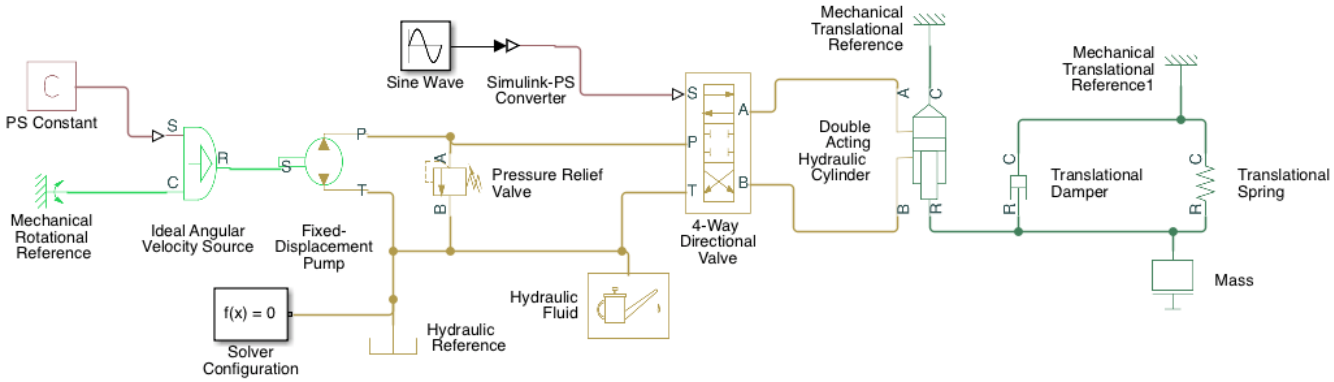


Figure 1: Physical DC Motor System

Task 1: Hydraulic Fluid System

1. Create the hydraulic fluid system described in figure 1.

After completing the block diagram perform the following modifications.

2. Modify the "Displacement" within the Displacement Pump to 5e-4 m^3/rev.
3. Within the 4-way directional valve under the "Basic Parameters" tab change the parameter to reflect as they do in figure 2.

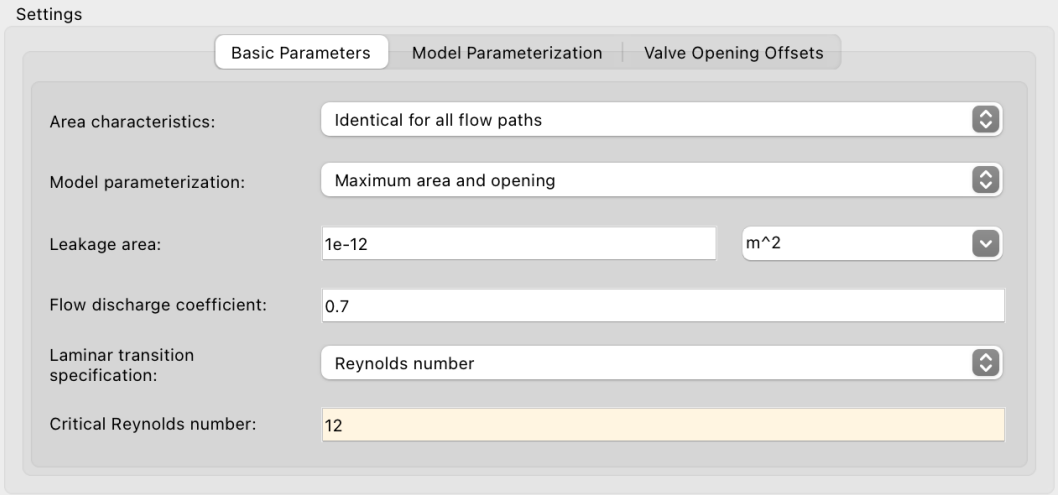


Figure 2: 4-Way Directional Valve Parameters

4. Within the 4-way directional valve under the "Model Parameterization" tab change the following as shown in Figure 3:
   a. Maximum Opening: 0.005 m
   b. Maximum Opening Area: 5e-4 m^2

