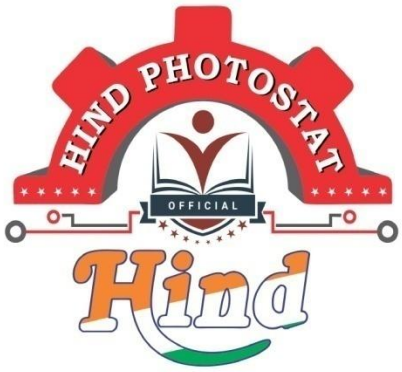

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ELECTRONICS ENGINEERING

Control System

By-Haneef Sir

- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

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Transfer Func^{n} model only for LTI system.

UNIT I :

i) BDR } Graphical
ii) SFG }
iii) Electrical network } Physical
iv) Mechanical System }
v) Integro differential Equation } mathematical
vi) Algebraic Equations

} ⇒ Transfer Function.

Analysis of Control System using Transfer function model

- Response Analysis (done for stable system).
  - Time Domain (2)
  - Freq^{n} domain (5)
- Stability Analysis (for any system).
  - Time domain (3) (4)
  - Freq^{n} domain (5).

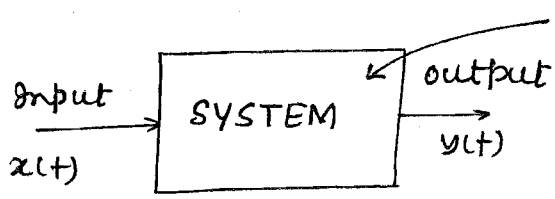
UNIT 6 : (Controller & Compensators)
↳ Redesigning of Control systems.

UNIT 7 :
State model approach. (for any system).

SYSTEM:-

*System is a means of Transforming a signal.

*Signal is one which carries Information.

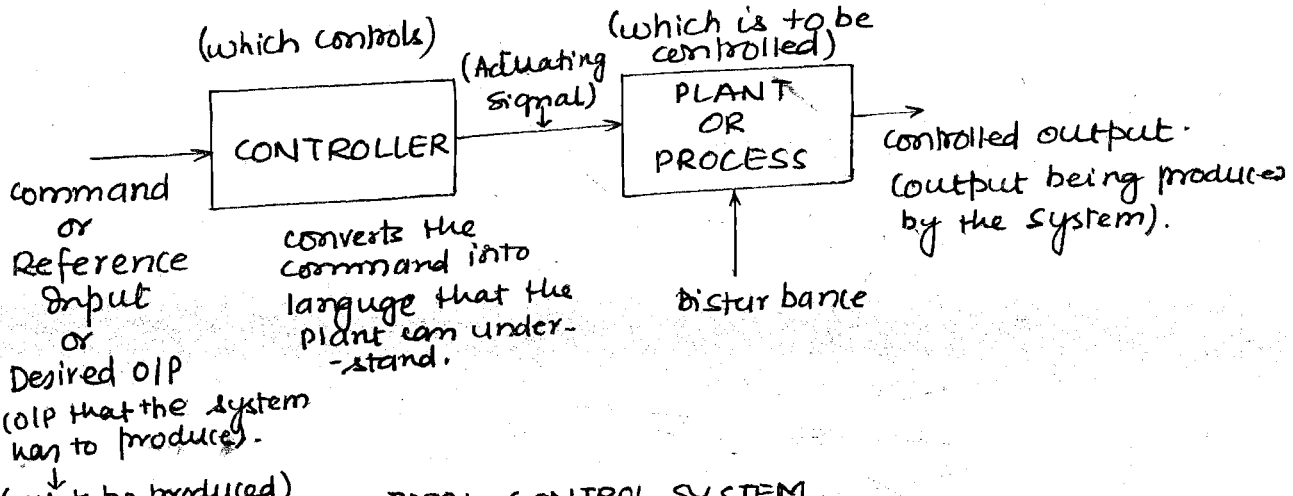


*control system gives specific output (demanded output). or desired output or deterministic output.

Note:-

*control system is that means by which any quantity of Interest is maintained or altered according to desired manner.

