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Subject: Control System-I
Class:-EI/EC-5th Sem.
Deptt. Of Electronics and Instrumentation Engineering

09/07

Control System

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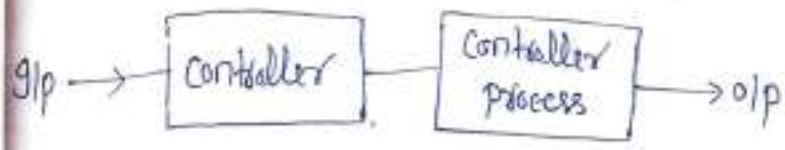
G → (20) & (20)

IES → 20 q's + (40 marks) conv.

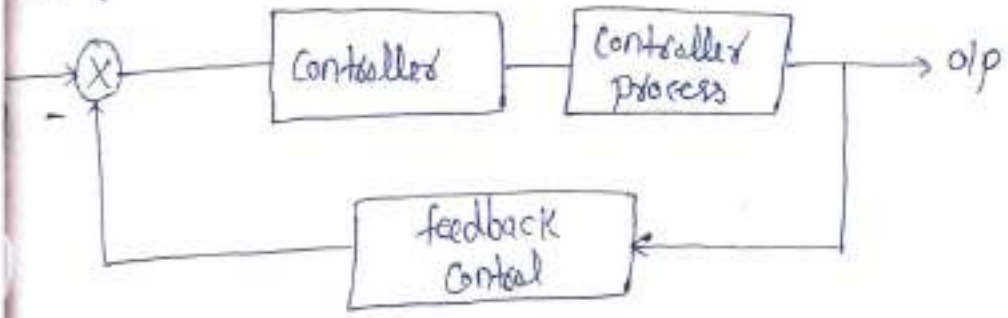
Control system → It is a combination of element arrange in manner that working of element produce best o/p for a given g/p.

(i) open loop control. system.
(ii) close loop control. system.

i) O.L.C System →



C.L.C System →



Characteristic of open loop :→

1) It has no Effect of control action.
2) It is more stable than ~~control~~ close loop.
3) It is less accurate than close loop.
4) construction is simple & cheap.

Effect of noise is direct in case of open loop.

Characteristic of close loop:-

(i) Higher accuracy

ii) complex structure

iii) Less Stable than open loop

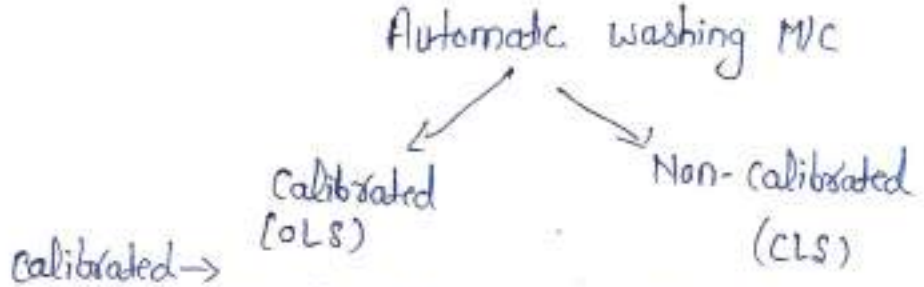
iv) Less Effect of disturbance on noise.

v) Close loop system are more Linear than open loop beca of Ext. disturbance is less as o/p depend on g/p.

Example:-

(i) Traffic light is an Ex. of open loop Control System.

(ii) All Automatic System Except calibrated one are close loop System.



Calibrated-> If amount of detergent, water, bleach and temp of water and cycle time are calibrated by Manufacture then this is known as open loop control System.

Non-calibrated-> If all Mention parameter can be adjusted by M/c itself then it is known as close loop control System.

firm ware → blw H/D & Soft ware

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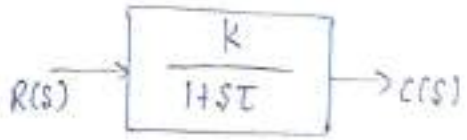

$$\frac{C(s)}{R(s)} = \frac{K}{1+s\tau} \quad \text{— O.L.C.S}$$

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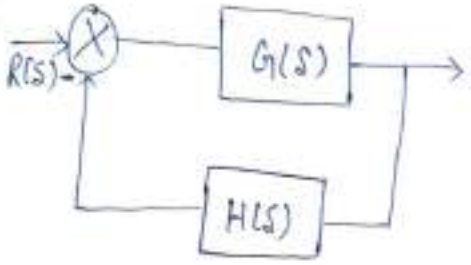
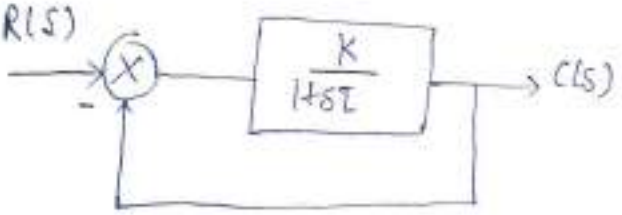


$$\frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)H(s)}$$



$$\frac{C(s)}{R(s)} = \frac{K/1+s\tau}{1+K/1+s\tau}$$

$$= \frac{K}{1+K+s\tau}$$

$$= \left(\frac{K/1+K}{1+\frac{s\tau}{1+K}}\right)$$

$$= \frac{K'}{1+s\tau_c} \rightarrow \text{C.L.C.S.}$$

Q. What is the Band width of

$$\frac{C(s)}{R(s)} = \frac{K}{1+s\tau}$$

Soln $\quad \frac{K}{\sqrt{2}} = \frac{K}{\sqrt{1+\omega^2\tau^2}} \Rightarrow \omega^2\tau^2 = 1 \Rightarrow \boxed{\omega_b = 1/\tau}$

