Lecture 1 – Part 1

Introduction

ME528 – Semester 1

Control Systems

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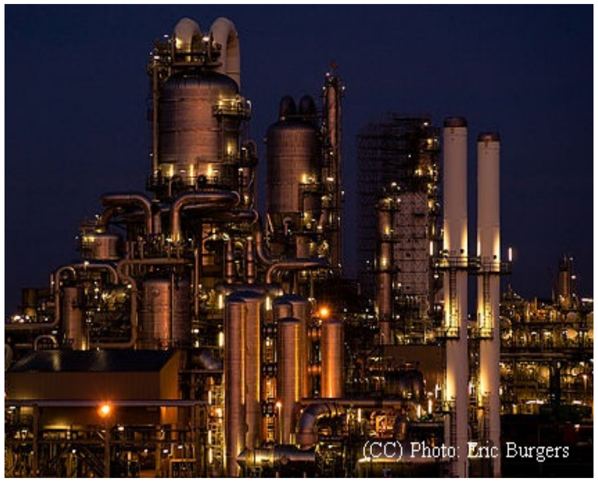
Automatic control

What actually *is* control?

It's where we make our working environment (often called a 'system' or a 'process') behave as we wish.

Why do we need *automatic* control?

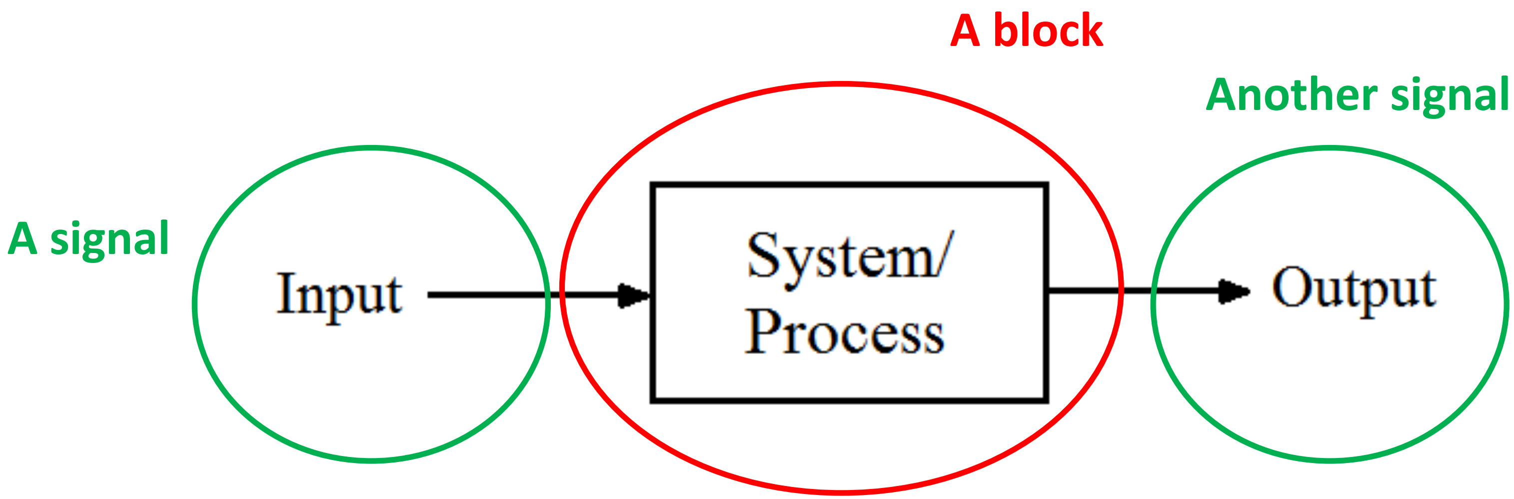
- To control the temperature of a room,
- To get increased efficiency, e.g. engine control,
- To minimise danger, e.g. in chemical plants,
- To operate where it is impossible for humans to control, e.g. an F22 plane or a nuclear reaction.