*Block Diagram of control system:-



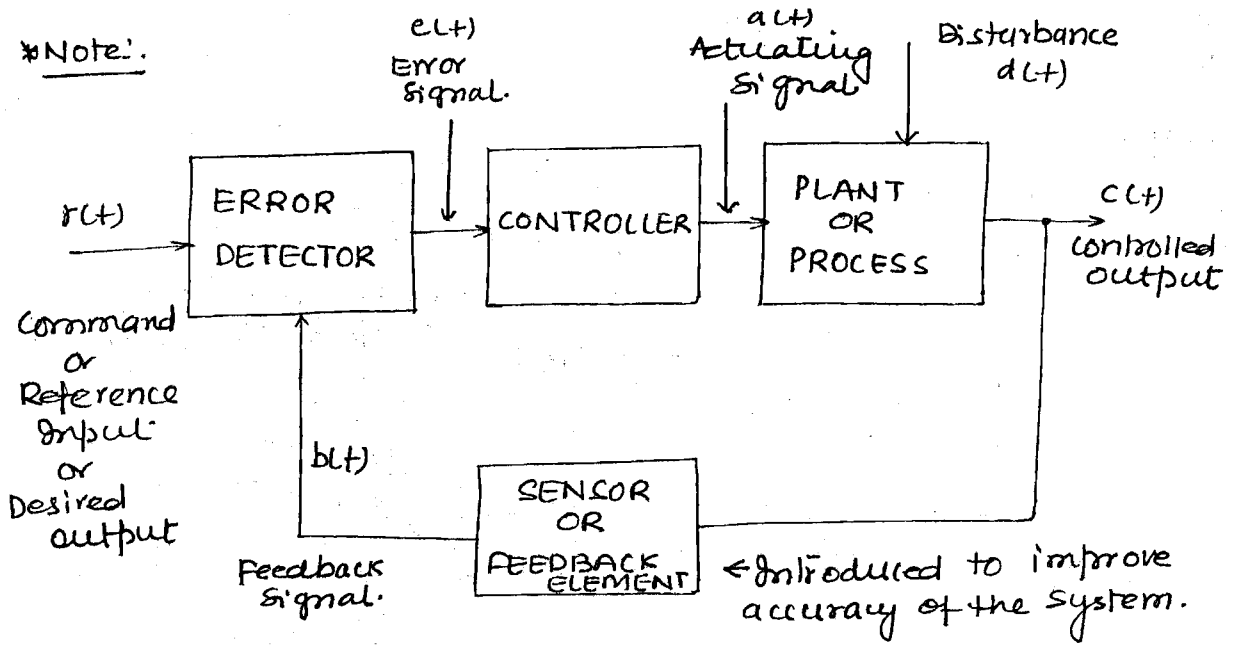
IDEAL CONTROL SYSTEM

Note:-

*Objective of any control system is to ensure that the controlled output becomes same as the command; or desired output.

*This state of the system is called as STEADY STATE.

*Note:-



Note:-

* If any disturbance occurs then the output of the control system differs from set value. To Restore the controlled output to its original value; the control system is modified as shown in above figure.

* Error Detector produces error signal with the help of sensor as the difference between desired output and actual output; which is suppressed by the controller by modifying the output of the Plant. Hence the effect of disturbance associated with the plant disappears from the total output. However, disturbance associated with other parts of the control system still continues in the output of the system which is unavoidable. Hence any practical system can reach the steady state with 100% desired output only at $t = \infty$.

