1.1 Introduction

- Control engineers

Concerned with understanding and controlling segments of their environment (called systems), which are interconnections of elements and devices for a desired purpose.

- Control engineering

Deal with design and implementation of control systems using linear, time-invariant mathematical models representing actual physical nonlinear, time-varying systems with parameter uncertainties in the presence of external disturbances.

Focuses of control engineering

- Model a wide assortment of physical systems
- Use those models to design controllers that will cause the closed-loop systems to possess desired performance characteristics, such as

1. Stability
2. Relative stability
3. Steady-state tracking with prescribed maximum errors
4. Transient tracking (percent overshoot, settling time, rise time, and peak time)
5. Rejection of external disturbances
6. Robustness to modeling uncertainties

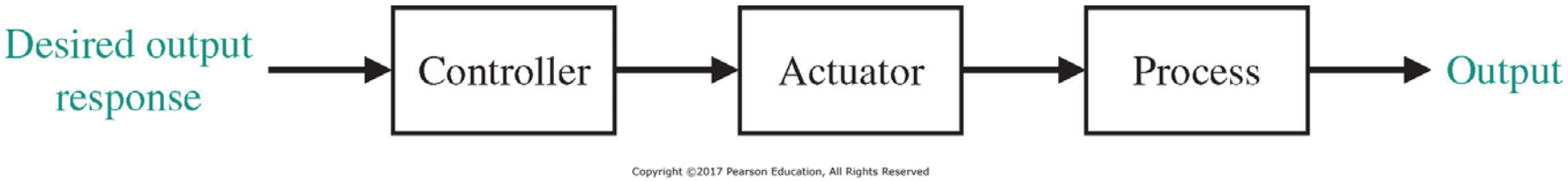
Foundation of Control

- Feedback theory and linear system analysis
- Integration of the concepts of network theory and communication theory
- Not limited to any engineering discipline but equally applicable to aerospace, agricultural, biomedical, chemical, civil, computer, industrial, electrical, environmental, mechanical, and nuclear engineering.

FIGURE 1.1 Process to be controlled.

A component to be controlled: process, plant, or controlled system

FIGURE 1.2 Open-loop control system (without feedback).

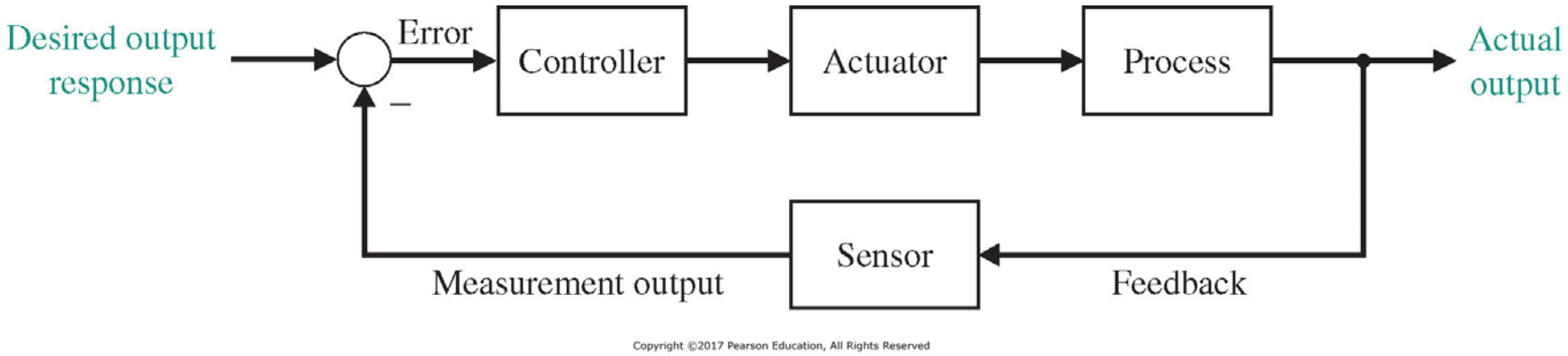


Actuator: device employed by the control system to alter or adjust the environment