Automatic control

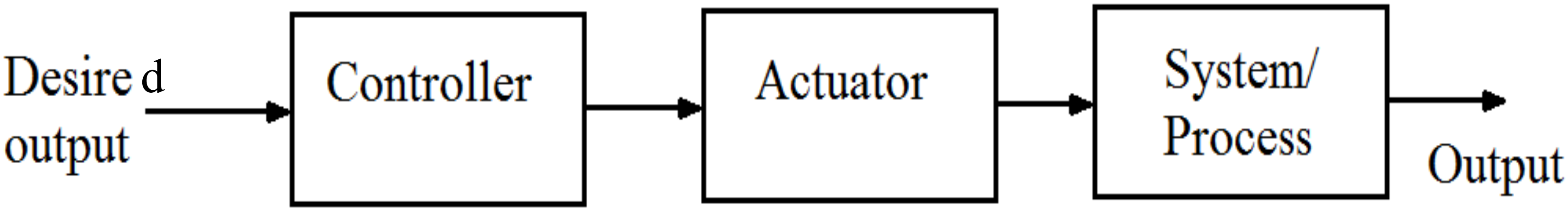
- Effective system control requires an understanding of *the physics* of a system in order to:
  - Derive *a mathematical model* based on the system's *dynamics*,
  - Then to choose *an appropriate control system* to represent those dynamics,
  - Finally, to analyse the *performance* of the system.

