SEHS4653 Control System Analysis

Experiment 1 : Transient response analysis of continuous systems

Objective : To investigate the time domain characteristics of control systems such as step response and impulse response using Matlab.

Equipment : PC computer, Matlab with Simulink, Introduction to Matlab, Quick start on Simulink

Procedure :

Part 1 of the Experiment (Use of Simulink):

1. Open the software "Matlab". Type "simulink" in the command window.

2. Select "Blank Model" under "New" tab of Simulink window.

3. Click the "Library Browser" in the menu bar. The library of different blocks will be shown on the left-hand side of the window.

4. Locate the "Simulink" library in the Library Browser. Double-click it and a dropdown menu will be shown.

5. Identify different blocks in the control system shown in Figure 1 and then search for correct blocks in the Library Browser.

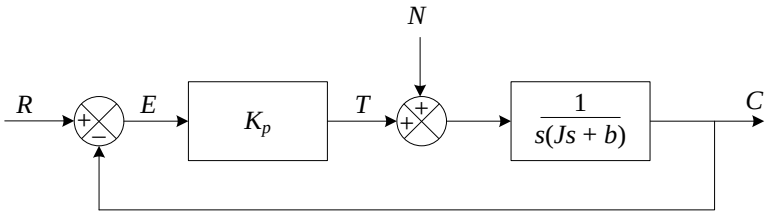

Figure 1

6. Once a suitable block is identified, drag and drop the block on the workspace on the right-hand side of the Library Browser.

7. Placing the mouse cursor over the arrow of a block. Hold the left click of the mouse, a red dotted line will appear. Move the line to another block for making a connection. The result will be similar to Figure 1.

8. In this control system the proportional controller (with proportional gain = K_P) delivers torque T to position the load element, which consists of moment of inertia (J) and viscous friction (b). The torque disturbance to the system is denoted by N. Determine the steady-state error due to a unit-step disturbance torque when the reference input $R(s) = 0$.

9. Hence, obtain the system response for the following cases.

Case 1: $J = 1, \quad b = 0.5, \quad K_p = 1$
Case 2: $J = 1, \quad b = 0.5, \quad K_p = 4$

Discussion Questions:

10. Comment on your results in Step 9.

11. Based on the controllers you have learnt, design a controller that can eliminate the steady state error of the system. Comment on the performance of your designed controller.

Part 2 of the Experiment (Use of Command Window):

12. Consider the mechanical system shown in Figure 2. Write down the differential equation for modeling this mechanical system.

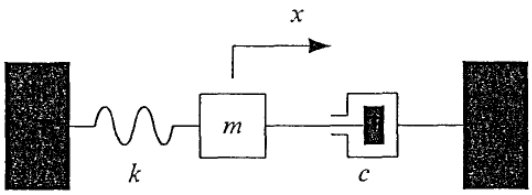

Figure 2.

13. Using the Laplace Transform Table, obtain the transfer function of the system where m = 1 Kg, c = 3 N-s/m, and k = 2 N/m. Assume that at t = 0 the mass m is pulled to the right such that $x(0)$ = 0.1 m and $\dot{x}(0) = 0.05$ m/s.

14. Input the transfer function obtained in Step 13 into Matlab via the "Command Window". One of the command you may use is "tf" – construct transfer function. You may type "help tf" in command window to learn how to use this command.

15. Once enter the transfer function into Matlab, obtain the system response (motion of the mass) subjected to the initial conditions given above in the command window. You need to determine whether it is a step response or impulse response because selecting suitable command to do the simulation.

Discussion Questions:

16. Compare your simulated result obtained by Matlab in Step 15 with theoretical calculation.

17. Comment on using computer simulation over actual plant testing.

End of Experiment 1

Updated on 31 August 2023