System Dynamics Introduction

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Course details

Main text Book:

"Control systems engineering“, nise

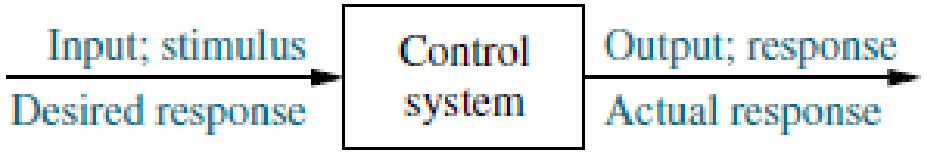
Grades:

- Attendance – 5 %
- Assignments – 5 %
- Midterm – 20 %
- Final exam – 70 %

Introduction

- System dynamics is an approach of understanding a system behavior over time. This understanding is important in designing a control system.

- A control system consists of subsystems and processes (or plants) assembled for the purpose of obtaining a desired output with desired performance, given a specified input.

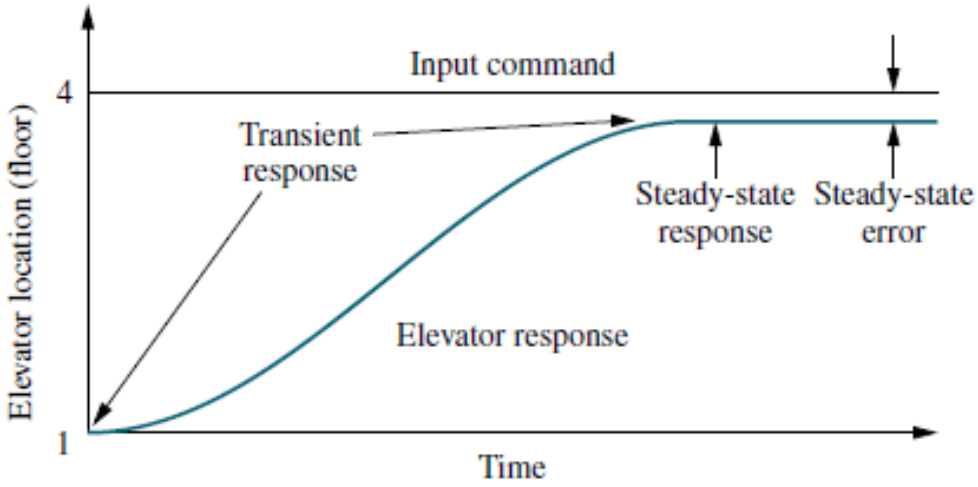


Control system Example

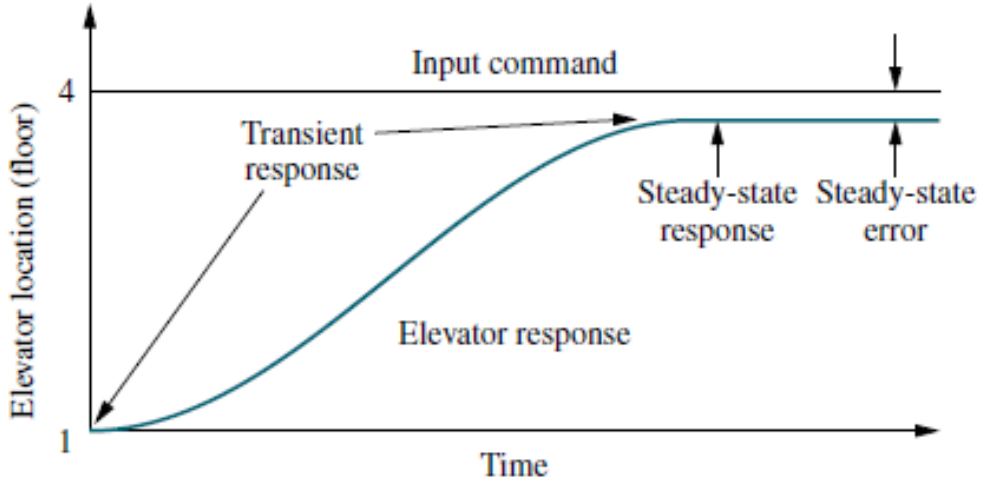
For example, consider an elevator.

When the fourth-floor button is pressed on the first floor, the elevator rises to the fourth floor with a speed and floor-leveling accuracy designed for passenger comfort.

