Q.1) What is Control System?

A: A control system is a set of mechanical or electronic devices that regulates other devices or systems by way of control loops. Typically, control systems are computerized.

Control systems are a central part of industry and of automation. The types of control loops that regulate these processes include industrial control systems (ICS) such as supervisory control and data acquisition (SCADA) and distributed control systems (DCS).

Control systems are used to enhance production, efficiency and safety in many areas, including:

- Agriculture
- Chemical plants
- Pulp and paper mills
- Quality control
- Boiler controls and power plant
- Nuclear power plants
- Environmental control
- Water treatment plants
- Sewage treatment plants
- Food and food processing
- Metal and mines
- Pharmaceutical manufacturing
- Sugar refining plants

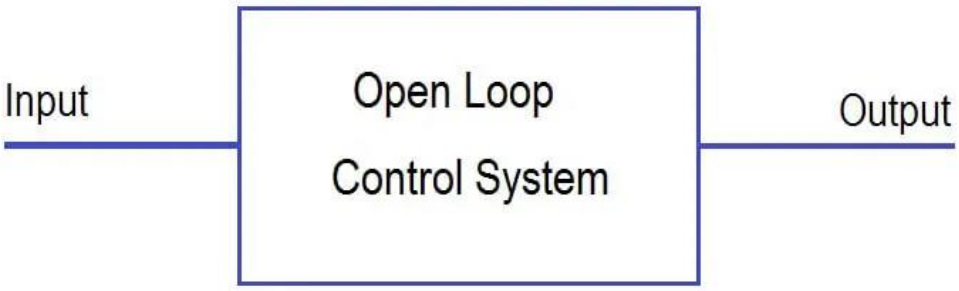
Q2.) How many types?

A: There are two types of control systems namely:

1. Open loop control systems (non-feedback control systems)
2. Closed loop control systems (feedback control systems)

Open Loop Control System

If in a physical system there is no automatic correction of the variation in its output, it is called an open loop control system. That is, in this type of system, sensing of the actual output and comparing of this output (through feedback) with the desired input does not take place. The system on its own is not in a position to give the desired output and it cannot take into account the disturbances. In these systems, the changes in output can be corrected only by changing the input manually.



These systems are simple in construction, stable and cost cheap. But these systems are inaccurate and unreliable. Moreover these systems do not take account of external disturbances that affect the output and they do not initiate corrective actions automatically.

Examples of open loop control systems:

1. Automatic washing machine
2. traffic signal system
3. home heating system(without sensing, feedback and control)

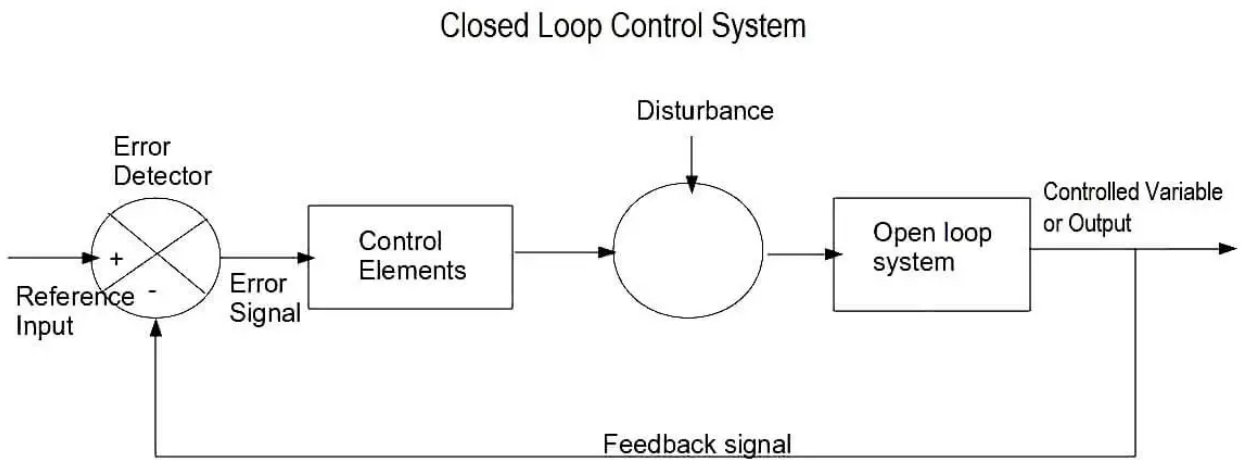
Any non-feedback control system can be considered as a feedback control system if it is under the supervision of someone. Although open loop control systems have

economical components and are simple in design, they largely depend on human judgement.

As an example, let us consider a home furnace control system. This system must control the temperature in a room, keeping it constant. An open loop system usually has a timer which instructs the system to switch on the furnace for some time and then switch it off. Accuracy cannot be achieved as the system does not switch on/off based on the room temperature but it does as per the preset value of time.

Closed Loop Control System

A closed loop control system is a system where the output has an effect upon the input quantity in such a manner as to maintain the desired output value.



An open loop control system becomes a closed loop control system by including a feedback. This feedback will automatically correct the change in output due to disturbances. This is why a closed loop control system is called as an automatic control system. The block diagram of a closed loop control system is shown in figure.

In a closed loop control system, the controlled variable (output) of the system is sensed at every instant of time, feedback and compared with the desired input resulting in an error signal. This error signal directs the control elements in the system to do the necessary corrective action such that the output of the system is obtained as desired.

