Second Order System Response LabVIEW GUI Assignment

The following exercises can be used with the Single Degree of Freedom System Response LabVIEW GUI to better understand its capabilities and the concepts which it illustrates.

Free Response

Set the "Response type" to "Free response".

1. Give the system some initial displacement. Could you determine the initial displacement from the plot alone, if you didn't already know what it was?

2. Re-set the initial displacement to zero, and give the system an initial velocity. How does the time response differ from that for the system with an initial displacement? Do either of the other plots (frequency response or root locus) differ?

3. Give the system some combination of an initial displacement and initial velocity, and observe the time response.

Impulse Response

Set the "Response type" to "Impulse response".

4. Set the initial displacement and velocity to zero, and give the system an impulse input. Observe the time response. How could you determine that this was an impulse response, based solely on the time response?

5. Add an initial displacement, along with the impulse, and observe the response.

6. Compare the initial velocity response and the impulse response. Do they differ? Would you be able to tell them apart based only on the time response?

Step Response

Set the "Response type" to "Step response".

7. With the default values of mass, damping, and stiffness (1, 0.5, and 10, respectively), what is the force input to the system to achieve the unit step?

8. Change the stiffness. Now what is the force input required to obtain a unit step? If you do not understand how to calculate the force input, refer to the note at the bottom of the GUI or the second-order step response tutorial.

9. If the initial displacement and velocity remain set to zero, how can you see that this is a step response, based only on the response plot?

10. Give the system a combination of step input, and initial displacement and velocity, and observe the effect on the response.

Using any response type:

11. Set two parameters (mass, damping, or stiffness) and adjust the third to observe the effects on the three plots

12. Set the mass to 5. Adjust damping and/or stiffness to achieve a natural frequency of 3 rad/sec (note that you are given the natural frequency in Hz, not rad/sec) and an approximate maximum frequency response magnitude of 10^{-1}. Notice the pole locations on the root locus plot and the damping ratio.

13. Set damping to 20. Adjust the mass and/or stiffness to get two real roots as indicated by the root locus plot. Which parameter had a greater effect? What is the critical damping, and how does this relate to the current damping of the system?

14. Repeat the above exercise and adjust the mass and/or stiffness to get two repeated roots as indicated by the root locus plot. How do you know that they are indeed two repeated roots?

15. Set the stiffness to 30. Adjust the mass and/or damping to achieve a natural frequency of 1 Hz. Were you able to do this? Adjust the stiffness until the natural frequency is 1 Hz.

16. Set the mass to 5 and the stiffness to 100. Look at the frequency response plot and observe the shape and location of the peak at the natural frequency. Now change the damping, observe the change in the natural frequency and damped natural frequency, and compare to the frequency response.

17. Adjust the parameters until the critical damping is approximately 30 lbf-s/in. How does each of the parameters affect the critical damping?