Automatic Control Theory

Dr. Basheer Mohammed Nasef

Course Web Site

- **www.bmabdelaty.faculty.zu.edu.eg**
- Email:

bnasf179@gmail.com

Teaching Assistant:-

Eng. Hamde Soltan

Grading Scheme

Semester work	**45**
Final	**80**
Total	**125**

Course Outlines

- Introduction to Control Systems.
- Laplace Transform (to be covered in sections).
- Mathematical Modeling of Systems.
- Block Diagram.
- State Space Representations.
- Transient and Steady State Response.
- Stability of Systems.
- Steady State Error.
- Root Locus Analysis.
- Frequency Response.

Reference

- Modern Control Theory (4th or 5th Edition)

Katsuhiko Ogata.

Prerequisites

- Differential Equations
- Laplace Transform
- Matrices
- Matlab

Practical Sessions

- Practicals are divided into two sessions

  - Software Based
    (Interactive Lab)
    - Matlab
    - Simulink
    - Control System Toolbox
  - Hardware Based
    (Instrument & Control Lab)

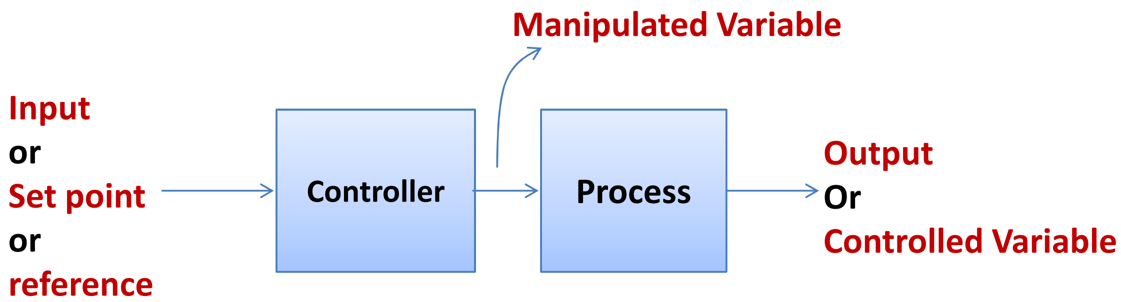
Definitions

System: Is a combination of components that act together and perform a certain objective.

Control System: An interconnection of components forming a system configuration that will provide a desired response.

Process: The device, plant, or system under control. The input and output relationship represents the cause-and-effect relationship of the process.

Definitions



Disturbances– A disturbance is a signal that tends to adversely affect the value of the system. **It is an unwanted input of the system**.

- If a disturbance is generated within the system, it is called ***internal disturbance***. While an ***external disturbance*** is generated outside the system.

Definitions

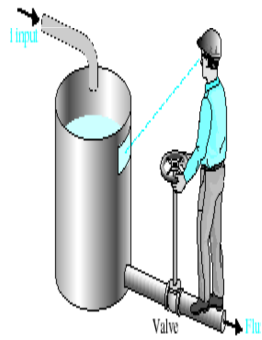
Controlled Variable– It is the quantity or condition that is measured and Controlled. Normally *controlled variable* is the output of the control system.

Manipulated Variable– It is the quantity of the condition that is varied by the controller so as to affect the value of *controlled variable*.

Control – Control means measuring the value of *controlled variable* of the system and applying the *manipulated variable* to the system to correct or limit the deviation of the measured value from a desired value.

Types of Control System

- Manual Control Systems
  - Room Temperature regulation Via Electric Fan
  - Water Level Control

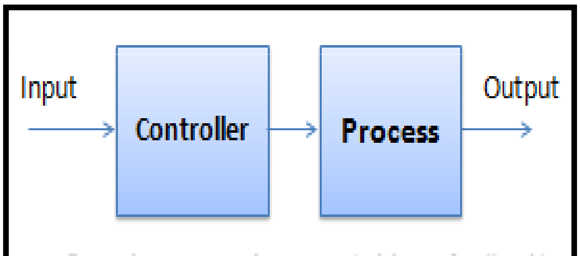


- Automatic Control System
  - Room Temperature regulation Via A.C
  - Human Body Temperature Control

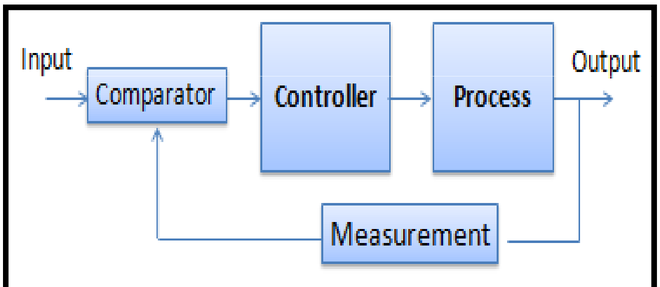
Types of Control System

Control systems are classified into two general categories:

Open-loop and **Closed-loop systems**



Open-loop control system (without feedback).



