LINEAR CONTROL SYSTEMS

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Lecture 1

An Introduction to Linear Control Systems

Topics to be covered include:

- About the Course
- Introduction.
- Some Advanced Control System.
- Different Parts of Control Systems.
- Open-loop and Closed-loop systems.
- Feedback Property

Syllabus

- An Introduction to Linear Control Systems.(Lecture 1)
- Different Representations of Control Systems and Linearization.(Lectu 2)
- Internal and External Description. (Tf and SS Description). (Lecture 3
- Stability Analysis. (Lecture 4)

A

- Time Domain Analysis of Control Systems. (Lecture 5)
- Root Locus Criteria. (Lecture 6)
- Controller Design in the Time Domain. (Lecture 7)

B

- Frequency Domain Analysis of Control Systems.(Lecture 8)
- Nyquist Stability Criteria. (Lecture 9)
- Controller Design in the Frequency Domain. (Lecture 10)

C

Prerequisite and Grading

Prerequisite

- English Knowledge, Primary Mathematics, MATLAB Software

Grading

- Quizzes (Important part).
- Class works(Important part).
- Midterms.
- Final.

Around 50%

References

- Modern Control Systems (12th Edition) By Richard C. Dorf , Robert H. Bishop.
- Automatic Control Systems (9th Edition) By Farid Golnaraghi, Benjamin C. Kuo.
- Control Systems Engineering (Wiley 2000) By Norman S. Nise

Introduction

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

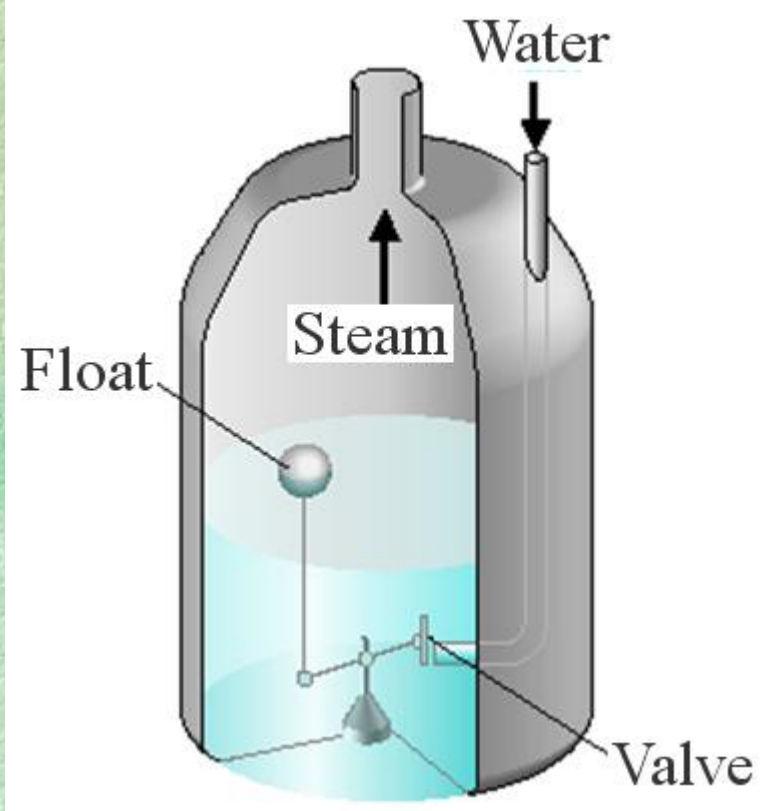
????

