EE352 Automatic Control

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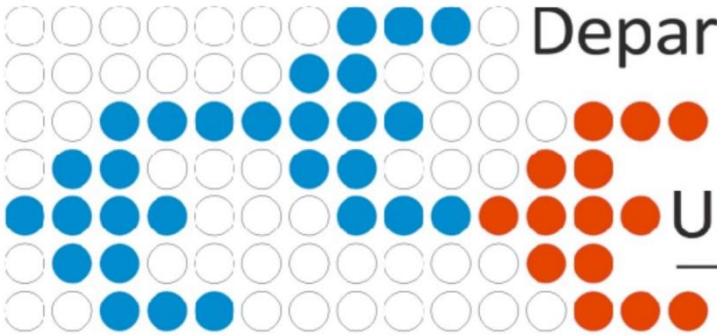

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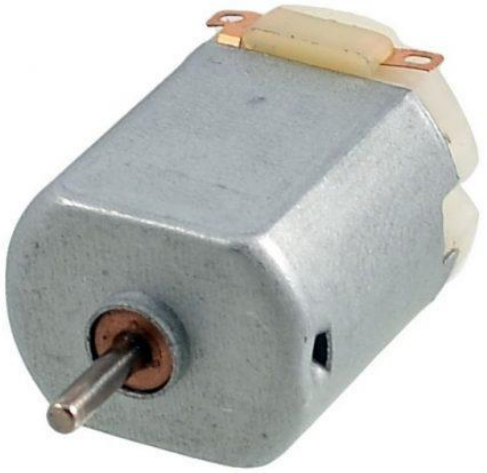
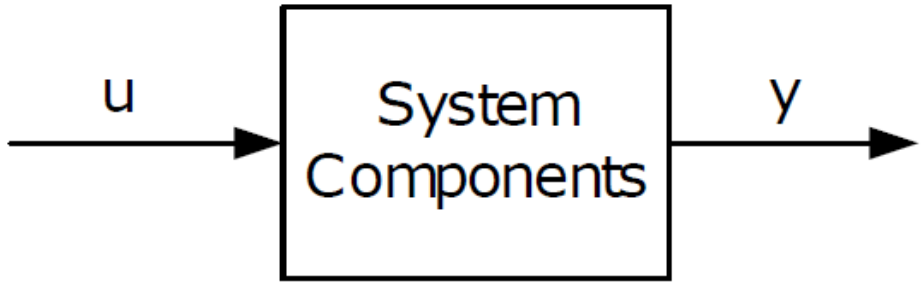
What is a control system?

- **SYSTEM** is an arrangement of physical components connected or related in such a manner as to form and/or act as one unit.
- **CONTROL** ≡ Regulate, Direct or Command
- **CONTROL SYSTEM** is an arrangement of physical components connected to regulate, direct or command itself or another system.
- Ex:
  - Temperature control in a room using an air conditioner
  - Speed control of a vehicle using Cruise Control