Closed-loop feedback control system (with feedback).

Types of Control System

Open-loop control **versus** Closed-loop control

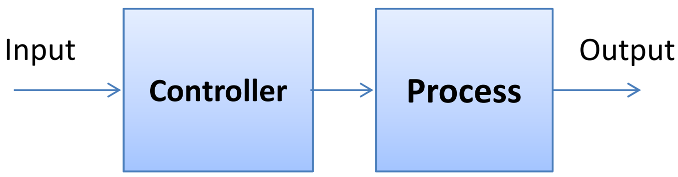
OLS	CLS
Simple construction	Complex construction
Low cost	High cost
High gain	Low gain
Not controlled output	Controlled of o/p
Recalibration is necessary from time to time	
	Increased accuracy
	Increased speed of response
	Reduced effects of disturbance

Types of Control System

Open-Loop Control Systems

Open-Loop Control Systems utilize a controller or control actuator to obtain the desired response.

- Output has no effect on the control action.
- In other words output is neither measured nor fed back.



Open-loop control system (without feedback).

Examples:- Washing Machine, Toaster, Electric Fan

Types of Control System

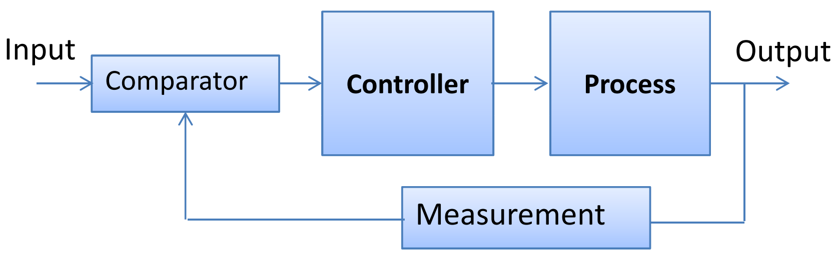
Open-Loop Control Systems

- Since in open loop control systems reference input is not compared with measured output, for each reference input there is fixed operating condition.
- Therefore, the accuracy of the system depends on calibration.
- The performance of open loop system is severely affected by the presence of disturbances, or variation in operating/ environmental conditions.

Types of Control System

Closed-Loop Control Systems

Closed-Loop Control Systems utilizes feedback to compare the actual output to the desired output response.

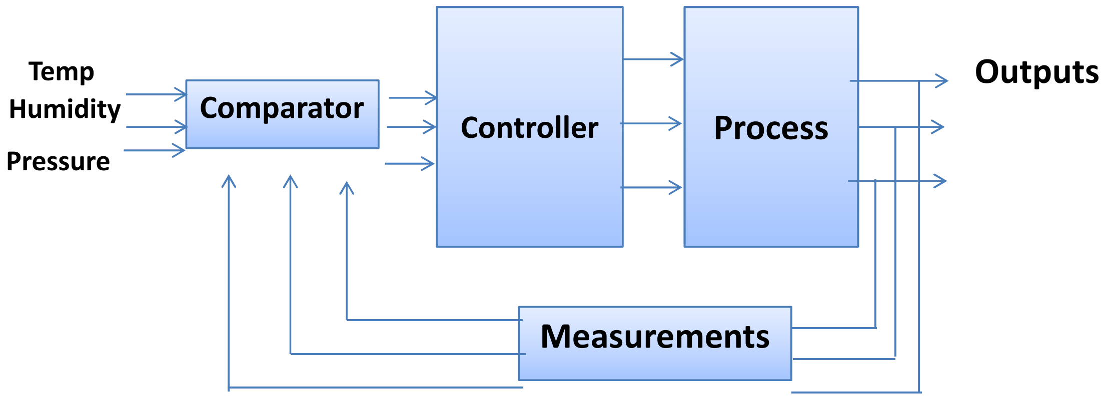


Closed-loop feedback control system (with feedback).