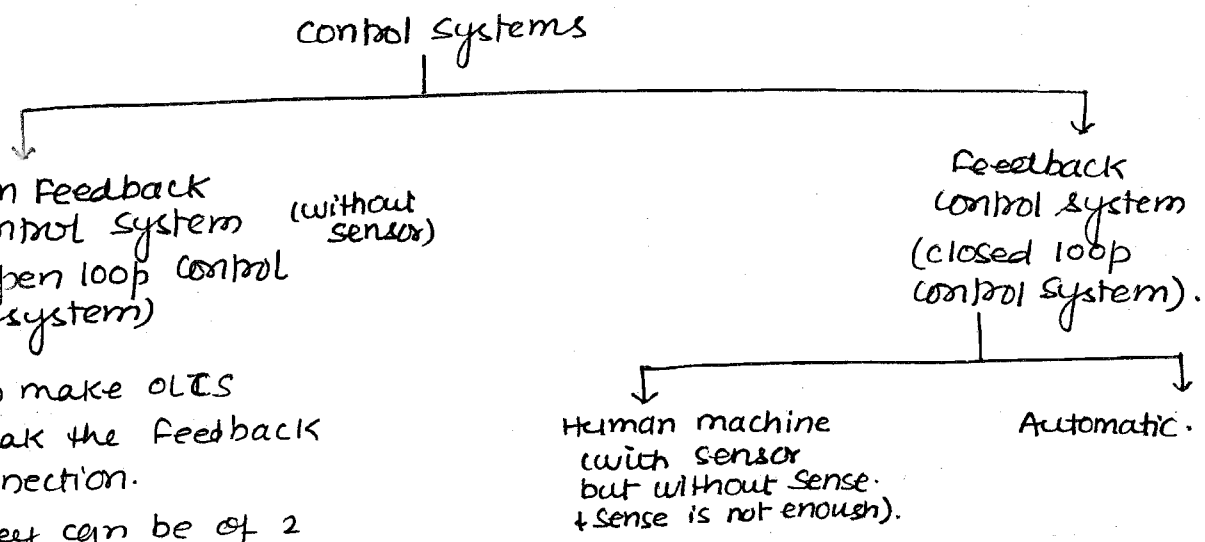
* $e(t) = 0$; hence rate of change of actuating signal is zero.

$$\frac{d}{dt} a(t) = 0 \Rightarrow d(t) = K.$$

Hence output becomes constant.

* Feedback in control system is introduced mainly to improve its accuracy but it also has impact on Gain, Bandwidth ; speed ; sensitivity ; stability etc.

* Classification of control systems:-



* To make OLCS break the feedback connection.

* They can be of 2 types:-

i) with sensor but without sense { used in Real time → Automobile → speedometer doesn't interact with Brakes. ↳ Gap is present since the sense is not enough to drive the process }.

ii) without sensor.

* Differences between performance of open & closed loop control system:-

OPEN LOOP CONTROL SYSTEM	CLOSED LOOP CONTROL SYSTEM
i) Behaviour of open loop system does not change though it's output changes. Hence the open loop system is not accurate.	i) Behaviour of closed loop system does change, if its output changes. Hence closed loop system is accurate.
ii) In open loop system sense is not present/complete, but usually sensor is present not compulsorily.	ii) In closed loop system sence is always present/complete either manually or automatically
iii) Time constant of open loop system is larger due to which the Transients takes large time to die-out. Hence open loop system is slow.	iii) Time constant of closed loop system is small due to which transients dies out rapidly. Hence closed loop system is faster.
iv) The effect of external disturbance and internal parameter variation is more in open loop system. ie open loop system is more sensitive.	iv) The effect of external disturbance and internal parameter variations is less in closed loop system ie closed loop system is less sensitive.

v) Open loop system is simple & economical.

vi) Open loop system is usually stable but cannot be stabilised if becomes unstable.

v) Closed loop system is complex and expensive.

vi) Closed loop system can become unstable but can be stabalised.

Note:

* Control systems have to stable whether they are:.
  i) Linear or non linear
  ii) time variant or invariant
  iii) Static or Dynamic etc.

} Control systems has to be stable whether it may be any of the diff. systems. (L, NL, TV, TI etc).

* Stability is necessary in control system since in that condition only we can obtain steady state in which output follows input.

Note:

* No Feedback gaurantees stability or unstability, -ve F/B always gaurantees better stability than +ve F/B.
* Inspite of presence of -ve feedback control system can still become unstable due to HIGH OPEN LOOP GAIN; HIGH TYPE NUMBER; HIGH SENSITIVITY; HIGH TRANSPORTATION DELAY or LAG PHASE.

i) high open loop gain
ii) high type number.
iii) high sensitivity.
iv) High transportation delay or Lag phase.