The push of the fourth-floor button is an input that represents our desired output.



Control system performance



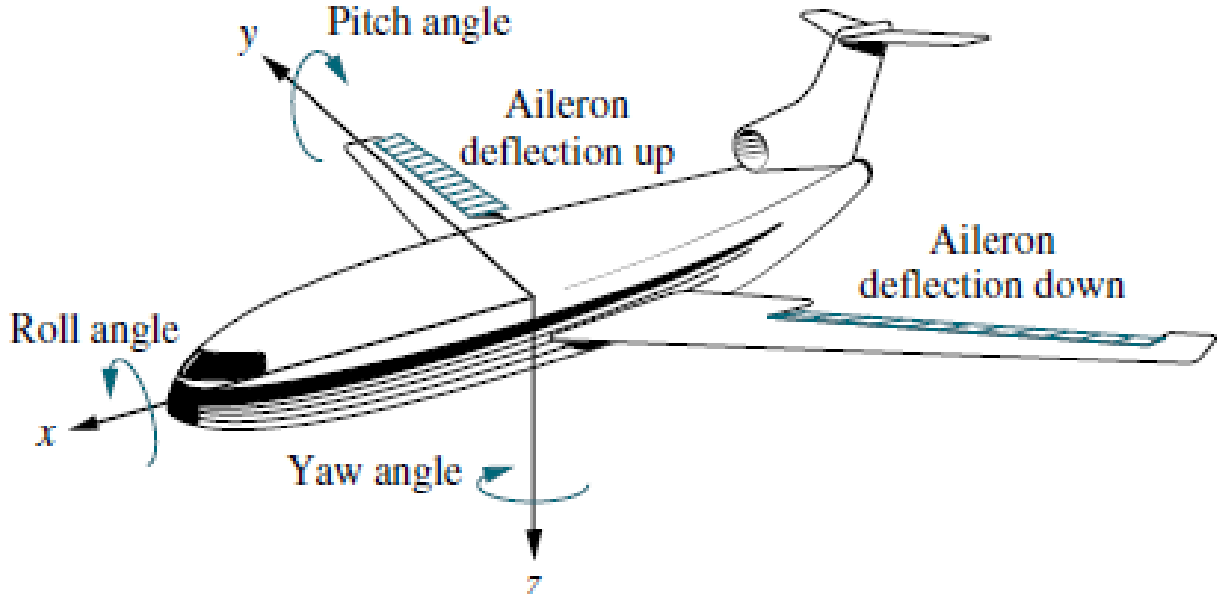
Two major measures of performance are important:

- the transient response, and
- the steady-state error.

Importance of system dynamics and control systems

We build control systems for four primary reasons:

- Power amplification
- Remote control
- Convenience of input form
- Compensation for disturbances



Control system application

control systems find widespread application in the guidance, navigation, and control of missiles and spacecraft, as well as planes and ships at sea.

Example: modern ships use a combination of electrical, mechanical, and hydraulic components to develop rudder commands in response to desired heading commands. The rudder commands, in turn, result in a rudder angle that steers the ship.

System Configurations

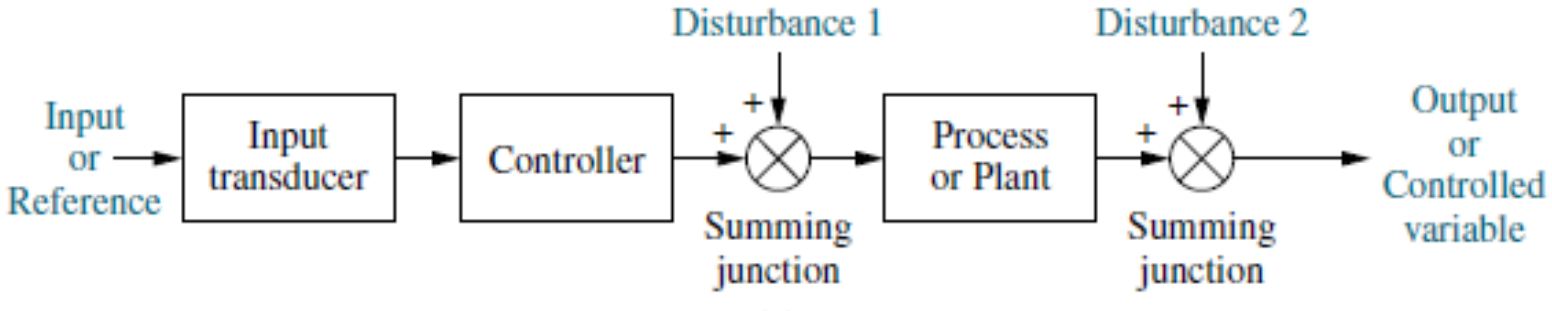
There are mainly two system configurations:

- Open-loop system
- Closed-loop system

Open-loop system

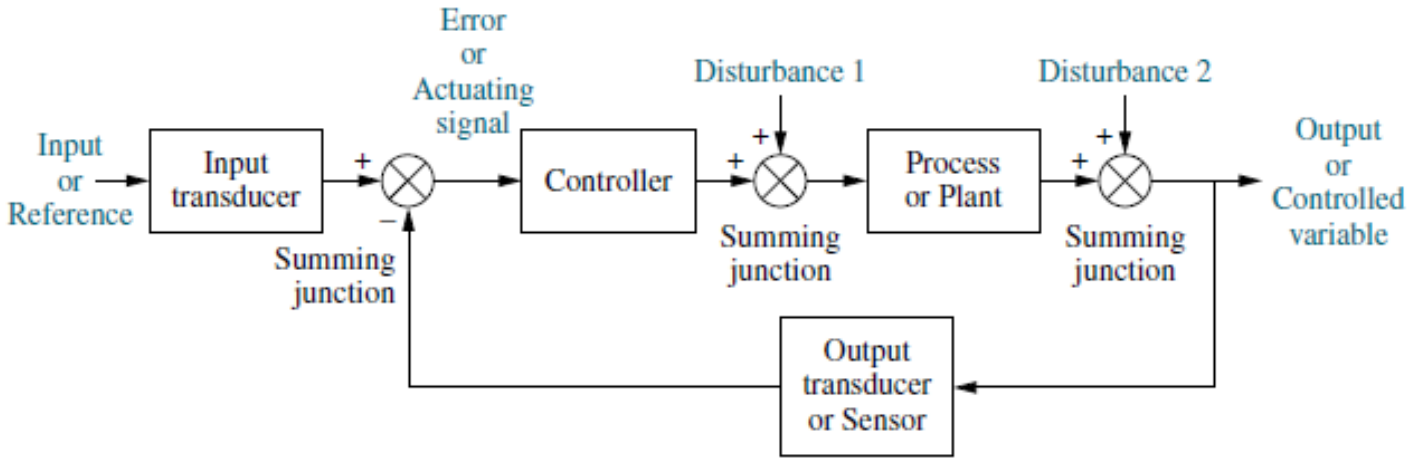
- It starts with a subsystem called an *input transducer*, which converts the form of the input to that used by the controller.
- The *controller* drives a process or a plant. The input is sometimes called the *reference*, while the output can be called *the controlled variable*.
- The objective is to make the output value equal the input, without readjusted the output continually.
- open-loop systems are sensitivity to disturbances and inability to correct for these disturbances.

An example us the heater or furnace.



Closed-loop system (Feed-back control system)

- The *input transducer* converts the form of the input to the form used by the *controller*. An *output transducer*, or *sensor*, measures the output response and converts it into the form used by the controller.
- The controller can continuously adjust the output based on the system error, and the system can take corrective action.
- The closed-loop system compensates for disturbances by measuring the output response, feeding that measurement back through a feedback path, and comparing that response to the input at the summing junction.



Control system analysis and design

Analysis studies a system's performance. For example, we evaluate its transient response and steady-state error to determine if they meet the desired specifications.

