

## MODULE - 1

**INTRODUCTION****LESSON STRUCTURE**

- 1.1. Introduction**
- 1.2. Open Loop System**
- 1.3. Closed loop control system**
- 1.4. Concepts of feedback**
- 1.5. Requirements of Ideal control system**
- 1.6. Types of controllers**

**OBJECTIVES:**

To teach students the characteristics of closed-loop control systems, and feedback control system and different types of controllers.

**1.1.Introduction:**

A system is an arrangement of or a combination of different physical components connected or related in such a manner so as to form an entire unit to attain a certain objective.

Control system is an arrangement of different physical elements connected in such a manner so as to regulate, director command itself to achieve a certain objective

Any control system consists of three essential components namely input, system and output. The input is the stimulus or excitation applied to a system from an external energy source. A system is the arrangement of physical components and output is the actual response obtained from the system. The control system may be one of the following type.

- 1) Man made
- 2) Natural and / or biological and
- 3) Hybrid consisting of man-made and natural or biological.

Requirements of good control system are accuracy, sensitivity, noise, stability, bandwidth, speed, oscillations

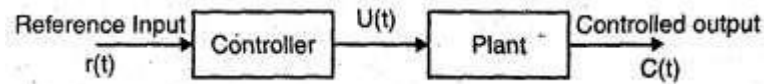
## Types of control systems

Control systems are classified into two general categories based upon the control action which is responsible to activate the system to produce the output viz.

- 1) Open loop control system in which the control action is independent of the output.
- 2) Closed loop control system in which the control action is somehow dependent upon the output and are generally called as feedback control systems.

## 1.2. Open Loop System

It is a system in which control action is independent of output. To each reference input there is a corresponding output which depends upon the system and its operating conditions. The accuracy of the system depends on the calibration of the system. In the presence of noise or disturbances open loop control will not perform satisfactorily.



Example: Automatic hand driver, automatic washing machine, bread toaster, electric lift, traffic signals, coffee server, theatre lamp etc.

### Advantages of open loop system:

1. They are simple in construction and design.
2. They are economic.
3. Easy for maintenance.
4. Not much problem of stability.
5. Convenient to use when output is difficult to measure.

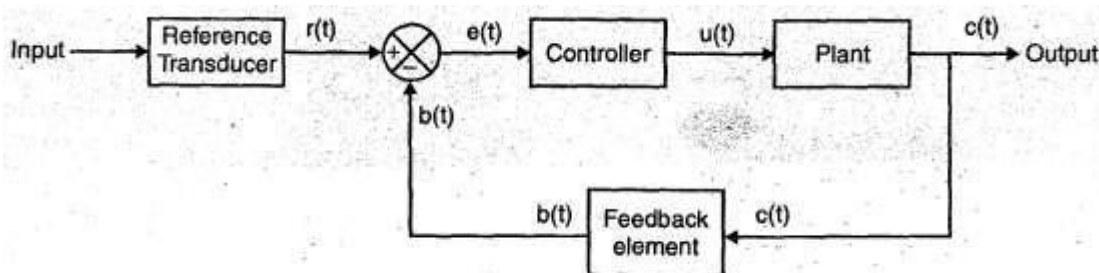
### Disadvantages of open loop system

1. Inaccurate and unreliable because accuracy is dependent on accuracy of calibration.
2. Inaccurate results are obtained with parameter variations, internal disturbances.
3. To maintain quality and accuracy, recalibration of controller is necessary from time to time.

## 1.3. A closed loop control system:

Is a system in which the control action depends on the output. In closed loop control system the actuating error signal, which is the difference between the input signal and the feedback signal (output signal or its function) is fed to the controller.

The elements of closed loop system are command, reference input, error detector, control element controlled system and feedback element.



### Elements of closed loop system are:

1. **Command:** The command is the externally produced input and independent of the feedback control system.
2. **Reference Input Element:** It is used to produce the standard signals proportional to the command.

- 3. Error Detector:** The error detector receives the measured signal and compares it with reference input. The difference of two signals produces error signal.
- 4. Control Element:** This regulates the output according to the signal obtained from error detector.
- 5. Controlled System:** This represents what we are controlling by feedback loop.
- 6. Feedback Element:** This element feedback the output to the error detector for comparison with the reference input.

**Example:** Automatic electric iron, servo voltage stabilizer, sun-seeker solar system, water level controller, human perspiration system.

#### **Advantages of closed loop system:**

1. Accuracy is very high as any error arising is corrected.
2. It senses changes -in output due to environmental or parametric change, internal disturbance etc. and corrects the same.
3. High bandwidth.
4. Facilitates automation.

#### **Disadvantages**

1. Complicated in design and maintenance costlier.
2. System may become unstable.

### **1.4. Concepts of feedback:**

Feedback system is that in which part of output is feeded back to input. In feedback system corrective action starts only after the output has been affected.

