Chapter 12

Design via State Space

Nise/Control Systems Engineering, 3/e

Figure 12.1
An automatic pharmacy system showing a robot picking up drugs to deposit in boxes for individual patients at a hospital

Figure 12.2
a. State-space representation of a plant;
b. plant with state-feedback

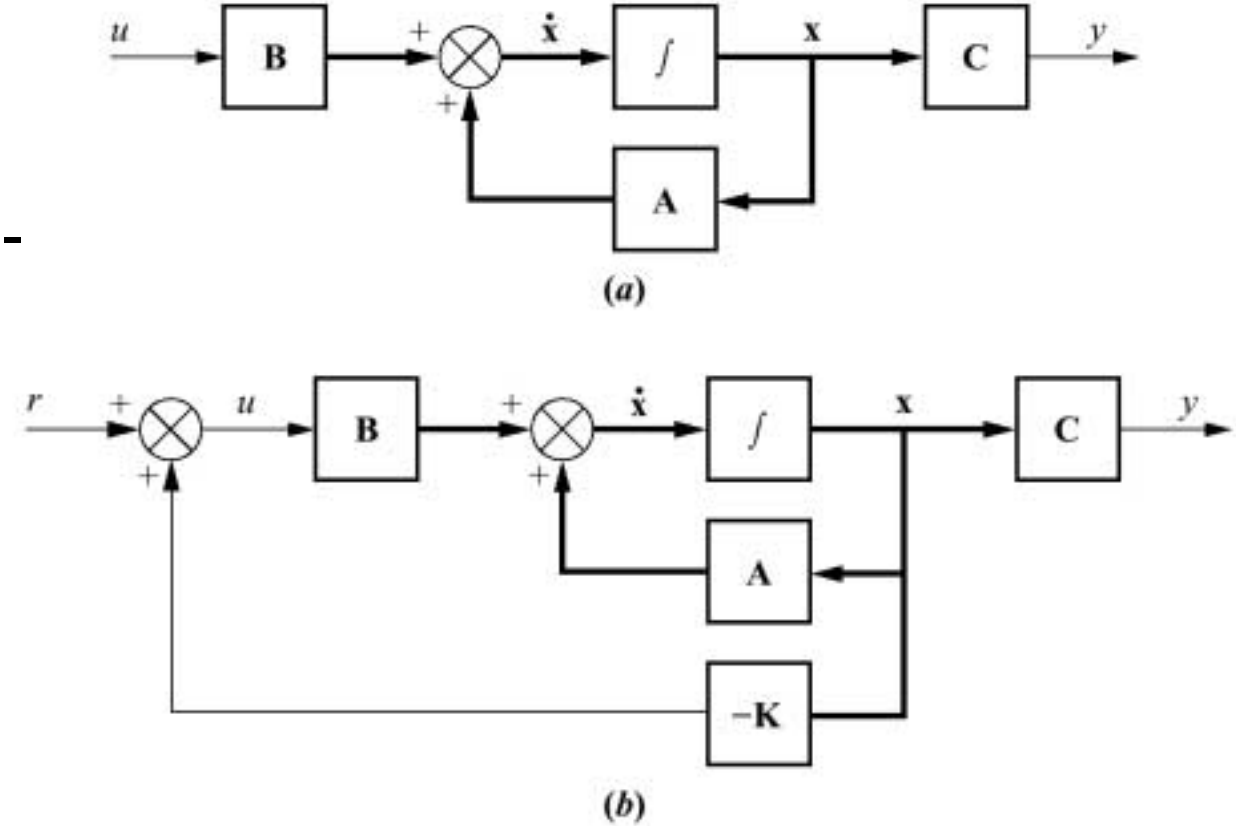


Figure 12.3
a. Phase-variable representation for plant;
b. plant with state-variable feedback

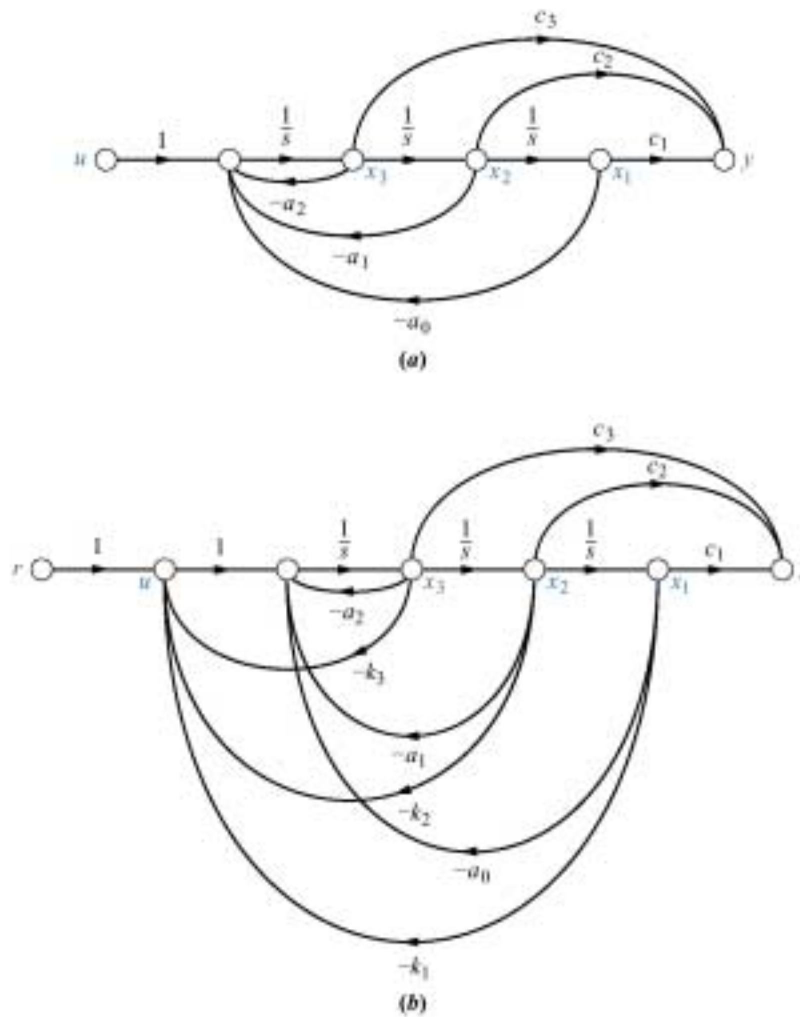
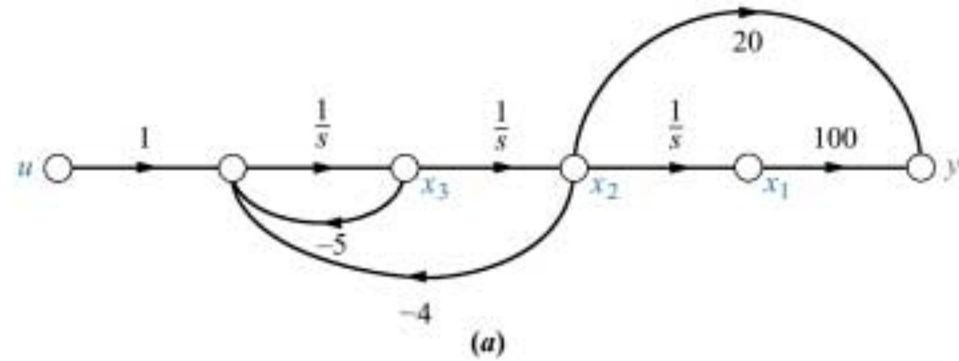


Figure 12.4
a. Phase-variable representation for plant of Example 12.1;
b. plant with state-variable feedback