Basic components of a control system

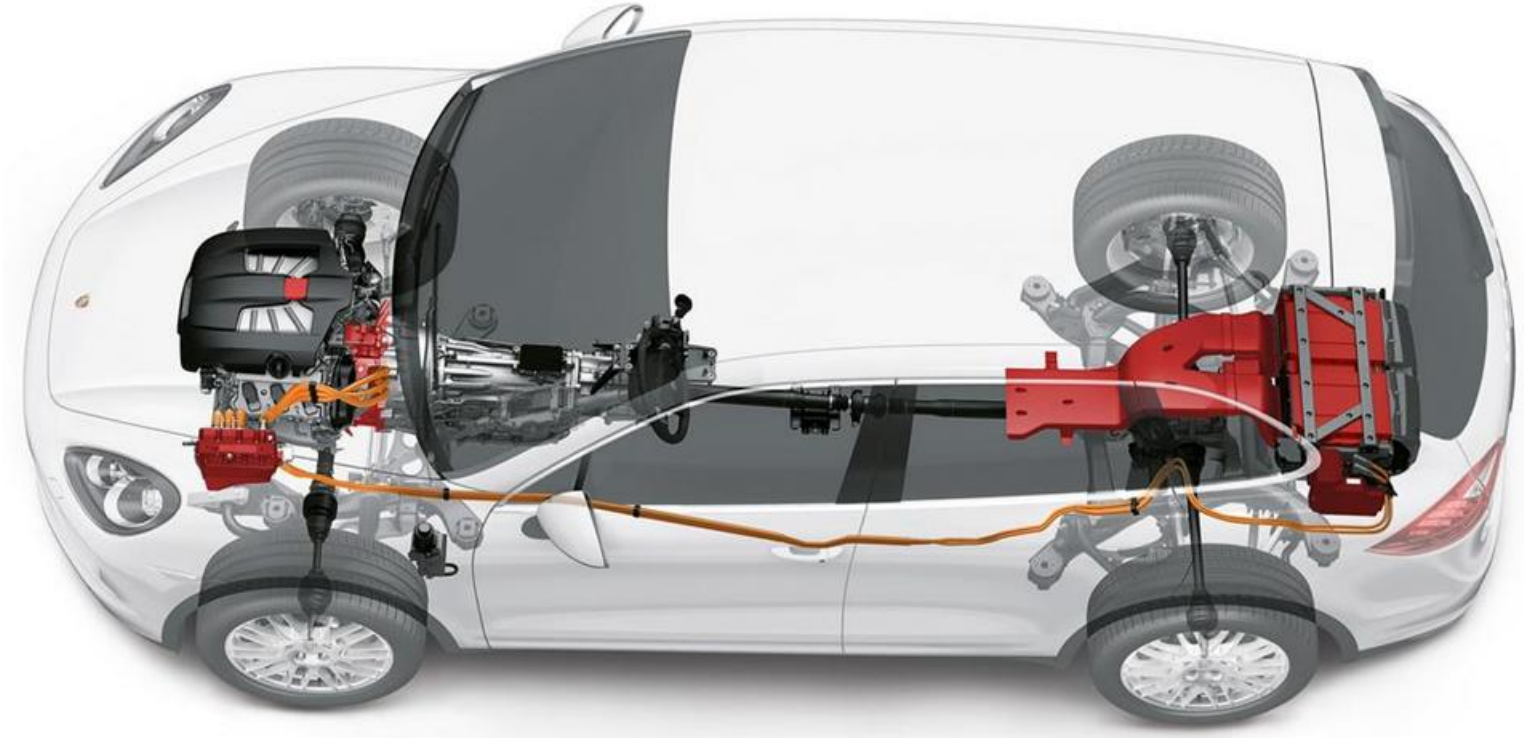


1. **Input**(s) ≅ Actuating signal(s) are known as objectives.
   Ex: In an armature controlled dc motor, voltage is the objective function.
   Denoted by *u*
2. **Output**(s) ≅ Controlled variable(s) are known as Results.
   Ex: the armature current and / or shaft speed of an armature con trolled dc motor.
   Denoted by *y*
3. **System Components** ≅ Components used to control the **outputs** in some prescribed manner, by manipulating the **inputs**.



Identifying **control system components**

- Let us consider an automobile. If we severely simplify it such that it has only driving forward, driving backwards and the steering functions, then we can identify three scenarios.



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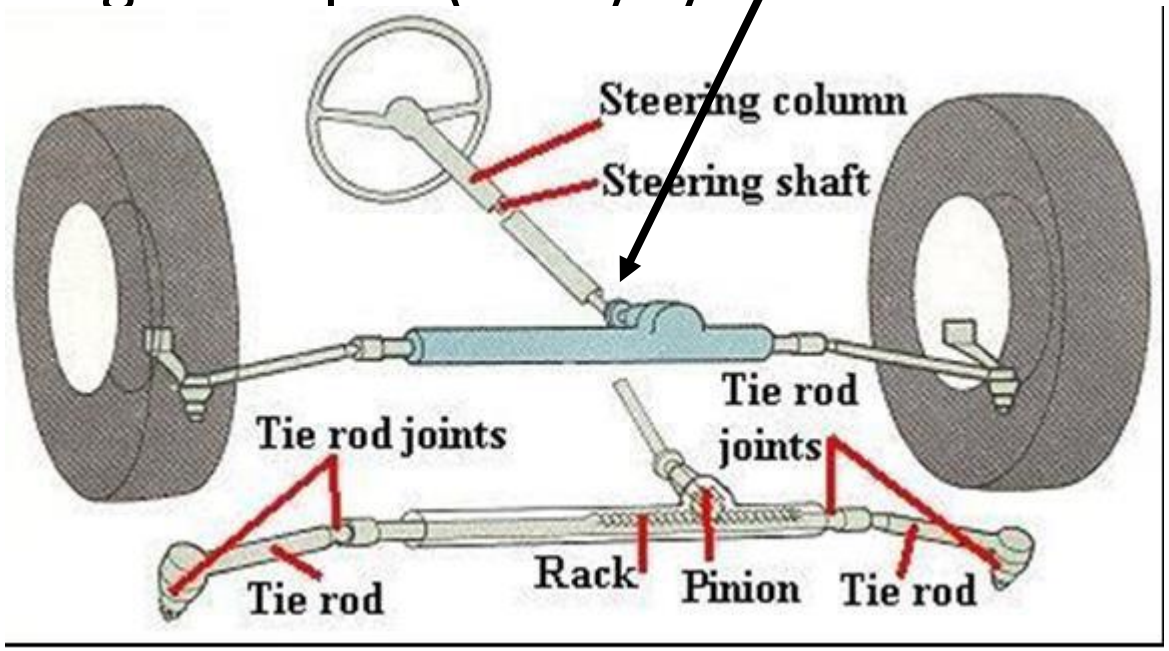
Control system components contd.,

