DIGITAL EDUCATION
MARTCOST

ELECTRONICS ENGINEERING DEPARTMENT

Controls Notes

Hand Notes For Electronics Engineering Department

HAND NOTES

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DATE : May. 20, 2007.

EE

7.00 - 1.00 ⇒ Control systems → Hall 7

2.30 - 8.30 ⇒ Digital electronics → Hall 7.

21-05-07

CONTROL SYSTEMS → 15 Marks.

1. Nagrath & Gopal.
2. B.C. Kuo
3. IES / IAS papers G.K. publishers.
4. A.K. Jairath

→ T/f, Block diagram, signal flow — 2 M

→ Time Domain Analysis → 4 M {f/b changes the location of poles.

→ stability → 4 to 6 M } → for closed loop [RH / RL / BPIND]

→ Compensators (PID controller) → 2 M

→ state space Analysis → Multi i/p, Multi o/p. 2 to 4 M

(Ogata)

Transfer functions

→ order of the system → no. of (or) one time constant storage elements

T/f is a mathematical equivalent Model for a system.

* T/f valid for → Linear time Invarient (LTI) { Time domain specifications }

TDA → to knows about the performance of the system. w.r.t. time.

→ for unbounded signals we donot find the stability ↓ ramp

State space Analysis for → Dynamic systems [linear / Non-linear / time varient / Invarient]

→ -ve f/b → poles shifted to left

+ve f/b → poles shifted to right

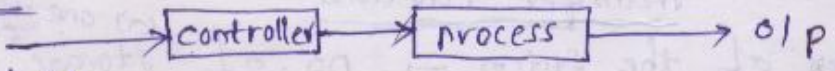
→ In closed loop systems if order of the system is very high, it is difficult to find roots of T/f. so we use

* RH → char. eq to find CL. stability ← RH, RL/BP/NP
* RL / BP / NP → OL
* order → NP, RL, BP, RH.

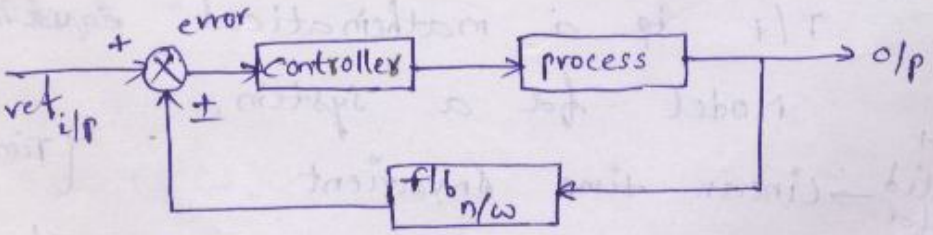
⇒ Control system: It is an arrangement of group of phy. components in such a way that it gives the desired o/p by means of controller. either direct method or indirect.

→ Based on the controller action, control systems — OL system, CL system.

OLCS :-



CLCS :-



OLCS :- A system in which the controller action is indc. of o/p. Eg :- fans, heater. normal, iron box, traffic lights

Eg :- Any system which not sense the o/p.

CLCS :- The controller action is totally depends on o/p. Eg :- Any m/c with Automatic which sense the o/p. [Refrigerator, iron box automatic

⇒ f/b n/w :- It is nothing but a transducer which converts energy from one form to the another form.

* It consists passive elements R, L, C. The max. value of f/b n/w ratio is one.

⇒ f/b is the property of the CL system which brings the o/p to the ~~with~~ accept i/p ~~is~~ to compare with ref i/p and generates error signal, then the controller is adjusted such that error becomes zero.

⇒ T/f :- It is a mathematical equivalent model for the system.

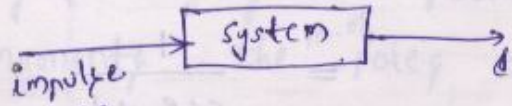
DEF: A T/F of a Linear time Invariant (LTI) is defined as ratio of L.T o/p to L.T i/p. with all initial condi.s are zero.

(Low pass → Integrator)

Linear Systems → Transfer function

Non-linear → Decribing function

DEF 2: A T/f of a LTI, is also defined as L.T. of Impulse response with all initial condi.s are zero.

* 

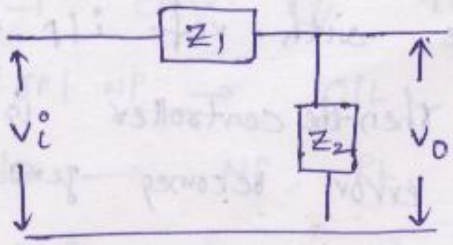
↓

{ Natural response or actual system response or free response.

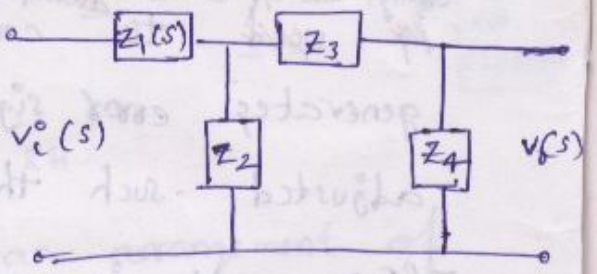
* for, Ramp, step → forced response. forced response.