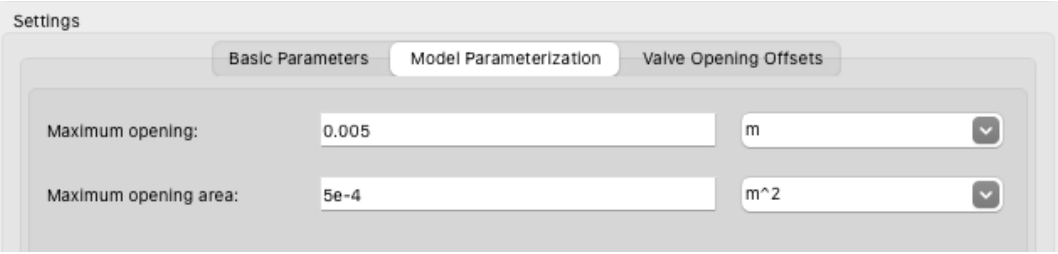


Figure 3: 4-Way Directional Valve Parameters

5. Within the "Double Acting Hydraulic Cylinder" change the following as shown in Figure 4 below:
   a. Piston area A: 0.125 m^2
   b. Piston area B: 0.125 m^2
   c. Piston Stroke: 0.5 m

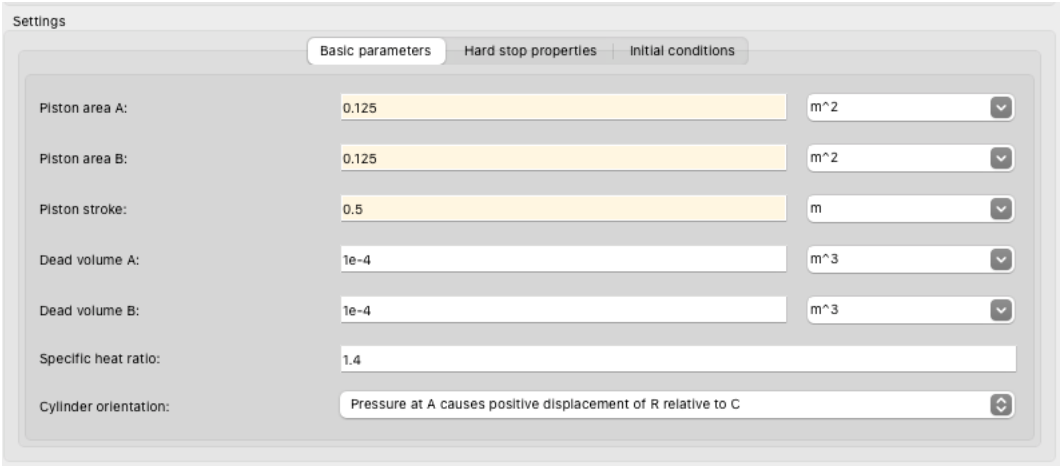


Figure 4: Double Acting Hydraulic Cylinder Parameters

6. On the "Hard stop properties" ensure the parameters reflect as shown in figure 5

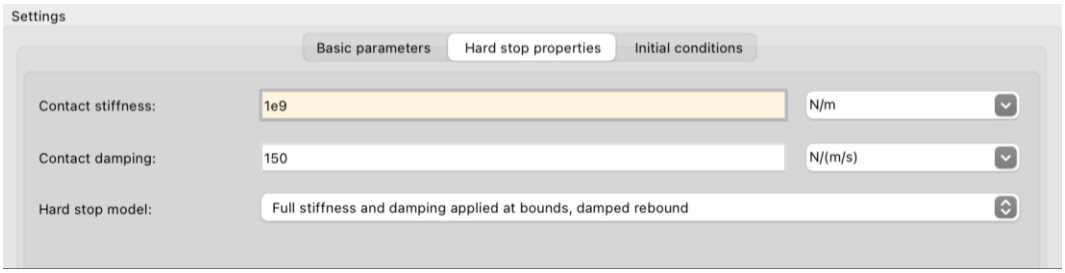


Figure 5: Double Acting Hydraulic Cylinder Parameters

7. Within the “Pressure Relief Valve” ensure the parameters reflect as shown in figure 6.

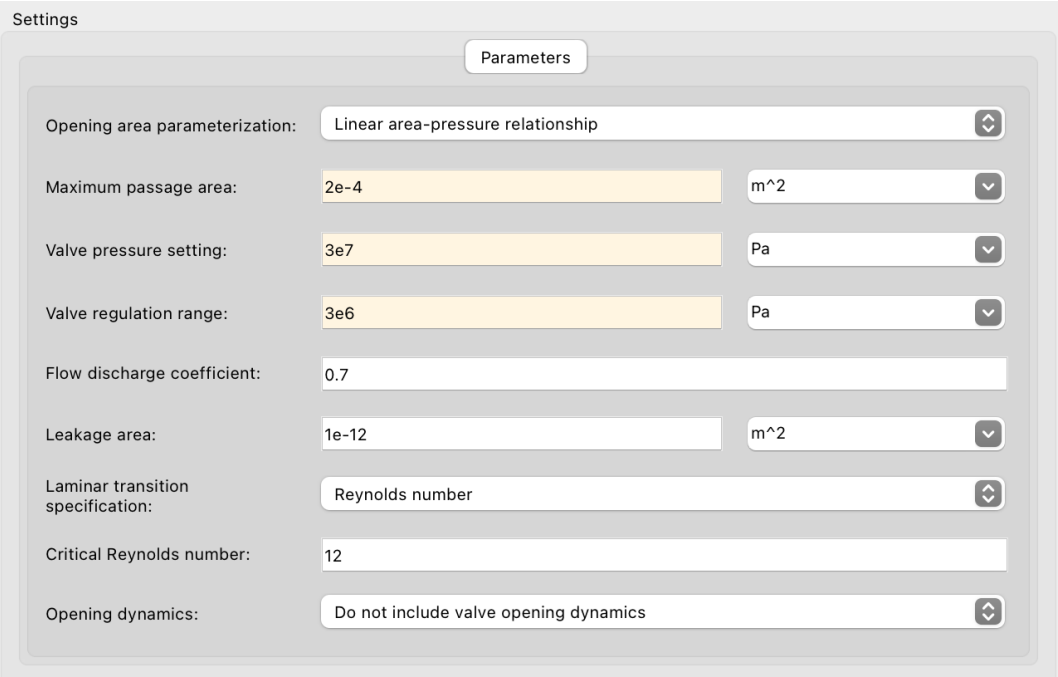


Figure 6: Pressure Relief Valve Parameters

8. Change the translational spring stiffness to 1000 N/m
9. Change the translational damper damping rate to 100 N/m/s
10. Mass to 100 kg
11. Within the “PS Constant” block, change the constant value to 188 rad/s
12. Within the “Simulink-PS Converter” block connecting the “Sine Wave” and the “4-way Directional Valve”, change the “Input Signal Unit” to meters, as shown in figure 7.

Figure 7: Simulink-PS Converter Unit Parameter

13. Open the “Sine Wave” block and make the amplitude 0.003
14. Within the “Hydraulic Fluid” change the Hydraulic Fluid to Skydrol LD-4

15. Enable Simscape Logging by going to Simulation → Model configuration parameters → Simscape Pane → data logging section → select all.
16. Uncheck Limit data points as shown in Figure 8.