Steering control of an automobile

- **Input**: position of the steering wheel
- **Output**: direction of the road
- **Control system components**: steering mechanisms + dynamics of the complete automobile.
- **S**ingle **I**nput **S**ingle **O**utput (**SISO**) system



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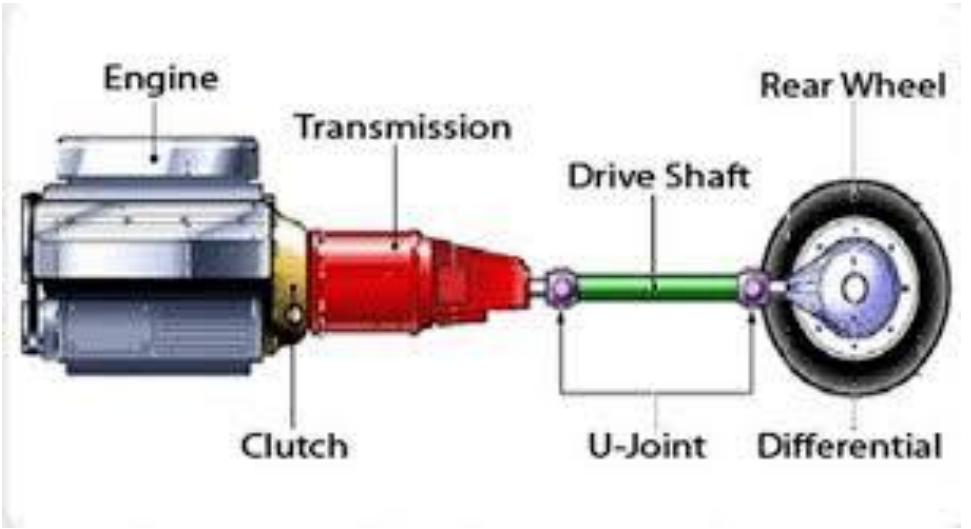
Control system components contd.,

Speed control of an automobile

- Input: pressure put by the driver on the gas peddle
- Output: speed of the vehicle

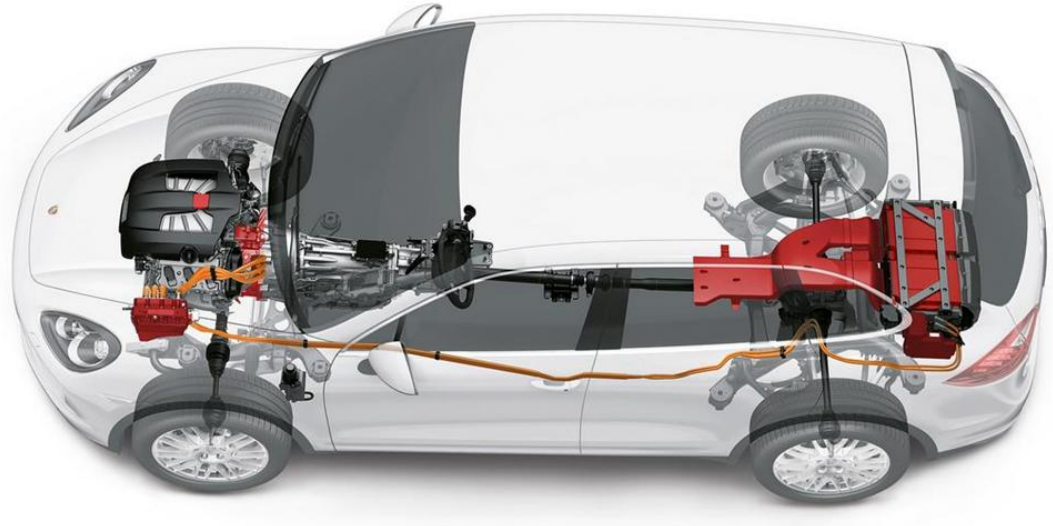
- Control system components: engine, transmission system and the dynamics of the automobile
- **S**ingle **I**nput **S**ingle **O**utput (**SISO**) system