Basic parts of control systems

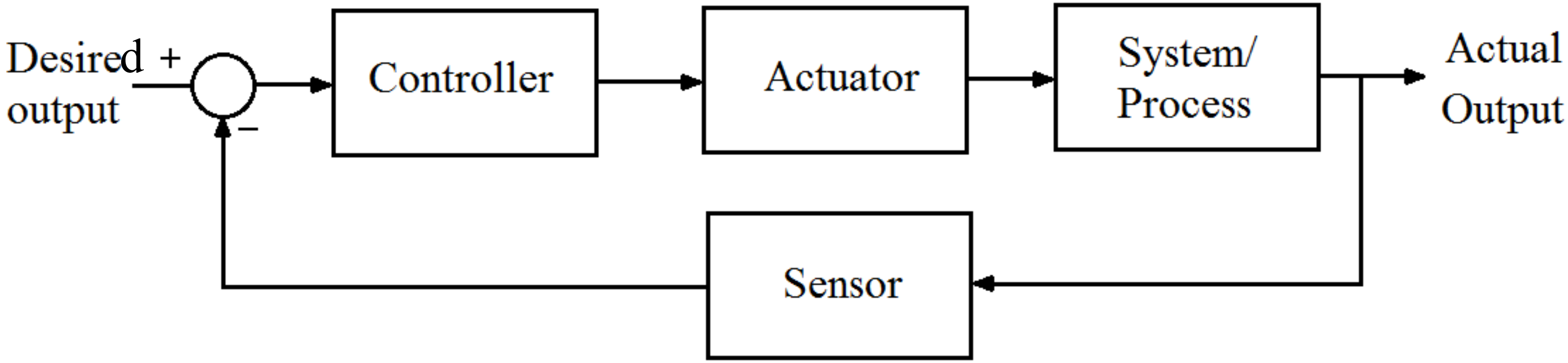


There are two principal groups of control system

1. The open loop control system:

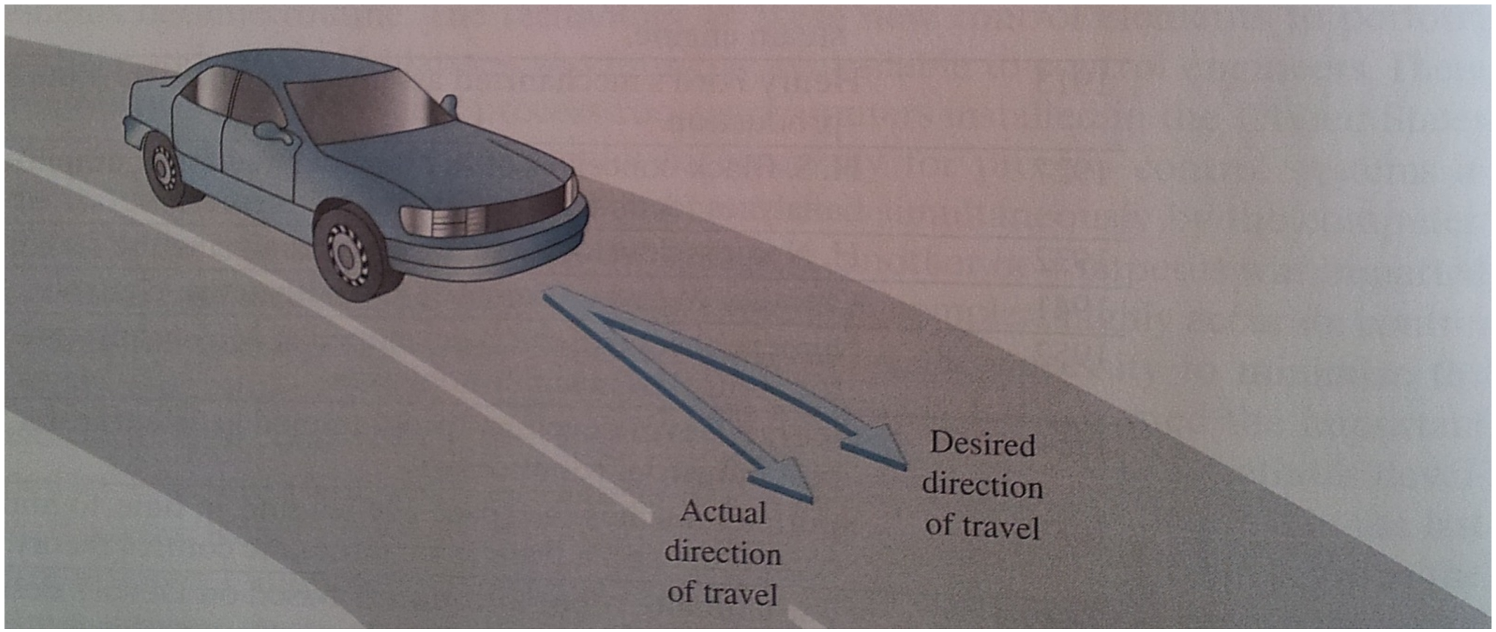


2. The closed loop feedback control system



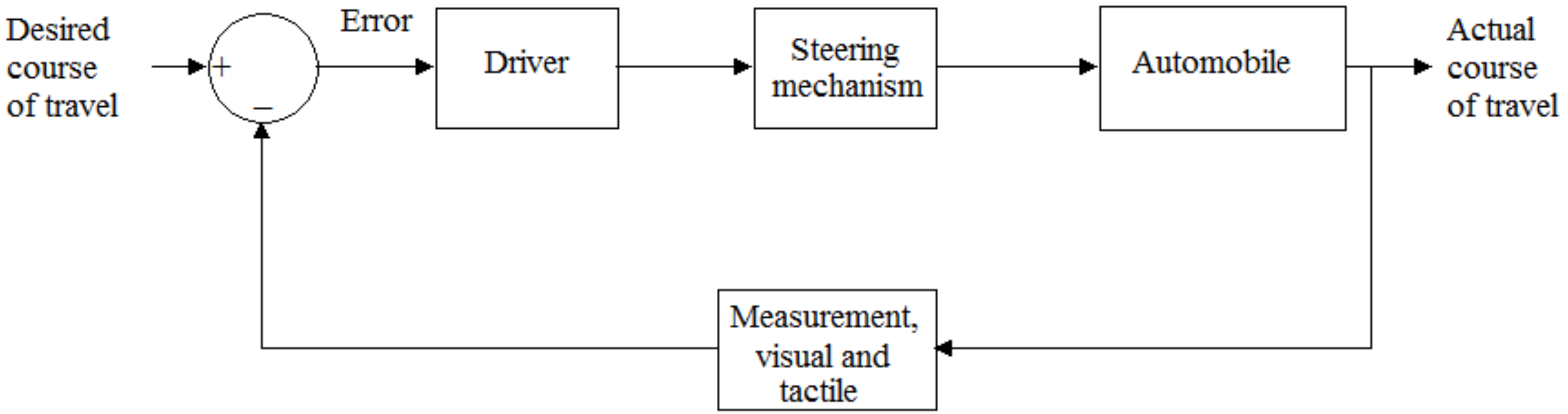
Simple example of a closed loop control system

Control of car steering



TRY THIS NOW!

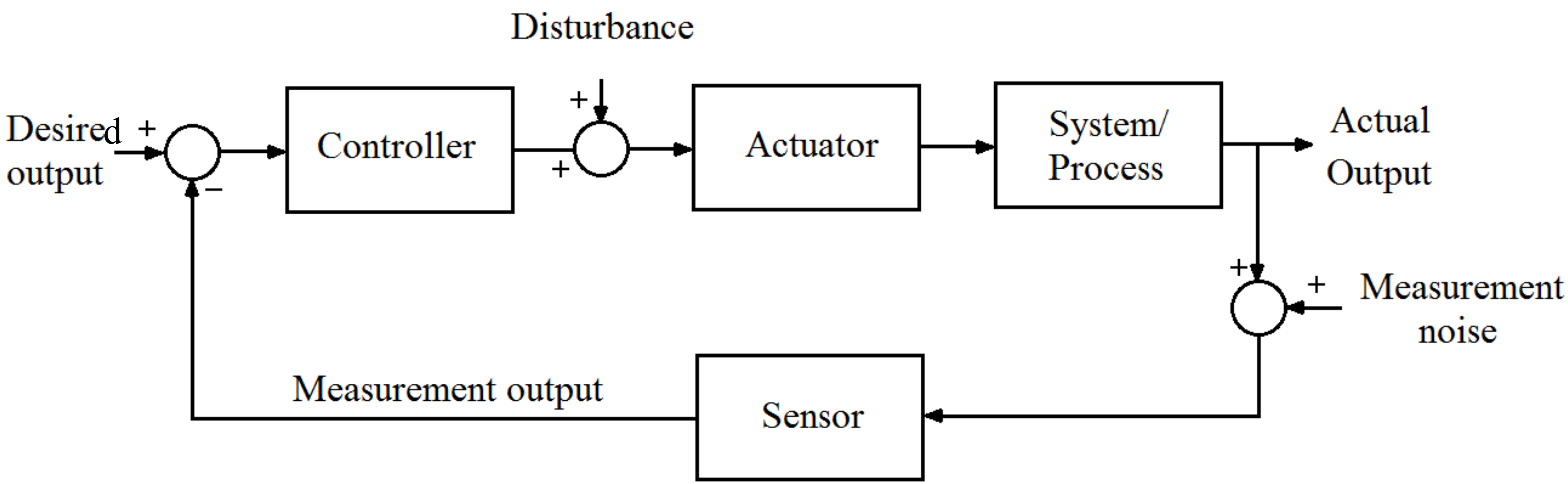
Block diagram of a steering control system for a car:



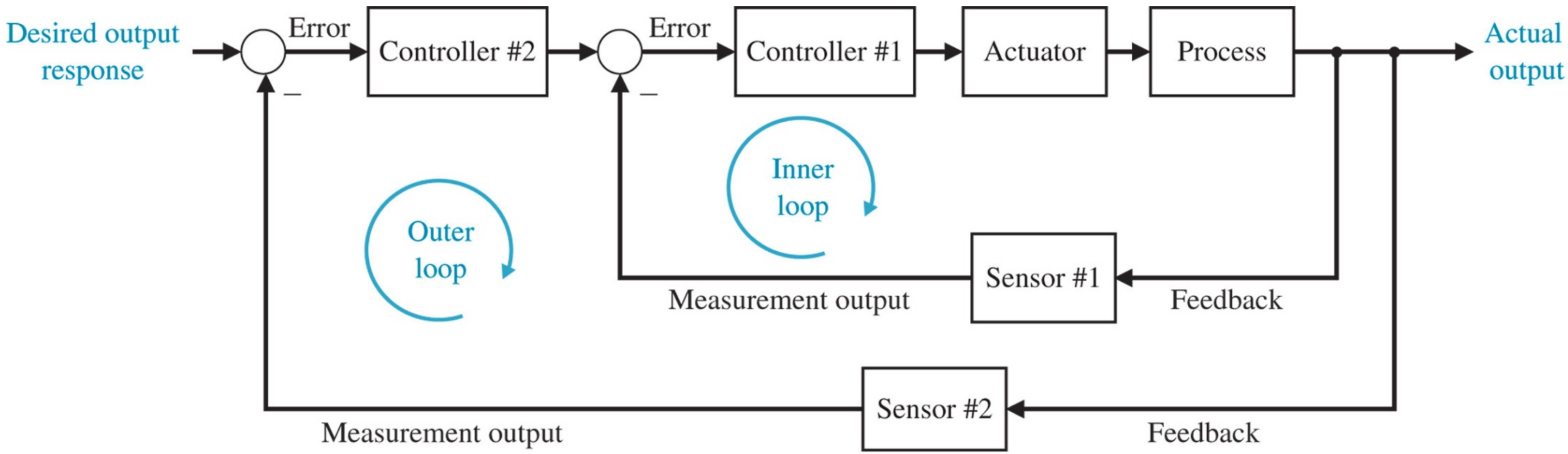
The driver uses the difference between the desired and the actual path to generate a controlled adjustment of the steering wheel. This is usually a very robust **and** adaptive controller indeed!