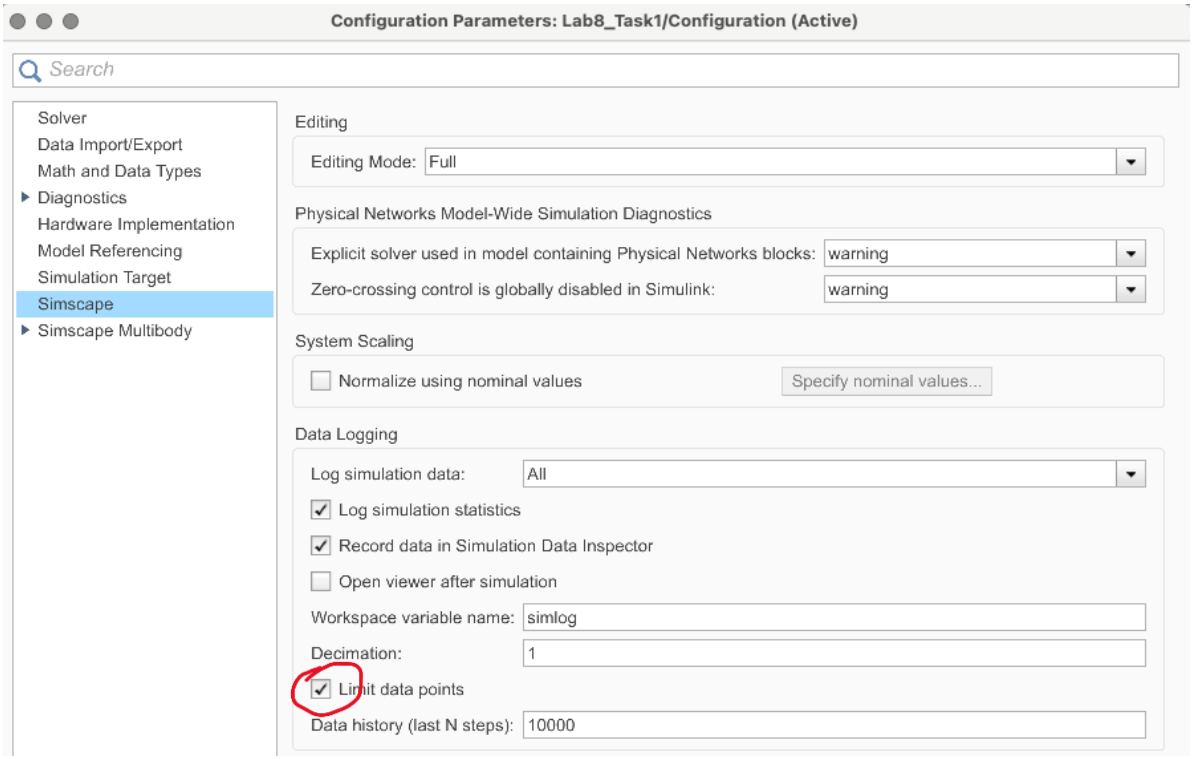


Figure 8: Data-Logging Setup

17. After making the changes, run the simulation.
18. Within the “Review Results” section in the “Simulation” ribbon tab, click on the “Simscape Results” button as seen in figure 9.

Figure 9: Simscape Results

19. In the left-hand pane, click on the “Translational Spring”. In the main window, 3 stacked plots showing the input force, the velocity, and the displacement to the translational spring will display, as shown in figure 10.

