Experiment 4

Table of Contents

William Watkins 5 February 2022

Clean up

```
clear all
close all
clc
```

Constants

```
m1 = 10;
m2 = 350;
Kw = 500000;
Ks = 10000;
b = 0;
Input = 1;
tspan = 0:0.001:5;
Initial = [0; 0; 0; 0];
```

Try in LTI SS model

```
A = [-(b/m1) (b/m1) -(1/m1) (1/m1);
     (b/m2) -(b/m2) 0 -(1/m2);
     Kw 0 0 0;
     -Ks Ks 0 0];

B = [0;0;-Kw;0];
C = [1 0 0 0;
     0 1 0 0];
D = [0;0];
```

Simulating

```
simOut = sim('Car_Suspension_Model.slx');
output(1,:) = simOut.yout{1}.Values.Data(:,2)';
tSpan(1,:) = simOut.yout{1}.Values.Time';
output(2,:) = simOut.yout{2}.Values.Data(:,2)';
tSpan(2,:) = simOut.yout{2}.Values.Time';
Final = simOut.yout{3}.Values.Data(:,2)';
tfinal = simOut.yout{3}.Values.Time';
```

```matlab
output(4,:) = simOut.yout{4}.Values.Data';
tSpan(4,:) = simOut.yout{4}.Values.Time';

figure('Position', [200 200 1000 800]);
hold on;
grid on;
plot(tfinal,Final)

b = 2000;
A = [-(b/m1) (b/m1) -(1/m1) (1/m1);
     (b/m2) -(b/m2) 0 -(1/m2);
      Kw 0 0 0;
     -Ks Ks 0 0];
simOut = sim('Car_Suspension_Model.slx');
Final = simOut.yout{3}.Values.Data(:,2)';
tfinal = simOut.yout{3}.Values.Time';
plot(tfinal,Final)

b = 4000;
A = [-(b/m1) (b/m1) -(1/m1) (1/m1);
     (b/m2) -(b/m2) 0 -(1/m2);
      Kw 0 0 0;
     -Ks Ks 0 0];
simOut = sim('Car_Suspension_Model.slx');
Final = simOut.yout{3}.Values.Data(:,2)';
tfinal = simOut.yout{3}.Values.Time';
plot(tfinal,Final)

b = 4000;
A = [-(b/m1) (b/m1) -(1/m1) (1/m1);
     (b/m2) -(b/m2) 0 -(1/m2);
      Kw 0 0 0;
     -Ks Ks 0 0];
simOut = sim('Car_Suspension_Model.slx');
Final = simOut.yout{3}.Values.Data(:,2)';
tfinal = simOut.yout{3}.Values.Time';
plot(tfinal,Final)

b = 6000;
A = [-(b/m1) (b/m1) -(1/m1) (1/m1);
     (b/m2) -(b/m2) 0 -(1/m2);
      Kw 0 0 0;
     -Ks Ks 0 0];
simOut = sim('Car_Suspension_Model.slx');
Final = simOut.yout{3}.Values.Data(:,2)';
tfinal = simOut.yout{3}.Values.Time';
plot(tfinal,Final)

b = 8000;
A = [-(b/m1) (b/m1) -(1/m1) (1/m1);
     (b/m2) -(b/m2) 0 -(1/m2);
      Kw 0 0 0;
     -Ks Ks 0 0];
simOut = sim('Car_Suspension_Model.slx');
```

```
Final = simOut.yout{3}.Values.Data(:,2)';
tfinal = simOut.yout{3}.Values.Time';
plot(tfinal,Final)


b = 10000;
A = [-(b/m1) (b/m1) -(1/m1) (1/m1);
     (b/m2) -(b/m2) 0 -(1/m2);
     Kw 0 0 0;
     -Ks Ks 0 0];
simOut = sim('Car_Suspension_Model.slx');
Final = simOut.yout{3}.Values.Data(:,2)';
tfinal = simOut.yout{3}.Values.Time';
plot(tfinal,Final)


b = 12000;
A = [-(b/m1) (b/m1) -(1/m1) (1/m1);
     (b/m2) -(b/m2) 0 -(1/m2);
     Kw 0 0 0;
     -Ks Ks 0 0];
simOut = sim('Car_Suspension_Model.slx');
Final = simOut.yout{3}.Values.Data(:,2)';
tfinal = simOut.yout{3}.Values.Time';
plot(tfinal,Final)


legend({'b = 0','b=2,000','b=4,000','b=6,000','b=8,000','b=10,000'...
     ,'b=12,000'},'Location','northeast')
title('Car Body Acceleration in Response to Step Input')
xlabel('Time [s]')
ylabel('m/s^2')
```