Different Parts of a Control System

- System or Plant
- Objective
- States
- Output
- Input
- Sensors
- Actuators
- Computing
- Disturbance, noise & uncertainties

Introduction - History of Control Engineering

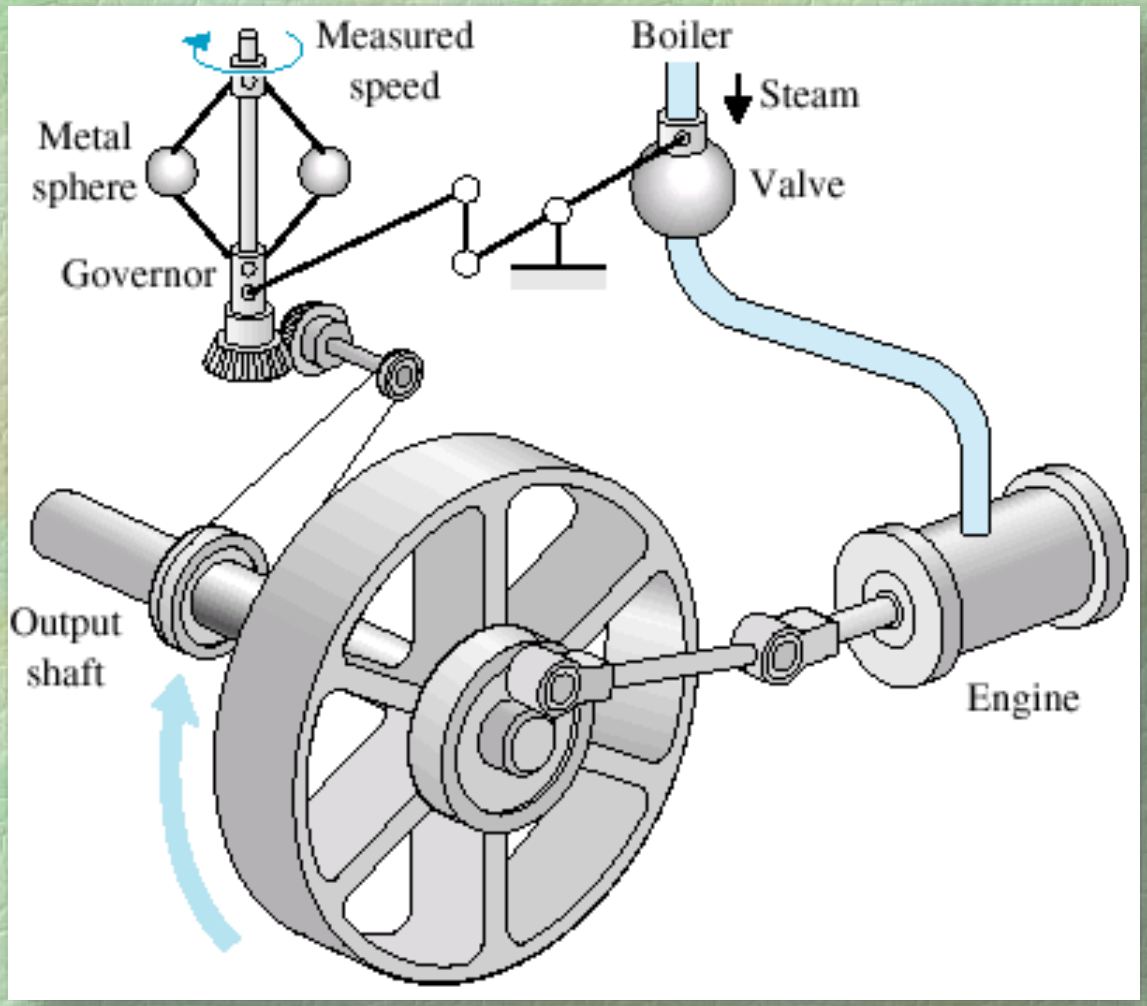
Water-level float regulator
(before BC)



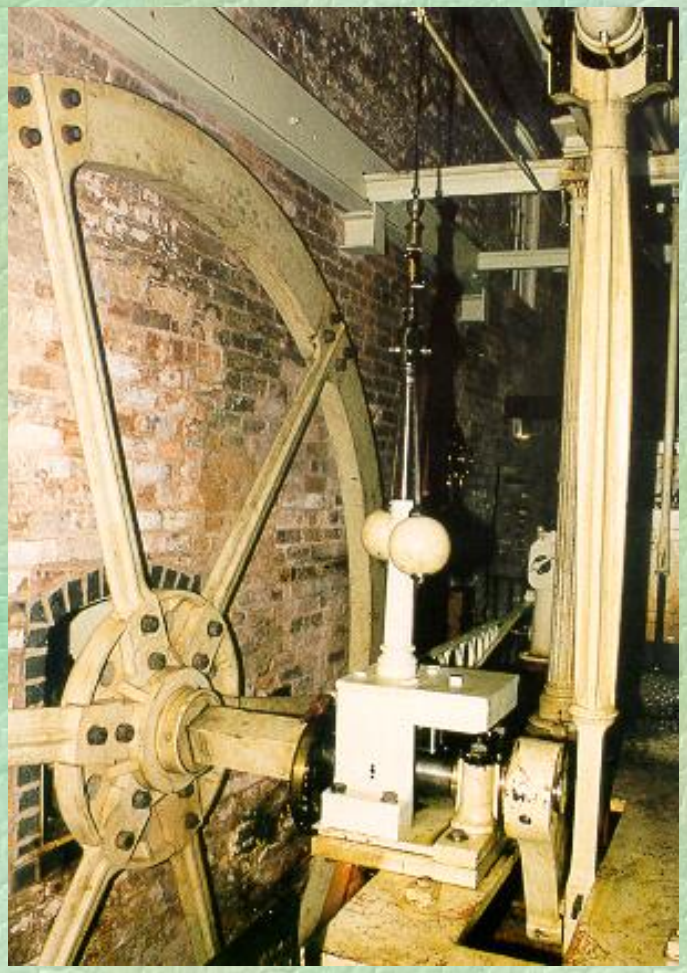
RQ-170 unmanned plane
(Nowadays)

Introduction - History of Control Engineering

18th Century James Watt's centrifugal governor for the speed control of a steam engine.



Introduction - History of Control Engineering



This photograph shows a flyball governor used on a steam engine in a cotton factory near Manchester in the United Kingdom. Actually, this cotton factory is still running today.

Introduction - Earliest Control Systems?

Human System

i. Pancreas
   + Regulates blood glucose level
ii. Adrenaline
   + Automatically generated to increase the heart rate and oxygen in times of flight
iii. Eye
   + Follow moving object
iv. Hand
   + Pick up an object and place it at a predetermined location
v. Temperature
   + Regulated temperature of 36°C to 37°C

Introduction

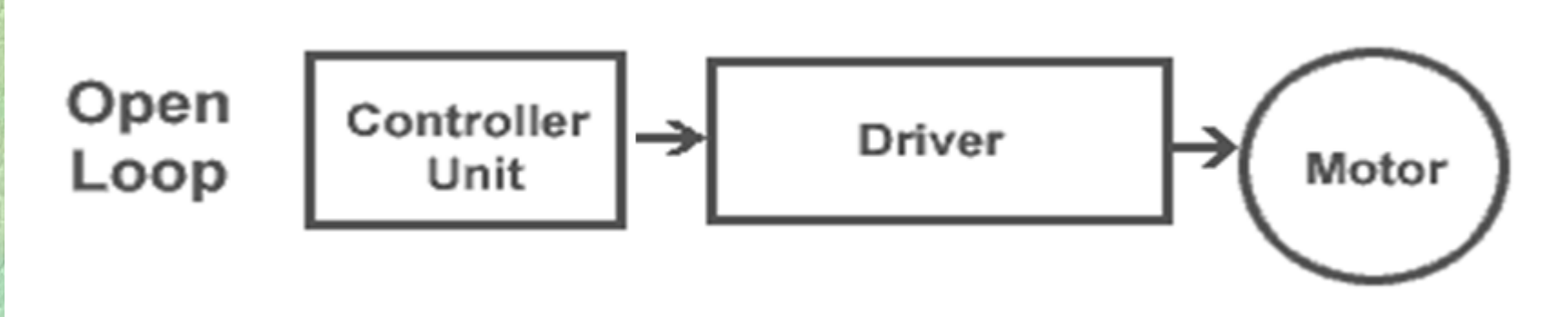
Some Control benefits

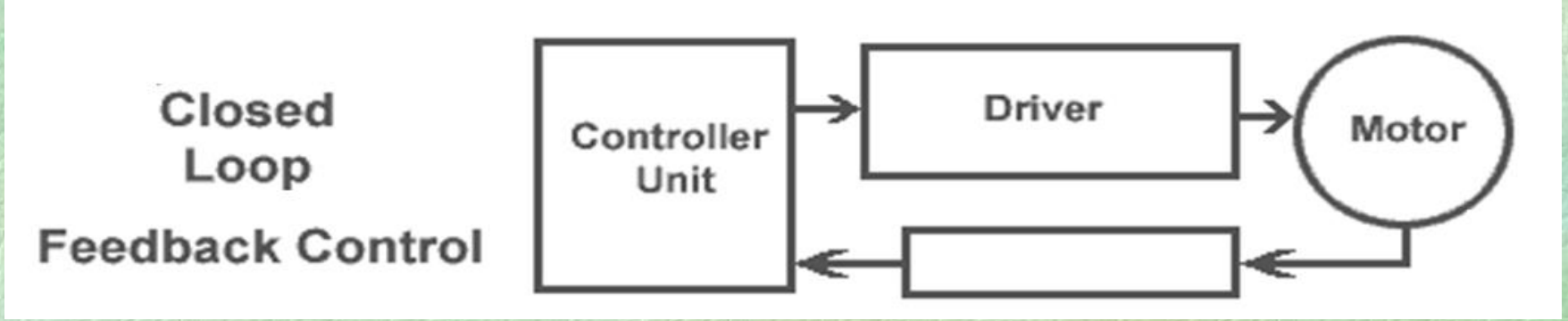
- Enhanced Product Quality.
- Waste Minimization.
- Environmental Protection.
- Greater Throughput for a Given Installed Capacity.
- Higher Safety Margins.

Introduction - Control System Classification

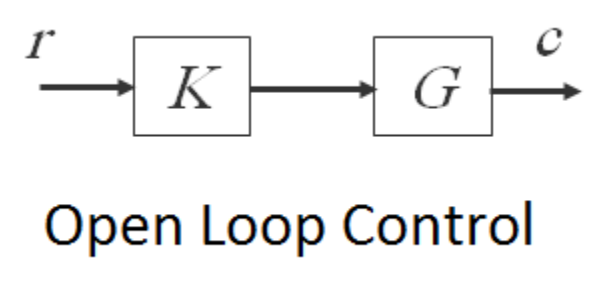
1- Open Loop Control.

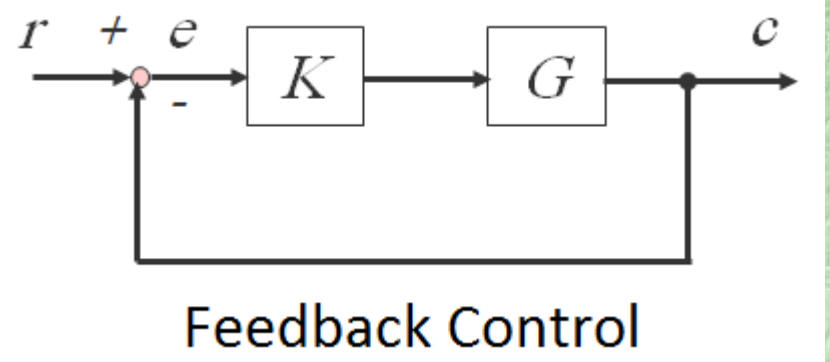
2- Closed Loop Control(Feedback).