* Differences blw the Performance of -ve & +ve Feedback closed loop system:

Performance Criteria	-ve F/B	+ve F/B
i) Gain → Product const	↓	↑
ii) BW	↑	↓
iii) Time Constant	↓	↑
iv) Speed.	↑	↓
v) Sensitivity	↓	↑
vi) Stability.	↑	↓

Note!:

To analyse the control systems we have 2 standard models. They are:

1) Transfer function model.
2) State model. (latest model 1960).

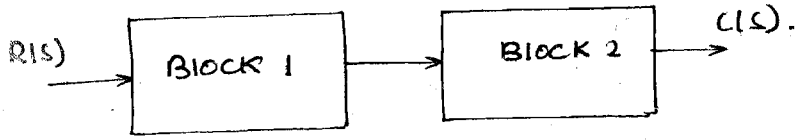
*Transfer function:
Ratio of laplace xform of the output and input with initial conditions zero.

*BLOCK DIAGRAM REPRESENTATION!:

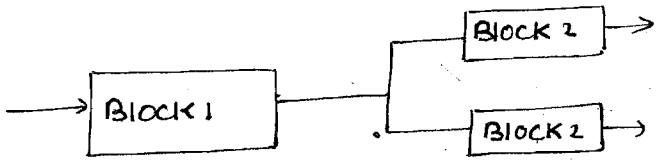
Standard Topologies!:

i) Series / cascade connection
ii) Parallel / Feed forward connection.
iii) closed loop / feedback / canonical connection.

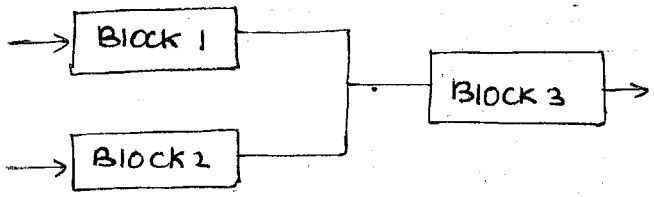
i) series / cascade connection:



one to one.

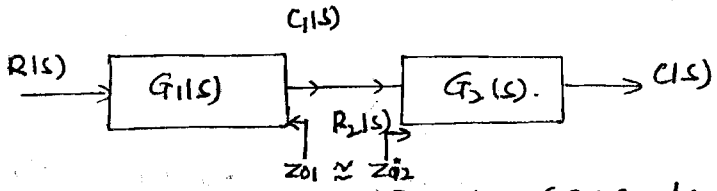


one to many



Many to one.

Note:-



✓i) $R_2(s) = C_1(s)$ → Non interactive cascade (no loading effect).

×ii) $R_2(s) \neq C_1(s)$ → Interactive cascade (not possible to find TF by BDR but can be found out by electrical network representation

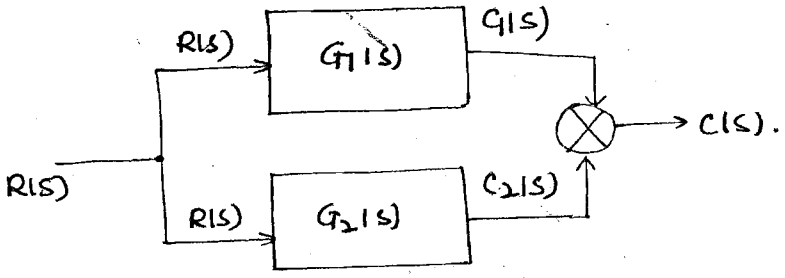
$$C(s) = G_2(s) R_2(s)$$

$$C_1(s) = R(s) G_1(s).$$

$$C(s) = G_2(s) \cdot G_1(s) R(s)$$

$$\boxed{\frac{C(s)}{R(s)} = G_1(s) \cdot G_2(s)}$$

ii) Parallel connection (Topology) :-



$$C(s) = C_1(s) + C_2(s)$$

$$= R G_1(s) + R G_2(s)$$

$$\boxed{\frac{C(s)}{R(s)} = G_1(s) + G_2(s)}$$

iii) Feedback / closed loop / canonical connection :-