⇒ T/f → Electrical n/w
→ Differential eq.
→ Signal response

↳ Electrical n/w :-



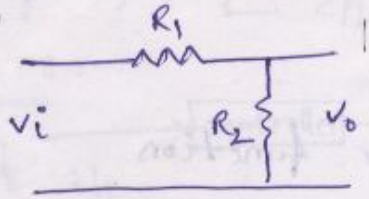
$$\frac{V_o(s)}{V_i(s)} = \frac{Z_2(s)}{Z_1(s) + Z_2(s)}$$



$$\frac{V_o(s)}{V_i(s)} = \frac{Z_2(s)\cdot Z_4(s)}{Z_1(s)\left[Z_2(s)+Z_3+Z_4\right] + Z_2\left[Z_3+Z_4\right]}$$

Q. find the T/f for the following :-
and represent poles and zeros in s-plane.

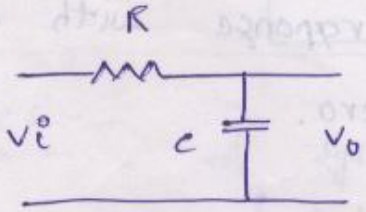
(i).



$$\frac{V_o}{V_i} = \frac{R_2}{R_1 + R_2}$$

↑
* attenuation factor
[No poles & zeros]
because no storage element

(ii).



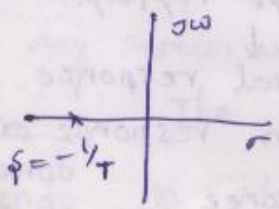
$$\frac{V_o}{V_i} = \frac{1/cs}{R + 1/cs}$$

$$= \frac{1}{scR + 1}$$

take $\tau = RC$

$$= \frac{1}{s\tau + 1}$$ (first order)

standard form



* A pole is nothing but -ve of inverse of system time constant at which the magnitude of T/F is infinity

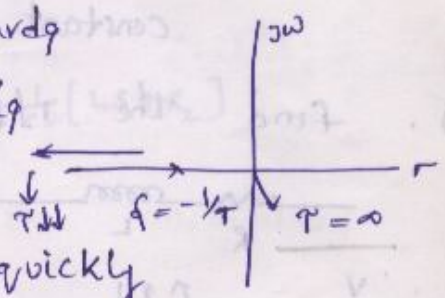
* → Behaviour of the system is given by τ.

* If τ ↑, (large) system response is slow.

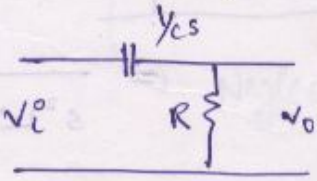
* τ at origin is infinity.

→ τ is nothing but -ve of inverse of dominent pole location $\tau = -1/\text{pole}$.

* As the pole moves towards to the left, the τ is decreased and system reaches steady state quickly and becomes more stable.



(iii).



$$T/F: \frac{v_o}{v_i} = \frac{R}{R + 1/Cs}$$

$$= \frac{CsR}{sCR + 1}$$

Let $\tau = RC$

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

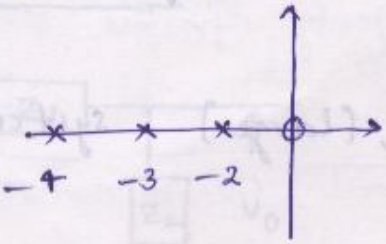
* By changing the position of components the no. of poles are

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

same and position also same but the no. of zeros changes and position changes.

⟹ A zero is -ve of inverse of system time constant at which magnitude of T/f is zero.

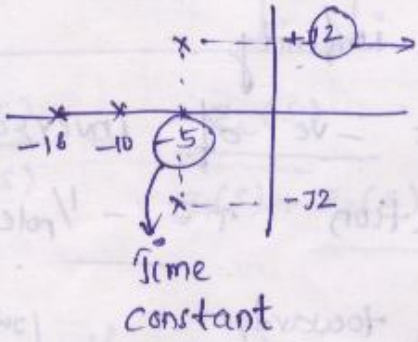
(iii). findout time constant,



$\tau = -1/(-2)$

$= 0.5$

(iv).



(v). find the T/f. 2 storage elements → 2 order.

$V(s) = I(s)\left[R + sL + \frac{1}{sC}\right]$

$T/f = \frac{I}{V} = \frac{1}{R + sL + \frac{1}{sC}}$

$= \frac{sC}{s^2LC + sCR + 1}$

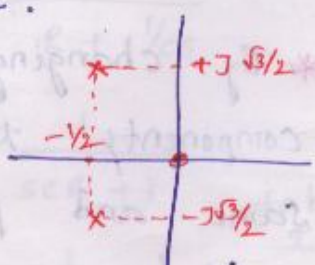
Let $L = 1H$

$C = 1F$

$R = 1\Omega$

Then locate poles & zeros. and explain what type of response.

$\frac{I}{V} = \frac{s}{s^2 + s + 1}$



Time constant = 2

freq of oscillation = $\frac{\sqrt{3}}{2}$ rad