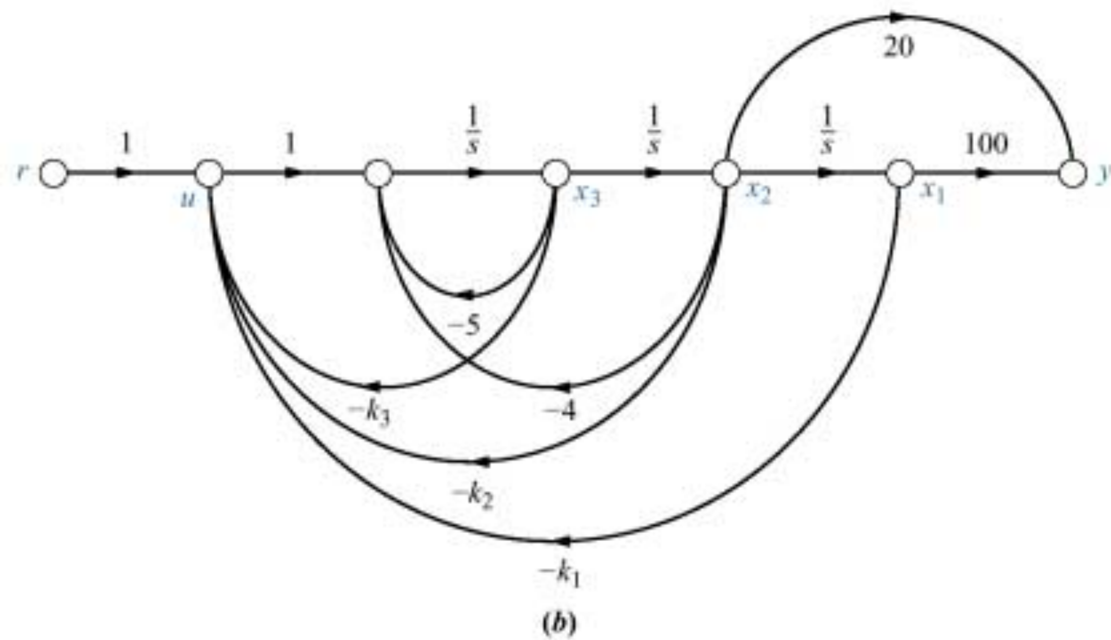


Figure 12.5
Simulation of closed-loop system of Example 12.1

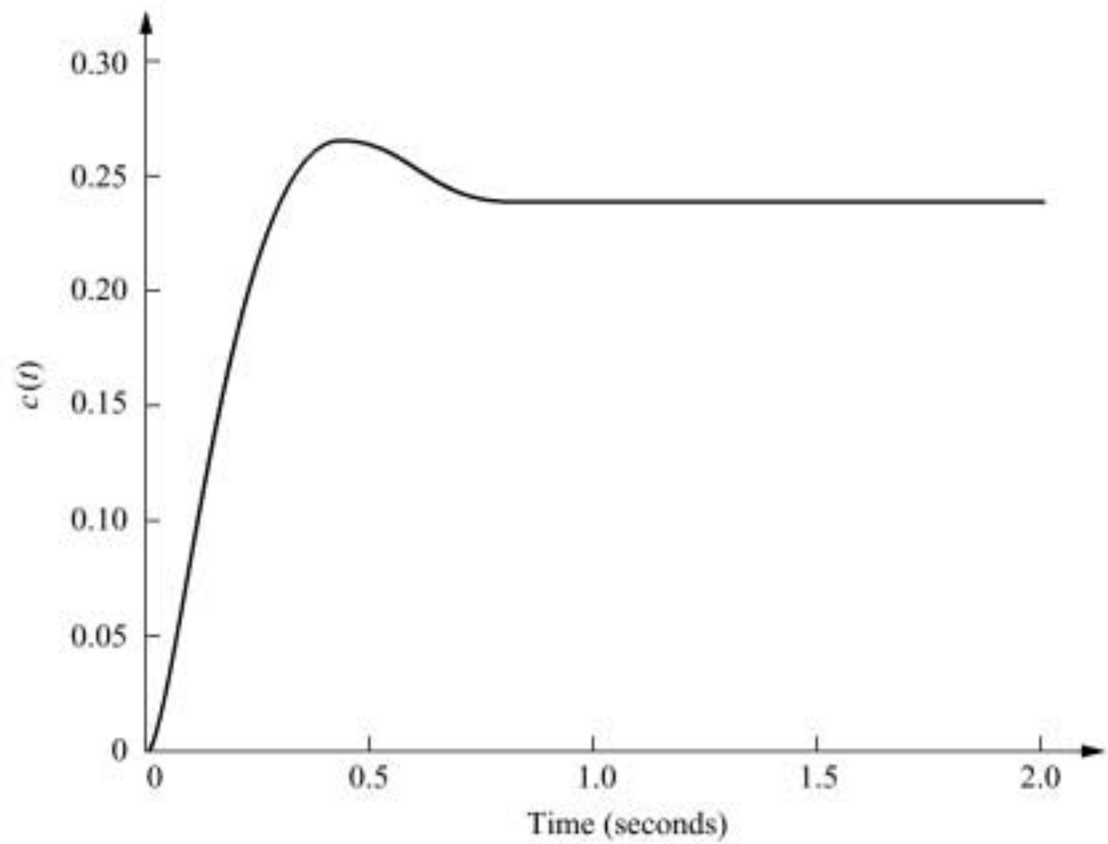


Figure 12.6
Comparison of
a. controllable and
b. uncontrollable
systems

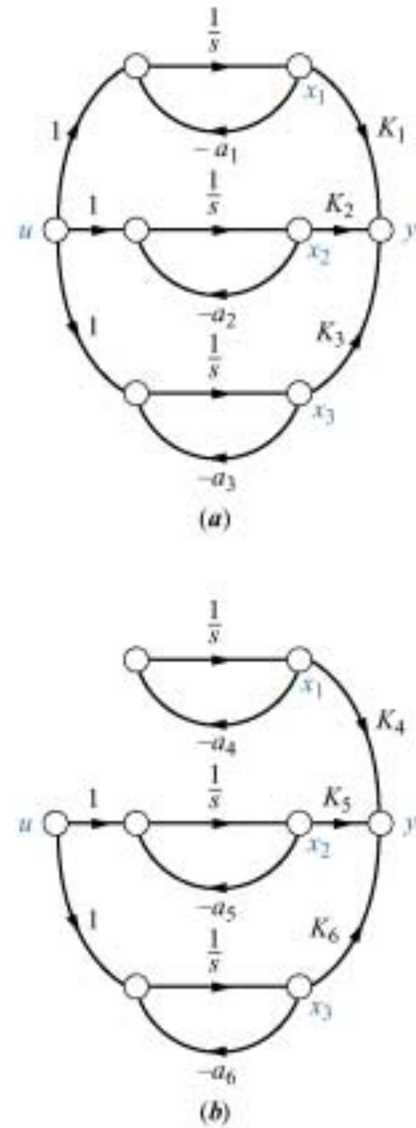


Figure 12.7
System for
Example 12.2

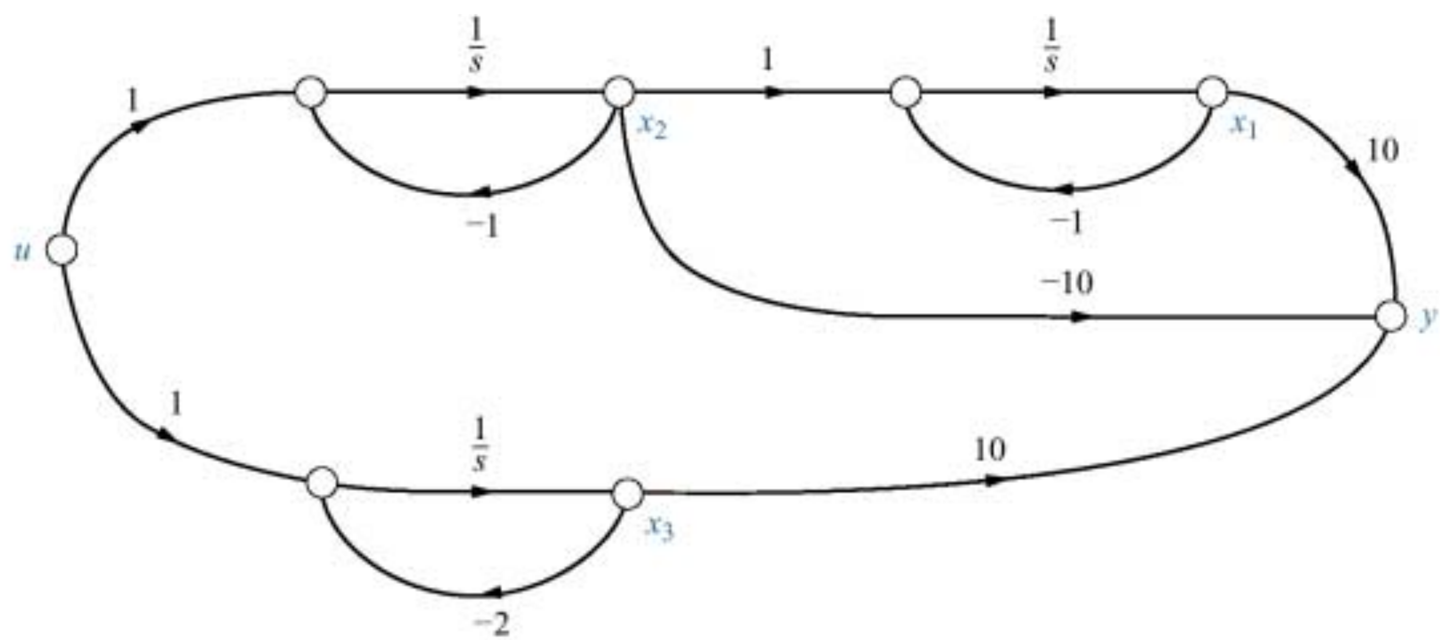


Figure 12.8
a. Signal-flow graph in cascade form for $G(s) = 10/[(s + 1)(s + 2)]$;
b. system with state feedback added

