Control Systems

Derivation of transfer function for closed loop negative feedback system

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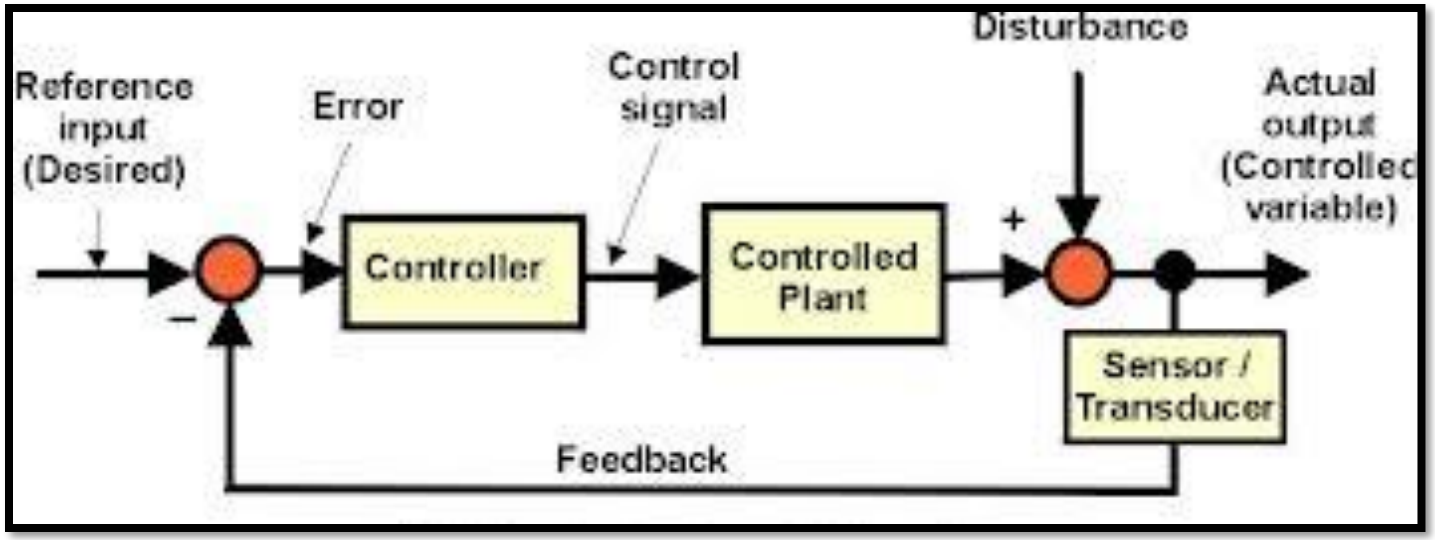
Closed-loop control system:

It is a control system where its control action depends on both of its input signal and output response.

Examples: automatic electric iron, missile launcher, speed control of DC motor, etc.



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.

Basic block diagram of a closed-loop negative feedback control system

Let R(s) = Reference Input

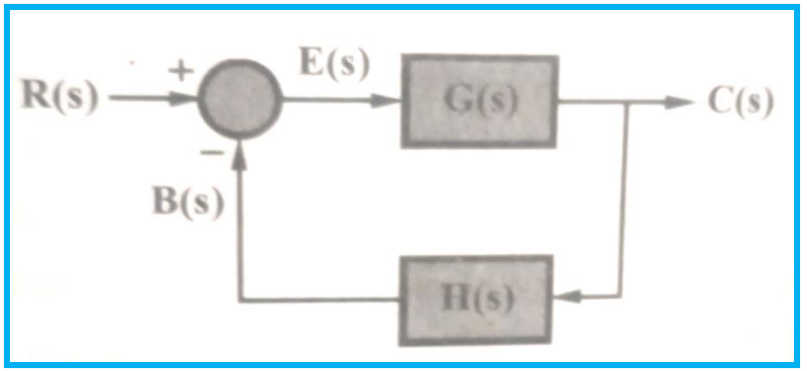
B(s)= Feedback Signal

C(s)= Controlled Output Signal

E(S) = Manipulated Signal

G(S) = Forward path transfer function

H(S) = Feedback path transfer function



As $E(S) = R(s) - B(s)$ ……..(1)

and $B(s) = C(s).H(S)$ ……..(2)

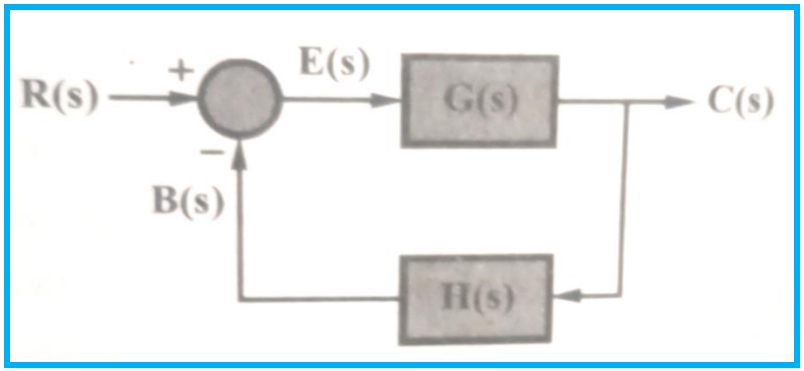
Substituting the value of B(s) from eq. (2) in equation (1) from (in), we have

$$E(S) = R(S) - C(s).H(S) \quad \text{……....(3)}$$

It is also seen that

$C(S) = E(s).G(s)$

Or $E(s) = \frac{C(s)}{G(s)}$ .....(4)



Put the value of E(s) from Eq. 4 in Eq.3

$\frac{C(s)}{G(s)} = R(S) - C(s).H(s)$

$C(s) = G(s).\ R(S) - G(s).\ C(s).H(s)$

$C(s) + G(s).\ C(s).H(s) = G(s).R(S)$

$C(s)\ [1+G(s).H(s)] = G(s).\ R(S)$

$C(s) = \frac{G(s).R(S)}{[1+G(s).H(s)]}$

$$\frac{C(s)}{R(S)} = \frac{G(s)}{[1+G(s).H(s)]}$$