Warning: Solver is encountering difficulty in simulating model '<a
href="matlab:open_system ('Car_Suspension_Model')">Car_Suspension_Model'
* at*
time 1.0000000000000038. Simulink will continue to simulate with warnings.
Please check the model for errors.
Warning: Solver was unable to reduce the step size without violating minimum
step size of 3.55271E-15 for 1 consecutive times at time 1. Solver will
continue simulation with the step size restricted to 3.55271E-15 and using an
effective relative error tolerance of 0.0135238, which is greater than the
specified relative error tolerance of 0.001. This usually may be caused by the
high stiffness of the system. Please check the system or increase the solver
* <a*
href="matlab:configset.internal.open('Car_Suspension_Model','MaxConsecutiveMinStep');">Num
of consecutive min steps violation parameter.
Warning: Solver is encountering difficulty in simulating model '<a
href="matlab:open_system ('Car_Suspension_Model')">Car_Suspension_Model'
* at*
time 1.0000000000000038. Simulink will continue to simulate with warnings.
Please check the model for errors.
Warning: Solver was unable to reduce the step size without violating minimum
step size of 3.55271E-15 for 1 consecutive times at time 1. Solver will
continue simulation with the step size restricted to 3.55271E-15 and using an
effective relative error tolerance of 0.0135238, which is greater than the
specified relative error tolerance of 0.001. This usually may be caused by the

high stiffness of the system. Please check the system or increase the solver
<a
href="matlab:configset.internal.open('Car_Suspension_Model','MaxConsecutiveMinStep');">Num
of consecutive min steps violation parameter.
Warning: Solver is encountering difficulty in simulating model '<a
href="matlab:open_system ('Car_Suspension_Model')">Car_Suspension_Model'
at
time 1.0000000000000038. Simulink will continue to simulate with warnings.
Please check the model for errors.
Warning: Solver was unable to reduce the step size without violating minimum
step size of 3.55271E-15 for 1 consecutive times at time 1. Solver will
continue simulation with the step size restricted to 3.55271E-15 and using an
effective relative error tolerance of 0.0135238, which is greater than the
specified relative error tolerance of 0.001. This usually may be caused by the
high stiffness of the system. Please check the system or increase the solver
<a
href="matlab:configset.internal.open('Car_Suspension_Model','MaxConsecutiveMinStep');">Num
of consecutive min steps violation parameter.
Warning: Solver is encountering difficulty in simulating model '<a
href="matlab:open_system ('Car_Suspension_Model')">Car_Suspension_Model'
at
time 1.0000000000000038. Simulink will continue to simulate with warnings.
Please check the model for errors.
Warning: Solver was unable to reduce the step size without violating minimum
step size of 3.55271E-15 for 1 consecutive times at time 1. Solver will
continue simulation with the step size restricted to 3.55271E-15 and using an
effective relative error tolerance of 0.0135238, which is greater than the
specified relative error tolerance of 0.001. This usually may be caused by the
high stiffness of the system. Please check the system or increase the solver
<a
href="matlab:configset.internal.open('Car_Suspension_Model','MaxConsecutiveMinStep');">Num
of consecutive min steps violation parameter.
Warning: Solver is encountering difficulty in simulating model '<a
href="matlab:open_system ('Car_Suspension_Model')">Car_Suspension_Model'
at
time 1.0000000000000038. Simulink will continue to simulate with warnings.
Please check the model for errors.
Warning: Solver was unable to reduce the step size without violating minimum
step size of 3.55271E-15 for 1 consecutive times at time 1. Solver will
continue simulation with the step size restricted to 3.55271E-15 and using an
effective relative error tolerance of 0.0135238, which is greater than the
specified relative error tolerance of 0.001. This usually may be caused by the
high stiffness of the system. Please check the system or increase the solver
<a
href="matlab:configset.internal.open('Car_Suspension_Model','MaxConsecutiveMinStep');">Num
of consecutive min steps violation parameter.
Warning: Solver is encountering difficulty in simulating model '<a
href="matlab:open_system ('Car_Suspension_Model')">Car_Suspension_Model'
at
time 1.0000000000000038. Simulink will continue to simulate with warnings.
Please check the model for errors.
Warning: Solver was unable to reduce the step size without violating minimum
step size of 3.55271E-15 for 1 consecutive times at time 1. Solver will
continue simulation with the step size restricted to 3.55271E-15 and using an

