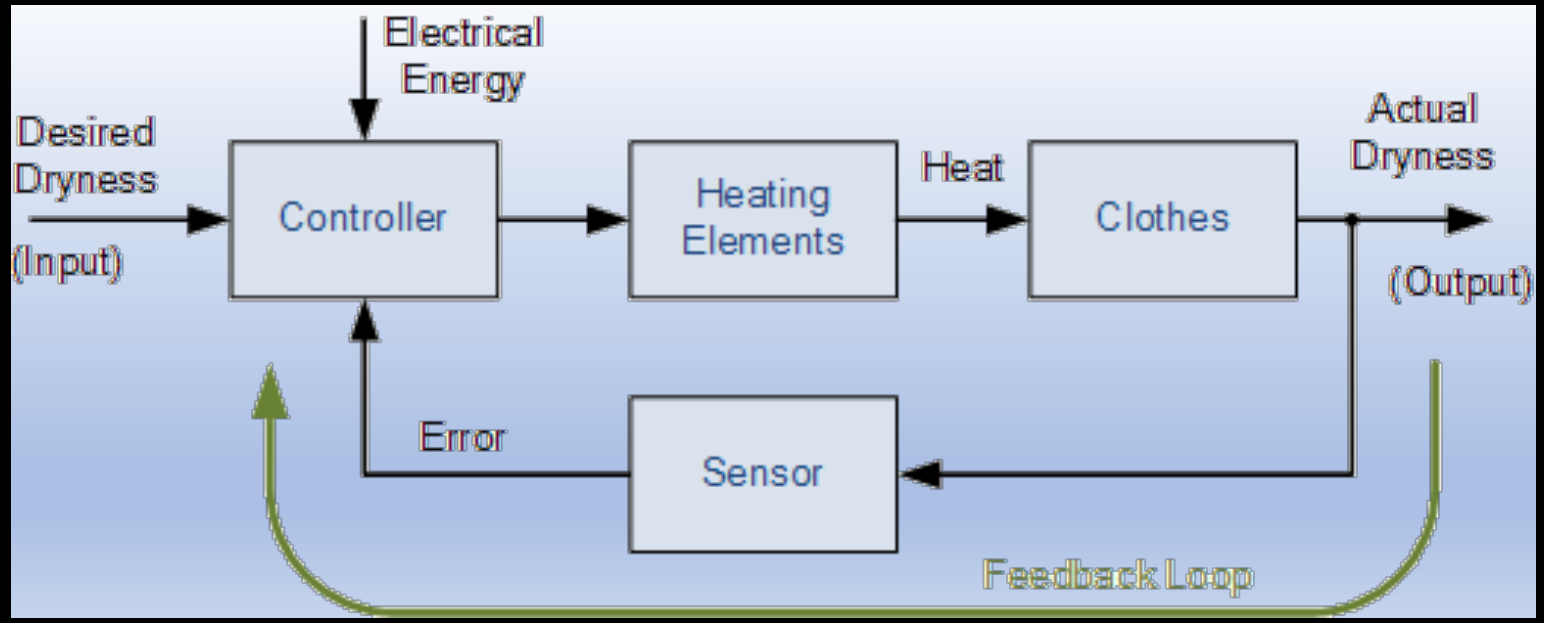
SFWR ENG 3DX4:
Introduction to Control Systems

Overview

- What is a control system?
- Example control systems
- Terminology, response characteristics and system configurations
- Analysis and design objectives
- Control systems design process