Introduction – Feedback Properties





1- Feedback Advantages:

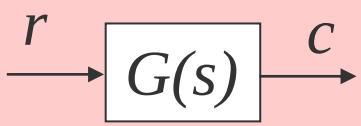
- Error reduction
- Gain regulation
- Sensitivity reduction
- Stabilization

2- Feedback Disadvantages:

- Speed reduction

Feedback properties

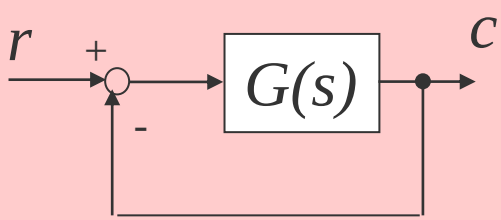
Example 1: Derive step response of following system in open loop and closed loop.



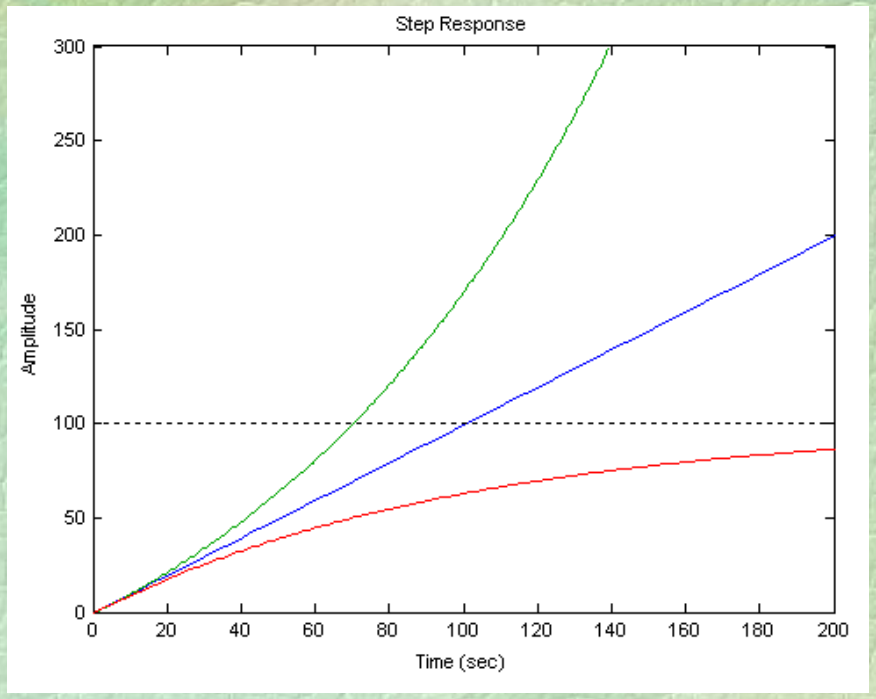
Open loop system

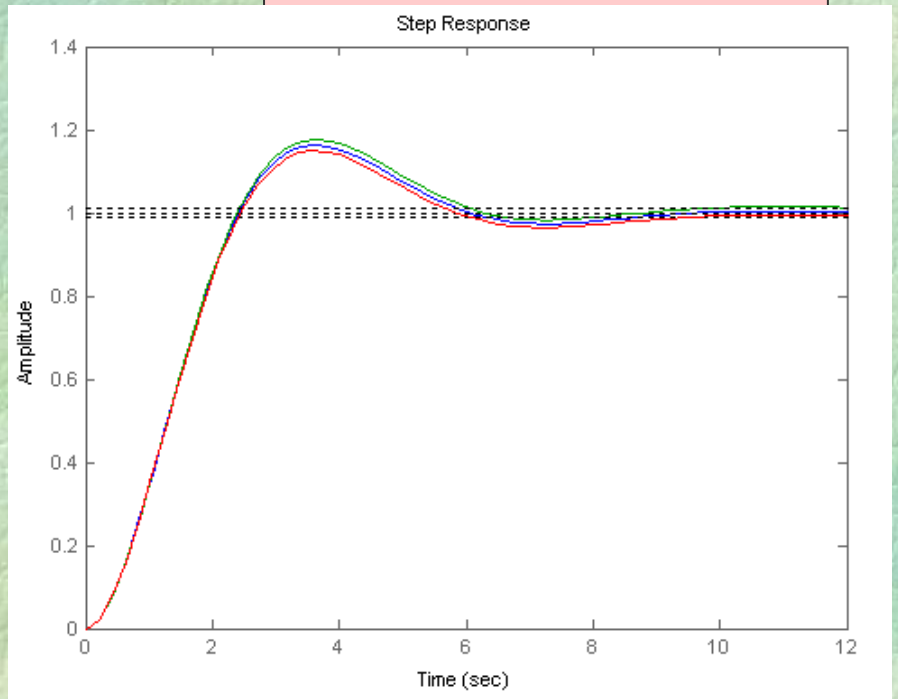
$$G(s) = \frac{1}{(s+1)(s+a)}$$

$$a = -0.01, 0, 0.01$$



Closed loop system



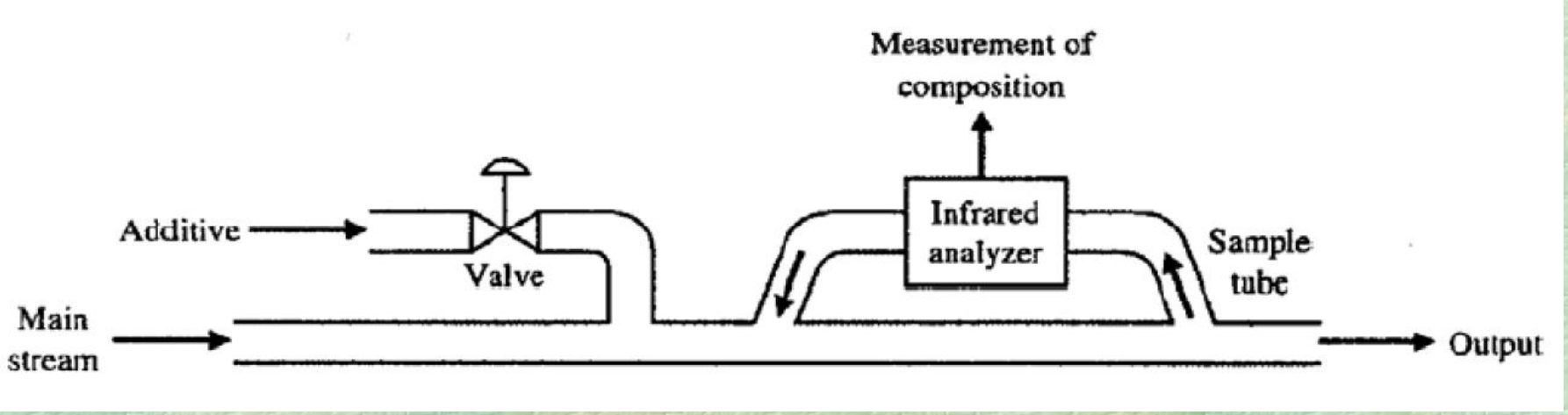


When is the open loop representation applicable?

- The model on which the design of the controller has been based is a very good representation of the plant,
- The model must be stable, and
- Disturbances and initial conditions are negligible.

Exercises

1-1 In a control system of an industrial composition process , it is very important to control the chemical composition of the output. There is an infrared analyzer for measurement and the valve of additive stream is controllable. Explain different elements of system.



1-2 Describe a control system and explain different elements of system.