Closed-loop feedback control systems

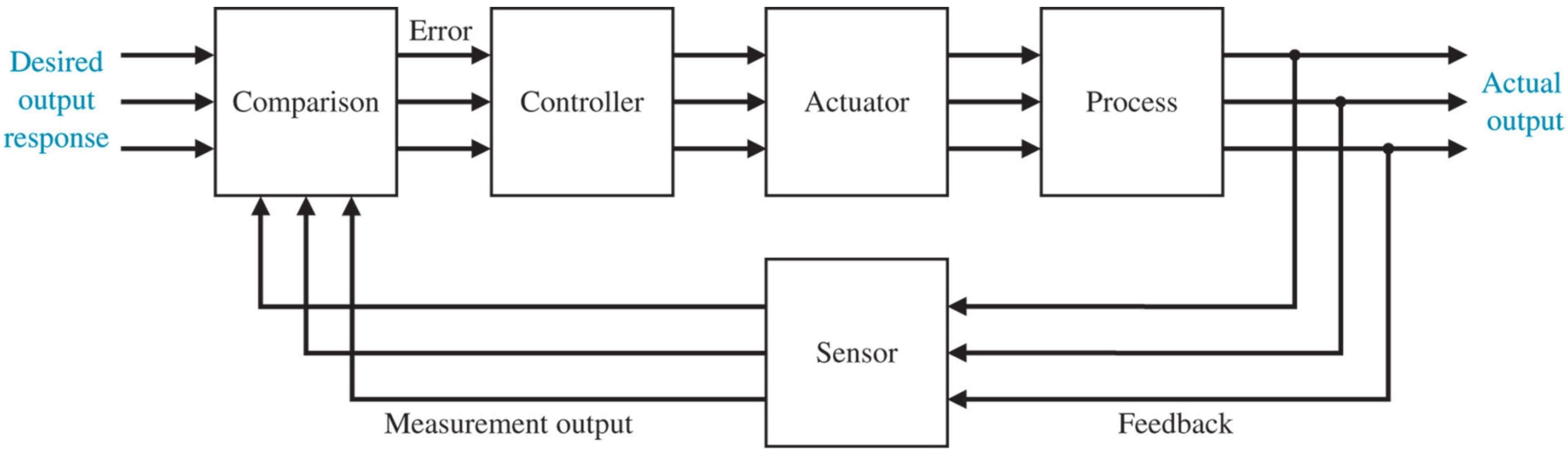
With a disturbance and also with measurement noise – both added in.



Multi-loop feedback control systems:

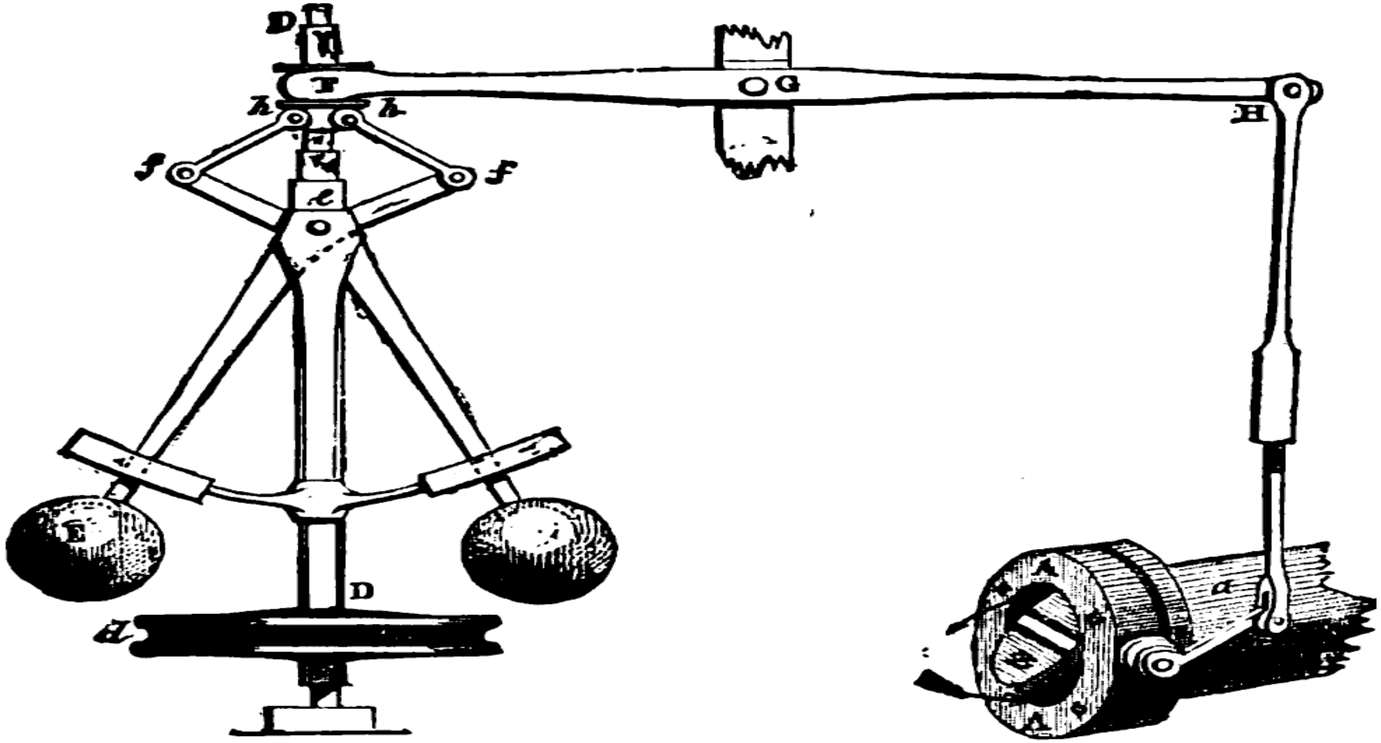


Multivariable control systems



Early history of practical control systems

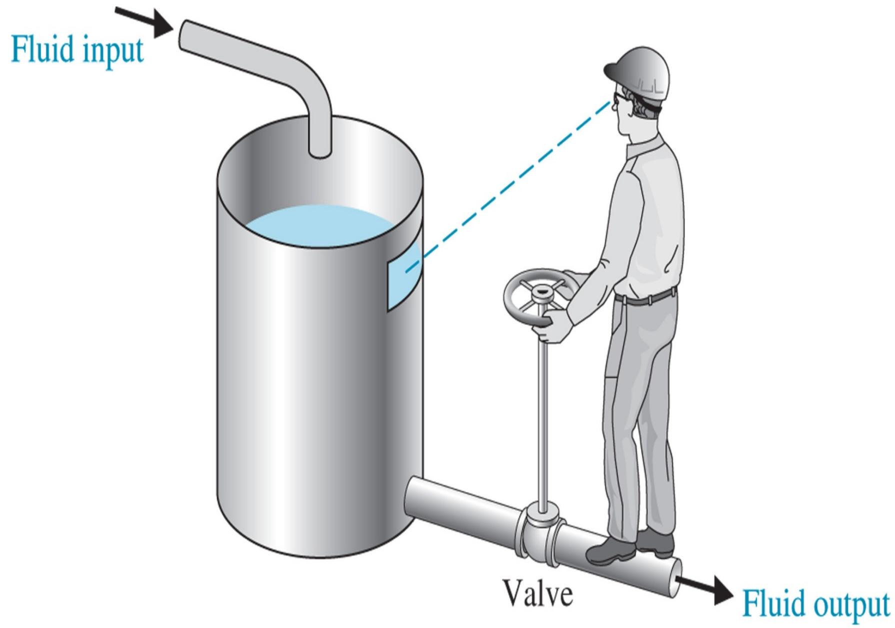
- Water clock float regulator invented by Ktesibius in Greece, in about 270 B.C.
- Temperature regulator for the incubation of eggs by Cornelis Drebbel in the Netherlands, in 1624.
- Steam engine speed control governor by James Watt, Scotland, 1796:



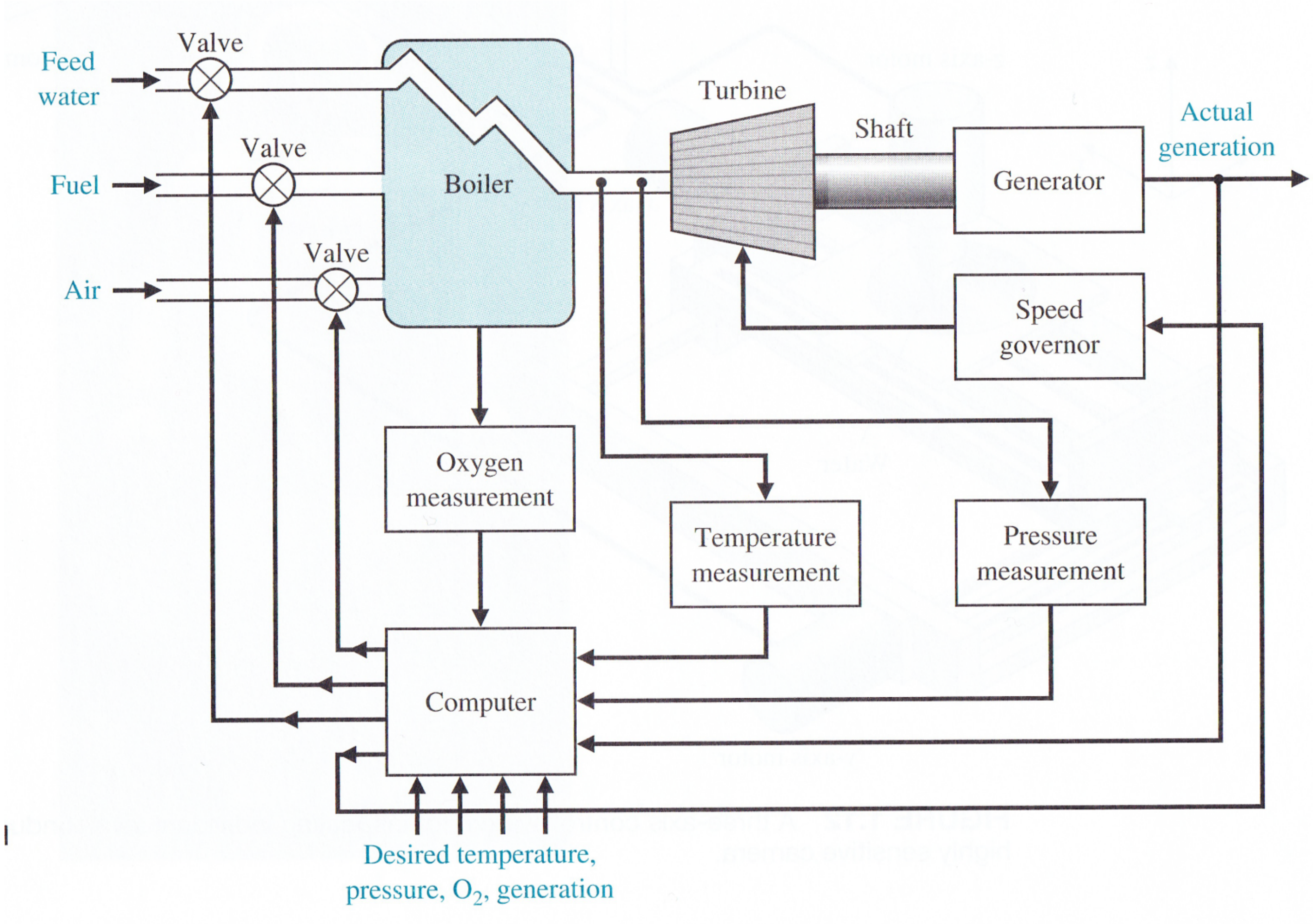
Everyday examples of control systems

- Domestic examples: refrigerators, ovens, water heaters.
- Industrial systems frequently provide:
  - Speed control,
  - Process temperature and pressure control,
  - Position control,
  - Robot kinematics.

Simple manual control of fluid level in a tank – entirely reliant on hand-eye control and fast operator reactions.

