Chapter 5

Reduction of Multiple Subsystems

Chapter Objectives

In this chapter you will learn the following:

- How to reduce a block diagram of multiple subsystems to a single block representing the transfer function from input to output
- How to analyze and design for transient response, a system consisting of multiple subsystems
- How to represent in state space a system consisting of multiple subsystems
- How to convert between alternate representations of a system in state space

SKIP SEC. 5.7 & 5.8
Figure 5.2
Components of a block diagram for a linear, time-invariant system
Figure 5.3

a. Cascaded subsystems;
b. equivalent transfer function
Figure 5.4
Loading in cascaded systems

\[ G_1(s) = \frac{V_1(s)}{V_i(s)} \]

\[ G_2(s) = \frac{V_2(s)}{V_1(s)} \]

\[ G_T(s) = \frac{V_2(s)}{V_i(s)} \cdot G_2(s) \cdot G_1(s) \]

\[ G_1 \text{ loads } G_2 \]

\[ G_2 \text{ does not load } G_1 \]
Figure 5.5

a. Parallel subsystems;
b. equivalent transfer function

\[ X_1(s) = R(s)G_1(s) \]
\[ X_2(s) = R(s)G_2(s) \]
\[ X_3(s) = R(s)G_3(s) \]

\[ C(s) = \pm G_1(s) \pm G_2(s) \pm G_3(s) \]
Figure 5.6
a. Feedback control system;
b. simplified model;
c. equivalent transfer function
Figure 5.7
Block diagram algebra for summing junctions—equivalent forms for moving a block
a. to the left past a summing junction;
b. to the right past a summing junction
Figure 5.8
Block diagram algebra for pickoff points—equivalent forms for moving a block
a. to the left past a pickoff point;
b. to the right past a pickoff point

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Nise/Control Systems Engineering, 3/e