B.W is the range of freq. at which O.L. gain reduces to $\frac{1}{\sqrt{2}}$ of its value at $\omega = 0$.

Q. What is B.W of O.L.C. system given by

$$\frac{C(s)}{R(s)} = \frac{1}{s+1}$$

A) 1 rad/sec. B) 0.5 rad/sec.

C) 2 rad/sec. D) 4 rad/sec.

$$\frac{1}{\sqrt{2}} = \frac{1}{\sqrt{1+\omega_b^2}}$$

$$1+\omega_b^2 = 2$$

$$\omega_b^2 = 1$$

$$\omega_b = 1 \text{ rad/sec.}$$

Q. B.W of C.L.C System of above pbm.

$$\frac{C(s)}{R(s)} = \frac{1/(s+1)}{1+\frac{1}{s+1}}$$

$$= \frac{1}{s+2}$$

$$\frac{1}{2\sqrt{2}} = \frac{1}{\sqrt{\omega_b^2+4}}$$

$$\omega_b^2+4 = 8$$

$$\omega_b = \sqrt{4} = 2 \text{ rad/sec.}$$ Ans.

Q. presence of feedback in control system

a) (↑) Accuracy & (↓) B.W.

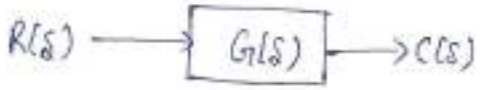
b) (↓) B.W & (↑) distortion

c) (↑) Effect of Non-linearity & reduce distortion

d) Reduce distortion & (↑) B.W. (✓)

Sensitivity

O.L.S.



S_G^M → Sensitivity of M. w.r.t. G.

$$\frac{\partial M/M}{\partial G/G}$$

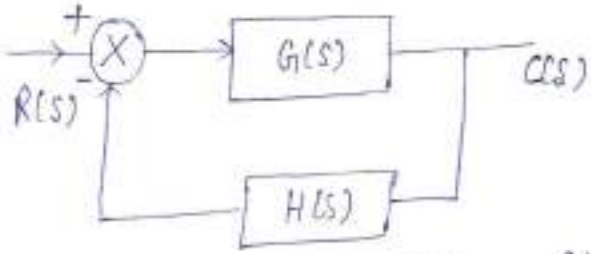
$$M = \frac{C(s)}{R(s)} = G(s)$$

$$= \frac{\partial M}{\partial G} \times \frac{G}{M}$$

$$= 1 \times 1 = 1$$

Means Sensitivity of OLS is 100 %

C.L.S.



M → transfer fn.

S_G^M = ??

$$M = \frac{C(s)}{R(s)} = \frac{G(s)}{1 + G(s)H(s)}$$

$$= \frac{\partial M}{\partial G} \times \frac{G}{M}$$

$$= \frac{1}{1 + G(s)H(s)}$$

Transfer function calculations

↓

$$(T/F)\,f^{n} = \frac{C(s)}{R(s)}$$

Transfer f°. of LTI (Linear time Invariant) is ratio of Laplace transform of o/p and Laplace transform of i/p assuming initial conditions are zero. i.e, System is at rest & No memories is present. This concept is not valid for Non-Linear and time varying System.

Q. IES 07 Initial condition for a system as inherently zero, what does it physically means?

A) System is at rest but Store Energy

B) System is working but does not store Energy.

C) System is at rest & no energy is stored in any of its parts. (✓)

D) System is working with zero reference i/p

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pole-zero Exploration:-

$$\frac{C(s)}{R(s)} = \frac{K(s-z_1)(s-z_2)(s-z_3)\cdots}{s^n(s-p_1)(s-p_2)(s-p_3)\cdots} = \frac{K(s-3)(s+2)}{s^2(s-1)(s-2)}$$

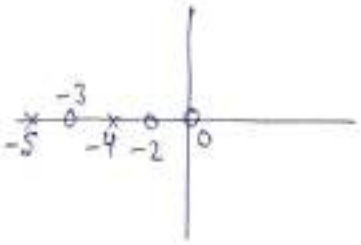
type of the system:- i.e value of n. type → 2

order of the system:- i.e order of Dr. order → 4.

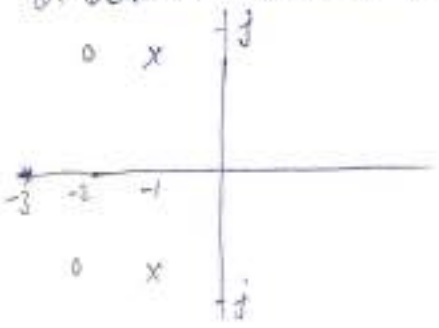
$z_1, z_2, z_3 \cdots$ Zeros

p_1, p_2, p_3 are poles

$$H(s) = \frac{s(s+2)(s+3)}{(s+4)(s+5)}$$, type → 0, order → 2



Q. Determine transfer fn of given pole-zero diagram.



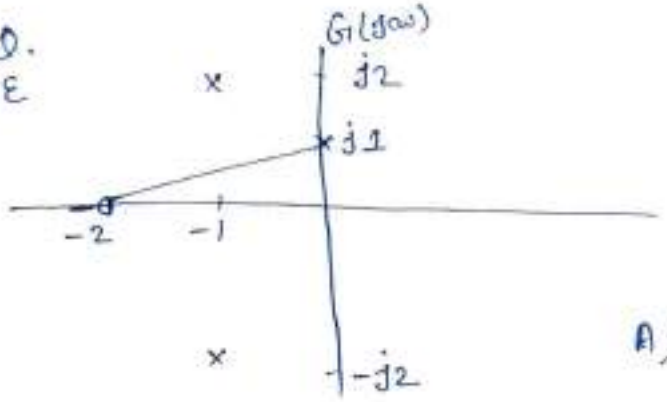
Soln $p_1 = (-1+j), (-1-j) = p_2, \quad p_3 = -3$

$z_1 = -2+j, \quad z_2 = -2-j$

$$TF = \frac{(s-z_1)(s-z_2)}{(s-p_1)(s-p_2)(s-p_3)}$$

$$= \frac{(S+2-j)(S+2+j)}{(S+1-j)(S+1+j)(S+3)} = \frac{(S+2)^2+1}{(S+3)((S+1)^2+1)}$$

Q. GATE



What is value of T/F at $S = j1$.

$G(j1) = ??$

A) $\frac{1}{2}\angle 0°$ B) $2\angle 45°$

C) $2.7\angle 31°$ D) $2\angle 64.4°$

Soln

$p_1 = -1+j2$, $p_2 = -1-j2$, $p_3 = j1$

$z_1 = -2$

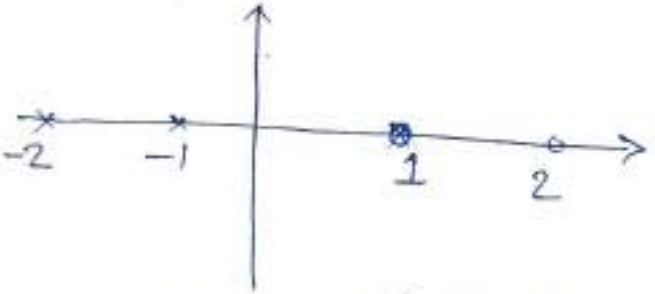
$$T/F = \frac{(S+1-j2)(S+1+j2)(S+j1)1.(S+2)}{(S+1-j2)(S+1+j2)}$$

$$= \frac{S+2}{(S+1)^2+4} = \frac{S+2}{S^2+1+2S+4} = \frac{S+2}{S^2+2S+5}$$

$$\frac{2+j1}{(j1)^2+2(j1)+5} = \frac{2+j1}{2j+4}$$

$$= \frac{(j+2)}{2(j+2)}$$

Q.

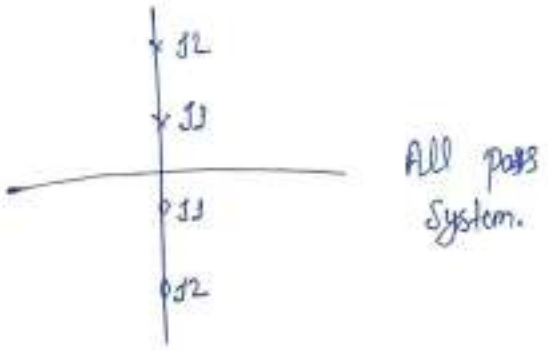


- All Pass System.

$$T/F = \frac{(S-1)(S-2)}{(S+1)(S+2)}$$

$$\frac{\sqrt{\omega^2+1}\ \sqrt{\omega^2+4}}{\sqrt{\omega^2+1}\ \sqrt{\omega^2+4}} = 1$$

If poles & Zeros are Equal dis. from origin then this system is called as all pass system & in this case there is no change in Magnitude & only change in phase.



#Min. phase & Non-Min. phase:- If both poles & Zero's are at L.H.S. then H is called as Min. phase. otherwise Non-Min. phase. (Reverse of Min. phase).

Q. Non. Min. phase transfer fn. can be defined as

A) which have pole in left half S-plane

B) which " " & Zero in left half.

C) " " in Right (↓)

d) which has poles at origin.

Q. which Statements are true ~~for~~ about Min phase

1) All pole should lie in left half of S-plane

2) Zero of transfer fn. can lie anywhere. in S-plane

A) 1 (↓) B) 2

C) 1,2 D) None