What is a Control System

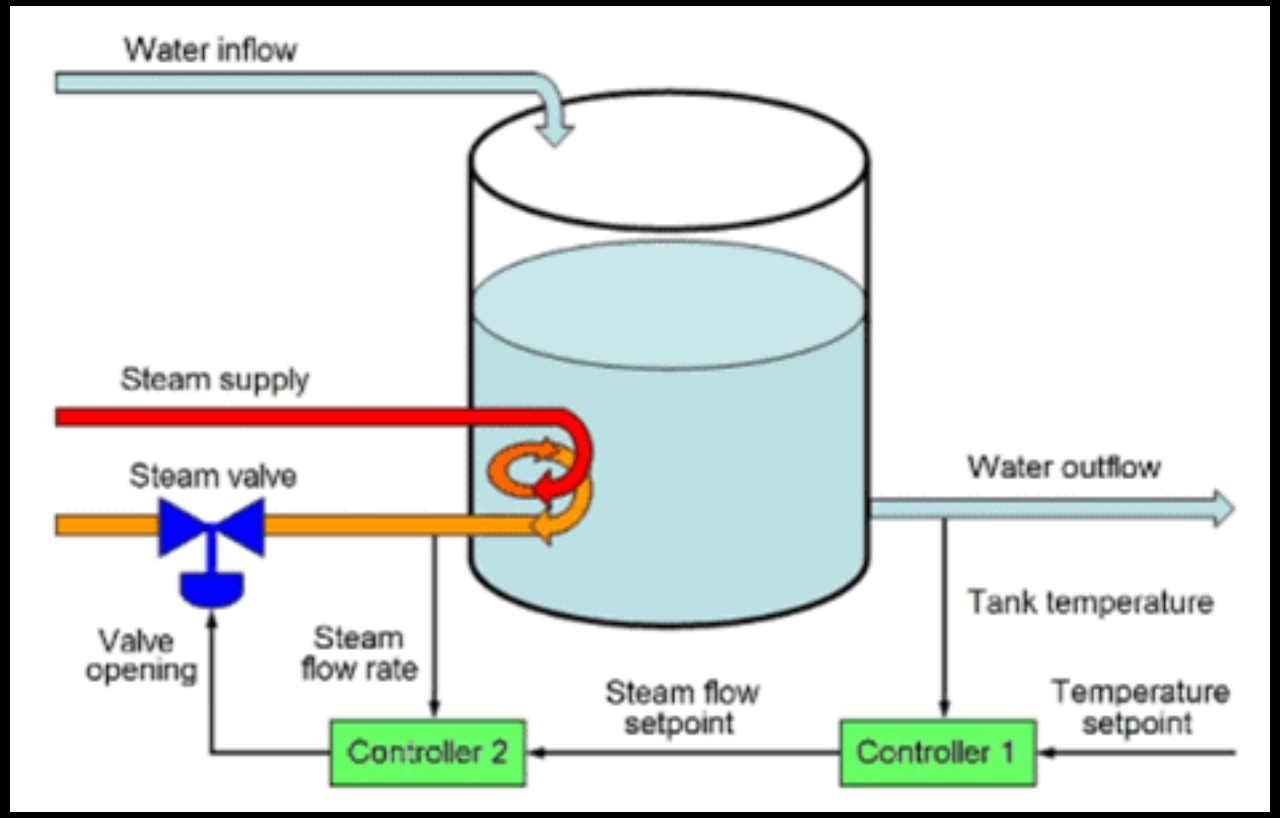
- A control system provides an output (response) for a given input (stimulus)