Control system components contd.,

Speed and steering control of an automobile

- This is a combination of the above two cases
- Inputs:
  - pressure on the gas peddle
  - position of the steering wheel
- Outputs:
  - direction of the road wheels
  - speed of the vehicle
- Control system components:
  - steering mechanism
  - engine, transmission system and dynamics of the vehicle.
- **M**ulti **I**nput **M**ulti **O**utput (**MIMO**) system



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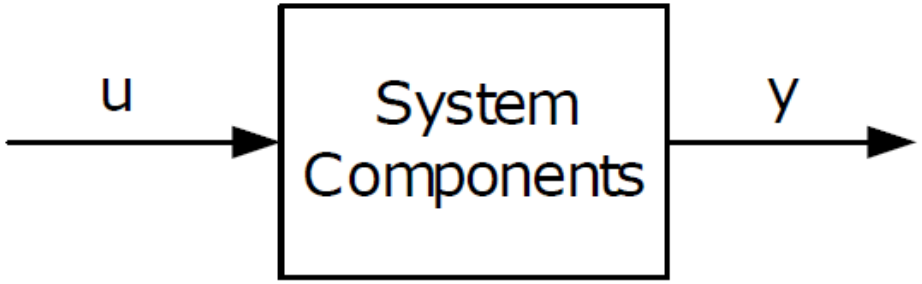
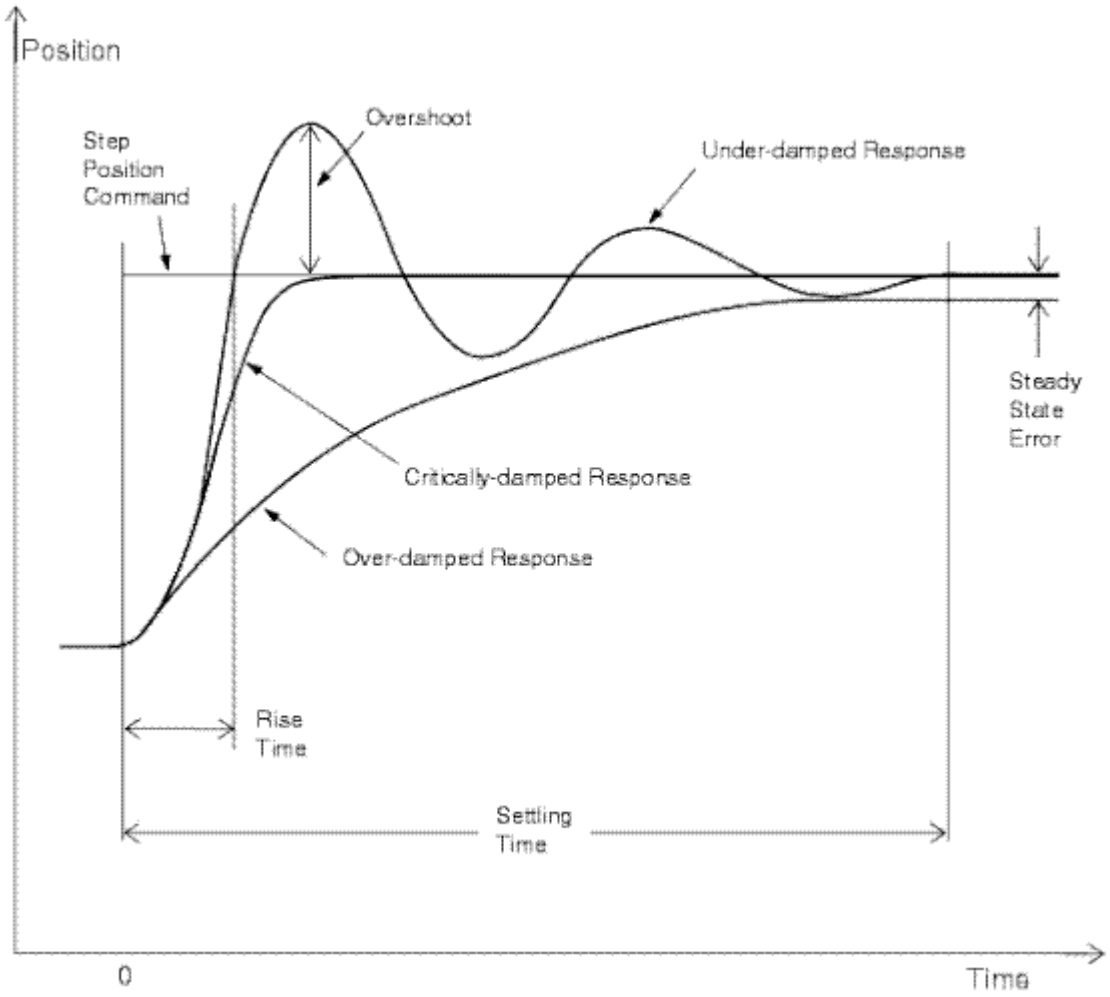
Open loop control