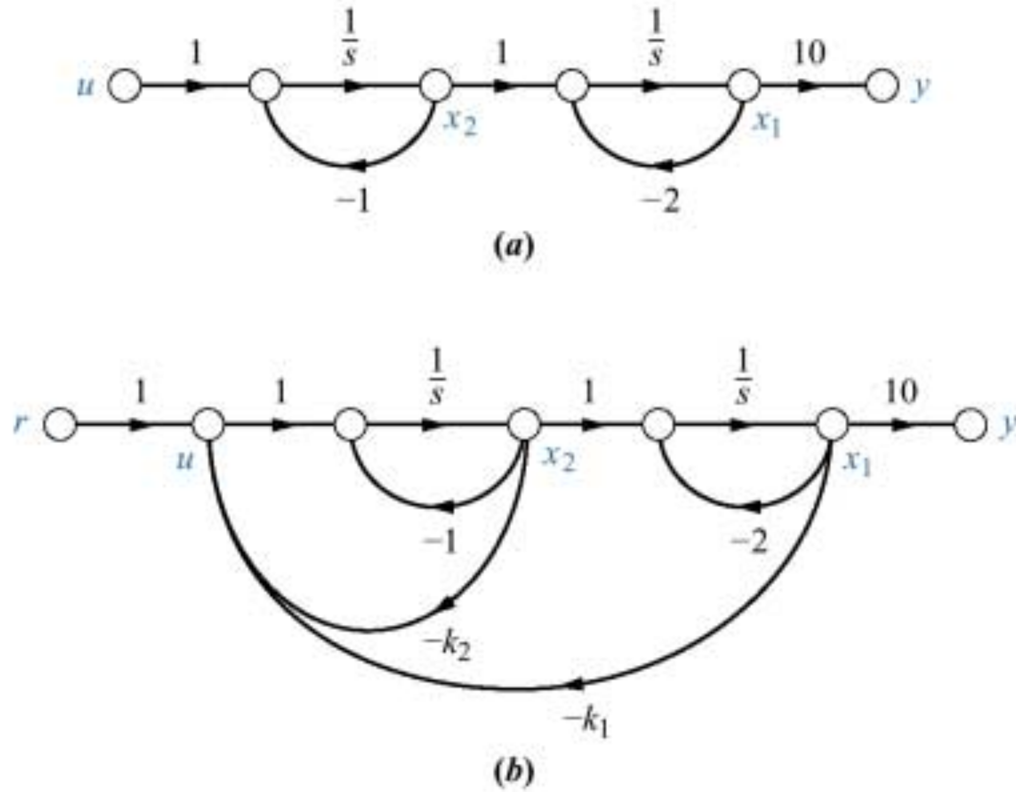


Figure 12.9
Signal-flow graph for plant of Example 12.4

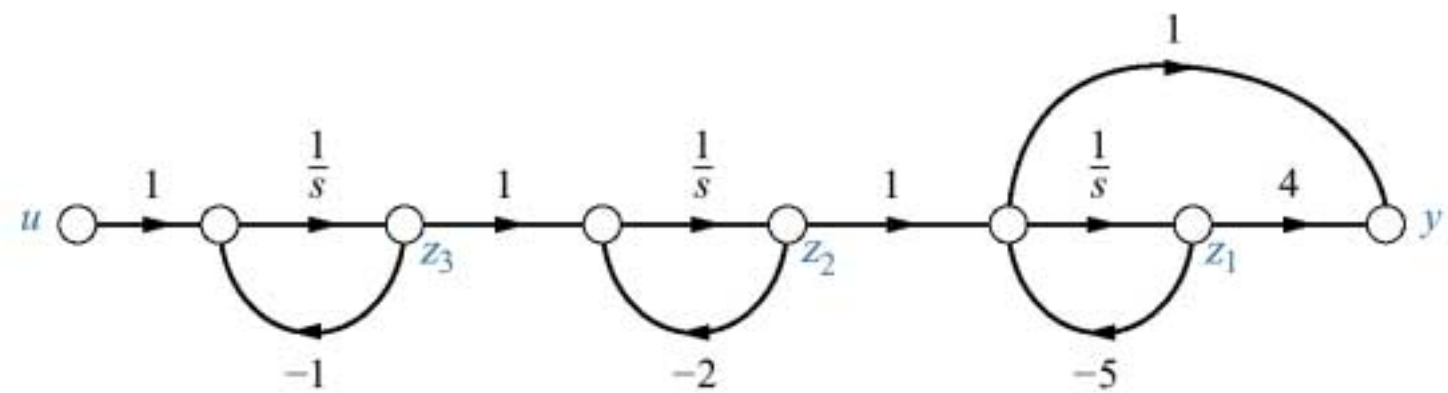


Figure 12.10
Designed system with state-variable feedback for Example 12.4

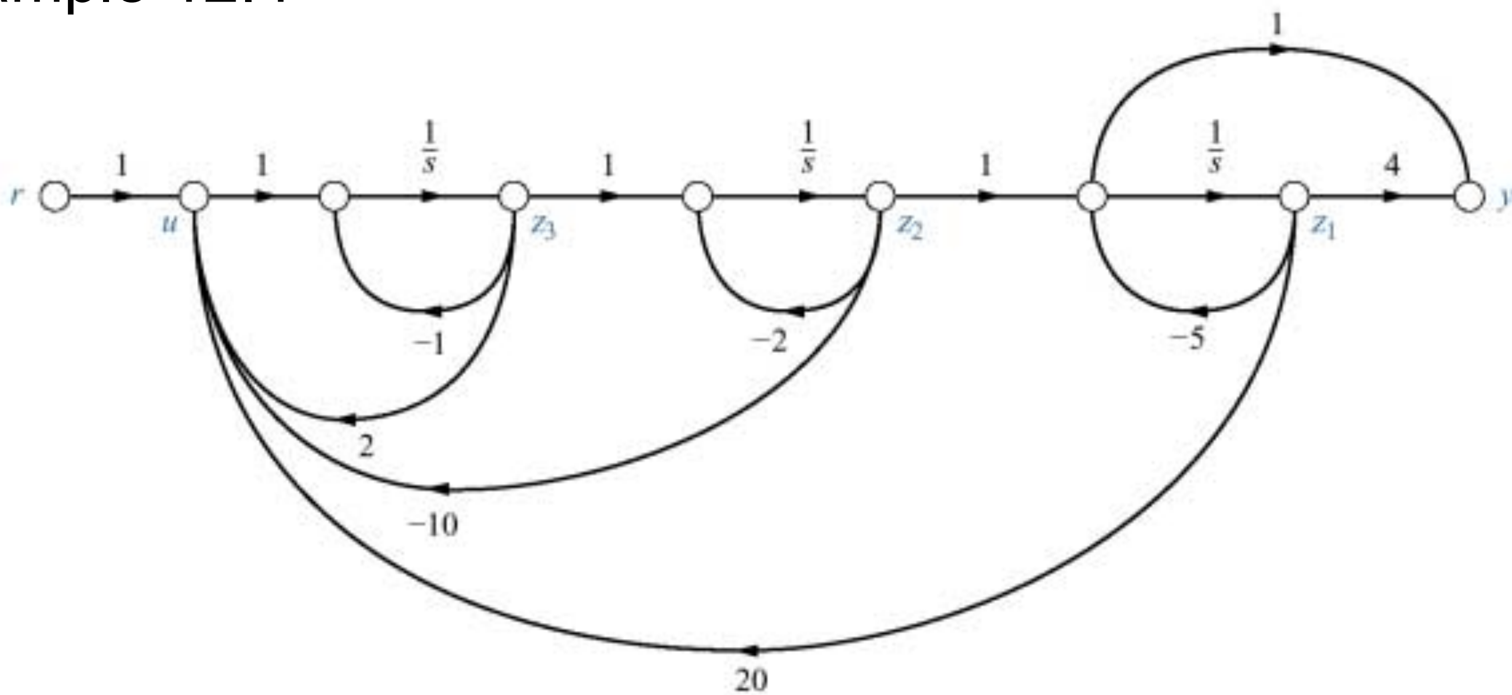


Figure 12.11
State-feedback design using an observer to estimate unavailable state variables:
a. open-loop observer;
b. closed-loop observer;
c. exploded view of a closed- loop observer, showing feedback arrangement to reduce state-variable estimation error

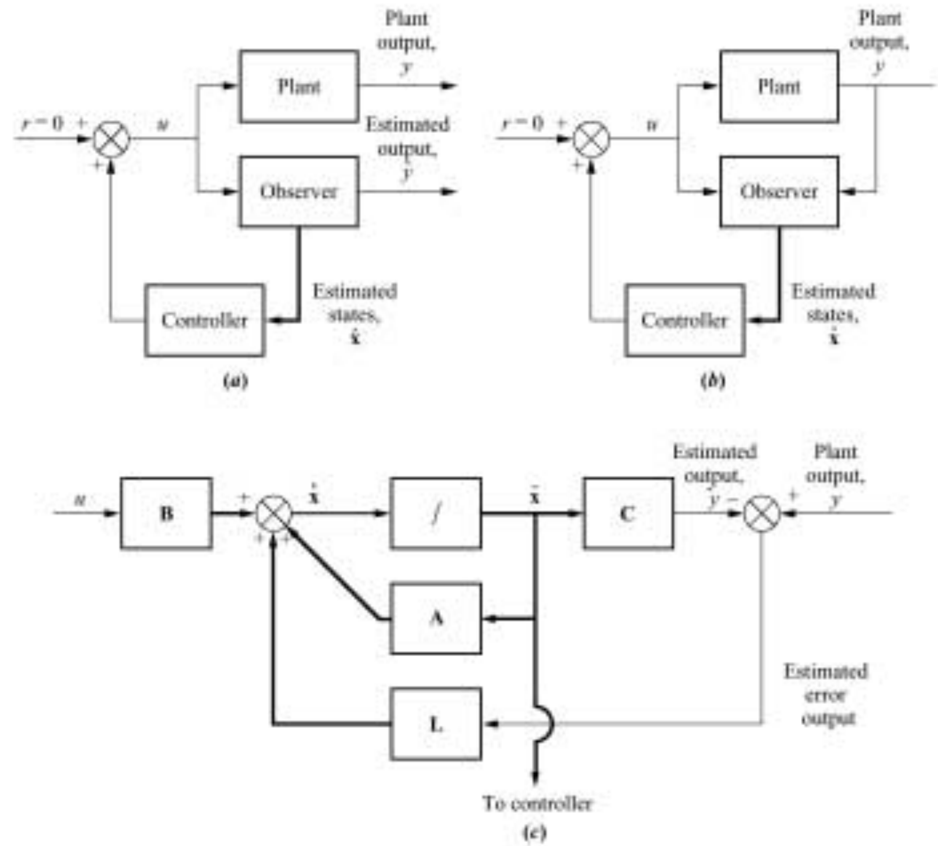


Figure 12.12
Third-order observer in observer canonical form:
a. before the addition of feedback;
b. after the addition of feedback

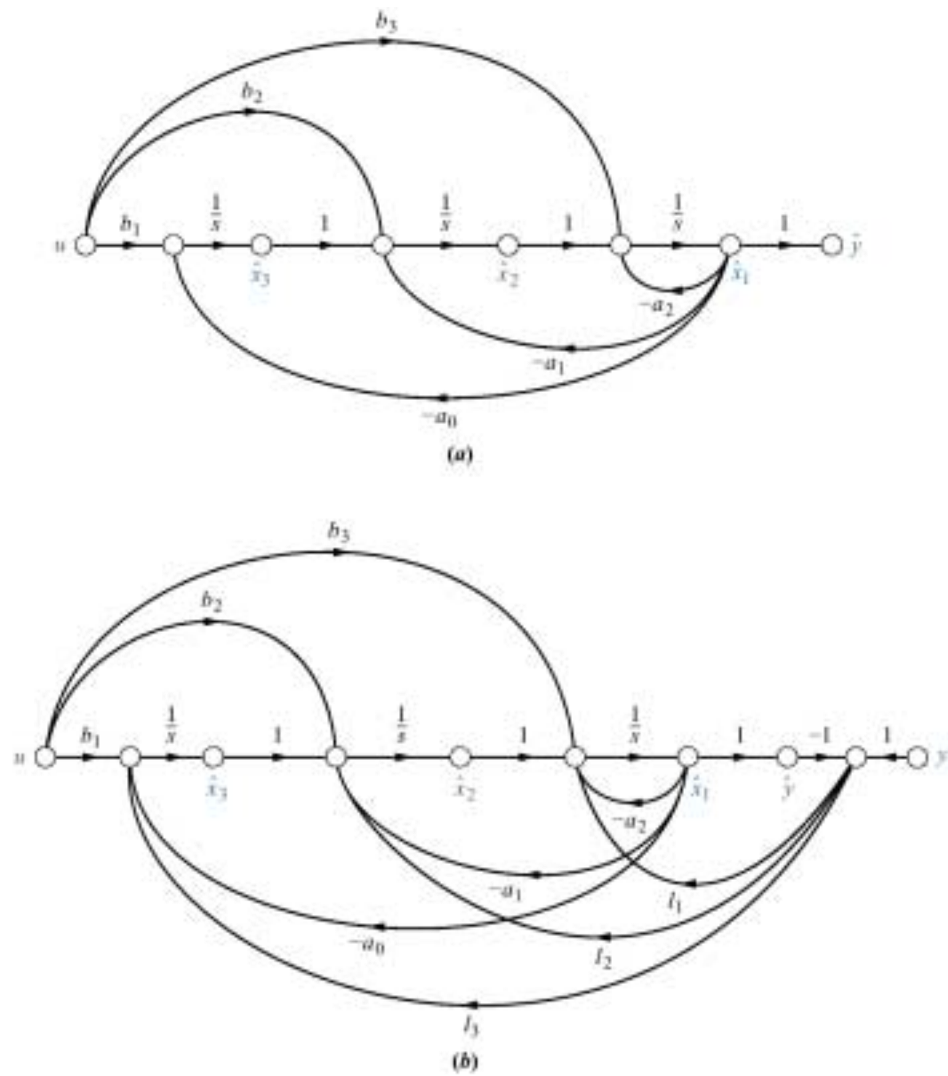


Figure 12.13
a. Signal-flow graph of a system using observer canonical form variables;
b. additional feedback to create observer

