SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECT212 – CONTROL SYSTEMS

II YEAR/ IV SEMESTER

UNIT I – CONTROL SYSTEM MODELING

TOPIC 2- OPEN LOOP AND CLOSED LOOP SYSTEMS

OUTLINE

- **REVIEW OF PREVIOUS CLASS**
- **CONTROL SYSTEM**
- **DEFINITION & FEATURES OF CONTROL SYSTEM**
- **REQUIREMENTS OF GOOD CONTROL SYSTEM**
- **TYPES OF CONTROL SYSTEM**
- **OPEN LOOP CONTROL SYSTEM**
- **PRACTICAL EXAMPLES OF OPEN LOOP CONTROL SYSTEM**
- **(AD & DIS)VANTAGES OF OPEN LOOP CONTROL SYSTEM**
- **ACTIVITY**
- **FEEDBACK LOOP OF CONTROL SYSTEM**
- **CLOSED LOOP CONTROL SYSTEM**
- **PRACTICAL EXAMPLES OF**
- **CLOSED LOOP CONTROL SYSTEM**
- **PRACTICAL EXAMPLES OF CLOSED LOOP CONTROL SYSTEM**
- **(DIS) ADVANTAGES OF CLOSED LOOP CONTROL SYSTEM**
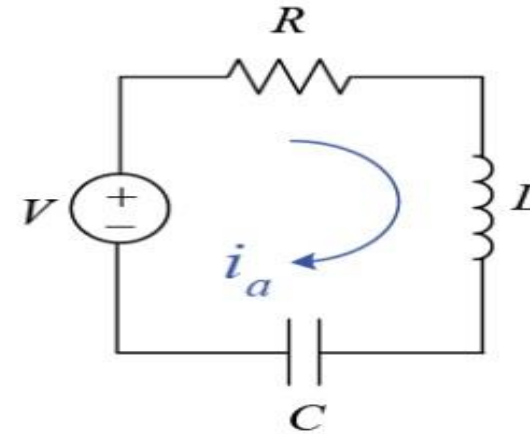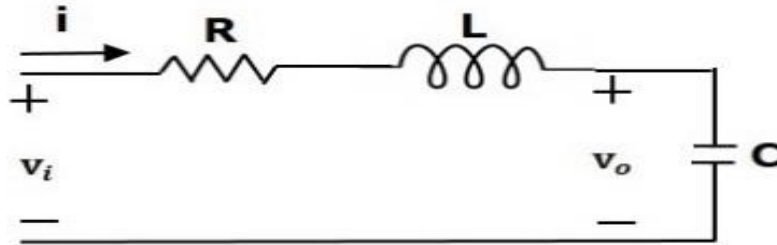- **COMPARISON OF CLOSED LOOP AND OPEN LOOP CONTROL SYSTEM**

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

Manual transmission | Automatic transmission

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.

ACTIVITY

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.
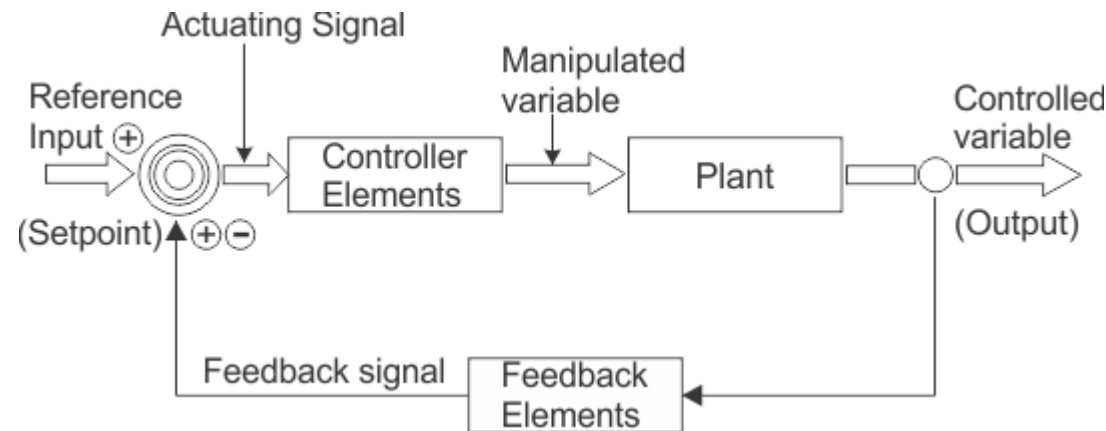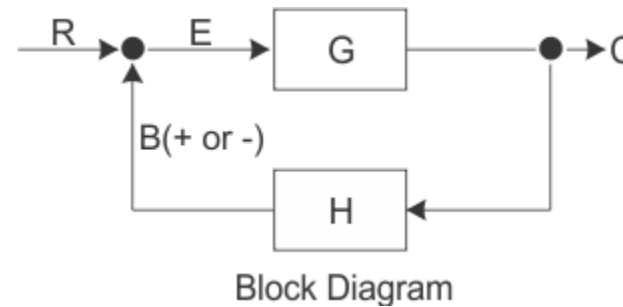
FEEDBACK LOOP OF CONTROL SYSTEM

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

Block Diagram

•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.
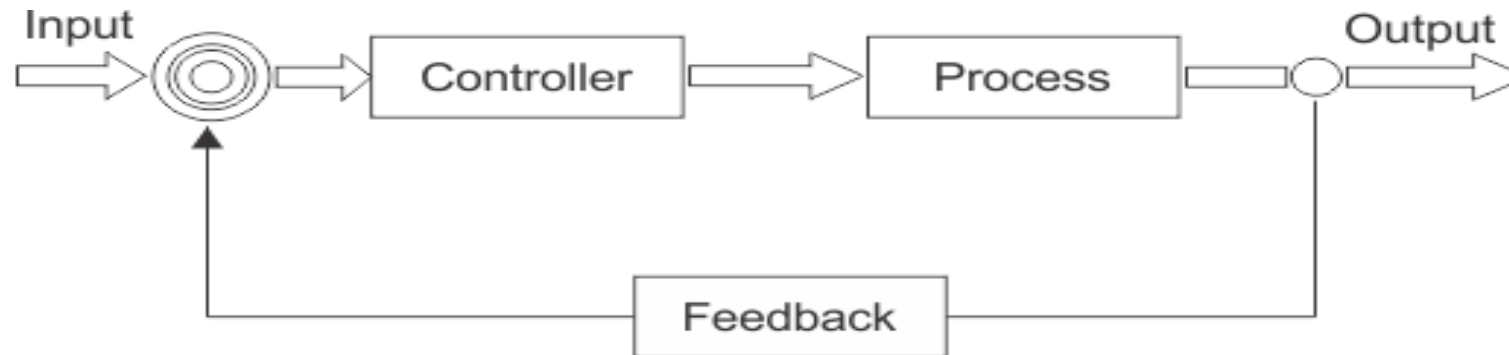
PRACTICAL EXAMPLES OF CLOSED LOOP CONTROL SYSTEM

•**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.

COMPARISON OF CLOSED LOOP AND OPEN LOOP CONTROL SYSTEM

S. No.	Open loop control system	Closed loop control system
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