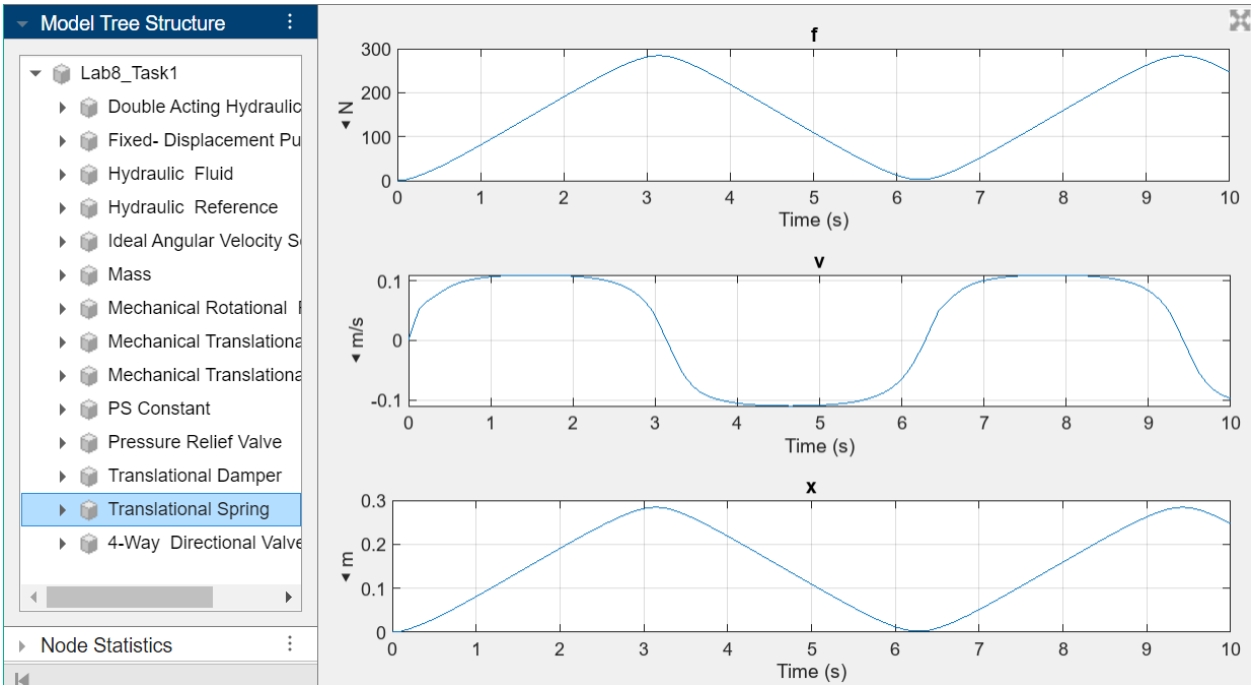


Figure 10: Data Inspector Layout

NOTE: Alternatively, to step 15, you can right click on the "Translational Spring" and select Simscape → View Simulation Data → Simlog to quickly view the Simscape results. Figure 11 illustrates this selection.

NOTE: To view changes to the system, you will need to reload the data within the "Simscape Results Explorer" after each simulation run. To view the effects of changes to the system simulation, click on the "Reload Logged Data" button or by closing the "Simscape Results Explorer" window and re-opening it.

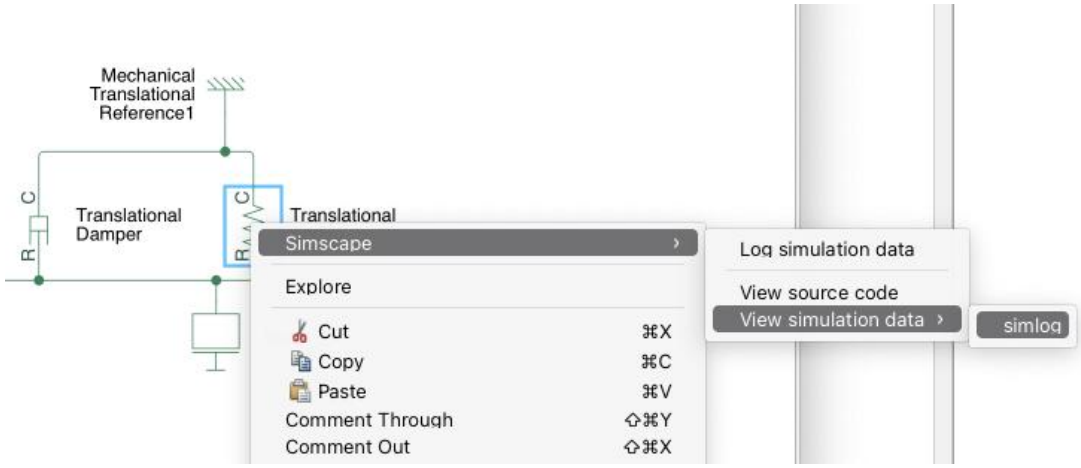
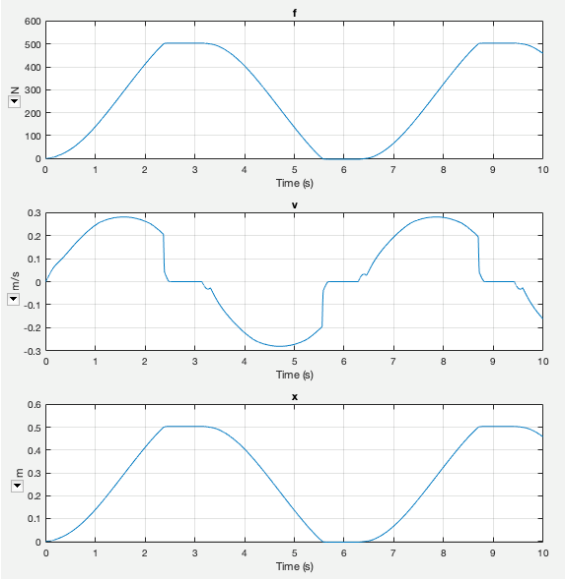


Figure 11: View Simlog

To show completion of this task, take a screenshot of all three plots together and show the TA.

Post-Lab Questions

1. Adjust the displacement of the system in a way that will match the output as shown below. What value of displacement did you find that re-produced the plot? Show your plot.



2. Briefly describe how the displacement of the displacement pump affects a hydraulic fluid system.

3. Briefly describe what a 4-way directional valve is for a hydraulic fluid system.