Flight Control Systems
ASE 370L Spring 2002

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General information
- Office hours
- Objectives
- Textbook
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Introduction to process control
- Manual and automatic control. Example
- Components of a control system
- Phases in the design of a control system
Office hours

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Objectives

- Introduction to systems theory
  - Analysis and design of control systems
    - Frequency domain
    - State-space domain
- Implementation of control systems
  - MATLAB and SIMULINK programming
Textbook

Modern Control Systems, 9th Ed.
by R. C. Dorf & R. H. Bishop
Grading and Exams

• 3 exams (60%)
  1 in-class
  2 take-home

• Homework+Project (40%)

Project
• Team (2 people)
• simulation, control and animation of the process.
www.ae.utexas.edu/courses/ase370/

- Syllabus
  - Homework policy
  - Topics
  - ...  
- Homework and solutions
- Topics in control systems
  - Articles in control systems for aerospace applications
  - MATLAB tutorial and help
Aircraft roll control

Bank angle, $\varphi$

Aileron

Plane of symmetry

Bank angle, $\varphi$

Control surface

Actuator

Power amplifier

Pump

Motor

Aircraft roll control
Aircraft roll control. Variables and elements (I)

- **Manipulated Variable**: Aileron Deflection
- **Controlled Variable**: Bank Angle
- **Disturbances**: wind
- **Measured Variable**: Gyro

**Reference**: Bank Angle command

**Feedback** line connects the reference to the aileron deflection, indicating the control loop.
Aircraft roll control. Variables and elements (II)

- **Reference Variable**: Bank angle command
- **Controlled Variable**: Bank angle
- **Manipulated Variable**: Aileron deflection
- **Disturbances**: Wind
- **Measured Variable**: Gyro

**Control Loop**

**Controller** → **Aileron Actuator** → **Aircraft Dynamics** → **Bank Angle**

**Aileron Deflection**
<table>
<thead>
<tr>
<th>Elements</th>
<th>Variables involved</th>
<th>Can be modified</th>
</tr>
</thead>
</table>
| Process      | • Controlled variable  
• Manipulated variable  
• Disturbances                        | Cannot be modified                                                                |
| Sensor       | • Controlled variable  
• Measured variable                        | Cannot be modified                                                                |
| Controller   | • Controlled variable  
• Measured variable  
• Reference                             | Can be modified  
(Computer program)                                                            |
Control Objective:
The controlled variable value must be moved towards the reference value despite the disturbances.
How?: Moving the manipulated variable.
Control Objective:
The Bank Angle must be close to the Bank Angle command despite of the wind.

How?: Moving the aileron.

Aircraft roll control. Control Objective:

Control Objective:
The Bank Angle must be close to the Bank Angle command despite of the wind.

How?: Moving the aileron.

Aircraft roll control. Control Objective:

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How?: Moving the aileron.

Aircraft roll control. Control Objective:

Control Objective:
The Bank Angle must be close to the Bank Angle command despite of the wind.

How?: Moving the aileron.
**Phase 1: Study of the process**
- Controlled variables are chosen
- Control objectives

**Phase 2: Obtain the process model**
- Very important
- 70% time in the control project
- Simulation and Validation

**Phase 3: Analysis**
- Dynamic and static behavior
- Manipulated variables are chosen

**Phase 4: Design of the control system**
- Controller selection
- Controller design and tuning
- Controller+process simulation

**Phase 5: Implementation and test**
- Instrumentation test (actuators and sensors)
- Controller programming
- Controller validation (objectives)