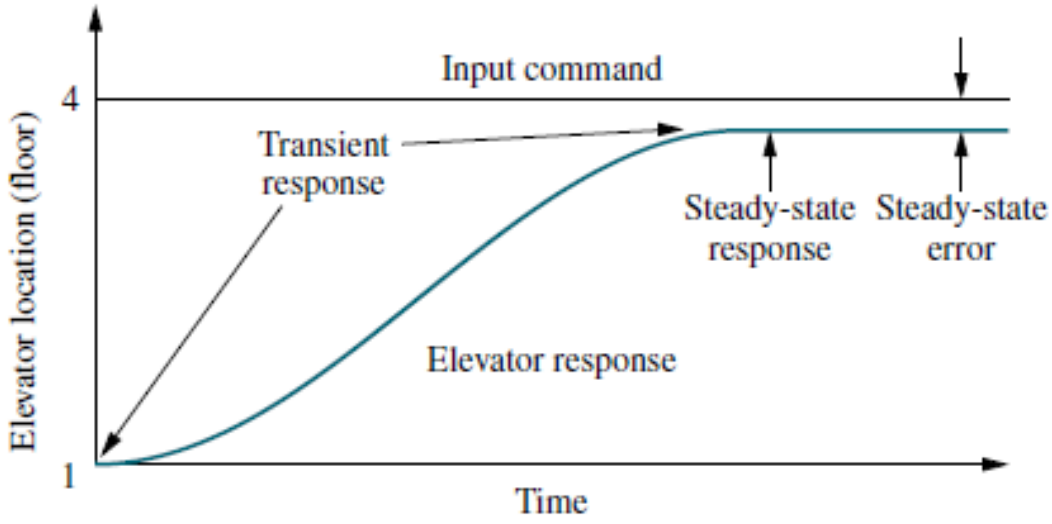
Design is the process by which we create a system performance or change it. For example, if a system's transient response and steady-state error are analyzed and found not to meet the specifications, then we change parameters or add additional components to meet the specifications.

System analysis and design objectives

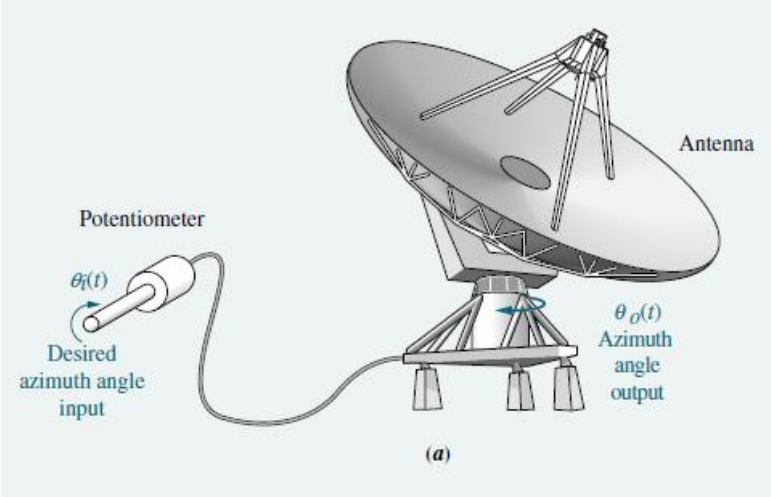
Transient Response: transient response is important. In the case of an elevator, a slow transient response makes passengers impatient, whereas an excessively rapid response makes them uncomfortable.

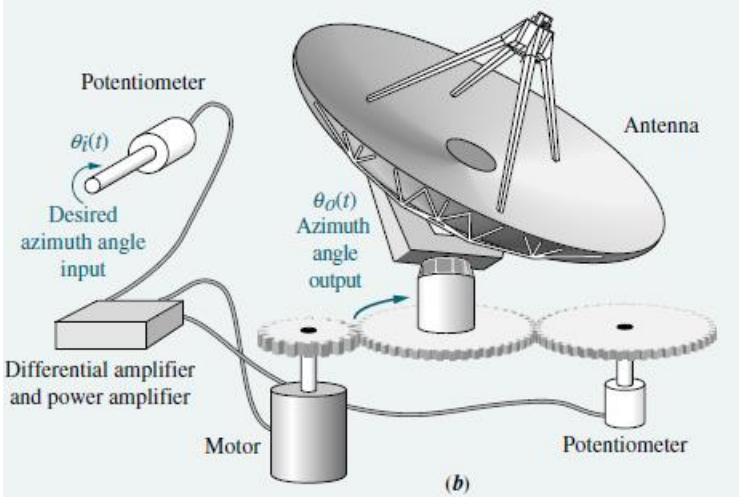
Steady-State Response: We are concerned about the accuracy of the steady-state response. An elevator must be level enough with the floor for the passengers to exit.

