Control Systems

Subject Code: BEC-26

Third Year ECE

Unit-I

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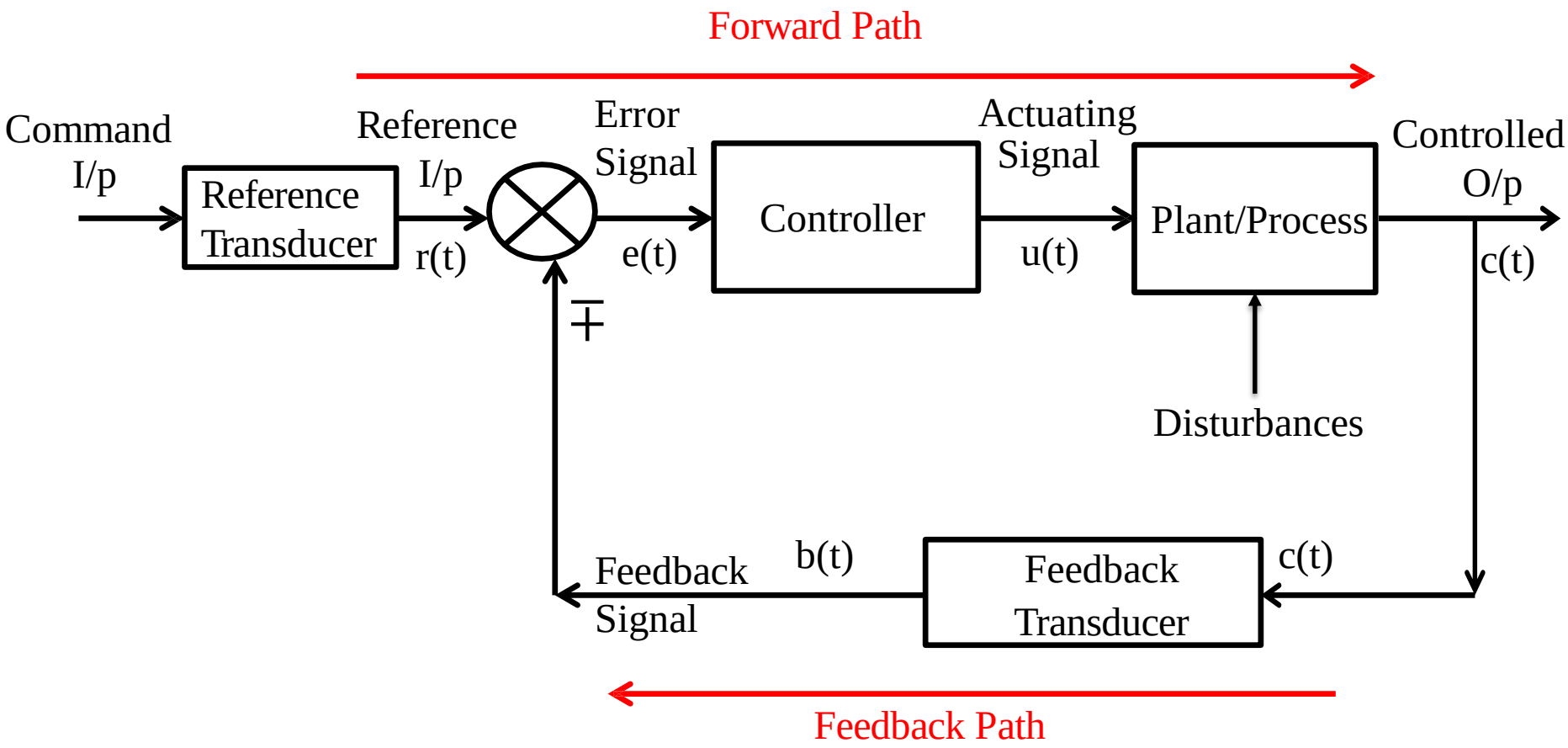
UNIT- I

- Introduction to Control Systems
  - Control System – Definition and Practical Examples
  - Basic Components of a Control System
- Feedback Control Systems:
  - Feedback and its Effect
  - Types of Feedback Control Systems
- Block Diagrams:
  - Representation and reduction
  - Signal Flow Graphs
- Modeling of Physical Systems:
  - Electrical Networks and Mechanical Systems
  - Force-Voltage Analogy
  - Force-Current Analogy

Basic Components of Control System:



- ✓ Basic components in the control systems are shown in the above block diagram.
- ✓ Disturbances can be external or internal.