The feedback control system takes into account the disturbances also and makes the corrective action. These control systems are accurate, stable and less affected

by noise. But these control systems are sophisticated and hence costly. They are also complicated to design for stability, give oscillatory response and feedback brings down the overall gain of the control system.

Q3.) Classification of control System?

A: Based on some parameters, we can classify the control systems into the following ways.

Continuous time and Discrete-time Control Systems

- Control Systems can be classified as continuous time control systems and discrete time control systems based on the **type of the signal** used.
- In **continuous time** control systems, all the signals are continuous in time. But, in **discrete time** control systems, there exists one or more discrete time signals.

SISO and MIMO Control Systems

- Control Systems can be classified as SISO control systems and MIMO control systems based on the **number of inputs and outputs** present.
- **SISO** (Single Input and Single Output) control systems have one input and one output. Whereas, **MIMO** (Multiple Inputs and Multiple Outputs) control systems have more than one input and more than one output.

Q4.) Difference Between Open Loop & Closed Loop System.

Basis For Comparison	Open Loop System	Closed Loop System
Definition	The system whose control action is free from the output is known as the open loop control system.	In closed loop, the output depends on the control action of the system.
Other Name	Non-feedback System	Feedback System
Components	Controller and Controlled Process.	Amplifier, Controller, Controlled Process, Feedback.
Construction	Simple	Complex
Reliability	Non-reliable	Reliable

Basis For Comparison	Open Loop System	Closed Loop System
Accuracy	Depends on calibration	Accurate because of feedback.
Stability	Stable	Less Stable
Optimization	Not-Possible	Possible
Response	Fast	Slow
Calibration	Difficult	Easy
System Disturbance	Affected	Not-affected
Linearity	Non-linear	Linear
Examples	Traffic light, automatic washing machine, immersion rod, TV remote etc.	Air conditioner, temperature control system, speed and pressure control system, refrigerator, toaster.

Q5.) What do you know about feedback.

A: If either the output or some part of the output is returned to the input side and utilized as part of the system input, then it is known as **feedback**. Feedback plays an important role in order to improve the performance of the control systems.

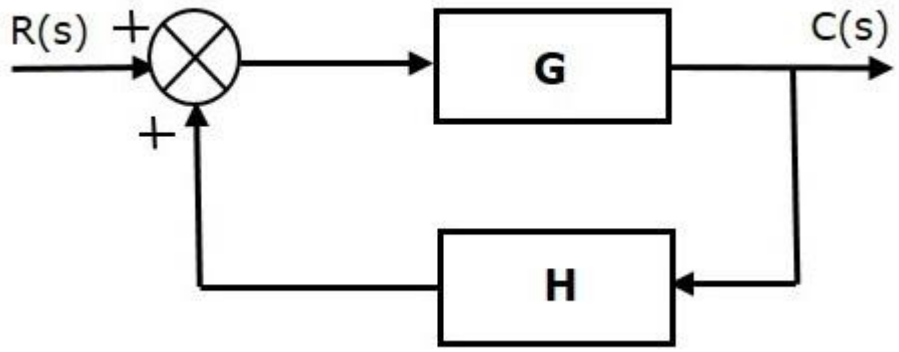
Types of Feedback

There are two types of feedback –

- Positive feedback
- Negative feedback

Positive Feedback

The positive feedback adds the reference input, R(s) and feedback output. The following figure shows the block diagram of **positive feedback control system**.



The concept of transfer function will be discussed in later chapters. For the time being, consider the transfer function of positive feedback control system is,

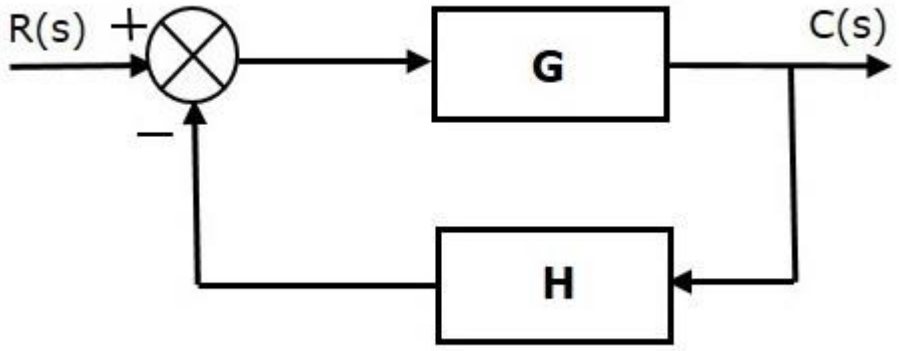
$T=G/1-GH$ (Equation 1)

Where,

- **T** is the transfer function or overall gain of positive feedback control system.
- **G** is the open loop gain, which is function of frequency.
- **H** is the gain of feedback path, which is function of frequency.

Negative Feedback

Negative feedback reduces the error between the reference input, R(s) and system output. The following figure shows the block diagram of the **negative feedback control system**.



Transfer function of negative feedback control system is,

$T=G/1+GH$ (Equation 2)

Where,

- **T** is the transfer function or overall gain of negative feedback control system.
- **G** is the open loop gain, which is function of frequency.
- **H** is the gain of feedback path, which is function of frequency.