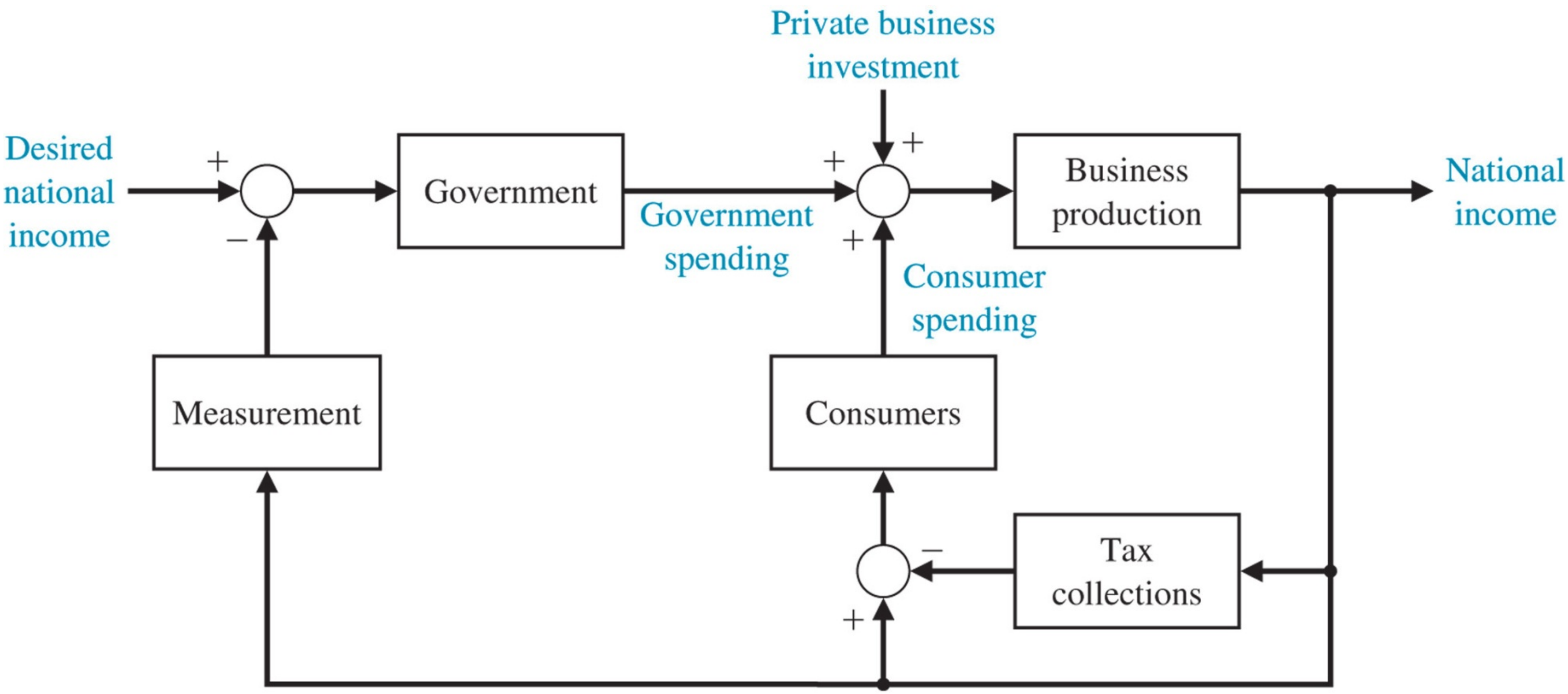


Example of multivariable industrial control system



Control system for a boiler-generator (taken from Figure 1.13 of *Modern Control Systems* by R.C.Dorf, 1992)

Socio-economic application: a national economy



Consumer loop is somewhat de-emphasised in a communist model, but this loop is vital in a capitalist system (adapted from R.C.Dorf, 1992).

The future for control

- Vastly distributed ‘intelligence’ in consumer products,
- *Internet of Things*,
- Increasing sophistication in telecoms,
- Biomechanical systems integration,
- International payment systems,
- Driverless vehicles,
- Domestic comfort and security,
- Spacecraft GNC,
- Astronomy,
- Automated flight (drones),
- Learning and education,
- Information and entertainment
- Virtual reality simulations

Principal topics within the syllabus for this course

- Introduction to control systems,
- Differential equations for modelling physical systems,
- Linear approximations,
- Block diagram representations,
- The Laplace Transform,
- Error signal analysis,
- Disturbance rejection,
- Test input signals,
- Response of second order systems.