Basic Components of Control System:

- **Plant/Process:-** The portion of a system which is to be controlled or regulated is called a plant or process.
- **Controller:-** The element of a system itself or external to the system which controls the plant/process is called controller. It consists of error detector to control logic element.
- **Error detector:-** It received the measured signal (feedback) & compare it with reference input and determine the error signal.

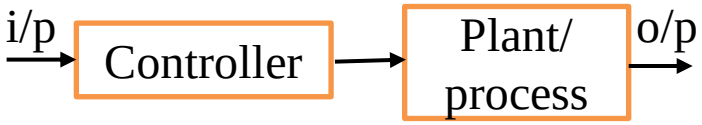
$$e(t) = r(t) \mp b(t)$$

- **Feedback:-** It is used to fed back the o/p signal to error detector for comparison with the input.
- **Input:-** It is applied signal to a control system from an external energy sources in order to produce specific output.
- **Output:-** It is a particular signal of interest or the actual response obtained from the control system when input is applied.
- **Disturbances:-** It is a signal which tends to adversely effect the value of the output of a system. It may be external disturbances or internal disturbances.

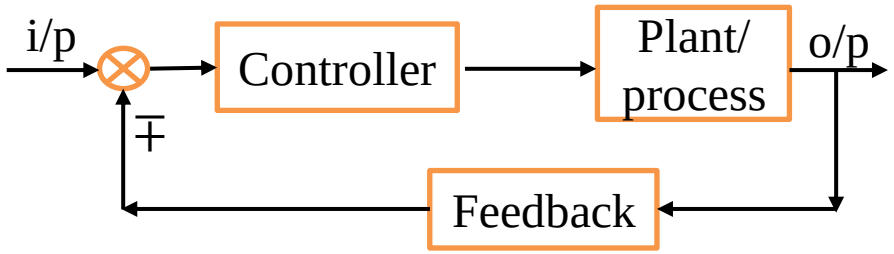
Classification of Control System:

Control system can be broadly classified as-

1. Natural control system e.g: Respiratory system, Biological systems of human body
2. Man-made control system e.g: Vehicle
3. Combination control system e.g: Driving a car
4. Time variant and Invariant control system
5. Linear and Nonlinear control system
6. Continuous time and Discrete time control system
7. Deterministic (o/p is predictable) and stochastic (o/p is unpredictable) control system
8. Lumped parameter and Distributed parameter control system
9. SISO (Serial input serial output) and MIMO (Multiple input and multiple output) control system
10. Open loop and Closed loop control system



Open Loop Control System



Closed Loop Control System

Classification of Control System

(Depending on control action)

- Open Loop Control System
- Closed Loop Control System

Open Loop Control System

Definition: "A system in which the control action is totally independent of the output of the system is called as open loop system"

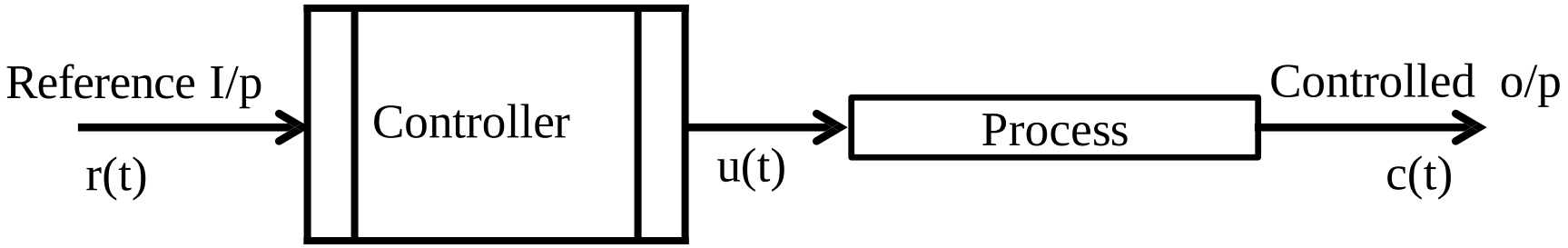


Fig. Block Diagram of Open loop Control System

OLCS Examples

- **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.

OLCS Examples

- **Automatic Tea/Coffee Vending Machine:-** These machines also function for pre adjusted time only.
- **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.

