



# SNS COLLEGE OF TECHNOLOGY

Coimbatore-35  
An Autonomous Institution



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## DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

### 23ECT212 – LINEAR CONTROL SYSTEMS

II YEAR/ IV SEMESTER

#### UNIT I – CONTROL SYSTEM MODELING

#### TOPIC 2- OPEN AND CLOSED LOOP SYSTEMS

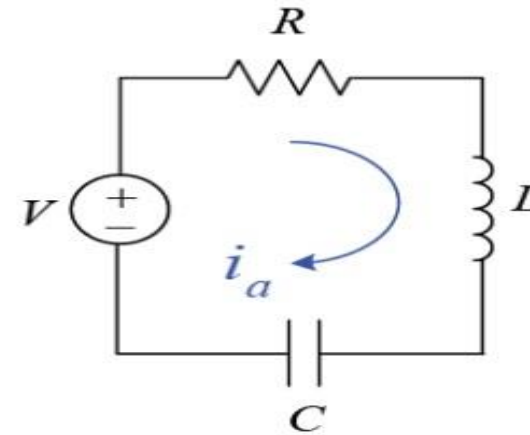
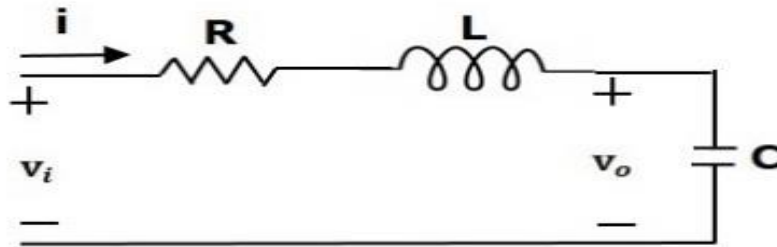


# CONTROL SYSTEM



- When a number of elements are combined together to form a system to produce desired output then the system is referred to as **control system**.
- system controls the output,
- Each element connected to the system has its own effect on the output.

## What is a Control System?





# DEFINITION & FEATURES OF CONTROL SYSTEM



- A control system is a system of devices or set of devices, that manages, commands, directs or regulates the behaviour of other devices or systems to achieve desired results.
- System which controls other systems.
- human civilization -modernized -demand for automation-requires control of devices

## Features of a Control System

- Mathematical relationship between input and output of the system can be represented by a linear proportionality, the system is called a **linear control system**.
- If Its related by some non-linear relation, the system is **non-linear control system**.



# REQUIREMENTS OF GOOD CONTROL SYSTEM

**Accuracy:** measurement tolerance of the instrument ,limits of the errors made in normal operating conditions. improved by using feedback elements & error detector

**Sensitivity:** parameters changes - surrounding conditions, internal disturbance or any other parameters in terms of sensitivity. Any control system should be insensitive to such parameters but sensitive to input signals only.

**Noise:** An undesired input signal.

**Stability:** For the **bounded input signal**, the **output must be bounded**  
if the input is zero then output must be zero= stable system.

**Bandwidth:** An operating frequency range decides. It should be as large as possible for the frequency response of good control system.

**Speed:** It is the time taken by the control system to achieve its stable output.. The transient period for such system is very small.

**Oscillation:** A small numbers of oscillation or constant oscillation of output tend to indicate the system to be stable.



# TYPES OF CONTROL SYSTEM



**Automatic control system**

**Manual control system**



The temperature of the room (output) increases as long as the power supply switch is kept on. heating element produces heat -power supply-on and final room temperature does not have any control over the input power supply of the system = **open loop control system.**

The heating elements of the system function : error of the system = actual temperature – (minus) desired temperature. This error signal is fed back to the system to control the input. As the input to the output path and the error feedback path create a closed loop, = **closed loop control system.**



# OPEN LOOP CONTROL SYSTEM

- A control system in which the control action is totally independent of output of the system then it is called **open loop control system**.
- A manual control system is also an open loop control system.
- process output is totally independent of the controller action.