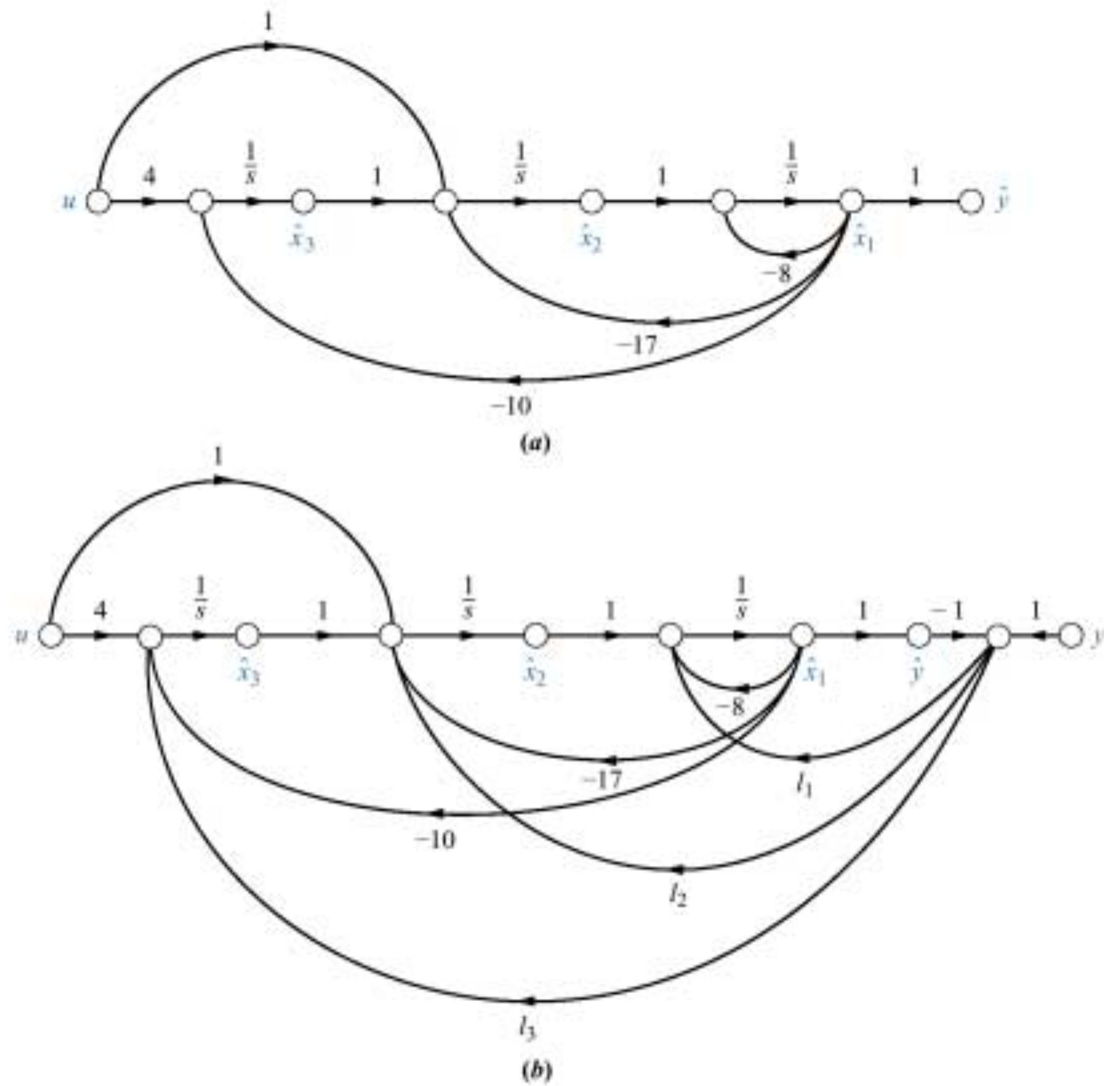
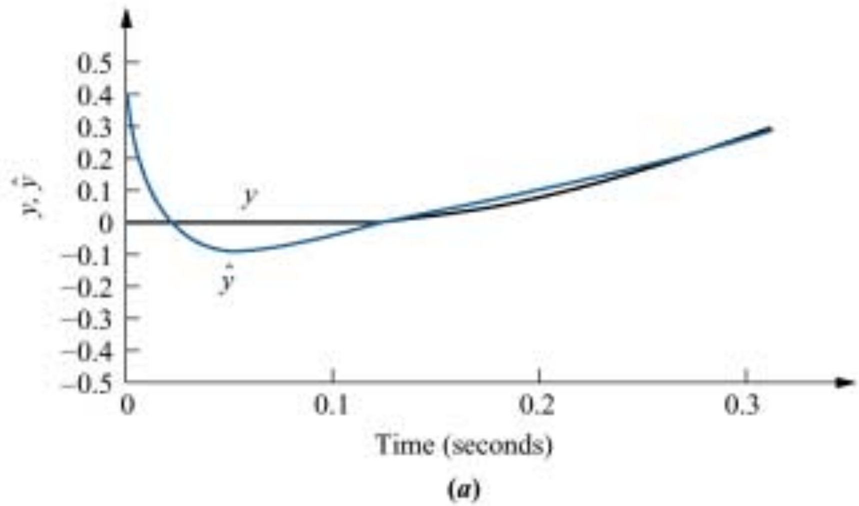


Figure 12.14
Simulation showing response of observer:
a. closed-loop;
b. open-loop with observer gains disconnected