Advantages of OLCS

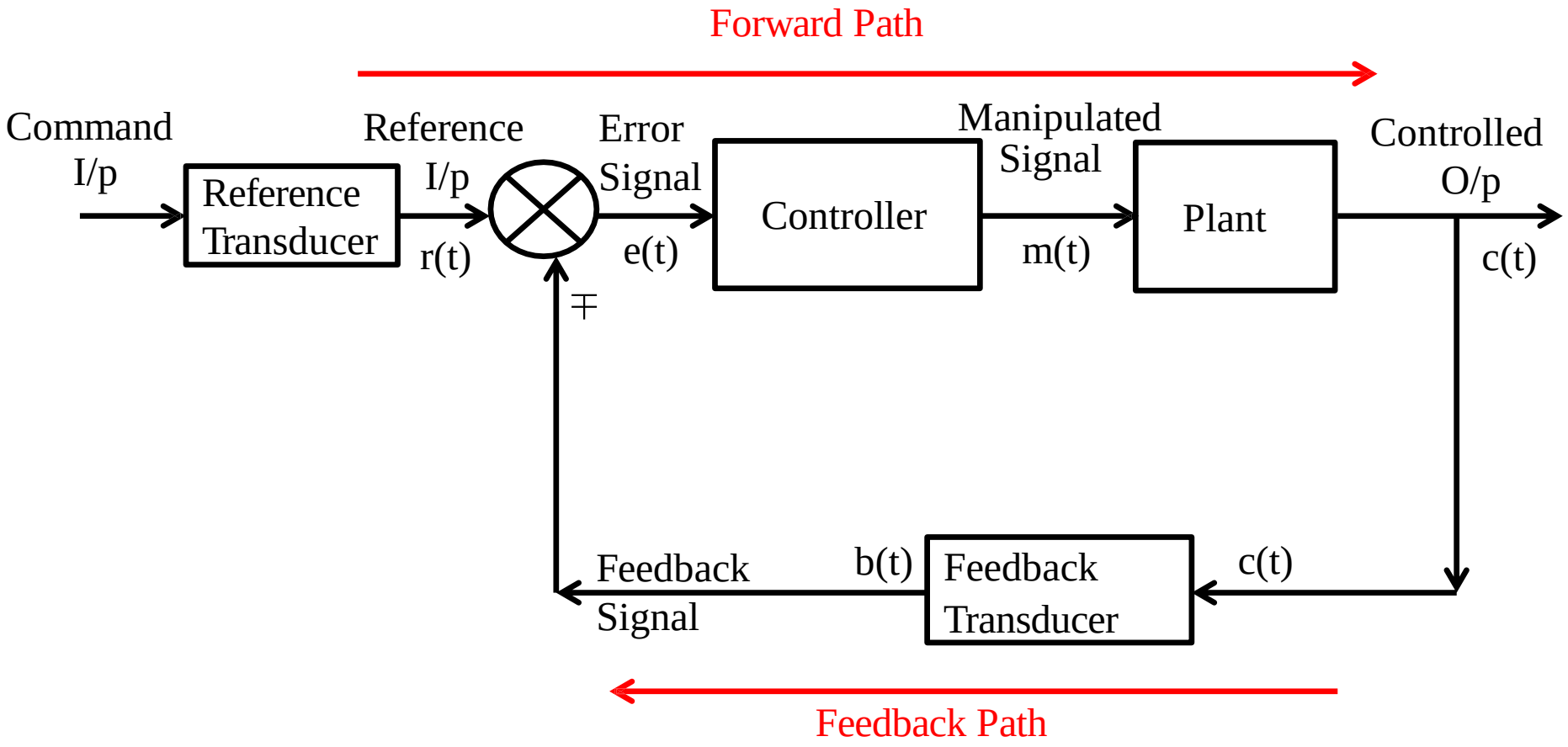
- Simple in construction and design
- Economical
- Easy to maintain
- Generally stable
- Convenient to use as output is difficult to measure