Open-loop control system: use a controller and an actuator to obtain the desired response

Example: microwave oven (set to operate for a fixed time)

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

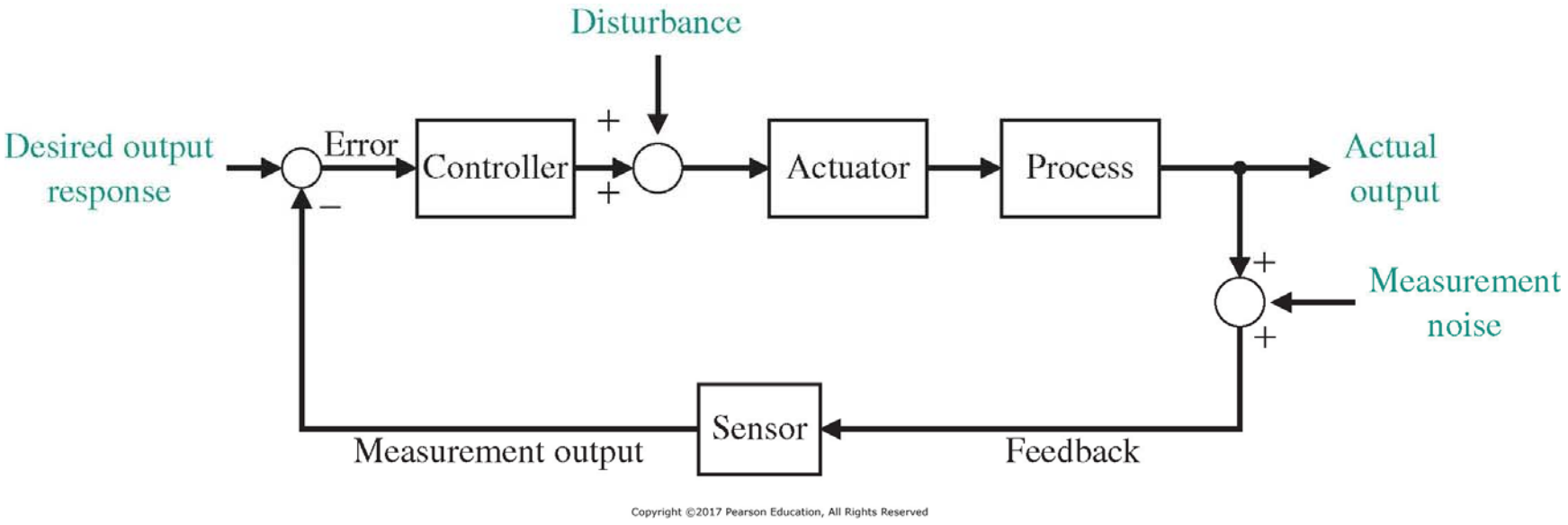


Sensor: device that provides a measurement of a desired external signal

Closed-loop control system: use an additional feedback loop to maintain a prescribed relationship of one system variable to another

Example: a person steering an automobile

FIGURE 1.4 Closed-loop feedback system with external disturbances and measurement noise.



Modeling disturbances and measurement noise as external inputs

Negative feedback: the output is subtracted from the input and the difference is used as the input to the controller

FIGURE 1.5 Multiloop feedback system with an inner loop and an outer loop.