### **1.5. Requirements of good control system :**

Requirements of good control system are,

1. Accuracy
2. Sensitivity
3. Noise
4. Stability
5. Bandwidth
6. Speed
7. Oscillations

### **1.6. Types of controllers:**

An automatic controller compares the actual value of the system output with the reference input (desired value), determines the deviation, and produces a control signal that will reduce the deviation to zero or a small value. The manner in which the automatic controller produces the control signal is called the control action. The controllers may be classified according to their control actions as,

1. Proportional controllers.
2. Integral controllers.
3. Proportional-plus- integral controllers.

4. Proportional-plus-derivative controllers.
5. Proportional-plus- integral-plus-derivative controllers

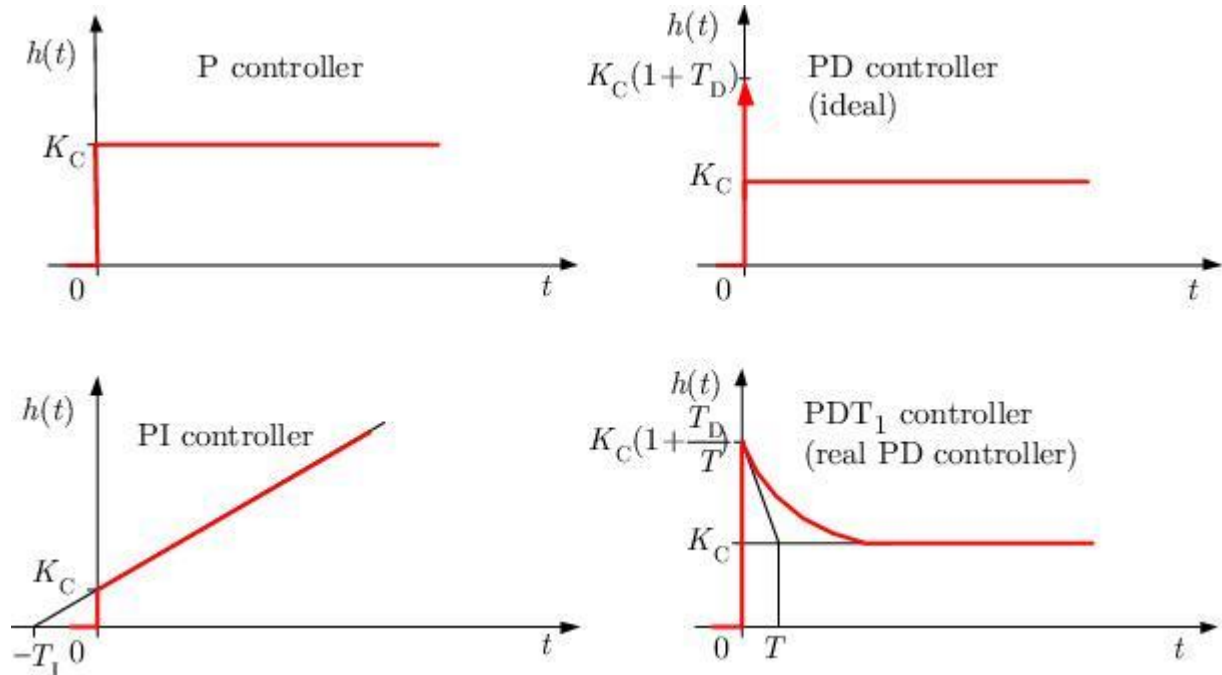
A **proportional control system** is a feedback control system in which the output forcing function is directly proportional to error.

A **integral control system** is a feedback control system in which the output forcing function is directly proportional to the first time integral of error.

A **proportional-plus-derivative control system** is a feedback control system in which the output forcing function is a linear combination of the error and its first time derivative.

A **proportional-plus- integral control system** is a feedback control system in which the output forcing function is a linear combination of the error and its first time integral.

A **proportional-plus-derivative-plus- integral control system** is a feedback control system in which the output forcing function is a linear combination of the error, its first time derivative and its first time integral.



**OUTCOMES:**

At the end of the unit, the students are able to:

- Different types of control system.
- Ideal requirements of a good control system.
- Different types of controllers.

**SELF-TEST QUESTIONS:**

1. Define control system.
2. Distinguish between open loop and closed loop control system with suitable example.
3. What are the requirements of an ideal control system? Explain them.
4. With a suitable example explain regulatory system and follow - up system.
5. Explain the concept of feedback control system.
6. What is control action?
7. Explain proportional integral differential controller with the block diagram.
8. Explain following controller. State its characteristics.
  - a) Proportional plus derivative control action
  - b) Proportional plus integral control action.

**FURTHER READING:**

1. **Control engineering**, Swarnakiran S, Sunstar publisher, 2018.
2. **Feedback Control System**, Schaum's series. 2001.