Disadvantages of OLCS

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

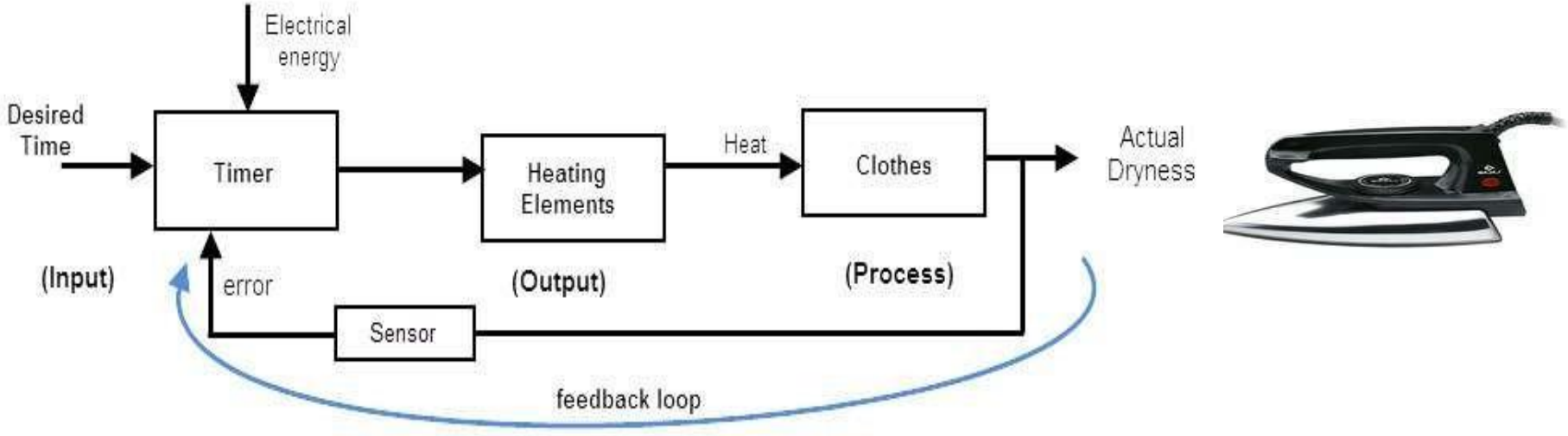
Closed Loop System

Definition:- A system in which the control action is somehow dependent on the output is called as closed loop system



CLCS Examples

- **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.

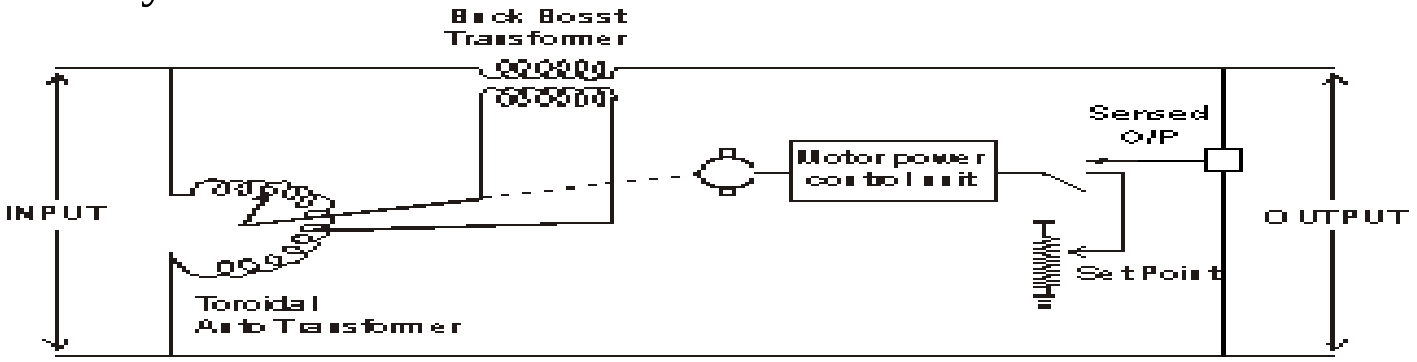


Fig. 5.6 Servo Voltage Stabilizer

Advantages of CLCS

- 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 CLCS

- 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

Difference Between OLCS & CLCS

Open Loop Control System

1. The open loop systems are simple & economical.
2. They consume less power
3. The OL systems are easier to construct because less number of components required
4. The open loop systems are inaccurate & unreliable
5. Stability is not a major problem in OL control systems. Generally OL systems are stable
6. Small Bandwidth
7. Feedback element is absent
8. Output measurement is not necessary
9. The changes in the output due to external disturbances are not corrected automatically. So they are more sensitive to noise and other disturbances.
10. Examples: Coffee maker, Automatic Toaster, Hand Drier etc.

Closed Loop Control System

1. The closed loop systems are complex and costlier
2. They consume more power
3. The CL systems are not easy to construct because more number of components required
4. The closed loop systems are accurate & more reliable
5. Stability is a major problem in closed loop systems & more care is needed to design a stable closed loop system
6. Large bandwidth
7. Feedback element is present
8. Output measurement is necessary
9. The changes in the output due to external disturbances are not corrected automatically. So they are more sensitive to noise and other disturbances.
10. Examples: Guided Missile, Temp control of oven, Servo Voltage Stablizer etc.