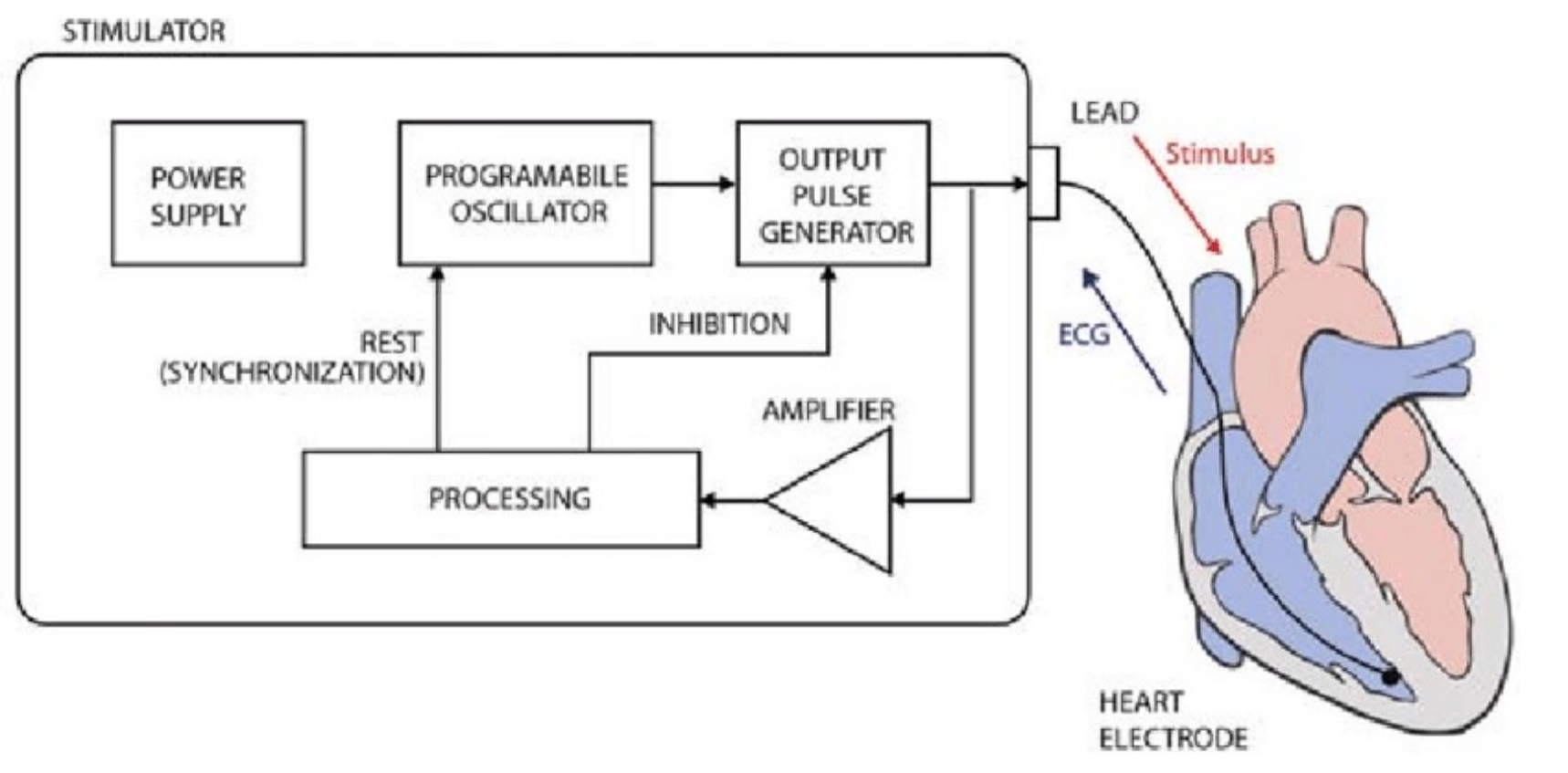
Why do we need control systems?

- Conversion of device input (thermostat setting to room temperature, cruise control to vehicle speed, etc.)
- Power amplification (power steering)
- Remote control
- Compensation for disturbances
- Improve system performance (speed, accuracy, repeatability, etc.)