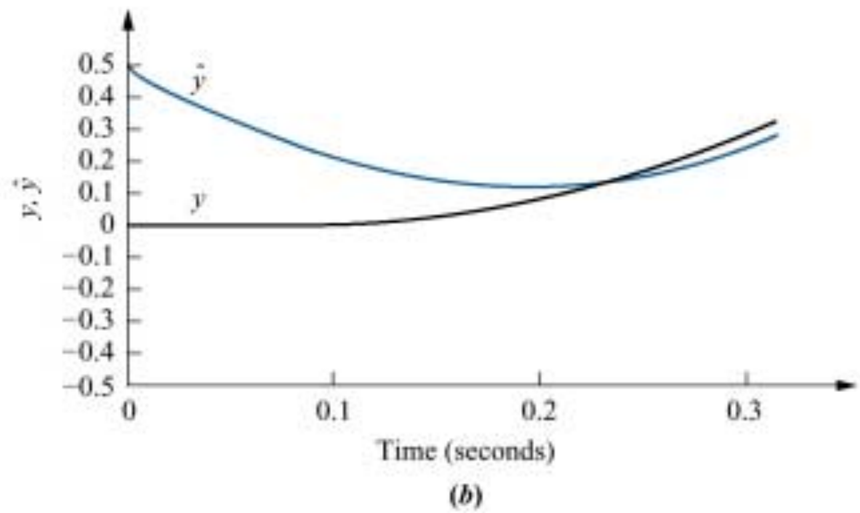


Figure 12.15
Comparison of
a. observable and
b. unobservable
systems

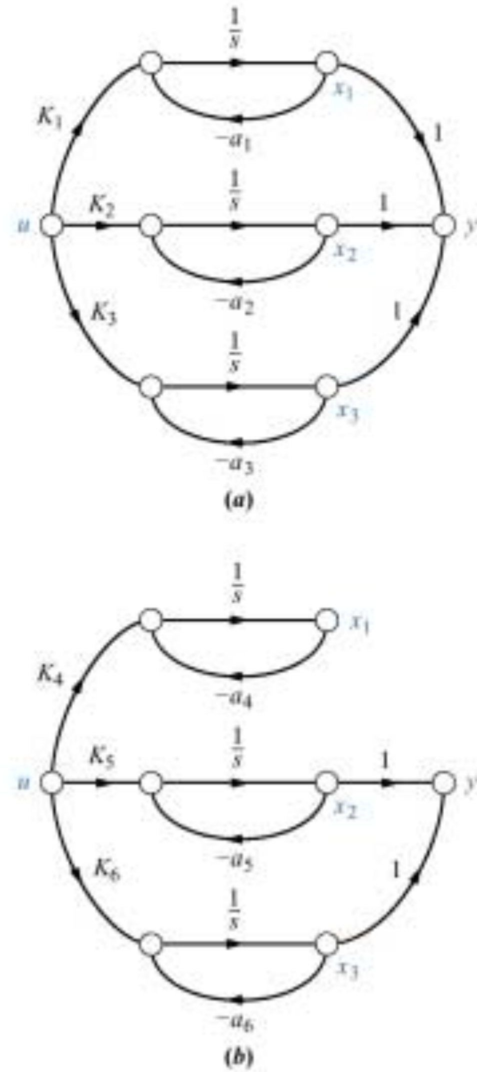


Figure 12.16
System of
Example 12.6

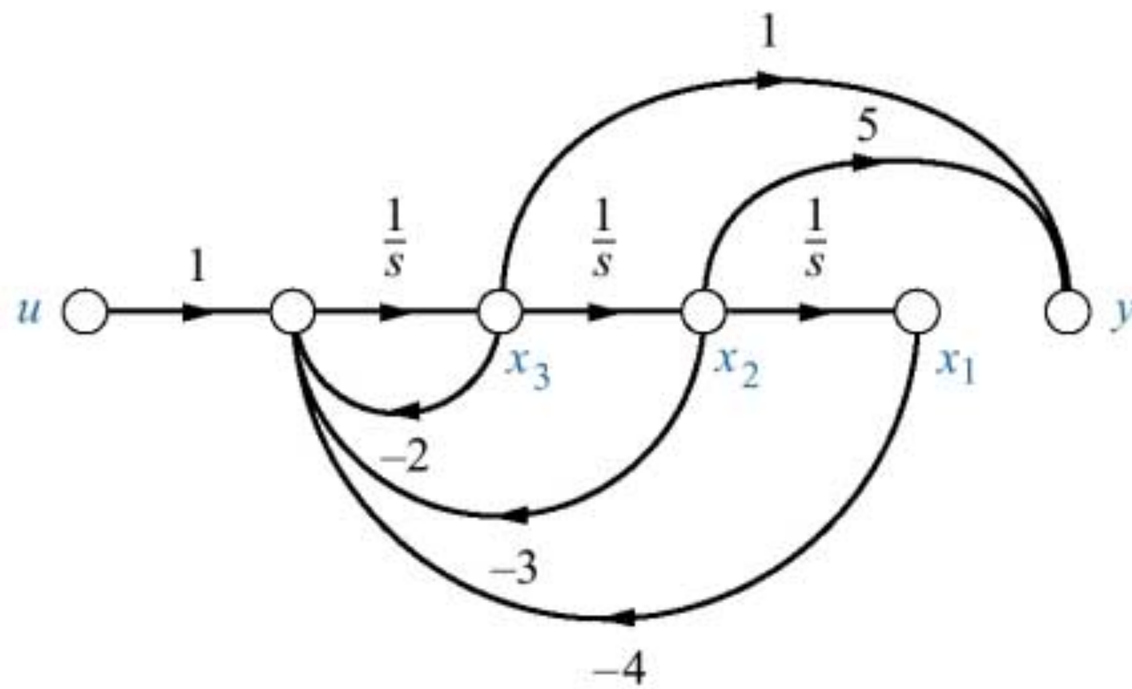


Figure 12.17
System of
Example 12.7

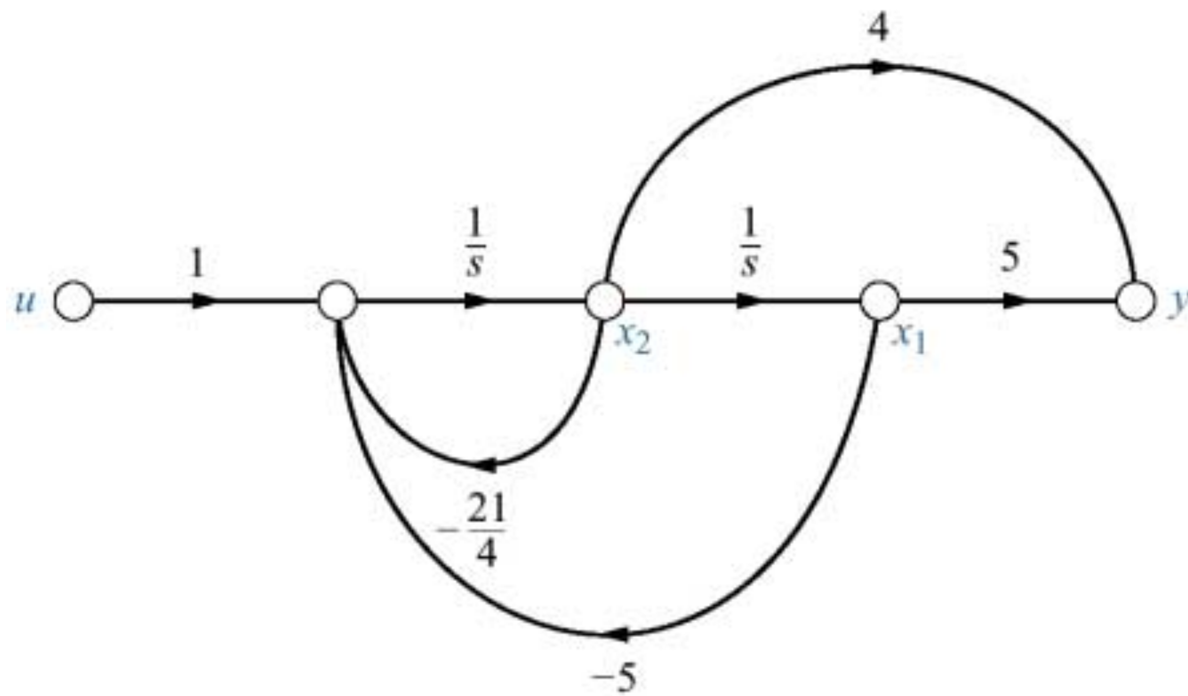


Figure 12.18
Observer design

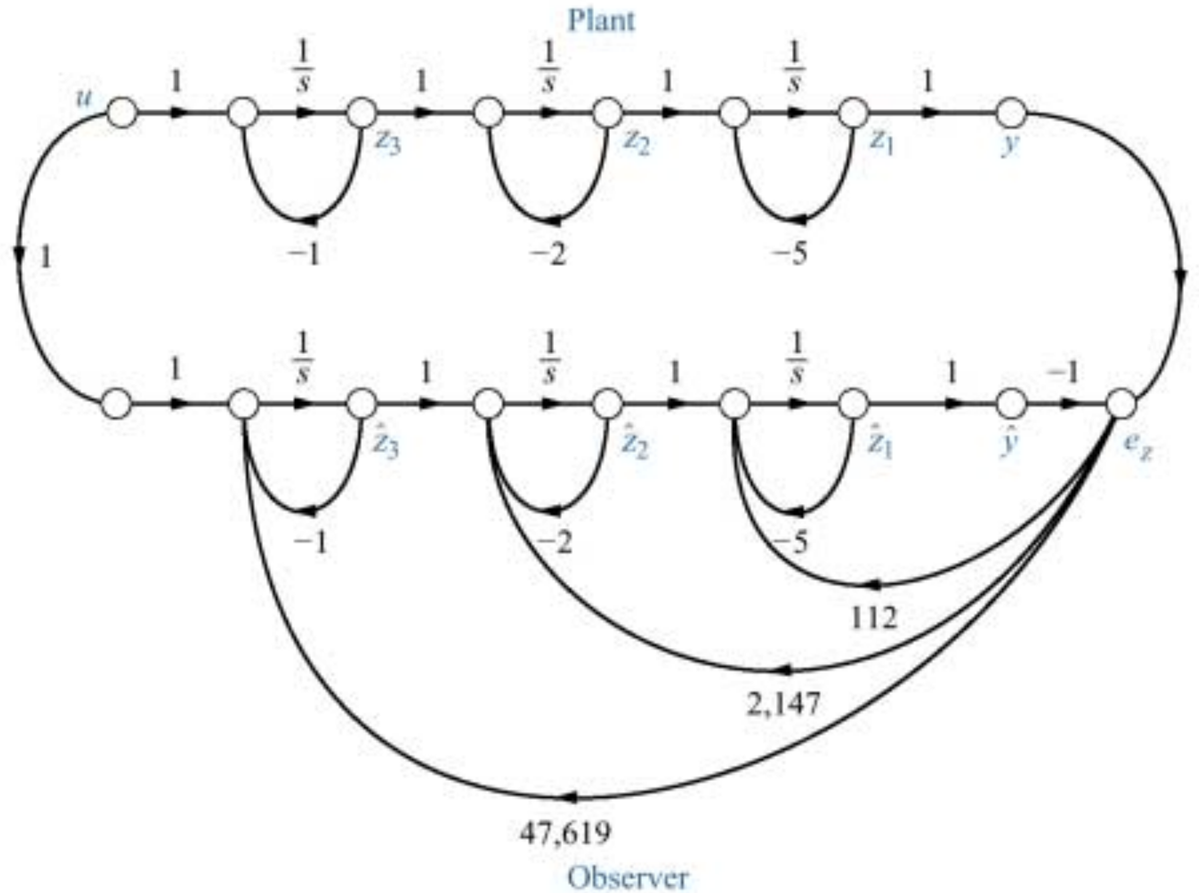


Figure 12.19
Observer design step response simulation:
a. closed-loop observer;
b. open-loop observer with observer gains disconnected

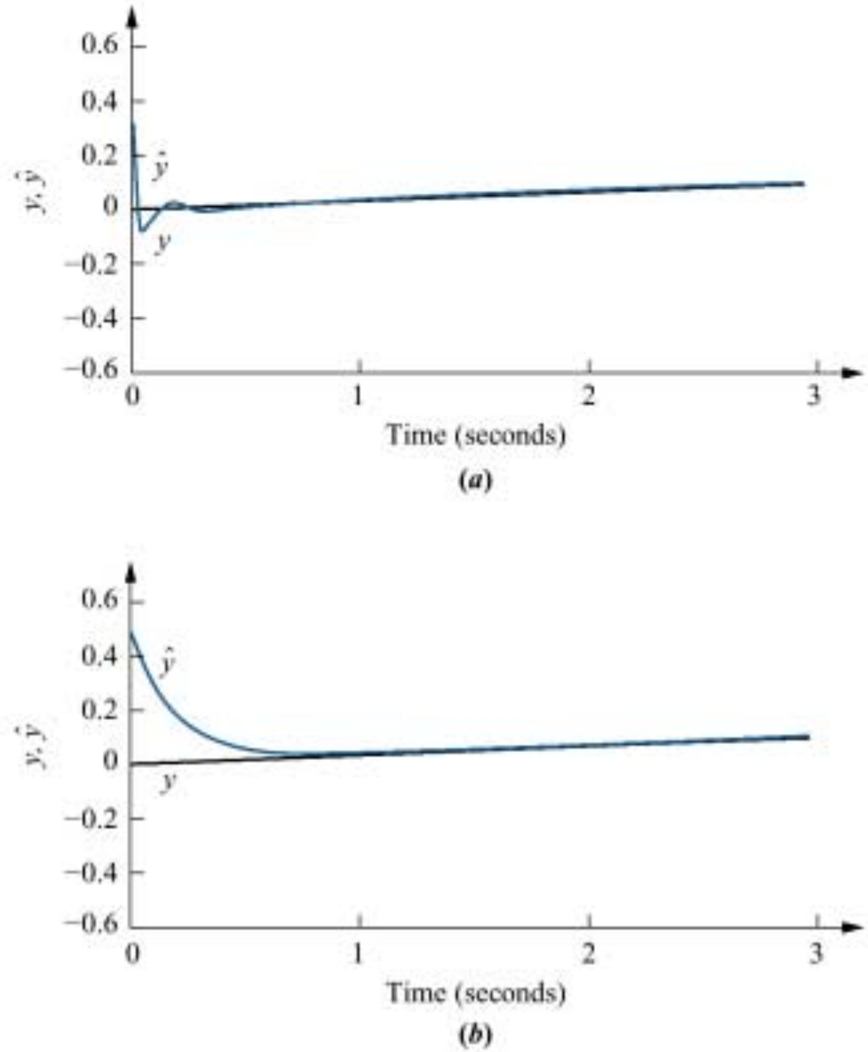
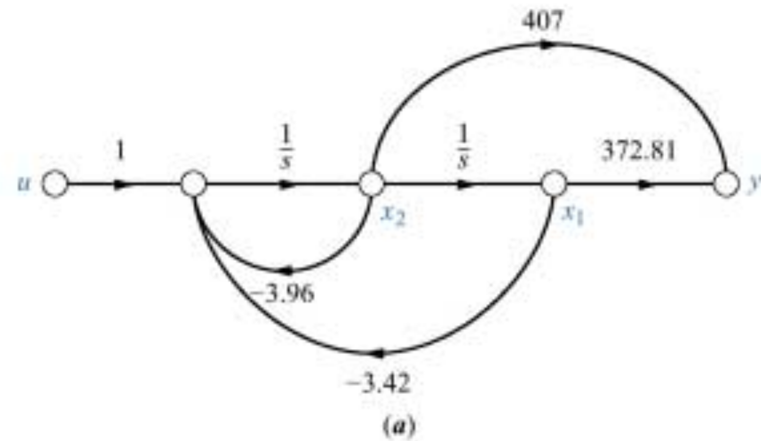


Figure 12.20
a. Plant;
b. designed observer for Example 12.9



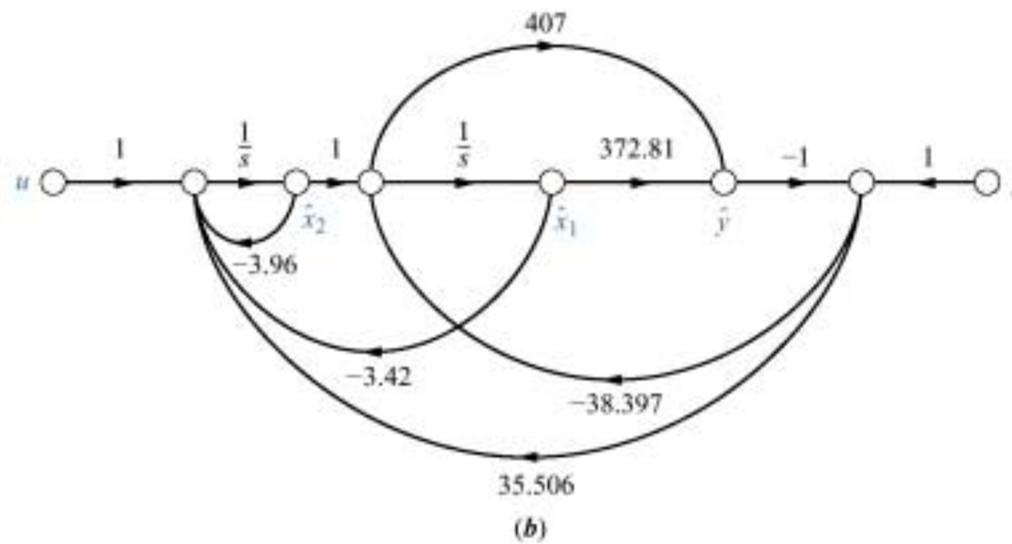


Figure 12.21
Integral control for steady-state error design

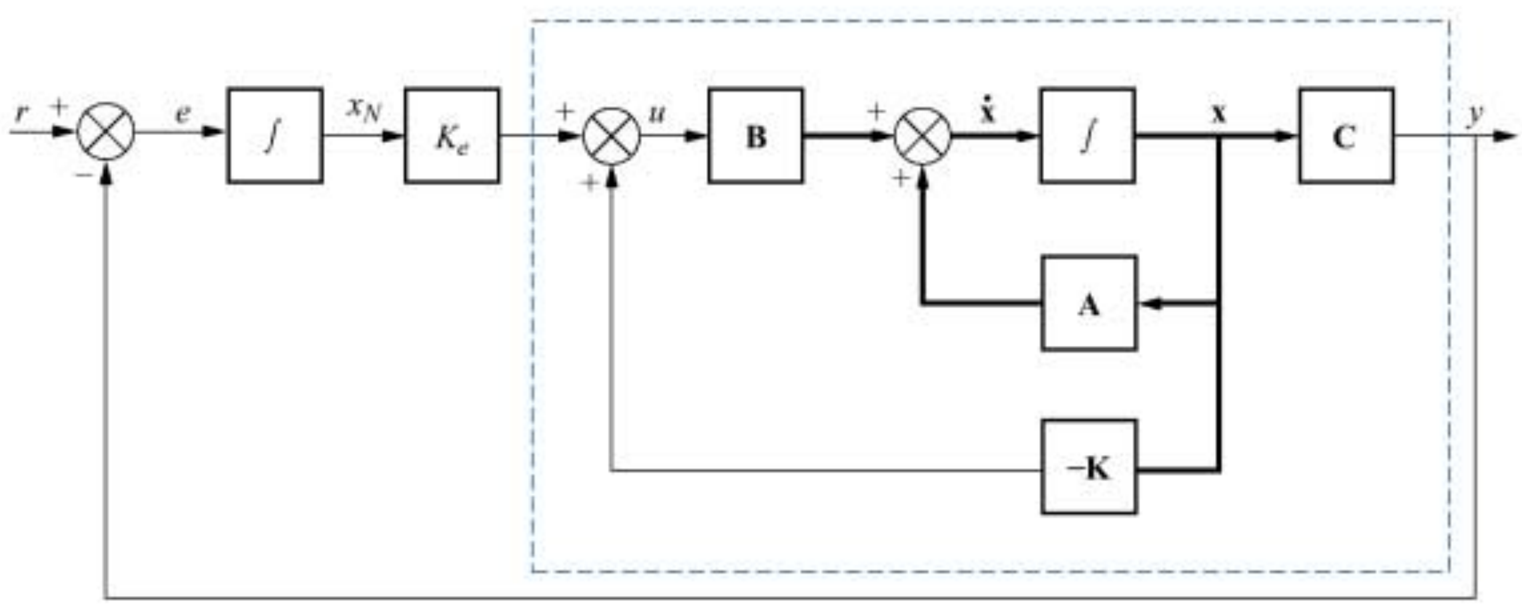


Figure 12.22
Simplified block diagram of antenna control system shown on the front endpapers (Configuration 1) with $K = 200$

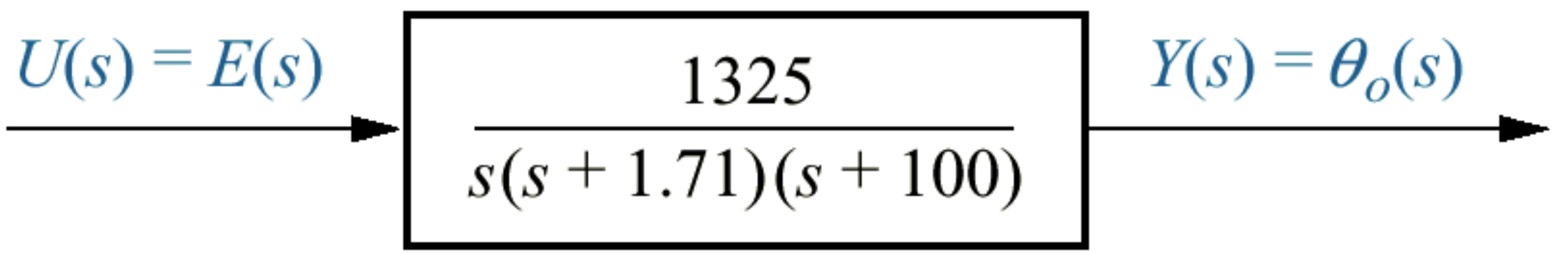


Figure 12.23
Conceptual state-space design configuration, showing plant, observer, and controller

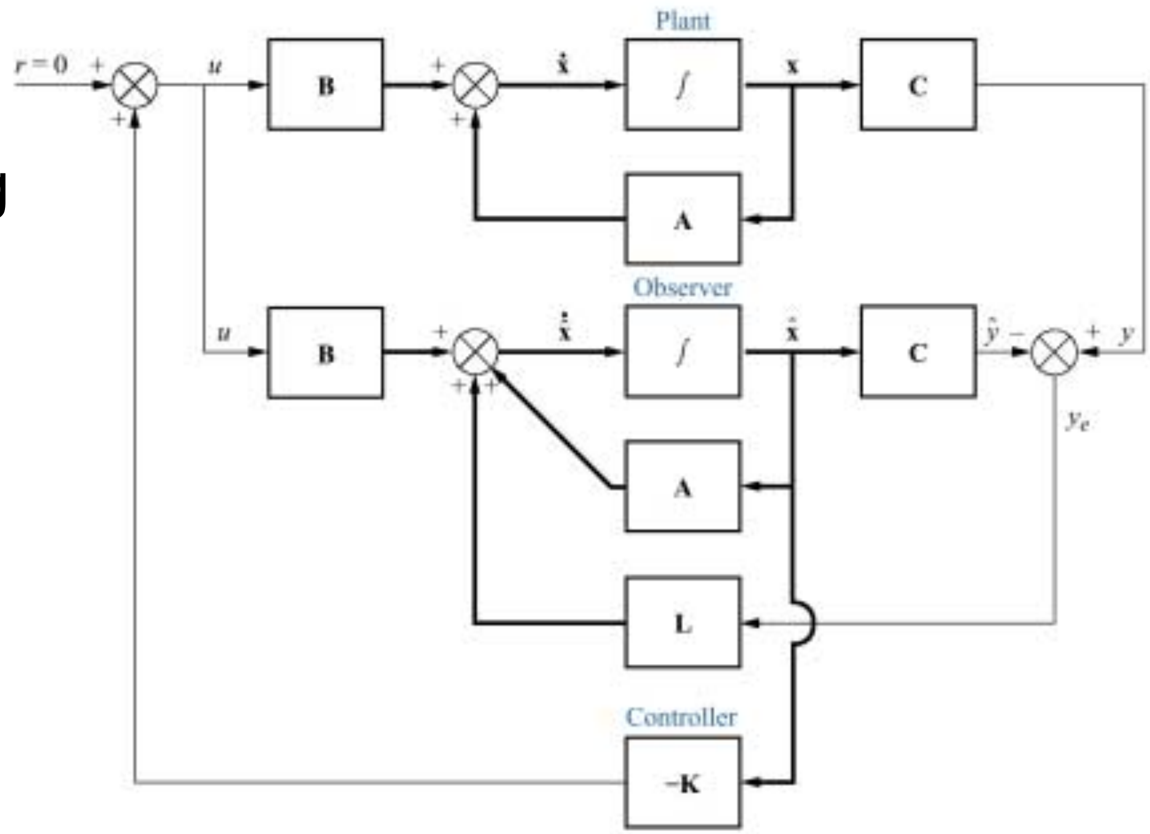


Figure 12.24
Signal- flow graph for
$G(s) = 1325/[s(s^2 + 101.71s + 171)]$

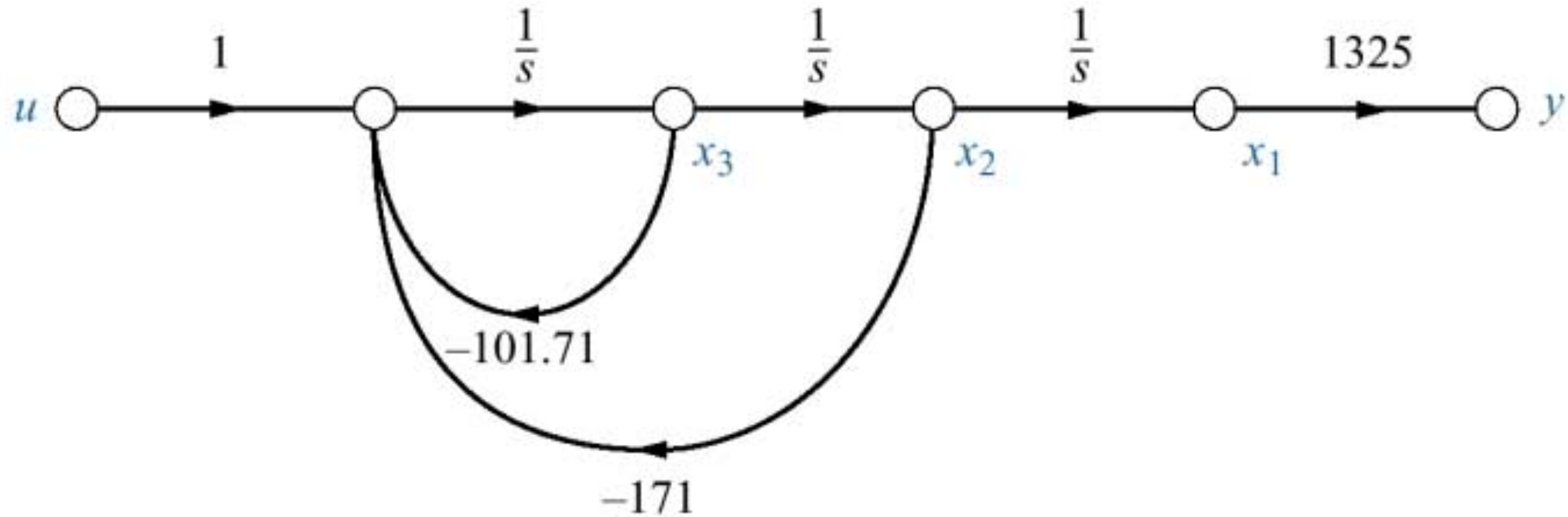


Figure 12.25
Plant with state-variable feedback for controller design

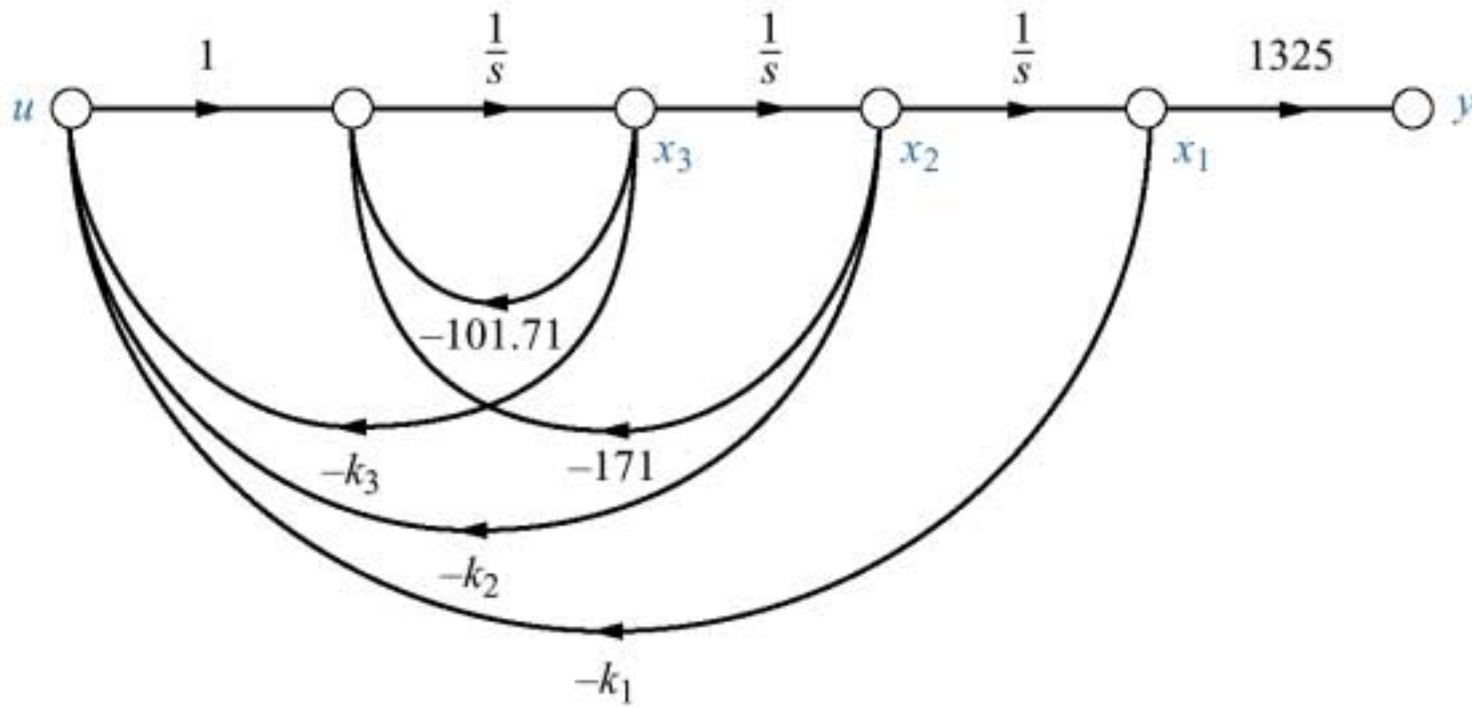


Figure 12.26 Completed state-space design for the antenna azimuth position control system, showing controller and observer

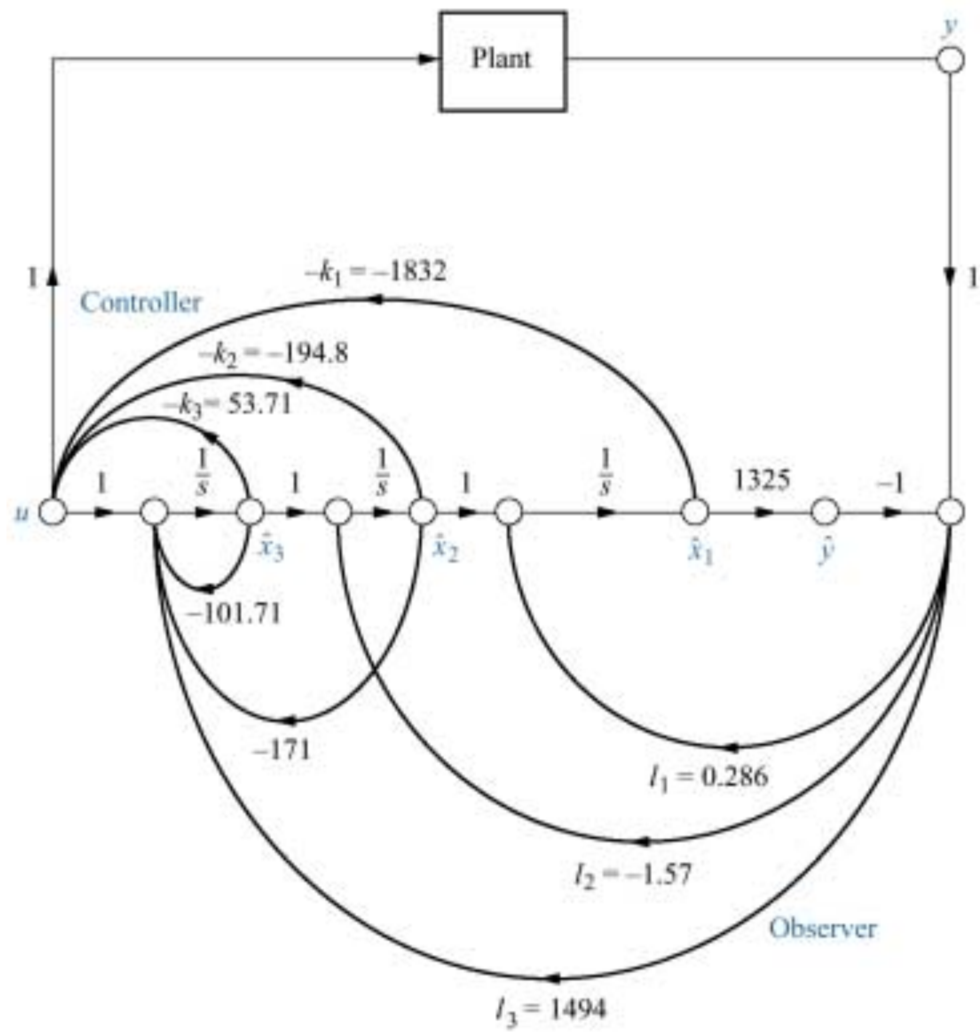


Figure 12.27
Designed response of antenna azimuth position control system:
a. impulse response—plant and observer with the same initial conditions. $x_1(0) = \hat{x}_1(0) = 0$;
b. portion of impulse response—plant and observer with different initial conditions, $x_1(0) = 0.006$ for the plant, $\hat{x}_1(0) = 0$ for the observer

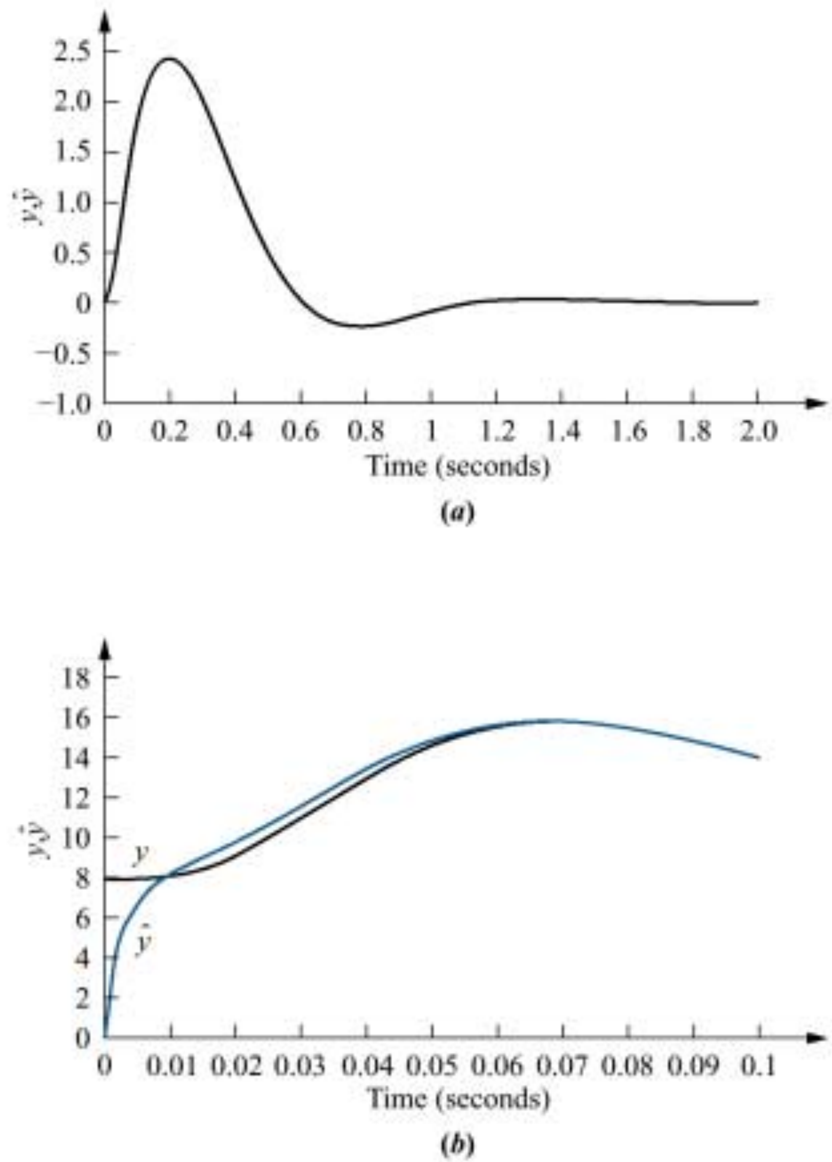


Figure P12.1

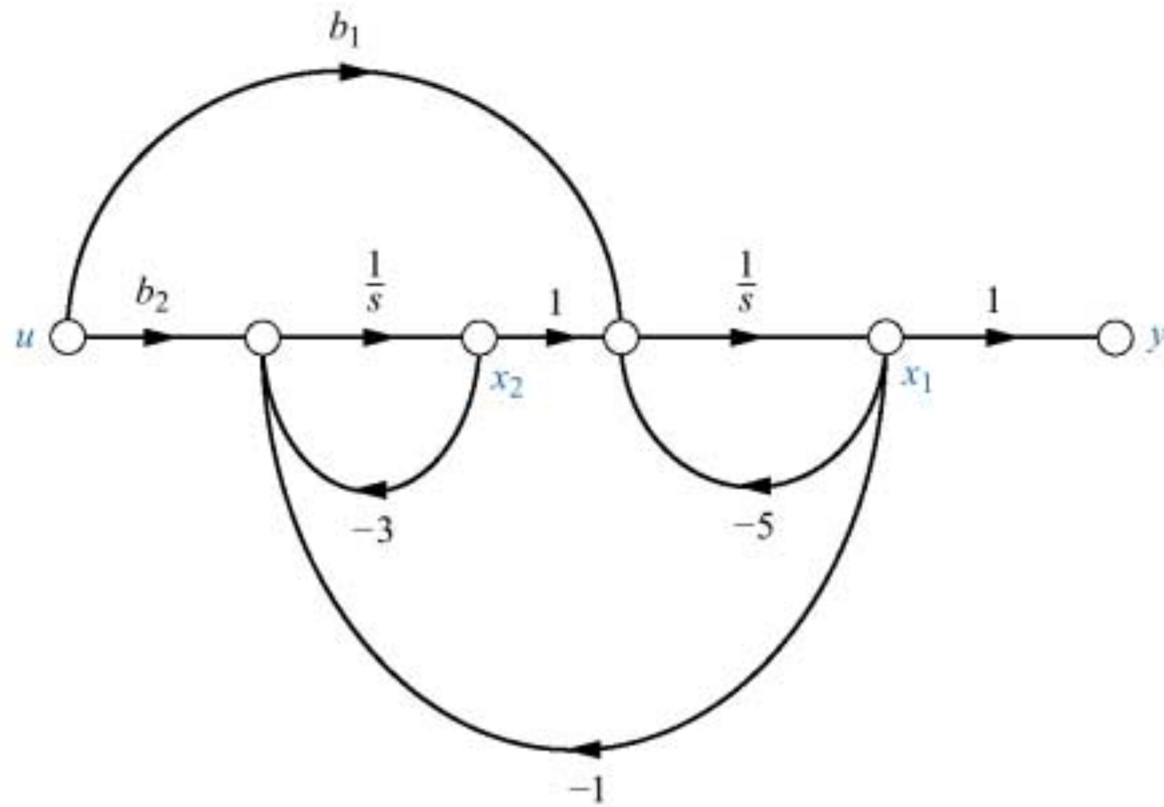


Figure P12.2
(figure continues)

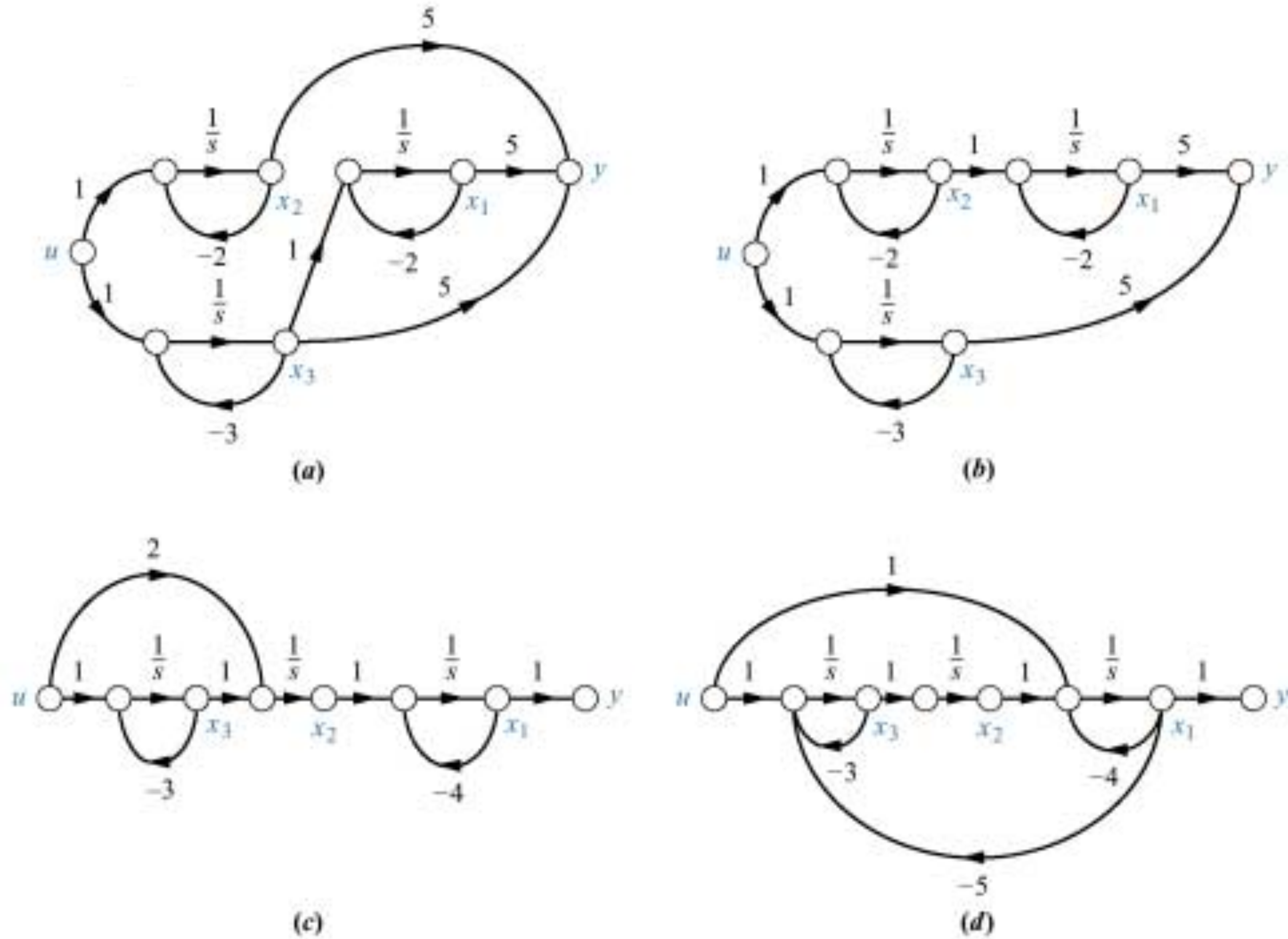
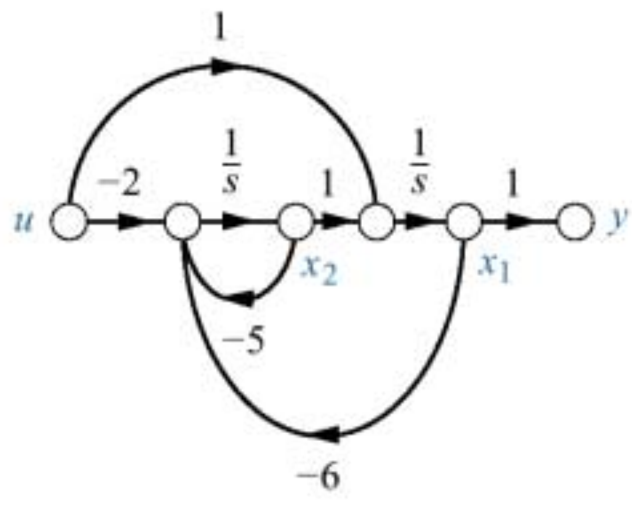
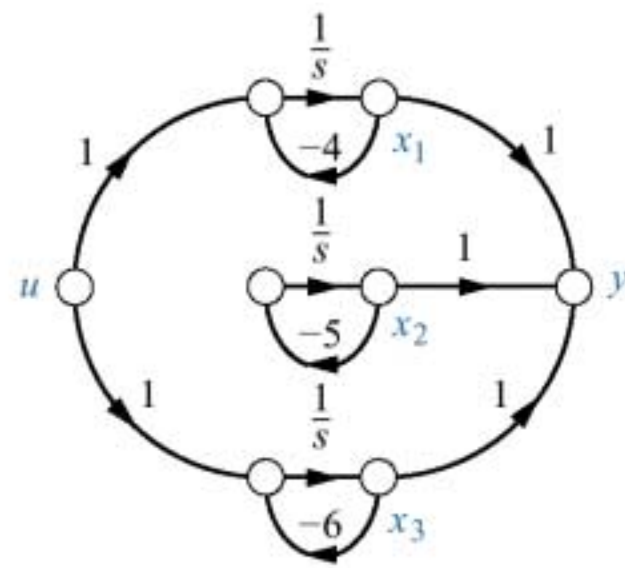


Figure P12.2 (continued)



(e)



(f)

Figure P12.3

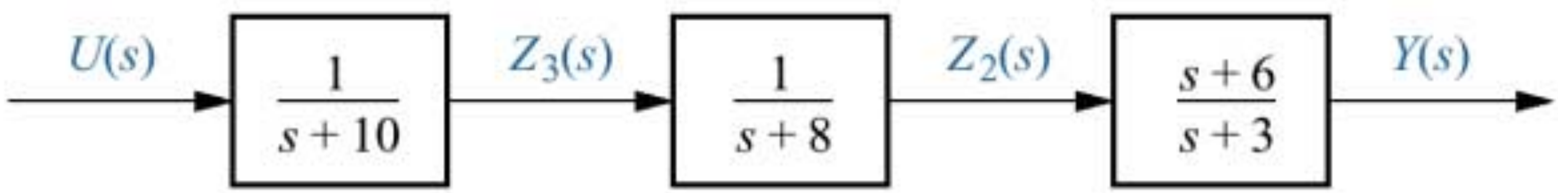


Figure P12.4

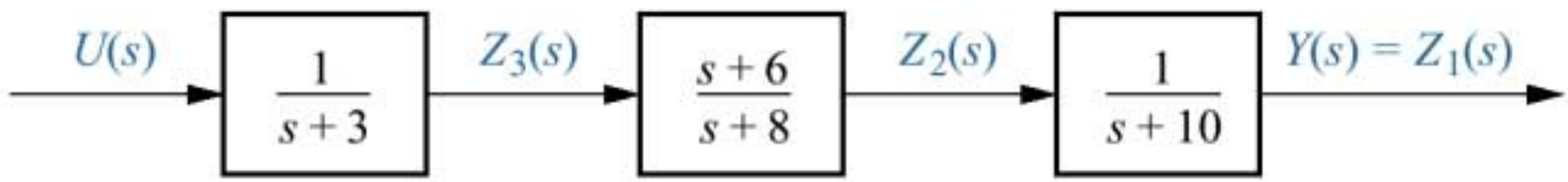


Figure P12.5

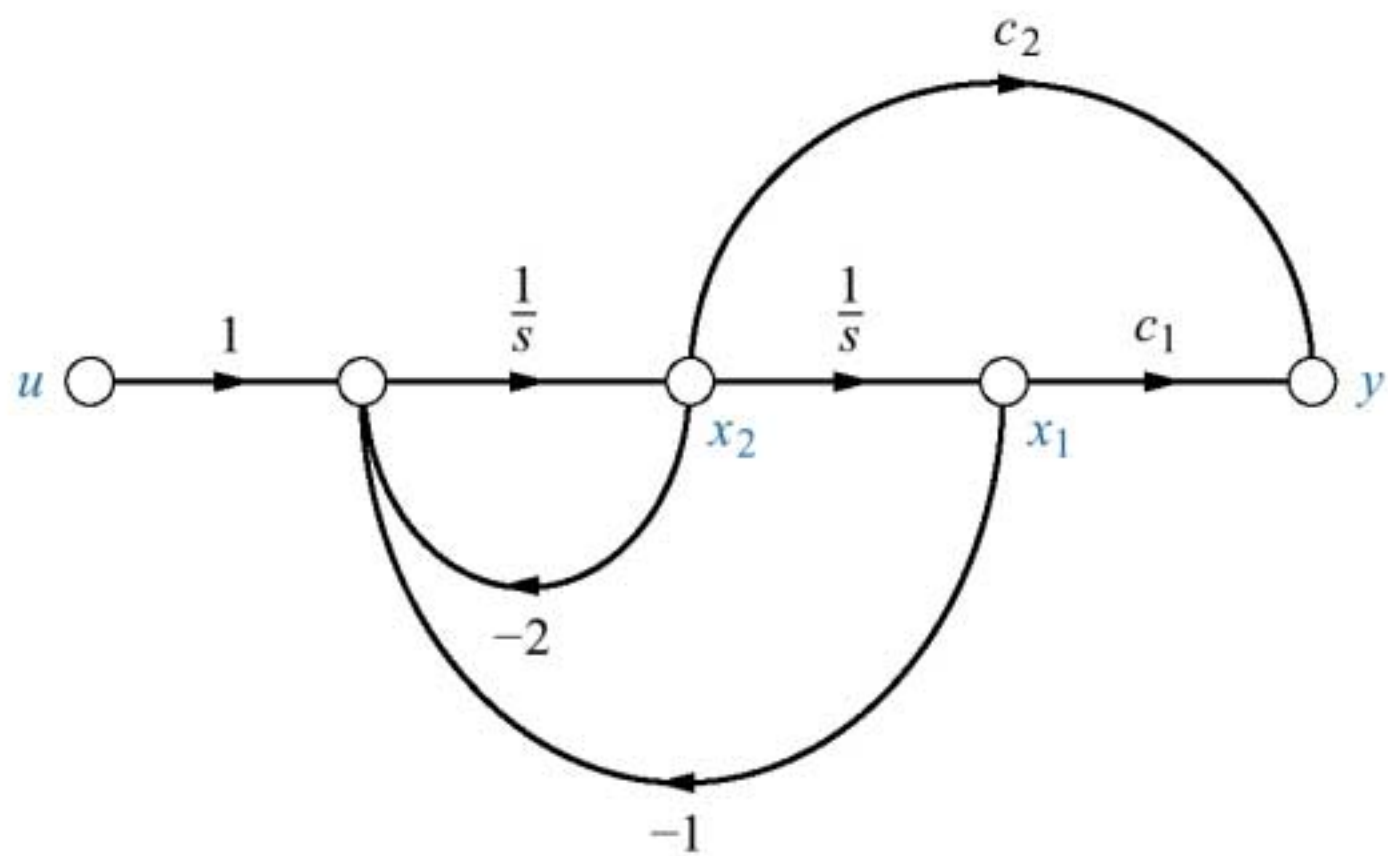


Figure P12.6
Block diagram of a gas-fired heater