## Today's EE 231 Lecture

- What is EE 231?
- Motivation for control.
- Examples of control systems.
- Basic control system.






## What is EE 231?

- Analysis of control systems.
  - modeling, transfer functions, block diagrams and SFG.
  - root locus, Bode plots, Nyquist plots.
  - stability.
- Design of controllers.
  - compensation techniques, PID, phase-lead
  - sensitivity, disturbance rejection.
- Multivarible control, robust control, adaptive control.






## Motivation for Control

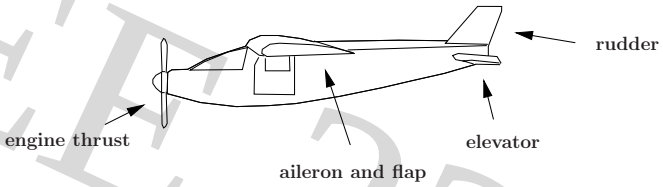
- Sophisticated control is crucial for the successful operation of many modern industrial plants.
- Improved control is an enabling technology.
  - enhanced product quality.
  - less waste.
  - leads to environment friendliness.
  - greater throughput for a given installed capacity.
  - greater yield.
  - deferring costly plant upgrades.
  - higher safety margins.






## Examples of Control Systems

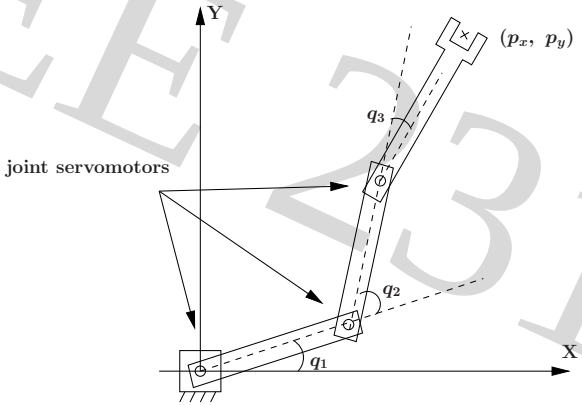
- Control of an aircraft.




  - engine thrust affects aircraft speed.
  - rudder controls aircraft yaw.
  - elevator controls the pitch.
  - aileron controls the roll of the aircraft.

## Examples of Control Systems

- Robotic manipulator.
  - servomotors control the joint angles.







## Examples of Control Systems

- Biological system.
  - nutrient flow controls bacteria growth.
  - input is nutrient material.
  - output is the bacteria concentration.

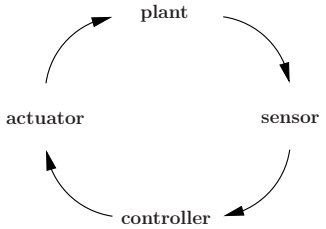
- Population system.
  - population depends on different factors.
  - inputs may be food supply and climate conditions.
  - output is population.




## Basic Elements of a Control System

- Plant.

  This is the process you want to control, i.e., drive to the desired state.




- You need to be familiar with the physics of the process in order to control it.

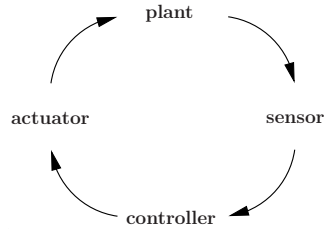
  Requires knowledge of basic energy balance, mass balance and material flows in the system.




## Basic Elements of a Control System

- Sensor.

  Eye of the control. Enables the control to see what is going on. Reports on the state of the process.



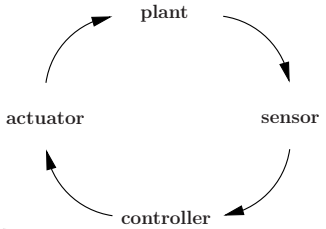

- Actuator.

  Moves the process from current state to the desired state. If the sensor is the eye, then the actuator is the muscle.

## Basic Elements of a Control System

- Controller.

  Takes the sensor information and decides how to actuate the plant to achieve the desired state.




- In this course, we will start with the mathematical representation of the plant.

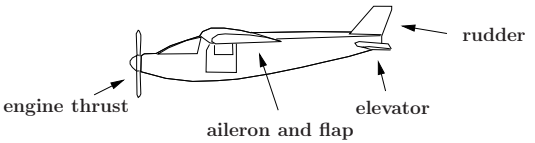
  We will then proceed to learn tools for analysis.

  Look at different control schemes to achieve control objectives.




## Basic Elements of a Control System

- Control of an aircraft.




- Actuators are
  - engine thrust.
  - rudder, elevator and aileron.

- Sensors could be
  - aircraft speed sensor.
  - pitch, roll, yaw angle sensors.

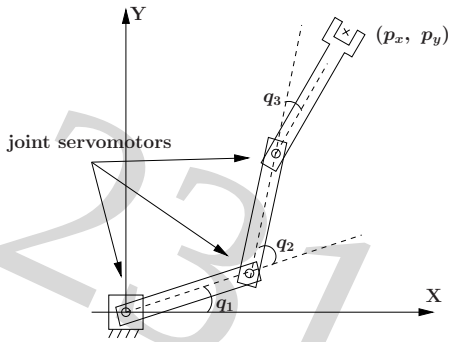



## Basic Elements of a Control System

- Robotic manipulator.

- Servomotors are the actuators.

- Sensors are shaft encoders.




- No need for $x, y$ end-effector position sensor. Why?




## Basic Elements of a Control System

- Biological system.
  - the actuator is the nutrient material.
  - the sensor could be an image processing system coupled to a microscope.

- Population system.
  - the actuators are food supply and climate conditions.
  - the sensor could be random population sampling.

## Summary

- Why EE 231?
- Examples of control systems.
- Parts of a control system.
- Next time.
  - mathematic modeling.
  - block diagrams.
  - signal flow graphs.