# PRACTICAL EXAMPLES OF OPEN LOOP CONTROL SYSTEM

- **Electric Hand Drier** – Hot air (output) comes out as long as you keep your hand under the machine, irrespective of how much your hand is dried.
- **Automatic Washing Machine** – This machine runs according to the pre-set time irrespective of washing is completed or not.
- **Bread Toaster** – This machine runs as per adjusted time irrespective of toasting is completed or not.
- **Automatic Tea/Coffee Maker** – These machines also function for pre adjusted time only.
- **Timer Based Clothes Drier** – This machine dries wet clothes for pre-adjusted time, it does not matter how much the clothes are dried.
- **Light Switch** – Lamps glow whenever light switch is on irrespective of light is required or not.
- **Volume on Stereo System** – Volume is adjusted manually irrespective of output volume level.



# (DIS) ADVANTAGES OF OPEN LOOP CONTROL SYSTEM

- Simple in construction and design.
- Economical.
- Easy to maintain.
- Generally stable.
- Convenient to use as output is difficult to measure.

## **Disadvantages of Open Loop Control System**

- inaccurate.
- unreliable.
- Any change in output cannot be corrected automatically.

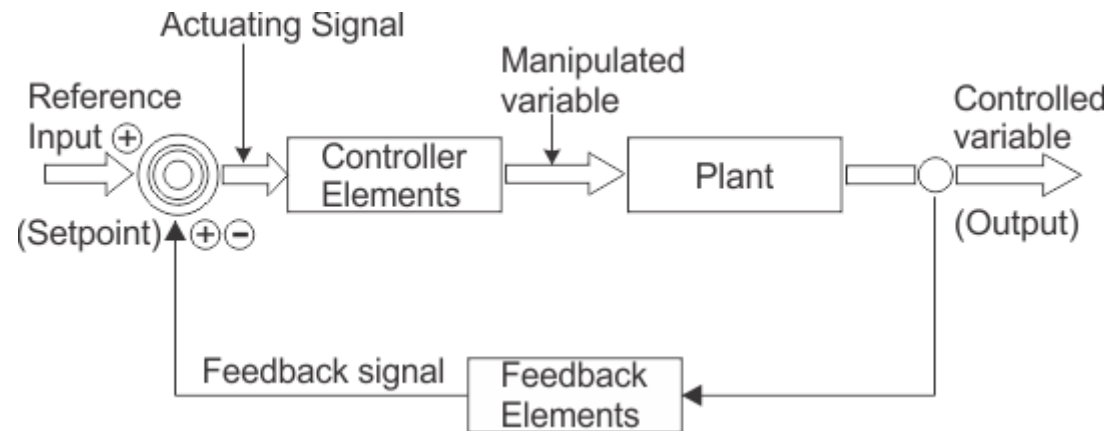




# FEEDBACK LOOP OF CONTROL SYSTEM



- A feedback is a common and powerful tool when designing a **control system**.
- Feedback loop is taken the system output into consideration and enables the system to adjust its performance to meet a desired result of system.
- In any control system, the output is affected due to change in environmental condition or any kind of disturbance.
  - So one signal is taken from the output and is fed back to the input.
  - This signal is compared with a reference input and the error signal is generated. This error signal is applied to controller and output is corrected.

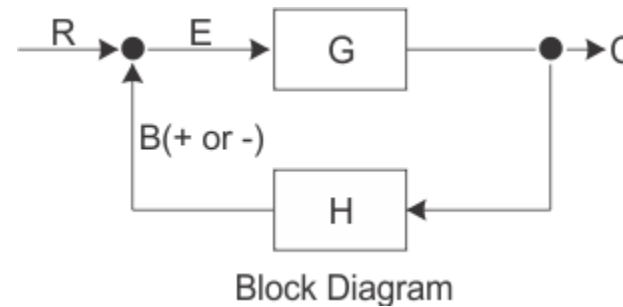




# FEEDBACK LOOP OF CONTROL SYSTEM



R = Input signal  
E = Error signal  
G = Forward path gain  
H = Feedback  
C = Output signal  
B = Feedback signal

