CASE STUDY #6: Applications of control systems: An electric transportation system

Control systems are widely used in transportation, especially in Europe and Japan where electric traction trains are a common transportation means. The desired speed is the input to the system that controls the rate of acceleration, with override by the operator in case of an emergency.

The following block diagram represents the transfer function between a motor drive (input signal) and the velocity of the vehicle in feet per second.

1.- Calculate the steady-state velocity of the vehicle (in feet/sec.) if the input $R(s)$ is a step signal.

The previous vehicle is part of a feedback system for velocity control where $V_R(s)$ is the desired input velocity. The block diagram for this system is shown below:
2.- Explain the previous block diagram

3.- Calculate the transfer function $T_V(s)$ between the output velocity $V(s)$ and the desired input velocity $V_D(s)$.

The error signal will be: $E_V(s) = V_D(s) - V(s) = [1 - T_V(s)] V_D(s)$

Note that this case is different from the usual cases because the feedback is not unity.

4.- Convert the system into a unity-feedback system

5.- What Type is the system?

6.- Calculate the steady-state error for position and velocity. It may be necessary to do some approximations

7.- Comment on the differences between the poles of this system and the poles of the vehicle by itself. How have they changed?

To achieve control of the vehicle position, a second feedback loops needs to be added, what results in the following block diagram:

8.- Calculate the total transfer function

9.- Plot the time response for a step input

9.- Evaluate the stability of the system

10.- What system Type is this?

11.- Calculate the steady-state errors for a step, ramp and parabolic inputs

12.- Create the lab report following the guidelines.
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SUMMARY SHEET

To be completed during the laboratory period
Submit it to the instructor at the end of the laboratory period

1.- Type of System:

2.- Discuss system stability:

3.- Steady-state error for a ramp input

Instructor’s Signature and Date: