FIGURE 1.1

Process to be controlled.
FIGURE 1.2

Open-loop control system (without feedback).
FIGURE 1.3

Closed-loop feedback control system (with feedback).
FIGURE 1.4

Multivariable control system.
FIGURE 1.5

Watt’s flyball governor.
FIGURE 1.6

Water-level float regulator.
FIGURE 1.7

Closed-loop feedback system.
FIGURE 1.8

(a) Automobile steering control system.
(b) The driver uses the difference between the actual and the desired direction of travel to generate a controlled adjustment of the steering wheel.
(c) Typical direction-of-travel response.
FIGURE 1.9

A negative feedback system block diagram depicting a basic closed-loop control system. The control device is often called a “controller.”
FIGURE 1.10

A manual control system for regulating the level of fluid in a tank by adjusting the output valve. The operator views the level of fluid through a port in the side of the tank.
FIGURE 1.11

A three-axis control system for inspecting individual semiconductor wafers with a highly sensitive camera.
FIGURE 1.12

Coordinated control system for a boiler-generator.
FIGURE 1.13

A computer control system.
The Utah/MIT Dextrous Robotic Hand: A dextrous robotic hand having 18 degrees of freedom, developed as a research tool by the Center for Engineering Design at the University of Utah and the Artificial Intelligence Laboratory at MIT. It is controlled by five Motorola 68000 microprocessors and actuated by 36 high-performance electropneumatic actuators via high-strength polymeric tendons. The hand has three fingers and a thumb. It uses touch sensors and tendons for control. (Photograph by Michael Milochik. Courtesy of University of Utah.)
FIGURE 1.18

Future evolution of control systems and robotics.
If the performance does not meet the specifications, then iterate the configuration and the actuator.

If the performance meets the specifications, then finalize the design.

FIGURE 1.19

The control system design process.
FIGURE 1.20

(a) Open-loop (without feedback) control of the speed of a turntable.
(b) Block diagram model.
FIGURE 1.21

(a) Closed-loop control of the speed of a turntable.
(b) Block diagram model.
FIGURE 1.24

(a) A disk drive ©1999 Quantum Corporation. All rights reserved.
(b) Diagram of a disk drive.
FIGURE 1.25

Closed-loop control system for disk drive.
FIGURE P1.2

Fluid-flow control.
FIGURE P1.11

FIGURE P1.20

A high-performance race car with an adjustable wing.
FIGURE P1.21

Two helicopters used to lift and move a large load.