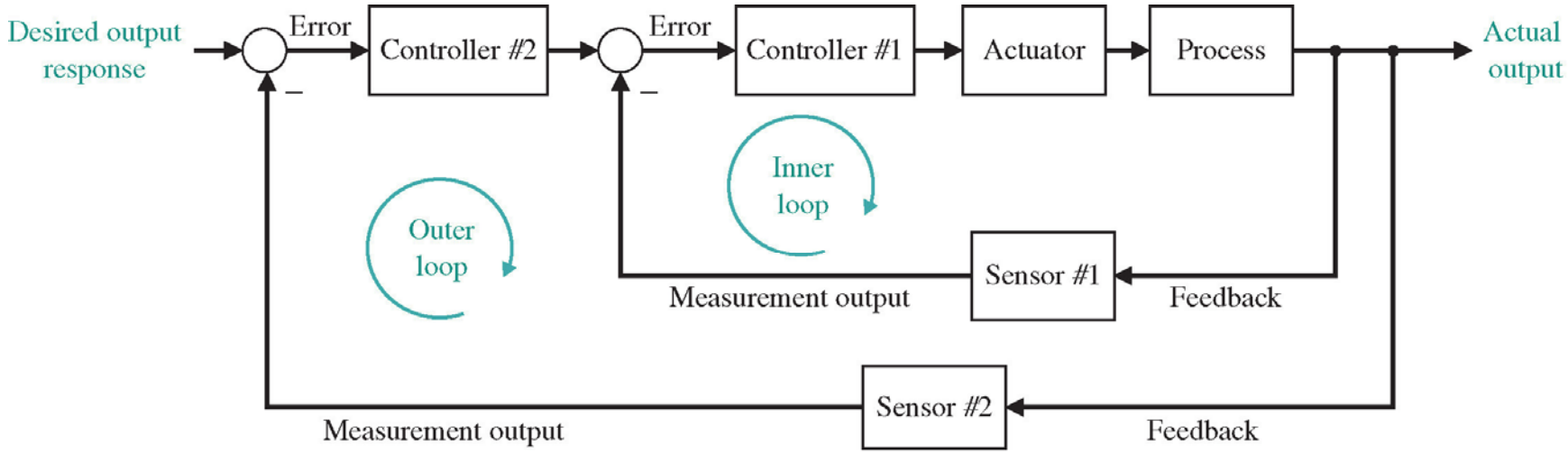
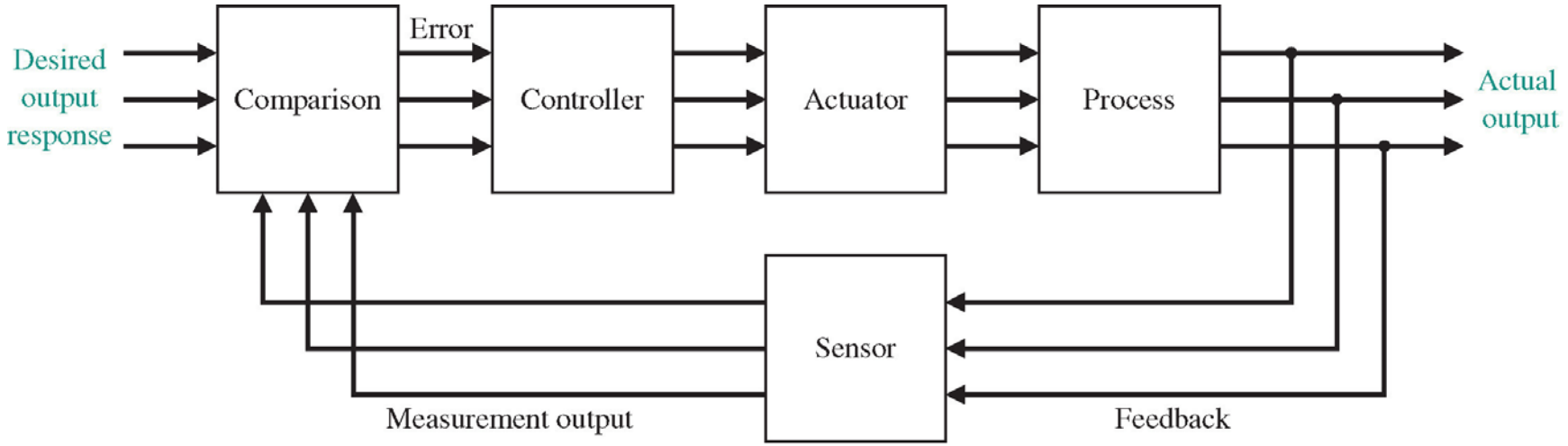


FIGURE 1.6 Multivariable control system.



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First automatic feedback controller used in an industrial process

FIGURE 1.7 James Watt's flyball governor.