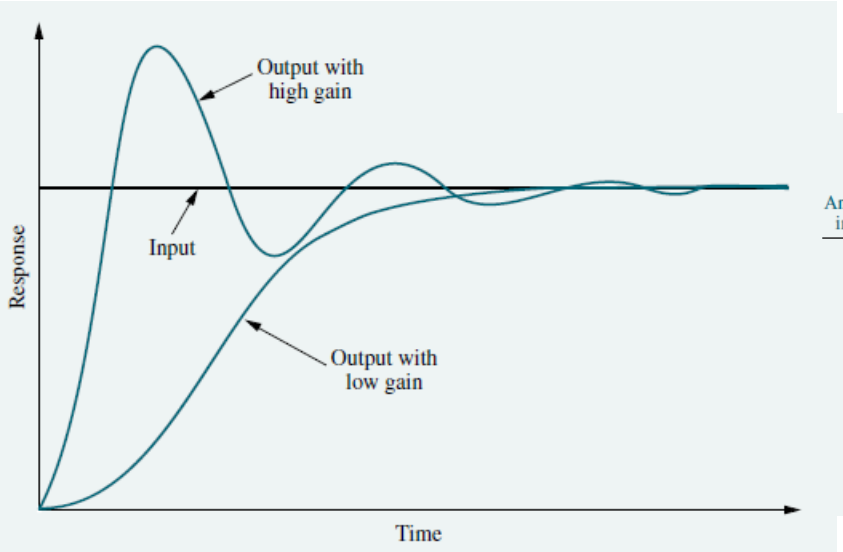
Stability: the system should be totally under control and reach to its final state smoothly.

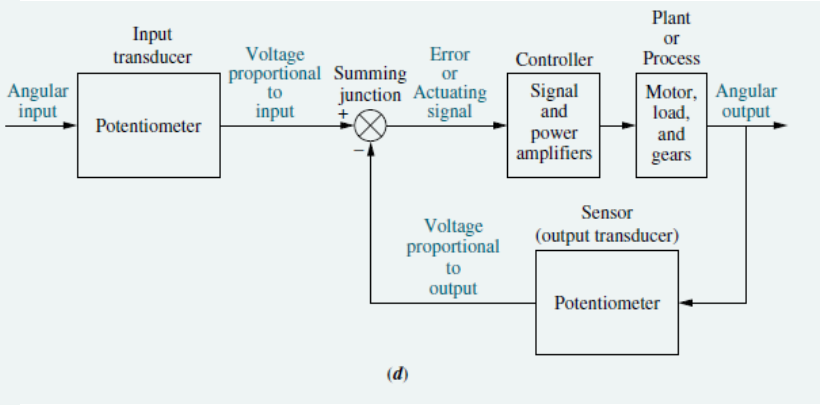


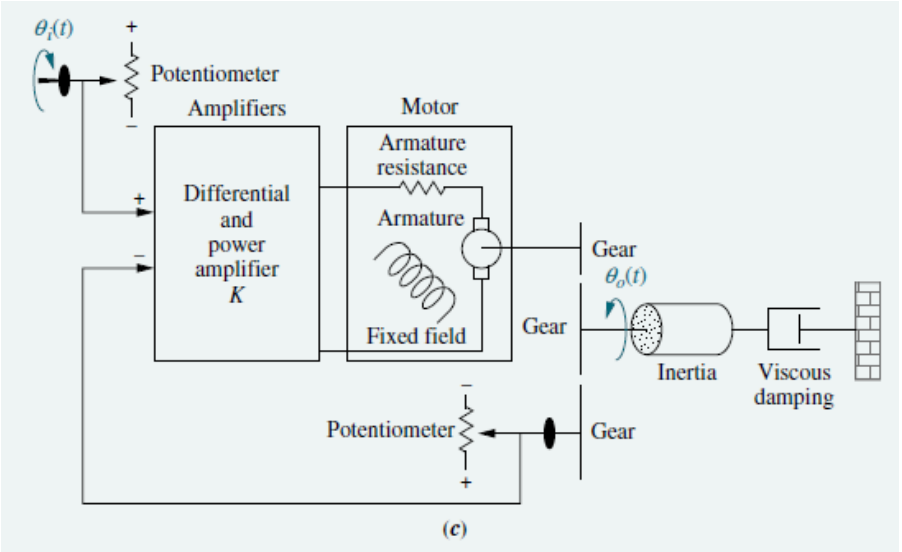
Position control system Example
Antenna Azimuth











Control system design process