Examples:- Refrigerator, Air-condition

Types of Control System

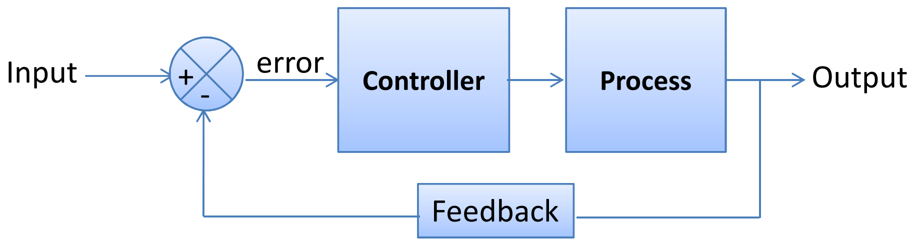
Multivariable Control System



Types of Control System

Feedback Control System

- A system that maintains a prescribed relationship between the output and some reference input by comparing them and using the difference (i.e. error) as a means of control is called a feedback control system.

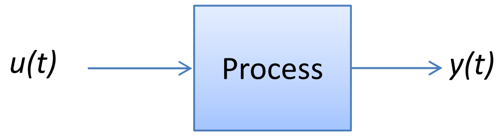


- Feedback can be **positive** or **negative**.

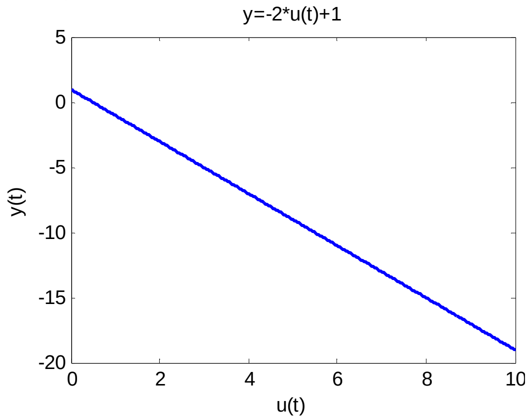
Types of Control System

Linear Vs Nonlinear Control System

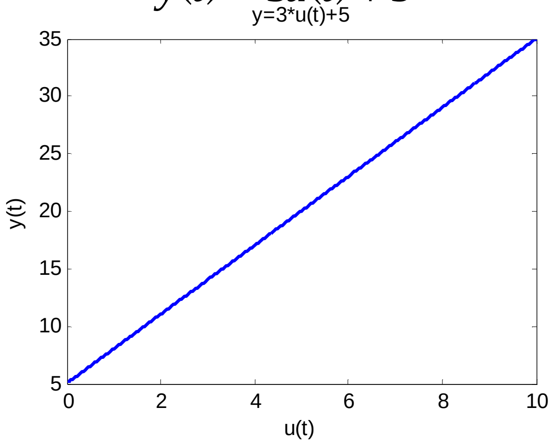
- A Control System in which output varies linearly with the input is called a **linear** control system.



$$y(t) = -2u(t) + 1$$



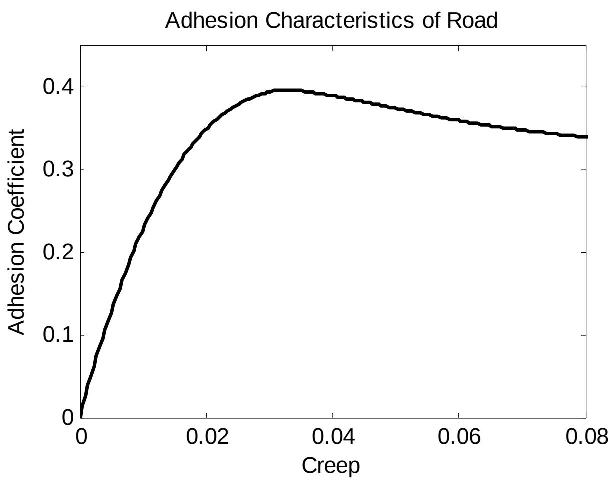
$$y(t) = 3u(t) + 5$$



Types of Control System

Linear Vs Nonlinear Control System

- When the input and output has nonlinear relationship the system is said to be **nonlinear**.