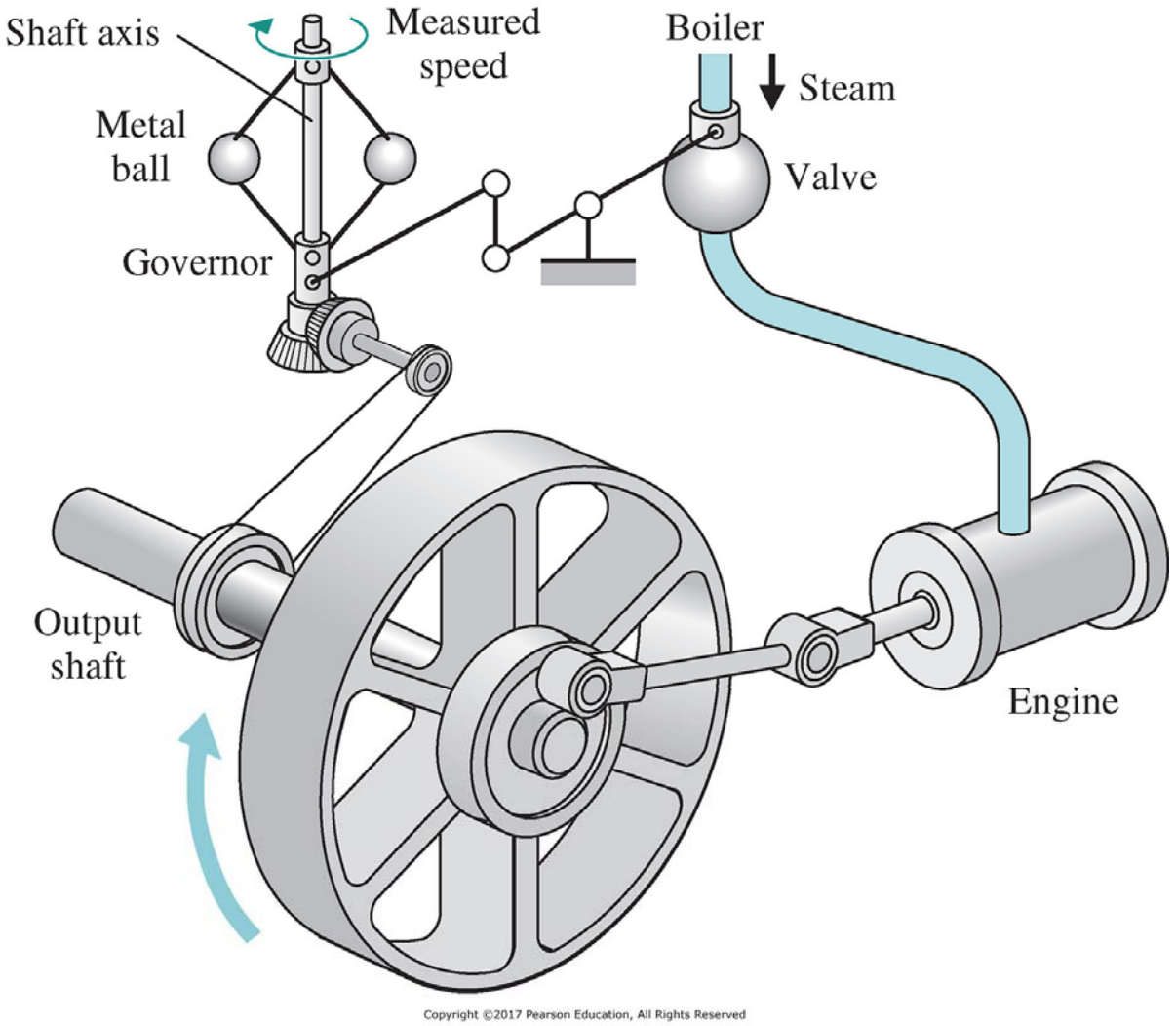

FIGURE 1.25 (a) Closed-loop control of the speed of a rotating disk. (b) Block diagram model.