effective relative error tolerance of 0.0135238, which is greater than the specified relative error tolerance of 0.001. This usually may be caused by the high stiffness of the system. Please check the system or increase the solver
<a
href="matlab:configset.internal.open('Car_Suspension_Model','MaxConsecutiveMinStep');">Num of consecutive min steps violation parameter.
Warning: Solver is encountering difficulty in simulating model '<a
href="matlab:open_system ('Car_Suspension_Model')">Car_Suspension_Model'
at
time 1.0000000000000038. Simulink will continue to simulate with warnings. Please check the model for errors.
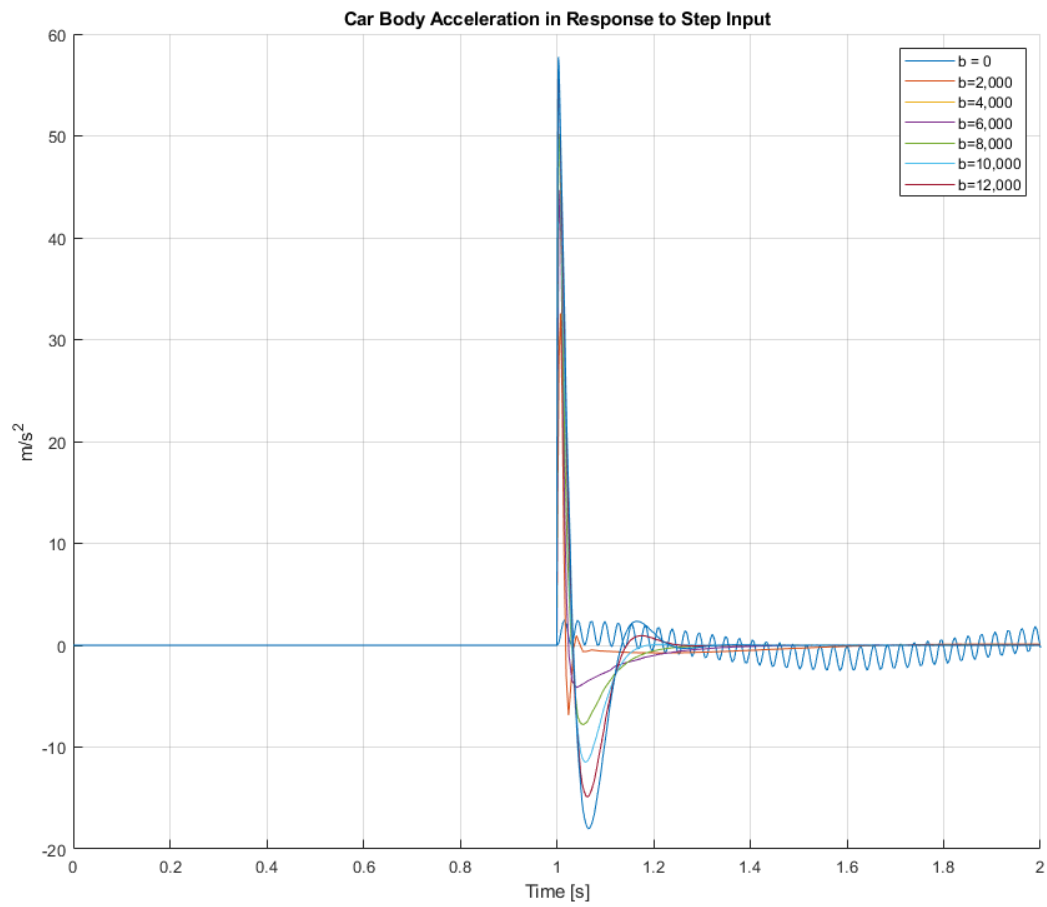*Warning: Solver was unable to reduce the step size without violating minimum step size of 3.55271E-15 for 1 consecutive times at time 1. Solver will continue simulation with the step size restricted to 3.55271E-15 and using an effective relative error tolerance of 0.0135238, which is greater than the specified relative error tolerance of 0.001. This usually may be caused by the high stiffness of the system. Please check the system or increase the solver*
<a
href="matlab:configset.internal.open('Car_Suspension_Model','MaxConsecutiveMinStep');">Num of consecutive min steps violation parameter.
Warning: Solver is encountering difficulty in simulating model '<a
href="matlab:open_system ('Car_Suspension_Model')">Car_Suspension_Model'
at
time 1.0000000000000038. Simulink will continue to simulate with warnings. Please check the model for errors.
Warning: Solver was unable to reduce the step size without violating minimum step size of 3.55271E-15 for 1 consecutive times at time 1. Solver will continue simulation with the step size restricted to 3.55271E-15 and using an effective relative error tolerance of 0.0135238, which is greater than the specified relative error tolerance of 0.001. This usually may be caused by the high stiffness of the system. Please check the system or increase the solver
<a
href="matlab:configset.internal.open('Car_Suspension_Model','MaxConsecutiveMinStep');">Num of consecutive min steps violation parameter.

Published with MATLAB® R2021b