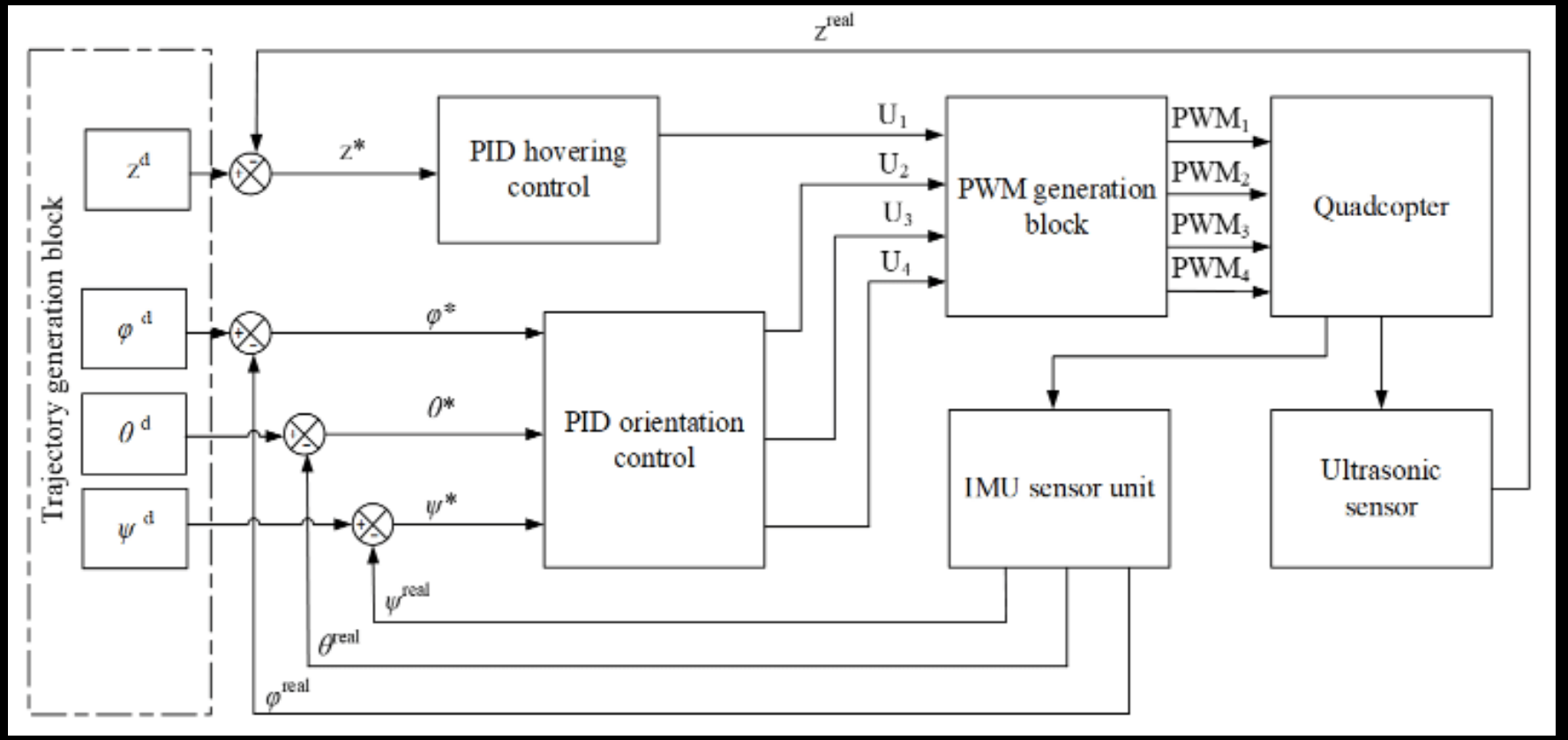
Example 1: Industrial Temperature Control