Types of Control System

Time invariant vs Time variant

- When the characteristics of the system do not depend upon time itself then the system is said to **time invariant** control system.

$$y(t) = -2u(t) + 1$$

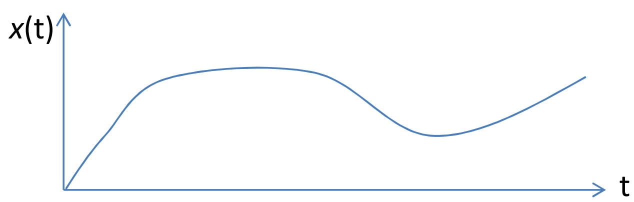
- **Time varying** control system is a system in which one or more parameters vary with time.

$$y(t) = 2u(t) - 3t$$

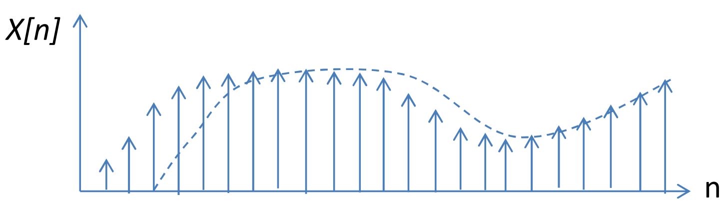
Types of Control System

Continuous Data Vs Discrete Data System

- In continuous data control system all system variables are function of a continuous time t.



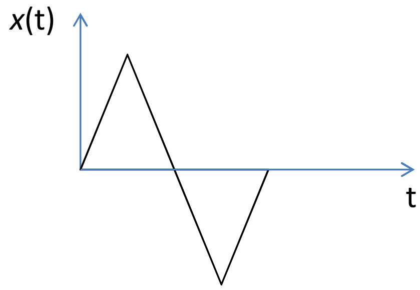
- A discrete time control system involves one or more variables that are known only at discrete time intervals.

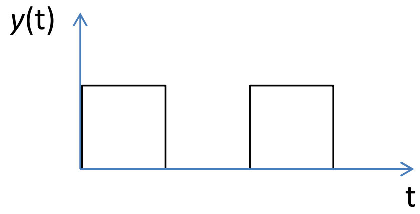


Types of Control System

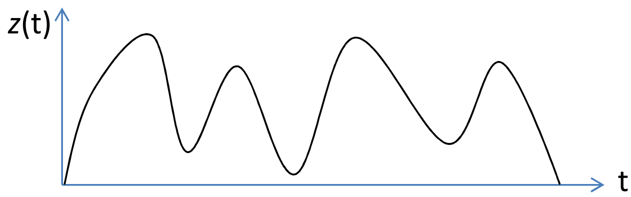
Deterministic vs Stochastic Control System

- A control System is **deterministic** if the response to input is predictable and repeatable.