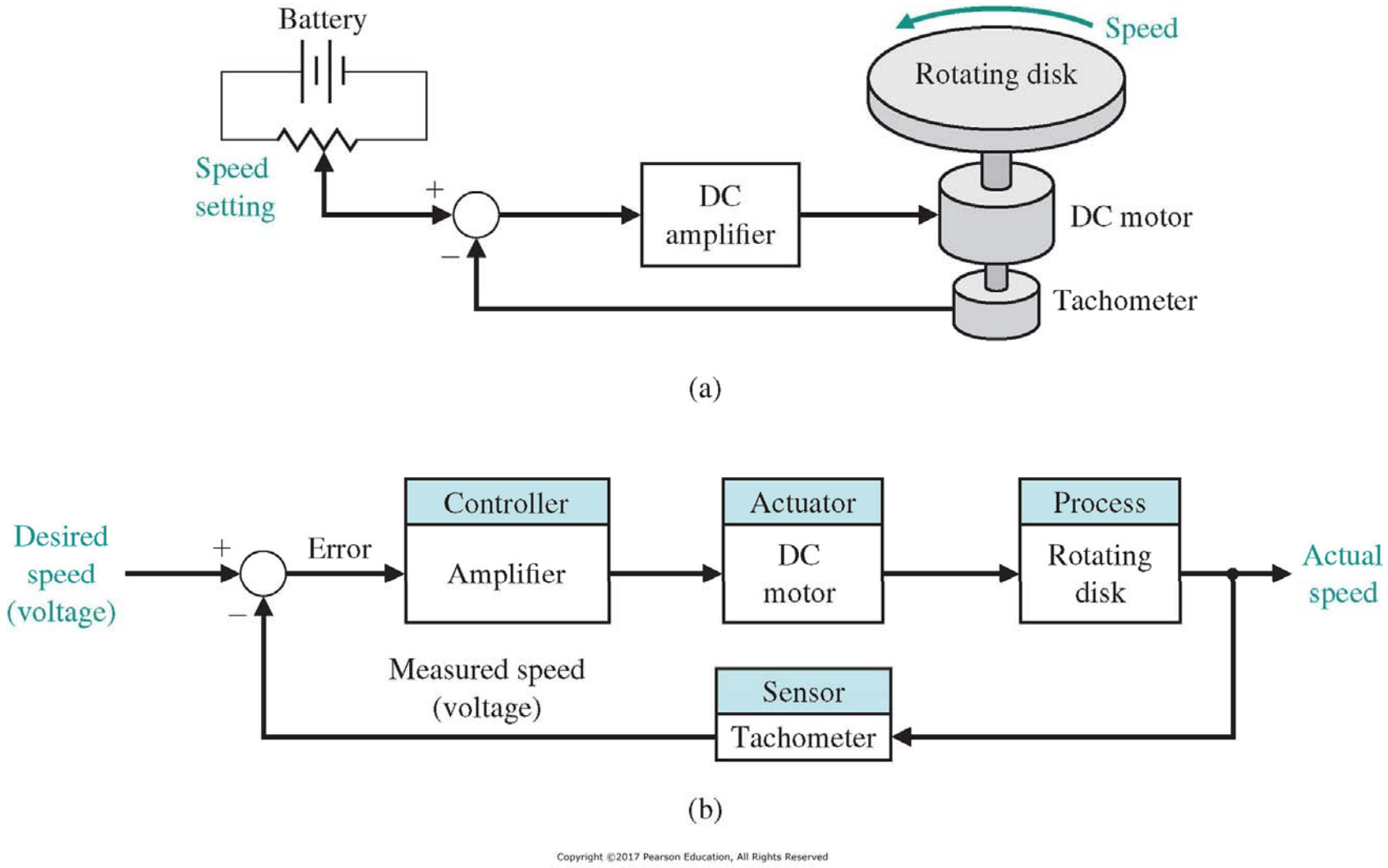

FIGURE 1.1 Process to be controlled.

What you have learned:
process + input → output?

What you will learn:
process + (desired) output → input?
(the input is generally automatically generated using feedback, controller and actuator)