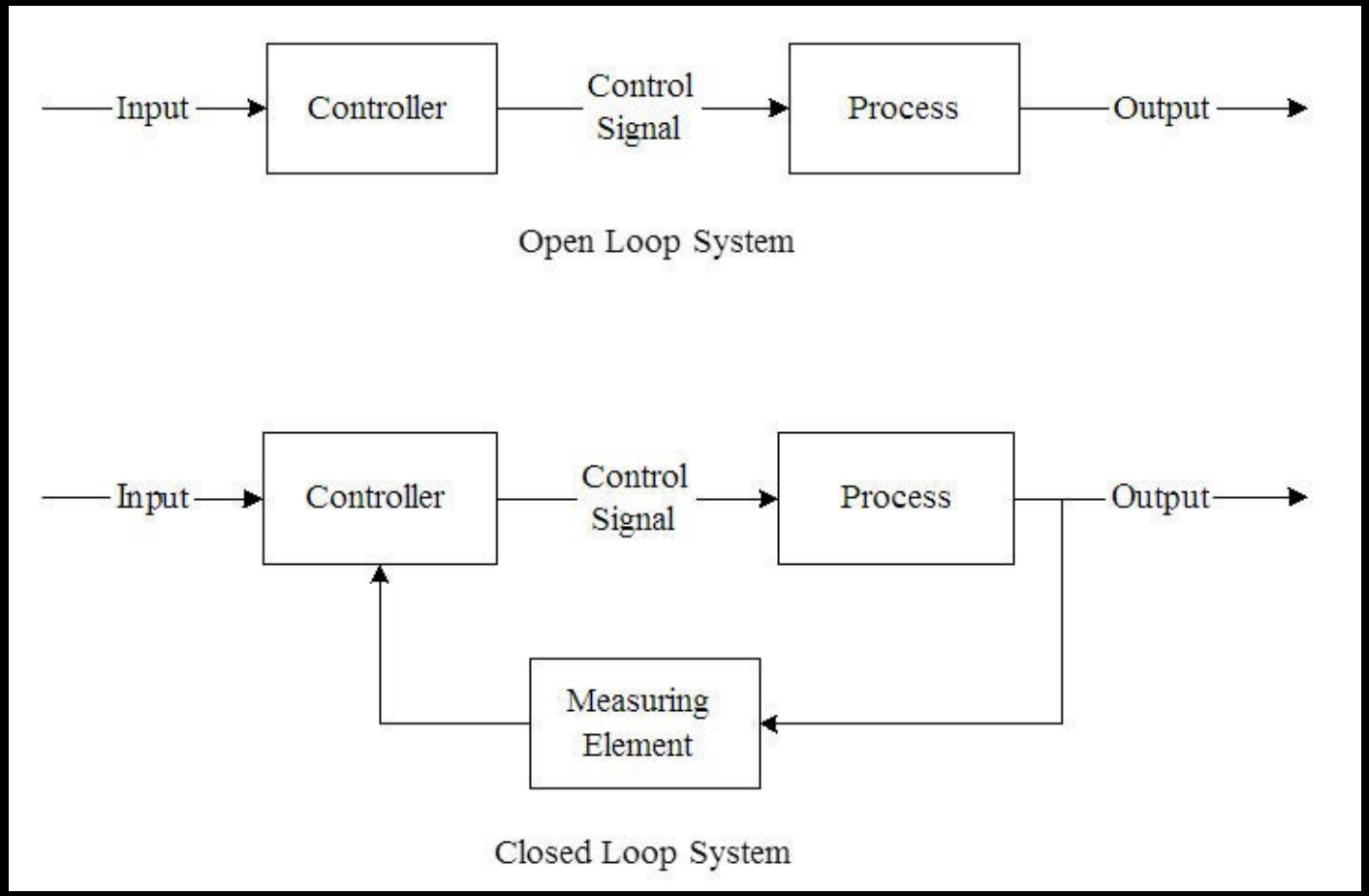
Example 2 – Medical Device



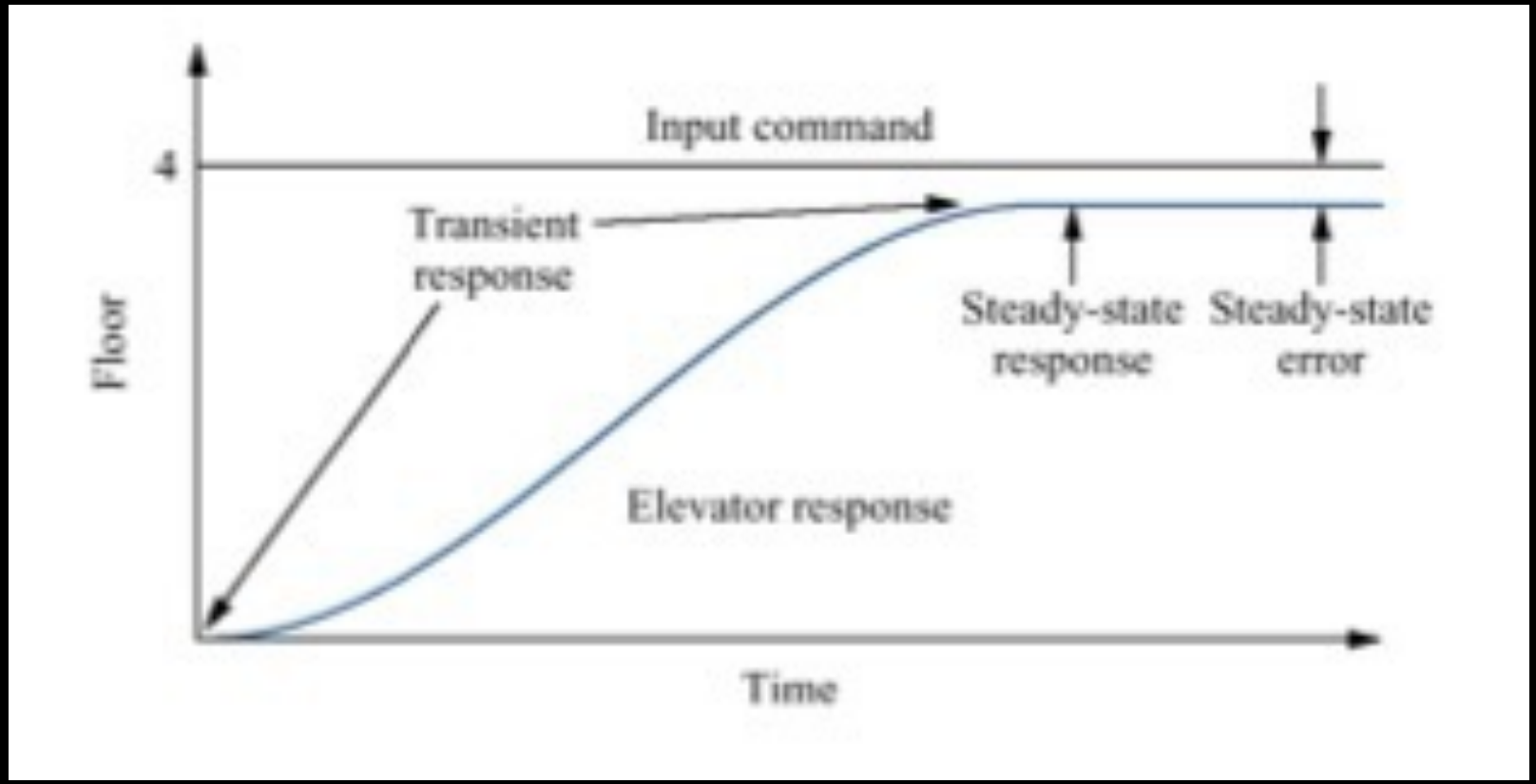
Example 3 – Drone Control



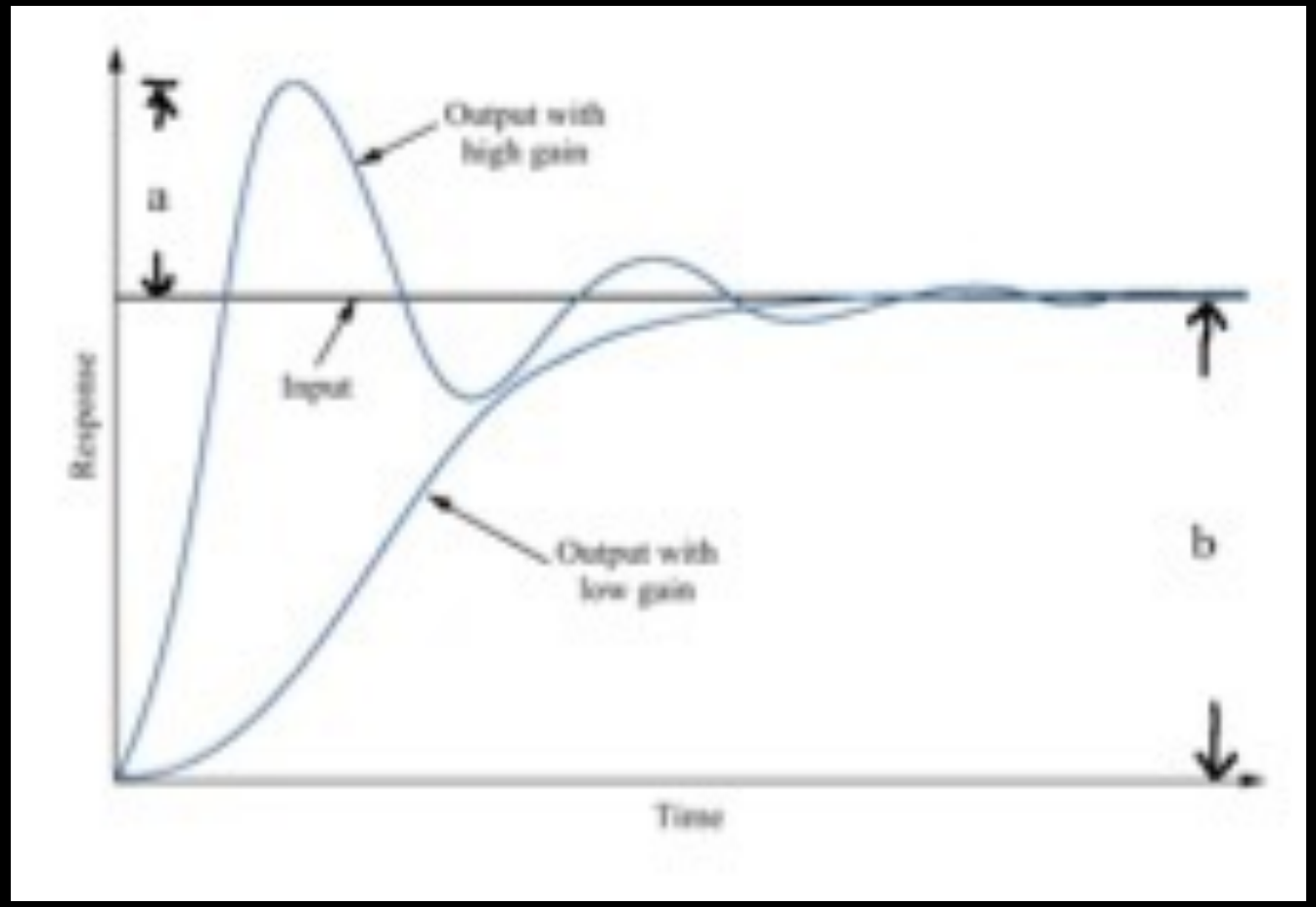
Open-loop versus closed-loop



Transient and steady-state response



Transient response tradeoffs



Stability

- Total response = Natural response + Forced Response
- Natural response (homogeneous solution): evolution of system due to initial conditions
- Forced response (particular solution): evolution of system due to input
- In general terms, a system is stable if the natural response eventually goes to zero (or at worst oscillates with some fixed amplitude)
- In an unstable system, the natural response grows without bound, swamping the forced response; control is not effective
- In general, a control system must be stable to be useful

Control Objectives

- Stabilize the system
- Produce the desired transient response
- Decrease/eliminate steady-state error
- Make system “robust” to withstand disturbances and variations in parameters
- Achieve optimal performance

Control Design Process

1. Determine a physical system and specifications from the requirements
2. Draw a functional block diagram
3. Develop model of physical system
4. View as closed-loop system
5. Analyze, design and test to see that requirements and specifications are met