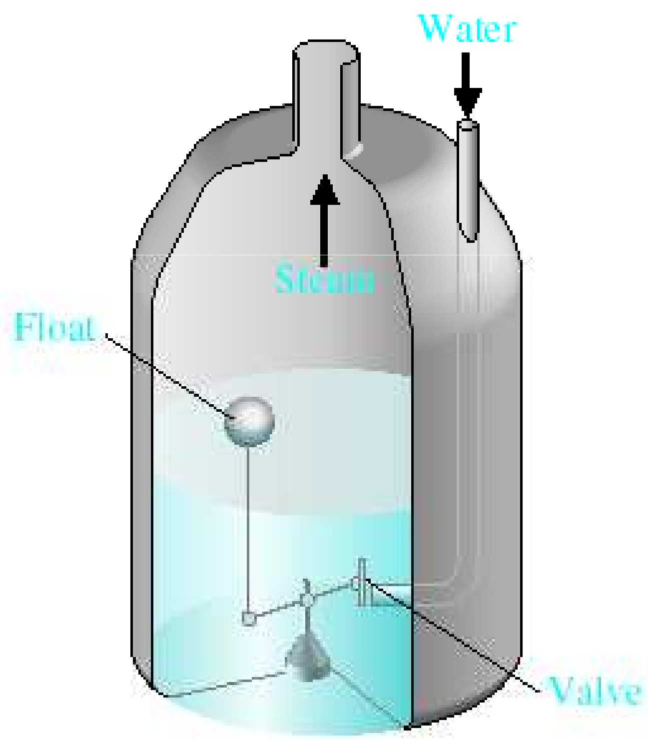


- If not, the control system is a **stochastic** control system

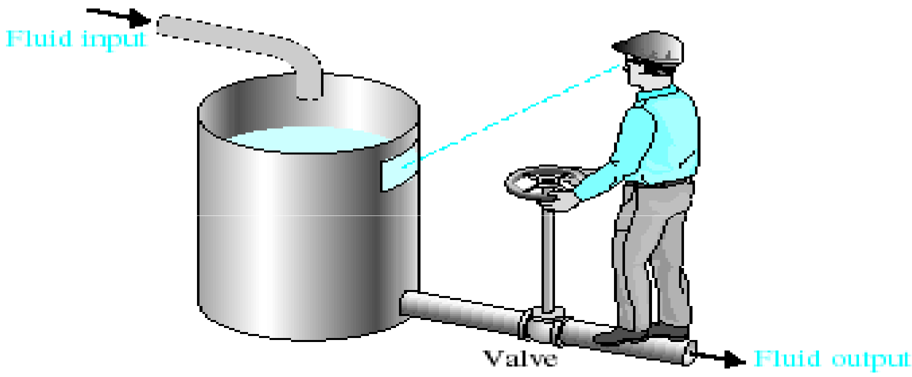


Examples of Control Systems

Water-level float regulator

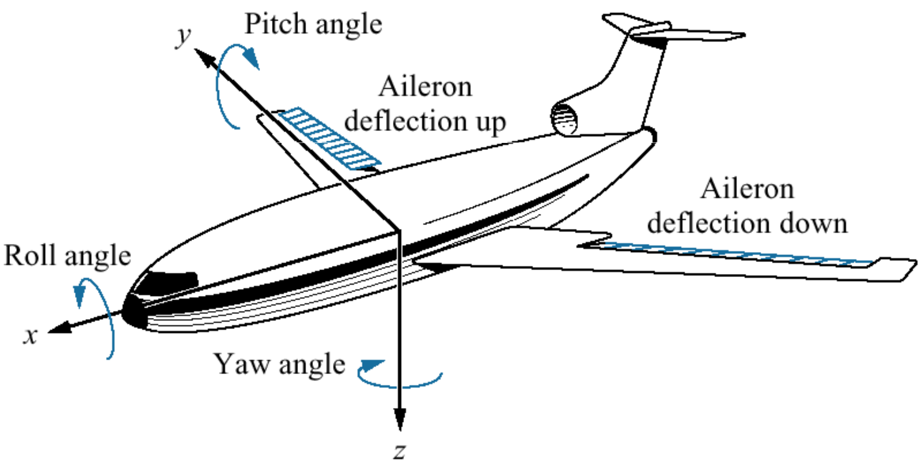


Examples of Control Systems

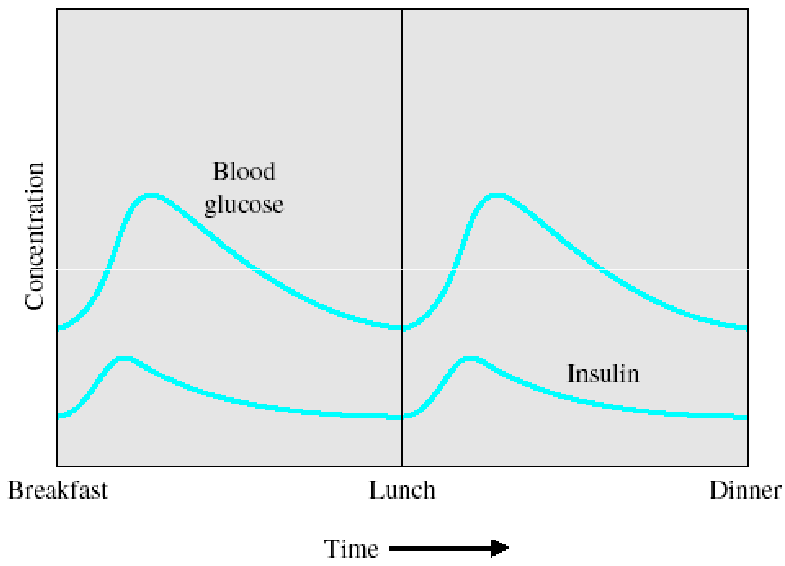


A manual control system for regulating the level of fluid in a tank by adjusting the output valve. The operator views the level of fluid through a port in the side of the tank.

Examples of Modern Control Systems



Examples of Modern Control Systems



The blood glucose and insulin levels for a healthy person.