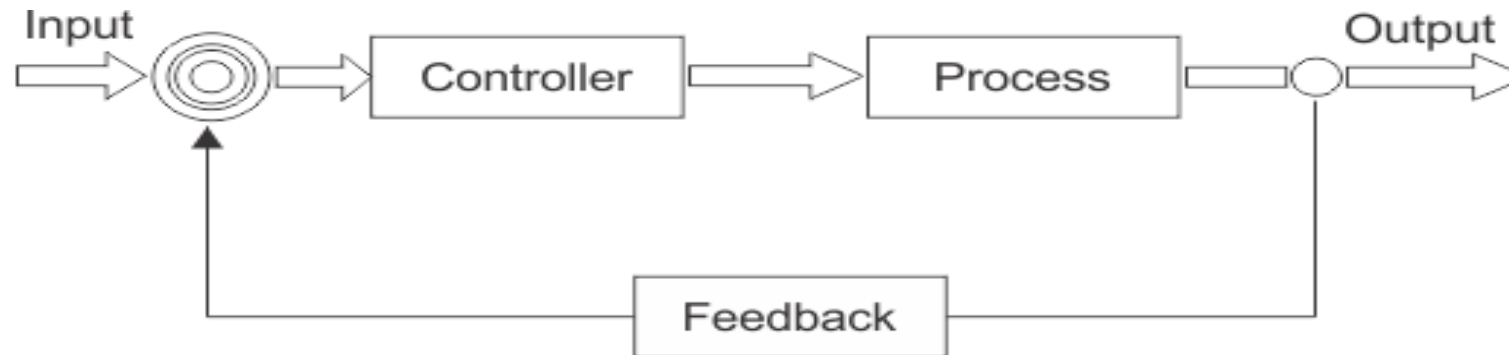


- Error between system input and system output is reduced.
- System gain is reduced by a factor  $1/(1 \pm GH)$ .
- Improvement in sensitivity.
- Stability may be affected.
- Improve the speed of response.



# CLOSED LOOP CONTROL SYSTEM

- Control system in which the output has an effect on the input quantity in such a manner that the input quantity will adjust itself based on the output generated is called **closed loop control system**.
- Open loop control system** can be converted in to closed loop control system by providing a feedback. This feedback automatically makes the suitable changes in the output due to external disturbance. In this way closed loop control system is called automatic control system.
- feedback is taken from output and fed in to input.





# PRACTICAL EXAMPLES OF CLOSED LOOP CONTROL SYSTEM



- **Automatic Electric Iron** – Heating elements are controlled by output temperature of the iron.
- **Servo Voltage Stabilizer** – Voltage controller operates depending upon output [voltage](#) of the system.
- **Water Level Controller** – Input water is controlled by water level of the reservoir.
- **Missile Launched and Auto Tracked by Radar** – The direction of missile is controlled by comparing the target and position of the missile.
- **An Air Conditioner** – An air conditioner functions depending upon the temperature of the room.
- **Cooling System in Car** – It operates depending upon the temperature which it controls.



# (DIS) ADVANTAGES OF CLOSED LOOP CONTROL SYSTEM

- Closed loop control systems are more accurate even in the presence of non-linearity.
- Highly accurate as any error arising is corrected due to presence of feedback signal.
- Bandwidth range is large.
- Facilitates automation.
- The sensitivity of system may be made small to make system more stable.
- This system is less affected by noise.

## **Disadvantages of Closed Loop Control System**

- They are costlier.
- They are complicated to design.
- Required more maintenance.
- Feedback leads to oscillatory response.
- Overall gain is reduced due to presence of feedback.
- Stability is the major problem and more care is needed to design a stable closed loop system.



## Assessment

In what scenarios is an open-loop system more suitable than a closed-loop system?

<b>S. No.</b>	<b>Open loop control system</b>	<b>Closed loop control system</b>
1	The feedback element is absent.	The feedback element is always present.
2	An error detector is not present.	An error detector is always present.
3	It is stable one.	It may become unstable.
4	Easy to construct.	Complicated construction.
5	It is an economical.	It is costly.
6	Having small bandwidth.	Having large bandwidth.
7	It is inaccurate.	It is accurate.
8	Less maintenance.	More maintenance.
9	It is unreliable.	It is reliable.
10	Examples: Hand drier, tea maker	Examples: Servo voltage stabilizer, perspiration



# SUMMARY