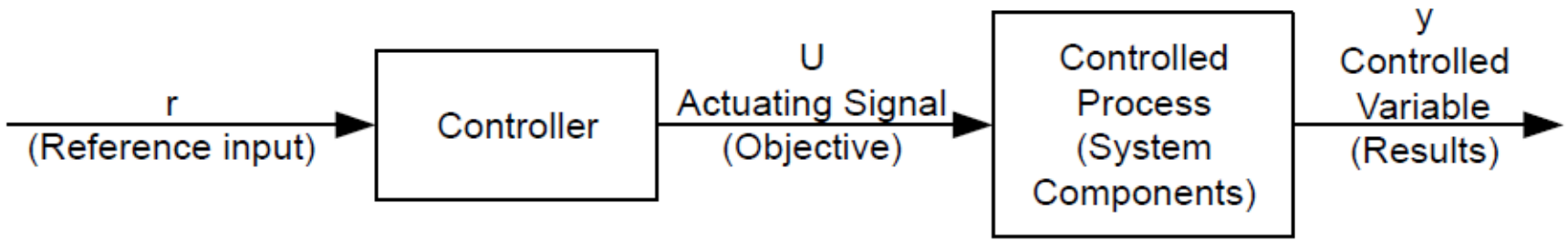


- How do we measure the Results (Output)? Ans. By using Sensors at the Output
- Upon receiving the Input, Control system components will drive the system towards the desired output.
- The actual output can be measured using Sensors
- However, still the output can deviate from the desired Objective (Input)



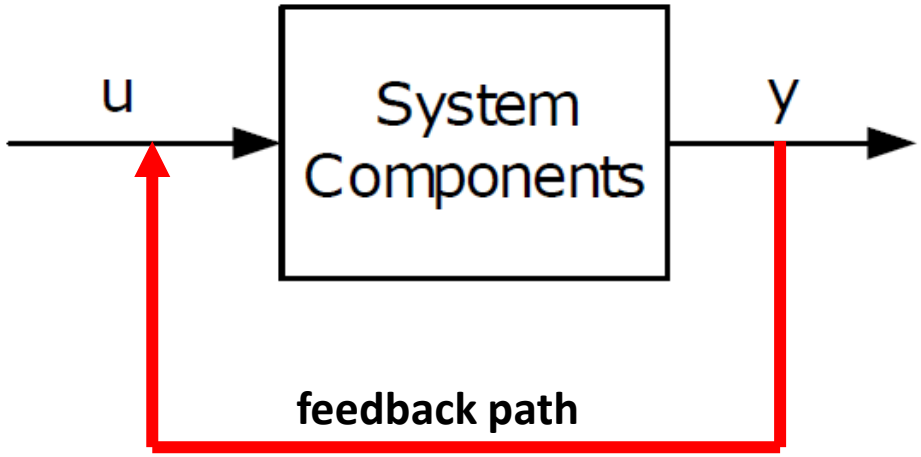
Open loop control contd.,

- If the Input is not adjusted based on the present output, such is an **Open Loop Control System**
- Reference input signal or a command *(r)* is applied to a controller whose output act as the actuating signal or the objective *(u)* to the control system components, so that the output *(y)* is driven towards the desired results



- Function of the controller is to convert *(r)* to the respective *(u)*, so that the *(y)* will follow *(r)* . The controller may be an electronic amplifier, filter, mechanical linkage, microcontroller, microprocessor, etc.

Closed loop control



- What is lacking in the open loop control system to guarantee the output will reach the objective despite disturbances, is the **closed signal path between output and input.**
- In **closed loop control system**, the present value of the output *y* is taken in to account in manipulating the future input signals *u*.
- Hence $u = f(r,y,t)$
- The signal path from output towards input is **feedback path** and a closed loop system can have one or many such feedback paths.